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Environment and Health

Problems of environmental health in the United States and the Public Health Service programs which aid States and communities in their efforts to solve such problems

FEDERAL
SECURITY
AGENCY

Public Health Service

1951

TO THE men and women of this generation, it has become apparent that the capacity of the individual to improve the condition of life on this earth is realized only to the degree that the individual understands evolving environmental forces. It is fitting therefore that the Public Health Service has prepared this book to describe the relation of fundamental environmental forces to the health and comfort of present and future generations.

This publication endeavors to advance the knowledge and competence of those, including members of the Public Health Service, who have hopes of a world healthier and happier than men have known before. It seeks also to describe the respective activities of those engaged in these fields.

In its concept, objectives, and functions, therefore, it is a valuable book. I commend it to the attention of all who are interested in public health, as students, technicians, administrators, educators, patrons, or citizens.

Oscar R. Ewing

Federal Security Administrator.

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Contents

WHILE THIS book was being written, the President declared a national emergency. For the duration of this emergency, the Public Health Service, like every other organization in our Nation, must assess all its activities in terms of their contribution toward critical national objectives. In addition to surveying the long-term prospect of improving the public well-being, it is necessary now to direct our gaze at the short-term security problems that lie immediately before us. The intensity of these problems will determine what measures that are dedicated primarily toward improving the environment must be pressed and what measures must be deferred.

Many environmental changes, by improving the public health, increase the productive power of the American people and strengthen their resistance to stress. Such changes now are more desirable than ever, because American strength and production are essential to national security and world peace.

Leonard A. Scheele

Surgeon General, Public Health Service.

The Changing Environment

THIS CHAPTER begins a book, ENVIRONMENT AND HEALTH, that deals chiefly with the *modern* environment as it affects *public* health.

The *modern* environment contains, in addition to eternal mysteries, certain forces and processes which have been identified in relatively recent times. Physicians, engineers, and other health workers have had the privilege of dealing with these forces and processes so as to influence or control them in the interest of public health. This book tells of some of their trials and triumphs.

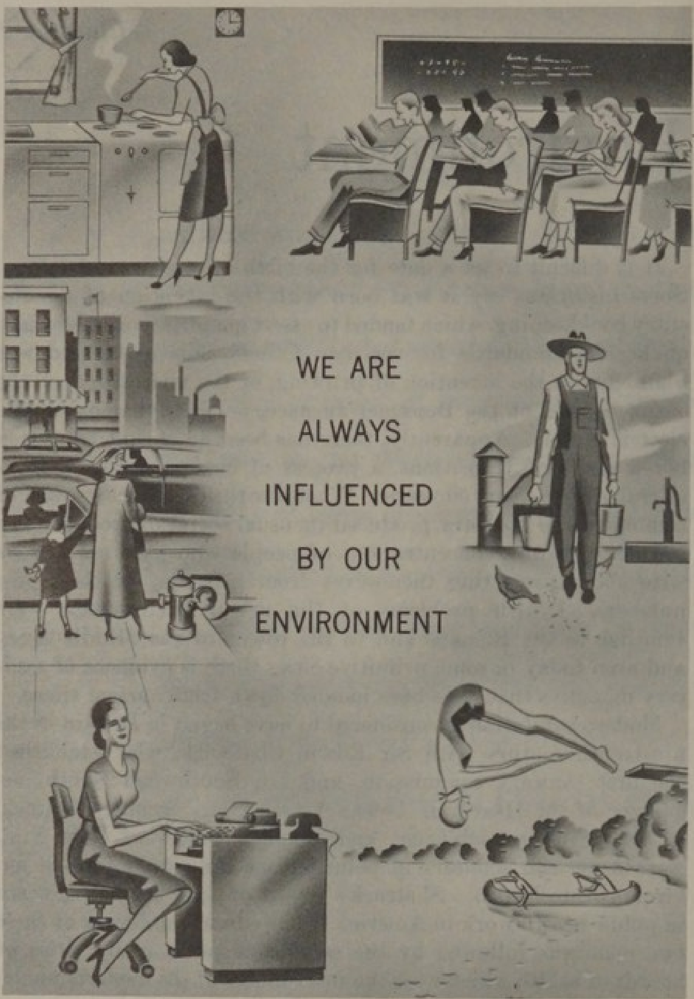
As noted above, the object of concern here is less individual or personal health than *public* health, the total health of the total population in the total environment. It is a characteristically American concept that the health of the individual, high or low, is held to be not ordinarily separable from the health of his neighbors and his physical environment. And it is characteristically American, also, to seek such environmental change as will promote health, individual and community alike.

Although the book emphasizes activities of the Public Health Service, it is hoped that the text will keep the reader mindful that many organizations—international, national, State, local, some public and some private—join in seeking to improve the condition of man on earth.

The concept that men may change the environment so as to improve the public health is not new. The chief novelties in the modern concept of environmental health are that we have a surer knowledge of our relation to our surroundings, and that modern technology is different from that of the ancients.

It is difficult to set a date for the birth of modern technology. Some historians say it was born with the invention of double-entry bookkeeping, which tended to assert quantitative rather than qualitative standards for society. Others believe the seed was planted with the invention of printing, or the microscope, or the steam engine, or the Bessemer furnace, or the dynamo and the electric motor. Apparently, there has been no abrupt transition but a series of transitions, a process of change, which has accelerated in the past 50 years. Whatever the cause, the growth of commerce and industry produced its usual social byproduct: The growth of towns, concentrations of people who were not always wise about protecting themselves from infection by their own numbers. Health problems of the urban environment were familiar to the Romans and to the towns of the Middle Ages, and even today in some primitive cities there is evidence of sanitary measures that have been handed down from ancient times.

Modern sanitation is considered to have begun in Britain in the nineteenth century with Sir Edwin Chadwick, who established the first sanitary commission, and Dr. Southwood Smith, organizer of the Health of Towns Association. Lemuel Shattuck, a Massachusetts publisher, and Stephen Smith of New York were American pioneers in pointing out the significance of environment to health. Shattuck's report of 1850 began a new era in public health work in America. The educational work of these two men was followed by the establishment in many cities of boards of health which were the forerunners of the modern municipal health department.



With only a vague knowledge of the origin and the mode of transmission of disease—the germ theory was not then established—these men had to lean upon common sense to guide them. Observing that certain types of illness were most prevalent where a certain water supply was used, where certain food was eaten, where certain vermin abounded, where certain living conditions were common, they undertook to correct conditions associated with disease, and incidentally they reduced the numbers of many disease organisms. For the most part, they obeyed the old precept of the Massachusetts Health Act of 1797, which ordered health officers "to remove all filth of any kind whatever * * * whenever such filth shall, in their judgment * * * endanger the lives or health of the inhabitants."

At the same time, the science of bacteriology was beginning to hit its stride. In 1812, Amici of Modena had invented the first lens to correct the chromatic aberrations of the microscope that Leeuwenhoek had built more than 150 years earlier. This was a basic contribution of optical engineering. The new instrument enabled Pasteur, Koch, and others to see, identify, and classify a host of disease-bearing micro-organisms. In 1871, Weigert learned how different stains made these organisms easier to see. Koch in 1875 began to grow cultures of bacteria on plates instead of in tubes, and in 1881 he published his classic papers on tuberculosis. By the end of the century, the science of bacteriology was in full flower and it had made basic contributions to public sanitation.

Consider the water problem alone. Although slow sand filters had first been used for water purification in England as early as 1829, it was not until 1871 that Burdon-Sanderson identified bacteria in water in London. A few years later Miquel in Paris worked out a method of counting bacteria in water as a guide to its potability. In 1887, the Massachusetts State Board of Health established its Experiment Station at Lawrence, to study water purification; the same year, Plagge and Proskauer devised filters for purifying water for Berlin. The first municipal health laboratory was opened the following year in Providence. In 1890, Winogradsky isolated nitrifying organisms, and his work was confirmed at Lawrence.

In addition to these basic contributions in water sanitation, research just prior to the turn of the twentieth century had uncovered basic facts about the transmission of disease by food and various carriers. Sir Ronald Ross and Walter Reed pinned down the mode of insect transmission of malaria and yellow fever. Bacteriology made such contributions to the sanitation of milk that the process of heating milk to kill germs was named for Pasteur.

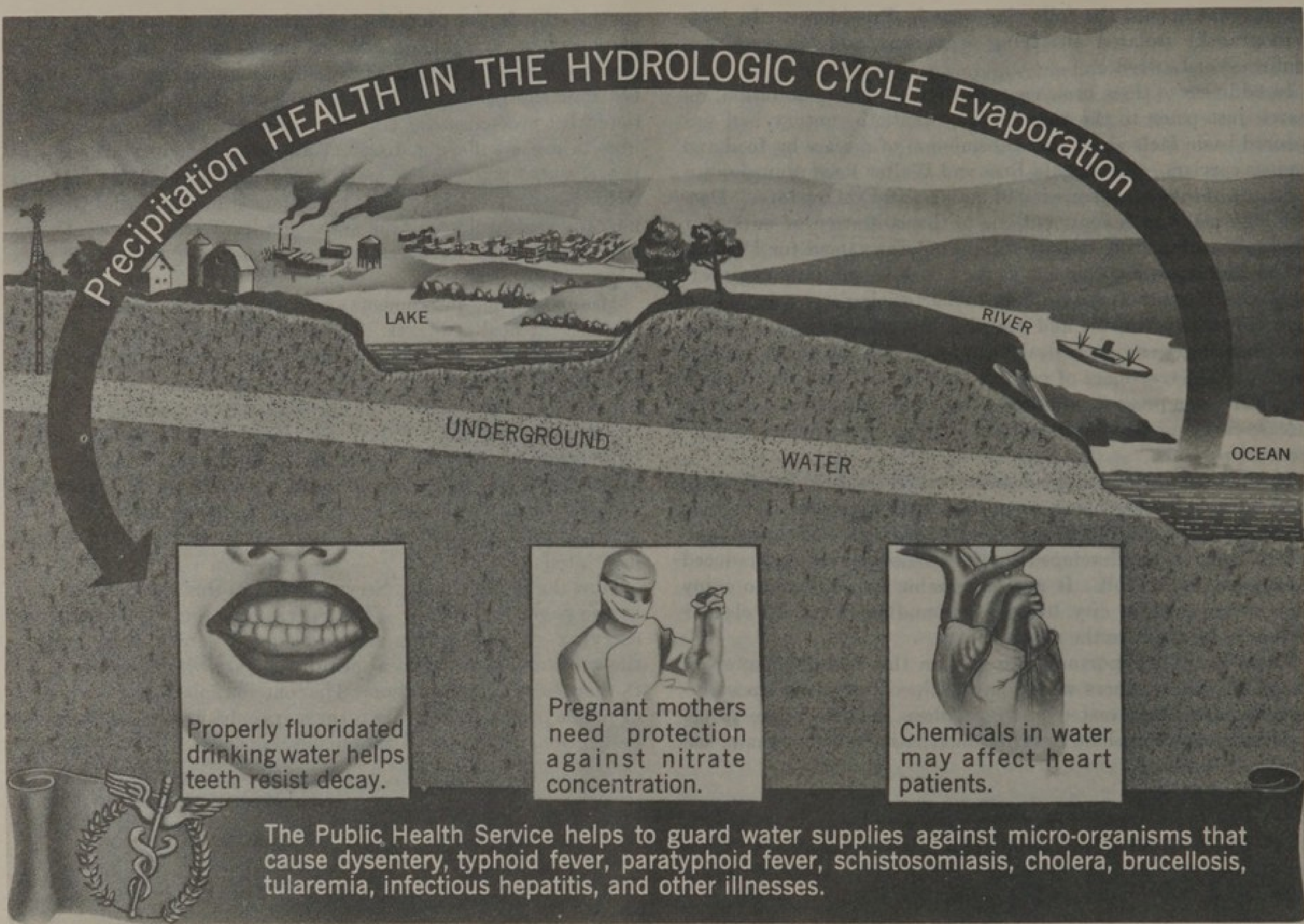
The Lawrence Experiment Station was to sanitary engineers what the Pasteur Institute was to bacteriologists: a center of knowledge, experiment, and training for the profession. And though sanitary engineers dealt primarily with the purification of water and the treatment of sewage, their special skills and knowledge were soon pressed into service for milk sanitation, control of disease-carrying vermin, industrial hygiene, and similar environmental problems.

By the turn of the century, health workers, assisted by advances in chemistry, were achieving competence to deal effectively with most epidemics. Chlorination, pasteurization, and insect and rodent control, all developed in the twentieth century, reduced infection's annual toll. It now is possible for millions to enjoy the conveniences of city life in surroundings that are cleaner and safer than ever in the past.

There is little opportunity to rest on this triumph, however. Technological advances which have helped to conquer most infections also have created other problems. These relate to occupational and household hazards; international rather than local control of infection; ionizing radiations; the stresses and strains of noise, speed, light, congestion, and associated stimuli in the modern environment; chemical contamination; food processing; environmental influences which afflict an aging population particularly; protection for travelers; application of sanitary measures in areas suffering disaster; air pollution; recreational improvements; water uses; popular education in modern health techniques; air conditioning; substandard housing; and the volume and healthfulness of the water supply. On the whole, modern problems are less bound up with *preventing sickness* than with *promoting health.*

Meanwhile, new instruments and knowledge have been developed to assist the health worker. The Delft school advanced the study of biochemistry. Fleming, Florey, Waksman, and others developed bactericidal fungi. The electron microscope expanded research in virology. DDT was applied to insects, warfarin to rats, and 2,4-D to ragweed. The World Health Organization, founded by the United Nations, established international standards for health reports. A system of examinations was introduced to survey community health rapidly and economically. And these are only a sampling of the work that is contributing to the public health today.

How the Public Health Service shares in this work is described in the pages that follow. The Service has the responsibility of carrying on, stimulating, and fostering research; of supporting the work of State and local health agencies, which bear most of the burden of administration. The contribution to date is a matter of public pride: its measure is the margin between prosperity and destitution, between civilization and barbarism.


Precipitation HEALTH IN THE HYDROLOGIC CYCLE Evaporation
LAKE
RIVER
UNDERGROUND
WATER
OCEAN
Properly fluoridated drinking water helps teeth resist decay.
Pregnant mothers need protection against nitrate concentration.
Chemicals in water may affect heart patients.
The Public Health Service helps to guard water supplies against micro-organisms that cause dysentery, typhoid fever, paratyphoid fever, schistosomiasis, cholera, brucellosis, tularemia, infectious hepatitis, and other illnesses.

Drinking Water

ON THE EVENING of September 7, 1854, Dr. John Snow proposed that the vestrymen of St. James remove the handle from the Broad Street pump. The vestrymen were dubious. All their neighbors in Golden Square in London filled their pitchers at this spout. But within the preceding 10 days, 500 of their neighbors had died of cholera. Dr. Snow said the cholera victims had taken sick from drinking polluted water. So they stopped the pump's foul flow. And cholera disappeared from Golden Square. This was the triumph of a pioneer in the epidemiology of water-borne disease.

Five years earlier, at his own expense, Dr. Snow had published his historic pamphlet, "The Mode of Communication of Cholera." His studies and his logic satisfied him and his colleagues that cholera germinated in the intestine. He was convinced that cholera attacks only those who unsuspectingly swallow a trace of the discharge from cholera sufferers or carriers. But he did not find it easy to convince others that polluted water was the main channel to carry this choleraic discharge.

In 1855, Dr. Snow obtained from the Registrar-General statistics showing 286 fatal cases of cholera. He demonstrated that in every 10,000 households served by the Southwark and Vauxhall water company, there were 71 of these deaths. In every 10,000 households served by the cleaner waters of the Lambeth Co., there were only 5 cholera deaths. But it was not until 1890, long after Snow's death, that Dr. John Simon conceded that Dr. Snow's evidence of the danger in contaminated water was "the most important proof yet acquired by medical science for the prevention of cholera."

By that time, the case against cholera was closed. But the struggle to assure a healthful water supply had barely begun.

The health qualities of the water supply today are protected by State and municipal health and waterworks personnel. They have primary concern with:

1. The presence of dangerous micro-organisms,
2. Chemicals dissolved in the water supply, and
3. The adequacy of the water supply, in volume and in quality.

MICRO-ORGANISMS IN WATER

The Public Health Service today seeks to identify and attack all micro-organisms that imperil the public health. Research has put its finger on most of the causes of water-borne epidemics of:

Cholera
Typhoid fever
Paratyphoid fever
Dysentery
Schistosomiasis
Gastroenteritis

Research teams are studying contaminated water as a possible source also of undulant fever (brucellosis). They have found that water may carry *Pasteurella tularensis* of rabbit fever (tularemia). And they have traced to contaminated water the virus that causes outbreaks of jaundice (infectious hepatitis). Many other problems of virology are subjects of research in this relatively new and unknown field.

There is no peace in this microbe war. From 1938 to 1948, it was reported that water-borne infections broke through our defenses at least 408 times, striking 128,950 persons, killing 91. Many other instances of infection were not reported. For example, water carries the parasite that causes amebiasis, including amebic dysentery. This parasite is found generally in the United States, and surveys indicate that as many as 5 to 10 persons in every 100 harbor the organism. These figures are the more startling when it is realized that many cases of amebiasis escape professional detection. The organism plays a hard game of hide-and-seek with investigators, and its effects often defy diagnosis.

The worst of America's water-borne killers was typhoid fever. Only 50 years ago, when the science of water treatment was already somewhat advanced, 10 States reporting to the Federal Government showed that typhoid and paratyphoid fevers each year killed 31.3 out of every 100,000 in the population. Today, typhoid fever is so rare as to be almost unknown, and that triumph gives promise that other water-borne micro-organisms and virus diseases likewise can be conquered.

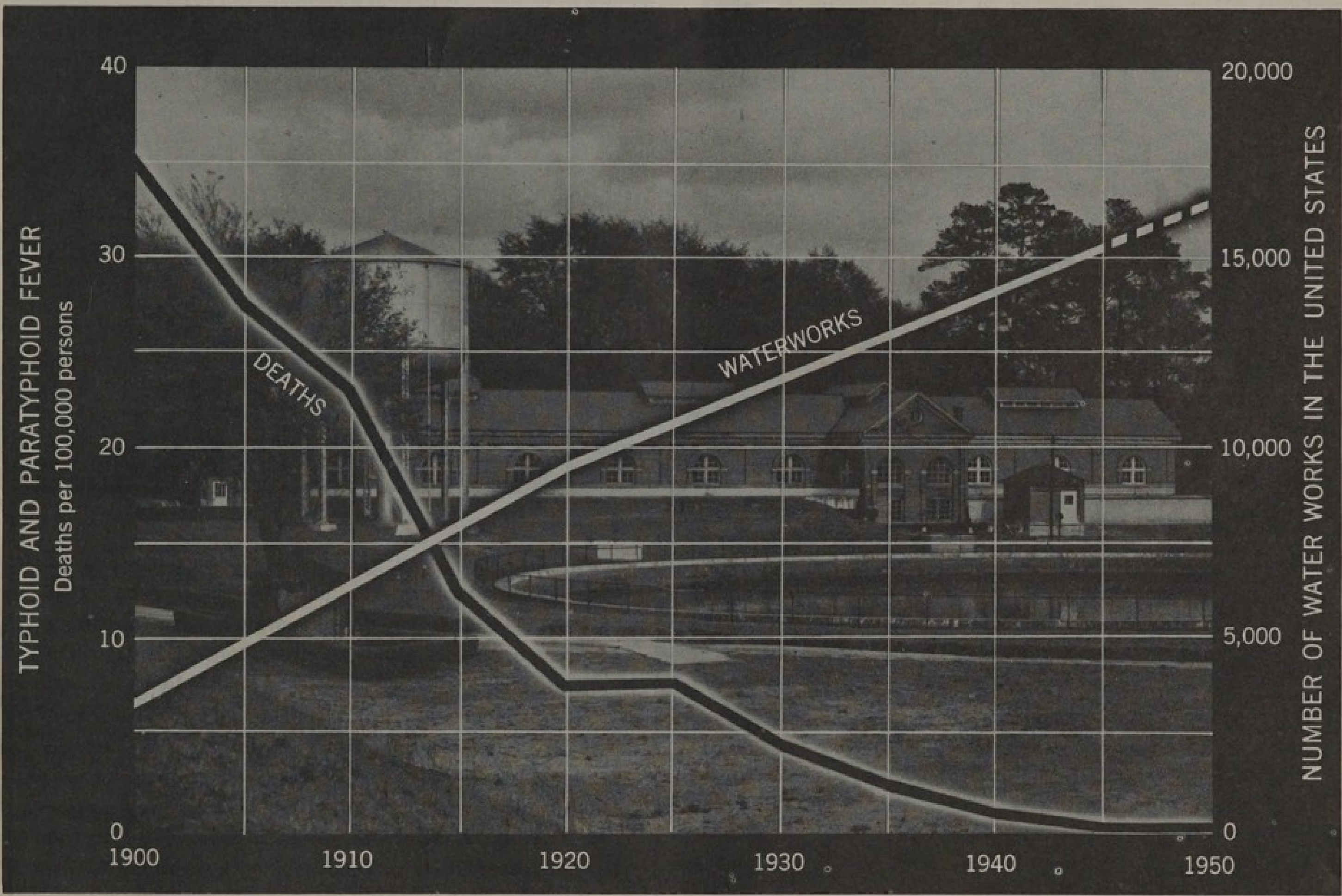
CHEMICALS IN WATER

The *Public Health Service Drinking Water Standards* names the chemicals that are toxic in given concentrations in water and specifies the maximum concentrations that are tolerable.

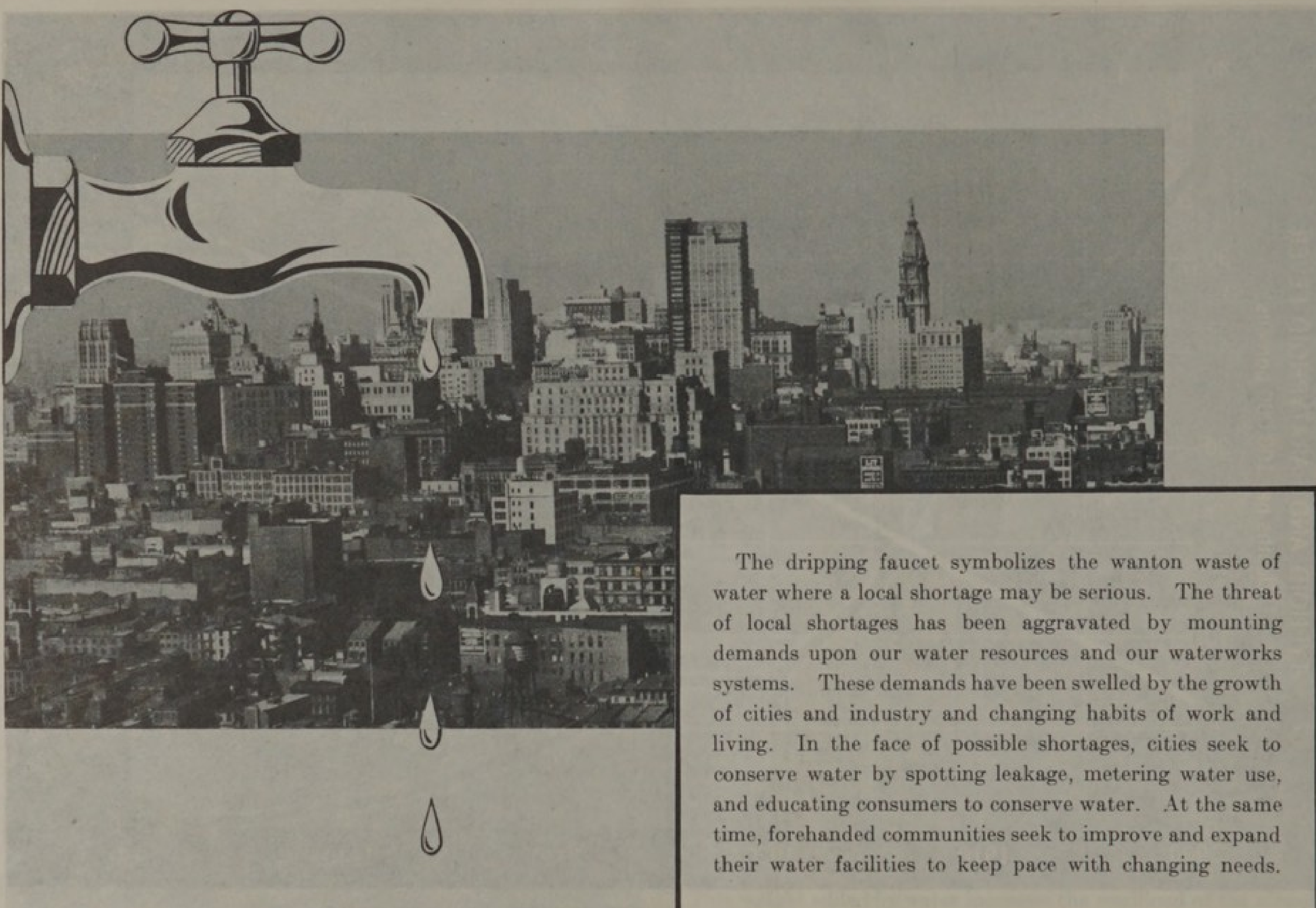
Fluorides, for example, occur in high concentrations in some waters of the Nation. Drinking such water may produce a condition known as "mottled enamel" (fluorosis). Investigations of fluorosis, on the other hand, led to the knowledge that drinking water with low concentrations of fluorides (1 part to 1,000,000 parts of water) helps to defend the teeth against decay. Although the margin between a harmful and helpful amount of the fluorides is narrow, it has been demonstrated that children who drink properly fluoridated water have 65 percent fewer cavities in their teeth than they would otherwise, and suffer no ill effects.

The tragedy of infant cyanosis, or "idiopathic" methemoglobinemia, has been laid to a high concentration of nitrates in well-water. This hypothesis, supported by later investigation, was first offered in the United States as recently as 1945 by Dr. H. H. Comly, University of Iowa pediatrician. In 18 months, in Iowa alone, epidemiologists found 139 cases. Of those affected, 10 percent died.

Everyone who is concerned with a heart condition—common enough in an aging population—may benefit from recent investigations of the effects of sodium in the diet. Sodium makes the body retain water. A healthy person throws off the sodium and water in his diet as rapidly as necessary. But a heart patient has difficulty in eliminating sodium and tends to put on weight in the form of water with an ordinary amount of sodium in the diet. This weight added by water increases the workload of the already weakened heart.



As public water works systems in the United States have increased in number, deaths from typhoid fever have declined.



The dripping faucet symbolizes the wanton waste of water where a local shortage may be serious. The threat of local shortages has been aggravated by mounting demands upon our water resources and our waterworks systems. These demands have been swelled by the growth of cities and industry and changing habits of work and living. In the face of possible shortages, cities seek to conserve water by spotting leakage, metering water use, and educating consumers to conserve water. At the same time, forehanded communities seek to improve and expand their water facilities to keep pace with changing needs.

For this reason, the physician tries to limit the amount of sodium in the diet of certain heart patients. If the patient is on a practically salt-free diet, it would be useful to know how much sodium the patient takes in with his drinking water. It might be a practical advantage to the physician in treating such patients to know accurately the proportion of sodium in the local water system. With such information, the physicans may measure with some precision the chemical balance of the diet. The chemistry of water thus once more offers striking possibilities of collaboration between the sanitary engineer and the medical profession.

ADEQUACY OF SUPPLY

In the entire United States in 1900, there were 3,200 public water supplies serving almost every village of more than 2,000 residents. But the palatability of the water was poor; its safety was doubtful. Fewer than 2,000,000 people were served a supply of filtered water. That year, 23,000 men, women, and children in this country died of typhoid fever; more than 100,000 were killed by infectious enteric disorders. Contaminated drinking water caused many of these deaths.

In 1945, more than 16,000 public water supplies in the United States served 100,000,000 consumers, more than two-thirds of the population. The foundations of a first-line defense against contamination had been built upon filtration (introduced into the United States about 1870) and chlorination (introduced here about 1908). As rapidly as water purification measures were adopted, water-borne typhoid fever disappeared. Even so, today there are still 5,700 communities with a combined population of 2,500,000 which lack a public water works system. In rural areas, an additional 27,000,000 people need improved water systems.

Production of radioactive materials by the Atomic Energy Commission has introduced to the water works fraternity several chemical problems so new that they are still to be identified. One cluster of these problems is related to the disposal of radioactive waste. A minute amount of radioactive ions in the drinking water may be harmful. The public health worker is taking steps to see that radioactive wastes do not concentrate where they can be damaging.

Investigations of the chemistry of water assure us that absolutely pure water never occurs in nature. Water ordinarily contains an assortment of dissolved gases, minerals, and other chemicals. It also may contain matter which is not dissolved but suspended, such as dirt, micro-organisms, and other contaminants. Surface water, captured in lakes, streams, and cisterns, does not usually contain as many dissolved chemicals as underground water holds. Underground water, thanks to the natural processes of filtration and percolation, is relatively free of suspended matter, but contains a relatively high proportion of soluble chemicals. More than 10,000 wells and 1,500 springs are used in the United States for public water supplies. About 7,000,000 farm dwellings obtain their water from wells and springs. Because of this wide use of underground water, the public health worker has a far-reaching interest in the character of the chemicals that water contains in solution.

The uses of water have increased with our industrial progress. Use of the public water supply has grown from about 90 gallons a day per capita in 1890 to more than 135 gallons a day. This includes only a small part of the industrial uses. Air-conditioning, automatic laundries and dishwashers, garbage disposal units, irrigation, and growing industries have levied new demands upon our water resources. The United States Geological Survey in 1948 indicated that municipal systems used 12,000,000,000 gallons of water daily; rural consumers used 3,000,000,000, private industry used 70,000,000,000, and irrigation used 95,000,000,000. Against this total national use estimated at 1,200 gallons a day per capita, we have almost 10,000 gallons per capita available for development from surface sources. But serious local water shortages can take no comfort from this national surplus.

During the drought of 1949–50, in the city of New York it was illegal to wash a car with city water. Buildings turned off their air-conditioning plants. The mayor asked citizens to observe "Dry Thursday" each week by refraining from shaving or bathing. Many restaurant managers refused to serve water with meals. All this happened because the city used more water than its reservoirs could gather.

To offset local shortages, communities may improve both their conservation and their planning programs. Waste surveys, water metering, and public education help to reduce extravagant uses of water. Metering alone, by making the user conscious of leakage and waste, may reduce water waste substantially. But the major need is to provide for the economical supply and use of water in advance of impending shortages, to keep pace with the growth of industry and the community. The President's Water Resources Policy Commission in December 1950 published a statement of principles to guide such conservation activities.

Whether the water system be large or small, the pattern of good management is always the same. That pattern aims to furnish at all times a safe and palatable supply of water at the least possible cost consistent with the services rendered. The system should be so flexible and so expansible that it can readily adjust to the changing needs of the community.

DEFENSE OF THE WATER RESOURCE

Despite rapid and continuing advances in the science of water purification, facilities for purification have not kept pace with the load imposed by the growth of our cities and our industry. For the lack of a common effort to stop the pollution of water supplies at the source of pollution, sanitary engineers have found it necessary to draw a strong line of defense between the users of water and its abusers.

The water that approaches these defense lines may be treated for clarity, palatability, usability, and other factors, but the main interest of the public health worker is to screen out the threat

Faulty plumbing in office, home, factory or school is a weak point where germs may enter the water supply. Drinking water must be protected all the way from the reservoir to the tap.

of disease. For this reason, research has evaluated the processes of water purification with regard to their efficiency in protecting health, and the Public Health Service has used such studies to set up criteria that, if observed, should assure that today's water supply will be potable. The defense lines which bar noxious substances from the water supplied to the consumer may include aeration, sedimentation, coagulation, filtration, disinfection, and many other processes. Each of these processes does a particular job of its own. How well the job is done is often literally an issue of life and death.

Although most of these processes have been used for years, there seems to be no end to the study of them. Chlorine, for example, has been used for more than 40 years to disinfect water, but it is still not certain how it does its work of destroying germs. The precise chemical relation between water and chlorine has been determined only in the last 10 years. Basic research at several points has added to our knowledge of the use of diatomaceous earth as a filter medium. It has introduced an iodized pill, globaline, for disinfecting contaminated water. It has developed the use of chlorine dioxide to control taste and odor.

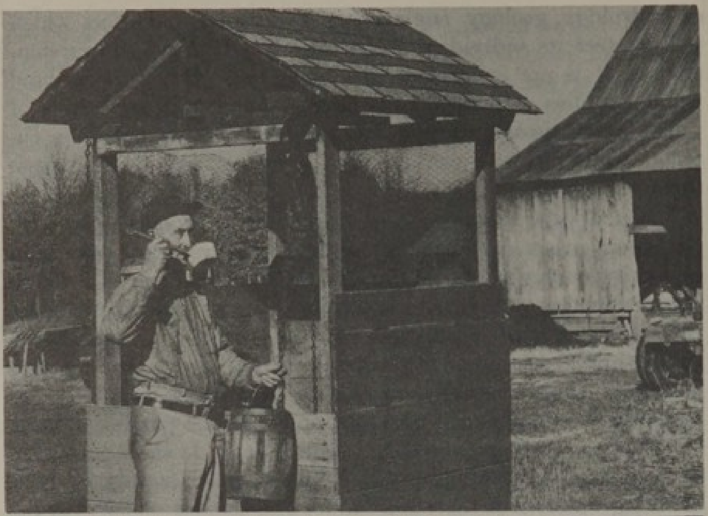
In addition to advances in chemical, physical, and biological knowledge, there have been improvements in engineering. For example, a recently constructed water plant filters water at a rate as high as 4 gallons per square foot per minute. This is exactly double the usual rate of filtration, but it is satisfactory for that particular water.

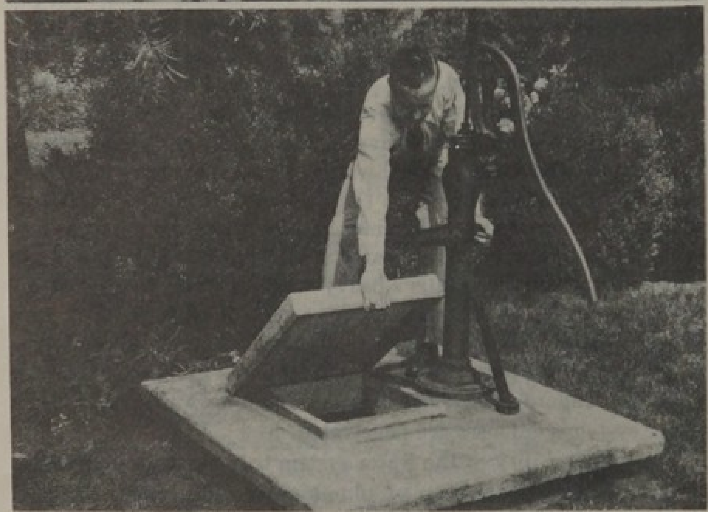
The line of defense for rural water supplies takes on aspects of guerrilla tactics. Every one of the millions of wells, springs, streams, and cisterns which supply rural and urban-fringe homes and establishments is vulnerable to contamination. A typical farm family, on a small acreage, builds its barn and animal pens close to the house, as a rule. The privy, also, is close to the house. And then, in this same confined area, the rural family digs or drills a well or taps some other nearby water supply. It is hardly to be expected that every rural family will have the knowledge of hydrology, geology, engineering, and sanitary sciences which will protect its individual water supply. Under these circumstances, it is not surprising that wells and other underground water supplies account for the largest number of outbreaks of water-borne diseases, caused for the most part by pollution entering wells. Health workers need to be eternally alert to these threats.

The city water system also has its guerrilla problem. Most of the recent urban outbreaks of typhoid and dysentery have been caused by contamination of the water *after* it had passed through the purification process and entered the mains and pipes. More than 90 percent of these cases had their source in a secondary water supply not intended for drinking. In many cities, such a secondary supply, usually taken directly from a dirty river, is introduced for industrial uses to supplement the purified supply, and the two water systems join at some points. If these points are not protected to prevent entry of the secondary supply into the drinking water, or if there is a failure of a connection between the two systems, infection is to be expected. Connections between the two systems are illegal in most States, and in any event they are a constant health hazard.

Faulty plumbing also makes the water supply vulnerable to contamination behind the defense lines. Plumbing connections that permit a backflow of used water are a serious danger. There are many conditions in which the direction of flow in the water pipes may be reversed. This may happen when the pumping operation is interrupted, when water is shut off for repairs, or when a fire or other disaster pulls a heavy surge of water to one part of the system. On such occasions, a vacuum may form in certain pipes, a vacuum strong enough to siphon fluid from lower levels. If faulty fixtures permit a vacuum to siphon a backflow of sewage or other dangerous material into the drinking water supply, the water system's defenses are penetrated.

The vulnerability of the water system to such contamination is indicated by the condition of plumbing installations in Federal





buildings in New York City and Detroit studied in 1936 by the Public Health Service. The investigators classified as possible health hazards, exposing the water supply to contamination, two-thirds of the 22,000 fixtures inspected in New York. By the same standards, the investigators disapproved three-fourths of the fixtures inspected in Detroit. The security of plumbing installations was not improved during the war years.

On the basis of its experience and findings, the Public Health Service now consults with and advises other Federal and State authorities on hygienic plumbing; it participates actively in developing Nation-wide plumbing codes; it has conducted demonstrations of methods for locating plumbing defects, and has recommended remedies.

Beyond protecting the water supply in the distribution system, the line of action now extends to points where water sources are being polluted. Measures are being taken to prevent noxious waste from entering the streams and to clean up those streams which are already polluted, as detailed in the following chapter. The advantages to the environment will be both sanitary and aesthetic.

A deep concern with health factors in the water environment is not new to the Public Health Service. In 1893, Congress assigned to the Service the responsibility for administering regulations designed to prevent disease from spreading from State to State. One of the early concerns of the Service was the purity of water used for drinking and cooking on trains and other interstate carriers. In 1946, the American Water Works Association recommended that States adopt the *Public Health Service Drinking Water Standards* for all domestic water supplies.

Wrong (above) The open, unprotected well is dangerously close to the barn and its wastes.

Right (below) Covering protects a well from direct contamination; isolation protects from seepage.

Local government and private authorities shoulder the responsibility of developing, operating, and maintaining our water supplies. State and local health authorities work to maintain and control the purity of this water. Their efforts are supported by a six-point program of the Public Health Service aimed at preventing water-borne diseases in this country:

1. Adoption and continuing review of sanitary standards for drinking water.
2. Research on the efficiency of water-purification processes.
3. Epidemiological studies of outbreaks of diseases which appear to be water-borne.
4. Consultation with and advice to States on public water-supply problems.
5. Preventive measures directed by the Federal Water Pollution Control Act.
6. Technical aid and advice on programs of immunization from epidemic diseases.

The combined efforts of all health workers have virtually eliminated water-borne typhoid fever. Their continued efforts now aim at improving all water supplies as a factor in environmental health.

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Water Pollution Control

POLLUTION MAY BE defined as anything which disturbs the natural condition of a stream or other body of water and has an undesirable effect on public welfare.

From the point of view of the perfectionist, all water should be good enough to drink. The Supreme Court has said that drinking and other domestic functions are the highest uses of water. But there are other practical, economical, and necessary uses of water of high importance, too.

The problem of water pollution control is to moderate or regulate quality, flow, and even the temperature, so as to assure the greatest advantages from the various allied uses of water and to serve the greatest public interest. This objective relates the question of controlling water pollution directly to the question of determining the legitimate uses of water.

The continuing task of water pollution control authorities is to determine existing stream conditions, to select the priority of use of available water, to establish water standards for respective legitimate uses, and to control pollution so as to serve those uses. Data must be continually sought and revised for these purposes. For example, data are lacking now on the effects of wastes discharged by more than 4,000 separate industrial installations.

MEASURING POLLUTION

In accumulating data, it is essential to have objective measures of the character of streams.

The test used most commonly to measure pollution applies more to domestic than to industrial wastes. This test measures the biochemical oxygen demand (B. O. D.) of waste from which may be computed a population equivalent: the number of the population that would be expected to produce a volume of sewage with that B. O. D.

The B. O. D. of the wastes dumped daily by American paper mills is equivalent to that of the sewage of 28,000,000 people. Other forms of waste may have no B. O. D. at all and still they may have a decided effect on the quality of water. For example, phenol, which is not significant in terms of B. O. D., is not tolerable in Ohio River water at Cincinnati at more than 15 parts to 1,000,000,000. It is possible to tell by the taste of water in Cincinnati whether refineries 300 miles upstream are producing butadiene or styrene wastes.

Therefore, not one but a variety of tests must be employed to give satisfactory estimates of all the many kinds and degrees of water pollution. Also, standards must be developed to apply to different legitimate stream uses: standards of taste, clarity, bacteria, hardness, acidity, and so on.

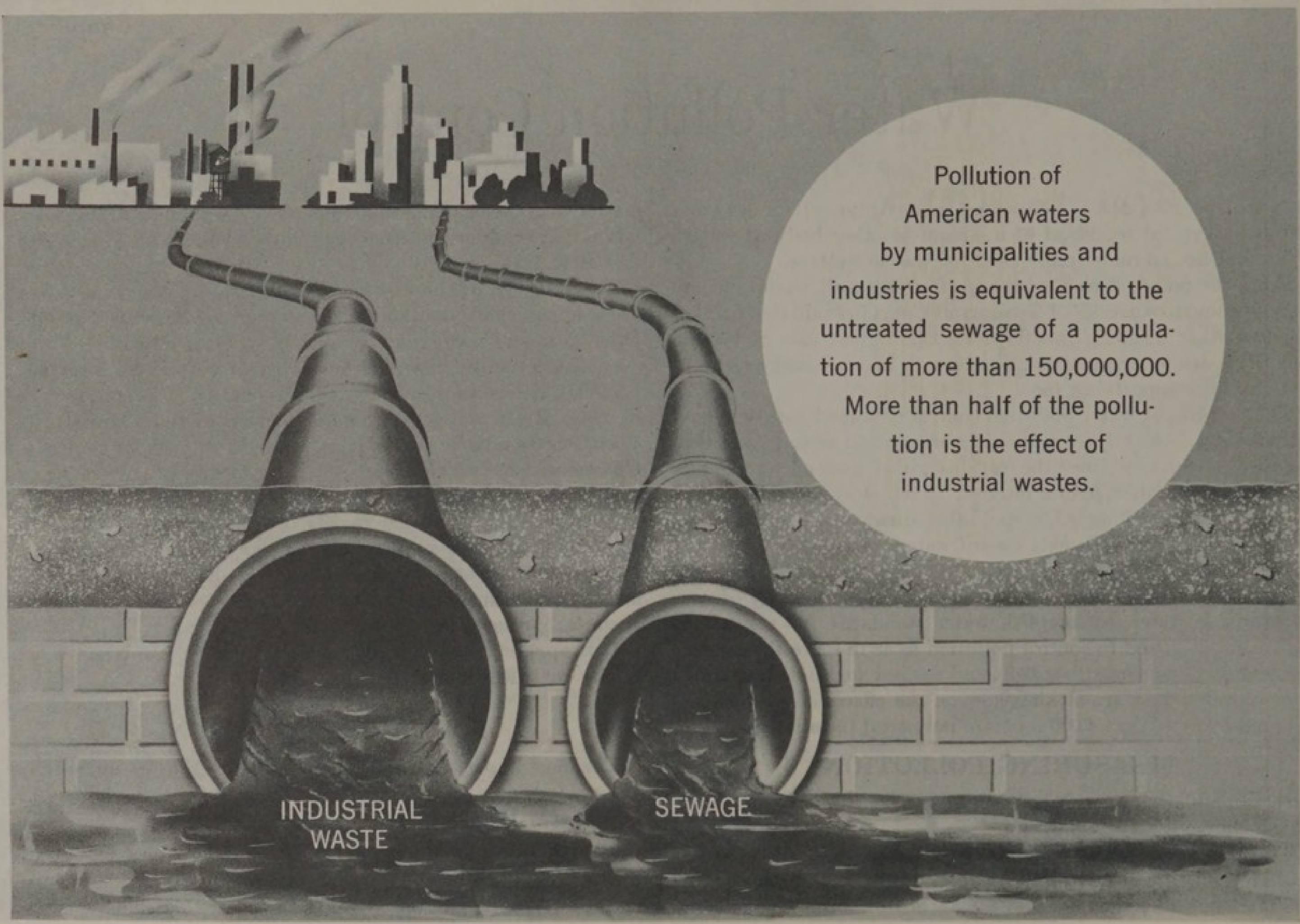
It is apparent, however, that many waters in America are not fit for such legitimate uses as bathing, fishing, and irrigation.

FORMS OF POLLUTION

The most important forms of pollution are wastes and silt.

Domestic Wastes

The sewerage systems of towns and cities carry a variety of wastes into the rivers. These wastes include the body wastes, soaps, detergents, garbage, and other refuse. Households, restau-



Pollution of American waters by municipalities and industries is equivalent to the untreated sewage of a population of more than 150,000,000. More than half of the pollution is the effect of industrial wastes.

rants, laundries, hospitals, hotels, and other domestic establishments, as well as factories, contribute to this collection. Domestic wastes are relatively uniform and consistent in their chemical behavior. They present no serious technical treatment problems.

Industrial Wastes

Industrial processes produce a variety of wastes, with an even greater variety of effects. These wastes include animal and vegetable rubbish, acids, alkalies, synthetics, oils, and metals. Not only do industrial wastes present a greater variety of treatment problems than domestic wastes, but they also have a less calculable effect on the stream. For example, alkaline wastes may at one point be a nuisance and at another point they may serve to offset the effects of acid waste from another source.

Other Factors

The sulfuric acids which drain from abandoned coal mines are another important form of pollution. They amount to 86 tons of acid a day in one region of the Potomac River Basin. Some waters are polluted by drainage from farms where poison sprays and cattle dips are used. Excessive use of ground water may permit brine to invade ground water storage areas. A dam may dry up a river, or reduce a stream to a trickle, although on the other hand a dam's regulation of the flow of a stream sometimes helps to overcome pollution. The temperature of the Mahoning River has been raised by effluent from steel mills until it reached 120° F., too warm for cooling purposes. Regulation of the flow has helped to deal with this problem.

CORRECTIVE MEASURES

Water pollution control is one phase of the broad national policy on use of water resources. The 1950 report of the President's Water Resources Policy Commission states that National policy is evolving in the direction of "comprehensive development of an entire river system for many purposes." The Tennessee Valley is one of several examples of such development.

Because of the interstate character of most streams, it has become necessary for States to have the cooperation of the Federal Government in controlling pollution. This has been authorized by the Taft-Barkley Act of 1948 (Public Law 845), which reflects the progressive development of the policy of comprehensive programs in drainage basins. While providing full cooperation, the policy of the Federal Government is to recognize, preserve, and protect the primary rights and responsibilities of the States in controlling water pollution.

The responsibility of the Public Health Service is to develop comprehensive water pollution control programs for the drainage basins, and to encourage States to take remedial action consistent with those programs. The Public Health Service is authorized to conduct investigations for these purposes and to provide technical and some financial assistance to stimulate construction. Also, if the Surgeon General finds that pollution in one State endangers the health or welfare of persons in another, he may declare the pollution to be a public nuisance. If the pollution continues after formal notices, the Federal Government may hold hearings before a board which recommends corrective action. If the board's recommendations are not followed, the Government, with permission of authorities in the State where the pollution originates, may take the offender into court.

Comprehensive Surveys

As a first step in developing comprehensive basin programs, the Public Health Service, with the aid of States, regional bodies, industry, and other Federal agencies, has collected and analyzed preliminary data on the needs for waste treatment facilities in the major drainage basins of the country.

Men who study polluted waters have acquired many useful facts about water conditions near individual towns or factories.

These studies have helped citizens to realize that pollution problems may originate far upstream, even in another State. For this reason, it has been desirable to gather together all the facts on pollution in a given drainage area. These collections of information are being organized to show the sources, kinds, and degrees of pollution in an entire drainage area and to evaluate the effectiveness of present treatment facilities and the need for further treatment. The realization that all the people in a drainage basin depend upon the same water resources is behind this program for basin-wide water pollution control.

As noted above, the success of the control program depends on a method of determining how the people of a drainage basin can improve their uses of water resources. Anticipating the building of the treatment plants, the water pollution control authorities help to determine improved uses by gathering, reviewing, revising, and interpreting data, by developing standards of water use, and by creating administrative mechanisms for deciding which allied uses of waters should be encouraged. Such determinations and decisions may be expected to stand if they have the participation, support, and approval of the people of the valley.

Existing current data are used as a basis for action, if action is possible. New or additional facts are sought by the States and the Public Health Service, with assistance from industry and other government agencies, if existing studies are incomplete. If necessary, special laboratory data are developed to clarify understanding of the sources, character, and effect of pollution.

Surveys of treatment facilities take into account that pollution changes in volume and kind. Also stream uses change. Treatment facilities become worn or outmoded. The estimates of repair, replacement, and expansion of treatment facilities must be revised periodically. From the national point of view, it appeared in 1950 that more than 6,500 municipal sewage-treatment plants ought to be built, expanded, or replaced. The corresponding estimate for the number of treatment plants needed in industry was 3,500.

Domestic Waste Treatment: Municipal

Since 1946, there has been a pronounced rise in the rate of construction of municipal treatment plants, as the accompanying chart shows. In 1946, 39 city sewage-treatment plants were built; in 1947, there were 93; in 1948, 176; and in 1949, 338. Plans for another 1,000 were on the drawing boards, and nearly 1,000 more had been approved. In these few postwar years, municipal sewage treatment works, valued at nearly 1,500,000,000 dollars, were built or under construction for a population of 16,000,000. Since 1915, 9,000,000,000 dollars has been invested in treatment works and sewerage systems.

Industrial Waste Treatment

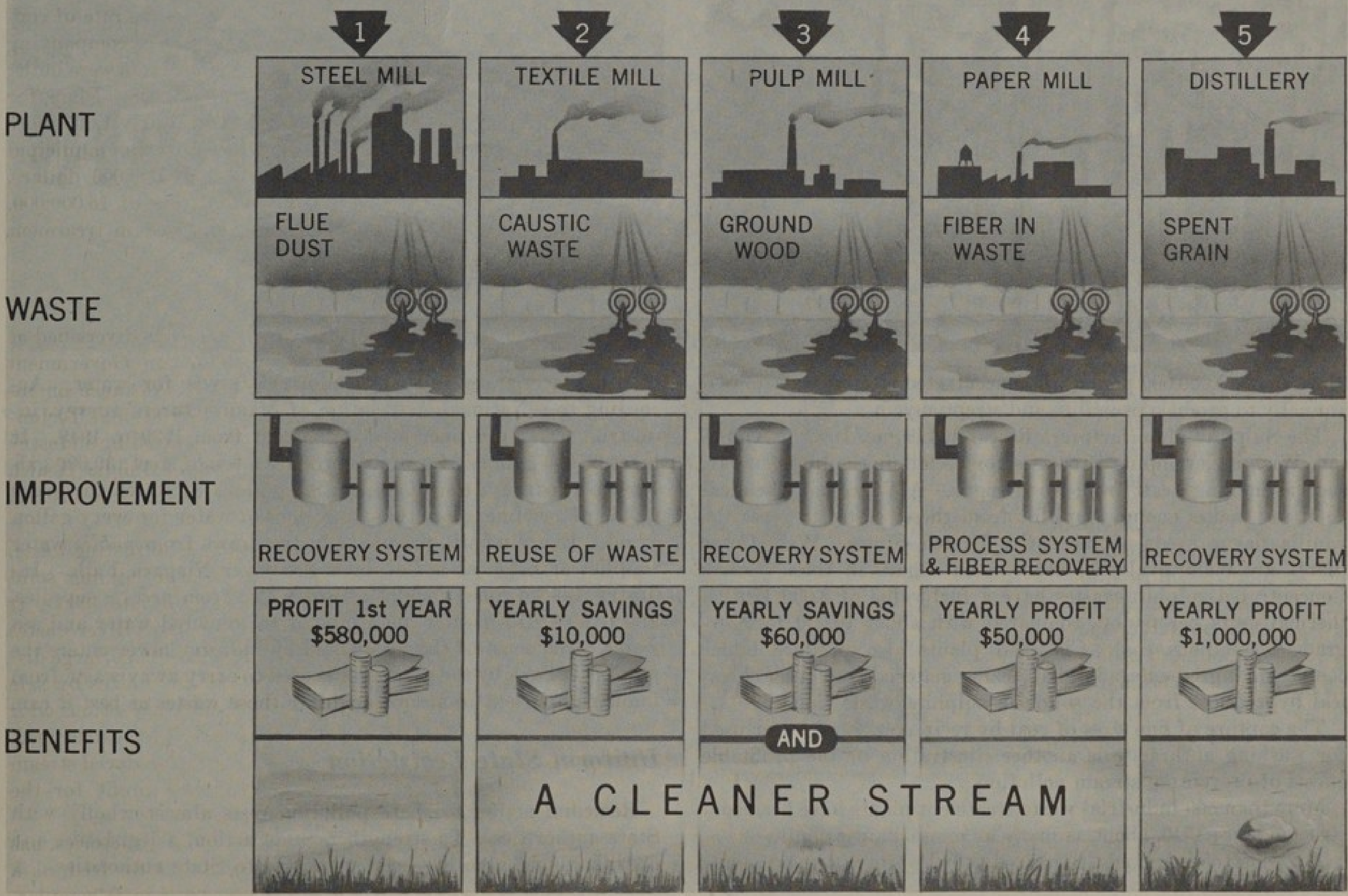
Industrial waste-treatment methods are almost as diversified as industrial processes. Representatives of the Federal Government and industry are exchanging information and assistance on industrial waste-treatment processes through the National Technical Task Committee on Industrial Wastes, organized by industry at the invitation of the Surgeon General of the Public Health Service. This coordinating body represents the major industrial groups with waste disposal problems.

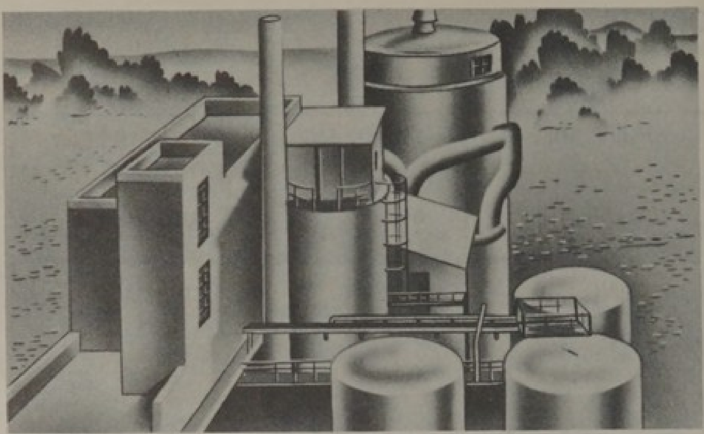
Several industries have had spectacular success in treating waste.

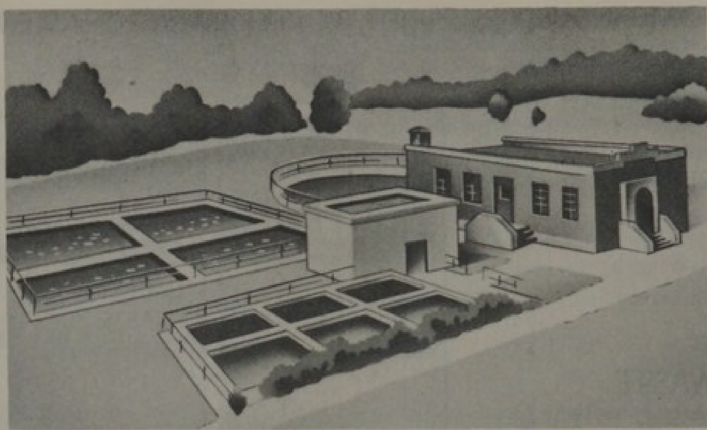
Since 1940, the distillery industry has been reclaiming solid residue for profitable sale as cattle feed. In the late 1930's, at Peoria, Ill., distilleries were dumping into the Illinois River wastes with a population equivalent of 7,000,000. At that time, large distilleries were able to dispose of some semiliquid wastes by sale locally as cattle feed, but the business suffered from a serious odor nuisance. In 1940, the residue, dried for sale as a cattle feed, found a national market. The sale of this residue reduced stream pollution dramatically and earned a handsome profit for the distilleries.

Steepwater, formerly a waste from corn-products factories, has been used for many years as a constituent of cattle feed, as a culture for yeast, and in the making of the vitamin B complex.

SOME INDUSTRIES PROFIT BY RECLAIMING WASTE PRODUCTS . . .







More than 12,000,000 pounds of concentrated steepwater are used annually to produce penicillin and streptomycin.

The Sulphite Manufacturers Research League, Inc., of Appleton, Wis., is developing processes for reclaiming sulphite waste, such as making yeast from wood sugar. A Wisconsin chemical company makes enough vanillin from these wastes to meet the vanilla flavor needs of the entire United States. West Coast plants are making alcohol from wood sugars in these wastes. Concentrated sulphite wastes have a fuel value of 8,000 British thermal units per pound, compared with about 10,000 for low-grade bituminous coal. Chemical plants also produce boiler compound ingredients, adhesives, sizing material, and other chemical byproducts from the solids in sulphite waste liquor.

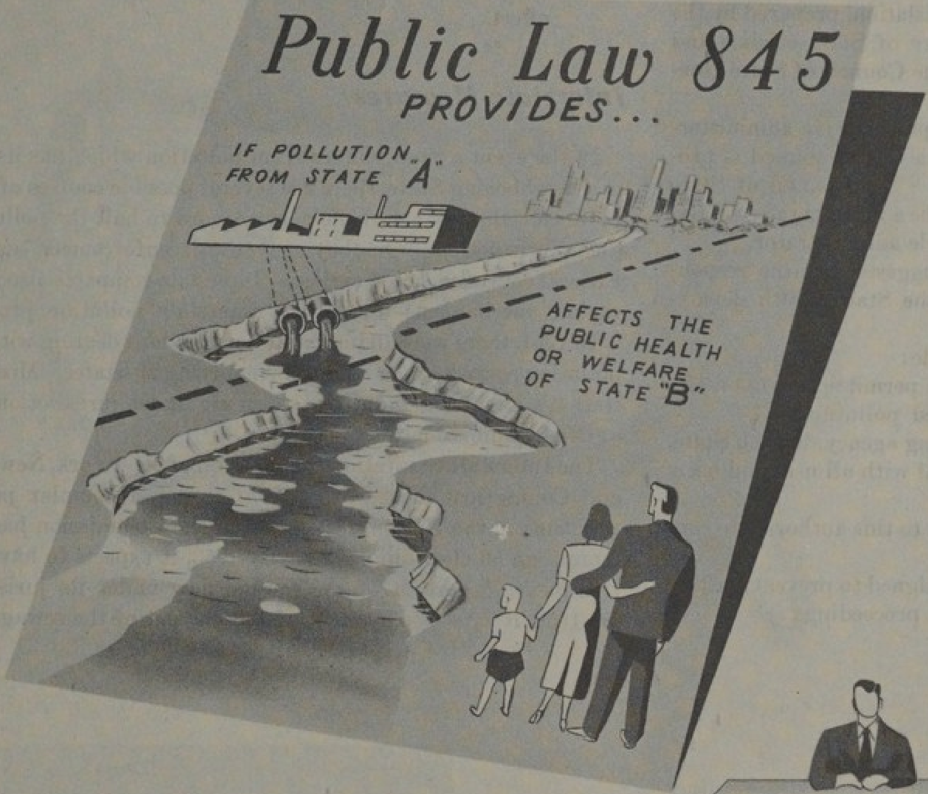
The capture of fine sizes of coal by recirculation of water used for washing anthracite is another illustration of the profitable effects of preventing stream pollution.

More than 500 industrial waste treatment plants have been constructed since 1946, about as many as municipalities built.

The construction of additional industrial waste treatment plants is being accelerated also by industry's needs for water. According to a National Association of Manufacturers' survey, industrial water uses increased 36 percent from 1939 to 1949. It takes 65,000 gallons of water to produce a ton of steel; 39,000 gallons to produce a ton of paper; 8.5 gallons of water for every gallon of gasoline; more than 18 gallons of water for every gallon of oil. Every month, private industry draws from *public* water supplies as much as a full day's flow over Niagara Falls. Industry uses an equal amount of water also from *private* supplies, and it uses still greater quantities of recirculated water and sea water. But most of the water used by industry never enters the plant. It flows by the plant and is used to carry away waste from industrial outlets, to absorb or dilute those wastes as best it can.

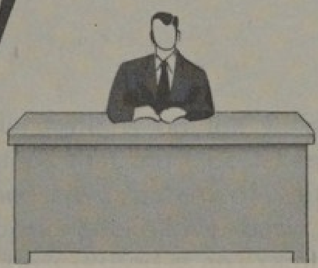
Uniform State Legislation

Remedial action to abate pollution rests almost wholly with State authorities. To strengthen State action, a legislative and organizational plan has been submitted to State authorities. A



THE PUBLIC HEALTH SERVICE CAN--

1. Make investigations.
2. Hold hearings.
3. Declare a public nuisance.
4. Institute action in Federal Courts (but only with the approval of the appropriate agency in the State where the pollution originates).



principle of this plan, supported by the United States Public Health Service, is that all groups concerned in the use of water should share in determining policies of regulating water use. This principle is incorporated in a draft of legislation, prepared by the Public Health Service with the assistance of State officials and other consultants, and recommended by the Council of State Governments.

The draft law provides for either a representative administering body or a single administrator. An advisory council is proposed, if there is a single administrator. The Council of State Governments recommends also that there be a representative board of review to pass upon decisions of a single administrator.

The Council of State Governments suggests that the responsibility for administration be given to the State health department, unless a new agency is established.

Other principles of the draft law include:

1. A broad definition of pollution, to permit action upon any form of unanticipated, unexpected pollution.
2. A single, independent administering agency, in each State, with comprehensive powers to deal with all uses and users of water.
3. No exemptions from or exceptions to this authority to control pollution.
4. Adequate enforcement powers, designed to prevent stalling by means of long-drawn-out court proceedings.
5. Agency responsibility and authority to establish standards and to issue permits for water use. The permits would oblige the users to protect the quality of the waters they affect.

Interstate Measures

In the event a State suffers from pollution which has its source in a neighboring State, there are several possible courses of action. State officials may act of their own accord to halt the pollution in their jurisdiction. Or they may await enforcement action by Federal courts, as noted earlier. Interstate compacts also provide various mechanisms for solving interstate pollution problems.

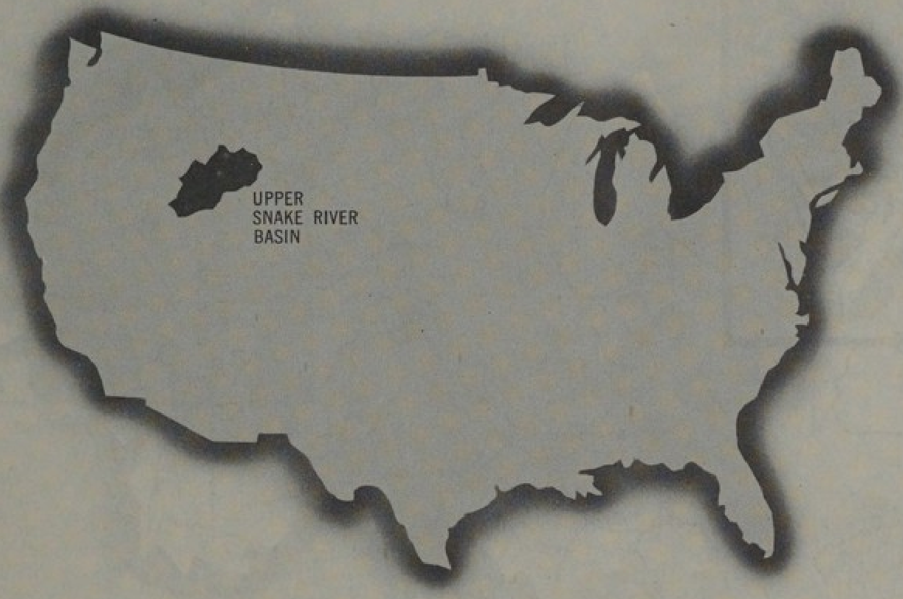
In 1951, there were 10 interstate commissions dealing with water pollution control under compacts involving 29 States. Most of the Nation's important industrial areas are under jurisdiction of one of these commissions.

The Interstate Sanitation Commission of New York, New Jersey, and Connecticut deals with one of the most complex pollution problems in the Nation. In 13 years, the Commission has issued more than 80 clean-up orders. By 1953, it expects to have under treatment 75 percent of the sewage flow under its jurisdiction. By 1959, it expects treatment of 100 percent of the sewage.

THE FOLLOWING SIX PAGES PRESENT AN ILLUSTRATED CASE STUDY OF A PROGRAM OF WATER POLLUTION CONTROL

CASE STUDY OF A COMPREHENSIVE PROGRAM

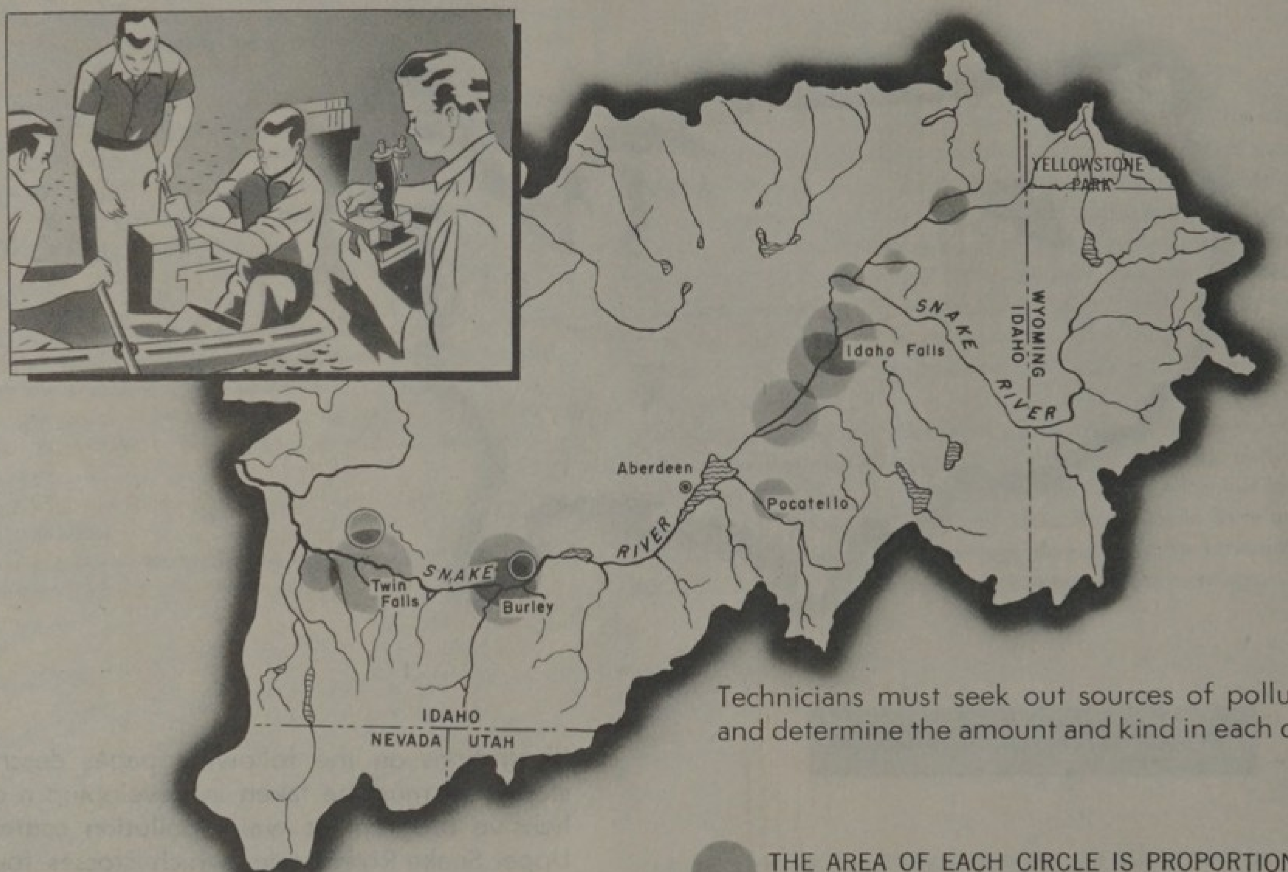
Pollution Control in the Upper Snake River Basin



AN AUTHENTIC ILLUSTRATION

Illustrations on the following pages describe the steps that must be taken in developing a comprehensive program of water pollution control. The Upper Snake River basin, which crosses four State lines, is used as an example.

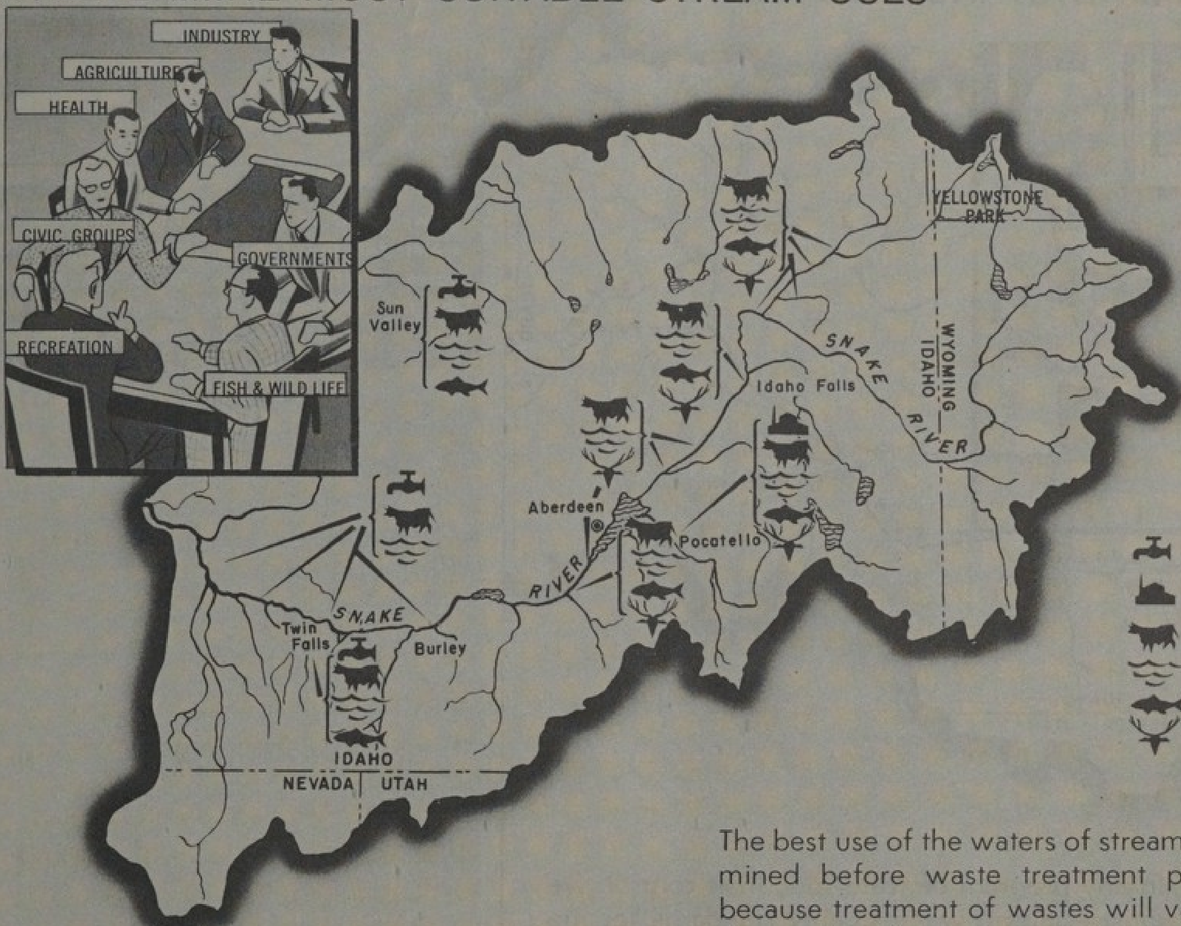
1... DETERMINE EXISTING STREAM POLLUTION CONDITIONS



Technicians must seek out sources of pollution and determine the amount and kind in each case.

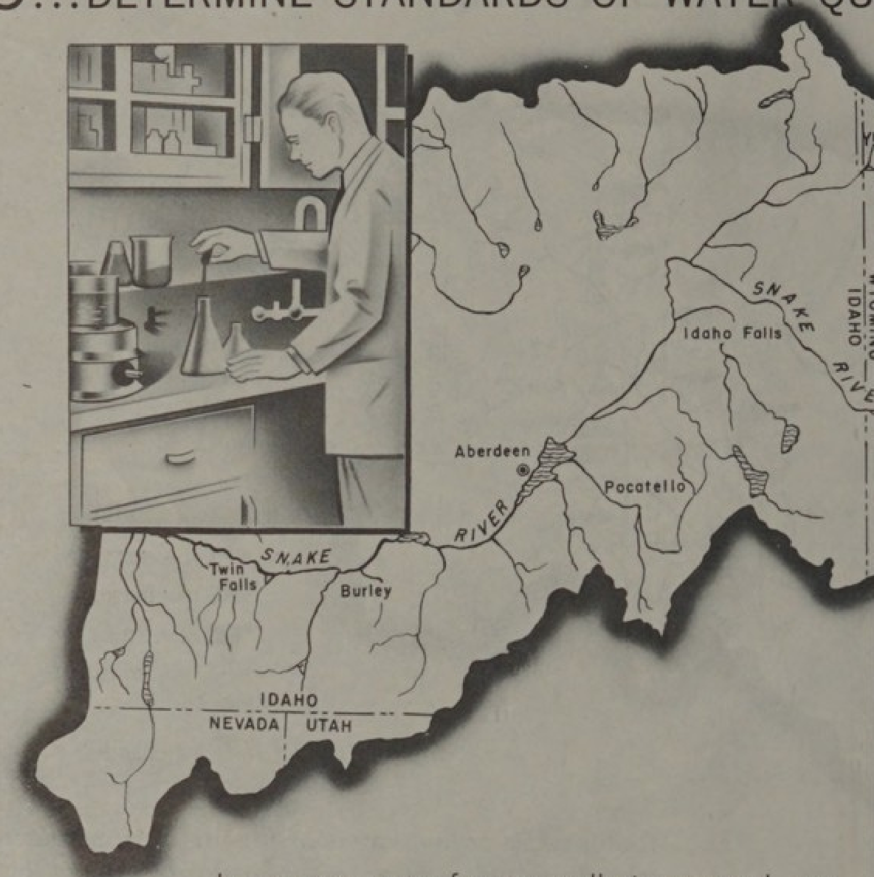
THE AREA OF EACH CIRCLE IS PROPORTIONATE TO QUANTITY OF WASTES DISCHARGED.

2...DETERMINE MOST SUITABLE STREAM USES



The best use of the waters of streams must be determined before waste treatment plants are built, because treatment of wastes will vary according to the quality of the water desired.

3...DETERMINE STANDARDS OF WATER QUALITY

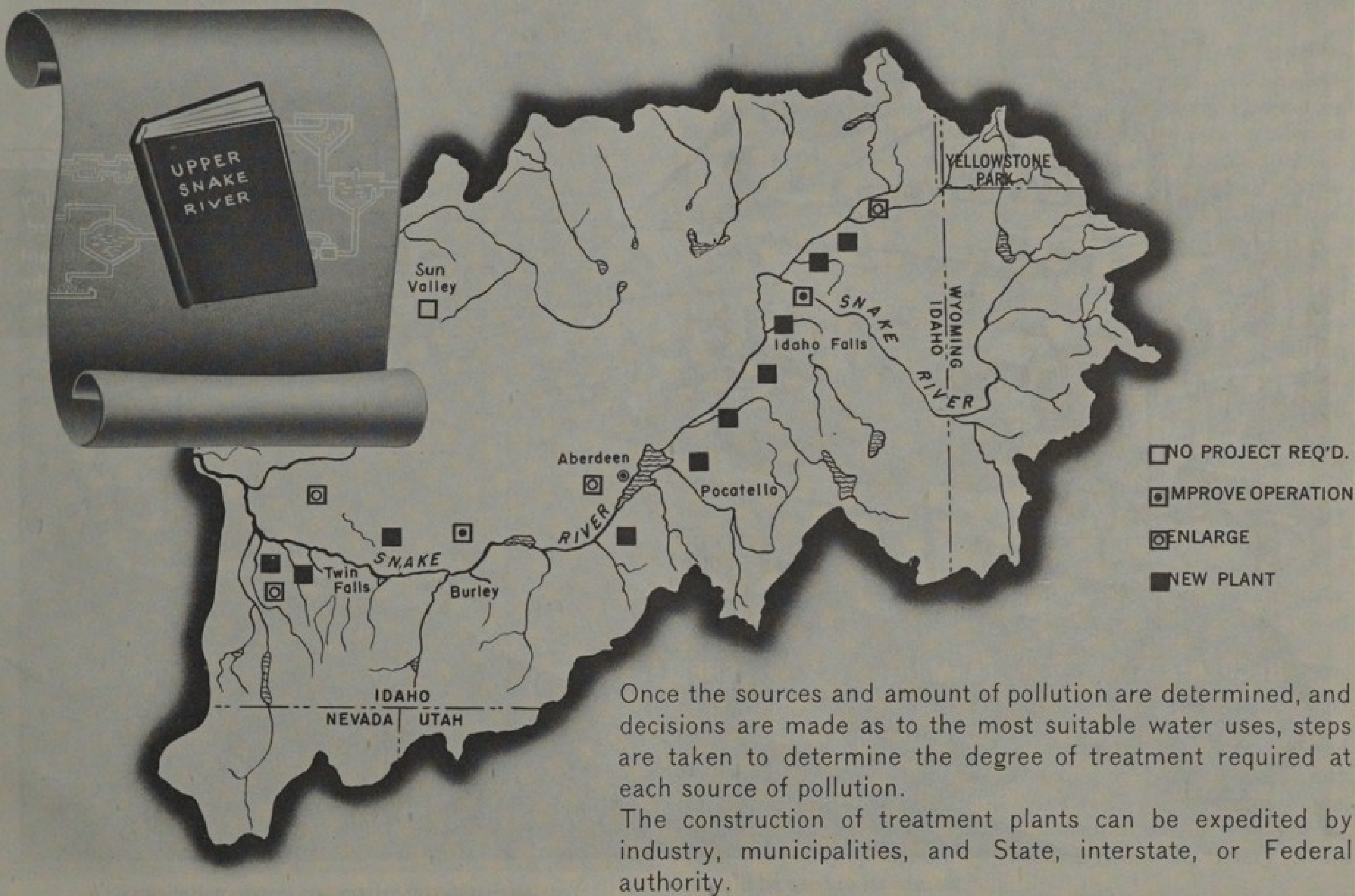


In any program of water pollution control, we must establish water quality standards for the legitimate uses of our waterways.

If we want to use water for the purposes indicated in the first column below . . . we must determine the quality for each use according to the amount and intensity of the following elements:

DOMESTIC WATER SUPPLY	Oxygen, bacteria, waste solids, acidity, alkalinity, color, clarity, odor, taste, oil, sludge, plant life, chemistry
INDUSTRIAL WATER SUPPLY	Waste solids, acidity, alkalinity, temperature, color, oil, sludge, clarity
FISH AND WILDLIFE	Oxygen, acids, waste solids, plant life
BATHING AND RECREATION	Bacteria, waste solids, oil, sludge
IRRIGATION AND AGRICULTURE	Waste solids, bacteria, oil, sludge

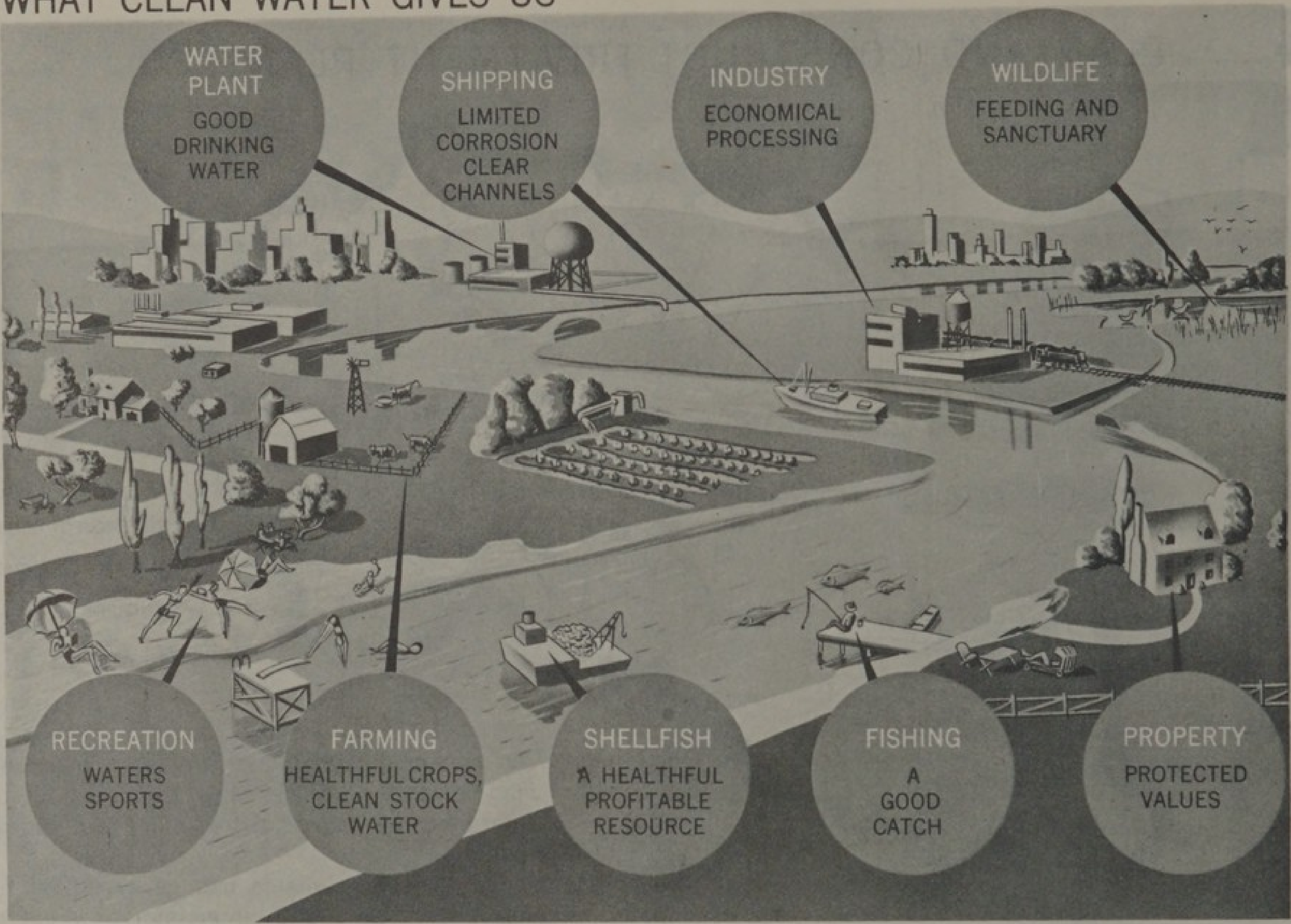
4 . . . PLAN AND CONSTRUCT TREATMENT PLANTS

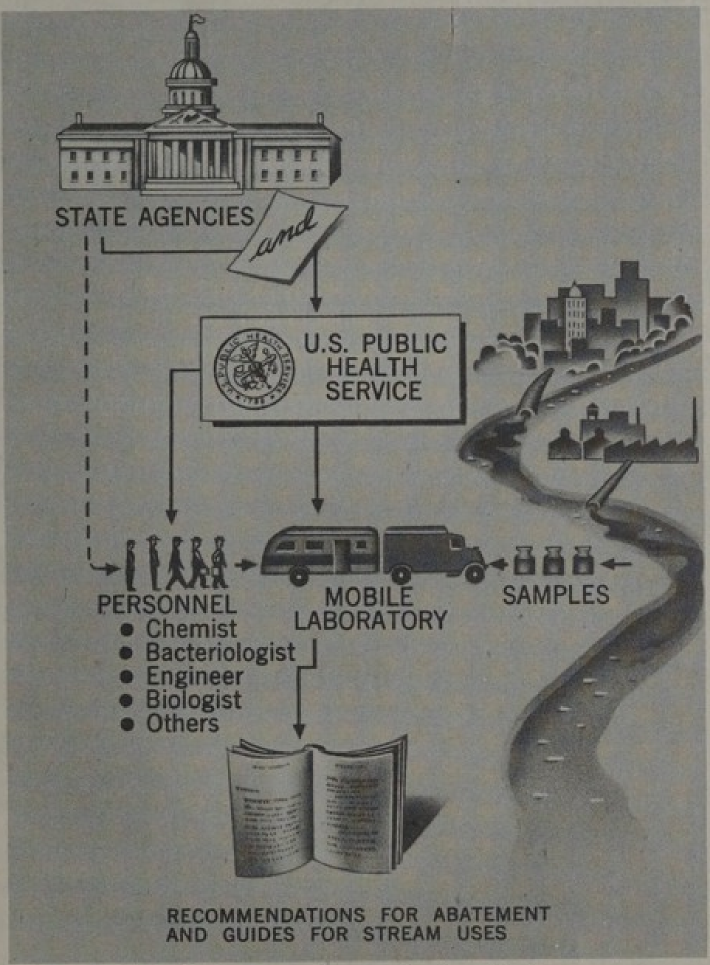


Once the sources and amount of pollution are determined, and decisions are made as to the most suitable water uses, steps are taken to determine the degree of treatment required at each source of pollution.

The construction of treatment plants can be expedited by industry, municipalities, and State, interstate, or Federal authority.

WHAT CLEAN WATER GIVES US





Water pollution control cooperative investigations.

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THE PENALTY OF POLLUTION

The penalty society pays for pollution may be judged according to various standards, but by any standard it is high.

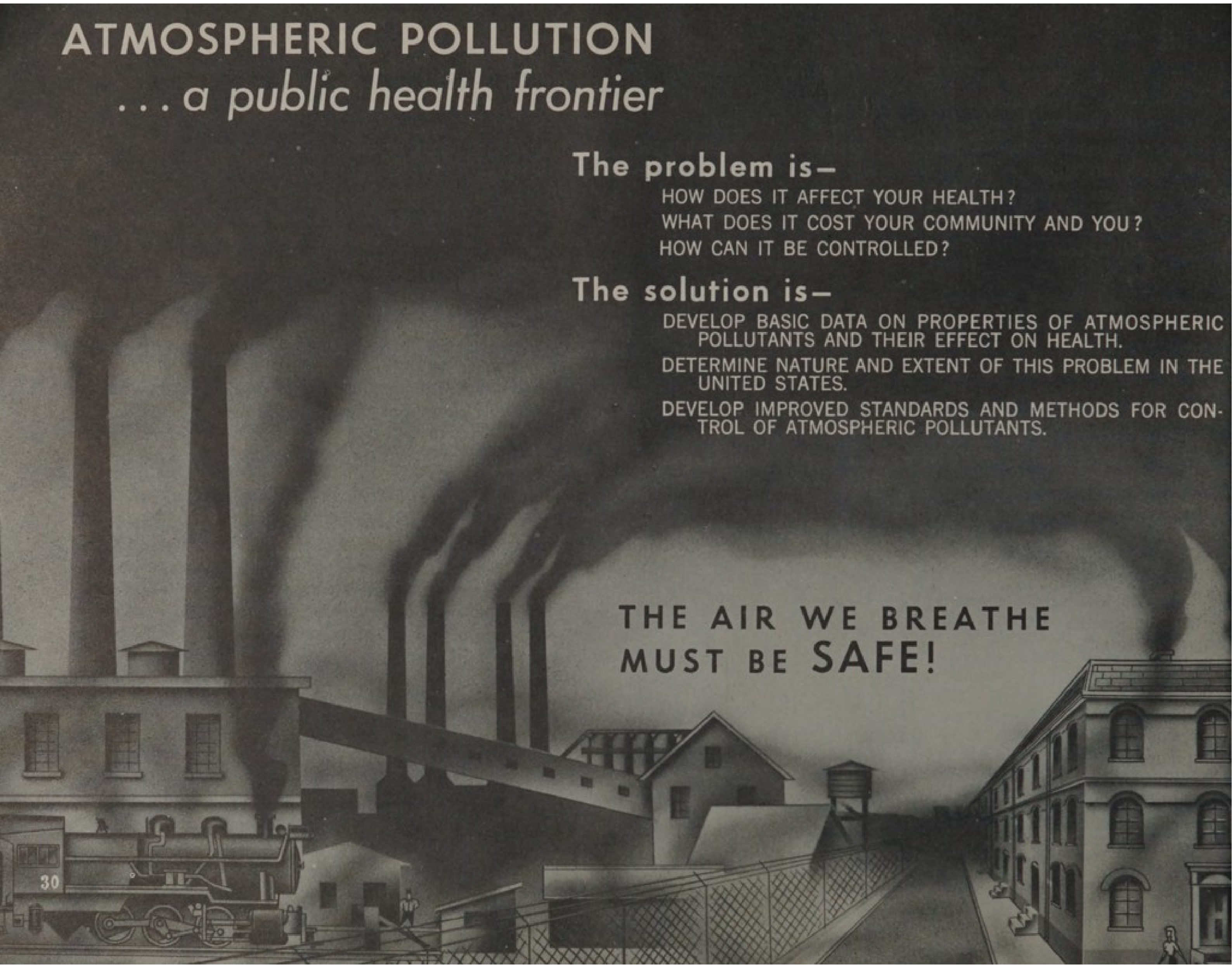
Direct financial penalties of pollution include the cost of treating polluted water to be used in the home or in industry; depression of real-estate values; limitations of commercial resources, such as shellfish beds; rapid depreciation caused by corrosion of waterside structures; the charges for correcting the effect of pollution upon hydro-electric plants, flood-control works, and navigation channels; and the write-down in the value of polluted recreational facilities.

Indirect financial penalties include the additional cost of seeking sport or recreation at distant unpolluted waters; the enforced movement of industry to uneconomical locations; the loss of commodities and services that are not produced because of pollution; industrial lay-offs and shut-downs imposed by water pollution; and the various economic losses which attend illness resulting from polluted waters.

The aesthetic penalty is not stated in terms of money but it is appreciable. The moral penalty is reflected in the manner in which water pollution flouts the principle of mutual responsibility in a close-knit society. The social penalty can be estimated on the basis that water resources are essential to a strong and healthy society; the impairment or destruction of those resources at other stages of human history has contributed to the dry-rot of proud civilizations.

CONCLUSION

The serious impact of water pollution on public health and public welfare justifies immediate action by industry and by city and State governments to protect the quality of water resources. To be valid, however, remedial measures should support the National policy epitomized by Theodore Roosevelt, "Every stream should be used to its utmost."


ATMOSPHERIC POLLUTION
. . . a public health frontier
The problem is—
HOW DOES IT AFFECT YOUR HEALTH?
WHAT DOES IT COST YOUR COMMUNITY AND YOU?
HOW CAN IT BE CONTROLLED?
The solution is—
DEVELOP BASIC DATA ON PROPERTIES OF ATMOSPHERIC POLLUTANTS AND THEIR EFFECT ON HEALTH.
DETERMINE NATURE AND EXTENT OF THIS PROBLEM IN THE UNITED STATES.
DEVELOP IMPROVED STANDARDS AND METHODS FOR CONTROL OF ATMOSPHERIC POLLUTANTS.
THE AIR WE BREATHE MUST BE SAFE!
30

Air Pollution Control

SEVEN CENTURIES AGO, coal smoke had come to be regarded in England as a menace to health. For this reason, in the year 1306, the burning of coal was prohibited by edict of the King. In 1661 in London, a report titled *Fumifugium* claimed that almost one-half of the deaths in the city were the result of "phthisical and pulmonic distempers" resulting from polluted air. Fumes of sulfur and arsenic were said to be the chief contaminants in smoke. Other studies connected a rise in mortality with the appearance of smoke fogs. Even today a Glasgow newspaper automatically allows extra space for obituary notices following a smoky fog. It is not news that dirty air is both a nuisance and a danger.

SMOKE

The problems of air sanitation have been, and continue to be, the identification of dangerous contaminants in the air and the devising of effective means of reducing the concentrations of the most dangerous contaminants, if not all pollutants. These problems are social as well as technical. Most people think of air pollution in terms of disagreeable odors, irritating pollens, dust, or smoke. Usually, complaints against smoke have been the strongest.

Whenever civic groups in industrial centers have clamored against the smoke nuisance, however, the conventional retort of practical men has been, "Smoke means prosperity. It means our factories are busy. Are you against that?"

In the absence of convincing knowledge of the danger of smoke and the means for reducing it, this retort was unanswerable. Understandably, the belching factory smoke-stack is to many a symbol of industrial progress. It towers over the horizon as a token of common prosperity, of the might of power machinery.

Unfortunately, smoke indicates something besides prosperity. It implies costly laundry bills, feeble sunlight, sick vegetation, dirty buildings, and other annoyances. It frequently represents a preventable loss of fuel that could be productive of revenue. There are, of course, methods of controlling smoke, and citizens in many communities have adopted and enforced regulations that trim the dark plumes that billow from factories, locomotives, river boats, and household furnaces.

MORE THAN SMOKE

The control of soot is only part of the job, however. While civic organizations and newspapers have waged campaigns against the more obvious offense of soot, scientists have become concerned about the effects of other industrial contaminants. Many industrial chimneys pollute the air with gases and other industrial byproducts which are invisible but possibly more dangerous than the pall of soot. Realizing this fact, the Smoke Prevention Association in 1950 changed its name to the Air Pollution and Smoke Prevention Association.

Industrial contaminants in general fall into two classes: (*a*) particulate matter; (*b*) gases and vapors. Particulate matter includes metallic oxides, sulfur trioxide, fumes, mists, fogs, carbon, tar, fly-ash, and other matter. Of the gases and vapors, the more common ones are sulfur dioxide and carbon monoxide.

Industrial Contaminants

The sources of contaminants are many. In the burning of fuel, smoke is created wherever there is incomplete combustion—in furnaces, incinerators, brush fires, and in automobile motors. Automobiles also are a major source of carbon monoxide, a poison gas. Industrial plants emit a variety of contaminants. The use of poisonous sprays and dusts against pests has created still other forms and sources of air contamination.

Natural Contaminants

Certain natural contaminants also present health problems. One can only speculate as to the amount of discomfort suffered as a result of sensitivity to pollens, danders, and other natural materials in the atmosphere. Several million Americans yearly suffer from hay fever. Perhaps half of these develop more serious disorders, such as asthma. The pollens of ragweed cause more than half of the hay fever in the United States. Many health departments use 2,4-D to eliminate ragweed.

Still another natural set of contaminants of concern are fungi which flourish in dry and dusty regions of the South and West.

Although "vapor" and "miasma" have long been considered sources of diseases in actuality carried by insects or in water or food, the fact that aerosols and small particles carry disease organisms in the air has been established only within the past fifteen years. The relation of atmospheric conditions to bacterial and virus diseases has been the basis of successful experiments with humidity, temperature, and ventilation controls, glycol vapors, dust suppression, and ultraviolet irradiation to kill off air-borne germs.

Agricultural Effects

Farmers near heavily industrialized areas long have complained that crops and animals were suffering from polluted air. Their case has been proved by scientific investigation. When sulfur dioxide is in the air in concentrations of 0.4 parts per million, it is poisonous to sensitive plants during the growing season. Fluorides in the air also are absorbed by plant life, and, even when they do no damage to the plants, they damage the health of sheep and cattle fed on such plants. A diet of heavily contaminated vegetation stunts growth, lowers vitality, and even causes death in farm animals.

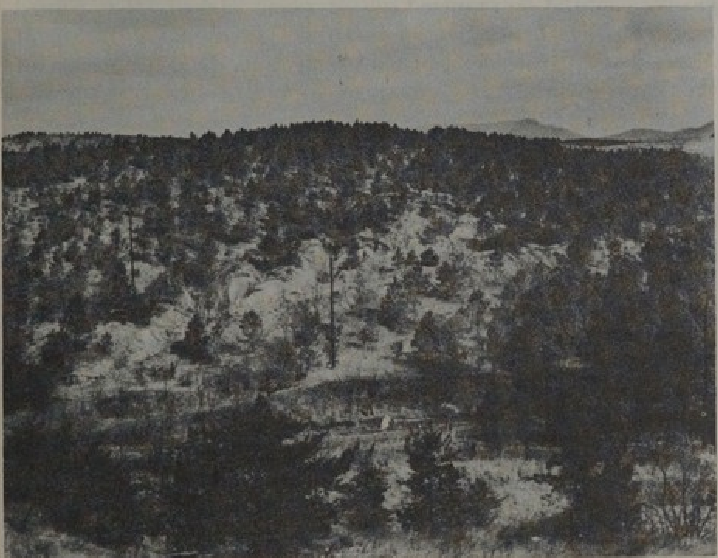
Industrial fumes at Copper Hill and neighboring towns killed vegetation over an area of a hundred square miles in the neighborhood of the Great Smokies National Park.

Human Effects

When these effects are observed in animals, it is natural to ask, what are the effects on human beings?

Biological Aspects of Air Pollution, a bibliography compiled by the Public Health Service, abstracts 320 references on this subject. There can be no doubt that contaminants in the air affect human beings. However, there is not as yet sufficient evidence on the agents and their effects, singly or in combination, in specific communities.

Although sulfur dioxide is identified as a dangerous contaminant, its effects vary with weather conditions, duration of exposure, and the susceptibility of the individual. The report to the Trail Smelter Arbitral Tribunal, submitted in 1944, recommended that sulfur dioxide emissions be curtailed under given weather conditions.



Air pollution control and plantings at Copper Hill, a joint project sponsored by TVA, the Tennessee Department of Conservation, and private industry, are restoring vegetation to the denuded area.

In St. Louis, sulfur dioxide concentrations were found to be twice as high on the average when winds blew above 14 miles an hour as when the winds fell below that speed.

Medical men have long suspected also that air pollutants shut out a large percentage of the rays of the sun that normally stop the growth of disease-producing bacteria. They have pointed out that ultraviolet rays, which help the formation of calcium and phosphorus in bones and teeth, are filtered out by smoke and dust. One study conducted in an industrial city revealed that the presence of smoke or fog reduced the bactericidal action of daylight by 25 percent.

With the development of industry in southern California, an air pollution problem of a special kind has been found in Los Angeles. The entire Los Angeles area 20 or 30 times a year experiences a smoky fog which severely irritates the eyes. This problem is under intensive investigation which has shown promising results.

United States and Canada

The Trail Smelter Investigation, mentioned above, is one of several international studies of air pollution. This investigation dealt with fumes released by a smelter in British Columbia, affecting farm land in the State of Washington. The International Joint Commission established many years ago by the United States and Canada, is currently studying sources of air pollution and related weather and health conditions in the Detroit-Windsor area.

The Meuse Disaster

Belgium in 1930 was the scene of an inadvertent demonstration of the perils of air pollution. An area of the heavily industrialized Meuse Valley was blanketed for about 4 days by fog which was saturated with mill smoke and fumes. Thousands were ill; 63 died. Scientists who studied the phenomenon agreed that chemicals which contaminated the air were to blame.

Donora

Late in 1948, the United States experienced a similar tragedy. Southeast of Pittsburgh, Pa., the Monongahela River twists through a cluster of mountains that, at one sharp bend, hem in the mills of Donora, a town of 14,000 inhabitants. It is not unusual in Donora for a combination of smoke and fog to cling to the valley. Whenever the ground is colder than the atmosphere, most frequently in the spring or in the fall, this fog begins to form. Ordinarily, such fogs are dissipated in a few hours by action of wind and sunshine, but under protection of the mountains that surround Donora, fog frequently lasts a day or two. On October 27, 1948, a smoke fog settled down in Donora to last until rain cleared the air 4½ days later. In that period, 20 residents of the town died. This was many times the normal death rate. Almost 6,000 persons were ill in varying degrees, including attending physicians and undertakers.

The Public Health Service's industrial hygiene experts were called into Donora and spent a full year in cooperation with the Pennsylvania Department of Health studying all aspects of the event. They consulted weather records and examined hundreds of persons who had been sick during the fog. They reviewed sickness and mortality records of the area for several years back. They analyzed plant operations and took thousands of samples of materials processed in the town's industrial plants. They also sampled gases and fumes which these plants discharged into the air of the valley. They studied smoke and gases from trains that ran through the valley and examined smoke and gases from the boats that ply the Monongahela.

The investigators found that more than 30 different gases and fumes were generated in the valley in varying quantities. They concluded that no single contaminant but probably a combination of several, including sulfur dioxide, had contributed to the illness and deaths that distressed the valley.

Investigations of both the Meuse and the Donora disasters showed that almost all the victims of the fog suffered from respiratory difficulties. Many had respiratory and cardiac ailments, and their conditions were aggravated by the bad air. Those who suffered most were persons who had been ill or enfeebled and were unable to cope with the heavy load of pollutants in the air.

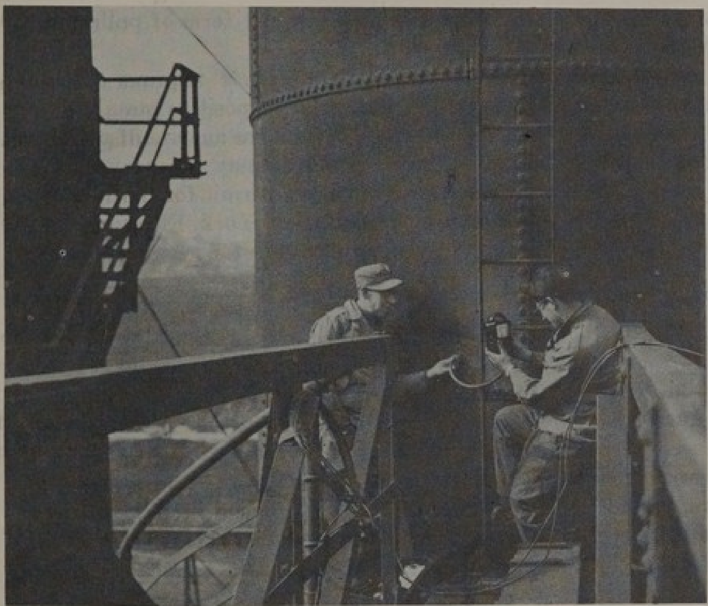
Mexico

A third air pollution disaster occurred in Poza Rica, Mexico, November 24, 1950, when hydrogen sulfide fumes escaped from a gas refinery and hospitalized 320, of whom 22 died. The United States Public Health Service and the United States Bureau of Mines assisted the Mexican Government in its investigation of the tragedy.

QUESTIONS TO ANSWER

One of the chief effects of the Donora investigation was to emphasize that much must be learned in order to deal with air pollution effectively. There is no doubt that industrial contaminants in the air, under unusual weather conditions, may cause acute distress and death. But there are as yet insufficient medical data on the effects of prolonged exposure to polluted air usually found in many industrial areas. Specific questions raised by the Donora investigation about chronic effects of polluted air include:

- Are children and the aged especially susceptible to bad air?
- What is the effect of polluted air on heart and asthma patients?
- What is the relation of polluted air to all respiratory diseases?
- To what extent does damage to the respiratory system affect the heart and circulatory system?
- What effects have air pollutants on the incidence of cancer?



Public Health Service engineer taking static pressure reading for purpose of calculating air flow at Donora.

How does polluted air affect the teeth and tissues of the mouth?

What influence have air pollutants on allergies and on the skin?

These and many other questions can be answered definitively only by painstaking and time-consuming research. The consensus is that such research should include:

Epidemiological studies on the effects of polluted air upon general population groups, whatever their ages or state of health.

Comprehensive clinical investigations of exposed persons, correlated with all essential studies of their atmospheric exposure.

Studies of the effects on human volunteers of controlled and specific atmospheric conditions within safe limits.

TOWARD CLEANER AIR

Through use of sootfall measurements, impingers, filters, electrostatic precipitators, and other specialized equipment, samples of industrial contaminants can be collected, measured, and analyzed. Once their source and concentration are known, steps can be taken to cope with them.

Gases and vapors are collected and treated by a variety of devices. Methods are tailored to the nature of the pollutant. The tall smoke stack is intended to scatter pollutants and dilute their effects. Scrubbing—running air through a water column—is an effective method for removing acid contaminants. Still another method is to transform the contaminant by combustion into a less harmful substance. Particulate matter may be handled by dilution. It may be collected by centrifugal action and impingement, wet collectors, filtration, or electrostatic precipitation. Even sound waves (ultrasonics) may be employed to precipitate particulate matter.

Progress toward control of air pollution has made substantial gains in recent years. The Donora disaster gave new impetus to research and corrective action. At the same time air pollution research was assisted by the declassification and release of studies by the Armed Forces and the Atomic Energy Commission. These included studies of adsorbents and filters for both gases and smokes, of the dispersal of gases from high stacks, of novel methods of dust measurements, of the movements of smoke, and of the role of condensation nuclei in storm and rain formation. Recent developments in micro-meteorology—studies in small-scale weather phenomena—have advanced knowledge of the relation between sources of air pollution and the areas of dangerous concentrations.

Such studies have emphasized the value of high stacks for diluting contaminants, and have related the "effective" height of the stack to discharge velocity and temperature.

Equipment

A rich array of devices is marketed for controlling dusts, gases, fumes, or mists. They include scrubbers, adsorbers, and electrostatic separators. The problem in equipment is to develop simple and economical control devices and to determine which of these devices will provide the most efficient controls.

Equipment for research is used to sample and analyze air pollutants. If a laboratory is available, such equipment might include an electron microscope, spectroscopes, and proton-scattering apparatus. One investigation, to obtain simultaneous readings over a broad area, used radio telephones to report from sampling cars to a central control point.

Mobile laboratories may be the next step in equipping field studies of air pollution.

Legislation

At present, no Federal agency is authorized to coordinate air pollution control. Aside from international treaties and a law applying to the District of Columbia, no Federal legislation applies to atmospheric pollution, although legislation has been proposed.

California enacted exceptionally thorough State legislation in 1947. It authorized a limit on the dusts or fumes which may be emitted by any industrial process, a limit on the quantity of sulfur that may be emitted, and a requirement of official approval of plans for any installation that may add any form of pollution to the air.

Government regulation of the atmosphere requires first the establishment of standards. There is no positive standard for fresh air. Standards instead tend to limit the amount of pollution that may be tolerated. These standards may be enforced by a system of fines or by a system requiring a permit for the operation of any facility that pollutes the air. New York, Pittsburgh, and St. Louis, for example, require permits only for new installations.

Success Story

Within the last 5 years, Pittsburgh and St. Louis have scored a historic success in controlling and reducing the amount of smoke produced by local industry. Observations in St. Louis in 1950 showed that sulfur dioxide concentrations in the air had been reduced 83 percent below levels of the winter of 1936–37, and 73 percent below the summer levels. The downtown concentration was found to be no higher in 1950 than it had been 20 miles out of town in 1936–37. As a result, vegetation is heartier, stone and metal and paints last longer, and the air smells better.

CONCLUSION

Every day, man takes in, pound for pound, several times more air than food. He takes in 10 times as much air as water. It seems elementary to take heed of the quality of this volume of air that enters his lungs. It is for each community to decide whether it is important to have air that is clear, fresh, and clean, or at least whether it is important to have air that will help people to stay well.

Milk and Food

SIXTY YEARS AGO, the wives and mothers of America were shaken with grief and indignation at the number of babies that were dying. There were neighborhoods where a child had barely an even chance of living through the first year. The average for New York City was one dead for every three who lived. Ten years later, for every one who died, nine lived. The infant death rate in 1950 was lower still.

A MIRACLE OF COMMON SENSE

This slash in the infant death rate was a miracle, a miracle of common sense, science, and philanthropy.

Common Sense

It was common knowledge among mothers at the turn of the century that breast-fed children had a better chance of life. In Liverpool, of 1,000 breast-fed babies, only 20 died with diarrheal symptoms; of 1,000 bottle-fed babies, 300 died with diarrheal symptoms. New York confirmed the judgment as late as 1908; of 1,000 infants who had died with diarrheal symptoms, only 90 had been entirely breast-fed. What was killing babies fed on bottled milk?

The mothers did not know. They knew only that their babies had died, and their laments stirred a tender-hearted New York merchant, Nathan Straus.

Science

Straus learned from two medical friends, Caille and Freeman, that Jacobi had determined that boiling momentarily in the bottle made milk safe enough for an infant to drink. And Freeman showed him how a new apparatus devised by Soxhlet in 1886 for the heat treatment of milk for baby feeding might be used, and how depots might be established to dispense milk that would be safe for the infants of New York.

Philanthropy

Beginning in 1892, at his own expense, Nathan Straus built and maintained milk-heating stations to dispense safe milk for babies. As noted above, 241 of every thousand babies in New York died in their first year in 1891. In 4 years, of 20,111 babies who drank the heat-treated milk, all but 6 lived beyond their first birthday. By 1920, Straus had set up 297 milk stations in 36 cities in the United States and abroad. Moreover, he gave courage and support to a legion that fought to protect food against contaminants of all kinds.

Thanks to milk sanitation and other health measures, in the past 100 years, infant mortality has been reduced 90 percent!

A WORLD PROGRAM

It is hard to realize that health workers 60 years ago were struggling with the problem of setting up the first heat treatment station for milk. In contrast, today, the Public Health Service is asked to render assistance on numerous problems: To approve the design of milk and food processing equipment, to study the thermal death curve of newly recognized disease organisms, to advise what insecticides may be used safely in a food processing plant, to determine the possible toxicity of plastics and other substances used in food equipment, to study and recommend sanitary construction features for milk equipment, to determine the effects on food of chemical compounds used as detergents and bactericides, and other problems.

The mail brings a variety of requests. The World Health Organization forwards an inquiry from the Health Ministry of El Salvador asking help on a technical problem related to milk evaporating equipment manufactured in the Netherlands. Another letter asks if there is tularemia in frozen rabbit meat from Australia. A letter from Mexico seeks a laboratory test to show whether cow's milk has been adulterated by goat's milk.

The contrast between the question of establishing the first milk treatment station and the questions that reach the health worker's desk today demonstrates that the task of protecting food from contamination has grown in proportion to the business of processing and shipping food among states and nations. Nathan Straus did more than curb this threat to child health. He helped to start a process of protecting the public health wherever food is handled.

FOOD-BORNE DISEASES

Food and food utensils can be contaminated with bacteria, parasites, or poisons. Food may carry the germs of brucellosis, tuberculosis, typhoid, paratyphoid, Q fever, scarlet fever, diphtheria, tularemia, salmonellosis, septic sore throat, and a variety of other disorders. There are good grounds for assuming that colds, influenza, and other respiratory infections may be spread also by contaminated glasses, forks, and spoons. Trichinae, tapeworms, and other parasites and botulin, staphylococcal enterotoxin, and other toxins, too, occasionally contaminate the food supply.

Frequency of Infection

It is difficult to assess the danger of contaminants in food because, outside of institutions, there are no present means of checking thoroughly the number, frequency, and sources of cases of food-borne disease. We know that enteric disorders are common, and that a high proportion of these disorders results from eating contaminated food. In the period 1938–48, inclusive, official reports counted 3,079 epidemics traceable to milk and other food, causing more than 120,000 cases of illness and 522 deaths. But even these reports are incomplete, and it is doubtful that more than one out of 10 cases of food-borne disease are ever reported. They include no cases of milk-borne tuberculosis or of Q fever, and only 249 cases of brucellosis. Yet spot-checks suggest that during this 11-year period, there were many cases of such infections, including at least 18,000 individual cases of milk-borne brucellosis. Official statistics report only a fraction of the actual incidence and prevalence of food-borne disease. Only 29 States require reports of food-borne infections.

One of the most common forms of illness today is the condition popularly called diarrhea, dysentery, or food poisoning. In the absence of specific diagnosis, these conditions may be grouped under the general heading of gastroenteritis. Physicians now distinguish two main subgroups. One is enterotoxic, usually induced by a poison secreted by staphylococci. The other is infectious, induced by invasions of salmonella, shigella, streptococci, and other organisms.

Foods, other than milk or milk products, are believed to be the agent of 90 percent of the outbreaks of gastroenteritis. It has been estimated that at least three-fourths of the gastroenteritis outbreaks reported are caused by staphylococcal enterotoxins. Salmonella infections seem the next most common cause, and shigella infections appear to follow in order. Ham, cream and custard baked goods, and poultry are the usual vehicles of the enterotoxin. Meat products, poultry, bakery products, milk and milk products, vegetables, and eggs are common carriers of salmonella. The human carrier is the most common vector of both the staphylococci and salmonella. It is estimated that the Nation may suffer as many as 1,000,000 enterotoxic cases a year, without counting the vast number of mild, subclinical, undiagnosed, and therefore unreported cases.

Tapeworms

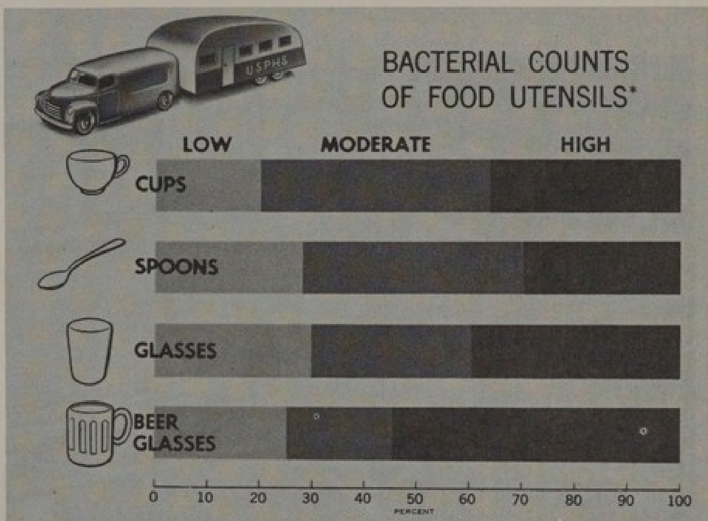
The tapeworm, *Diphyllobothrium latum*, parasitizes millions of persons of the Northern Hemisphere, including many in the lake country of Minnesota and Michigan. It produces in its hosts a blood condition resembling pernicious anemia. The life cycle of this parasite includes a fish-eating mammal, such as man or the dog, a crustacean called a copepod, and a fish, usually a species of pike. As a rule, infections occur when housewives taste chopped fish as they season it for cooking. Infected fish is not safe to eat unless it has been frozen or thoroughly cooked. Kitchen practices are the decisive environmental factor in this problem.

Utensil-borne Infections

Utensils may be means of transmitting respiratory infections as well as others. However, statistics on the number of respiratory infections contracted from food utensils are elusive. The possibilities of utensil-borne disease are suggested by the fact that the bacterial count on spoons, glasses, and cups in many restaurants is relatively high, and that 500,000 restaurants in the United States serve 60,000,000 meals daily. Most Americans, including school children, eat one or more meals a day in a public dining room. The opportunities for disease to spread through contamination of food on food utensils present a major health problem.

Defenses Against Contamination

Food-borne infection is limited to a degree by natural immunity in individuals; by certain automatic safeguards in food processing, such as heating, freezing, or drying; by the adoption of



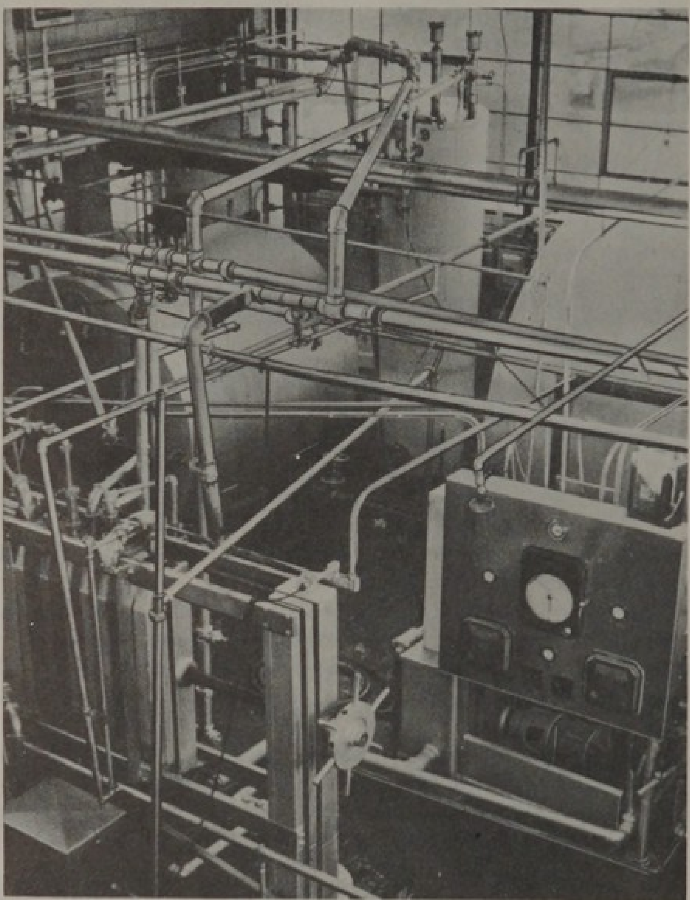
*Based on examination by USPHS mobile laboratories of more than 90,000 utensils from more than 8,000 restaurants in 112 cities

customs of sanitation in the food industry; and by activities of health workers in the public employ.

Modern refrigeration is particularly effective in preventing the growth of dangerous numbers of bacteria. Most outbreaks of food-borne enteric diseases have been caused by serving perishable foods which, after contamination, had been allowed to stand at room temperatures.

Cooking is an equally or perhaps a more valuable defense, but its effectiveness against an individual type of contamination will depend upon the time and temperature of heating. For example, cooking is not always sufficiently thorough to kill the trichinae in pork.

Activities of the Public Health Service to protect food from contamination are described below in three programs dealing with milk, shellfish, and general food sanitation.



Pasteurization is not a simple process. This high-temperature short-time unit illustrates the intricacy of the techniques used to protect milk consumers against harmful micro-organisms.

MILK: A PARADOX

Health workers pay particular attention to milk above all other foods because paradoxically it nourishes children and bacteria both. Almost a perfect nutrient, milk is a staple diet for children. But germs of tuberculosis, brucellosis, and Q fever may be present in milk when it comes from an infected cow, as well as the organisms which cause septic sore throat and enterotoxic poisoning. Moreover, milk from a healthy cow may be contaminated in handling. Even though containers are thoroughly cleaned and treated, they may be contaminated by an impure water supply or by dirty hands. Contaminants may enter pure milk also when it is opened for serving. Once in the fluid, at a favorable temperature, disease organisms may increase quickly to dangerous numbers. Thus a few bacteria may multiply to millions between milking time and delivery, if the milk is not properly safeguarded. This is the contradiction of milk: One of the most valuable foods, it is also highly vulnerable to contamination.

Pasteurization

Pasteurization, a controlled heat treatment, is the one sure way of destroying pathogens without impairing the flavor or nutritive quality of milk. Today, about 90 percent of the fluid milk sold in the United States is pasteurized. In 5 States, 15 counties, and 521 municipalities, pasteurization of all market milk is compulsory. An additional 346 towns and cities require pasteurization of all except "certified" raw milk. Pasteurization strictly performed is the basic safeguard against the transmission of disease through milk.

Cooling

Cooling of milk is important as a supplemental safeguard, both before and after pasteurization. In the routine handling and processing of milk, its temperature is raised or lowered a number of times. With each significant rise, there is an increase in the number of bacteria. Cooling of milk at the farm, before pasteurization, retards the growth of all organisms.

Pasteurization destroys or inactivates all pathogens, but certain bacteria which spoil milk, though they do not cause illness, survive pasteurization. Careless handling may reintroduce pathogens into milk after it is pasteurized. Therefore, it is necessary to cool milk promptly after it is pasteurized, and to keep it cool until it is consumed.

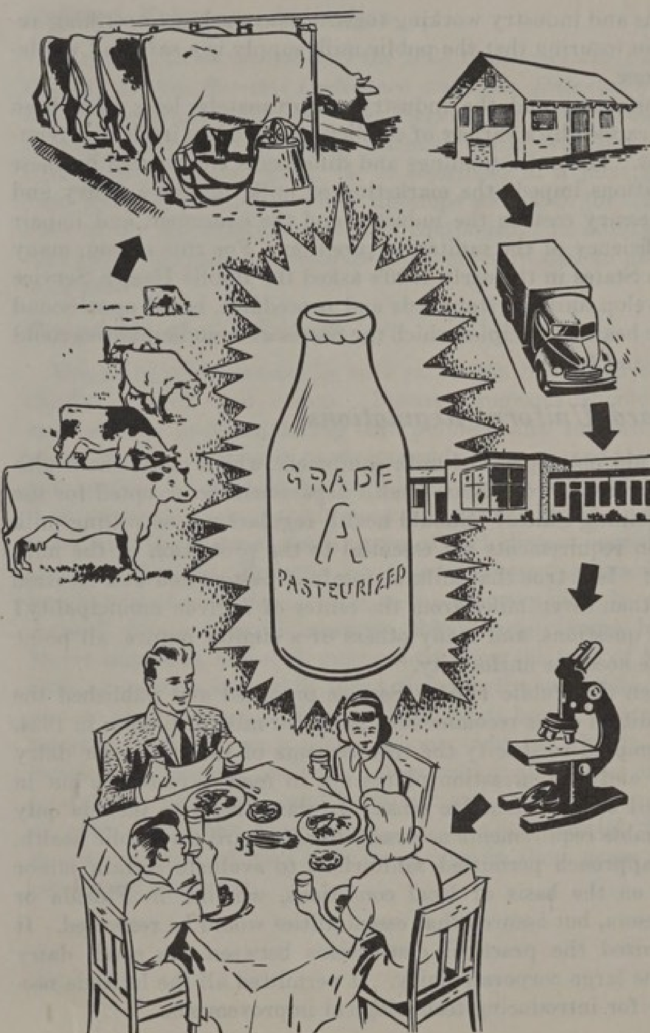
Total Defense

All defenses against contamination are subject to human or mechanical failure. Moreover, pasteurization does not destroy enterotoxins produced by certain bacteria, and present pasteurization methods have not been entirely successful in overcoming Q fever rickettsia. For these reasons, measures to protect our milk supply must cover the industry, from herd and dairy farm, through the pasteurization plant, to consumer.

Control Program

With so many processes and operations to watch in the distribution of milk, it was to be expected that society would form multiple defenses. Public health agencies, agriculture departments, and responsible elements in the food industry stand vigil together over the milk supply. Effective control programs are administered by trained city and county sanitarians with the support of State health and agriculture departments and private dairy interests. Most of their work is guided by basic State laws, supplemented by local ordinances. The States have vested authority over milk sanitation in either the health department or the agriculture department, and sometimes in both. Milk sani-

Healthy cows, careful handling, and proper pasteurization and other sanitary safeguards assure a safe milk supply. ➤



tarians and industry working together have achieved striking results in insuring that the public milk supply is a safe and wholesome one.

Sanitarians and the industry unfortunately long have been handicapped by a variety of conflicting and often irrelevant regulations. Misunderstandings and differences engendered by these regulations impede the marketing of milk, impose a heavy and unnecessary cost on the industry and the consumer, and impair the efficiency of the sanitation program. For this reason, many of the States in the early 1920's asked the Public Health Service to develop uniform standards and procedures, based upon sound public health principles which the States and municipalities could adopt and follow.

Toward Uniform Regulations

Should not a piece of milk equipment which meets the health requirements of one State health department be accepted for use in adjoining States? Should health regulations controlling milk contain requirements not essential to the protection of the milk itself? Is it true that milk is unsafe if pasteurized at a location more than seven miles from the center of a given municipality? These questions, and many others of a similar nature, all point out the need for uniformity.

When the Public Health Service prepared and published the first edition of its recommended standard milk ordinance in 1924, it attempted to specify the requirements of sanitation for dairy farms and pasteurization plants not in restrictive terms, but in a broad and constructive sense. It was careful to include only reasonable requirements necessary to safeguard the public health. This approach permitted sanitarians to evaluate certain minor items on the basis of local conditions, whether in Florida or Minnesota, but assured that essentialities would be respected. It recognized the practical distinctions between the small dairy and the large corporate dairy. It permitted all the latitude necessary for introducing technological improvements.

To support consistent standards and to promote uniformity nationally, the Public Health Service in 1927 published a code interpreting the standard milk ordinance. Since then, the Federal Government has published nine revised editions of the *Milk Ordinance and Code Recommended by the United States Public Health Service*, a product of the experience of sanitary engineers and other health officials, the milk industry, veterinarians, agriculturists, scientists, consumer representatives, and others. A National Advisory Committee assists in keeping each successive edition abreast of modern techniques and research.

This *Milk Ordinance and Code* now forms the basis for regulations of 32 of the States, and it is enforced State-wide in 11. Adopted by 367 counties and 1,468 municipalities in 38 States, on a voluntary basis, the ordinance and code now protects more than 58,000,000 consumers. It is recognized as the only fluid milk regulation approaching a National standard. And it has been accepted by many States as the basic regulation for an interstate certification program and an industry-wide education program.

Health Regulations as Trade Barriers

Complicating this problem of standardizing regulations, many States and communities have resorted to arbitrary milk prohibitions ostensibly with the purpose of protecting health but with the practical effect of restricting trade. States with a milk surplus favor uniform milk regulations that will enable them to market milk beyond their borders; but in some of these same States, local health ordinances are found containing special features that have the effect of blocking competitive sales of milk perfectly acceptable in other States. No matter what the economic issues may be, such local variations in health regulations can play havoc with a sanitation program.

For the foregoing reasons, many State health officials and leaders of the milk industry favor the national certification program, described below, to protect the sanitary quality of milk shipped interstate.

The Interstate Milk Certification Program

In the certification program, milk shippers under local or State supervision are inspected and rated by State health officials. The United States Public Health Service certifies these ratings. Milk from a certified shipper may then be accepted in other States and municipalities without further inspection. Certification makes it unnecessary for milk shipments to be inspected by milk control authorities of more than one State or city. A number of States and cities refuse now to accept out-of-State milk unless it is certified by the Public Health Service, and many have filed requests for certification of specific supplies by the Public Health Service. Also, States voluntarily have requested that the Public Health Service review and criticize the work of their milk sanitarians. These reviews and spot checks assure States receiving certified shipments that the States which rate interstate milk shippers are doing a proper job.

Education Program

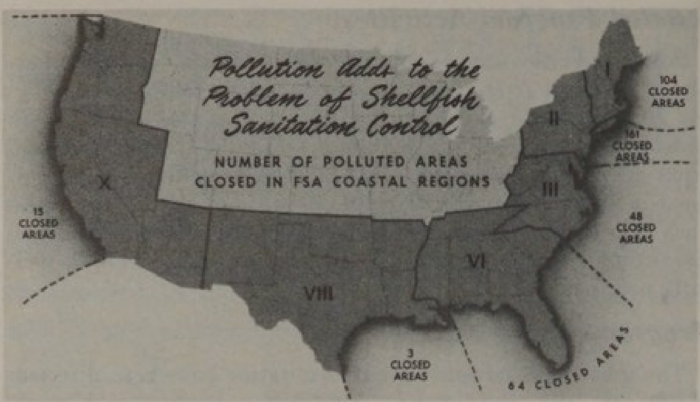
The Public Health Service milk sanitation program emphasizes the use of education rather than compulsion to achieve results. More than 50 training seminars from 1947 to 1949 were attended by more than 5,000 milk sanitarians and during this same period more than 50 demonstration schools were conducted for milk handlers, but it is hoped that the States will take over this activity. Also, educational materials are provided by the Service for the use of industry, schools, and public groups to encourage pasteurization and other sanitary practices. The Public Health Service maintains a constant study and review of problems of milk handling, in consultation with the States and the industry, to demonstrate to States how they may handle their own training program.

Related Program Activities

States and cities use not only the *Milk Ordinance and Code* but also the *Frozen Desserts Ordinance and Code Recommended by the Public Health Service.* The Service has also developed a standard rating procedure for States to use in evaluating municipal milk sanitation work. It is a member of a joint government-industry committee which develops standards for the guidance of the manufacturers of milk equipment. In addition, the Service participates in research and studies related to milk and milk products.

Programs of the Future

The great achievements in milk sanitation have been directed chiefly at milk and cream. Future programs should move against other problems facing both public health authorities and the industry. Most milk products, aside from canned milk, present certain hazards to health which need study and control. New pasteurization methods need to be investigated and correlated with the thermal death curve of such disease organisms as Q fever rickettsia. Recently developed processes, equipment, materials, and chemicals adaptable to the industry must be studied. Animal disease control measures should apply more broadly. Major emphasis, however, must continue on the task of keeping milk as pure as it is kept today through the established cooperation of the milk industry, local and State health departments, agriculture departments, dairy schools, and the Public Health Service. This task includes safeguarding all phases of milk production, processing, and handling, and the pasteurization of all milk for public consumption. It is also essential that the sanitary control of fluid milk be assured in those areas not yet adequately protected.



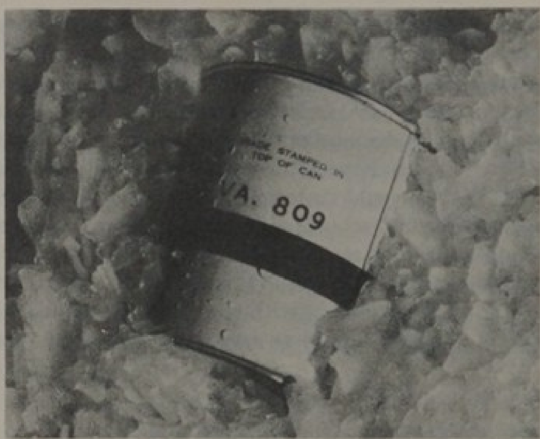
SHELLFISH

Shortly before Christmas in 1924, the health departments of New York, Chicago, and Washington were alarmed by a sudden flurry of typhoid fever cases. Detective work by the United States Public Health Service established that most of the typhoid cases had been contracted from oysters which were but a small portion of the total shipments of a single company operating in the Great South Bay off Long Island. As a safeguard, the New York City Health Department ordered an embargo on oyster beds in the New York City area. The public reaction was even more sweeping; people stopped buying shellfish of all kinds, and many also stopped buying scale fish. When they recall today what happened to their industry that Christmas, old fishermen still shake their heads in dismay.

Sanitary Control

To restore consumer confidence in seafood, the industry and city health departments appealed to the Public Health Service to develop a program which would strengthen sanitary regulations then in effect and broaden the scope of their application. In response, the Service published the *Manual of Recommended Practice for Sanitary Control of the Shellfish Industry.* All shellfish sanitation work in the Nation now refers to this standard.

As recommended by the manual, State shellfish authorities inspect and survey sanitary and bacteriological conditions in the growing areas. They restrict contaminated waters and patrol the waters to prevent illegal digging. State sanitarians also inspect shellfish plants periodically, and they award each satisfactory plant a numbered certificate of approval. Certified plants place the number of the certificate on each package of the shellfish they ship. These measures help to assure that shellfish will be protected against contamination. Also, in the rare event of accidental contamination, certification will help to trace and stop the offending shipment without penalizing the entire industry.



Each shellfish container should bear a number indicating certification of the contents.

Review and Endorsement

The Public Health Service reviews and evaluates the sanitary measures of the States. All State records and information are available for this purpose. The Service does not confine its review to examining papers, however; Public Health Service sanitarians personally check the waters and the packing plants to insure that the records are valid. So effective is this program that only a few States have ever failed to earn the Public Health Service endorsement that their controls are satisfactory.

Protecting Shellfish from Contamination

Normally, shellfish are a healthful food, exceptionally rich in minerals. They endanger health only if they are contaminated. As a rule, shellfish—or mollusks—are contaminated only if they were grown in contaminated waters, if they were stored in contaminated waters, or if they were contaminated by insanitary packing operations. Except for the allergic, anyone ill from eating shellfish should blame the contamination, not the food.

State authorities have closed at least 400 separate growing areas to the shellfish industry, because the waters of these areas were contaminated by sewage. Shellfish taken from moderately polluted waters can be treated in tanks or natural beds of clean water until they are free of contaminants, but this operation must be carefully controlled. The usual procedure is to take the shellfish from clean waters only, and to apply sanitary methods of shucking, packing, shipping, and serving.

The danger of polluted water lies in the fact that oysters, clams, and mussels filter water through their bodies to obtain their food. They feed on microscopic organisms which they screen out of the waters that run off the land. When this water carries sewage, the shellfish screen out certain organisms which may attack anyone who swallows them. These organisms are carried only in sewage. And they are likely to cling to the body of any shellfish taken from waters contaminated by sewage.

The best protection for the consumer and the industry—about 2,000 dealers ship $150,000,000 annually in produce—is to keep contaminants out of shellfish-growing waters. Until the coastal waters are clear of dangerous pollutants, the Public Health Service helps to keep contaminated shellfish out of the market with a program of research, education, supervision, and certification.

From shucker to consumer, the handling of shellfish must be sanitary.

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GENERAL FOOD SANITATION

As with milk and shellfish, State and local health departments have most of the responsibility for protecting the public from disease carried by other foods. Federal supervision and control is limited to foods served on interstate carriers, shipped in interstate commerce, or used by Federal institutions and the military forces. The United States Department of Agriculture inspects interstate shipments by meat-packing plants; the Food and Drug Administration of the Federal Security Agency examines interstate shipments of other foods; and the Public Health Service supervises the sanitation of food served on interstate carriers. But even Federal inspections are frequently supplemented by inspections by local authorities.

Jurisdiction

In most States, two departments share authority and responsibility for food sanitation: The health department is given responsibilities that bear directly upon preventing transmission of diseases through foods; and the agriculture department is given responsibility for such work because of its relation to food production and animal husbandry. County and municipal supervision of food handling is usually the task of health, rather than agriculture, officials. A few States and many local governments have achieved excellent results in food sanitation.

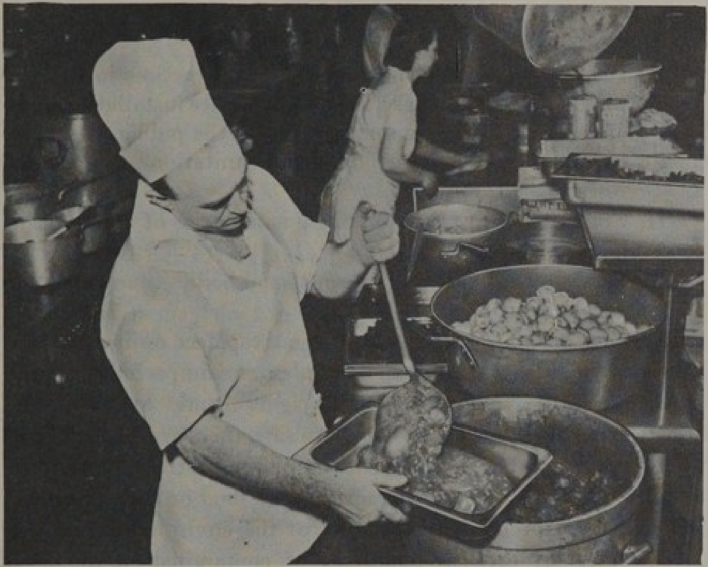
Restaurant Sanitation

Once the milk and shellfish controls were established, the most immediate task in preventing the spread of food-borne disease was the enforcement of sanitation in restaurants, soda fountains, bars, and similar establishments. The scope and urgency of this problem was established by State reports to the Public Health Service of food-borne disease. The Public Health Service, using mobile laboratories to inspect sanitary conditions in restaurants in 112 cities, confirmed the need for sanitation controls. Following this survey, the Public Health Service, with the aid of a National Advisory Board, State and local health officers, and industry representatives, developed and published in 1938 the *Ordinance and Code Regulating Eating and Drinking Establishments Recommended by the Public Health Service.*

This regulation has been adopted by 30 States and the District of Columbia, and 19 of these enforce it State-wide. It is also the regulation used by 212 counties and 529 municipalities. This regulation now protects more than 70,000,000 people in 41 States. The Public Health Service assists States, municipalities, and the restaurant industry to develop and improve restaurant sanitation by methods similar to those used in the milk sanitation program.

Next Steps

Health workers aim to install sanitation programs in all food handling and food processing establishments where there may be a hazard to public health. Such a program has been recommended by the Association of State and Territorial Health Officers, by the National Sanitation Clinic, by food industry associations, and by individual State and local health officials. Health workers and industry leaders have asked the Public Health Service to develop standards and recommend programs for sanitary supervision of bakeries, delicatessens, confectionaries, frozen food plants, meat and fish markets, slaughter houses, grocery stores, and bottling plants. Such establishments are being studied now to determine the type and scope of sanitary supervision which is advisable. When these studies are completed, and if a need exists, the Public Health Service will recommend standards for State and local adoption.



(Upper left and right) Sanitary measures must be applied to the handling and service of food to assure the public safety.

(Lower right) Given a realization of the importance of sanitation, and given instruction and experience in appropriate techniques, food handlers may exercise their inherent responsibility to protect the customers they serve.

SUMMARY

The Public Health Service engages in the following activities to protect the Nation from food-borne, including milk-borne, disease:

1. Develops and revises standards.
2. Promotes State and local programs based upon uniform standards and operations.
3. Advises and consults with State and industry officials on technical and administrative problems relating to sanitation of milk, shellfish, and other foods.
4. Encourages the training of food handlers and food sanitarians.
5. Certifies State ratings of milk and shellfish shipped interstate.
6. Prepares educational materials to train sanitarians and food handlers.
7. Evaluates State and local programs, upon request of State and local officials.
8. Consults with industry representatives on design and construction of food handling equipment and participates in joint industry-government development of equipment standards.
9. Inspects food handling facilities and practices in Federal prisons, National parks, in Indian Service installations, and on interstate carriers serving food to the public.
10. Conducts and advises on food sanitation and related research.
11. Compiles and publishes annual summaries of outbreaks of disease traced to food.
12. Serves on national and international bodies concerned with food sanitation.

Food has both a positive and a negative effect on health. On the positive side, there are the complex and imperfectly understood effects of food on long life, vigor, mental alertness, and resistance to disease. On the negative side, there are hazards from swallowing food-borne organisms or poisons. Hazards may result from individual idiosyncracies of the food or the person fed, but many are peculiarly a product of the environment: of polluted water, of careless handling, of contamination by insect vectors, and of improper processing. To the extent that it is possible to do so, the Public Health Service seeks to provide assistance in eliminating these hazards.

Pest Control

DISEASES THAT travel from one person to another have their own peculiar highways. The germs of communicable disease may float in water or air, and they may ride also in or on animals. Man himself is frequently a carrier. Some travel exclusively in or on animals and cannot live without their intermediary hosts. The intermediary hosts are significant disease vectors that transmit dangerous micro-organisms by channels subtle and pervasive.

DISEASE VECTORS: ARTHROPODS

The germs that travel by these vectors move in varied and complex paths. As germs make their way from man to man, they may be carried by several different animals. *Pasteurella pestis*, agent of plague, for example, usually moves from rat to flea to man. *P. pestis* may lodge as well in a squirrel, prairie dog, or other flea-bitten rodent. All sorts of animals may become temporary havens for such travelers and may help to carry them.

Disease vectors of primary concern to the Public Health Service are jointed creatures classed as arthropods. These include six-legged animals (the multitudes of the insect world, flies, fleas, roaches, lice) and eight-legged animals (mites and ticks of the arachnid group).

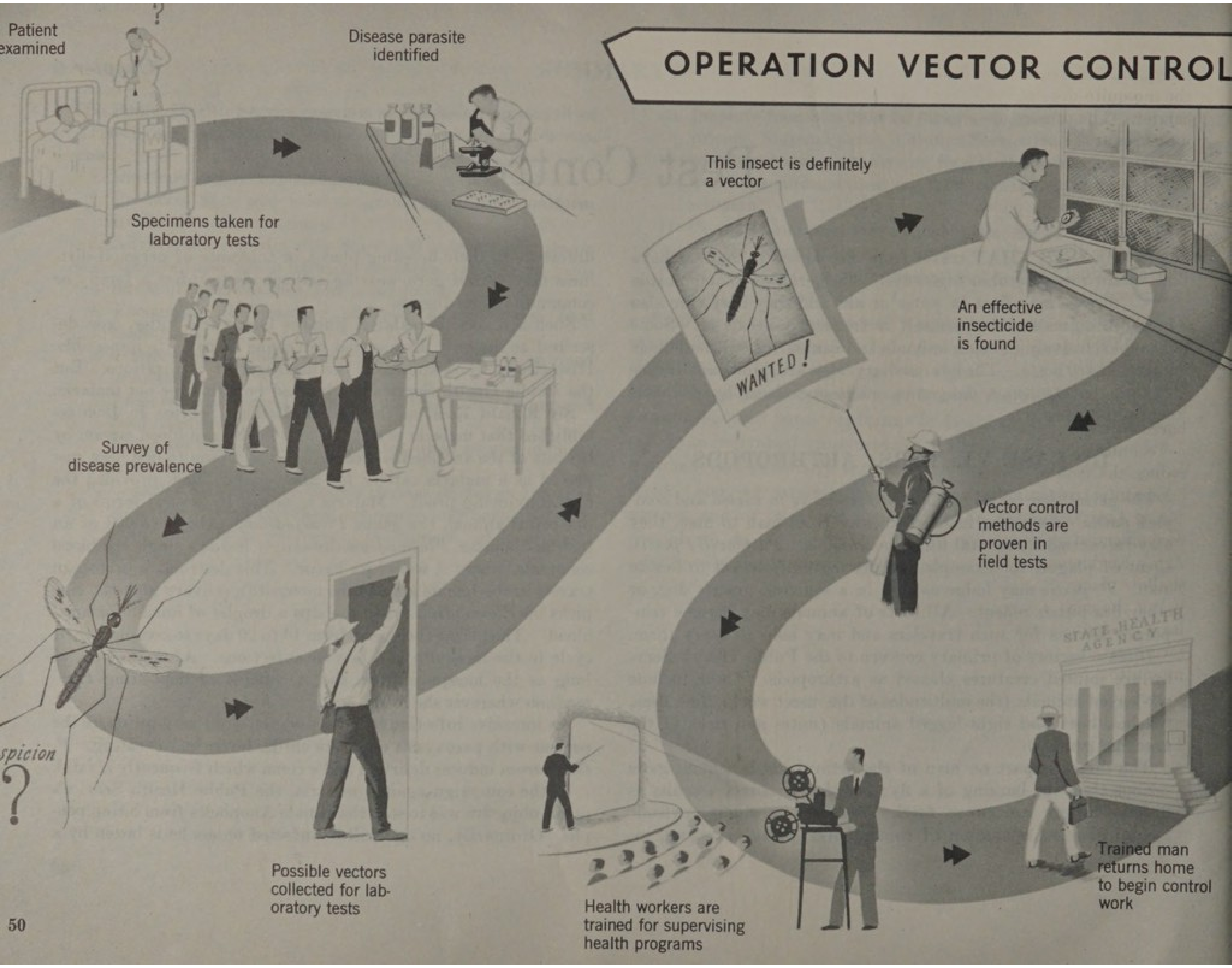
The direct impact on man of the arthropods is seldom more serious than the buzzing of a fly; but their indirect assaults as disease vectors can prove fatal. Moreover, a slight environmental change, relaxation of control over waste or refuse, indifference to their breeding places, or tolerance of personal dirtiness may permit germ-bearing arthropods to infect a family or community with disease.

Such a disease is malaria, Number One world killer, once described as the only disease that can make human life impossible. Historically, it is known as the destroyer of civilizations. But the Public Health Service has learned how to wipe out malaria.

Sir Ronald Ross, of the Indian Medical Service, in 1895 established that malaria is stabbed into the human blood stream by the bite of the anopheline mosquito. The mosquito had been suspected as a malaria carrier for 2,000 years. Ross provided the first convincing proof. Malaria is caused by several forms of a one-celled animal, the genus *Plasmodium*. About 1/3000 of an inch in diameter, *Plasmodium* fits snugly inside a single red blood corpuscle, where it works its havoc. This destructive protozoan travels in the female anopheline mosquito's salivary glands. She picks up *Plasmodium* when she sips a droplet of human malarial blood. The germs then need from 10 to 20 days to complete their cycle in the mosquito and become infectious. After they do, as long as the mosquito lives, she is capable of depositing *Plasmodium* wherever she feeds.

An intensive infection by *Plasmodium vivax* may prostrate the patient with paroxysms of severe chills, fever, and sweating. *P. falciparum* induces delirium and a coma which frequently is fatal.

In the campaign against malaria, the Public Health Service's prime objective was to stop the female Anopheles from biting people. Ordinarily, no one will be infected unless he is bitten by a


OPERATION VECTOR CONTROL
Patient examined
Specimens taken for laboratory tests
Disease parasite identified
Survey of disease prevalence
Possible vectors collected for laboratory tests
This insect is definitely a vector
WANTED!
An effective insecticide is found
Vector control methods are proven in field tests
Health workers are trained for supervising health programs
STATE HEALTH AGENCY
Trained man returns home to begin control work

mosquito. Moreover, the disease cannot be circulated so long as the mosquito does not have the opportunity to pick it up from a carrier. The present strategy, therefore, is to concentrate control measures at the point of transmission.

Various measures are used in the general mosquito control campaign. Screens and repellents, as a defense against mosquito bites, are partially effective. Doses of DDT in marshes where Anopheles mosquitoes lay their eggs reduce the swarm. Drainage ditches dry out the breeding grounds. Health workers employ a residual DDT spray to slay the adult Anopheles mosquito in exposed homes. Operations to destroy the larvae, however, are confined to large towns and cities, because it is not economical or even physically possible to find all breeding places. Anopheles larvae float and feed horizontally on the surface of swamps, ponds, and quiet streams. Any impounded water—water in poorly graded highway ditches or irrigation canals, swamps, marshes, borrow pits, and reservoirs—is a possible site for mosquitoes.

Technical advice by the Public Health Service has helped to reduce the mosquito swarms on lakes created by dams built for flood control by the Tennessee Valley Authority and by the United States Army Engineers. By shifting the level of these lakes, as recommended by the Public Health Service consultants, the U. S. Army Engineers prevent the breeding of the mosquito larvae in shallow places near the shore line.

But the most efficient, economical, and practical attack on malaria mosquitoes has been to apply small doses of DDT to the interior walls of the dwellings of malaria patients so as to kill those mosquitoes which get into the home. Mosquitoes are vulnerable to this attack because they tend to linger on the walls after a blood meal. This attack destroys mosquitoes which bite persons who harbor malaria. It kills mosquitoes at the point where they pick up or transmit the germ. Entomologists have known for years that most malaria mosquitoes bite in the home at night, and the present strategy of the Public Health Service against malaria is based on that knowledge.

The drive against the mosquito gained new impetus during the Second World War, when it was necessary to protect the health of soldiers quartered where malaria was endemic. This drive has continued since the war in an effort to eradicate malaria in the United States. The achievements of that drive have demonstrated that Nation-wide victory over malaria is a practical possibility.

The traditional tactics of mosquito control were effective in cleaning malaria out of cities, but they were less useful in rural communities or in those foreign countries lacking the resources to undertake costly draining and screening programs. Where economic resources and educational facilities were limited, the campaign against malaria was severely handicapped until the Public Health Service employed the technique of residual spraying of DDT on the walls of dwellings. This technique was the first efficient and economical approach to malaria control outside of prosperous urban areas. If not for that development, the Nation would not now be at the point of eradicating this disease. Moreover, this technique, because it is economical, may be applied world-wide. Many malarial countries are employing the method today with confidence that the health, vigor, and productivity of their people will benefit.

The malaria story illustrates the significance of the vector in the campaign for public health. It illustrates also the role of environmental factors—in this instance, window-screening and drainage conditions—in the control of vectors.

OPERATION VECTOR CONTROL

In its environmental health program, the Public Health Service conducts a special campaign to determine how diseases are transmitted, what are the specific and important vectors, and what are the best practical methods for controlling the vectors.

A primary unit of the Public Health Service in this campaign is the Communicable Disease Center in Atlanta, Ga., in association with the Service's Rocky Mountain Laboratory at Hamilton, Mont., and other branches of the National Institutes of Health. Teams of physicians, engineers, veterinarians, epidemiologists, microbiologists, entomologists, and research workers in many fields develop the strategy, tactics, and weapons which State, county, and municipal health workers from Alaska to Puerto Rico may use in the fight for health.

Research laboratories gather facts about disease, vectors, and controls. Next, research laboratory findings are tested on a small scale in field studies. Third, if the findings prove sound, they are broadened into large-scale control operations carried on by State and local health departments.

Before, during, and after large-scale operations in the control of communicable disease, the Public Health Service sponsors educational demonstrations of control operations and achievements. The Service aids also in training skilled health workers to assist in wiping out communicable diseases.

VECTOR-BORNE DISEASES

The list of diseases carried by vectoral arthropods is long and ominous. In addition to malaria and plague, mentioned above, the list includes typhus, a rickettsial infection carried by rats, lice, and fleas; yellow fever and breakbone fever, carried by the aedine mosquitoes; Q fever, Rocky Mountain spotted fever, and other rickettsial infections carried by ticks and mites; encephalitis, carried by culicine mosquitoes; and a variety of diseases caused by germs carried by several kinds of flies. The Service is also investigating the relation of eye gnats to conjunctivitis, which afflicts many in rural areas of the South and West. So long as the vectors abound, there is always the possibility that the germs they carry may multiply.

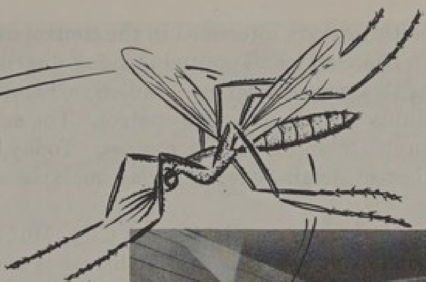
An attack on any one vector may simultaneously reduce other vectors and thus eliminate several possibilities of infection in one stroke. The following paragraphs describe work that has been aimed at four clusters of arthropods: mosquitoes, flies, rat-fleas and lice, and household pests.

MOSQUITO CONTROL

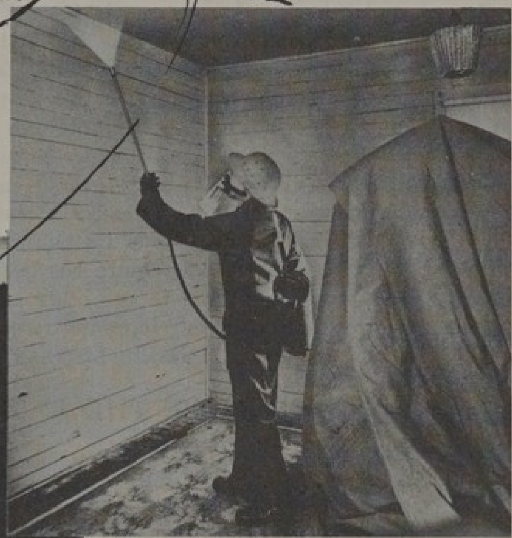
Much as the Public Health Service is concerned with protecting people from fatal fevers, it seeks to reduce minor afflictions, also. And mosquitoes, even when they do not carry infections, are clearly a nuisance that should be curbed where possible. This practice is in keeping with the modern view that the public health worker is as much a contributor to general welfare as he is a destroyer of disease. For this reason, mosquito control, aimed primarily at the carriers of malaria, attacks other kinds of mosquitoes also. Although malaria mosquitoes in the United States have been greatly reduced, control efforts continue in order to prevent their resurgence. At the same time, control measures tend to curb some carriers of encephalitis and breakbone fever, also.

The Public Health Service is well advanced in a 5-year program to drive malaria out of the continental United States. Jointly administered and financed through Federal, State, and local health services, DDT residual spray treatments have been applied to more than a million homes in 13 Southern States in a single year.

The 5-year program to wipe out malaria includes, in addition to the typical measures of direct control and technical consultation described above, improvements in malaria diagnosis, a reporting system, a training program, and a campaign of public education. Training technicians to recognize *Plasmodium* in its several forms in the blood cells helps to secure accurate diagnosis and reporting. Improved laboratory facilities and the appointment of "malaria detectives" by State health departments also help to obtain accurate reports on the causes of deaths reported as malarial. Observation and investigation stations for this purpose are operating now at Helena, Ark.; Newton, Ga.; and Manning, S. C. The education program includes practical training



Drainage empties the stagnant pools where mosquitoes breed.



The most effective and economical method of stopping malaria is to spray rooms where malaria patients sleep. This kills the mosquitoes at the point where they are likely to pick up the disease and carry it to others.

Spraying the surface of pools kills the mosquito larvae.

courses for public health workers interested in the control of mosquito-borne disease. The Service also produces for distribution to State and local health agencies a series of bulletins, handbooks, and audio-visual training aids on mosquito control. The achievements of this total program speak for themselves. Today, there are few if any authentic death reports giving malaria as the primary cause.

Meanwhile, a team has been set up in Kansas City, Mo., to investigate the vector role in encephalitis. This disease is endemic in many areas. Epidemics in Massachusetts, California, Louisiana, and several States of the Missouri Valley have afflicted thousands of human beings and tens of thousands of horses. The team to investigate encephalitis includes an epidemiologist, a veterinarian, an ornithologist, and several entomologists and virologists. They are giving particular attention to the role played in this disease by arthropods, including the mite and the culicine mosquito. Since the mosquito has been identified as a carrier, the Public Health Service and other agencies are working to the end that projects to develop water resources will be built and operated so as to prevent mosquito breeding.

RIDERS OF THE RAT

Outside the laboratory, there are few clean rats. On their backs, rats carry lice, mites, and fleas. In their bodies rats and their ectoparasites carry the agents of typhus and the evil germ of plague. Well may man shudder when he sees a rat.

Where rats thrive, death threatens. In 1945, the annual mortality from murine or endemic typhus was 5,338. The United States Public Health Service wheeled into action with health departments in the affected States: first, research; second, pilot operations; third, training; and then Operation Rat—protection of buildings against entry by rats, DDT dusting to kill rat ectoparasites, a wholesale cleanup of rat nests and feeding places, and poisoning. The number of murine typhus cases reported declined then to fewer than a thousand a year.

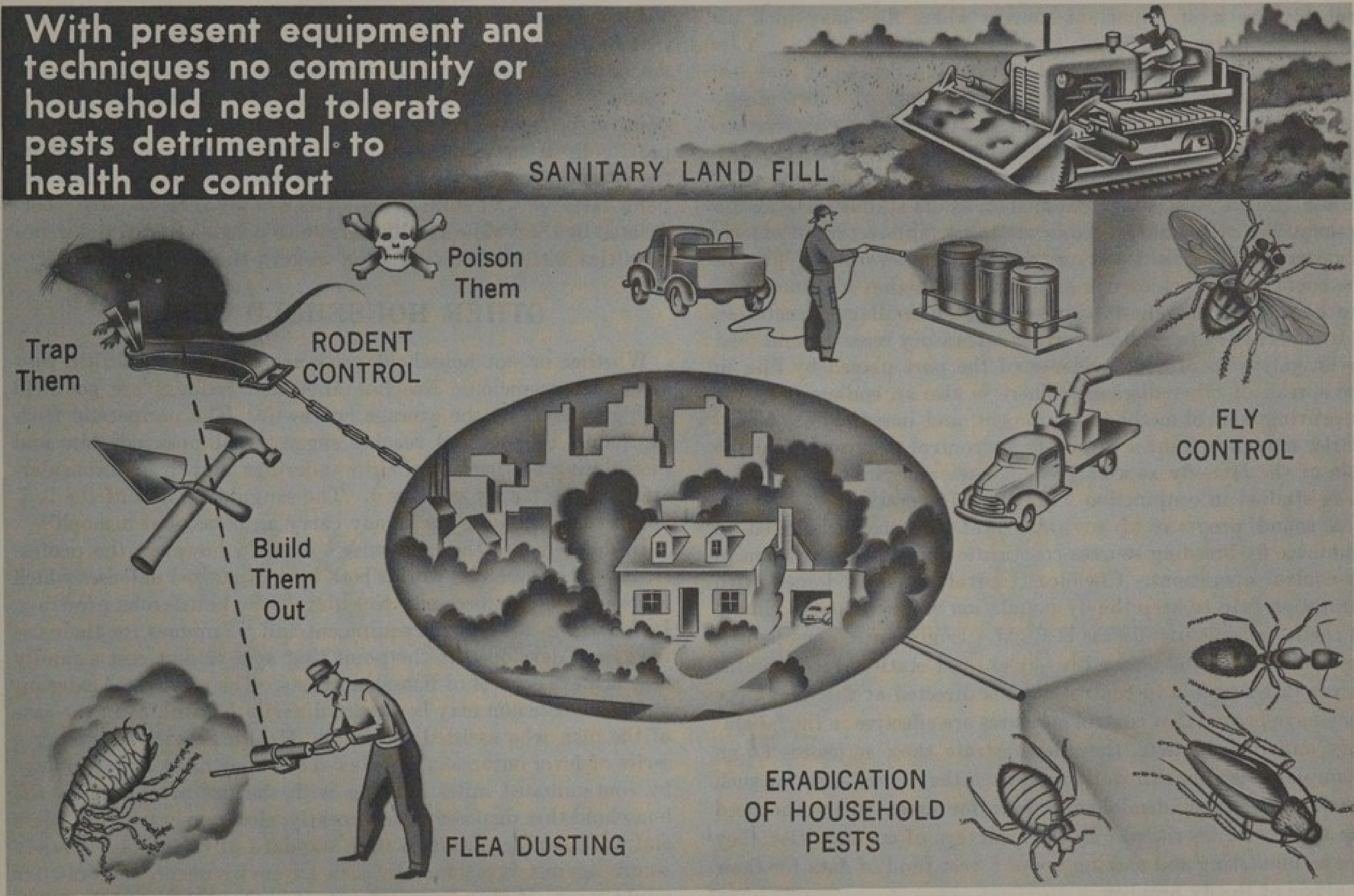
But the rodent force has not surrendered. Ground squirrels are known to have carried plague germs from the west coast as far east as North Dakota, Kansas, Oklahoma, and Texas. The rats may pick it up again. They may carry typhus or plague to new territory, wherever they find carelessly stored food, loose garbage, open dumps, a chance to share the meals of hogs or other animals, and junk, trash, or timber piles that give them cover.

Against this threat, the Public Health Service continues a program of field studies and basic research, described in Chapter 14. Federal, State, and local officials join forces against the rat wherever typhus is endemic or where it shows as a menace. Student health workers learn the techniques of rat control from rodent control experts who supervise and direct them in the practical work of spotting and eliminating nests, feeding places, and runways. Such intensive training provides competent personnel to deal with rats even where disease is not a present problem. To supplement these courses, the Public Health Service also distributes a comprehensive manual, audio-visual strips, and motion pictures to advance the rodent control activities of health departments.

FLIES

Of all the arthropods in this country, among the worst offenders today are the common housefly and its fellow travelers: stable flies, green bottles, blue bottles, blow flies, deer flies, flesh flies, and fruit flies.

The common housefly lays its eggs in garbage, feces, and other moist, warm, organic wastes. The young flies take their first meals in these deposits. Inevitably, they pick up dangerous micro-organisms and carry them, on their bodies and in their stomachs, to kitchens, dairies, and water sources. Flies breed abundantly in hog pens, poultry yards, stables, garbage, packing-house wastes, and other points where organic waste is piled. Insanitary privies and neglected septic tanks and cesspools are



With present equipment and techniques no community or household need tolerate pests detrimental to health or comfort
SANITARY LAND FILL
Poison Them
Trap Them
RODENT CONTROL
Build Them Out
FLY CONTROL
FLEA DUSTING
ERADICATION OF HOUSEHOLD PESTS

probably the most important sources where flies may pick up pathogenic organisms.

The housefly has been accused of carrying dozens of diseases. It is under suspicion of carrying the agents of tuberculosis, anthrax, trachoma, and poliomyelitis, although it is not certain what part, if any, it plays in their distribution. It is certainly guilty of epidemic outbreaks of several enteric diseases. The Public Health Service has established by its studies in Hidalgo County, Tex., that domestic flies are important vectors of enteric disorders. When field workers reduced the swarms of flies in the county, they achieved a significant reduction in illness and death caused by shigella-type infections, the bacillary dysenteries.

It is necessary to conduct further laboratory research and field investigation to provide evidence of the part played by flies in the spread of other diseases. There is also an endless need for improving control methods, equipment, and insecticides. Meanwhile, enough is known to justify fly control programs, and the role of the housefly as a carrier of disease organisms continues to be studied in conjunction with control operations.

A sound program of environmental sanitation designed to eliminate fly-breeding sources constitutes the primary weapon in fly-control operations. Chemical control measures joined with sanitation help to keep the fly population so low that the chance of their transmitting disease is slight. Engineers, entomologists, epidemiologists, public health nurses, and statisticians combine forces in research and control actions directed at the fly. Once they have proved that control measures are effective in the laboratory and in field tests, they demonstrate these measures as an example to local health workers. When they select sites for such demonstrations, epidemiologists look for areas where the need for fly control is critical. In their surveys of communities, they are accumulating and making use of a vast fund of data for their analysis of the fly problem.

A complicating factor in the chemical phase of fly control is that flies build up a resistance to insecticides. Such changes in the nature and habits of arthropods as disease vectors oblige health workers intermittently to revise their control tactics. For the same reason, State and local health workers who are training and practicing in environmental sanitation seek up-to-date facts on the effects of chemicals and other control techniques. The far-flung research and control activities are all reviewed and coordinated by the Public Health Service to provide States and municipalities with such information to curb the filthy housefly.

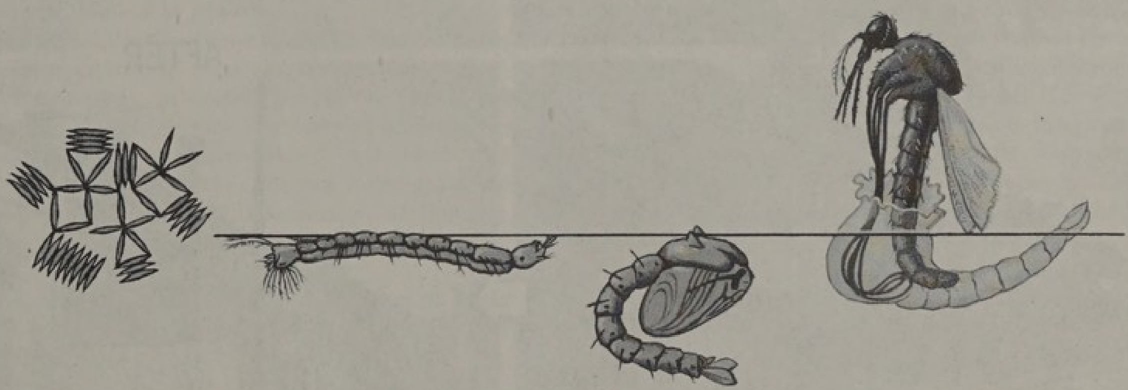
OTHER HOUSEHOLD PESTS

Whether or not household pests are a threat to health, they are under suspicion. Roaches, ants, and bedbugs are not held in high esteem by the average housewife. The peripatetic feeding habits of ants and roaches suggest that unsavory bits and pieces cling to them in their wanderings and drop inconsiderately on the family sideboard. The sanguinary diet of the bedbug is one that suggests it may carry an occasional hemophil.

In deference to the housewife's instinct, however, the professional and commercial worlds both have organized defenses which relieve her of the necessity to endure their pestiferous prowling. Lethal chemicals and the equipment and techniques for their use have been developed to the point that at a modest cost a family may achieve control of household pests. The services of exterminators on occasion may be extraordinarily helpful, as in the case of the man who assisted the Public Health Service in tracing a series of fever outbreaks in a New York apartment center to bites by contaminated mites. Along with the use of chemicals, the household that disposes of food neatly, closes up crevices in floors and walls, and maintains a high standard of cleanliness is fairly secure against invasion. In such an environment, the crawlers might starve if chemistry did not administer the coup de grace.

SUMMARY

Cleanliness, construction, and chemistry are major headings over the many activities that combat disease vectors in the arthropod world. Public cleanliness, exemplified in proper garbage disposal, impairs the environment for rats and flies and simultaneously improves it for man. Habits of personal cleanliness reduce the danger of bites from ticks. Screening of windows protects a family from a host of annoying insects, particularly from infectious flies and mosquitoes. Ratproofing inhibits the movements of fleas and lice. Other measures prevent the breeding of mosquitoes and contamination by flies. Liberal use of chemicals destroys flies, mosquitoes, and other vectors of disease before they do their damage. In these activities, society enlists the professional skills and knowledge of the entire community. The Public Health Service has had a share in this campaign.



The pictures on the right show how the neighborhoods on the left were improved by a health official's effective administration of provisions of the housing code.

Health and Safety at Home

THE NATURAL ENVIRONMENT—air, water, food—with the plants and animals that are a part of this environment, has been the recurrent theme of the previous chapters. The following three chapters deal with the man-made environment as manifested in shelter, transportation, and industry.

This discussion begins with an elementary health need, the need for shelter. Improvement in present housing is surely possible, in line with the principles developed by the American Public Health Association for satisfying physiological and psychological needs, and for providing protection against accident and contagion. The Public Health Service is concerned with the environmental effects of shelter on communicable disease, on chronic disease, on safety, and on mental health. Studies of design, structure, lighting, heating, ventilation, and sanitation of housing, undertaken by more than 50 universities and privately endowed institutions, help in the attack on these problems.

Since Americans, collectively, spend three-fourths of their life under a roof, it seems worth while to consider how the structures they inhabit affect their physical and mental health. Temperature, humidity, ventilation, dust, bacteria, and light affect them physiologically. Crowding, noise, appearances, and other factors affect them psychologically.

In the National Housing Act of 1949, it is stated as public policy that the "general welfare and security of the Nation and the health and living standards of its people require a decent home and a suitable living environment for every American family."

PROBLEMS OF HOUSING

Probably the basic problem of health in housing is the development of adequate standards of design, construction, and equipment. This problem is comparable to the problem of establishing standards of money, weight, or electric current.

The Committee on the Hygiene of Housing of the American Public Health Association, after drawing up its classic statement of principles for healthful housing, mentioned above, set out to publish three volumes on housing standards. The first, embracing the principle that the health of the home is inseparable from the health of the community, is *Planning the Neighborhood.* The second is *Planning the Home for Occupancy.* The third is *Construction and Equipment of the Home*, published in 1951.

Air

The standard of air is a consideration that enters into all three of these topics.

Apart from containing enough oxygen to sustain animal life, air should be relatively free of toxins, bacteria, and other dangerous organisms, offensive odors, dirt, dust, grit, and dangerous radiations. The site usually determines the quality of air in the home. If the site of a dwelling is unfortunate, it may be possible, if not economically feasible, to keep its air clean with the use of filters or a precipitator. Other atmospheric hazards may be averted by attention to leaking gas pipes, leaking refrigerants, and the release of carbon monoxide by gas-burning heaters.

The Naval Medical Research Center has demonstrated that odors cannot be overcome successfully except by ventilation, isolation, or removal of the source. Ventilation helps also to dilute concentrations of bacteria, provided the draughts do not merely stir up bacteria from the floor.

Efforts to regulate the air's relative humidity and temperature have been far more ambitious than efforts to keep air clean.

Relative humidity has a direct relation to the concentration of bacteria: the die-off rate of typical nose and throat bacteria has been shown to be greatest at a relative humidity of 50 percent at room temperature. The heating system in a house also has a pronounced influence on the health qualities of the air: gravity warm air convection, for example, induces greater variations in air temperature than baseboard panel systems.

Interrelations

As many elements of structure—site, windows, heaters, pipes, and vents—are related to a single health factor in air, so are many health factors affected by a single structural element—for example, the floor. Flooring may be selected with regard to its chilling or heating effects, fatigue effects, slipperiness, noisiness, and ease of cleaning. Chilling or heating of the floor may be affected by insulation, construction, and heating design.

Space

One question fundamental to housing standards is, how many square feet of shelter are needed for health and safety? Family housing accommodations, particularly multiple-dwelling-unit structures, have been built with less than 650 square feet per unit. The Committee on the Hygiene of Housing feels that a family of three should have 1,000 square feet of living space, efficiently distributed for eating, sleeping, storage, and other functions.

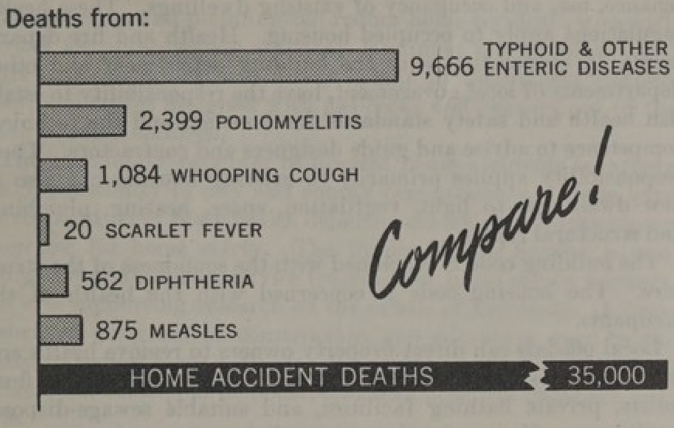
Studies relating health to space show that in a dwelling with no more than one person per room, there are fewer cases of contact diseases than in more crowded homes. Preliminary figures from the 1950 Census of Housing show that more than 6,500,000 families live in homes with more than one person per room. More than 2,500,000 families live in homes with more than 1.5 persons per room. In uncrowded homes, there are proportionately fewer cases of contact diseases that are relatively dangerous to toddlers and infants. These diseases occur less frequently among preschool children in uncrowded homes than among school children. It is possible that if there were one room to a person the cases of tuberculosis contracted from others in the same home (the "secondary attack rate") might be substantially reduced. This opinion is based on a study of children under 15 in all income groups. Secondary attacks of tuberculosis in homes with 1.5 persons per room were 80 percent greater than in homes with less than 1.0 persons per room. More than a million years of productive life were lost as a result of preventable tuberculosis deaths in the United States in the single year 1944.

Adequate living space in the home is associated with mental health and with wholesome personal relations within the family, attributable to opportunities for privacy and recreation in the home, and to relative freedom from noise and other irritations.

Toilet Facilities

The National Health Survey conducted by the Public Health Service in 1935–36 found that a private flush toilet makes a big difference in the average family's health. If a dwelling had such a fixture, the family was much less likely to suffer attacks of typhoid fever or other intestinal infections. Sanitary toilet facilities have been related also to the number of infants who survive their first year: the infant has a distinctly better chance of living if the home has adequate sanitary facilities.

The 1950 Census of Housing shows that more than 10,000,000 dwellings, otherwise in good condition, lacked a private toilet or bath. More than half of these, mainly rural, were without running water. More than a fourth of all dwellings in the Nation had no private flush toilet for the exclusive use of the immediate household. More than 3,500,000 of these dwellings were in cities.



Safety

Home accidents are a major source of death and disability. They kill more American children than all communicable diseases combined, including tuberculosis and poliomyelitis.

Every 16 minutes on the average, a home accident causes a death; every 4 minutes a permanent disability.

In 1948, those injured by home accidents in the United States numbered 5,250,000. Of this number, 140,000 were permanently disabled. More than 35,000 died, approximately the same number as were killed on the highways, more than the total number of Americans killed in the First World War.

In terms of wages lost, medical expenses, and insurance costs, the 1948 home accident bill was $700,000,000. For the past 15 years, there has been little change in this annual toll of falls, burns, and accidental poisonings and shootings.

The National Health Survey found that for all age groups and both sexes, the frequency of home accidents disabling for 1 week or longer increased as the monthly rental or value of the dwelling decreased. This study suggests a clear relation between housing and health. Loose or rotten boards, leaking pipes, littered yards, broken steps and rails, crumbling cement, and dark halls are hazards characteristic of rundown dwellings.

The 1950 census indicates that there were more than 4,000,000 dwellings that were "dilapidated," so as to endanger the health or safety of the occupants. About 90 percent of these units were occupied.

In new houses or old, structural factors such as steep stairways are important as causes both of accidents and of strains on the heart. It is an elementary objective of environmental health to reduce or eliminate accident hazards and sources of strain or fatigue in dwellings and other forms of shelter.

IMPROVEMENTS IN HOUSING

The character of dwellings may be improved as to qualities of health and safety by three forms of direct action.

1. Building enough new structures to eliminate overcrowding, to replace dwellings unfit for occupancy and unsuitable for rehabilitation, and to provide enough vacancies to allow a fair selection for families obliged to seek a change in quarters.
2. Rehabilitation of existing substandard housing, or, if rehabilitation is uneconomical, demolition of housing that menaces health and safety.
3. Maintaining housing conditions which are presently safe and healthful.

New Construction

Aided by liberal Government-insured financing, private enterprise has set new home-building records in the past five years. At the peak in 1950, builders started about 1,400,000 new dwelling units, including a small proportion of public housing. The Nation's health requires still more new housing.

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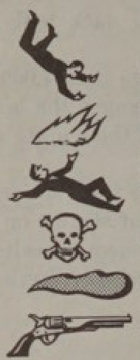
In 1948 —— —— 35,000 deaths from home accidents:



	NUMBER	PERCENT
FALLS	18,200	52
BURNS	6,000	17
MECHANICAL SUFFOCATION	1,800	5
POISONS (Except Gas)	1,450	4
POISONOUS GAS	1,450	4
FIREARMS	1,150	3
OTHER	4,950	15
TOTALS	35,000	100

Rehabilitation

Helpful though this vast productive effort is in meeting the demand for new housing, many families nevertheless find themselves still obliged to occupy substandard dwellings which need to be improved if their health and safety is not to suffer.

Although a rehabilitation program cannot wholly overcome inherent defects in a structure or neighborhood, it has two advantages: first, it is a means of increasing the supply of safe and healthful housing; second, it offers an opportunity for immediate remedial action by local officials.

In the past several decades, housing has been regulated primarily by building codes.

Today, many health departments administer housing codes regulating, in the interest of the health of the community, maintenance, use, and occupancy of existing dwellings. These health regulations apply to occupied housing. Health and fire departments, in cooperation with the building department and other departments of local government, have the responsibility to establish health and safety standards for housing, and the technical competence to advise and guide designers and contractors. Their responsibility applies primarily to existing housing but also to new dwellings—to light, ventilation, space, heating, plumbing, and structural repair.

The building code is concerned with the soundness of the structure. The housing code is concerned with the health of the occupants.

Local officials can direct property owners to remove health and safety hazards. Installations of hot running water, private flush toilets, private bathing facilities, and suitable sewage-disposal facilities usually require the active collaboration of local government. By ordering improvements in heating systems, they can improve the healthfulness of the living environment as well as remove fire hazards that threaten an entire neighborhood. By directing repairs of broken glass, boards, steps, walls, and fences, they can help to reduce accidents.

Accidents can be prevented. Accidents do not simply "happen." There is always at least one direct cause. A national organization says that practical methods can reduce home accidents as much as 80 percent.

Health organizations can investigate causes of home accidents, evaluate remedial or preventive measures, educate the public to apply such measures, and encourage medical attention to the accident-prone and physically handicapped. They can help to educate the public to demand safe construction in the home; to eliminate housekeeping hazards; to select safe playthings for children; to install safety devices such as handrails; and to avoid hazardous tasks, particularly when the performer's physical condition is below par as a result of fatigue, a physical handicap, or an emotional disturbance.

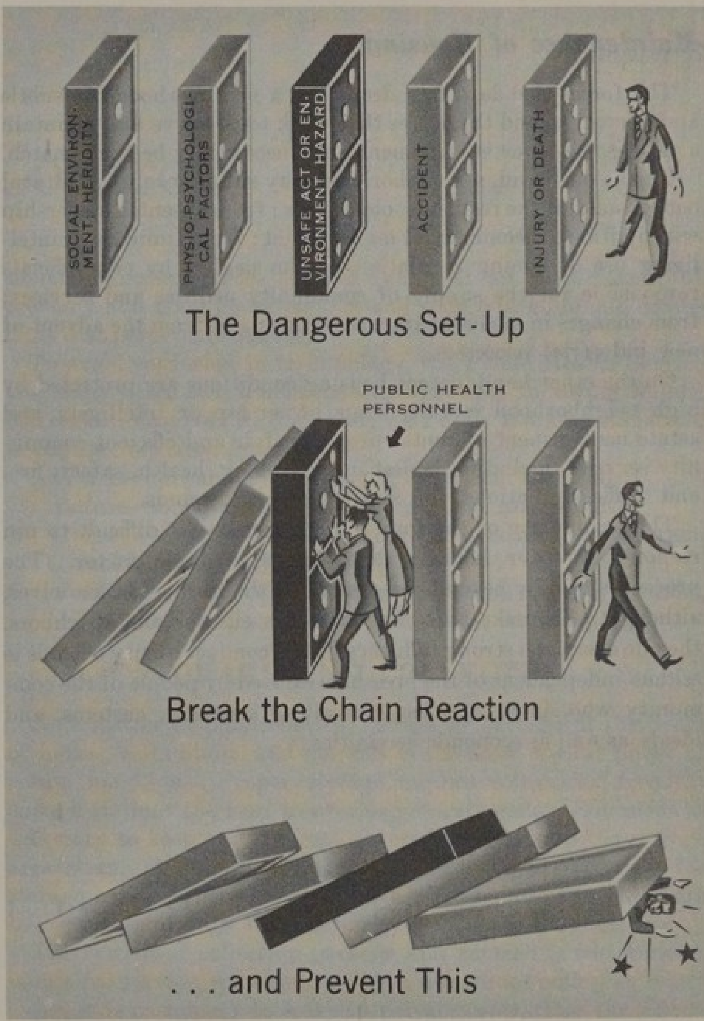
Engineering and planning can reduce home accidents with such devices as: intermediate stairway landings; slip-proofed rugs; knife racks in kitchens; a 6-foot height for permanent clotheslines; and stoves designed with gas-cocks and burners out of the reach of small children.

The community program to prevent home accidents is largely the responsibility of city and county organizations. These have the cooperation of State health departments which are drawing up programs for home safety. The Public Health Service is providing materials for in-service training for home safety workers, and it is supporting research on the causes of accidents. A comprehensive program of construction and education may be expected to reduce home accidents decisively. A recent program in Kalamazoo, Mich., has demonstrated that practical gains are possible.

The APHA Committee on the Hygiene of Housing has developed an appraisal method for measuring the quality of the housing environment. Both at Atlanta, Ga., and at Syracuse, N. Y., the Public Health Service trains health workers and others to use this method. Municipal officials, including those in planning and urban development, have found the appraisal form an effective instrument for delineating the extent and nature of the community housing problem.

As a result of health department action in one eastern city, during a recent 2-year period, more than 2,100 dwellings were so improved as to affect the health of the occupants. This was a pilot program conducted with a small staff. If this program were applied nationally at capacity, it would significantly improve the health qualities of existing substandard housing.

Underlying the success of such programs is community support, secured through organization, education, and publicity; the intelligent establishment and application of housing standards; and a democratic and impartial administration of enforcement by the health department.



Maintenance of Housing

The forces that lead to a decline in a neighborhood are subtle and pervasive, and the forces that work to preserve and maintain a wholesome home environment must necessarily be their match.

On the one hand, a neighborhood may suffer from the cultural background of the residents, old or new; from absentee ownership with indifferent commercial management; from timid or unintelligent use of zoning regulations; from neglect by city officials responsible for the supply of community utilities and services; from changes in modes of transportation; and from the advent of new industrial processes.

On the other hand, decent housing conditions are protected by high neighborhood morale, home ownership or intelligent and astute management of rental property, fair and efficient community services, including honest use of zoning, health, safety, fire, and traffic regulations, and supervised playgrounds.

The complexity of the forces at work makes it difficult to pin responsibility for housing decay on any single factor. The process is usually beyond the control of the residents themselves, although as housekeepers and voters, as citizens and neighbors, they do exercise a strong influence. The conduct of city officials is seldom independent of the pressures exerted by people of the community who, in turn reflect prevailing attitudes, customs, and ideals, as well as economic necessities.

Basically, the task of maintenance of housing resolves itself into a process of teamwork among all concerned. And this process of teamwork must be animated and guided by common interests and hopes.

Individual leadership and education are important elements in this process. The first family to clean up its backyard automatically sets an example for the neighbors. But the neighbors in turn must have been educated to the fact that the condition of the yard is important, if not as a matter of vanity, then as a matter of safety.

Only if a community as a whole learns to identify decent housing standards and to respect them may it succeed in obtaining and using satisfactory housing to its full advantage.

SUMMARY

Public health is seriously handicapped by housing conditions that are productive of home accidents, contact diseases, mental stress, and other disorders. Congestion, debilitation, and above all the failure to install or maintain elementary sanitary facilities—these are the primary faults. A vigorous enforcement of health standards, requiring rehabilitation, can add substantially to the supply of suitable dwelling units. Educational measures and structural improvements can reduce the toll of home accidents. New construction, rehabilitation, and maintenance programs are all needed to improve housing conditions.

Refuse Control

NOT MANY years ago, the large brass spittoon was a fixture of all public meeting places and even of private parlors. It was regarded as a mark of refinement and good taste. Today the spittoon is an antique. Its passing is a sign that society is capable of improving itself.

Other evidence of improvement is found in those cities which have developed clean and efficient systems of refuse disposal. In order to encourage such exemplary practices, the Public Health Service is preparing a film which will demonstrate proper techniques of refuse handling observed in selected American cities.

In some communities, unfortunately, the system of refuse collection and disposal seems still to be dawdling in the spittoon stage of civilization. The cities have arranged repositories for refuse, but the repositories often are unsightly, odorous, and pestilential. They suffer also, as did the spittoon, from carelessness.

Such refuse dumps are inconvenient and uneconomical, an offense to the person and a burden to the taxpayer. But both the offense and the burden can be reduced to insignificance.

To this end, it is important that storage, collection, and disposal of refuse, although not usually an operating function of the health department, be recognized as an essential safeguard for public health. If these services are defectively or inadequately organized, they are a weak link in the chain of local public health defenses, however good these may be otherwise. No health department should countenance the insanitary conditions that attend open refuse dumps. Under competent direction of professional engineers, refuse services can meet all requirements of economy and good housekeeping, and they will eliminate conditions that perpetuate disease.

To avoid confusion in terminology, the Public Health Service and many State health departments accept the following simplified definitions given by the American Public Works Association, in *Refuse Collection Practice:*

Wastes—unwanted solid, liquid, or gaseous materials.

Refuse—solid wastes, including garbage and rubbish.

Garbage—wastes resulting from the handling, preparation, cooking, and serving of food.

Rubbish—refuse other than garbage and ashes (tin cans, bottles, papers, cardboard, and similar materials).

STORAGE AND COLLECTION

As a matter of public health, storage of garbage at the doors of homes, restaurants, and markets is the most critical phase of refuse handling. Proper storage implies collections frequent enough to limit the need to overload storage cans. Education is necessary to keep garbage cans covered, and to keep the storage area clean. A simple elevated stand is a useful accessory for storage cans. Where these stands are used, cans are less likely to corrode, and dogs are less likely to spill the garbage.

The system of collecting garbage and rubbish is sometimes a municipal service, sometimes private, sometimes both. In many cities, it is customary to leave to private contractors the collection of garbage and rubbish from commercial districts.

Most collection vehicles are motorized. Modern garbage trucks are fully enclosed and may be equipped to compact refuse on the way to the disposal station.

There are few generally established standard practices for refuse collection. Once or twice a week is the usual frequency of collections. Regulations governing storage receptacles are often loose or even nonexistent. And enforcement of even good regulations suffers from such problems as overloading and spillage and the curiosity of children and stray cats and dogs.

DISPOSAL METHODS

If garbage is not collected for disposal centrally, it is usually disposed of by incineration, burial, or dumping on the home site, or by grinding and flushing into the household sewer or septic tank. Neither incineration nor grinding completely disposes of refuse. In a 1950 survey of 200 cities by the American Public Works Association, 19 of 181 cities reporting forbade use of home garbage grinders.

This survey reported also that the most common method of refuse disposal in use today is the sanitary fill, a method that was not reported at all in a survey of 764 cities in 1938. Of 42 cities of more than 100,000 population, it was reported in 1950 that fills were employed by 25 and incineration by 22. Many communities employed several methods in combination.

In towns with less than 10,000 population, open dumps were the most common method of disposal of garbage and other forms of refuse. The next most common method was the feeding of uncooked garbage to hogs. Open dumps and hog feeding with uncooked garbage are the methods most likely to create health problems.

Sanitary Fills

The sanitary fill has been demonstrated in a number of cities through the cooperation of the Public Health Service and equipment manufacturers. Essentially a sanitary fill is a series of trenches or cells, usually several feet deep, containing refuse covered daily with a layer of earth. The cover is usually two feet deep.

A bulldozer is used to dig the trench, compact the refuse, and to spread the cover. An occasional fence is used to stop drifting paper.

In contrast to the open dump, the fill produces little or no odor, fire, rats, or other nuisances. The site should be selected with an eye to costs of hauling, problems of seepage of gas or polluted waters, and future uses. A covered fill may be suitable for a park area, but not as a site for heavy construction. Sanitary fills have been built successfully in almost every kind of soil, including gumbo. Of 72 cities reporting use of sanitary fills, only two declared the operation to be other than satisfactory.

Incineration

The thorough conversion of garbage to ash in furnaces built for that purpose is the modern form of incineration, far superior to the smoky and odorous condition normally associated with burning garbage. The efficiency of the design of a large modern incinerator is affected not only by the furnace size but also by the size and function of modern collection trucks. The furnace can be located near collection points. Incineration of garbage usually is found more practicable in large than small communities. Also, it is more successful in dry, breezy locations than in damp, foggy areas. Given efficient design, location, and operation, incineration is a sanitary and convenient method of garbage disposal.

Nevertheless, experience indicates that the process should be evaluated with respect to local conditions and alternative methods of disposal. The proportionate number of cities employing incineration, about 25 percent, has not changed significantly in 12 years.

Composting

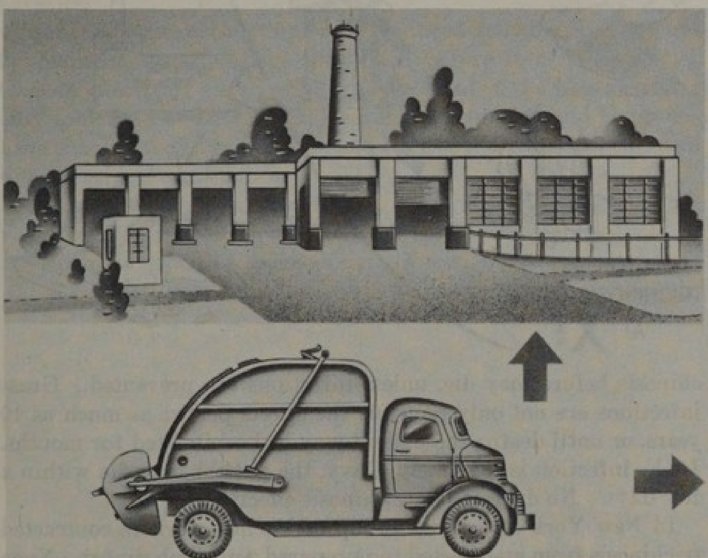
Composting is the oldest and possibly also the newest and most modern method of refuse disposal. The practice prevails widely in Europe and Asia, where fertilizer is usually in high demand.

When garbage and other waste organic material is composted in a mass, the action of bacteria and other micro-organisms converts it into a humus-like end-product, stable, inoffensive, dry, and useful for enriching soil. This composting process is accelerated if the mass is stirred and seeded with sewage or another form of digested refuse. Occasional stirring apparently improves distribution of the seed material, increases aeration, facilitates evaporation of excess water, and achieves a high uniform rate of decomposition. An important phase of this process is that the aeration must at a certain stage be charged with carbon dioxide in concentrations 20 to 100 times as heavy as in the atmosphere.

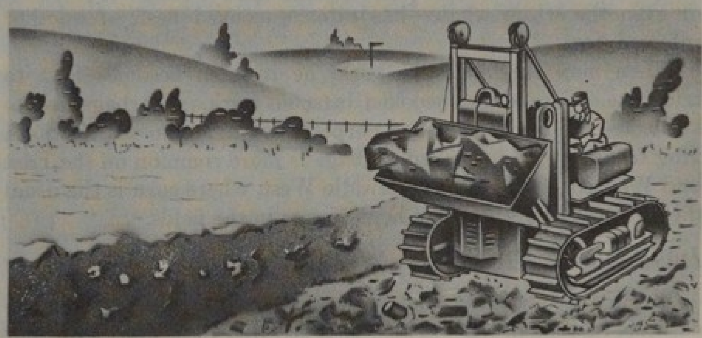
Operating costs of composting plants and the sale value of the end-product as fertilizer will decide whether cities will find composting economical, if the mechanisms prove satisfactory. However, the character of the refuse also may affect the success of composting; wetness and citrus rinds have created difficulties in a few American attempts at composting by nonmechanized processes.

Grinding

Many cities have established central grinding stations, which dispose of garbage by flushing it into the sewerage system or into a stream. The economies and conveniences of this process are to be balanced against the increased burden it places on the streams, on the sewer capacity, and on sewage treatment plants.



A community may use several systems of refuse disposal. Trucks may deliver it to nearest appropriate disposal station



Hog Feeding

There has been some apparent decline in the percentage of cities feeding garbage to hogs but no perceptible increase in the practice of cooking garbage, as a precaution against trichinosis. Of 52 American cities reporting on this subject in the American Public Works Association survey, not one reported that it cooked garbage fed to hogs.

HEALTH PROBLEMS

The correct disposal of organic matter is always fundamental to the health of a community. Open dumps provide food and breeding grounds for mosquitoes, rats, and flies, which carry germs of disease. But the primary health problem associated with garbage is trichinosis.

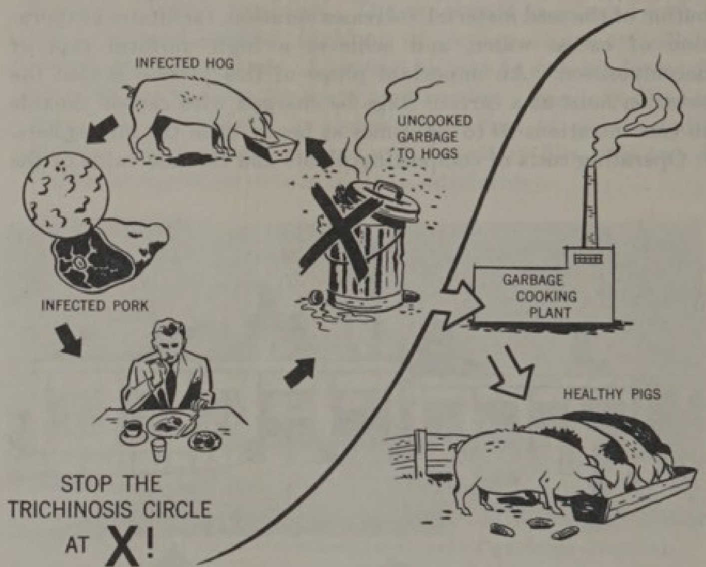
Trichinosis

Up to 6 percent of the hogs fed uncooked garbage in this country are infected with trichinous worm cysts. Trichinae are microscopic worms whose larvae burrow their way from the intestine into the muscles and mesenteric organs of swine and men. The parasites are carried only if the host—man, hog, rat, mouse, bear, or even the white whale—has eaten uncooked flesh of another infected host.

When man eats infected pork, he in turn becomes host to trichinae. Scraps of uncooked infected pork in garbage fed to swine are the usual means of perpetuating trichinosis infections. Hog feeding with uncooked garbage is more common on the East and West coasts than in the Middle West, where corn is the usual diet, or in the South, where hogs forage in the fields.

Incidence Is High

The United States is believed to have one of the worst trichinosis records in the world. It is believed to be one of the few countries where the incidence of trichinosis has increased in the last 60 years. The Public Health Service has found trichinae in 855 of 5,313 human diaphragms examined in 189 hospitals in 38 States, an incidence of 1 out of 6. In 4.2 percent of the subjects, infection probably was heavy enough to have caused clinical symptoms. These figures are the basis for estimating that as many as a million Americans may become noticeably ill from tri-



chinosis before they die, unless infections are prevented. Gross infections are not only painful; the effects persist as much as 10 years, or until death; the patient may be hospitalized for months. If the infection is extremely heavy, the patient may die within a few days. No drug treats trichinosis effectively.

In New York recently, a group of kitchen workers contracted trichinosis from an infected pig prepared for a club dinner. None of those who ate the cooked sausage reported sick. Two who prepared the sausage, and sampled it raw for flavor, were quite ill. Also seriously ill were a group who raided the ice box after the sausage was prepared. Under the impression that the meat was chopped beefsteak, they ate the sausages fried rare. One of this group died, after a violent, agonizing illness. He alone had eaten two of the sausage patties, raw.

Preventive Measures

Trichinosis can be practically eliminated if garbage is cooked before it is fed to hogs; heat kills trichinosis worms which may be in meat scraps in the garbage. Freezing pork for twenty days at a temperature of minus 15° C. is another way of killing trichinae. A third, and most common, method of averting infection is to cook pork for the table until the internal meat is white. Also, curing pork by proper methods is effective against the parasite.

Many European countries have reduced trichinous infections by requiring that garbage be cooked before it is fed to hogs. Canada effectively enforces such a law. But in the United States only four States—New York, Kentucky, Nebraska, and Oregon—have enacted such a regulation, and only one of these has obtained some degree of compliance.

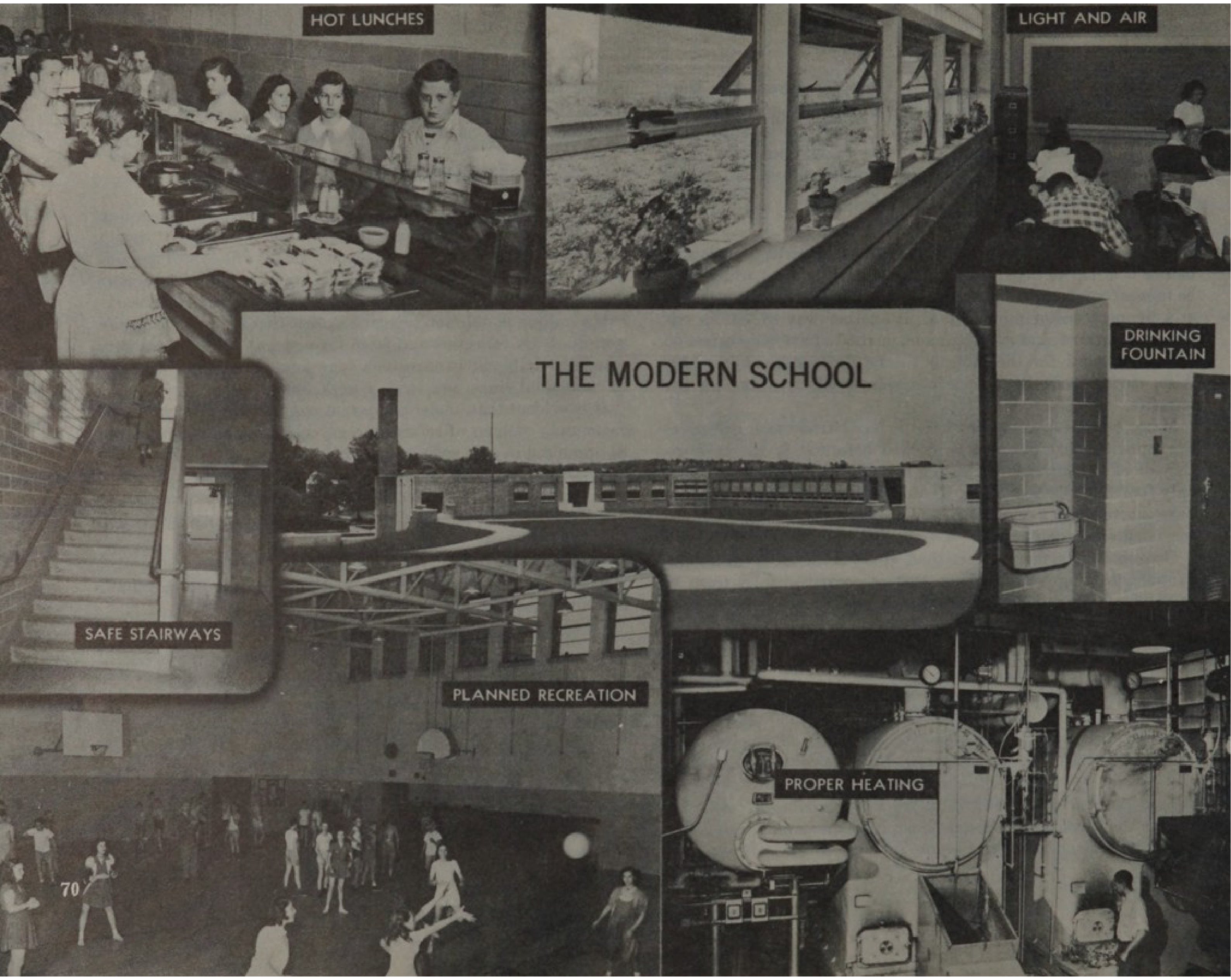
Oregon hog farmers report that, apart from the hygienic advantage, feeding with garbage that is cooked enables them to raise more hogs with a given amount of feed, to reduce losses from disease among their herds, to salvage grease as a byproduct, to reduce the amount of wasted or discarded feed in garbage, and to maintain sanitary conditions more efficiently.

MUNICIPAL ECONOMIES

Although the cost of refuse handling varies greatly according to local conditions, the charges for collection and disposal should not run more than $2 or $3 per person a year. The cost of storage, which is the cost of storage cans and a stand, should not be more than $1 or $2 a year for each household. One Texas city of nearly half a million population reported in 1946 that its costs per capita were $0.98 for collection and $0.43 for disposal. Collections were scheduled daily in business areas, four times a week for businesses in residential areas, and twice a week for residences.

It is evident that, under competent engineering direction, most community systems of refuse storage, collection, and disposal can be organized to save sufficient funds to pay for approved disposal methods and equipment and to pay satisfactory salaries to qualified personnel. In this connection, it is noteworthy that refuse handling was the subject of half of the complaints received in one American city.

The Public Health Service has prepared a variety of educational materials and practical aids to assist cities to improve refuse-handling practices.


HOT LUNCHES
LIGHT AND AIR
THE MODERN SCHOOL
DRINKING FOUNTAIN
SAFE STAIRWAYS
PLANNED RECREATION
PROPER HEATING

School and Rural Environments

ENVIRONMENTAL health problems of schools, recreational areas, and rural and suburban communities offer on the whole the most promising opportunities for improving public health services.

EDUCATION

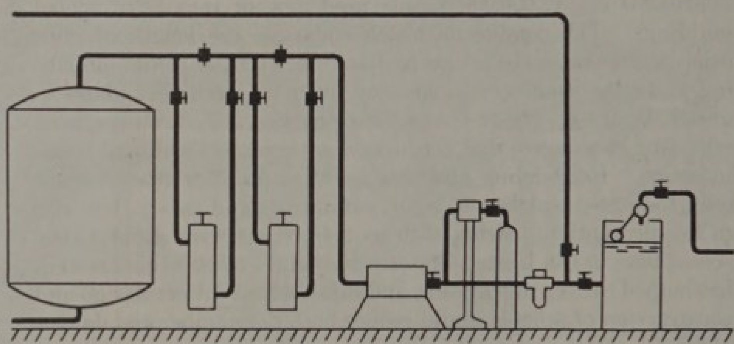
There are at least two reasons why parents should be interested in a healthful environment for the school. For one, parents are interested in protecting the health of their children in school. In addition, parents may consider that the child may bring infections from insanitary or congested school buildings into the home.

It has been estimated that for health and life protection alone, approximately 12,000,000 pupils need new or remodeled school buildings. The conditions which endanger the health of children in schoools include unsafe drinking water, defective plumbing systems, insanitary kitchen or luncheon facilities, glare-or-gloom lighting, fry-or-freeze heating, bad air, firetraps, and crowding to a degree that encourages fatigue, accident, and cross-infection. Remodeling and new building implies attention not only to space, ventilation, light, sanitation, and safety, but also to fire prevention. From 1930 to 1946, there were about 35,000 school fires in the United States. Faithful attention to fire drill has helped to keep down losses and injuries, but proper design and construction of schools would reduce both the number and danger of fires.

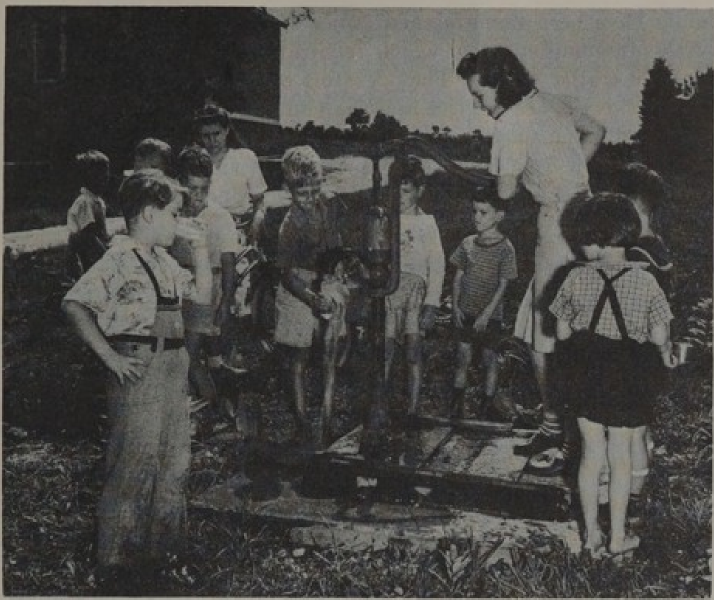
Far from improving, the condition of the schools in many communities appears to be declining. Not only do the established buildings grow older year by year, but reconstruction and new building are not keeping pace with the growth of population. In one major city there are nearly three times as many children age six and under as are now in school there. In the United States as a whole, there were 4,000,000 babies born in 1947—roughly double the usual total. By 1953, they will enter the first grade in schools which, in many communities, were built for barely half their number. It does not appear that many cities will have an opportunity to choose between building or remodeling; most are likely to be obliged to do both, to the extent permitted by prior needs of materials for defense.

Several States have school sanitation programs. Sanitarians in these States inspect schools and recommend corrective action. Action adequate to the total problem, however, would at least double the present rate of progress in construction and sanitation. A national set of standards for school sanitation would advance State programs and encourage corrective action.

Among the factors of school hygiene to be considered, in addition to those mentioned above, is the educational program itself. Teachers of physical education, including school sports and recreation, mindful of the adventurous appeal of strenuous and hazardous games, take every possible precaution to limit the inherent risks. They require medical examinations of players, the use of protective helmets and pads, and rules which reduce



Children of school age need protection from pollution of streams, beaches, and swimming pools. The treatment plant, to prevent contaminated water from entering a public swimming pool, utilizes an efficient and dependable chlorination system.



This leaky wooden pump platform leaves the well open to contamination which may infect all the pupils in the school.

hazards like hacking in basketball or clipping from behind in football. Teachers also try to limit activities to pupils of appropriate size and ability, so as to avoid unnecessary strains in competition. In health education courses, many schools take up such topics and activities as swimming and lifesaving, traffic safety, or sanitary preparation and serving of food, to help pupils learn to protect themselves.

Many schools are equipped and administered to serve as a good example to the community. In such schools, pupils learn lessons of health and safety from the regulation of traffic in halls and on stairways, from rules applied at the swimming pool and gymnasium, from the practice of keeping floors free of dirt and litter, and from observation of sanitary practices in the lunchroom and elsewhere. The health of pupils is enhanced by special services in such schools. These include medical and dental examinations and the keeping of cumulative health records. Many schools provide immunization services and professional emergency care. They also take pains to screen pupils for physical disabilities and, if the disabilities cannot be corrected readily, to guide pupils into pursuits where they will not feel unnecessary stress. In such an environment, school children are helped to achieve physical as well as intellectual development. Unfortunately, physical facilities in many schools tend to vitiate even the best efforts of the educators.

RECREATIONAL AREAS

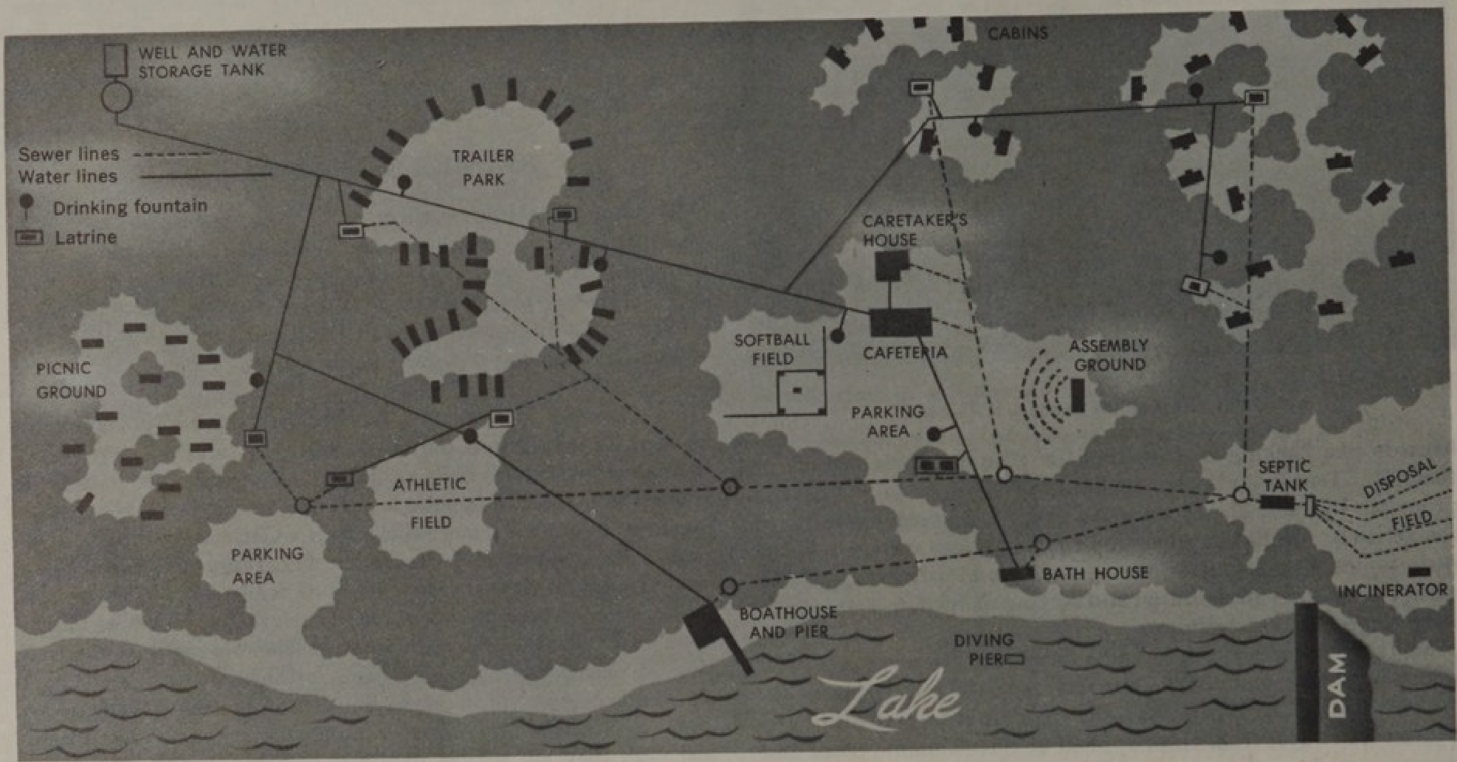
Vacations, once the privilege of a fortunate few, are today the general custom. Many a school child takes an annual trip to camp or spends some time at a pool or playground. Many a union man has 2 weeks of paid vacation. A trip or a rest has come to be looked on not as a privilege but a right and a necessity. For this reason, an insanitary recreation area means much to the public health.

No one looks forward to a holiday with the idea of having an accident or taking sick, but the fact is that vacations perceptibly increase the normal risks of injury or disease. It is difficult enough to protect the public health in a stable, permanent settlement; it is naturally more difficult in a settlement which is temporary and operated and attended by a floating population. Many stopping places are outside control of municipal health departments, with little or no supervision from other authorities. Moreover, many varied and individual problems arise in the sanitation of tourist courts, trailer camps, resorts, parks, cabins, and children's camps. Most of the burden of sanitation falls necessarily upon those who own and those who patronize these places, although they are seldom qualified as public health officials.

The major health problems in recreation areas arise from unsafe water supplies; from insanitary food preparation and serving; from inadequate sewage disposal; from the lack of protection against insect vectors of disease; and from the use of hazardous recreational facilities, particularly improperly managed swimming pools.

To this list may be added the problem of sanitary facilities for trailer camps. More than a quarter of a million house trailer units have been manufactured since 1946. Many are equipped with plumbing systems, which require water and sewer connections at trailer parks. The operators of trailer parks, including the National Park Service and the United States Forest Service, need and request help.

More than 30,000,000 persons annually visit areas under the jurisdiction of the National Park Service, including camp sites,



Camps should be properly located, planned, equipped, operated, and maintained.

tourist hotels, swimming pools, and bathing beaches. They come from all over the United States and from foreign countries. At the peak of the season, many limited areas accommodate numbers equivalent to the population of a large city. Adequate, sanitary facilities for food and drink and the disposal of all sewage and waste materials are essential to recreation areas.

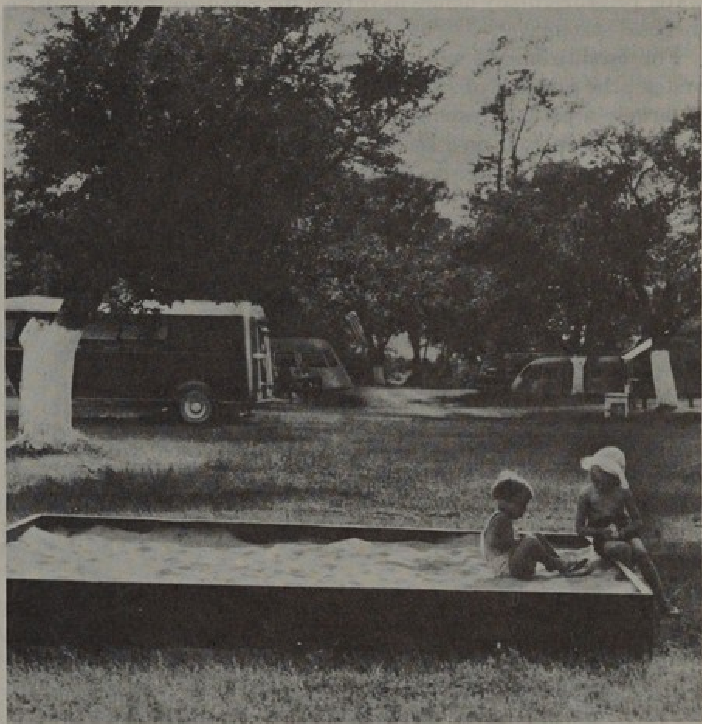
The varied character of these areas diversifies the environmental health problems, as their water and sewage installations range from typically rural and often relatively primitive facilities to elaborate systems comparable to those in urban areas. The isolation of many of these installations handicaps inspection and maintenance. Food and drink establishments are similarly isolated, and lack of electric power for refrigeration and other uses often aggravates the problem of safeguarding food products. The temporary or seasonal nature of the operation and maintenance of these installations further intensifies problems relating to good sanitation. The personnel turnover is high and necessarily a large percentage are untrained and inexperienced.

The Public Health Service supplies technical information and consultation services that assist those directly responsible for sanitary conditions in these vacation areas.

RURAL SEWAGE DISPOSAL

Four-fifths of the outbreaks of water-borne disease occur in communities of 10,000 or less, containing only about half of the population. These figures indicate not only the gaps in water treatment facilities outside the larger urban centers but also the lack of measures to prevent sewage from contaminating the public water supply.

More than a third of the American population depends for sewage disposal upon privies, chemical toilets, cesspools, septic tanks, and small treatment plants. Not only the rural home, but many a suburban home, and many camps, schools, and roadside businesses depend on such facilities.

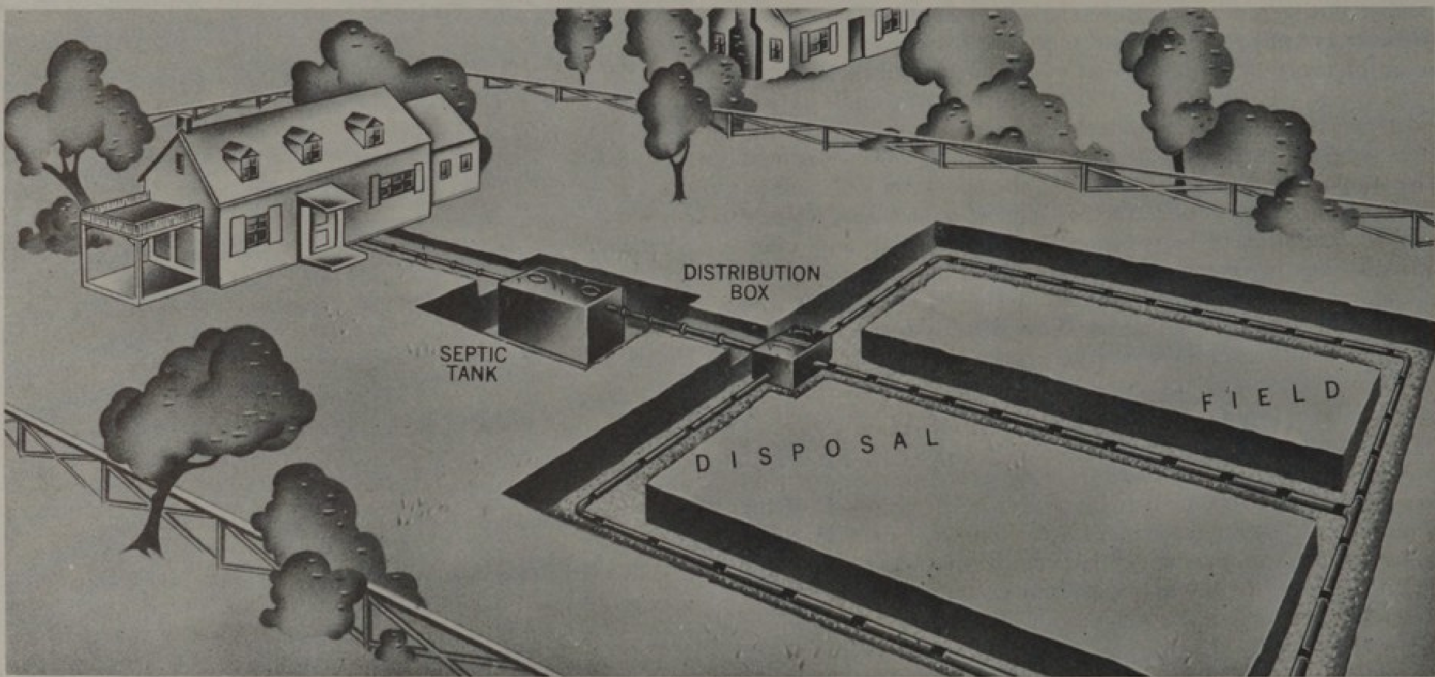


Sanitation during recreation and travel is vital to all.

Half of the new homes built in recent years use self-contained sewage disposal systems. More than a tenth of the population relies on residential septic tanks, the most effective system for the private home. More septic tanks have come into use now that rural electrification has brought power and many power appliances to 95 percent of the farm homes. Electric power makes it practical to pump water and supply water under pressure, which in turn makes possible a water-carried sewage-disposal system. Without water pressure, many homes have been forced to use more primitive disposal systems.

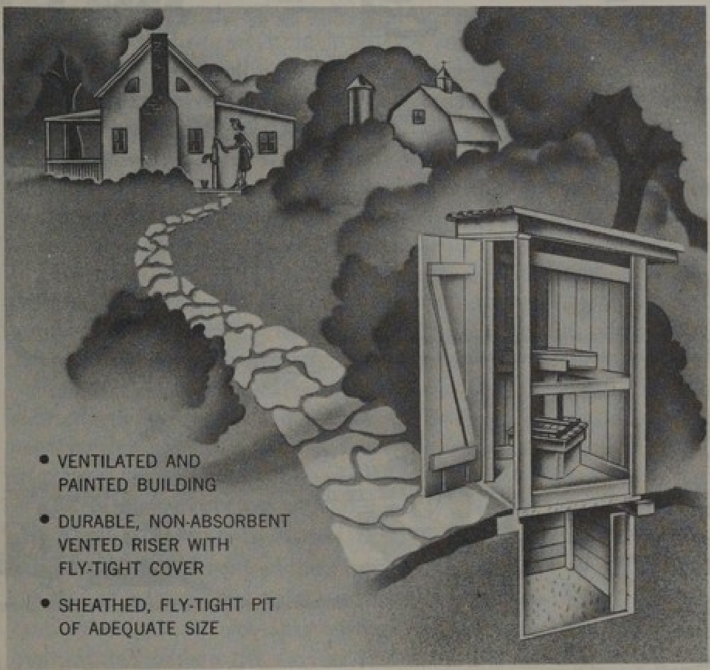
For establishments not connected to a community sewerage system, the problem of sanitary disposal and treatment of sewage is largely a private responsibility. Many of these are located in areas where there is no assistance or supervision by trained health officials, no planning or zoning boards, no plumbing codes. Whether the plant is properly designed and constructed, correctly located, adequate in area, and properly maintained is thus left to the discretion of the owner, the builder, and the service crew in those localities where local regulations are not yet established.

The Public Health Service has been working, in cooperation with the Housing and Home Finance Agency, to develop efficient and economical designs for small sewage disposal systems. At



Individual sewage treatment plants present many problems of sanitation for the home owner. State and local health departments will provide assistance in the design and maintenance of systems satisfactory for various local conditions.

its laboratories in Cincinnati, the Public Health Service is carrying forward the early fundamental work conducted by the State of Massachusetts at the Lawrence Experiment Station. This research includes field and pilot studies of soil absorption and various designs of septic tanks. Investigators hope to develop and improve standards that will be useful to State and local health departments, to builders, and to manufacturers with respect to sanitary factors in construction and maintenance of sewage disposal installations for single households. It is hoped also that this work will lead to economies.



One immediate effect of this study has been to encourage uniformity in the regulations and requirements ordered by various health departments. The development of uniform requirements is expected also to improve compliance with sanitary standards.

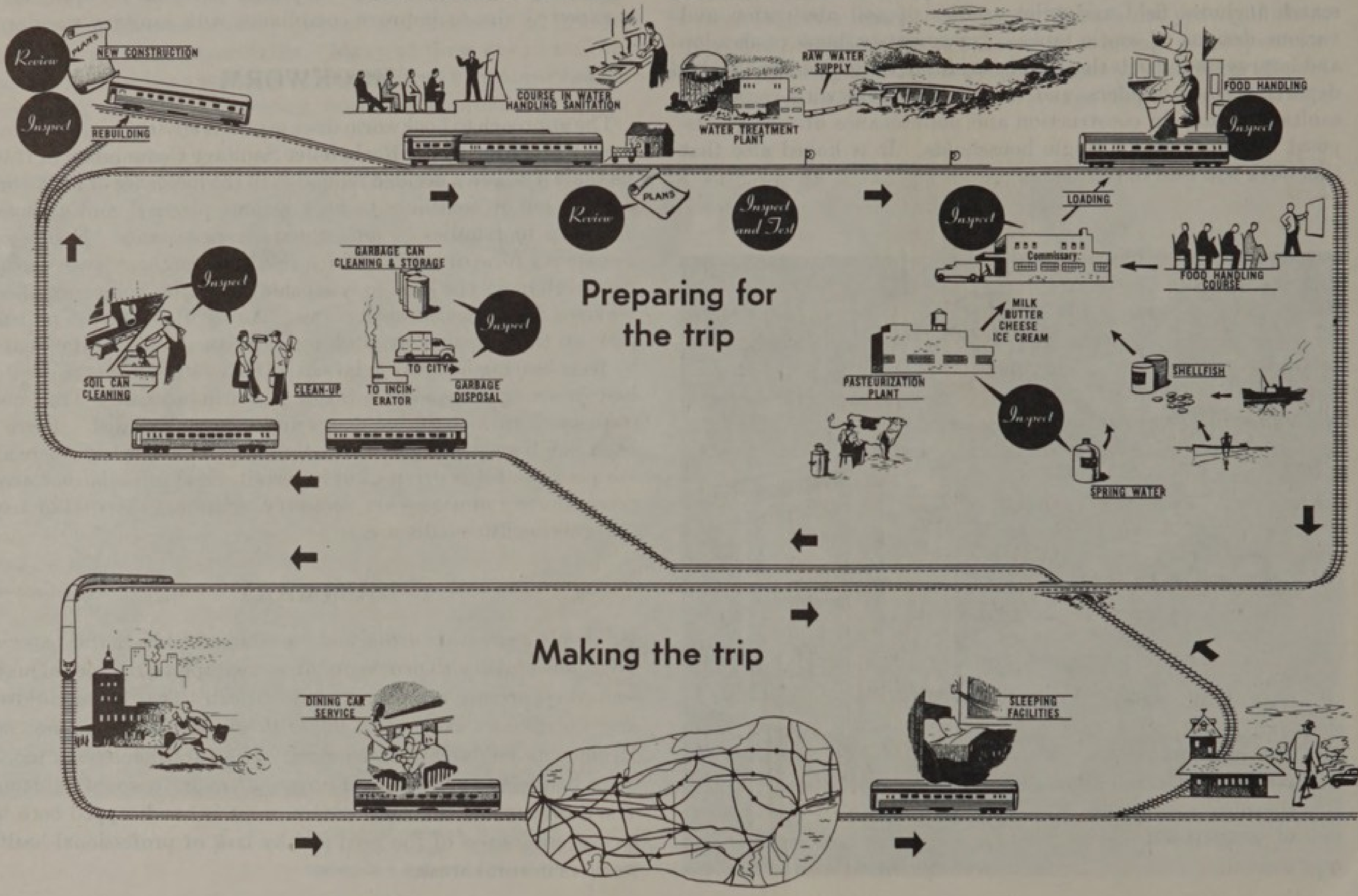
HOOKWORM

The approach to hookworm disease now is environmental. Since the investigation by the Rockefeller Sanitary Commission in 1910–14, there has been a decided reduction in the incidence of hookworm disease, but it continues to be a serious physical and economic handicap to families in unfortunate environments. Hookworm disease is a form of anemia which results when there is not enough iron-protein in the diet to compensate for the volume of blood removed by parasitic hookworms. As a rule, infested patients pick up the parasites by walking barefoot on soil contaminated by feces bearing hookworm larvae. The hookworm larvae develop best in sandy or sandy-loam soil in warm weather. Treatment consists of antihelminthic drugs and a corrective diet. There is little likelihood that hookworm disease will recur where there are adequate sewers or privies, but in certain rural and suburban areas precautionary measures are necessary. Sanitary disposal of feces prevents hookworm disease.

SUMMARY

Schools, recreation areas, and rural areas all have their special environmental health problems. In some respects, the special problems they present are urgent and critical. The school children and vacationers exposed to unhealthful conditions in these environments are largely defenseless. The rural household, too, is often helpless to protect itself unless it has professional guidance. The sanitation of the rural environment is handicapped both by lack of awareness of the need and by lack of professional health workers in rural areas.

RAILROAD SANITATION



Protection for Travelers

EACH YEAR, interstate public transportation in the United States ticks off about 60,000,000,000 passenger miles. On trains alone, the number of persons carried in a typical day is as large as the entire population of the city of Detroit.

Few travelers realize how much public-health workers have done and are doing to protect them from infection during their journeys. The general public is only dimly aware of the many health problems presented by the mass movements of people and properties across the face of the earth.

One general problem is to prevent infected travelers from carrying and spreading disease to unprotected areas. Another is to protect travelers themselves from infections which may develop during their journey. Travel fatigue lowers the body's resistance to infection. Congested quarters increase the possibility of infection. And the fact that traveling facilities are used by great numbers of transients, with widely varying standards of personal cleanliness, aggravates the normal problem of sanitation.

Some travelers may carry infections without suffering noticeable effects themselves from disease. But as a general rule, it is necessary to protect travelers from sources of infection in order to protect both themselves and the people they visit.

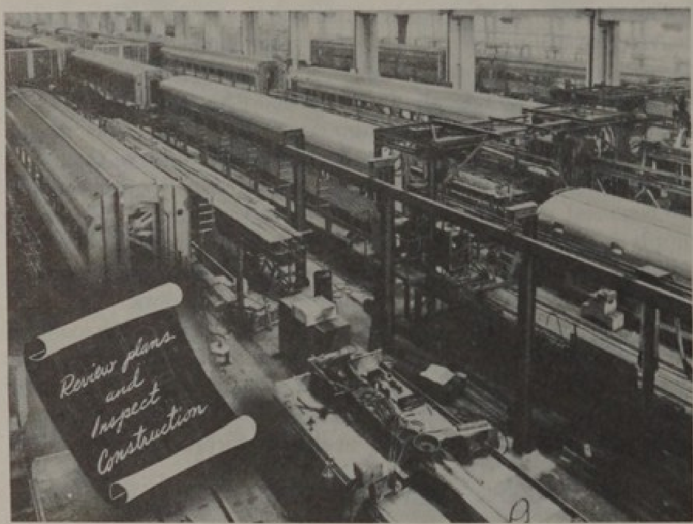
The faster people travel and the farther they go, the faster and farther infectious disease can strike. Different infectious diseases, like different plants, have different life spans. Before the end of a long journey, some diseases of travelers may die out, or they may reach the stage where they may be identified and quarantined before the carrier can do much damage. But the modern pace of travel permits a traveler to carry infection from Asia or Africa to America in less time than it takes for smallpox to incubate. Time and space no longer protect the sanitary city from invasion by exotic disease. Today's defenses against communicable diseases consist of environmental health protection, immunization, and the early detection, diagnosis, isolation, and treatment of diseased persons.

The diseases which have been the particular bane of travelers in America are typhoid fever, paratyphoid fever, amebic dysentery, bacillary dysentery, and other gastroenteric disorders. Federal, State, and local health agencies have curbed most of these afflictions by sanitary engineering practices. The mobile larders of our transportation system prepare and serve foods and beverages under extremely difficult conditions. Health controls are essential if meals in midpassage are to be safe. The water supply for travelers must have been given equally good protection.

The transportation industries are aware of the commercial value of the health of their passengers and their crews. Healthful work and travel conditions repay the industry in the coin of patronage, good will, and reduced operating charges. The Public Health Service and local and State health officials cooperate closely with the rail, bus, air, and ship companies and the transport trade associations to achieve a healthful travel environment.

RAILROADS

A half century ago, the railroad was the chief means of rapid transport in the United States. In those days, particularly in the southern part of the United States, railroads unfortunately were associated with typhoid fever. Since the fever was carried from one State to another, preventive action was the responsibility of a Federal agency. The response of the Public Health Service was the *Interstate Quarantine Regulations.* These were and still are—as revised in 1951—aimed at the control of the spread of disease. The railroads were, of course, eager to cooperate, but they needed help in assuring that water and food supplies would not contribute to the spread of disease. Health departments were a rarity 50 years ago. To a large extent, the establishment of health departments, and particularly their sanitary engineering divisions, was spurred by the need to have sanitary water and food on trains.



The Public Health Service reviews plans and inspects construction of sanitary facilities for railroad passengers.

Construction of New Railroad Cars

A strategic point of health control has been at the plants where passenger and dining cars are constructed for the railroads. The operators for whom the passenger cars are built have been cooperative, as have the car builders. Sanitary engineers of the Public Health Service discuss requirements in advance with builders and operators. As new methods or types of construction develop, sanitary requirements are changed. Blueprints of sanitary facilities, including food-handling equipment, are reviewed, before construction, by the Public Health Service. The greatest emphasis is paid to the sanitary construction of dining cars. A handbook explaining construction standards has been prepared for the guidance of the car builders.

During 1948, railroads spent $51,000,000 for the construction of 550 new railroad cars. An average coach costs about $80,000. An articulated kitchen-dining-dormitory car costs about $180,000. On such a unit the food is prepared in one part and served in another. Such cars, used on long hauls, also carry dormitory facilities for the crew. They must contain ample washing facilities so that cooks and waiters can clean their hands frequently. They must be equipped with refrigeration facilities to prevent growth of harmful bacteria in food.

The railroads spent about $1,310,000 in 1948 for improvements of sanitation at servicing areas. Of this total, $141,000 was spent on employees' sanitary facilities; $227,000 on railroad waste disposal and cleaning facilities; and $942,000 on improving car-watering facilities.

The Public Health Service has published a handbook to guide manufacturers in the design and construction of sanitary facilities on trains.

Water Supply

Trains are serviced and supplied at convenient points of the railroad system. Occasionally it becomes necessary for the Public

Health Service to prohibit the use of a certain water supply because of dangerous conditions in the servicing area. Watering point facilities are of particular concern to the Service in such an area. To load water on the many cars in a railroad servicing yard, there must be numerous outlets and many supply lines to bring the water from a city main to the loading point.

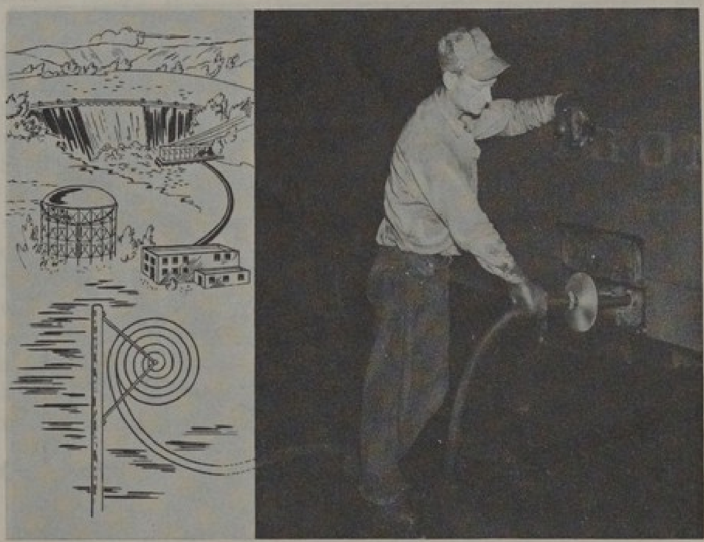
Few travelers realize how much must be done to assure that water used on trains is safe. There are 1,881 watering points in this country where railroads load water. There are 1,350 water supplies in the United States, supplying all types of interstate carriers. Railroads use almost all of these sources. All except 165 are municipal supplies. These same municipal supplies also normally serve a total population of more than 61,000,000 people. In other words, through the *Interstate Quarantine Regulations* the Public Health Service exercises authority and responsibility for three-fifths of the people served by public water systems.

The activities of the Public Health Service in bringing about correction of sanitary defects in these water supplies have been helpful to many of the State health departments, some of which have lacked authority to order the necessary improvements. Most State health departments cooperate by providing vigilant inspection of these facilities. The *Public Health Service Drinking Water Standards* have become the universally used water standards of the United States and of many other countries.

Supply lines that deliver water to railroad cars must be guarded against contamination. This is true particularly of the flexible rubber hose generally used to connect the hydrant and the car. It is the weakest sanitation link in the transmission of water from a good supply to the point of usage on a car. This hose must often be hooked on rapidly. It may fall or be thrown carelessly under a car, and it is subject to many types of contamination. Employees who do this work have to be educated to its importance. Visual aids to this end are used in conjunction with training courses given jointly by the industry, the States, and the Public Health Service.

Food

The task of maintaining sanitary conditions on dining cars is especially difficult. Storage and movements are handicapped by limited space, vibration, and sway. When it is realized that about 80,000,000 meals were served during 1949 on the 2,200 dining cars in operation in the United States, the achievement of sanitation under these conditions is impressive. Diners are operated by 58 companies. Public Health Service representatives inspected 1,824 cars during 1949. They gave these cars an average sanitation rating of 70 percent. While this average rating indicates improvement of about 6 percent over 1948, it is still short of an average rating of 90 percent, which may be considered satisfactory. Lack of cleanliness was one of the most frequent failings.



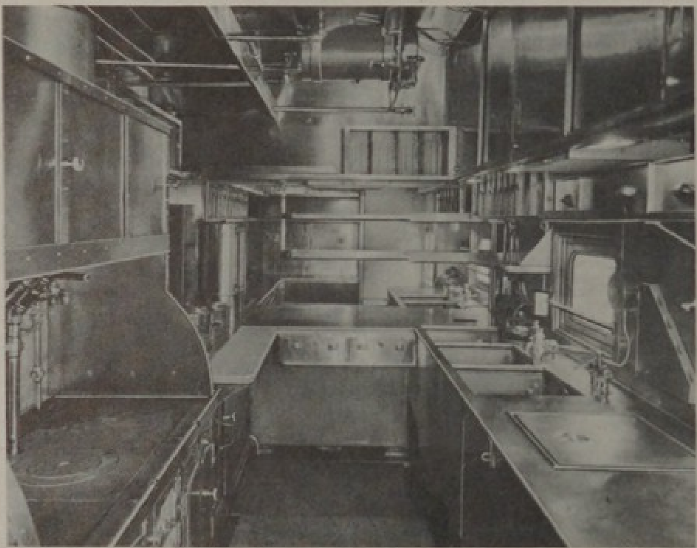
Special equipment is used to protect the water lines feeding water to passenger cars.

With the whole-hearted cooperation of the railroad industry, the Public Health Service and some State and local health departments have provided short courses for food handlers. Also, they have conducted seminars for dining car supervisory personnel.

Commissaries that supply, and in some cases process, food for delivery to railroad dining cars are inspected by Public Health Service or State personnel. There were 378 railroad and airline commissaries in 1949; their average sanitation rating was 86. There are about 550 milk plants in the United States that supply all types of interstate carriers. Most of these supply the railroads. Generally inspections are made by the States. In some locations Public Health Service personnel do spot inspections, or all of the inspection work. Ice cream sources also are listed by the railroads for inspection by State or Public Health Service personnel. Sources of natural bottled water are checked by health agencies to see that they are safe to use. Railroad dining car personnel are supplied with the Public Health Service's periodic lists of approved dealers in shellfish.

Waste Disposal

The railroads must do a herculean housekeeping job. They have to keep clean the coaches, dining cars, and sleeping cars. They must collect waste from washrooms, garbage from dining cars, and refuse from coaches, and dispose of it in a safe manner. They



Flat surfaces, stainless steel, and precise fitting facilitates the task of keeping the dining-car-kitchen clean.

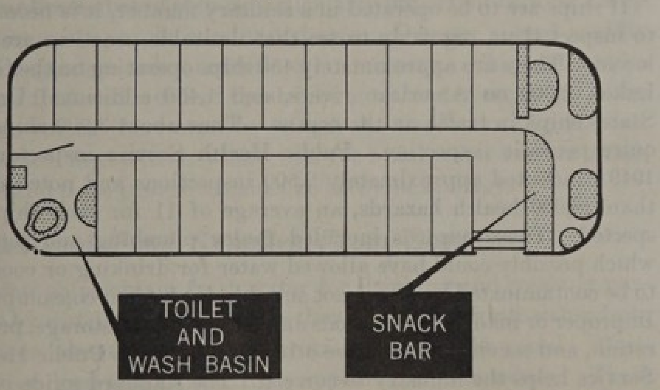
Cans placed at toilet outlets prevent contamination of station areas by waste from standing cars.

must clean, wash, and store soil cans with care to avoid contamination of other facilities, such as ice, water hoses, and food supplies.

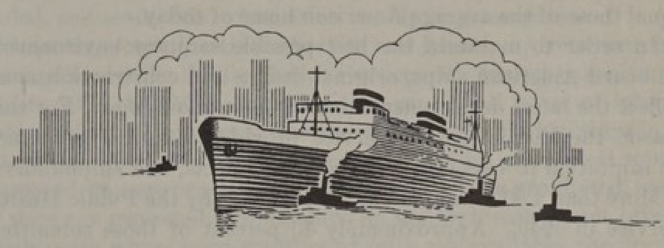
Toilet hoppers of moving railroad cars discharge wastes directly to the tracks. The Association of American Railroads has undertaken to study the health implications of this use of railroad rights of way, as well as the practicability of various methods of eliminating the practice.

BUSSES

Interstate travel by bus has doubled in the past 10 years; tripled in the past 20 years. At present only a few sanitation problems of interstate character are posed by busses. Only a few busses now carry water, other beverages, or food. The State and local health departments have the problem of supervising sanitation at bus stops. The Public Health Service's responsibility with respect to bus transportation is concerned with the water, milk, and food served aboard the bus, the occasional toilet facilities built into the bus, and bus-servicing areas.



Bus operators are experimenting with installations of toilet facilities and snack bars.



VESSELS

The marine shipping industry has important health aspects. About 150,000 persons live aboard American ships during any 24-hour period. The majority of these are crew members of tankers, freighters, and deluxe liners that carry people all about the world. The Public Health Service's interest in ship sanitation is not limited to interstate ship travel. It is concerned also with health aspects of construction and operation of United States ships operating in foreign traffic.

Generally speaking, the maritime industry has provided good working and living conditions for personnel. Transmission of disease from a foreign country to this country and from State to State has been low. The Public Health Service, in cooperating with associations in the shipping industry, provides pertinent information on ship sanitation, secures compliance with requirements, and cooperates with industry in setting standards and regulations. Reasonable requirements to achieve a healthful environment almost always gain cooperation by the industry.

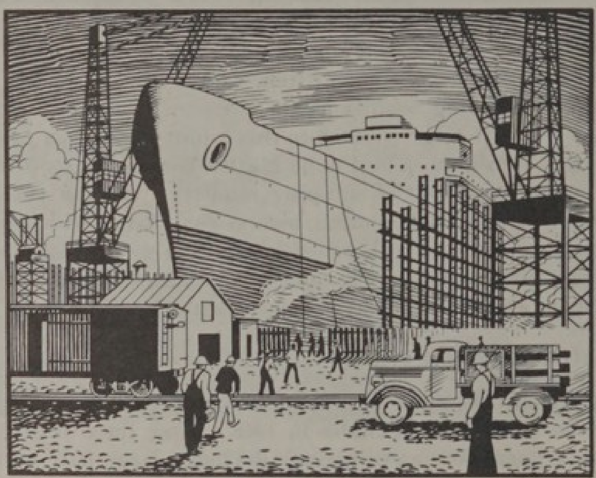
Construction of Vessels

More than 300 ships were repaired, converted, or under construction in the United States in 1948. Since these vessels constitute a home for many persons during a large part of their working lives, the vessel's sanitation standards should at least equal those of the average American home of today.

In order to maintain the best possible sanitary environment on board American ships, original design and construction must reflect the latest developments and the best knowledge. For this reason the Public Health Service provides technical assistance on sanitation to vessel owners, naval architects, and shipbuilders.

More than 1,000 ship plans were reviewed by the Public Health Service in 1949. Approximately 40 percent of those submitted required revision to eliminate sanitary defects. Many additional defects were avoided by advance consultation with naval architects, owners, and builders.

During construction, constant inspection service and guidance on sanitary aspects of a vessel's structure are necessary. During the last half year or year of construction of the largest ships, the Public Health Service assigns the full-time services of a vessel sanitation specialist. His time is devoted largely to supervising ratproofing construction, a complicated process on ships because of the structural arrangements. The Public Health Service inspects all cargo spaces, as well as living quarters, on United States vessels that travel to foreign countries to insure against rat harborage. Rats can carry from country to country some of the most deadly diseases known to man. Naturally, the Public Health Service is greatly concerned with protective ratproofing features, and this work has been so effective that many ships today are free of rats.



The Service is concerned also with water storage, piping, and treatment; food storage, handling, preparation, and serving; waste disposal; plumbing; insect control; and other general sanitation items, such as swimming pools. The Public Health Service's booklet entitled *Principles of Sanitation Applicable to the Construction of New Vessels* is used, world-wide, as a construction standard.

Ships in Operation

If ships are to be operated in a sanitary manner, it is necessary to inspect them regularly to see that desirable practices are followed. There are approximately 450 ships operating on the Great Lakes, 2,000 on American rivers, and 1,450 additional United States ships in traffic on the oceans. Thus about 3,900 ships require periodic inspection. Public Health Service inspectors in 1949 conducted approximately 2,500 inspections and noted more than 28,000 health hazards, an average of 11 for each ship inspected. These hazards included faulty plumbing and piping, which possibly could have allowed water for drinking or cooking to be contaminated by water not suitable for human consumption. Improper or inadequate methods and means for the storage, preparation, and serving of food are other problems the Public Health Service helps the industry to correct. The standard guide is the Service booklet entitled *Handbook of Sanitation of Vessels in Operation.*

Cleanliness aboard ship is particularly important because a ship confines many people in a limited area. Diseases spread rapidly in close quarters unless conditions are sanitary. Ships must store enough food and much of the drinking water for each long ocean voyage—often there must be enough for the return trip if ports visited are in countries where safe food and water are not available—and these provisions must be safe and sanitary.

Water and Food Supplies From Shore

A few ships obtain fresh water for drinking and washing purposes by distilling sea water, or they may draw fresh water from rivers or lakes for subsequent treatment aboard the vessel. Most, however, load fresh water from approved sources ashore. There are 433 ports of call in the United States where United States ships take water. The Public Health Service periodically certifies the status of the 1,578 specific piers or docks where water is loaded, and sends this information to shipping companies.

Ships buy foods, particularly milk and ice cream, from sources vouched for by the Public Health Service with respect to sanitary quality. Of the 550 milk plants that supply all types of interstate carriers, a high proportion also supply milk used by shipping companies. In 1949, 342 of the supplies used by all carriers were approved, 96 were provisionally approved, 21 were prohibited, and 90 were not inspected. Since ships on the high seas do not often touch ports where good supplies of milk are available, the fresh milk they carry must be of excellent quality, must be sanitary, and must be under refrigeration to inhibit growth of bacteria.

AIRLINES

Commercial travel by interstate airliner in 1949 attained a new high of 6.8 billion passenger-miles. In contrast, corresponding air travel in 1939 was only 0.7 billion passenger-miles. In 1949, 860 commercial passenger airliners flew domestic routes in the United States.

As more and larger aircraft are produced, more servicing areas are needed, and more airline commissaries, milk plants, and water supplies are used.

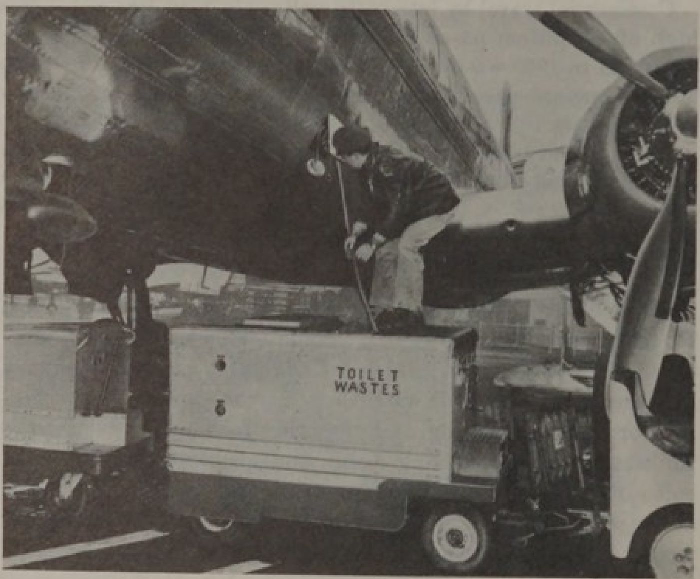
Construction of Aircraft

Plans of all new types and models of airliners are reviewed by the Public Health Service. Some airliners cost more than $1,500,000. Some have two decks and carry complete sanitary facilities. These include water supply, toilets, wash basins, facilities for storing, handling, and preparing food, and even facilities for washing and sanitizing dishes and glasses. The most difficult sanitation problem in airline construction arises, as with the other public carriers, from space limitations. With airliners, weight limitations are a complicating factor.

The Public Health Service reviews plans of new or reconstructed facilities at airports where food is prepared in advance of the flights, as well as watering facilities and devices to unload and transport wastes accumulated during flights.

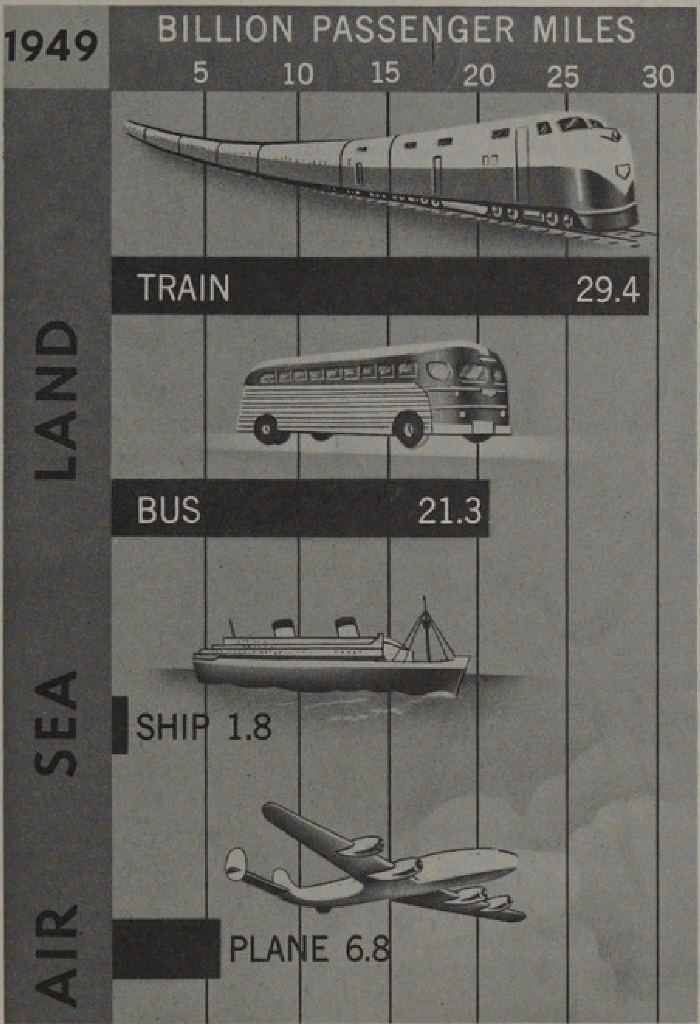
Water Supply and Sewage Disposal

Airliners carry only small amounts of water. In some, the drinking water system is a separate unit and consists essentially of large vacuum jugs. In the largest planes, there is a combined system of water for drinking and washing purposes. In 1948, there were 321 locations in the United States where aircraft took on drinking water. The water supplies are regularly inspected by the States. The watering point facilities for loading water on



This compact pantry on the plane stores beverages, above, and food, below, for sanitary service by the stewardess.

← All major airports use special equipment to dispose of wastes from transport planes.



planes are inspected by the States or by the Public Health Service.

At most of the places where water is loaded on planes there are facilities for disposal of sewage from the removable tank on the plane. It is extremely important that these wastes be handled so as not to contaminate the water supply or the food supply.

Food

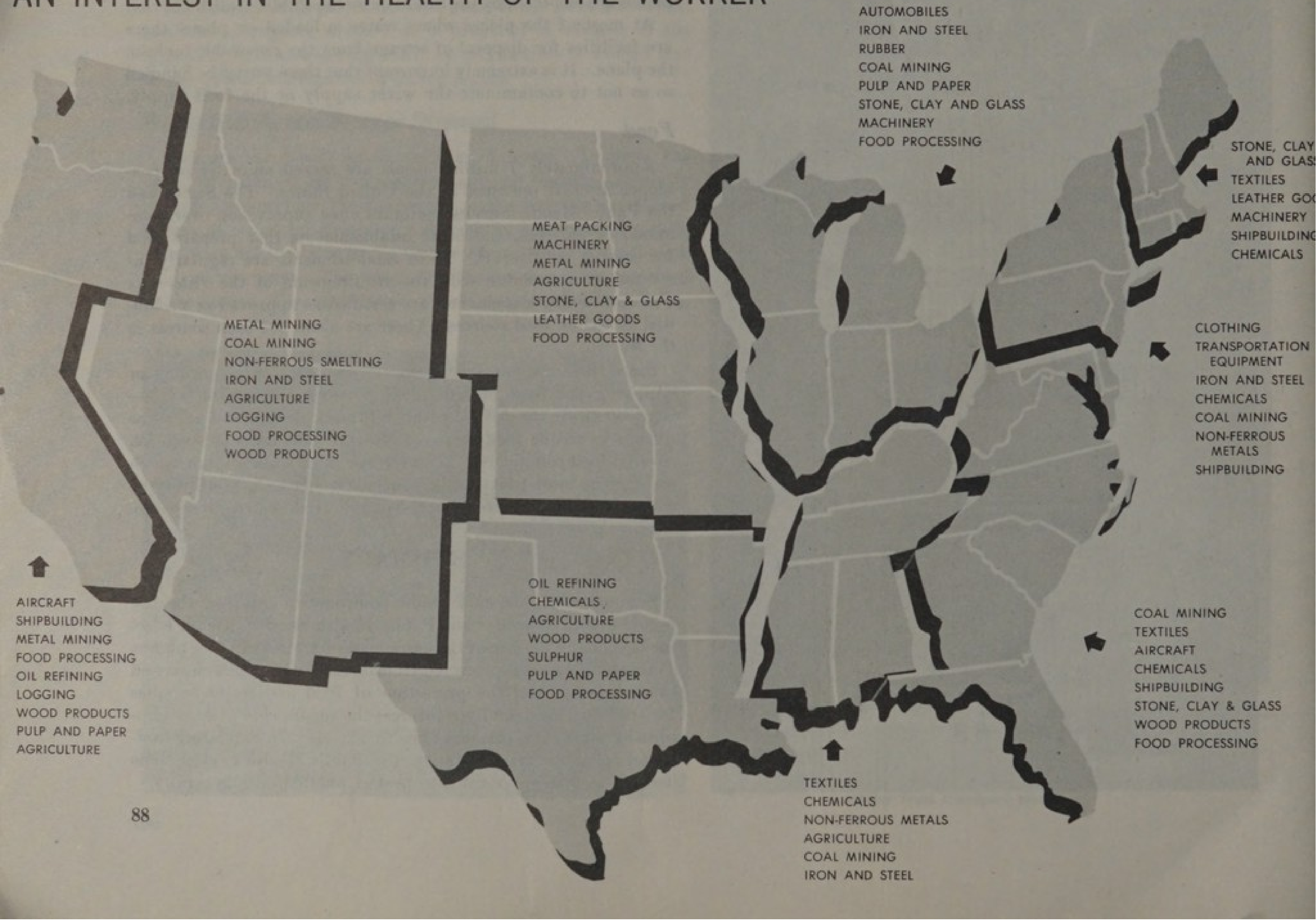
Approximately 7 million meals are served annually on passenger aircraft operated in the United States. The States and the Public Health Service maintain close supervision over commissaries, caterers, and other establishments that prepare food for serving on aircraft. These establishments are regularly inspected in accordance with the requirements of the *Interstate Quarantine Regulations* and are certified as approved or prohibited as airline food sources. There are about 185 such sources in the Nation.

Since these commissaries prepare complete meals—packing or wrapping the food in individual portions for serving aloft—they constitute the critical point in protection against food-borne disease in airline food service. Most airlines use single-service, covered food containers. With the exception of beverages, which are for the most part handled in bulk containers, possibility of contamination of the food on the plane is reduced to a minimum.

SUMMARY

Sanitation of interstate public transportation, one of the few regulatory functions of the Public Health Service, has an effect far beyond the welfare of the passengers on trains, ships, or planes. The general public is protected from diseases which may be carried by travelers. And the protection of food and water supplies for travelers incidentally reinforces the supervision of these supplies by State, city, or county health officials. In regulating sanitation on public transportation, the Public Health Service finds itself in a strategic position to protect public health generally.

INDUSTRY IN EVERY SECTION OF THE NATION HAS AN INTEREST IN THE HEALTH OF THE WORKER



Industrial Health

SIXTY MILLION Americans spend a third of their time at their jobs; often at hot, foul, dusty, noisy, dangerous jobs. The welfare of their families, indeed the security of the Nation, depends upon the personal health of these workers. It is their faith and their right that their employers and their public officials should do everything practical to see that the working environment is as safe and healthful as it can be.

A DEMOCRATIC POLICY

For this reason, measures to improve the industrial environment aim primarily to serve the workingman, whose health is his chief asset in his efforts to earn a livelihood. This aim is basic to a democratic policy, supported by industry, labor, and the general public.

This policy has contributed in no small way to the growth of the vast market and the enormous productive powers of American industry.

Those companies with the best health and safety records are for the most part also those where men do their best day's work, where productivity and profits are the highest. For years, management, as a sound business practice, has invested heavily in the improvement and maintenance of machinery. Modern management appreciates that it pays dividends to protect the health of the men who operate machines. A corollary to this thought is the concept that protection of the worker implies protection in the community as well as in the plant.

The history of measures to improve the industrial environment is at least as old as the careers of Robert Owen and Moses Brown, both industrialists of the early nineteenth century. The movement gained impetus with passage of the workmen's compensation laws, which obliged industry, for its own protection, to take a greater interest in elementary sanitation, reduction of working stress, accident prevention, and occupational disease.

In 1914, the Public Health Service began its work in industrial hygiene, which has developed until it now employs for this work physicians, engineers, chemists, dentists, toxicologists, nurses, and other technical personnel. Their laboratory studies and field investigations have helped to mitigate such industrial hazards as dermatitis, silicosis, lead poisoning, mercury poisoning, and other threats to the well-being of productive workers and the profitability of industry.

PUBLIC HEALTH SERVICE FUNCTIONS

The Public Health Service develops standards of good practice in industry to protect the worker's health. It conducts demonstrations for this purpose. It helps States, at their request, to investigate industrial hazards and encourages States to apply protective health methods in industry. It encourages such applications on the part of industry itself.

The hazards of the industrial environment are by no means limited to occupational diseases or accidents. Without counting the losses from accidents, deaths, or impaired efficiency, the time lost from work as the result of sickness is equal to the services of more than 1,000,000 men a year. Only a small fraction of this loss is a direct result of occupational activity. For this reason, establishment of in-plant health programs has become a major activity of industrial hygiene.

The Public Health Service encourages employers and others to install or improve health facilities for curative, preventive, and positive service, wherever large numbers of men and women are employed. The control and eradication of occupational disease is but one facet of this work.

The Public Health Service receives calls, not only from State health departments, but also from other Federal agencies and industries operating on a national scale. With production scheduled to rise by 25 percent between 1951 and 1955, demands for these services are expected to increase.

Emergency Services

In the Second World War, two essential industries were so hit by health problems that the War Manpower Commission asked the Public Health Servce for assistance. Health conditions in these industries were so bad they were finding it difficult to hire and hold employees.

One was the chromate manufacturing industry. The mists in chromate factories attacked the nasal septum and did other damage to the respiratory system. The Public Health Service recommended ventilating hoods, dust control, and good housekeeping practices for these plants, but the extremely complicated nature of the hazard is still under investigation.

The other industry was ferrous foundries. The need for proper methods of dust control to reduce silicosis had been evident in this industry for years. Since this wartime investigation, the Public Health Service has cooperated with the Illinois Department of Public Health in a survey and, in 1951, reported substantial improvements in the foundry industry's control of dust. Further improvements were expected as a result of the report.

Another industry under investigation at the request of several state health departments is uranium mining and milling in the Colorado Plateau, where workers are exposed to ionizing radiation and to dusts that cause silicosis.

Long-Term Services

In the words of Dr. C.-E. A. Winslow, "The function of industrial hygienists as a group is not merely to control the hazards of lead poisoning and silicosis but to advance in every possible way positive promotion of the physical and emotional health of the worker in industry."

Industrial hygiene therefore is concerned with any hazard in the industrial environment which may affect the health of the worker, both as an employee and as a resident of the community.

FOUR OBJECTIVES

The health of the industrial worker is far better protected today than at any time since the invention of the wheel. But modern technology adds new environmental problems as fast as old ones are discovered and attacked.

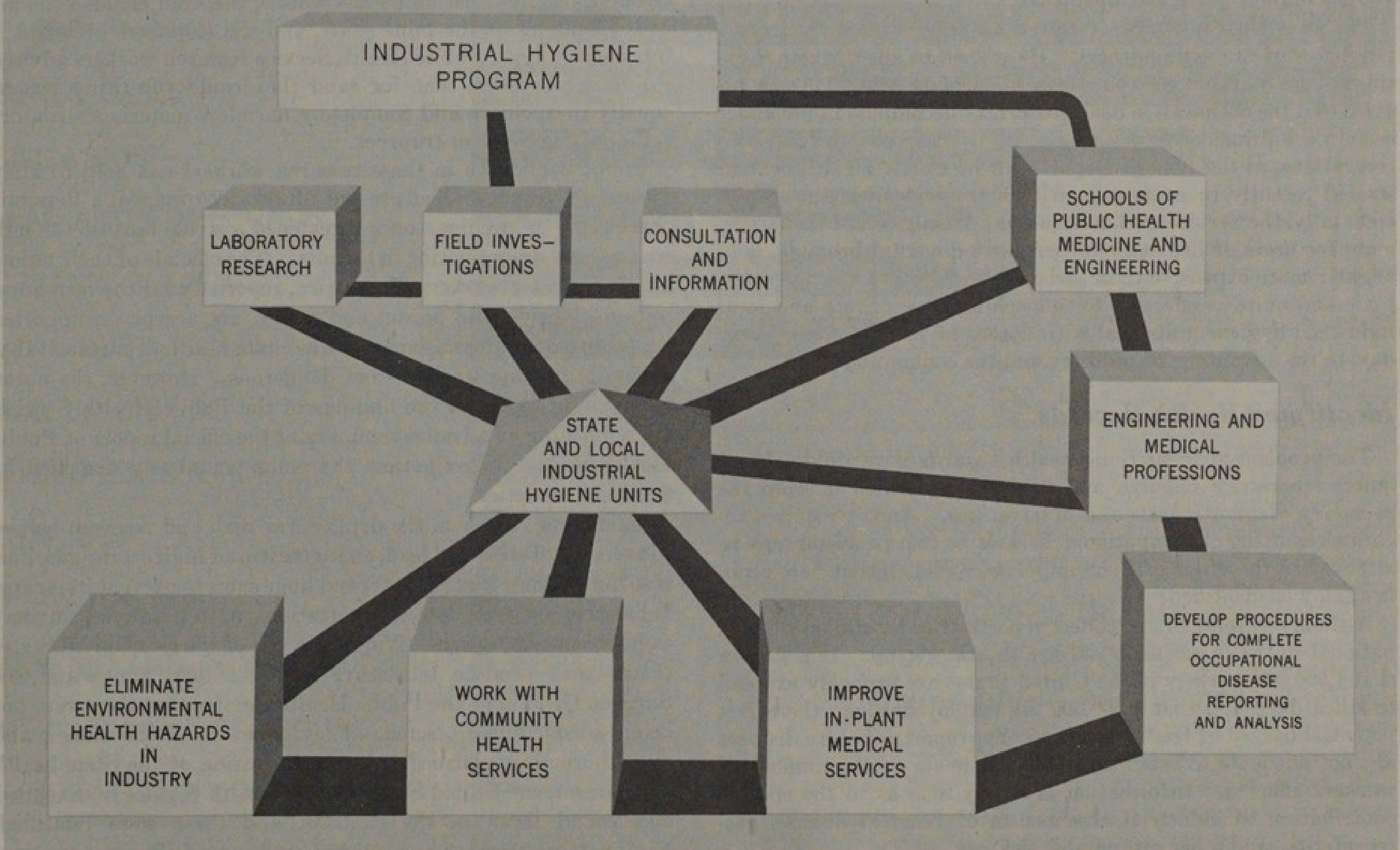
The program for occupational health therefore proceeds along four parallel footpaths, aiming:

1. To put present knowledge to good use.
2. To learn the nature and location of health hazards, old or new.
3. To discover means of coping with health hazards.
4. To promote the best medical service economically feasible in every place of employment.

Using Present Knowledge

The Public Health Service has assembled what is probably the Nation's most complete collection of information on the healthfulness of the industrial environment. This knowledge is promul-

HOW THE PUBLIC HEALTH SERVICE SEEKS TO SAFEGUARD THE HEALTH OF WORKERS



gated in bulletins and other publications issued by the Service, in conferences, and through individual correspondence. Nevertheless, thousands of plant managers have not heard of research of specific concern to them, or, if they have, they do not know how it applies to their particular operation.

For example, the Service received an inquiry recently from a purchaser of fire extinguishers. He wished to know whether extinguishers containing carbon tetrachloride are safe. He was advised that the chemical, in itself toxic, may decompose in use under certain conditions to release phosgene, a poison gas, in fatal concentrations, as the Illinois Department of Public Health demonstrated recently in connection with a tragic trailer fire. Coincidentally, the Service at that time was advising one of the largest manufacturers of fire extinguishers that dimethyl bromide, only slightly more expensive than carbon tetrachloride, was much less toxic and quite as effective for quenching fires. State and local industrial hygiene units deal with dozens of such questions every day, to the advantage of industry and the community.

Identifying Health Hazards

The problem of identifying health hazards is twofold. It requires laboratory research and field studies which develop the necessary diagnostic tests and observations. And it requires accurate reporting of occupational diseases, so that problems may be attacked in the order of their importance and so that new problems may be identified.

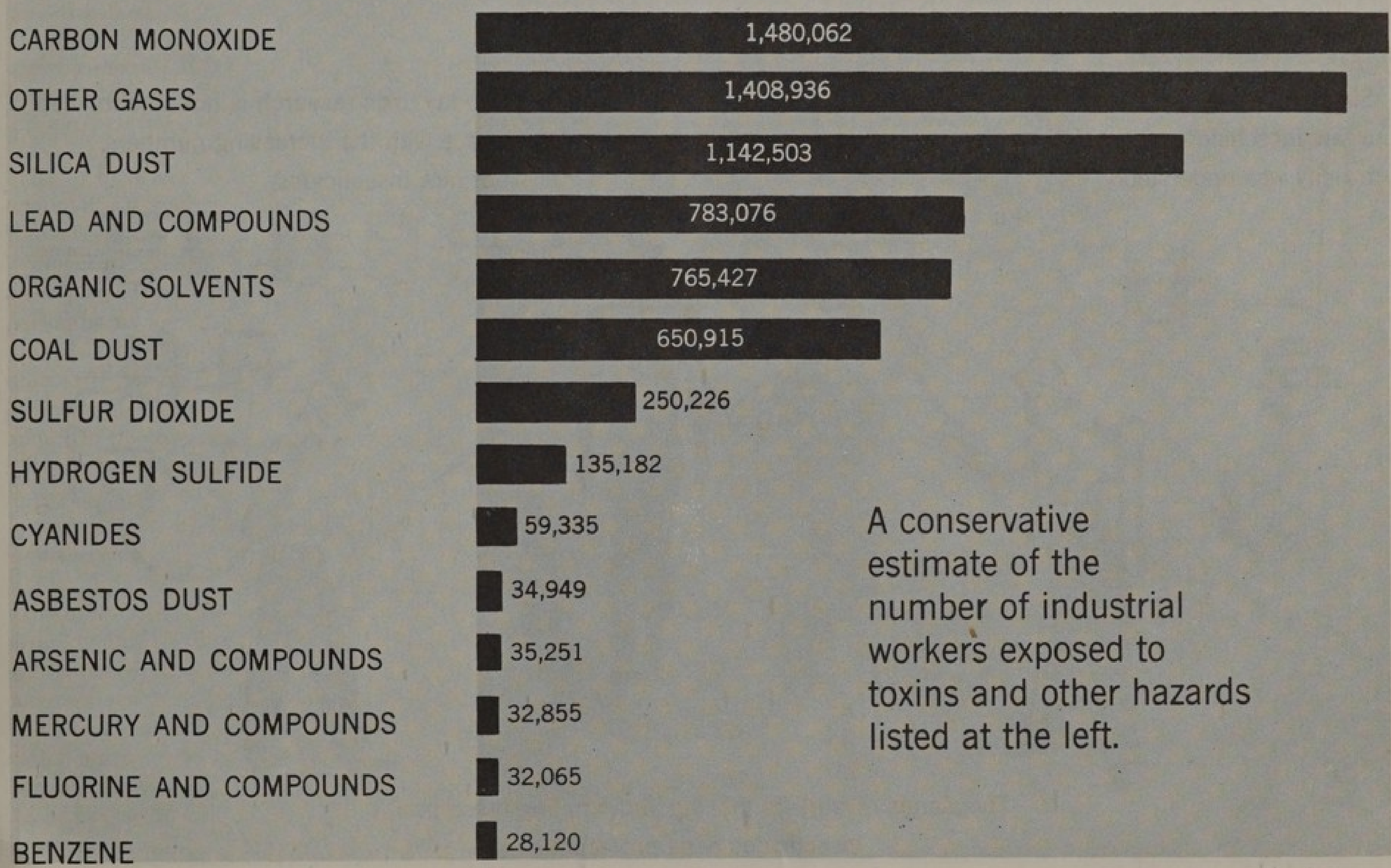
Although several States collect reports of occupational disease, national statistics on industrial health are sketchy. It is known that 1,500,000 workers in the United States are probably exposed to silica dust, and that 1,000,000 are employed where there is a potential hazard of lead poisoning. Yet reports of these diseases are not adequate to establish a good estimate of the number of workers afflicted. Information is scanty also as to the specific contribution to industrial absenteeism of venereal disease, gastroenteritis, and other preventable sickness.

When the hazard is known, corrective action can be prompt. The United Mine Workers not long ago reported that operators of mine locomotives were suffering from silicosis. The causative agent was sand used to give the coal car wheels a grip on the rails. Ground into fine dust under the wheels, the sand clouded the air in the confines of the mine shaft, and the engineers breathed it into their lungs. Public Health Service research workers advised the mine operators that for sand they could substitute several equally inexpensive and completely harmless materials: iron ore tailings, slag No. 4, or traprock.

Public confidence in these research workers can help to allay groundless fear as well as prevent illness. Workers at a Republic Steel plant in Michigan once threatened a strike because the mill was using sodium fluoride in the mix. The officials of their union, the United Steelworkers of America, reported that the men knew sodium fluoride was poison and would not accept unsupported assurances of the management or the State health department that its use in making steel was not dangerous. However, the union was willing to accept the findings of the Public Health Service. By publishing an advance summary of the official report of Public Health Service investigation, the union completely dispelled its members' anxieties.

In another situation, the danger was real, and research helped to avert it. Tetraethyl lead, an ingredient of high octane gasoline, is so highly toxic that plants spend huge sums to prevent its escape. Inhalation of even low concentrations of tetraethyl lead may cause insanity or death. Workers in one of the two United States plants that produce tetraethyl lead not long ago wired the Surgeon General of the Public Health Service that they were not being adequately protected. They could smell the fumes, and were thoroughly alarmed. At the invitation of the State health department, the United States Public Health Service investigated and found flaws in the controls, and these were remedied. Fortunately, there was no clinical evidence of illness.

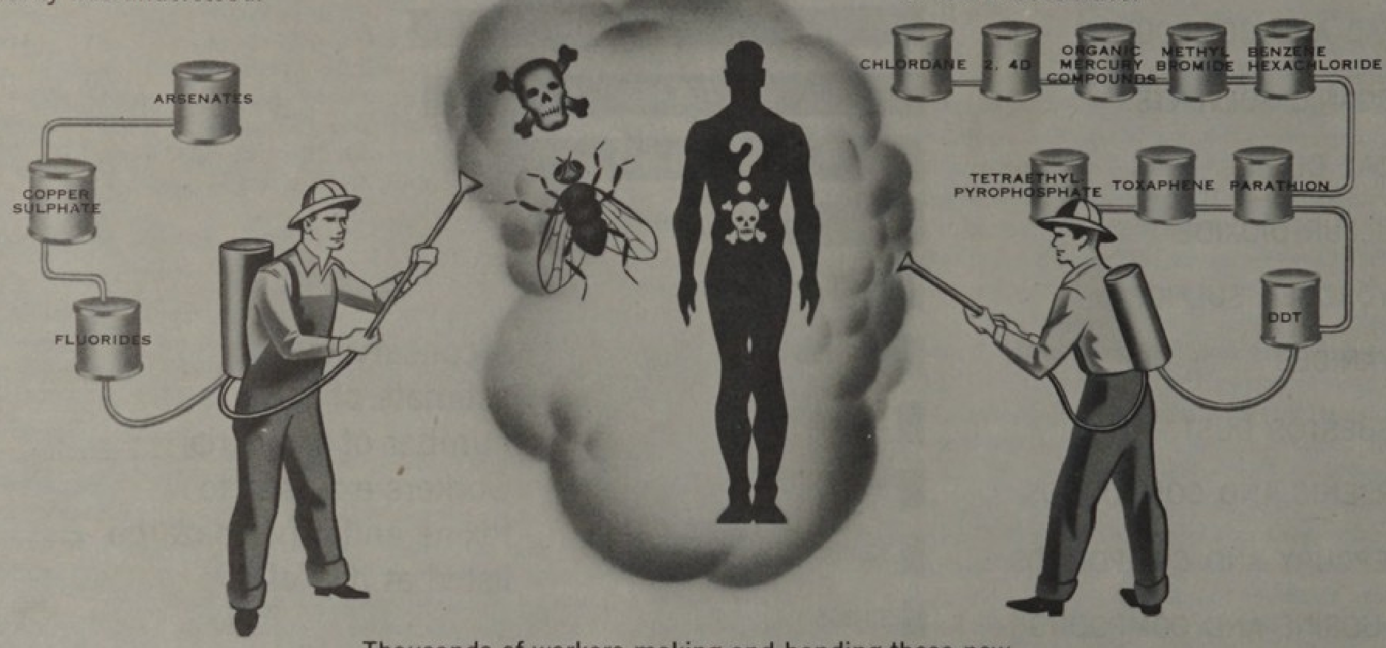
HEALTH HAZARDS IN INDUSTRY



INDUSTRY PRODUCES MANY NEW ORGANIC CHEMICALS DEADLIER TO INSECTS ... *BUT* HOW HARMFUL ARE THEY TO HUMAN BEINGS?

Six years ago there were only a few insecticides--and their toxicity was understood.

Today toxic research is not able to keep pace with the increasing numbers of new insecticides.



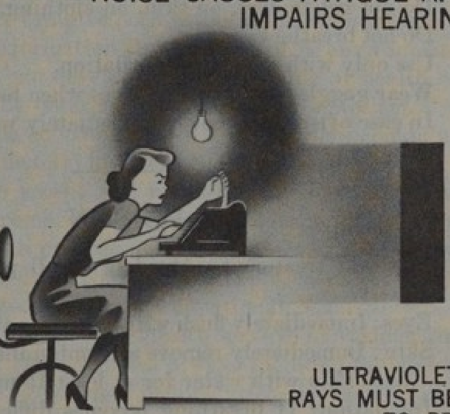
Thousands of workers making and handing these new insecticides need protection.

PHYSICAL AGENTS AFFECT MANY WORKERS

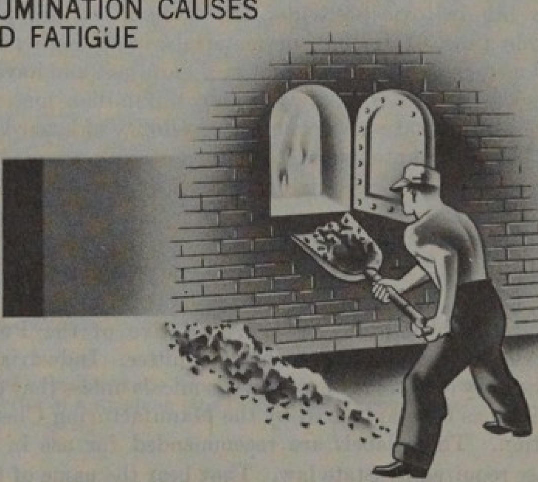
REPEATED MOTION INFLAMES TENDON SHEATHS AND JOINT SPACES

VIBRATION INJURES FINE NERVES AND BLOOD VESSELS

NOISE CAUSES FATIGUE AND IMPAIRS HEARING



IMPROPER ILLUMINATION CAUSES EYESTRAIN AND FATIGUE



ULTRAVIOLET AND INFRARED RAYS MUST BE SCREENED OUT TO PROTECT THE EYES

EXPOSURE TO EXCESSIVELY HIGH OR LOW TEMPERATURE REQUIRES SAFEGUARDS TO PROTECT HEALTH

Most jobs have health hazards but ALL can be protected

Other recent research by the Public Health Service has developed a lightweight electrostatic precipitator for taking air samples of potentially toxic materials in industrial plants. Chemists in the Service have devised a new test for detecting in human tissues the presence of parathion, a powerful insecticide which is sometimes toxic to those who apply it. These examples illustrate the research that is necessary to the systematic improvement of the health of the industrial environment. Coupled with an adequate system of reporting occupational diseases, such activities mark the path by which State and community health officers advance industrial hygiene.

Protective and Remedial Measures

The problem of coping with industrial hazards is complicated by their variable nature. Health hazards are not static. American technology constantly introduces new substances and processes. Many are potentially dangerous. There are grounds for alarm in the introduction of the use of certain toxic solvents, in certain new highly toxic pesticides, and even in certain processes for saving time, equipment, or materials. Although new processes and materials may seem completely harmless, and have been tested to some degree for safety, every unfamiliar material, device, process, or situation contains the possibility of hazards which cannot be wholly anticipated.

A particularly perplexing problem is posed by the multitude of chemicals in industrial use; many of these are known to be hazardous, and others are possibly so. One effective protective measure has been publication by the Manufacturing Chemists' Association of standard "warning labels" for use on packages of hazardous chemicals. A representative of the Public Health Service sits on the responsible committee. Industrial consumers ordinarily are unwilling to buy chemicals unless they carry a label which has been approved by the Manufacturing Chemists' Association. These labels are recommended for use in addition to those required by State law. They bear the name of the chemical and a signal word, expressing the degree of hazard: (1) DANGER! (2) WARNING! (3) CAUTION! There follows a statement of the hazard, and a description of protective and remedial measures. To illustrate:

DIMETHYL SULFATE

DANGER! Extremely *Hazardous* Liquid and Vapor Causes Severe Burns

Do not get in eyes, on skin, on clothing.
Do not breathe vapor.
Use only with adequate ventilation.
Wear goggles and rubber gloves when handling.
In case of spillage, cover immediately with dry soda ash.

POISON

First-aid treatment—Antidote: Call physician immediately.
Eyes: Immediately flush with water for at least 15 minutes.
Skin: Immediately remove all contaminated clothing and flush skin with water for at least 15 minutes.
Inhalation: If breathing becomes difficult, start oxygen inhalation through suitable equipment.

The book which presents these labels is eloquent testimony to the number of hazards which have been introduced in this generation by chemical technology peculiar to the industrial environment. It is a challenge to the industrial hygienist to identify them, to guard against them, and to correct so far as possible the injuries inflicted. Whether the danger is isolated or general, whether the injury is obvious or insidious, the task of industrial hygiene is vast.

The development of remedial measures requires constant surveillance and review of the changing technology. There must be research into the location and nature of hazards and methods of control, and there must be adequate reporting of their effects in the form of occupational disease.

Medical Services in Industry

Probably the best means for carrying through a program of industrial hygiene is the development of an in-plant health program. Such a service can give both workers and management authentic and current information about their specific environmental health problems. It can develop valuable records of health conditions in the plant by determining causes of absenteeism.

Its activities can be coordinated with appropriate community agencies to improve the total health of the employees.

Most industrialists accept full responsibility for providing a healthful work environment for their employees. They recognize their obligation to provide adequate lighting, a safe supply of water, air free of dangerous contaminants, clean washrooms and toilets, and protection from occupational hazards.

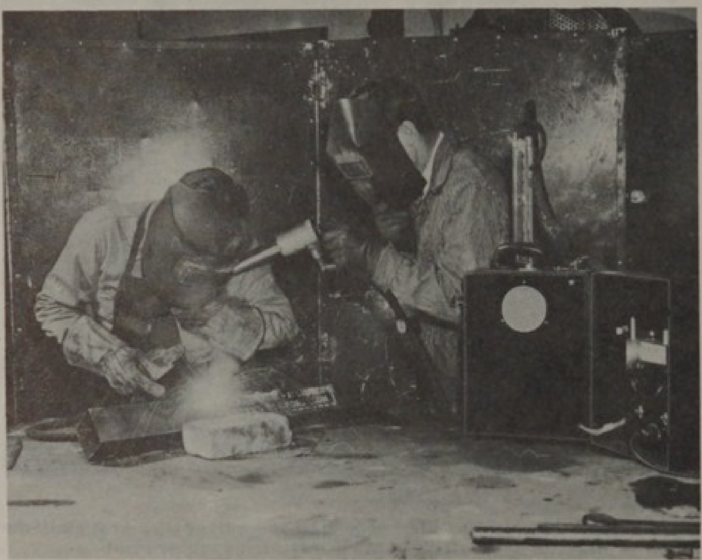
Many large plants also provide health services of various kinds to their employees. These services always include preplacement examinations. They sometimes include periodic health examinations, also. Broad programs may provide comprehensive preventive services, medical consultation, and other attentions encompassing the total family needs. In providing broad health facilities and services, management often has the support of employee organizations which make the health work a joint labor-management project. In several instances, cooperative health programs have been established independently by employee organizations.

Still others have been established by State or city governments.

An air-supplied helmet and life-line protect the worker who must clean the interior of a stripping tank in a synthetic rubber plant.

INDUSTRIAL HYGIENE IN ACTION

Apart from the information gained from research and reporting, the industrial hygienist is guided in his achievements by direct requests for assistance. The task force that organizes informally to answer such calls from industry, from labor, or from local health officials pools the skills, training, and services of engineers, physicians, dentists, nurses, chemists, toxicologists, statisticians, and similar specialists. As in other public health work, the team that conducts clinical and environmental investigations of industrial hazards is drawn from many professions.



Industrial hygienist samples welding fumes with an electrostatic precipitator.

Relations With States

The demand for health services in industry most commonly arises from contact with all sorts of toxic materials or from the effects of atmospheric pollution resulting from certain types of industrial activity. But some industrial health problems concern several different industries, and perhaps an entire region. In such situations, the laboratories of the Public Health Service collaborate with the States to do research which individual States cannot do unaided.

Such studies of the working environment vary widely in scope and size. A State may request the Public Health Service to evaluate all its industrial hygiene problems, to strengthen its health programs. Such a study was made in Utah in cooperation with the State Department of Health and with labor, industry, the medical profession, and the Industrial Commission. A preliminary survey pointed to siliceous dusts, lead, and other metallic dusts, fumes, and gases as the chief industrial health hazards in the State. The investigators then selected representative plants for further study. A detailed investigation which followed covered one-fifth of the State's coal miners, one-fourth of the nonferrous metal miners, and two-fifths of the workers in the nonferrous smelting industry. Silicosis, anthracosilicosis, and lead poisoning were found to be the chief occupational diseases among these men. At the same time, investigators studied sewage disposal, water supply, and other health factors in the community. The Public Health Service offered both medical and engineering recommendations for improving the environment. The recommendations guided Utah in enacting occupational disease disability legislation and in establishing a permanent industrial hygiene unit.

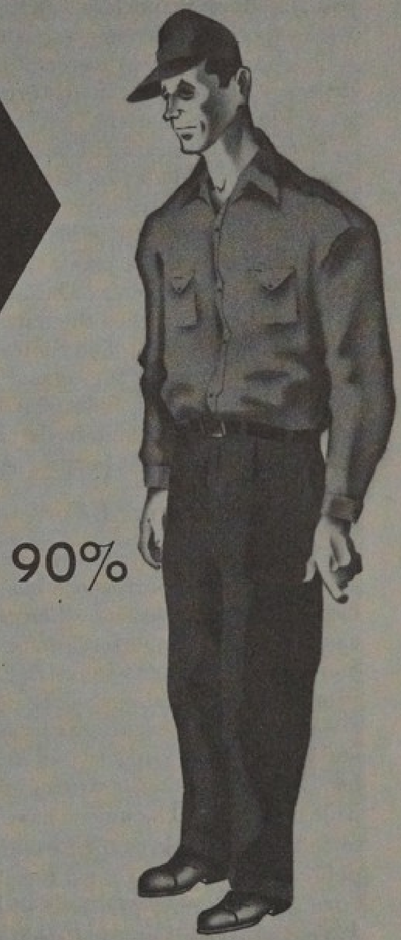
In addition to State-wide surveys, individual industries present hazards which require special research. A classic example is the investigation that revealed and brought about control of chronic mercury poisoning in the hatters' fur-cutting industry. It was formerly the practice of this industry to apply a mercury prepara-

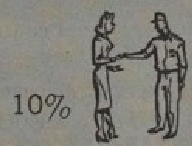
INDUSTRIAL HYGIENE COVERAGE MUST BE EXTENDED

FACILITIES AND TRAINED PERSONNEL ARE NEEDED FOR THE HEALTH OF INDUSTRIAL WORKERS

today—90 PERCENT of the labor force is NOT receiving proper industrial hygiene services . . .

In 46 States, 58 State and local industrial hygiene agencies employ only 400 physicians, nurses, and other professional workers: an average of only 1 industrial hygienist for each 150,000 workers.





tion in the treatment of fur felts for hats. This process is called carroting. Industrial hygienists checked the manufacturing process step by step and found that workers in each successive stage were exposed to mercury vapor and dust. Eight percent of the workers suffered from mercury poisoning. Some of the victims experienced such psychic disturbances from the poison that they were called "mad hatters."

To control the hazard of such exposures, the Public Health Service helped the States to establish standard maximum limits of tolerance for mercury vapor in the air. It recommended that the industry improve ventilation, segregate certain processes, reduce dust and debris in the plant, and provide careful periodic examinations of the workers. The hazard was eliminated completely several years later when the industry obtained a satisfactory substitute for mercury. The States then prohibited the use of the mercury carrot in the fur-cutting industry.

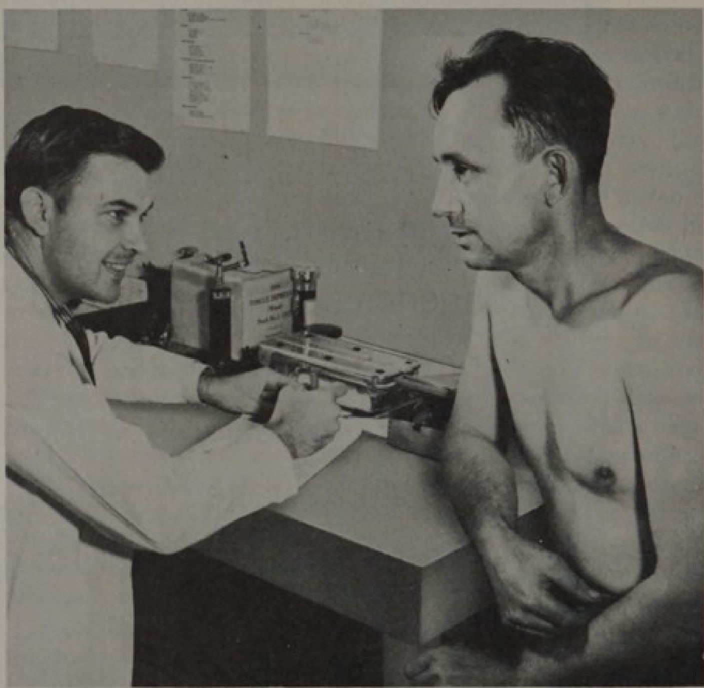
With such studies, industrial hygienists have learned how to control most industrial hazards. Many have been controlled. But many, such as silicosis, persist. And many new ones appear.

Other Cooperative Effort

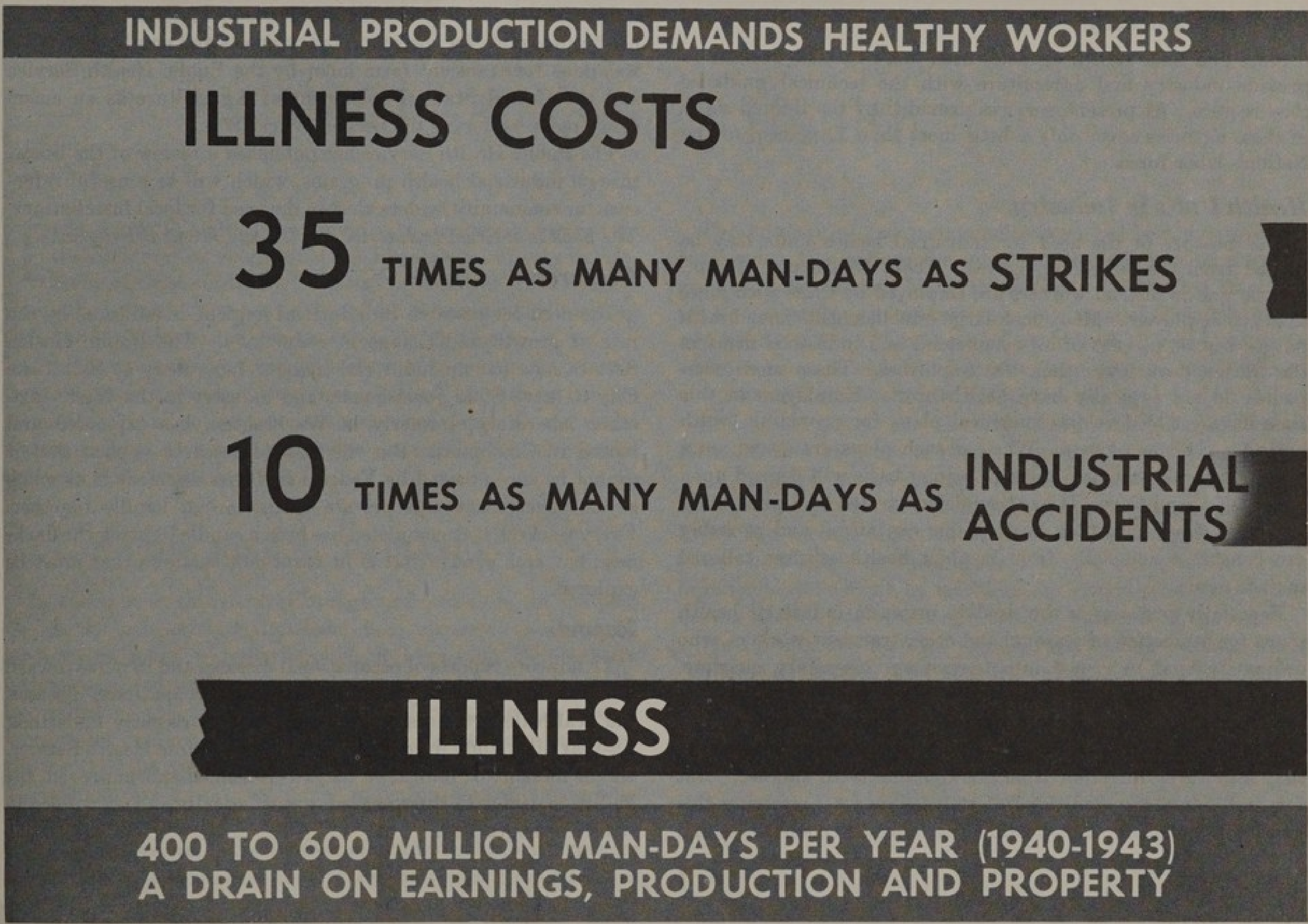
The work of industrial hygiene enlists the cooperation not only of many diverse professions but also of a variety of social and industrial organizations. Constructive activities of individual employers and employers' associations have been, of course, a major contribution to industrial hygiene, as have the efforts of insurance organizations. The activity of labor organizations, always alert to occupational hazards, has been expanding lustily and now includes programs of health education, union-sponsored health services, and the writing of health measures into industry-wide contracts. The unions have made special contributions also to industrial hygiene. An example is the recent printing as a public service by the United Steelworkers of America of an annotated bibliography, prepared by the Public Health Service, on *Biological Aspects of Air Pollution.*

IMMEDIATE NEEDS

To fulfill the obligations of industrial hygiene, the Nation needs more technical workers, more industrial medical services, more research, and more complete reports of occupational diseases. These are immediate and urgent requirements, if America's industrial prowess is to continue to be the marvel of the modern world.



Physician takes worker's history during a survey by the Public Health Service of industrial health.


INDUSTRIAL PRODUCTION DEMANDS HEALTHY WORKERS
ILLNESS COSTS
35 TIMES AS MANY MAN-DAYS AS STRIKES
10 TIMES AS MANY MAN-DAYS AS INDUSTRIAL ACCIDENTS
ILLNESS
400 TO 600 MILLION MAN-DAYS PER YEAR (1940-1943)
A DRAIN ON EARNINGS, PRODUCTION AND PROPERTY

Staff and Facilities

State and local health agencies need more trained workers to provide industry and agriculture with the technical guidance they require. At present, services provided by the limited staffs of these agencies cover only a little more than 10 percent of the Nation's labor force.

Health Units in Industry

The measure of the need for industrial health units may be gained from the following figures. About 40 percent of commercial and industrial workers are employed by firms with more than 500 employees. Many such large establishments have health units. But 98 percent of all commercial and industrial firms in the Nation have fewer than 500 employees. These small companies do not typically have health units. Employers in this class have yet to develop economical plans for providing health units for their employees. Whether such plans are drawn on a limited basis, a part-time basis, or a joint basis will depend upon the specific conditions. It has been demonstrated by a pilot study in Long Island City that small plants can afford and probably can benefit economically from in-plant health services tailored to their needs.

Especially pressing is the need to organize industrial health plans for protection of seasonal and other transient workers, who ordinarily tend to crowd into temporary, insanitary quarters. These conditions foment preventable infections dangerous to the community, to the industry, and to the workers themselves. Because these workers are mobile, there is the further danger that they may carry infection from one community to another. But few individual communities feel responsible for protecting this floating population. It is possible that affected communities and industries eventually will maintain State, regional, or Federal health programs for their temporary guests and employees. This was done for transient farm labor by the Public Health Service and the United States Department of Agriculture as an emergency measure during the Second World War.

The Public Health Service has published a review of the literature on industrial health programs, which will be a useful reference for community leaders alert to the need for local installations. The book is entitled *Industrial Health and Medical Programs.*

Research

The need for research in industrial hygiene is indicated by the rate of growth and change in technology. The Public Health Service now has an industrial hygiene laboratory at Salt Lake City to serve State governments and industry in the West. Another laboratory, formerly in Washington, has expanded and moved to Cincinnati. But the task of research is such that it cannot be encompassed by Federal facilities alone: it is as much as all government and private facilities can handle together. Every research task completed has been a candle lighting the darkness, but each candle that is lit casts new shadows that must be explored.

Reports

To improve reports of occupational diseases and to move toward a nationally uniform system for reporting occupational diseases, the health departments of 10 eastern States recently undertook a 2-year pilot study in cooperation with the Public Health Service. As the measure of industrial hazards is refined and improved, the ability to deal with these hazards systematically and economically will be strengthened.

Radiological Health

THE EARTH and all life upon it are constantly sprayed by invisible rays of energy that act like streams of tiny bullets. Some of these subatomic "bullets" produce electrical charges where they strike. Because of this effect, they are called ionizing radiations. These radiations penetrate living tissues.

Cosmic rays are one form of these highly penetrating radiations. Others include various rays given off by radioactive elements found in minute amounts almost everywhere. Even natural waters give out rays from detectable but usually inconsequential amounts of radioactive matter.

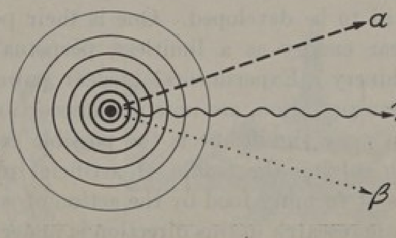
THE RISE OF RADIATION

In addition to this natural background radiation, in the past 50 years, men occasionally have been exposed to increased amounts of ionizing radiations which have been incidental to technological advance. Some exposures have been an unsought byproduct of the use of radioactive materials, such as minute amounts of radium in luminous watch dials. Others have been the result of the use of radiations as a scientific tool, as in making X-ray pictures. So far such added radiations probably have been of no appreciable danger to the health of the general public. But, whatever the source, in the interest of public health, any exposure to ionizing radiation above the natural level must be regarded as a potential danger.

The presence of radioactive substances has been known since 1896, when Henri Becquerel observed that a lump of uranium ore had fogged some photographic plates. Following this clue, the Curies, working to exhaustion in an open shed, isolated radium and polonium from a vast brew of pitchblende, 2 years later. In addition to these natural radioactive elements, we know now of about 50 additional naturally radioactive elements.

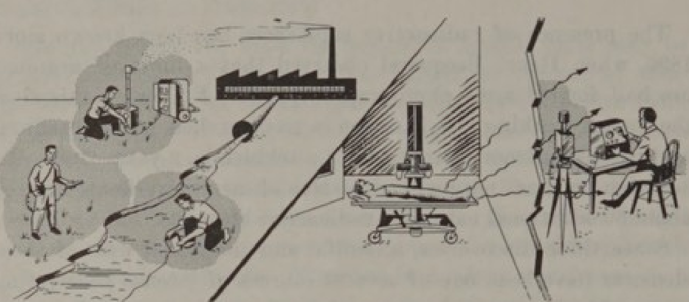
Since these discoveries, scientific and industrial uses of these elements have been one of several sources of intense penetrating rays. Another general source of exposure has been high-energy machines or installations, such as X-ray tubes, fluoroscopes, betatrons, and atomic piles, which have been growing in number, power, and usage. A third source has been elements which men have made radioactive by machines, by atomic piles, or by other devices that release the energies held in the heart of the atom.

Most people are familiar with X-rays. Other common kinds of ionizing radiation are alpha (α), gamma (γ), and beta (β).



BALANCE SHEET

Radiological health is that branch of health work concerned with these high-energy, penetrating radiations. It has two major aspects. One is the promotion of health through beneficial use of radiation. The other is the protection of people from harmful effects of penetrating radiations.



Benefits

The beneficial uses of radiation are still being explored. In therapy, penetrating radiations have made possible X-ray diagnosis and nonsurgical reduction of tumors. In research, they have permitted the study of submicroscopic processes which formerly were hidden from observation. In industry, they have a variety of practical uses now, but their greatest industrial possibilities are still to be developed. One is their possible use in releasing nuclear energy as a limitless, perpetual, and cheap mover of machinery. Experimental nuclear power plants, for use in heavy transportation, are now in construction.

Perhaps even more significant is the possible contribution of radioactivity in solving the riddle of artificial photosynthesis, nature's process of forming food by the action of sunlight on air and water. Basic research in this direction is under way at many laboratories, including the Public Health Service's National Institutes of Health. It is possible that success in this undertaking may pave the way for the world to produce food and fuel from air and water by an industrial process.

Dangers

These great benefits of radiation also present certain dangers. These dangers are the price of these benefits. But the price has not yet been fixed. There is a possibility that the dangers can be so well controlled that the damaging effect of ionizing radiations on human well-being will be negligible. There is also the fact that the nature of the effects of ionizing radiation is not fully known. Enough is known to realize that the possible effects include: Occasional genetic mutations productive of monsters or weaklings, cancerous mutations, and other physical harm. Much is still to be learned.

Rather obvious effects are produced by brief but intense irradiation. But there is small likelihood that any appreciable numbers of the general public will suffer injury by that means. Even if an atomic bomb exploded in the air over one of our cities, the consequences of irradiation would be relatively slight compared with the devastation produced by blast and flame.

The form of radiation which most concerns the public health worker is chronic, low-level, and subtle, because this hazard is the more likely one and because the tissue effects are cumulative and may build up from repeated exposures over a period of years. The general public is likely to be exposed to such chronic radiation from two general sources: machines used in hospitals, industry, and commerce; and radioactive materials which may occur in dangerous concentrations in the environment. These dangerous concentrations may arise in nature or they may be an aggregation of materials which have leaked or escaped from places where they had been used or stored.

SAFEGUARDS

Control measures in radiological health consist of preventing radioactive materials, including liquid and gaseous wastes, from concentrating where they may do damage, and of providing protective shields for those who must be exposed to radiations above the natural level. So far there is no known immunity to or effective therapy for radiation injury.

Detection

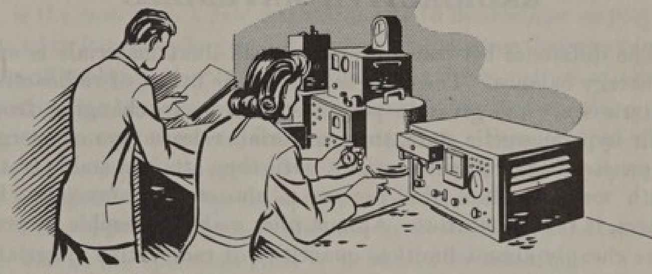
Radiation hazards often are ignored because they are not obvious. Radiation exposure usually produces no immediate pain, taste, or odor. The rays can neither be seen nor heard. Even in lethal doses, high-energy radiations may give no signal to the senses. And without such signal, the danger of an overdose of radiation is difficult to control.

Radiation doses are expressed in terms of roentgens. One roentgen indicates, on the average, two ionizations in one cubic micron of tissue. The average human body cell contains 500 cubic microns. Hence one roentgen indicates, on the average, 1,000 ionizations in every cell exposed. The accepted daily maximum dose permissible averages 50 ionizations per irradiated cell.

Because the biologic effects are not readily detectable and are often delayed, sensitive devices, such as pocket chambers or film badges, are used to warn against exposure.

The badge contains a striplike camera film, a few square inches in size. This strip bears a number or other symbol to identify the wearer. It is sealed against light. When developed, it darkens to the degree that it has been exposed to ionizing radiations. As the emulsion in different badges may have different degrees of sensitivity, it is important to subject a set of film from each lot of badges to a series of controlled exposures in order to have a standard for comparing exposures.

The pocket ionization chamber looks like a small telescope the size of a fountain pen. With the aid of an auxiliary instrument,



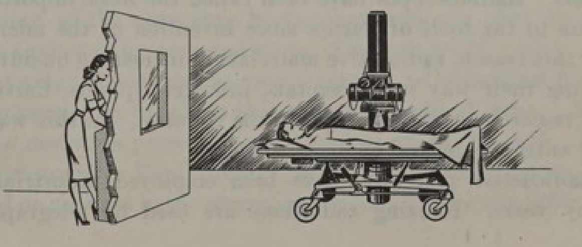
this device may be used to obtain instant and frequent readings of the exposure experienced.

Protection

It is not practical to eliminate all exposure to radiation. It is practical to strive to avert unnecessary additional exposure which, added to the natural background radiation, may be harmful.

A person may be protected from exposure by lead or concrete shields or by being a safe distance from the source of radiation. Other forms of protection are under investigation. Should the environment become charged with radioactive matter, either the inhabitants or the radioactive contaminants would have to go. But the removal of radioactive contaminants is difficult and expensive. It might be impossible to eliminate them within a lifetime.

In radiological health, an ounce of prevention is worth tons of cure.



RADIOACTIVE MATERIALS

The difference between radioactive and inert materials is one of energy balance. The energies within the nuclei of radioactive materials are too great to permit stability. In changing from their hyperenergetic state, these materials release rays of energy or penetrating, charged particles until they attain a stable state. With some elements, this process is almost instantaneous. In others, it takes centuries. Atomic piles make it possible to produce cheaply almost limitless quantities of radioactive materials, tailor-made to a specific use. For example, radioactive cobalt, which can be as useful as radium in treating cancer cells, is produced at will in almost any quantity desired.

The world supply of radium available for use in medicine and research in 1940 was about 3 pounds. Each atomic pile has produced radioactive materials with a radioactivity equivalent to hundreds of tons of radium.

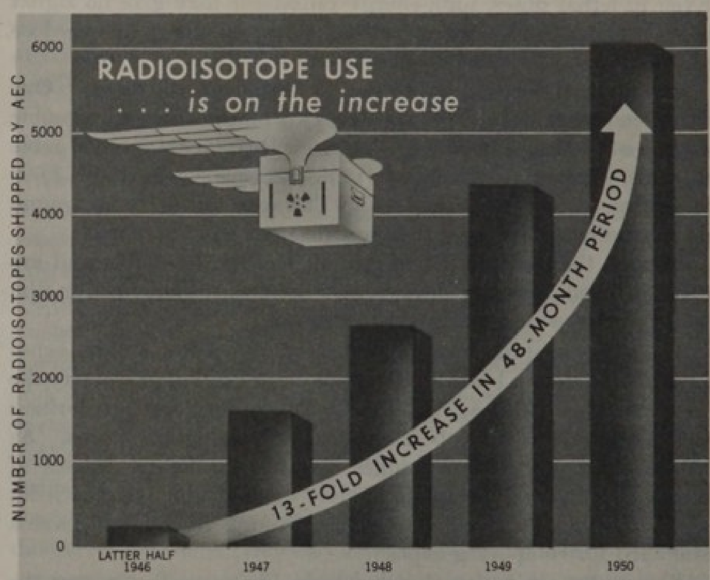
Many radioactive substances are isotopes of common elements such as carbon or oxygen. An isotope has the same chemical properties as its brother element but a different nuclear structure. A radioisotope will behave chemically the same as the inert isotope but will give off radiations. Radioisotopes have a variety of technical uses in science and industry.

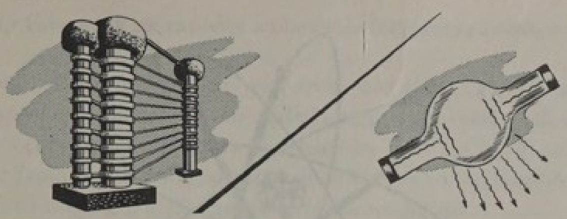
The accompanying chart, showing the growth of the shipments of radioisotopes from the Atomic Energy Commission to other users, is an indication of the increasing uses of radioactive materials. Radioisotopes have been called the most important addition to the tools of science since invention of the microscope. For this reason, radioactive materials in increasing quantities are finding their way into hospitals, industrial plants, universities, and research centers throughout the country. In this way, they may enter the general environment.

Radioactive materials have been employed industrially for many years. Ionizing radiations are used by telegraph companies to eliminate static electricity from teletypewriters. In the modern factory, radioactive materials are used in such tools as thickness gages, fluid-level indicators, and static eliminators. Radioisotopes are used also in industrial research.

There has been at least one attempt to introduce the use of radioactive fertilizer. This product was found to present a serious danger to the handler.

Interest in nuclear physics has recently inspired a toy manufacturer to market a play kit containing radioactive materials. Parts of the kit emit radiations intense enough to activate a Geiger counter but not enough to be hazardous.





RADIATION-PRODUCING MACHINES

Radiation-producing machines are used for generating ionizing radiations as they are needed. The first radiation-producing machine was the X-ray tube, developed by Roentgen in 1895. The voltages used with such machines have increased in range over the years and the uses of the machines have grown more general and diversified.

Powerful machines for smashing atoms, including cyclotrons, betatrons, synchrotrons, and Van de Graaff generators, are also sources of high-energy radiations, as are the nuclear reactors or piles which induce nuclear fission in controlled, self-sustaining chain reactions. The design and use of radiation-producing machines require vigilant protection of health.

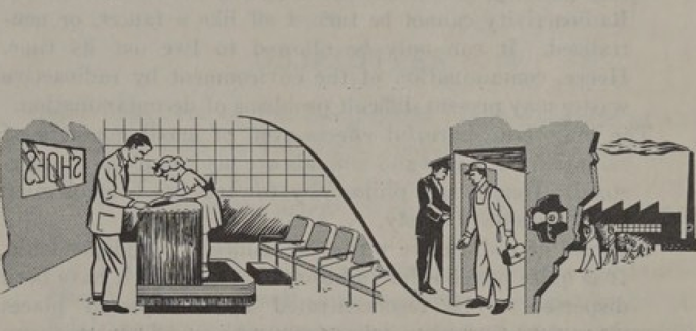
X-ray generators for medical use include diagnostic machines, photofluorographs, fluoroscopes, superficial and deep therapy machines, and multimillion-volt machines. Physicians, nurses, dentists, fluoroscopists, and technicians who expose themselves in the direct radiation beam or who neglect to shield themselves from the inevitable field of scattered radiation, subject their bodies to a definite, usually unnecessary hazard.

X-ray machines have many uses in industry. They permit the nondestructive study of the crystalline structure of metals. They provide a quick and effective method of discovering flaws in castings.

They are employed also for purposes of detection of pilfering; it is the custom in a few establishments to fluoroscope employees on a random sampling basis to determine whether they are carrying off tools or other radio-opaque items. This method of examination has been used not only in industry but in post offices and in penal institutions to discover smugglers. People, when they are fluoroscoped, are exposed to doses of ionizing radiations, which if repeated over long periods, may be harmful.

When super-voltage machines are used, workers in the vicinity as well as the operators must be protected by shielding.

Much modern knowledge of the fundamental nature of matter and of nuclear forces in subatomic structure has been acquired through research employing high-energy radiation machines.



High school science classes have experimented with building ray-producing atom-smashers. Whoever experiments with radiation must at the same time be familiar with the need for protection against dangerous radiation, if he is to avoid injury.

Many retail shoe stores in recent years have introduced the use of fluoroscopes on the claim that they aid the fit of shoes. Many of these machines present a radiation hazard to the clerk, if not to the customer. Public health workers in several States have advised on changes in the structure and use of these machines.

WASTE DISPOSITION

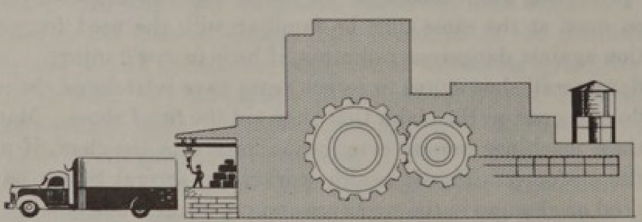
With the increasing use of radioactive materials, the country faces new problems of disposition of radioactive wastes. The handling and disposition of these wastes aims to avoid contamination of persons and places with radioactive gaseous, liquid, and solid materials. Unless radioactive wastes are disposed of safely, the level of radioactivity of the general environment may increase gradually to an undesirable degree. There is also the danger that isolated "hot" spots may form.

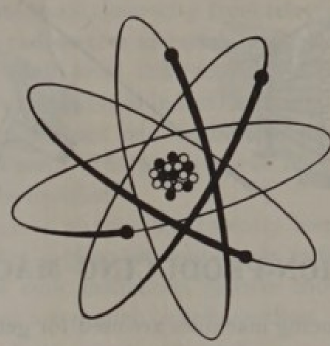
The following considerations must govern any program of radioactive waste disposition:

Decay, the process by which radioactive elements lose their radioactivity, cannot be altered by any means now known. Radioactivity cannot be turned off like a faucet, or neutralized. It can only be allowed to live out its time. Hence, contamination of the environment by radioactive wastes may present difficult problems of decontamination.

The long-term, harmful effects even of small amounts of radiation on plants and animals are not completely understood. Hence, any philosophy towards its control must be on the side of safety.

Disposal of radioactive wastes by dilution is undependable. It is quite possible for radioactive atoms which have been dispersed to be reconcentrated in unsuspected places through biological or industrial processes. They may even accumulate in plants and animals used by man for food.





RADIOACTIVITY—A CHALLENGE

The possibility of damage by ionizing radiations is certain to grow rather than shrink. It is hardly likely that society will give up the present and potential uses of the materials and machines that produce such radiations. The only recourse now is to learn to live with this danger, to control it, and to keep it harmless. Simply to be alert to the possibility of damage is a contribution to control.

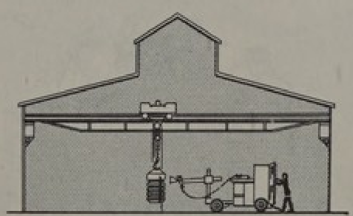
The Public Health Service has personnel qualified to investigate the environmental problems presented by high-energy ionizing radiations. Industrial hygienists competent in radiology consult with State agencies and help them work out with industry means of protecting workers and the public from harmful radiation. Field workers are completing 3 years of study of methods needed to protect uranium mine workers in the Colorado Plateau.

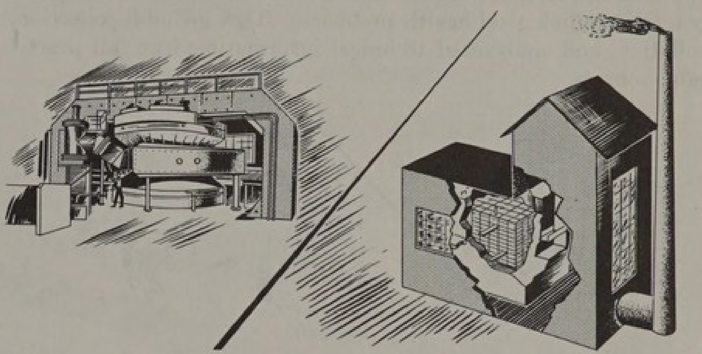
It is a responsibility of State and local officials to protect the community from dangerous radiation and they are expected to take up this work as rapidly as basic information becomes available.

Public health physicians, research scientists, and technicians with special proficiencies in radiation physics and radiological health cooperate with State agencies in dealing with problems arising from use of radioisotopes and X-rays in medical practice, biological research, and experimental procedures.

Sanitary engineers, physicists, and chemists with knowledge and experience in radiological health conduct research on contamination of soil, atmosphere, and water by radioactive solids, liquids, or gases; and they help devise means for preventing such contamination.

The contribution of these workers is illustrated by the story of an industrial nurse who learned that a newly constructed assembly line was to handle radioactive materials. She asked the engineers what protective devices were being built into the equipment, and was told that they did not think the material to be handled would present a hazard. Dissatisfied with this assurance, she invited competent radiological health officials to the plant. They advised that a heavy work load on the line would create a hazardous intensity of radiation. At their suggestion, adequate protective measures were introduced. By such vigilance health workers can and do protect workers and the general public from hazards of radiation produced either by radioisotopes or by machines.





OBJECTIVES

Major objectives of the radiological health program of the Public Health Service, working in conjunction with the Atomic Energy Commission, are:

(*a*) To define the extent of radiological health problems in this country.

(*b*) To develop technical proficiencies within the Public Health Service, as well as among State and local health officials, to assure the proper evaluation and control of public health problems arising from ionizing radiations.

(*c*) To render technical consultative services, advice, and information to Federal, State, and local agencies in regard to the public health aspects of ionizing radiations.

(*d*) To improve the health and well-being of the community at large by conducting and promoting research and investigations that will increase existing knowledge of the uses of nuclear energy.

These objectives are illustrated on the page which follows.

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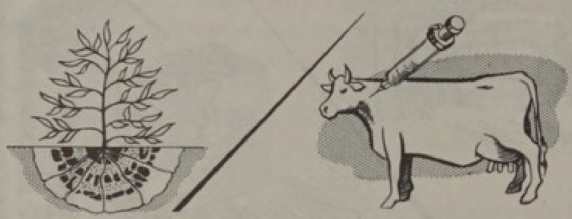
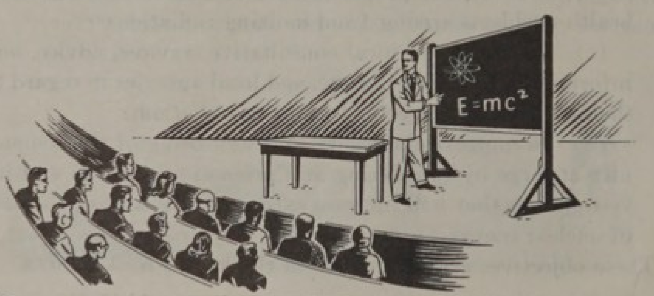
1. *Pilot investigations and field research.*—Pilot investigations and field research are needed to define the extent of existing and potential radiological health problems. This includes collection, collation, and analysis of technical information from all practicable sources.

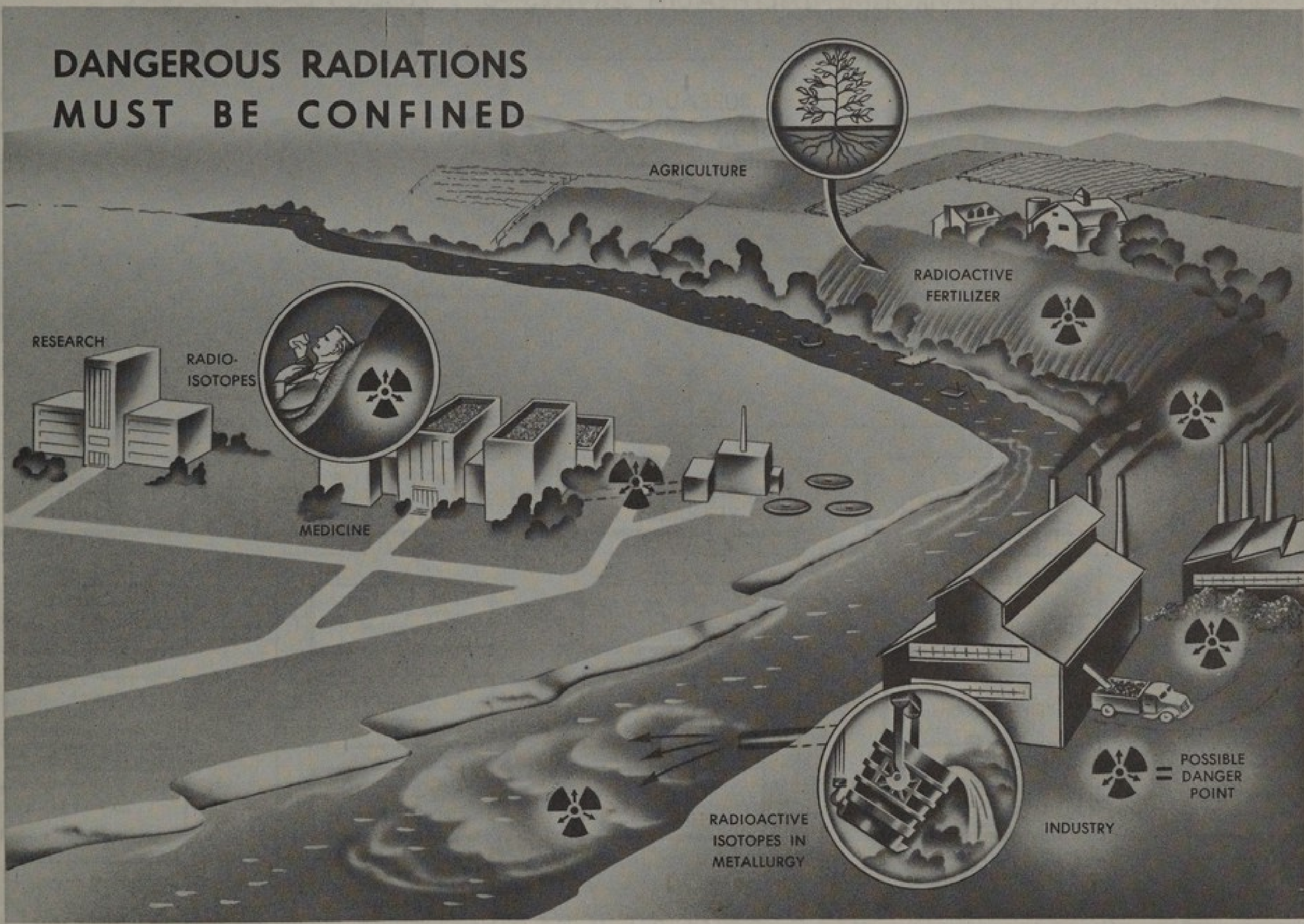


2. *Training.*—Before more complete understanding of the health implications of atomic energy can be realized, there must be developed among professional public health personnel a comprehension of the effects of ionizing radiations on the human body. To insure a prompt supply of radiological health personnel, the Public Health Service is giving its officers training and experience designed to prepare them to meet the responsibilities of the Service in this new field. In addition, the Public Health Service has initiated a series of similar training programs for Federal, State, and local health officials.

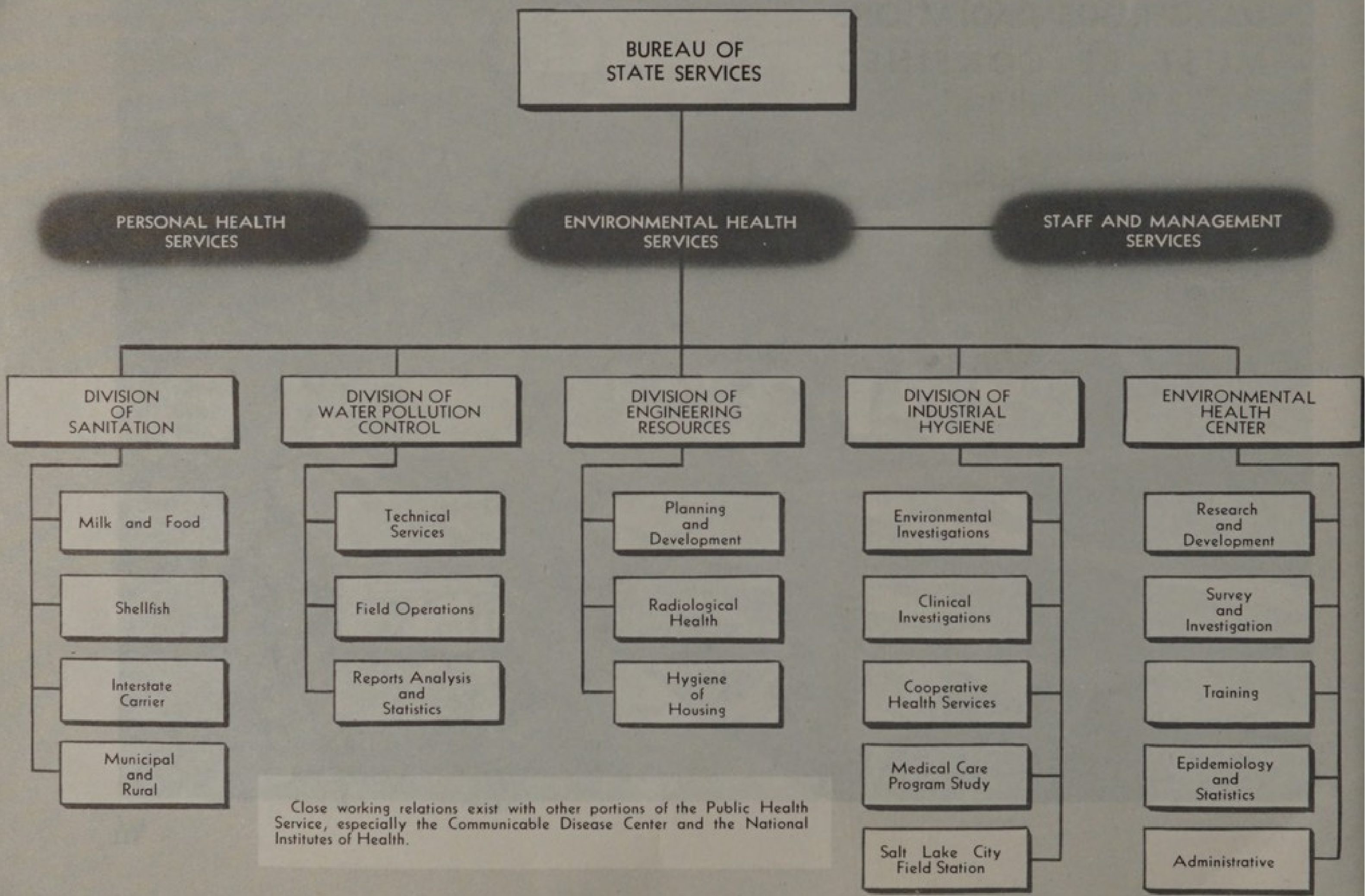


3. *Consultation and information.*—All public health officials are aware of and concerned with the implication of the expanding use of radioisotopes, and the increasing use of radiation-producing machines. Requests for consultation and advice in this regard are directed to the Public Health Service by Federal, State, and local officials, as well as by private citizens. In addition to consulting with responsible authorities, the Public Health Service distributes information pertinent to the environmental problems inherent in the use of radiation.

4. *Research.*—In collaboration with the Atomic Energy Commission and several universities, the Public Health Service is conducting studies and research to augment existing basic knowledge of the impact of the atomic age on ground, water, and atmosphere. The ultimate objective is not only the prevention of radiation injury to the individual but also the positive improvement of the health of the Nation.


DANGEROUS RADIATIONS
MUST BE CONFINED
AGRICULTURE
RADIOACTIVE
FERTILIZER
RESEARCH
RADIO-
ISOTOPES
MEDICINE
POSSIBLE
DANGER
POINT
RADIOACTIVE
ISOTOPES IN
METALLURGY
INDUSTRY

ORGANIZATION OF ENVIRONMENTAL HEALTH SERVICES—U. S. PUBLIC HEALTH SERVICE



The Administrative Task

IN 1798, Congress approved an act to provide hospital service for sick and disabled seamen at those ports where it was considered to be necessary, to be administered by a Marine Hospital Service. Thus was the Public Health Service born. Of necessity, the personnel of this Service were utilized to combat disease as well as to attend sick seamen. As emphasis changed to disease prevention, the name of the organization was extended to Public Health and Marine Hospital Service, and in 1912 to Public Health Service.

ENVIRONMENTAL HEALTH: 1912–48

Early in the history of the Marine Hospital Service, time and thought were devoted by medical officers to the causes and methods of prevention of those diseases which, in part at least, were a result of faulty environmental conditions.

By the act of 1912, the Congress authorized the Service to investigate "the diseases of man and conditions affecting the propagation and spread thereof * * * including sanitation and sewage and pollution either directly or indirectly * * * of navigable streams and lakes." By this act, Congress gave a fresh emphasis to the importance of environment in promoting the public health.

Leaders in the Public Health Service were quick to implement this new authority and to recognize the need to obtain skills not then available among the personnel in order to conduct investigations essential to carrying out the instructions of Congress. In 1913, an active program related to stream pollution was started under the guidance of Dr. H. S. Cumming, Dr. W. H. Frost, and Prof. Earle B. Phelps, and they employed engineers to assist them. The work of these engineers—Tarbett, Hoskins, and Streeter—became well known through results achieved at the Service's Ohio River Investigation Station (now the Environmental Health Center) at Cincinnati. As this work progressed, it soon engaged the specialized skills of other disciplines: bacteriologists, chemists, and planktologists. The contributions of Butterfield, Theriault, and Purdy resulted from this engagement.

Dr. H. R. Carter, one of the world's pioneer yellow-fever workers, appreciated the value of engineering knowledge in combating mosquito-borne disease. Hence, in 1914 he engaged LePrince, whose experience with mosquitoes and their control in Havana and Panama was well suited for use against the insects in the continental United States. These coworkers and their associates scored major triumphs in abating yellow fever and malaria.

In 1914 also, the Public Health Service's Hygienic Laboratory undertook research in industrial hygiene and sanitation. As this activity expanded, it required the services of physicans, engineers, chemists, statisticians, and other specialists, and, in 1937, their work was concentrated in a Division of Industrial Hygiene.

As the First World War emphasized the importance of environmental sanitation work in the neighborhood of military camps and wartime industrial installations, the Public Health Service engaged more engineers to support the Nation's hygienic defenses.

The need for protecting the purity of drinking water on interstate carriers in 1920 resulted in employment of more engineers in the Public Health Service and encouraged the recruitment of sanitary engineers by State health departments.

In 1922, an engineer took charge of research in problems related to the supply of safe and sanitary milk. This research developed into a program designed to secure uniform standards and regulations governing milk sanitation.

Despite its historical interest in environmental factors in health, the Public Health Service did not establish a branch with primary responsibilities to solve environmental problems until 1929. In that year, an Engineering Section, with Ralph E. Tarbett as chief, was established in the Domestic Quarantine Division. This later was renamed the Sanitation Section with Leslie C. Frank in charge. Although not all technical personnel working on environmental factors in health were attached to this section, the formation and title of the section was a sign that a new discipline had been recognized. The concept of environmental sanitation was firmly installed. An even broader and more positive term—environmental health—was in the making.

During the Second World War, as conservation of health became of strategic military importance, an organization entitled "Malaria Control in War Areas" was established by the Public Health Service in Atlanta. The task of combating malaria employed engineers, biologists, entomologists, physicians, and many others. After the war, these men revised the scope of their work under the name of the Communicable Disease Center with significant results.

In 1943, Congress authorized a Sanitary Engineering Division in the Public Health Service. Except for the Division of Industrial Hygiene, this Division contained most operations dealing with environmental factors in health. At the same time, many professional employees of this division were assigned also to special duty with other divisions of the Public Health Service.

PRESENT ORGANIZATION

By 1948, the Congress had charged the Public Health Service with so many responsibilities, even before those added by the Water Pollution Control Act of 1948, that a revision of its organizational structure was necessary. One aspect of the reorganization was to concentrate the great majority of activities concerned with environmental health in one of the Service's four bureaus—the Bureau of State Services. This Bureau now coordinates the activities of the Environmental Health Center, the Communicable Disease Center, the Divisions of Sanitation, Water Pollution Control, Industrial Hygiene, and Engineering Resources, and eight other divisions. These centers and divisions accomplish the greater part of the Service's work designed to improve and modify the environment. A chart of the current organization is shown on page 112.

Today the organization faces the challenge of problems posed by a changing environment. The many and diverse skills employed to deal with these problems are summarized by the table on the next page.

FEDERAL AGENCY SERVICES

Environmental health problems arise on several types of Federal property, including those with persons in residence and those with a large number of employees. Under long-established interagency agreements the Public Health Service furnishes to the administering Federal agency technical consultation and assistance on matters affecting public health. Responsibilities of the Public Health Service involve safeguarding the health of inmates of Federal prisons, personnel of Coast Guard stations, residents of Indian reservations, users of and visitors to the many units in the system of national parks and monuments, projects of the Bureau of Reclamation, and the extensive recreational areas in the national forests.

TYPES OF PERSONNEL ENGAGED IN ENVIRONMENTAL HEALTH ACTIVITIES UNITED STATES PUBLIC HEALTH SERVICE

	Division of Sanitation	Division of Water Pollution Control	Division of Industrial Hygiene	Division of Engineering Resources	Environmental Health Center	Communicable Disease Center[1]
PROFESSIONAL						
Engineers	X	X	X	X	X	X
Physicians			X	X	X	X
Bacteriologists	X	X	X		X	X
Chemists		X	X	X	X	X
Biologists		X	X		X	X
Sanitarians	X	X		X		X
Dentists			X			
Veterinarians	X		X	X		X
Nurses	X		X			X
Statisticians			X			X
Entomologists						X
Zoologists						X
Physicists			X		X	
Public health educators				X		X
Public health advisors		X				X
Other professionals	X	X	X	X	X	X
OTHER						
Subprofessionals	X	X	X		X	X
Managerial and clerical	X	X	X	X	X	X
Craftsmen, guards, custodians		X	X	X	X	X

[1] Environmental health activities only.

STATE AND LOCAL HEALTH AGENCIES

Public health work in this country is chiefly the responsibility of States and their political subdivisions—especially cities and counties. This fact has been emphasized often in previous chapters of this book.

The regional offices of the Public Health Service supply technical and consultative services as requested relating to surveys and investigations, planning of future developments, reviews of plans for new and improved facilities, inspection of existing installations, coordination of activities with State and local health authorities, and training programs to improve the knowledge of operating personnel.

The role of the Public Health Service ordinarily is to facilitate more than to execute, except when interstate problems place direct responsibility on Federal authority. The Service assists States and their political subdivisions to prevent and suppress communicable diseases. It advises State authorities. It works with such groups as the Association of State and Territorial Health Officers, the Conference of State Sanitary Engineers, the American Conference of Governmental Industrial Hygienists, and the Conference of Municipal Public Health Engineers. Through various means, including Federal grants to States for demonstrations and for training of personnel, the Public Health Service helps to establish and maintain adequate public health services at the State and the local levels. The Service is also directed by statutes to issue information related to public health, such as model ordinances, research bulletins, guides, and reports.

The Public Health Service frequently details commissioned officers to serve with State or local health organizations.

IN-SERVICE SPECIALIZED ASSIGNMENTS

Although for many years personnel of the Public Health Service have been detailed to other Federal agencies to work on specific sanitary engineering projects, it is only recently that engineer officers have been assigned as members of teams working on intramural projects under the sponsorship of nonengineering divisions within the Service. For example, engineers are assigned to work with the National Cancer Institute, the Division of Dental Public Health, and various other nonengineering operations. As the ramifications of environmental health become more apparent, assignments of engineers to an increasing variety of organizational units are to be expected.

Such assignments contribute technical competence and the engineer's point of view to activities directed primarily at personal health. They integrate environmental health activities with other activities of the Service. And they provide opportunities for environmental health specialists to improve their knowledge of collaborating disciplines.

Another recent development has been a career planning program for new engineer officers in the Regular Corps of the Public Health Service. During the first 3 years of a young officer's career he is assigned to different environmental health activities within the Service, or with State and local health departments. This varied experience serves as a basis upon which to direct the professional development of the officer in one or another field of importance. Such careful career planning is believed to be a guaranty of enduring value, both to the Service and to the individual officer.

The increasing scope and size of environmental health activities has made it necessary, in the interests of long-range planning, to increase staff work. In addition to engineers and physicians concerned with the technical aspects of environmental health, the staff includes professional workers in public administration, statistics, and education. One important function of the staff is to organize and develop activities insufficiently attended by many members of the public health profession. Development of radiological health is one such field; the hygiene of housing is another.

TRAINING

Well-trained personnel are as vital to the public health movement as they are to industry, business, and the professions. However, less than one-third of the 30,000 professional workers employed in public health work have had the formal training required by minimum standards. Furthermore, there is a need to recruit as many more to be trained for health work.

The ever-expanding body of knowledge in environmental health not only makes necessary sound academic preparation of recruits to the field, but also emphasizes the need for constant refresher training of experienced workers. The broadening of interest in environmental health, and especially the current emphasis on newer aspects of this field, have stimulated the development of large-scale training programs carried on by the Public Health Service, by State and local health agencies, and by universities. The greatest expansion in environmental health training activities has taken place since the close of the Second World War.

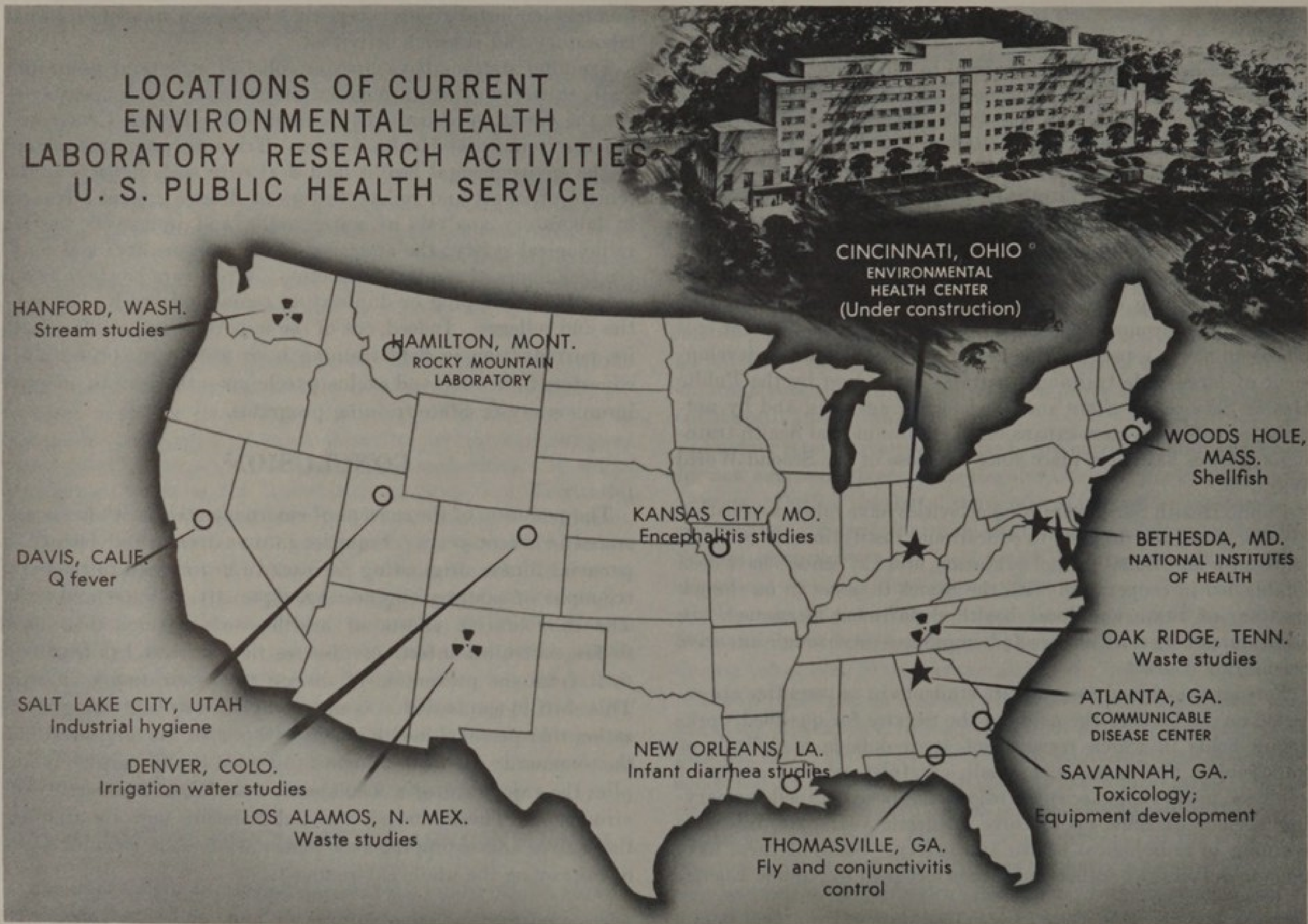
Public Health Service training activities have taken two paths: (1) Personnel are detailed to educational institutions or research centers for additional formal education, and (2) centers have been established in cooperation with the States to assist in on-the-job training of State and local health department personnel. In addition, new Service officers and employees go through intensive orientation courses.

Personnel assigned as graduate students in universities are selected on the basis of the needs of the Service for qualified workers in fields in which recruitment from outside is difficult or impossible. For example, a small, carefully selected group of engineer, medical, and scientist officers has been detailed for varying periods of time, up to three academic years, for intensive training in radiological health and safety. Some of these have gone to universities; others have been assigned to Atomic Energy Commission installations, where they have been trained in special laboratory and research activities.

Training stations have been established at several geographically scattered points throughout the country. They operate under the direction of both the Communicable Disease Center and the Environmental Health Center. Training programs offered in the environmental health field deal with such subjects as the control of insect and rodent vectors of disease; recent advances in laboratory analysis of water, milk, and industrial wastes; radiological safety; the appraisal of housing quality; and modern techniques of sanitary inspection. Great care has been taken to avoid overlapping or duplicating courses offered by universities and colleges. Indeed, one of the important reasons for Service participation in field training is to work with professional educators to develop and evaluate techniques that can be adopted in university or State training programs.

CONCLUSION

The evolution of the concept of environmental health has accelerated in recent years. Inquiries into environmental factors in personal illness, originating far back in history, led to the early triumphs of sanitary engineering, especially in water and milk. The collaborative efforts of health workers since then have so far controlled infectious diseases that interest has begun to shift from the prevention of disease to the creation of health. This shift in emphasis has been accompanied by a growing realization that personal health is but an aspect of the total health of the community, that the enjoyment of good health personally implies the enjoyment of a wholesome, cheerful, and attractive environment. Those interested in public health now are aligning themselves and equipping new personnel for the complex tasks of improving the whole environment.


LOCATIONS OF CURRENT
ENVIRONMENTAL HEALTH
LABORATORY RESEARCH ACTIVITIES
U. S. PUBLIC HEALTH SERVICE
CINCINNATI, OHIO
ENVIRONMENTAL
HEALTH CENTER
(Under construction)
HANFORD, WASH.
Stream studies
HAMILTON, MONT.
ROCKY MOUNTAIN
LABORATORY
WOODS HOLE,
MASS.
Shellfish
KANSAS CITY, MO.
Encephalitis studies
DAVIS, CALIF.
Q fever
BETHESDA, MD.
NATIONAL INSTITUTES
OF HEALTH
OAK RIDGE, TENN.
Waste studies
SALT LAKE CITY, UTAH
Industrial hygiene
ATLANTA, GA.
COMMUNICABLE
DISEASE CENTER
NEW ORLEANS, LA.
Infant diarrhea studies
DENVER, COLO.
Irrigation water studies
SAVANNAH, GA.
Toxicology;
Equipment development
LOS ALAMOS, N. MEX.
Waste studies
THOMASVILLE, GA.
Fly and conjunctivitis
control

Basic and Applied Research

IN A changing world, it is to be expected that every day new environmental health problems arise and old ones disappear. Some health problems have disappeared in the course of history without apparent or conscious human intervention. Others persist chronically. Public health research seeks to identify and define these chronic problems, to anticipate new problems, and to develop solutions, after investigation, laboratory study, and experimental analysis.

The organized knowledge, techniques, and imaginative powers available to environmental health workers include the Public Health Service research resources not only at the Environmental Health Center but also at the National Institutes of Health, the Communicable Disease Center, and the Industrial Hygiene Laboratory. These resources are addressed to basic questions which deal with environmental factors in health, including:

What are the toxic chemicals which enter the environment through agricultural or industrial use?

How can we accelerate the natural processes of stream purification?

How can we protect the water we use from pollution by our usage?

How can air pollutants which contribute to allergies and other illness be removed from the atmosphere?

What can be done about environmental factors which contribute to attacks of enteric and respiratory diseases, Q fever, cancer, heart disease, mental disorders, and other illness?

METHOD

The answers to these questions are not found in catechisms or in oracles. They will be revealed only by scientific inquiry.

Scientific Inquiry

The scientific approach to a problem may be divided into three stages: basic research, applied research, and developmental work. Although one appears to have priority over another, in the order given, in practice all three phases may go on simultaneously. It is usual to apply the term research only to the first and second stages, but the spirit of research, if not its precise methods, applies equally to all phases. The practical use of knowledge gained by research is in effect an advanced stage of study and experiment.

In 1881, John Tyndall wrote a report noting that "the turnip-infusion after developing in the first instance its myriad-fold Bacterial life, frequently contracts mould, which stifles the Bacteria and clears the liquid all the way between the sediment and the scum * * * the Bacteria which manufacture a green pigment appear to be uniformly victorious in their fight with *Penicillium.*"

Here 70 years ago was a fundamental finding for all scientific men to see, but its significance was not grasped until Alexander Fleming, in 1929, chanced to observe that mould contamination on plates of staphylococcal cultures destroyed the bacteria. Then Fleming suggested the possibility of cultivating penicillin, the first man-made antibiotic. But still another decade passed before penicillin was produced and applied with results that made medical history.

The story of penicillin illustrates the point that, along with careful skill employed in organizing details and manipulating techniques, research demands the freedom and ability of the human mind to seek new combinations, to think in fresh categories. And it requires the freedom and skill to make practical applications of fact, with the consciousness of common goals and ideals.

Scientific Teamwork

To conduct research with freedom of inquiry, there must be communication, particularly among scientific workers. Without such communication, one set of scientific workers may spend months or years on a problem which others have solved long before.

Communication is particularly weak among different disciplines. Not only do different disciplines need to draw upon each other's information, but they need each other's special skills and training for the completion of certain tasks. For example, effective malaria control was achieved only by teams of engineers, entomologists, parasitologists, and physicians.

To offset the increasing specialization of modern science, the Public Health Service, within the limits of its personnel and facilities, employs the team system to attack health problems from every conceivable scientific angle. Research teams in the Public Health Service explore the environmental, including the biological, chemical, physical, administrative, or clinical, aspects of a health problem. This teamwork is expressed not only in the close collaboration of diverse specialists but also in the circulation of their findings in both written and oral form to public health and other scientific workers in all fields everywhere.

Scientific Technology

The technological changes which create new health problems also provide instruments to assist in attacks on these problems. Electronics alone contributes sensitive measuring equipment, recording devices, instruments which automatically control temperature and humidity, and calculators. The electron microscope produces images of viruses and other structures never before visible. Experiences with these modern instruments assist scientists also in formulating more nearly satisfying theories about fundamental processes of nature, from the production of solar energy to the metabolism of a single living cell.

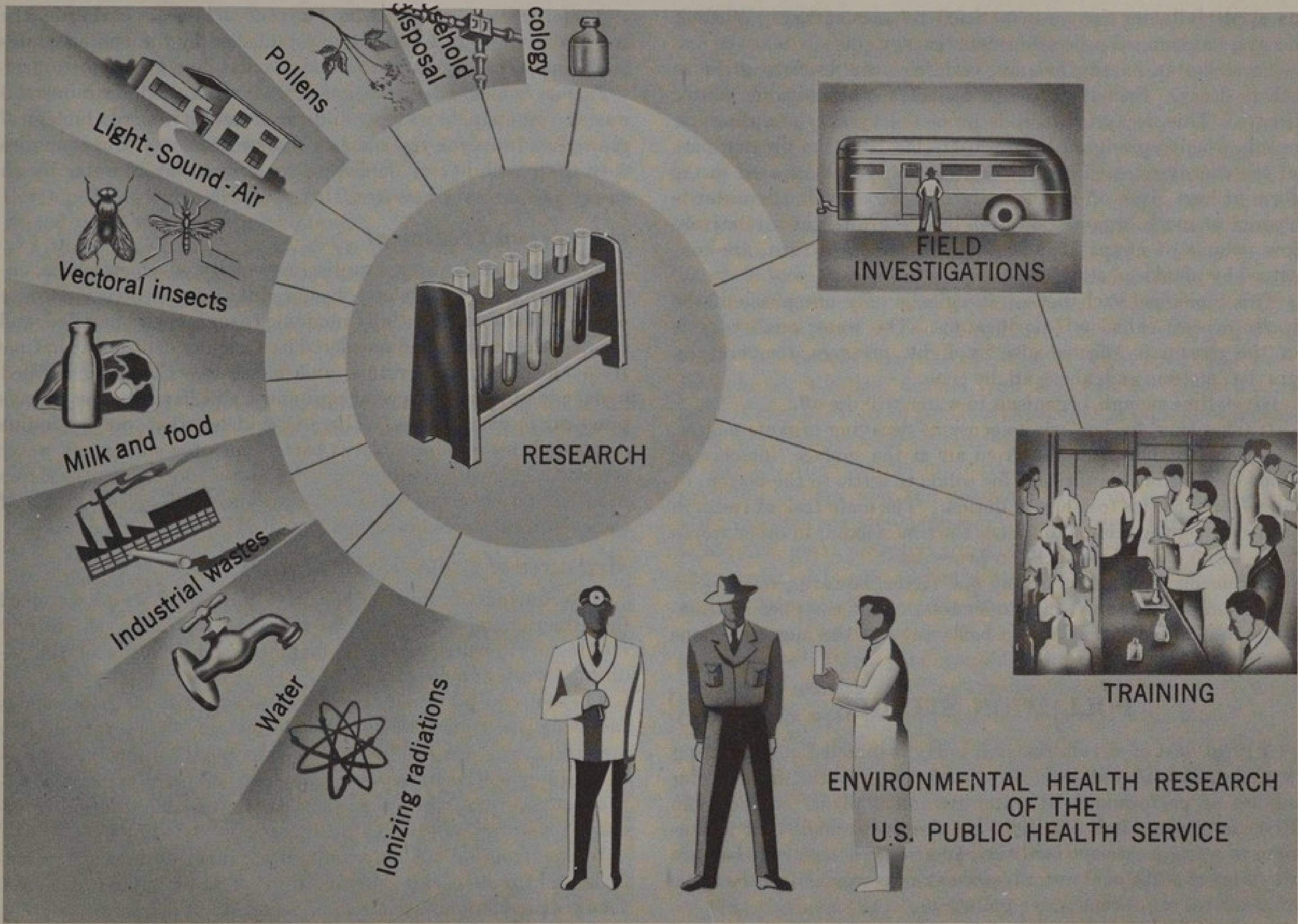
Through use of advanced technology, varied skills, and a systematic approach, the Public Health Service obtains the information and experience necessary to improve the physical environment.

WATER PROCESSES

Since the summer of 1913, the Public Health Service has maintained its station at Cincinnati for study of stream sanitation, including pollution and self-purification of streams and treatment of water and waste. Its first director, Dr. Wade Hampton Frost, devoted himself to coordinating fundamental research by men trained variously in engineering, chemistry, bacteriology, medicine, and biology. Much of the basic knowledge of the behavior of streams and lakes stems from this laboratory and its employees. This research station is now the Environmental Health Center.

The early series of investigations by the Public Health Service dealt not only with physical forces but also with the bacteriology, the biology, the chemistry, and the biochemistry of waters, with respect to stream behavior. One of the special problems of these studies was that the action of water in a laboratory could not duplicate conditions in nature: to study the natural processes of the stream, the stream itself had to be observed, and the stream itself was continually changing.

The studies of water delve into the deepest mysteries of the life process, the cycles of growth and decay. Decay is to the organic world what gravitation is to the physical world. When


Pollens
Light-Sound-Air
Vectoral insects
Milk and food
Industrial wastes
Water
Ionizing radiations
RESEARCH
FIELD
INVESTIGATIONS
TRAINING
ENVIRONMENTAL HEALTH RESEARCH
OF THE
U.S. PUBLIC HEALTH SERVICE

an apple falls, its change in position releases energy. When it decays, its chemical processes release energy.

To strike an energy balance, certain forms tend to grow as others decay. Bacteria grow in water as other organic matter decays. This decay in water is promoted by enzymes, catalytic agents usually produced by the bacteria. But the greater part of the energy released by this organic decay is dissipated in the form of heat given off by the bacteria. As a result, the water is cleared of much organic pollution by the growth of a relatively low volume of nonpathogenic bacteria which, in turn, are consumed by plankton, other organisms in the stream.

This biological exchange of energies is only one phase of the water process called self-purification. The water quality cycle of the stream is affected also by light, pressure, temperature, gravity, motion, and, above all, by time.

Given time enough, organisms in water will die off.

It takes time for bacteria to consume decaying organic matter, for water to absorb oxygen from air at the surface, for clay or stone to filter out impurities, for solids to settle to the bottom of a pool, or for rains to dilute pollution. The main task of research in stream purification is to reduce the time factor; in other words to speed up natural purification processes.

If considered in terms of any one factor, however, the process of stream-purification is misunderstood. The complex relationships in a water system would baffle any but the most tenacious research workers.

POLLUTION STUDIES

A great deal of stream research today is directed at preventing water pollution, discussed in Chapter 3. With the Streeter studies of performance of water treatment plants on the Ohio River and Great Lakes in 1929, the point was made that limitations of water treatment facilities had made it necessary to balance the value of additional water treatment measures against the value of measures to prevent water pollution.

A similar conclusion had been advanced 15 years earlier by the International Joint Commission established by the United States and Canada.

Factors which affect the quality of water include industrial wastes, municipal wastes, silt, radioactivity, and biological growths. In recent years, it has become necessary to reckon also with the possibility of deliberate contamination of water by an enemy as a military measure.

Emergency Treatment

To treat small water supplies, especially in emergencies, investigators seek to develop a bactericidal agent which is at once chemically stable, essentially nontoxic to man, easily handled, and cheap. Commonly used powdered bactericides deteriorate in time from effects of temperature and moisture. Chlorine, applied under pressure, needs special equipment and handling not always practical in emergencies. There is evidence that various iodine compounds serve admirably as bactericides for emergency water treatment. In addition, recent work on trichloromelamine shows promise. However, the physiological effects of continued use of these chemicals have not been assayed.

Measures of Industrial Pollution

Only during the past decade have industrial wastes received the attention they deserve. So far, there are not even entirely satisfactory yardsticks of the magnitude and nature of the industrial waste problem.

The study of pollution of water by wastes from a given manufacturing plant must weigh variable factors. They include raw materials, seasonal production, process modification, new processes, equipment, maintenance and operation, plant expansion, by-product recovery, waste treatment costs, available dilution in receiving waters, and geographical location.

Wastes from milk plants, canneries, tanneries, beet sugar factories, and meat-packing plants are typical of industrial wastes that are predominantly animal or vegetable in origin.

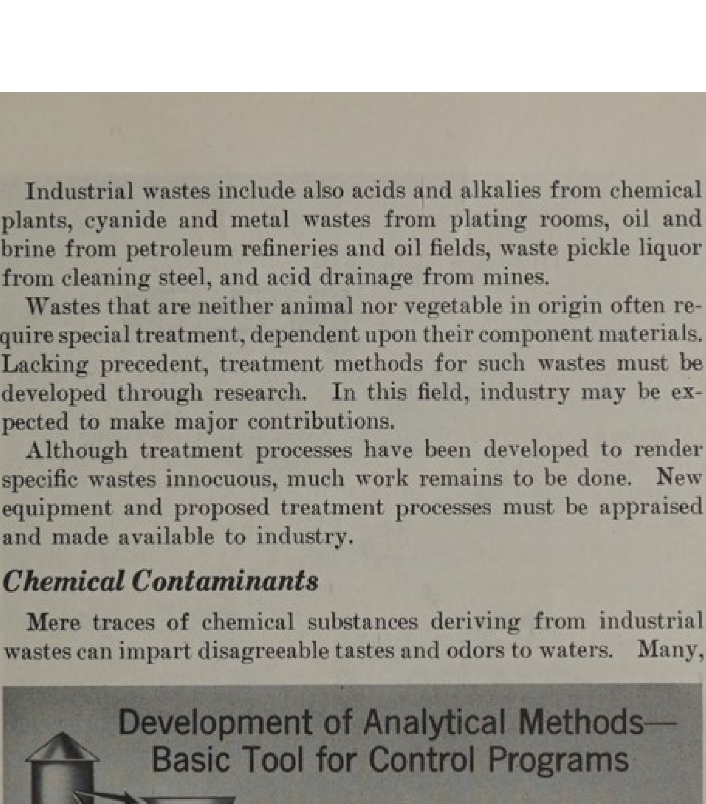
Industrial wastes include also acids and alkalies from chemical plants, cyanide and metal wastes from plating rooms, oil and brine from petroleum refineries and oil fields, waste pickle liquor from cleaning steel, and acid drainage from mines.

Wastes that are neither animal nor vegetable in origin often require special treatment, dependent upon their component materials. Lacking precedent, treatment methods for such wastes must be developed through research. In this field, industry may be expected to make major contributions.

Although treatment processes have been developed to render specific wastes innocuous, much work remains to be done. New equipment and proposed treatment processes must be appraised and made available to industry.

Chemical Contaminants

Mere traces of chemical substances deriving from industrial wastes can impart disagreeable tastes and odors to waters. Many, such as cyanide, can be harmful. Even when trace contaminants can be isolated, analyzed, and identified, it is often difficult to learn what characteristic causes the offense and how it may be controlled.

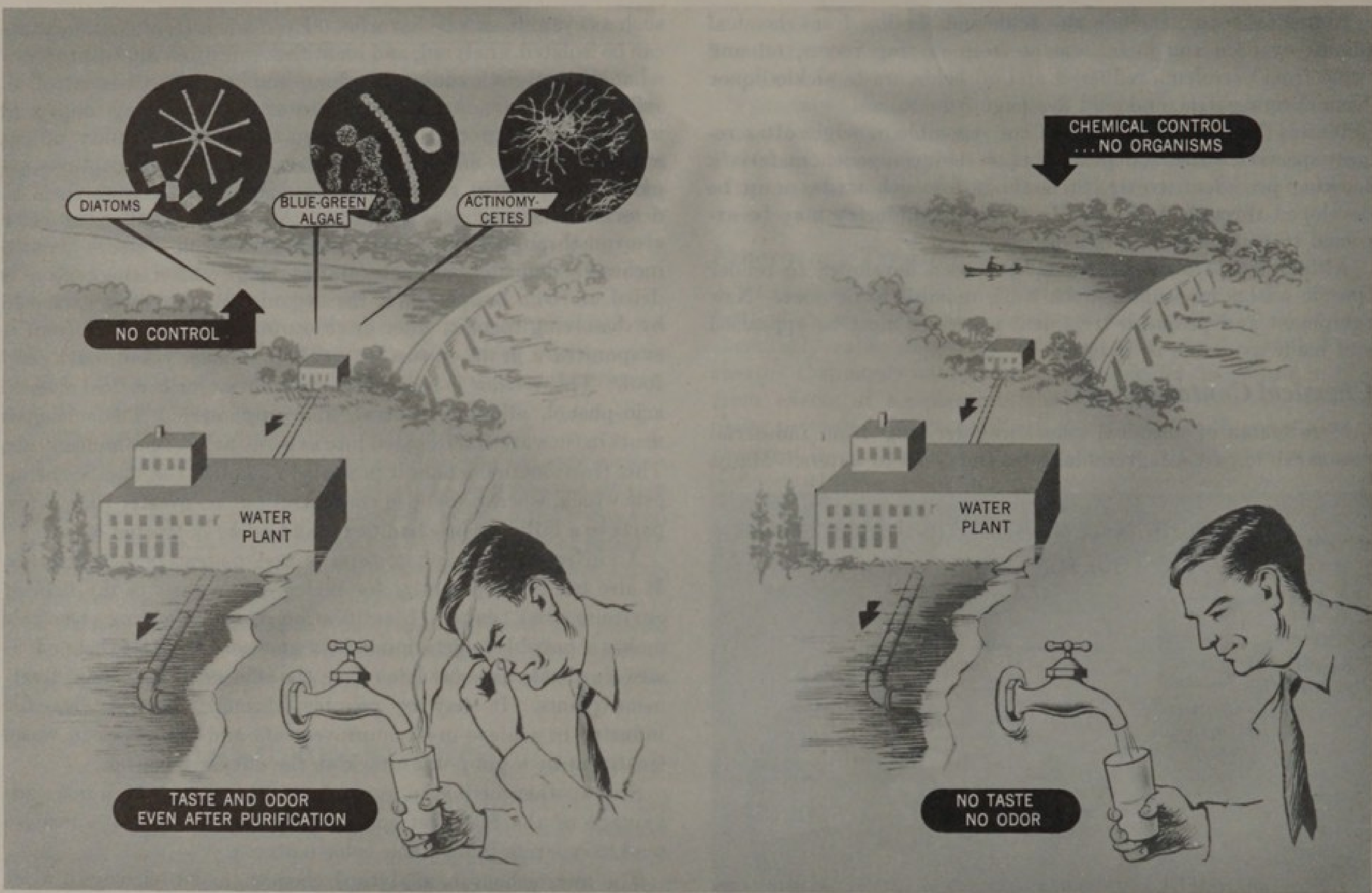


The Environmental Health Center is developing improved methods of "capturing" trace contaminants in a study of the etiology of tastes and odors in water. This project captures organic chemicals in raw or treated water and analyzes them to determine their sources and effects. About 10,000 gallons of water are run through a fine carbon filter, encased in a sleeve about 5 inches in diameter and several feet long. After the carbon is dried at room temperature, the organic materials are extracted by dissolving them in ether or chloroform. When the solvent is evaporated a gram or two of residue remains, viscid, dark, and foul. This residue is separated into four major chemical classes: acid-phenol, alkaline, neutral, and amphoteric. These components in turn are fractionated into as many as 18 organic chemicals. This fractionation makes it possible to identify the specific chemicals which, when present in concentrations no greater than a few parts to a billion, cause bad tastes and odors in treated water.

An infrared spectrophotometer is used to identify the chemicals. It also has great potential for biological analysis in the field of environmental health. Identification of the offending chemicals makes it possible to determine their sources. Some of these offensive chemicals have been found in the effluent of industrial treatment plants. It may be possible, through these studies, for industry to achieve great improvements and economies in waste treatment by a pin-point attack on the offensive matter.

Still another method in use is chromatography, which takes advantage of the fact that compounds filtered through a fixative tend to separate in definable color patterns.

The micro-chemist, analytical chemist, and toxicologist work together as a team to discover the nature of these complex organic substances, to learn what makes the odor or the strange taste, or what produces their toxic effects.



Research to prevent offensive tastes and odors in domestic water supplies.

Biological Growths

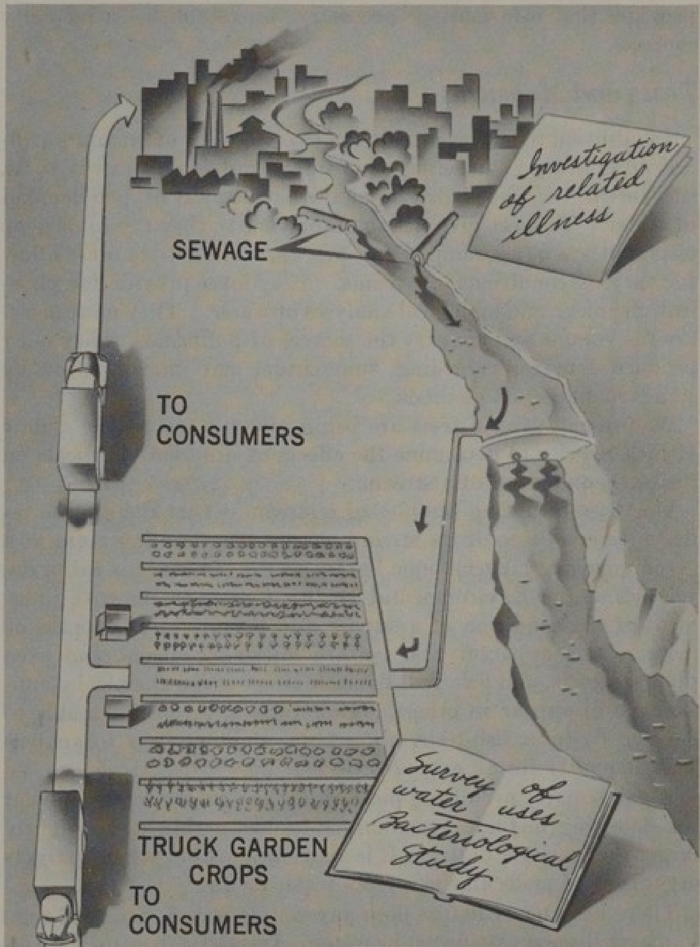
Biological growths in water cause many disagreeable tastes and odors. Impoundments for domestic water supplies or flood control provide ideal conditions for the growth of obnoxious organisms. Irrigation waters returning to streams carry with them food for such growths.

Biologists of the Public Health Service are isolating organisms which, like chemical contaminants, may cause objectionable tastes and odors in water supplies. These are being grown in pure cultures to discover how they survive and how they may be reduced. The scientists are developing and testing algaecides and experimenting with other possible controls, such as cultivation of parasites that will establish a biological balance with these growths.

Irrigation

When water contaminated by sewage is used to irrigate truck farms, the situation suggests a significant health problem. This problem is largely unexplored. More than three-fourths of the 20,000,000-odd acres of irrigated land in the West are irrigated entirely by surface waters. Much of this water is subject to contamination by sewage. But there is no accurate information on the health hazards associated with the handling and eating of foods so irrigated. However certain one may feel about the presence of these hazards, the specific proof is not at hand. Health standards for the uses of irrigative water may be determined after the Public Health Service completes its current studies to acquire the necessary data.

To acquire such data, the Public Health Service has teams of scientists studying bacteria on fruits and vegetables irrigated by various sources of water. They are also collecting reports on illness that may be associated with the handling or consumption of such crops. Samples of vegetables from irrigated farms are being studied in comparison with vegetables from protected plots which have been infected deliberately with typhoid germs



Effects of polluted irrigation water are being investigated.

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and other harmful bacteria. The combined studies are expected to provide the information necessary to establish satisfactory controls.

Tests and Measures

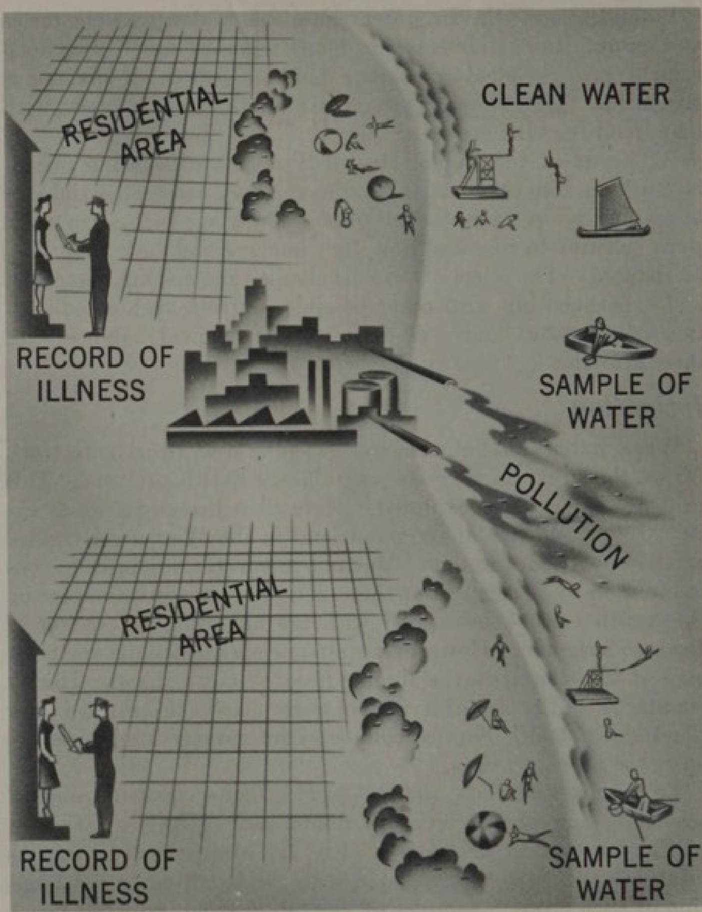
In addition to efforts to improve the processes of stream purification, sanitary engineers seek to improve their laboratory tools, such as the test used to determine the biochemical oxygen demand of water. To meet present laboratory needs, they try to develop tests that are quick, simple, and precise. These tests must allow for varying conditions in streams. They must provide for physical, chemical, and biological analyses of water. They must measure the volume and identify the sources of pollution. They must produce data for recording, summation, and interpretation by standard statistical methods.

At present, several tests are being investigated by the Public Health Service to determine the effects of different chemicals on the oxygen demand of a stream.

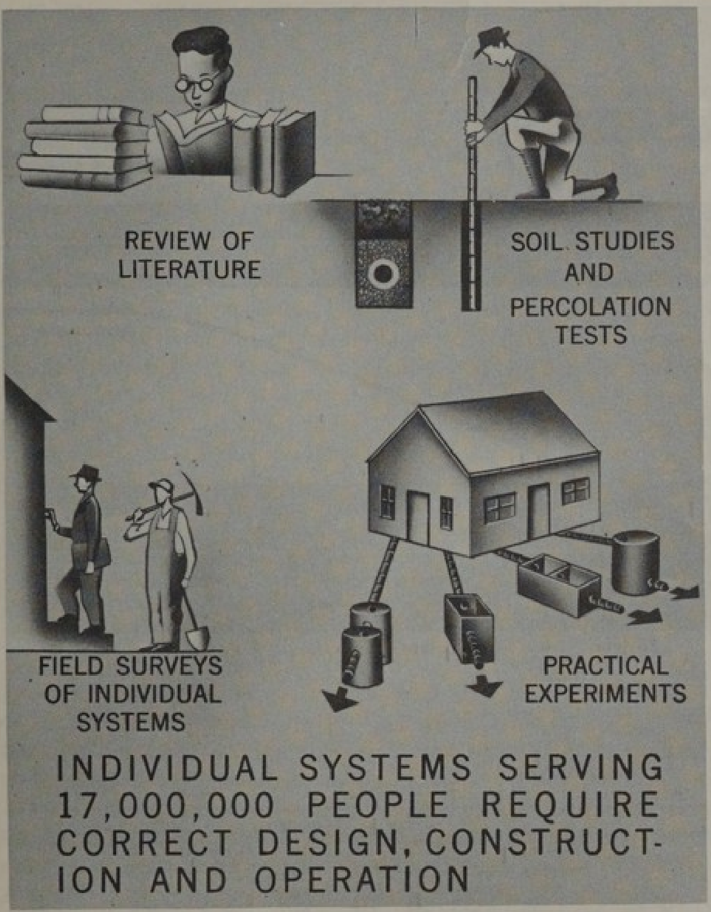
One flaw in testing samples of a stream is that the sample reflects the condition of the stream only at the sampling point at a given moment. A technique known as the bio-assay is being developed at the Environmental Health Center to improve judgment of the condition of a stream over a period of 6 months or more. It is apparent that certain micro-organisms, and even plants, insects, and fish, will flourish under given chemical conditions or disappear in others. Therefore, it becomes possible to develop fly-tests, fish-tests, algae-tests, or other tests to analyze stream quality for an extended period.

A particularly promising piece of mechanical testing equipment for detecting biological contaminants uses a thin disk, slightly larger than a silver dollar. It is a membrane filter which extracts organisms of molecular size from water or air.

There have never before been any simple, rapid, practical tests to detect disease organisms in water. Instead, laboratory workers usually assume the presence of disease germs when they find



Epidemiological studies of bathing places.



Research on the disposal of household sewage.

indicator organisms, such as coliform bacteria. It is possible, however, for water to contain disease germs and still be free of the indicator organisms.

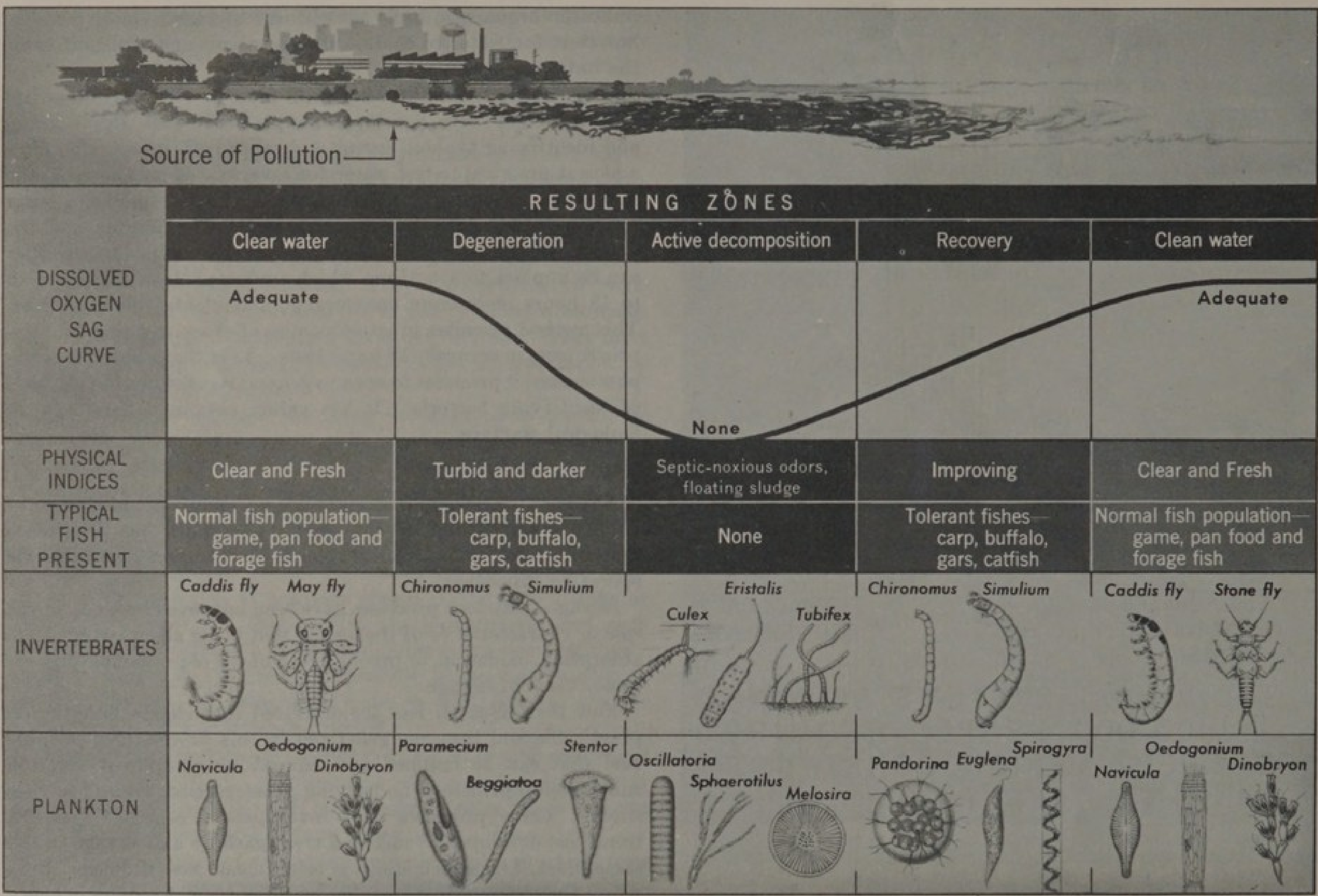
Experiments with the membrane filter at the Environmental Health Center have developed simple techniques for isolating and identifying typhoid germs and other pathogens. The filter makes it practical to test water for a variety of organisms at the same time. Investigators have used it also to establish a surer relation between the presence of indicator organisms and the presence of pathogens. Indicator organisms trapped on the filter can be applied to a medium which promotes their growth in 15 to 18 hours in discrete, measurable, and identifiable quantities. This method promises great economies of space and time and improvements in accuracy of water tests. Like the infrared spectrophotometer, it promises to open to general reinvestigation methods of identifying bacteria. It has values also in defense against biological warfare.

Sewage Treatment

Advances in sewage treatment are an excellent illustration of applied research and development. This work has progressed through stages of experimentation and expansion into full-scale operating procedures.

Sewage-treatment processes have been improved by study of the role or characteristics of the agents that bring about coagulation, absorption, oxidation, or precipitation of the objectionable organic constituents of sewage.

Now that research has demonstrated that sludge digestion is practicable and that gas generated in this process is a valuable fuel that can be trapped and burned to generate power, the fundamental principles underlying these reactions require further study. These processes need investigation, especially since a trend has developed to mix and treat garbage and sewage in the same plant. One such study is being conducted at Jasper, Ind., where the city required installation of garbage disposers in every kitchen.



How the life in natural waters changes with pollution.

Further study is required to reduce labor, land, and construction costs of treatment plants.

Septic Tank Research

As noted in Chapter 9, about 17,000,000 people live in homes equipped with household septic tanks. Requests to State and local health departments for approval of their installation run high—as many as a thousand a month in one county, for example.

More information about methods and designs is sought to reduce costs of installing and maintaining tanks and to assure satisfactory performance in various soils.

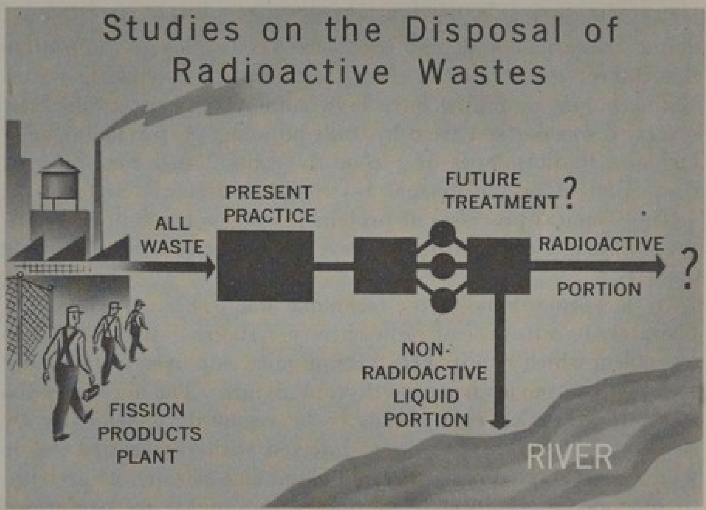
As noted earlier, research jointly financed with the Housing and Home Finance Agency has been underway at the Environmental Health Center since 1947 to develop data that will support standards of design and performance. The purpose of this research is to discover means for individual sewage disposal in areas where present methods are not practical.

Radioactive Wastes

In cooperation with the Atomic Energy Commission, the Public Health Service has several research teams at work at Hanford, Los Alamos, and Oak Ridge.

One of the teams engaged in radiological research is investigating the possible effects of the discharge of treated waters on the stream characteristics of the Columbia River. The findings of this study may be applied to any stream where a large atomic energy plant is situated.

The Los Alamos team deals with the treatment of radioactive wastes from laboratory and laundry. The findings of this study apply to the treatment of the liquid wastes disposed of in atomic installations. The Department of Defense is participating in the Oak Ridge study which seeks various means for decontaminating water supplies which have become dangerously radioactive. This study would apply to radioactivity resulting from the uses of nuclear energy.



Of special concern to environmental health workers is the disposition of radioactive wastes by hospitals and laboratories. The recommended practice for disposition of radioactive carbon is to embed it in a block of concrete and bury it deep at sea. Appropriate dilution is recommended for disposition of the short-lived iodine 131 and phosphorus 32.

ISOTOPE LABORATORY

Research facilities of the National Institutes of Health include a laboratory equipped to handle radioactive substances.

Studies conducted at this laboratory make use of radioactive substances to trace the movements of atoms through biochemical processes.

Other studies in the laboratory are concerned with radioactivity itself, its detection, its measurement, and its effects.

Radioactive tracers assist investigations of such broad problems as tooth decay, amebiasis, and chronic diseases. For example, research on dental problems has employed radioactive fluorine for studies of the effects of fluorides in drinking water. Radioisotopes of iodine have been employed to determine how several drugs derived from hydroxyquinoline performed as amebicides. Radioisotopes of carbon have been used for study of the action of bacteriophage, a virus that destroys bacteria.

The chemical processes of protein formation are followed with isotopes in a study relating to prevention or treatment of chronic diseases.

In one project, the tracer technique was combined with a deliberately harmful use of radioactivity. It was desired to pursue a problem which required that young mice employed in the study secrete no hormones from the thyroid glands. The mice were too small for their thyroid glands to be removed conveniently by surgery. Therefore, they were injected with radioactive iodine which concentrated in the thyroid gland and arrested its activity.

Injections of radioactive substances in animals are performed to study the long-term effects of low-level radiation on parts of the body and to learn more about the general process of retention and elimination of radioactive substances by the body.

Another set of studies, conducted by the National Institutes of Health and other agencies, deals with the effects of intense irradiation. These range from effects on the chemistry of minute processes in the body—in protein molecules, amino acids, peptides, carbohydrates, and enzyme systems—to effects on whole animals. It is hoped, through studies of whole animals, to develop effective treatment or protective techniques for radiation sickness. The basic biochemical studies will provide additional clues for this work.

This research includes studies of the effects of altitude, heat, or metabolic rate on organisms that have been exposed to ionizing radiations. Groundhogs, because they hibernate readily, were used for experiments with metabolic rates. Subjected to a slight chill, they curl up to sleep and their metabolic rate drops.

Along with these efforts to improve basic knowledge as to what radiation does biologically, research is directed at improving the ability to detect and measure radiation and its effects. These experiments use chemical measurement methods and nuclear track emulsions to record effects of ionizing radiation.

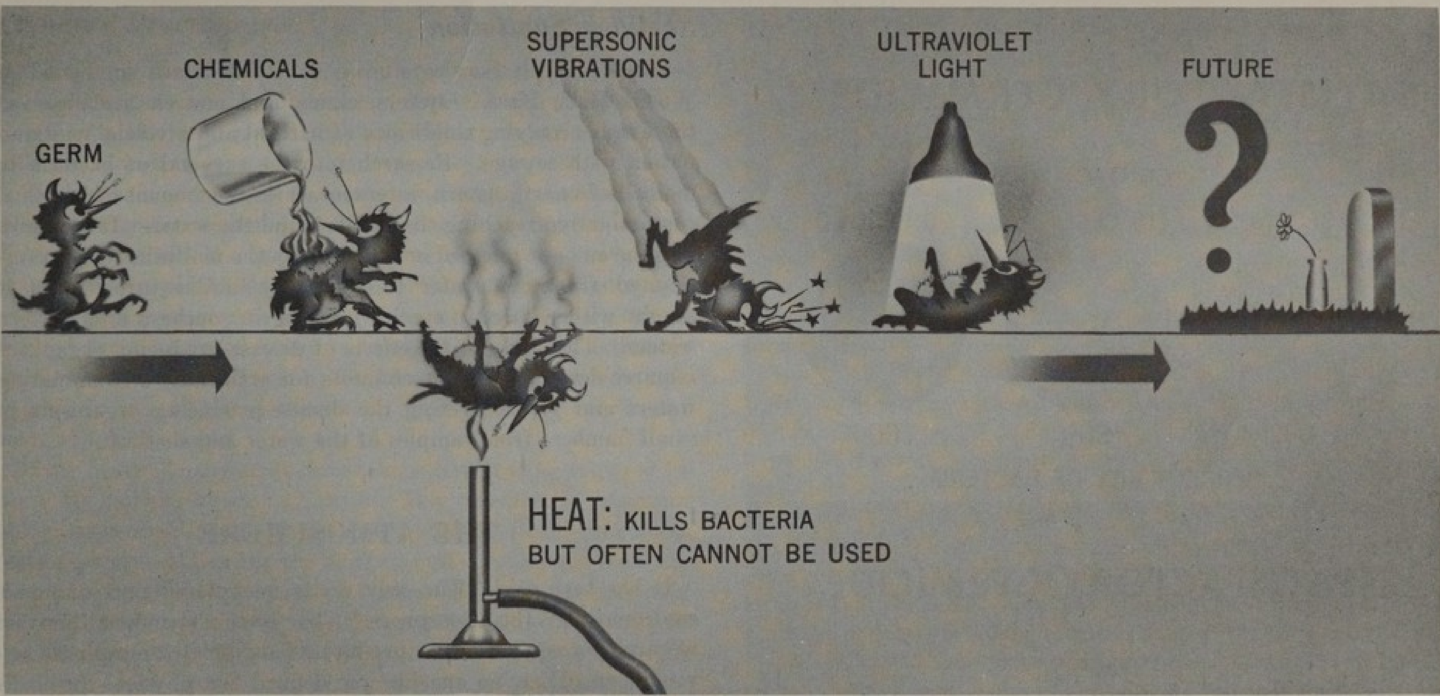
Such studies aid significantly in developing practical methods for protecting the public health from harmful radiations in atmosphere, water, and elsewhere in the general environment. They help men to decide how harmful radiation might be in a given situation, how much is allowable, and what protective measures can be used.

MILK AND FOOD

Examinations of 10,000 persons in California in 1947 indicated that as many as 50,000 cases of Q fever had occurred in Los Angeles within a few years. The largest number of cases were associated with milk or cows. It was found that a few Q fever organisms in milk survived the pasteurization process and remained dangerous. This problem is being attacked jointly by the University of California, the State Health Department of California, and the Public Health Service, with a plan to strengthen the pasteurization process.

Milk Sanitation

To improve measures for evaluation of the sanitary quality of milk, the Service continually studies alternative methods of bacteriological examination. These have been used as a basis for improvements in *Standard Methods for the Examination of Dairy Products* of the American Public Health Association. The Service also conducts research in connection with the development of bacteriological and chemical standards for milk and milk products. Findings are furnished to State and local milk control agencies and are used in revising the *Milk Ordinance and Code Recommended by the United States Public Health Service.*

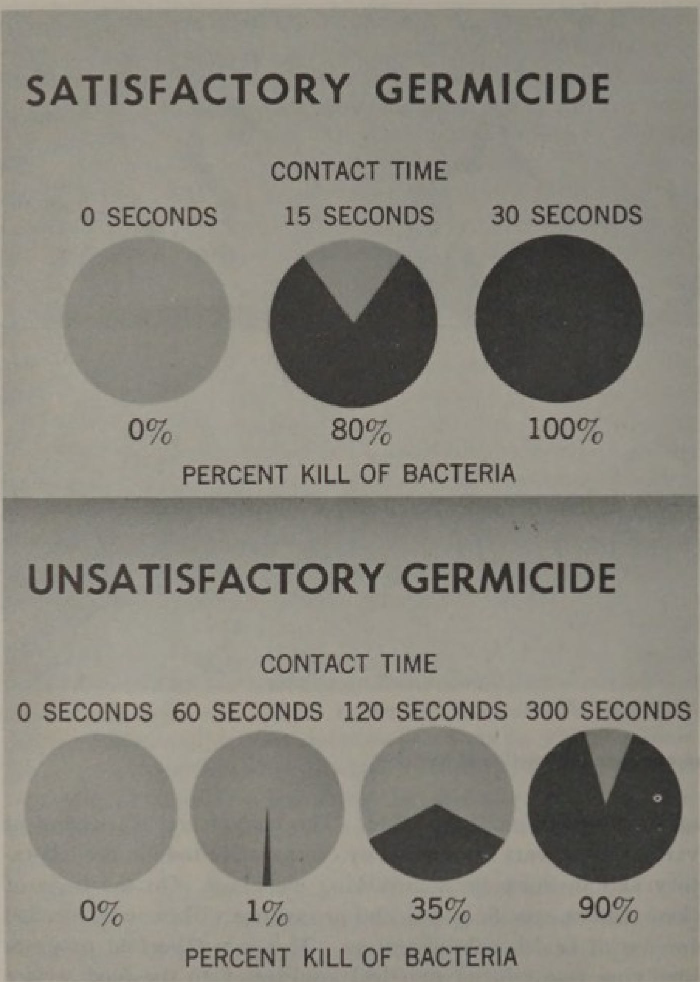


Development of agents for speedier, more complete destruction of bacteria.

Food Sanitation

Research is hard-pressed to keep pace with new processes and chemicals used in the food industry. Continued tests are applied to determine the efficiency of germicides used to sanitize eating utensils and food-handling equipment. Some sanitizers work well in certain waters, but poorly in others.

Laboratories keep a constant check on sanitizers, germicides, and detergents on the market. The bactericidal efficiencies of various detergents are studied by comparative tests in the laboratory and in domestic dishwashing machines. On the basis of these studies, specific germicidal procedures will be recommended for use of health administrators. This is a threefold program involving research, its practical application to the food service business, and education.



Research seeks efficient germicides.

Shellfish Sanitation

Public Health Service studies on shellfish are conducted at Woods Hole, Mass. Oysters, clams, and mussels are observed there under varying conditions of natural and artificial contamination with sewage. Research into the survival of bacteria in mollusks in northeastern waters measures the amount of bacterial contamination reaching the shellfish and the water. It measures also the amount released or taken up by the mollusks when transplanted from one water to another. Similar information is sought with respect to species growing in southern and western waters. The study of the effects of disease-producing organisms requires development of techniques for artificially contaminating waters and for recovering the disease-producing organisms in small numbers from samples of the water and shellfish.

THE ATMOSPHERE

It has been said, "The only really unexplored part of man's environment is the atmosphere." The Nation spends millions on research on equipment to produce an artificial atmospheric environment. Yet, no one has yet defined the physical-chemical-biological basis of "fresh air."

It is known that many diseases are air-borne and that infectious organisms or deadly toxins may be carried in aerosols or in clouds of dust. Dust clouds have been known to circle the globe. Industrial contaminants in the air also are possible factors in illness. Much industrial dust is significant for its mechanical rather than its chemical action on human tissues. Air pollution studies are one preliminary step for reducing air-borne diseases. At the same time, mass surveys are being conducted in a few communities in an effort to obtain clinical evidence of the effects of atmospheric contaminants.

Standard Procedures

Work on atmospheric pollution suffers from lack of a standard method of reporting air pollution and from the lack of a standard sampling procedure that will make possible comparison of data collected in various locations.

Work now is in progress to develop standard procedures which will insure uniform sampling and reporting.

Among the instruments used in these operations, the polarograph makes rapid determinations of small amounts of many materials and a permanent record of the analysis obtained. It can be used for analysis of heavy metals and for determinations of small concentrations of sulfur dioxide and certain common aldehydes. It is anticipated that other applications of this instrument will be developed.

Many health departments have been exterminating ragweed because its pollen causes hay fever. But research in sampling pollen concentrations in the air, in establishing threshold concentrations, and in indicating the drift of pollen into areas from distant sources has not kept pace with measures for ragweed control. Health workers using present-day sampling methods cannot determine accurately the amount of pollen in the air or assay the effectiveness of control programs and their geographical limitations. In 1949, a project was initiated at the Environmental Health Center for the study of ragweed pollens in the atmosphere. The exploratory phase of this program has been fruitful.

Progress in Prospect

Sulfur dioxide has been found to form, under certain conditions, a dangerous solution of sulphuric acid in the air in industrial communities. Its prevalence has shown the need for methods of sampling and analyzing this material at much lower concentrations than has been considered significant inside industrial plants. Considerable work has been done to determine the most efficient means of collecting sulfur dioxide in a form suitable for subsequent analysis.

In addition to evaluating the nature and extent of health hazards in the atmosphere, research is expected to develop engineering methods of control.

Dust Analysis

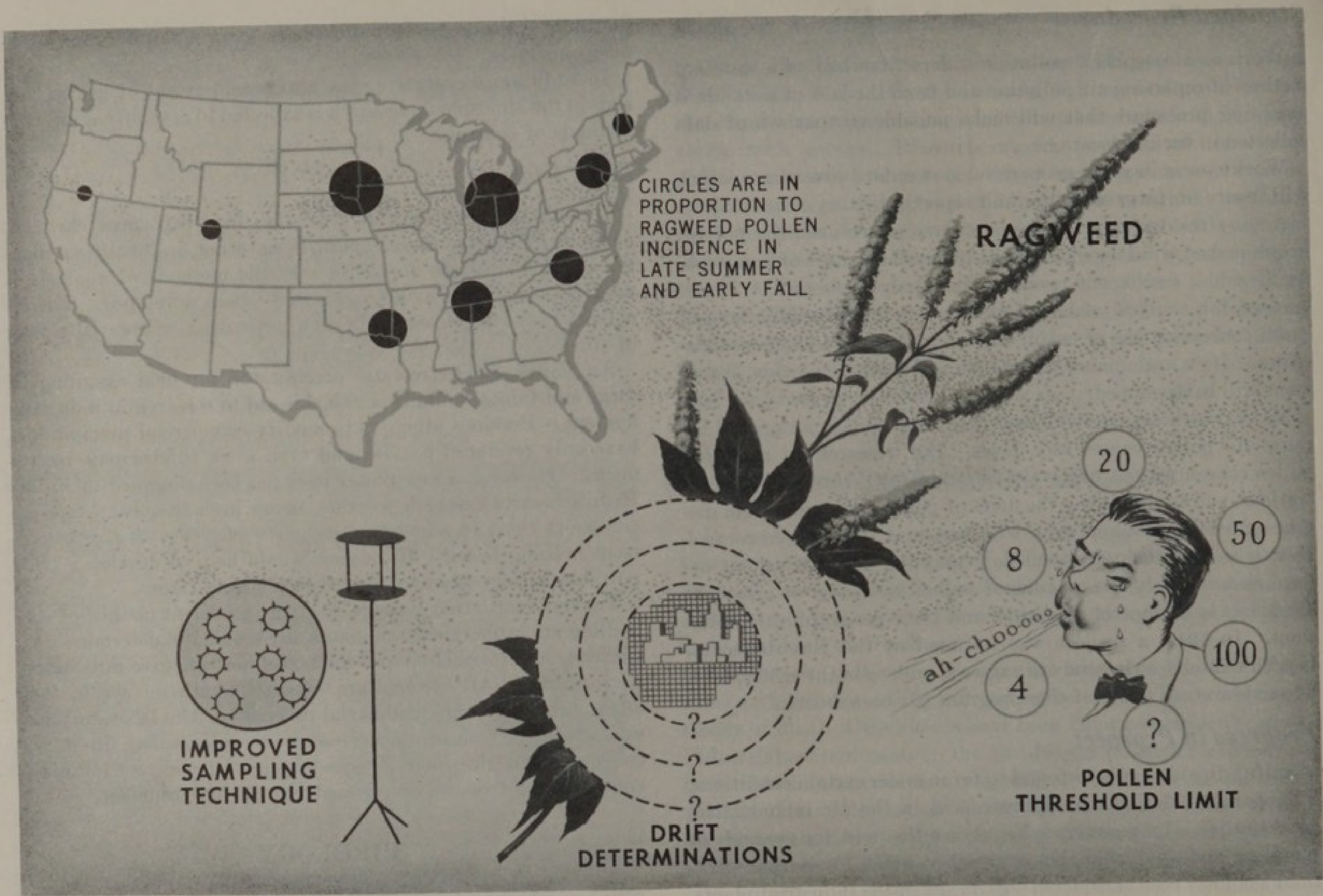
Despite extensive work on free silica dust exposures, chemical methods to analyze these exposures have not had many applications. In the search for more versatile methods of analysis, a modified phosphoric acid procedure has been developed. The results show an improvement in accuracy with a substantial saving of time.

An improved electrostatic precipitator for field sampling of dusts and fumes would be a valuable aid to research in industrial hygiene. Previous attempts to modify commercial precipitators have only produced heavier and even more cumbersome instruments. However, a new power pack has been designed by Public Health Service research workers, using high-frequency voltages similar to those in television sets. The efficiency of this instrument is being tested. Its success would help to develop a truly portable, battery-operated electrostatic precipitator.

Various ventilation systems, the most prevalent method of controlling atmospheric contaminants, are studied to determine their efficiency, as are other control methods known to give satisfactory performance. All systems are evaluated with an eye to their adaptability to specific industrial processes. The laboratory also evaluates collection equipment—such as cyclones, bag filters, wet collectors, and ultrasonic devices—designed to prevent industrial contaminants from being released into the environment.

VIROLOGY

Recent advances in the study of viruses offer hopes for control of or immunization against such diseases as measles, poliomyelitis,



Hay fever studies.

and influenza. The use of viruses to attack bacteria is another possibility. They may also help to answer the hardest question a biochemist can ask: How is the specific pattern of living chemical structure reproduced within the cell?

Viruses are much smaller than bacteria. Until the development of electron micrographs, virus shapes or sizes had not been visible to scientific workers.

Unlike bacteria, viruses do not multiply outside the living cells of a susceptible host. Inside the cell, apparently they assume a form different from the form that attaches itself to the cell. This idea resulted from the study of viruses that attack bacteria—bacteriophages. The process that takes place inside the infected cell or bacterium is not yet known.

Two or more viruses apparently may mix within a host cell to produce new virus strains. For this reason and others, a virus that causes only mild infections may evolve into one more deadly. Environmental factors may possibly contribute to such mutations. Also, the process in the cell may produce a harmless virus.

Generally, a host tends to build up immunity or resistance to a parasitic virus. If parasites destroyed their hosts completely, they would not themselves survive. It is said that the practical control of a virus disease will depend on understanding how the balance between virus and host is maintained and how it is modified by biological accident or by human design.

VECTOR RESEARCH

A variety of problems may be grouped under the general heading of vector research. These include studies of disease transmission, sanitation, and biochemistry.

Research on insects and their relationship to health and the environment seeks accurate knowledge of carriers of diseases, reservoirs of potential infection, modes of transmission of disease, sound methods of control, and effects of chemical controls upon insects and upon man, both directly and indirectly.

Transmission of Poliomyelitis

As flies may be infected naturally with poliomyelitis virus, they are strongly suspected to be vectors of the disease. For this reason, the Communicable Disease Center has joined with the National Foundation for Infantile Paralysis and the Yale University School of Medicine in a study to determine the effects of year-round fly control on the incidence of poliomyelitis. Previous studies by the Center had established that, once an epidemic has developed, emergency fly-control measures do not affect its course.

Cities were selected for this study because of the following circumstances: (1) A relatively heavy fly population, indicated by mortality from enteric infections; (2) no serious outbreak of poliomyelitis within the past 3 years; (3) a population between 50,000 and 200,000; (4) willingness of the city to participate and contribute; (5) existence of good practices of refuse collection and disposal.

Investigators studied methods of fly-control and the effects on other fly-borne diseases in association with the poliomyelitis project. Because it was determined that flies rapidly develop resistance to DDT, chlordane, dieldrin, and other insecticides and because insecticides are at best only temporarily effective, it is essential to suppress breeding places of flies, by use of approved refuse containers, sanitary land fills, and other measures. As yet, the effect of fly-control on poliomyelitis is not known.

Shigella Infections

A demonstration of fly control in south Texas, a form of applicational research, succeeded in reducing infant diarrhea caused by the *Shigella* bacteria. A similar fly-control demonstration has been introduced in Thomasville, Ga.

The controlled studies in Texas investigated several broad areas to determine ecological relationships between diverse species of flies and the transmission of intestinal diseases. Such research includes study of specific flies, their breeding, feeding, and migration, how and where they come in contact with man, and their seasonal abundance. It includes also a study of the control procedures suitable to individual species.

Chemical Killers

Improved sanitation is fundamental to lasting control of flies and other carriers of those diseases associated with the accumulation and disposal of waste materials. Chemical control either supplements existing sanitation or serves as a temporary substitute.

There is reason to believe that certain chemicals act on the enzyme systems of insects, but little is known of this rather obscure phase of insect control.

Powerful insecticides, such as DDT, made chemical control of flies economically feasible on a large scale. However, as flies develop a resistance to DDT, research seeks improved chemical combinations. Development of specialized equipment for safely and efficiently applying insecticides is another research problem related to vector control.

Hazards are inherent in the powerful new chemicals applied against insects. Insecticides that linger on the interior surfaces of dwellings affect occupants with a protracted concentration of fumes. The question is: How directly toxic are they to man? As mentioned earlier, use of insecticides on fruit and vegetable crops poses a similar question: What are the health hazards in the residues of these toxic materials? Answers to these important questions are being sought by toxicological laboratory studies. It is known that some of these powerful poisons are readily absorbed through dry skin and may be a definite hazard to spray crews. Spraying an area by airplane may expose citizens of the region to inhalation of the chemical with undetermined physiological effects.

It has been necessary to develop different chemical combinations appropriate to specific conditions of insect control. For example, formulations were developed by the Public Health Service to give insecticides an adhesive quality for use under outdoor conditions, so that despite weathering they would retain the power to kill insects. Also, formulations developed by the Service have been used as a basis for malaria control programs in many parts of the world, particularly through the efforts of the Economic Cooperation Administration and the World Health Organization.

A guiding premise in developing chemical controls for pests is that the poison should be harmless to human beings or at least safe for human use. The perfect poison for pests is yet to be discovered. Meanwhile, research must continue to seek better formulas and to establish treatment for accidental poisoning.

Despite man's long warfare against his enemy the rat, effective methods of rat control are yet to be applied generally. Development of the best procedures for the use of new rodenticides, such as sodium monofluoroacetate and the still-experimental poison, Compound 42, warfarin, is one objective of Public Health Service research. Tests have been made also of different materials for rat-proofing structures, including ships.

Studies have demonstrated that eliminating food and harborage for rats is basic to reducing the rat population.

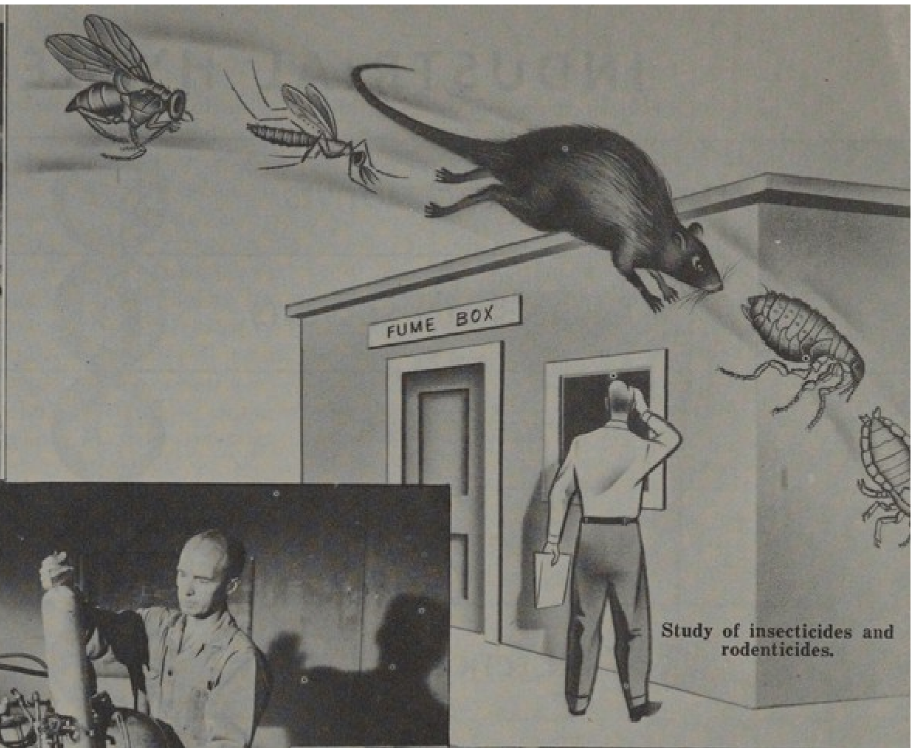
Although the Public Health Service has made basic contributions toward identifying ticks as disease vectors, it is doubtful whether it would ever be practicable to repress the offending species. Fortunately, aureomycin is proving to be an effective treatment for Rocky Mountain spotted fever, the disease most commonly carried by ticks.

The development of chemical killers is complicated by the fact that few of the millions of the earth's species are pests. Indiscriminate use of poisons, therefore, might destroy many species which are harmless if not beneficial, and may affect nature's balance.

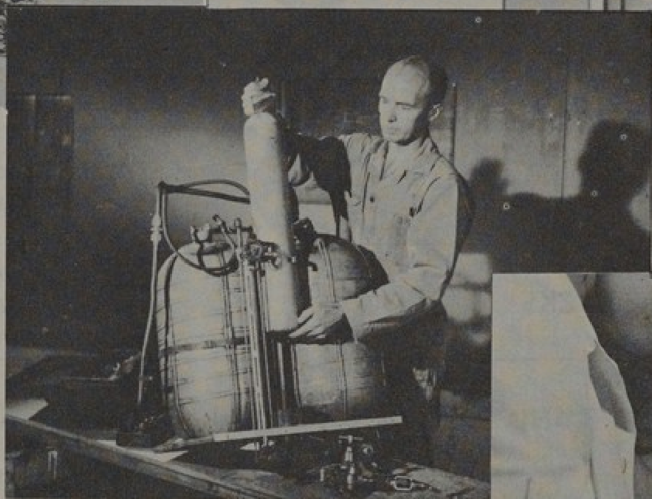
Tropical Diseases

Arthropods other than insects are known to carry certain trop-

Fly-trapping during field survey.

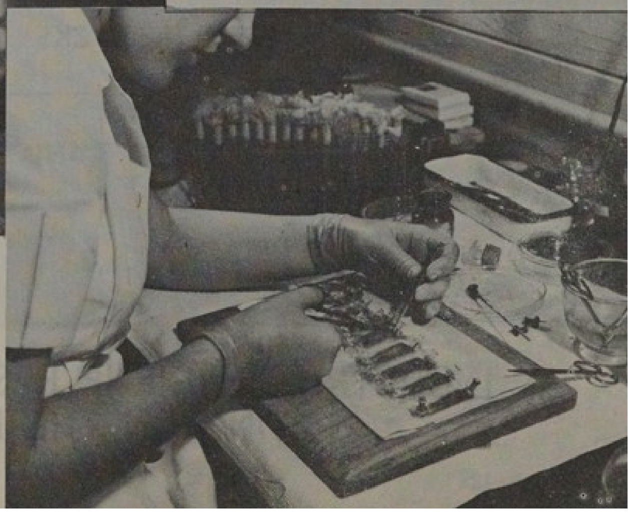


Study of insecticides and rodenticides.



An aircraft spraying unit used in tests over large areas.

THE RESEARCH PROGRAM DEVELOPS TECHNIQUES AND TOOLS TO STUDY AND ELIMINATE CARRIERS OF DISEASE.



Dissection of rats used in laboratory tests.

INDUSTRIAL HYGIENE RESEACH

APPLIED *to*	HELPS TO DETERMINE
to MINE LOCOMOTIVES	. . . safe substitutes for silicosis-producing sand used for traction
to INDUSTRIAL SOLVENTS	. . . satisfactory solvents of low toxicity
to WATER TANKS	. . . non-toxic protective coatings for steel in water storage tanks
to FLUORESCENT TUBES	. . . safe disposal methods for old tubes and the toxicological aspects of beryllium formerly used in fluorescent lights
to INSECTICIDES	. . . tests for toxicity and safe limits of exposure to newer organic insecticides
to EXHAUST STACKS	. . . controls and methods to eliminate atmospheric pollutants which may be dangerous to human health
to WOOL, HIDES AND HAIR	. . . best methods to eliminate industrial anthrax
to COTTON	. . . cause of acute respiratory diseases among handlers of low-grade stained cotton

INDUSTRIAL HYGIENE RESEARCH EXTENDS TO HEALTH PROBLEMS WAITING ON THE HORIZON OF INDUSTRIAL AMERICA ical diseases, but with respect to many of these diseases information is meager.

Research on the biology, ecology, physiology, taxonomy, and morphology of arthropods is of major medical importance. Knowledge of the life histories and habits of these disease-carriers will provide a basis for rational control measures. Many of these diseases are known to have reservoir hosts among lower animals. Further, the studies of these arthropods have noted that some hosts acquire resistance to these vectors.

Under the program of technical aid to other nations, fundamental research will be carried on in Liberia on tropical diseases with regard to medicine, entomology, and immunology. This work is expected to produce information that will apply to any area where tropical diseases are endemic.

Other environmental research in tropical diseases is directed at amebiasis and schistosomiasis.

TOXICOLOGY

Public Health Service toxicologists are interested in any substance which in relatively small amounts in the common environment starts a process that is injurious to human health. Their research aims at developing methods of detecting poisons, averting damage by poisons, and countering poisonous effects. Modern developments in chemical warfare have given impetus to such research. So has the increase in the variety of chemicals employed in agriculture, industry, and the home.

Many chemicals in the environment are suspected of having poisonous effects, but research is necessary to verify such suspicions, whether the effects are acute or whether they are subtle and chronic. Research must not only link effects with causes but must also determine how poisons operate in order to develop remedial measures. This task is not made easier by the fact that some poisons take as much as ten years to do their damage; others in apparently harmless quantities have the property of concentrating and building up to dangerous proportions in the body; and still others, harmless under certain conditions, are deadly in others.

The Select Committeee of the House of Representatives To Investigate the Use of Chemicals in Food Products, Insecticides, and Fertilizers has emphasized the urgency for expanding research on the toxicology of materials commonly added to foods.

Even with the certainty that specific commonly used chemicals are poisonous, research is necessary either to develop techniques which will permit their use with reasonable safety or to discover safe substitutes. The need for extensive toxicological research is indicated by the number of known and suspected poisons to which many Americans are ordinarily exposed. These include compounds employed in insecticides, in drugs and cosmetics, in fuels, in certain cleaners, in food processing, and in a variety of other industrial processes.

HEALTH IN INDUSTRY

Controlling and eradicating dangers of industrial poisons calls for exacting research. Substances new to the industrial scene, as well as those coming into greater use, must be evaluated for their toxic effects.

Toxins

Substances under study in the Public Health Service Industrial Hygiene Laboratory include beryllium, formerly used in fluorescent lamps, and parathion, one of the most important and most highly toxic insecticides. Exposure to parathion has killed workers engaged in packaging and spraying operations. A current study seeks to determine the safe limits of exposure. On the positive side there are efforts to develop pesticides that will do their work and still prove safe and economical to the user.

Among the new organic solvents now in large-scale commercial production is methylal, an excellent solvent for many carbon compounds. Full use of this substance, however, has been hindered by lack of information as to its toxicity. Animal experiments have been carried on to satisfy industry's need for such data. Preliminary results indicate that, while methylal has certain narcotic properties, it has a relatively low toxicity rating in comparison with many other industrial solvents.

Infections

Anthrax, increasing in recent years among industrial workers, is contracted while handling imported wool, hair, hides and skins, and similar materials which are infectious. Preliminary investigations have already indicated agents that disinfect the materials.

An acute respiratory disease occurs among workers handling low-grade stained cotton. Studies attribute this disease to a poison released from the cell of *Aerobacter cloacae*—a coliform bacterium. This organism will remain alive in contaminated stored cotton for as long as 6 years.

Respiratory infections as a group may spread easily in crowded industrial plants. The effort to reduce this hazard includes an investigation of air-borne bacteria and viruses and various control methods, such as the use of ultraviolet light.

Environmental Cancer

Research in cancer is deeply concerned with environmental forces. Certain forms of cancer appear to be related to soot and to a few waste products from the fractionation and distillation of coal and petroleum, including shale oil. Likewise, wastes resulting from the smelting and processing of certain metals may give carcinogenic properties to the air, water, and soil within the "fume zone" of plants producing them. Certain radiations also may be carcinogenic. Research in the Public Health Service is being conducted to develop preventive measures—medical and technical—for the synthetic fuel industry while it is still in the pilot stage of development. Studies of cancer explore its relation to the inhalation of dust and to other exposure in the handling of metals. Epidemiology and experimentation provide most of the important knowledge on the existence and incidence of cancer in relation to the environment.

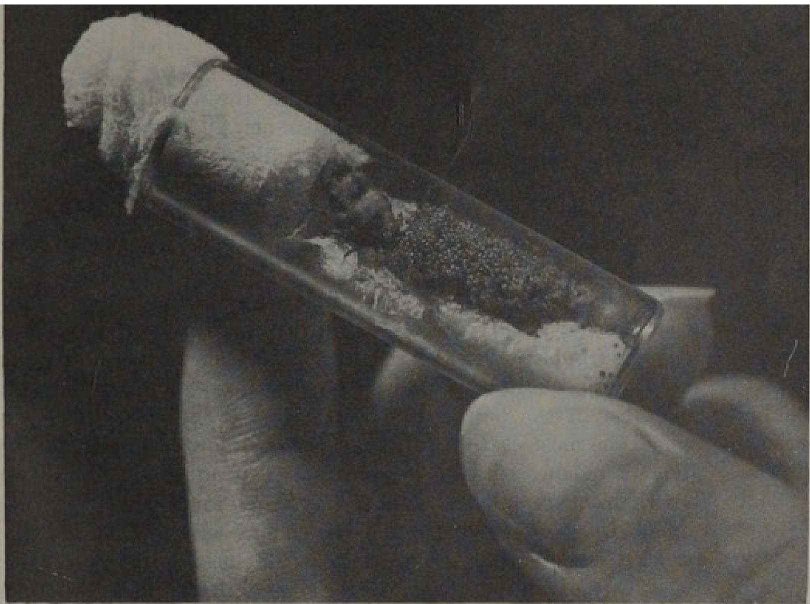
GRANTS AND FELLOWSHIPS

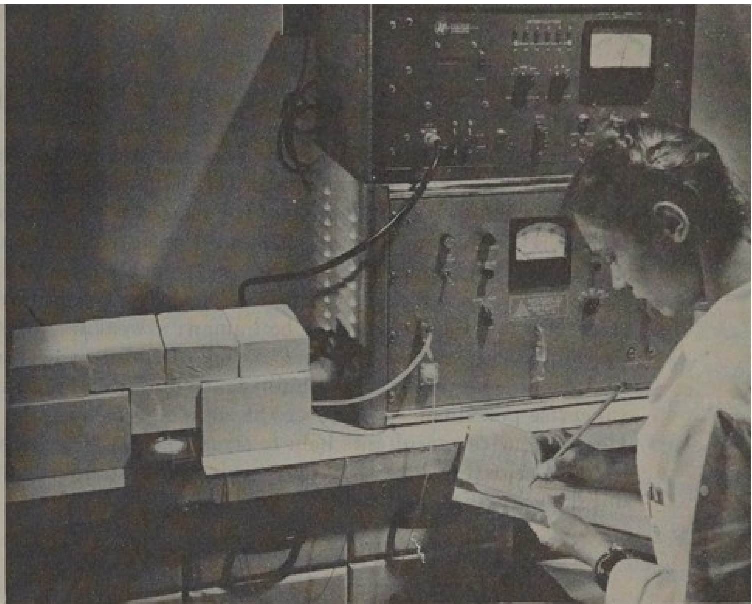
The Division of Research Grants and Fellowships of the National Institutes of Health, established in 1945, allots funds for basic research to qualified groups and individuals upon the advice and recommendations of its advisory councils, consisting of leaders in their respective fields. The advisory councils are assisted by study sections, composed of scientists trained respectively in special fields of interest. This organizational pattern has proved to be extraordinarily effective.

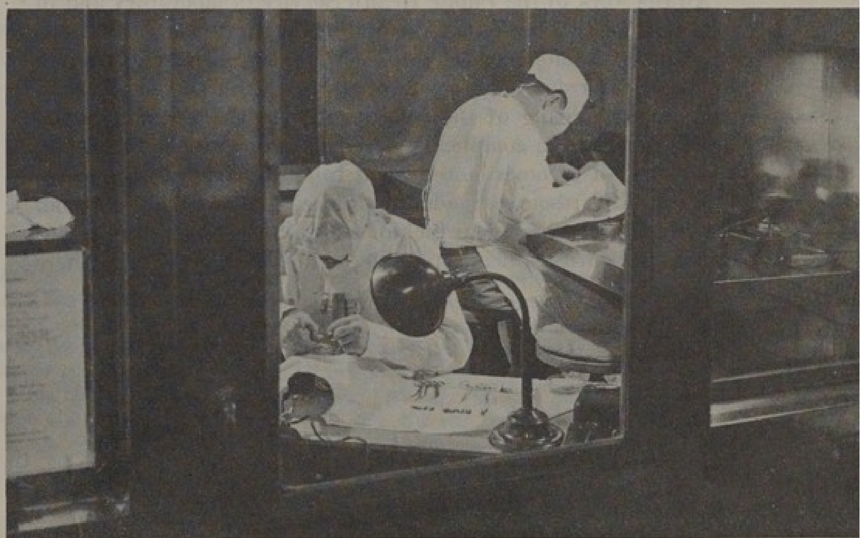
The Environmental Health Study Section includes subsections to review applications for grants, provide technical advice, and stimulate research in milk and food, housing, insect and rodent control, water, sewage and industrial wastes, industrial hygiene, and air pollution.

Although research grants may be given to individuals directly, as a rule the individual receives the grant through a university or other institution where he works. Grants are allotted on the basis of the merits of plans outlined in the application, but the scientist is free to deviate from these plans at his own discretion, should he encounter a more promising line of inquiry. It is the policy to confine grants to basic research as distinct from applicational or developmental work. An example is the study of the effect of high temperatures on organisms in cream and milk.

Since 1946, more than $1,000,000 has been allotted for more than 70 projects in the field of environmental health. The consensus of the Environmental Health Study Section is that much additional research is desirable with the aim of achieving economical, efficient, rapid, and flexible environmental controls.







(Above, left) Fully engorged tick held in vial, with mass of eggs.

(Above, right) The Geiger counter, a counting apparatus for determining radioactivity.

(Right) Operating on mice, using aseptic procedures.

LABORATORY CONSULTING SERVICE

Although mind and imagination are vital to effective research, scientific conclusions depend also on verifiable observations. The scientist seeks to obtain data that are as accurate as sensory and technical limitations permit. Observations, instruments, techniques, or records must be accurate also to enable laboratories and other institutions to protect the public health. The failure to obtain reliable observations may be human: a weakness of sensory perception. It may be financial: a lack of sufficient personnel or equipment. Or it may be administrative: failure to train and supervise personnel. Whatever the source of failure, the Public Health Service consultants help to strengthen laboratory services by demonstrating how they may correct and standardize procedures, techniques, and records.

ADMINISTRATIVE RESEARCH

All the work of the Public Health Service in laboratory and in field is of small avail unless the findings are put to use. For example, the development of an effective method of applying to interstate milk shipments a code of approved practices is as necessary as the writing of the code itself. As the work in public health increases in complexity—and its complexity is increasing every day—it becomes more urgent to look sharply into the Nation's health resources: administrative, human, and material. There has been an obvious lack of searching inquiry into the administrative process as it applies to public health practice. There is an increasing demand for inquiry into the recruiting, training, and utilization of public health personnel. There is a less well-defined urge among public health administrators for clear understanding of the economic implications of public health work. The very process of making standards in environmental health involves at once considerations of epidemiology, personnel, and economics.

Research in the administration of environmental health programs is not simply the collection of quantitative data dealing with environmental health services. Rather it evokes a series of more subtle, qualitative, policy questions. Is this standard sound and also in the best public iterest? Are these kinds of personnel the most useful in this program? How can a community strike a balance between large capital expenditures to eliminate health hazards and the annual payments for personal services aimed to cope with continuing health hazards? What activity, or what combination of activities, would most economically and effectively advance the health of the community? These questions are illustrative of those that administrative research must answer.

CONCLUSION

Research not only answers questions: it asks them. Questions are expected to produce action. Action is expected to produce answers, and new questions! The capacity to ask and answer questions explains why so much has been achieved for the public health. The achievements of the past are a portent of how much more will be achieved in years to come.

Epilogue

The foregoing pages have endeavored to present a relatively modern concept of a major and growing field in public health, based upon the view that the welfare of the individual is wedded to his human and physical environment as the tree is rooted to the earth and as the fish is cradled in the sea. Major factors of the physical environment—air, water, food, shelter—have been reviewed along with human factors in the environment as expressed in the industrialized economy and in social and cultural institutions. On the whole, despite the fact that a few environmental problems have tended to grow ahead of measures for dealing with them, the record of environmental health work contains achievements which give grounds for hope and optimism for the future.

Acknowledgments

This book is a team product. A number of persons have contributed either original drafts or critical reviews of chapters, sections of chapters, paragraphs, graphics, or ideas for graphics. An equitable tribute to their contributions and cooperation would necessarily refer to a large part of the roster of the Public Health Service.

All the drawings and most of the photographs are original with the Public Health Service. A few photographs have been borrowed; for permission to make use of them, the Service is indebted to the following: Baltimore City Health Department, Budd Manufacturing Co., Garnet W. Jex, Edna Jones, Nature Magazine, Prince Georges County Board of Education, H. Armstrong Roberts, South Carolina State Health Department, Tennessee Valley Authority.

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