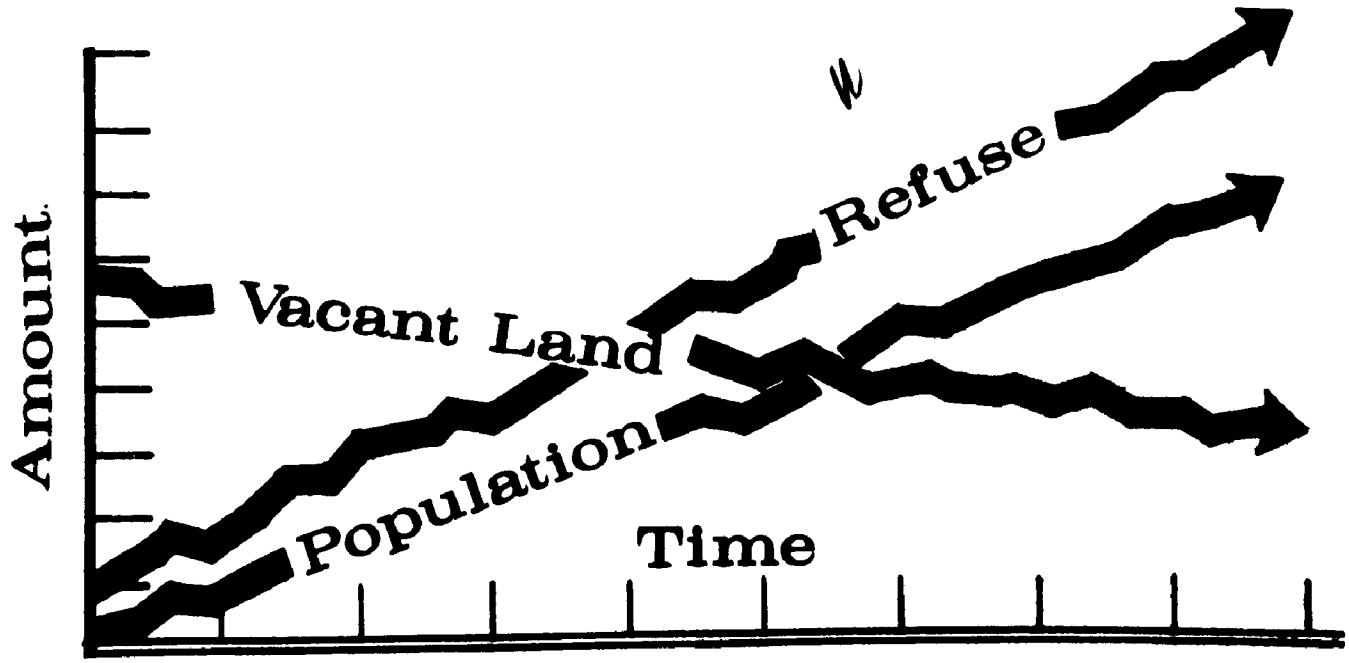
SOLID WASTE HANDLING IN METROPOLITAN AREAS

DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE



SOLID WASTE HANDLING

IN METROPOLITAN AREAS

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ON

URBAN HEALTH AFFAIRS

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U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service
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NATIONAL CENTER FOR URBAN AND INDUSTRIAL HEALTH
Solid Wastes Program
CINCINNATI

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T H E P R O B L E M

By the year 2000, the population of the United States is expected to double. Our cities and their surrounding urbanized areas are already bearing the brunt of this explosive growth with its accompanying increase in industrial activities. This growth, coupled with the increasing per capita rate of refuse production, results in an ever increasing volume of solid wastes that must be regularly collected, transported, and ultimately disposed of on suitable land. This long-term trend is shown in the accompanying graphs.

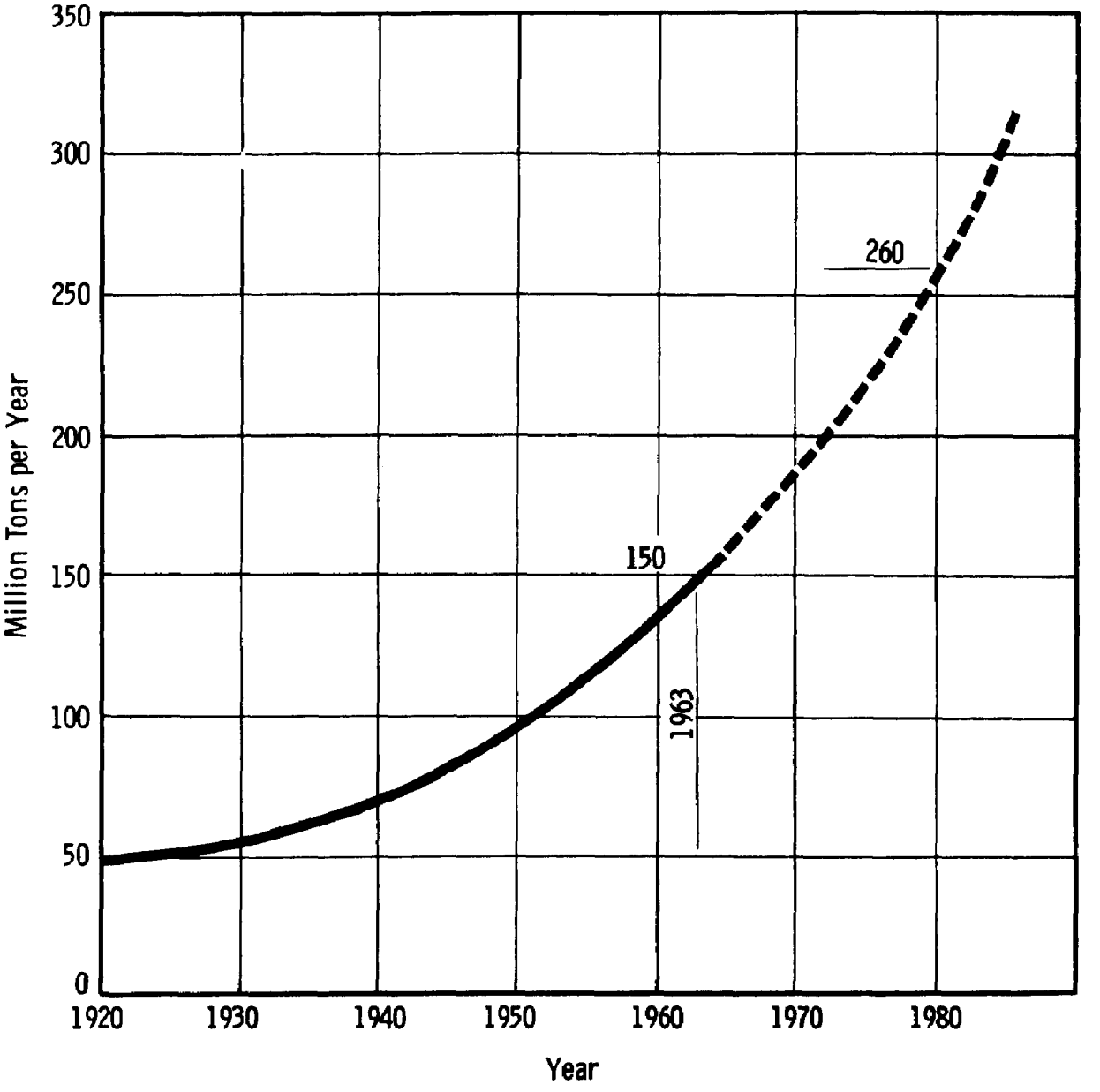
Land required for waste disposal facilities is also in demand for many other more attractive uses in every metropolitan complex. Therefore, unless workable plans are made and implemented, metropolitan areas will be forced to haul refuse long distances, thus placing an additional economic burden on this essential public service. To realistically meet even short-term needs, suitable areas must be reserved for refuse disposal as a part of the over-all metropolitan area environmental health plan.

A recent study has shown, for example, that most of the existing refuse disposal capacity in Northeastern Illinois is at sites on the periphery, too remote for efficient, economical use by areas of high population density. A key finding in this study was that "A growing menace to the beauty and healthfulness of the Chicago area will reach crises proportions well before 1980, unless better methods are used in disposing of a huge expected accumulation of garbage and other refuse." 1/

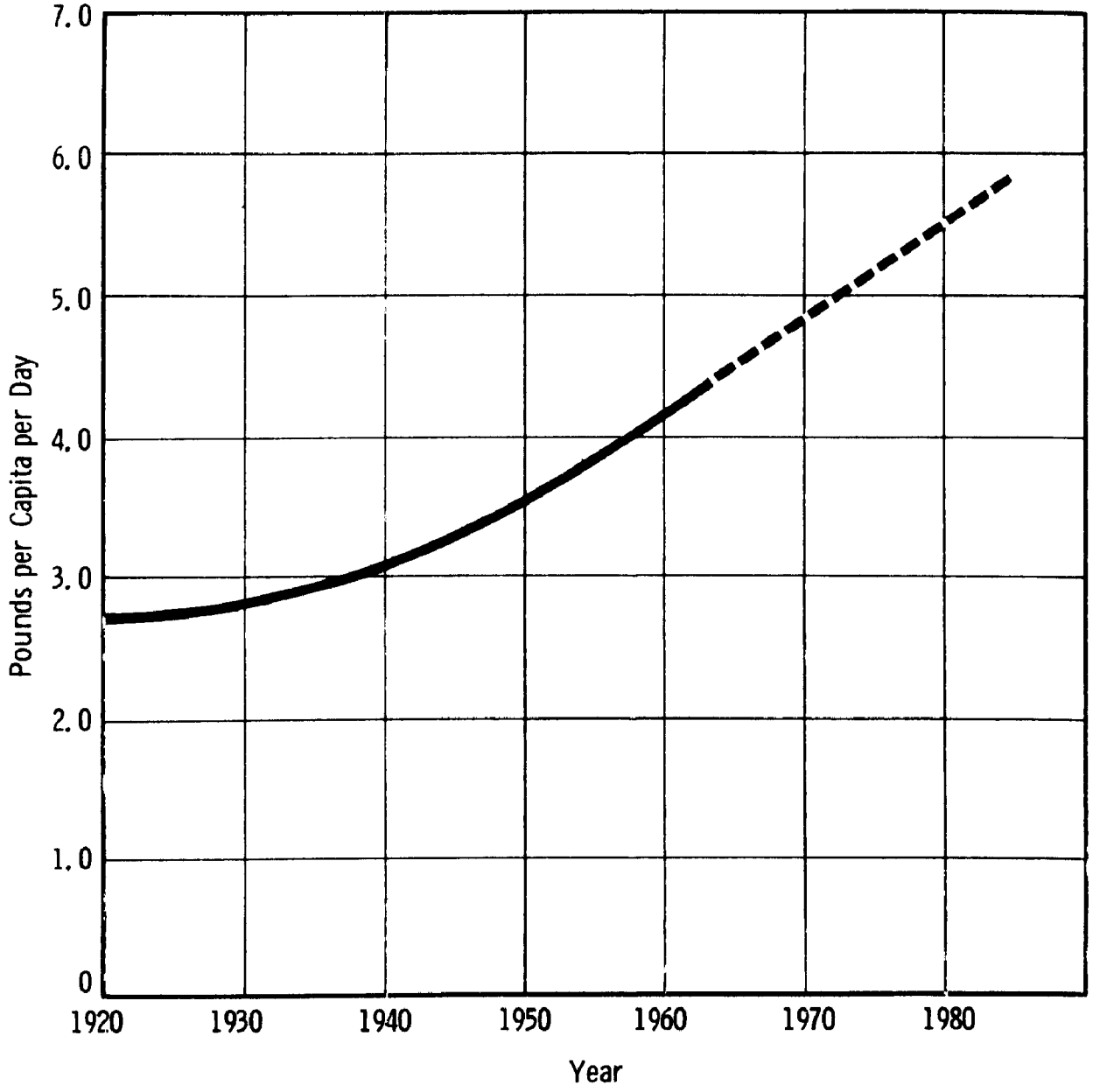
Refuse disposal facilities in urbanized areas must be operated without creating public health hazards or nuisances in order to be acceptable to nearby residents. Too often, refuse disposal operations are open dumps--festering scars that disfigure the landscape. Flies, rats, and other disease-carrying pests find large quantities of food, a favored breeding media, and suitable harborage in the piles of exposed refuse. The polluted drainage from open dumps is an additional insult to ground and surface water supplies in the area. The characteristic foul odors, produced by the decomposition of the refuse, together with the smoke created by inefficient open burning, are often identifiable for miles.

Unless an objectionable dump is nearby, the average citizen's interest is limited to having his refuse collected regularly. This lack of public concern is a real handicap to responsible local officials in securing the necessary funds to operate adequate refuse collection and disposal systems, usually preventing the planning and construction of needed facilities in time to prevent them from being overloaded. The technical problems involved have appeared so deceptively simple compared to other environmental problems that only a handful of communities have maintained sufficient records to enable them to determine their unit costs of providing this service or to make realistic plans for needed facilities.

TOTAL REFUSE PRODUCTION IN THE U. S.



PER CAPITA REFUSE PRODUCTION



PUBLIC HEALTH IMPLICATIONS

The storage, collection, and disposal of solid wastes have been shown to have a variety of public health implications. Research efforts by a variety of disciplines have demonstrated that in addition to the traditional sanitation aspects, air pollution, water pollution, vector control, occupational health, accident prevention, and fire prevention aspects of solid waste handling are frequently important in metropolitan areas.

Serious air pollution problems are commonly caused by inadequate refuse disposal facilities. Recent studies in New Orleans [2] revealed a definite relationship between the number of asthma cases admitted to Charity Hospital Emergency Clinic and the presence of a silica crystal associated with poor combustion products. Large quantities of the substance were produced by subterranean burning at an abandoned refuse dump. Although all possible sources of this material were not examined, a correlation was shown between the number of asthma admissions and the number of fire department calls for dump fires during the same period.

Open dumps, where burning is used to reduce the volume of solid wastes, often produce large quantities of smoke and odors. Improperly designed and operated municipal incinerators also contribute significant quantities of objectionable air contaminants. In addition, single chamber incinerators and backyard trash burners that contribute additional air contaminants are used in most communities. Fortunately, both sanitary landfills and incinerators, when

properly designed and operated, can dispose of municipal refuse without creating air pollution problems.

The available information concerning the effects of refuse fills on the quality of the adjacent ground water has been organized and reviewed by a research contractor for the California State Water Pollution Control Board.[3] Three basic mechanisms by which refuse fills can pollute the ground water were given. They are:

1. Direct horizontal leaching of the refuse by ground water,
2. Vertical leaching by percolating water, and
3. The transfer of gases produced during refuse decomposition by diffusion and convection.

Further investigations were recommended on gas production and movement, leaching rates, percolation, and methods of controlling the movement of gas and water in landfills.

An earlier study, sponsored by the California State Water Pollution Control Board, [4] concluded that the movement of water through incinerator ash dumps will leach soluble salts and alkalies from the dump. An investigation at a sanitary landfill proved that ground water in the immediate vicinity will become grossly polluted by continuous or intermittent contact with deposited refuse.[5] It was found that continuous leaching of an acre-foot of sanitary landfill extracted a minimum of approximately 1.5 tons of sodium plus potassium, 1.0 ton of calcium plus magnesium, 0.91 ton of chloride, 0.23 ton of sulphate, and 3.9 tons of bicarbonate. This amount of leaching would take place in less than one year, with a much slower leaching rate occurring over subsequent years.

From the fly production aspect alone, refuse handling deserves careful consideration. The ability of flies to quickly find and oviposit on any suitable material, including garbage, is well known. Siverly and Schoof [6] found that Phaenicia pallescens adults displayed the ability to enter garbage containers through openings as small as one-eighth of an inch in diameter.

In other studies, Siverly and School [7] found that as many as 70,000 flies were produced per cubic foot of garbage that was exposed to ovipositing flies.

When flies infest garbage, the larvae are usually concealed in the garbage or in the lower part of the can so that ordinarily the householder is unaware of their presence. Although many of these larvae are carted away when the refuse is collected, studies have shown that during warm weather large numbers of larvae migrate from the cans before the refuse is collected and pupate in the backyards. Campbell and Black, [8] for example, found that an average of 1,128 fly larvae per can, per week migrated from refuse cans to pupate before the combined refuse was collected at Concord, California. During the two years of study, a maximum count of 23,208 larvae was obtained from one can in a single week.

The fly infested refuse that is ordinarily collected during warm weather must be carefully handled to prevent fly production. A study [9] conducted in California shows that there are four essential factors to consider to prevent fly emergence from compacted cover material at sanitary landfills:

1. Soil that can be compacted,
2. Suitable equipment for compacting the soil,
3. Adequate range of soil moisture, and
4. Adequate thickness of cover.

Although no reasonable amount of uncompacted cover would prevent emergence, since house flies emerged through five feet of uncompacted cover, only a six inch layer of compacted cover was sufficient to prevent fly emergence.

The practice of feeding raw garbage to swine has both public health and economic implications. Consumers of improperly cooked pork, produced from swine fed raw garbage, are exposed to trichinosis, a disease caused by a parasitic roundworm contained in the infected pork. The fact that some ethnic groups in metropolitan areas eat foods containing raw or partially cooked meats may account for the continued high incidence of trichinosis in these areas. Swine fed raw garbage are exposed to trichinosis as well as vesicular exanthema, a disease that caused the slaughter of more than 400,000 swine during an outbreak in 1953 through 1955. Despite State and Federal regulations and generally effective control measures that prohibit the feeding of raw garbage to swine, approximately 40,000 swine [10] are still being fed raw garbage in the United States annually.

Solid wastes handling presents a formidable problem from an occupational health point of view. In a detailed study of the New York City Department of Sanitation, Sliepcevich [11] found that

sanitation workers have an extremely high injury frequency rate --69.2 average injuries per million man-hours worked for New York City sanitation men as opposed to 12.1 for manufacturing employees.[12] Arthritis, cardiovascular disease, muscle and tendon diseases (particularly muscle ailments affecting the back), skin disease, and hernia could all be classified as occupational diseases of refuse collectors. The following table contains figures for the number of injuries per million man-hours worked for various occupations. [12]

Occupation	No. of Injuries
Wholesale & retail trade	12.6
Local fire protection	28.6
Police	32.4
Contract construction	34.5
Lumber & wood products (not including furniture)	40.5

ECONOMIC IMPACT

The storage, collection, and disposal of solid wastes is one of the major economic problems of urban areas. As the American Public Works Association [13] recently pointed out:

> "The annual outlay for refuse collection and disposal services --over $1.5 billion--is exceeded only by expenditures for schools and roads."

In addition to the expenditures by local governmental agencies, the editors of Refuse Removal Journal [14] have estimated that the annual expenditures of the private sanitation industry are over $1.3 billion. From the standpoint of the average person, these costs can no longer be considered minor. For example, the Washington Suburban Sanitary District charges the average homeowner $40.20 per year for water and sewer charges, and $30 per year for refuse service. Thus, the refuse service charge amounts to 43 percent of the total charge of $70.20.

Field studies have shown that at least 85 percent of the total cost of providing refuse service is spent on collection. [15] Since labor charges account for the major cost in the collect on operation, the development of new and more efficient methods for planning and operating refuse collection systems would suggest a most productive area for research investigation.

LEGAL ASPECTS

Although municipalities generally have ample legal authority to regulate solid waste handling within their corporate limits, few States have enacted laws which enable local governmental units in metropolitan areas to deal effectively with solid wastes. While municipalities can exercise the power of eminent domain within their corporate limits, the land available for refuse disposal is frequently insufficient to meet their needs. Even when a city finds land to purchase in a neighboring community or an unincorporated area, political boundaries are formidable obstacles which may prevent the site from being used for refuse disposal facilities.

Few State laws provide any protection for city residents from the effects of nuisances that are maintained in neighboring communities. Illinois is one exception. The Criminal Code of Illinois authorizes municipalities to prohibit any offensive or unwholesome business or establistment located within one mile of their corporate limits (Illinois Revised Statutes (1961) ch. 24, Sect. 11-42-9, ch. 100-1/2, Sect. 27). In the recent case of the City of Chicago v. Fritz, 184 N.E. 2d. 713 (1962), the City sought to enjoin Fritz from operating a dump within one mile of the corporate limits of Chicago. The dump, where garbage was burned, was found to be both a statutory public nuisance violation of the Criminal Code and a common law public nuisance. Therefore, the operation was abated by court injunction.

State legal authority to provide refuse services on an area-wide basis is urgently needed in metropolitan areas. A few cities are

currently sharing disposal facilities on a fee or prorated cost basis, and some counties have county-wide refuse disposal systems, but State statutes often do not provide the legal authority for establishing and financing refuse disposal services on an area-wide basis. Although communities naturally wish to retain their rights of home rule, and therefore are often reluctant to give up their jurisdiction over such matters, scarcity of disposal sites and the economic advantages of using area-wide refuse disposal systems are forcing more metropolitan areas to consider this approach.

EFFECT OF COMMUNITY DIFFERENCES AND TECHNOLOGICAL ADVANCES

The composition and quantity of solid wastes are affected by the type of area served, the economic level of the area, the type and frequency of collection, and the types of industry served.

Industrial and technological changes are resulting in the production of ever increasing quantities of refuse. Hospitals, for example, are making more use of inexpensive equipment which can be discarded, instead of sterilized for reuse. Over 170 disposable items are available, ranging from paper blankets and latex surgeon's gloves to plastic cutlery and cardboard bedpans.

Some technological developments have changed the place where solid wastes are produced rather than introducing new kinds of wastes. Consumer prepackaging of vegetables, for example, produces sizeable quantities of trimmings and culls at the packing plant, but has virtually eliminated waste production in marketing some foods.

LACK OF PUBLIC CONCERN

The "garbage man" going about his dirty, noisy work is a frequent and familiar sight in any neighborhood. He is generally conceded to have the most demeaning job, that requires no skill, and so is poorly paid. It is no wonder that the average citizen does not give a second thought to his refuse collection service unless a failure occurs or his rates are increased.

Actually, however, constantly increasing labor costs have triggered the use of complex and costly equipment to speed the job of refuse collection. This use of specialized equipment generally is forcing a more careful evaluation of the amount of work performed and usually results in higher wages. Refuse collection is hard physical work that is particularly hazardous, but usually unappreciated by the public. Aside from perfunctory coverage of the annual "clean-up" campaign, mass media find little that is newsworthy in any community's refuse collection service.

Lack of public concern is too frequently translated into public apathy when city officials attempt to secure support for the expenditures necessary to provide adequate refuse collection and disposal systems.

DEVELOPMENT OF STANDARDS

Comprehensive survey procedures, together with applicable standards and criteria for the handling of solid wastes, are sorely needed. Although there are wide variations in the refuse handling procedures used throughout the country, there is ample justification for establishing minimum standards and criteria. These functional areas include storage; collection; and disposal, including incineration, sanitary landfilling, and composting.

Research has played an important role in the development of sanitary and efficient handling procedures. For example, the practicality of using the sanitary landfill method of disposal in cold climates was developed and demonstrated in a study conducted at Mandan, North Dakota. [16] This experimental operation helped to develop procedures for operating sanitary landfills under severe winter conditions, and provided new information on operating procedures that were successful under these conditions.

Recommended Standards For Sanitary Landfill Operations,[17] together with a rating system, were developed by the Public Health Service as an aid to both public works and public health officials who share responsibility for providing and maintaining adequate refuse disposal operations. A draft copy of these standards has been distributed for thorough review by State and local officials. It is hoped that the use of such standards will facilitate the exchange of technical information and provide the basis for further improvements in operating practice.

The orderly development of incinerator design practices and operational procedures is handicapped by the lack of generally acceptable standards, particularly those oriented toward the reduction of air pollution. Several research studies have been made on the effect of incinerator design and operation on stack discharges. Stenberg, et al.,[18] in a study of the effect of fuel moisture, combustion air, and rate of burning on pollutant emissions from central incinerators, found that the amount and distribution of combustion air had the greatest effect on particle emissions. In another study, Stenberg, et al., [19] pointed out the difficulties involved in burning highly volatile solid waste materials without contributing appreciably to atmospheric pollution.

The Process Industries Division of the American Society of Mechanical Engineers has established an Incinerator Committee to bring together as many diversified interests in one group as possible. Committee members represent many phases of the incineration industry--equipment manufactures, consulting engineers, and operational people. The Committee is studying many aspects of incineration including air pollution, design, instrumentation, materials handling, operations, refractories, and research.

The wide-spread use of flue-fed, apartment house incinerators and other on-site incinerators, to reduce refuse volumes before collection, creates serious air pollution problems in many metropolitan areas. In an effort to find economical and practical solutions to these problems, the Building Research Advisory Board recently has formed a special committee to evaluate the available information.

Several methods to improve present flue-fed incinerator designs have been suggested. MacKnight, et al., [20] recommended converting the single chamber design into multiple chambers and adding a storage bin or installing an afterburner and a draft control damper. Kaiser, et al., [21] recommended charging only during nonburning periods, using auxiliary gas burners, controlling combustion air, scrubbing the flue gas, or combinations of these methods.

Sterling [22] evaluated 35 different models of incinerators in conjunction with Detroit's regulations on domestic incinerators. The results showed that multiple chamber incinerators with gas burners produced less smoke, odor, and fly ash than did single chamber units. Several modifications in design were recommended for further investigation.

The development of workable standards for solid wastes handling requires the combined efforts of many interested groups. Competency in various aspects of solid wastes technology can be drawn from many sources, including researchers, professional societies and organizations, and Federal, State, and local health authorities.

R E S E A R C H A N D T R A I N I N G

The Public Health Service has awarded research grants, some of which have been completed, for a variety of projects in the field of solid wastes. The title of the project, the name of the principal investigator, the institution, and a brief description of the scope of the work involved in these projects are listed below.

SUCCESSION AND ECOLOGY OF DIPTERA IN CATTLE DROPPINGS

Mr. John R. Anderson
Assistant Professor of Parasitology
Department of Entomology and Parasitology
University of California
Berkeley 4, California
Grant No. EF-00515-01

Scope of Work: To ascertain the factors which determine the chronological appearance of different fly species on and in cattle droppings of various ages. Studies will be conducted under both undisturbed field and experimental conditions to determine the effects of the succession of spec es on the population dynamics of the various species comprising the cattle dropping community.

INTEGRATED CONTROL OF THE HOUSEFLY

Mr. R. C. Axtell
North Carolina State College
Raleigh, North Carolina
Grant No. EF--00454-01

Scope of Work: To determine the effects of insecticides on manure-inhabiting mites and the factors affecting the behavior of macrochelidae. The effects of various fly control techniques on the mites will also be investigated

SANITARY ASPECTS OF COMPOSTED SEWAGE SLUDGE

Mr. Anton H. Berkman
Professor of Biological Sciences
Texas Western College of the University of Texas
El Paso, Texas
Grant No. RG-5510

Scope of Work: To determine whether or not pathogenic, enteric, waterborne organisms can survive the temperatures generated in composting processes. Survival time of pathogenic bacteria will be determined by inoculation on laboratory scale composting pile with species from the American Culture Collection and local isolated species.

Isolation and identification of protozans, helminth ova and cysts, will be done by:

1. Screening and washing,
2. Sedimentation,
3. Centrifugation,
4. Flotation, and
5. Microscopic examination.

Viability of these pathogenic forms will be determined by feeding white rats and by inoculation of culture media, with life cycles to be completed when necessary.

GARBAGE AND WASTES FOR MUSHROOM PRODUCTION

Dr. Seymour S. Block
Assoc. Research Professor
Department of Chemical Engineering
University of Florida
Gainesville, Florida
Grant No. EF-085-04

Scope of Work: The investigators will attempt to prepare composts from municipal and industrial wastes that are capable of yielding

mushrooms for human consumption, protein and vitamin-rich fungus mycelium for animal feed, and humus fertilizer for plant growth. Work to date on this project has demonstrated that when properly blended, fortified and composted, these materials will support mushroom growth and produce, in good yield, mushrooms for food. Analysis of the spent residue, which is largely made up of mushroom mycelium, shows it to contain over 15 percent nitrogen, which will be evaluated as an animal feed. If found nutritious and palatable, large quantities of wastes can be composted and inoculated with different fungi for protein feed production. The composted wastes will also be tested for their suitability as a humus-type fertilizer to supply structure, drainage, moisture holding and base exchange properties to soils.

THE PHYSICAL AND CHEMICAL COMPOSITION OF MUNICIPAL REFUSE

Mr. Don E. Bloodgood
Professor of Sanitary Engineering
Purdue University
LaFayette, Indiana
Grant No. EF-146-05

Scope of Work: Development of methods of sampling and analyzing municipal refuse. The investigators will obtain analytical information regarding the physical and chemical composition of refuse, and secure accurate data on the total amount of refuse produced.

BACTERIAL CONTAMINATION FROM HOSPITAL SOLID WASTES

Mr. Richard G. Bond, Professor
School of Public Health
University of Minnesota
Minneapolis 14, Minnesota
Grant No. EF-007-03

Scope of Work: Study of the sanitary hazards involved in solid waste handling and associated housekeeping procedures in a representative cross section of hospital institutions. Waste handling and resulting bacteriological contamination will be investigated at production areas, storage and utility areas, and at the location of ultimate disposal. In addition to such solid wastes as waste-basket trash; disposable medical and surgical supplies; and contaminated instruments, laundry, and materials destined to be reused; other hospital solid wastes will also be studied. The techniques associated with waste handling will be duplicated in a chamber where the microbiological environment can be controlled, and the quantitative and qualitative bacteriology associated with the method of solid waste handling can be assessed.

SANITARY LANDFILL INVESTIGATION

Mr. Jerry C. Burchinal, Assoc. Professor
Department of Civil Engineering
West Virginia University
Morgantown, West Virginia
Grant No. EF-040-01

Scope of Work: Bacteriological study of a sanitary landfill. The investigators will attempt to identify the groups and numbers of microorganisms which are active in aerobic and in anaerobic refuse decomposition, to determine the rate of change in the environment of buried refuse from aerobic to anaerobic conditions, and the effect of high temperatures on Escherichia coli and

Aerobacter aerogenes and whether nitrogen, potassium, or phosphorus is a limiting factor. They will make both chemical and bacteriological analyses of the landfill seepage, and its effect on streams and walls in the vicinity of the landfill.

MATHEMATICAL SIMULATION OF REFUSE COLLECTION AND DISPOSAL SYSTEMS

Dr. Abraham Charens
Professor of Applied Mathematics and Economics
Northwestern University
Evanston, Illinois
Grant No. EF-355-01

Scope of Work: Development of a mathematical model to simulate the refuse collection and disposal problem. The mathematical model will give an optimum solution to the problem based upon considerations of direct cost factors and pollutional levels to be expected from the operation of the disposal process involved (i.e., expected contribution to air pollution from incineration of refuse); the model will describe the influence of each significant variable upon the optimum solution; and the model will delineate the performance standards which any new procedure or process must meet in order to be competitive with existing methods.

SANITARY ENGINEERING APPLIED TO LIVESTOCK MANURES

Dr. Samuel A. Hart, Assoc. Professor
Department of Agricultural Engineering
University of California
Davis, California
Grant No. EF-265-01

Scope of Work: Development of sanitary and effective methods of managing the manure produced on concentrated livestock farms, such as dairies, beef feedlots, and poultry farms. The investigator will attempt to develop methods and machinery to collect the manure from where it is defecated by the animals. Laboratory and

pilot plant operations of various processing and stabilization techniques--such as digestion, algae ponds, activated sludge composting, and drying--will be conducted to develop methods that are successful and feasible at the farm level. Final disposal techniques and outlets will be developed and evaluated. The most probable disposal will be on the agricultural land, where it must compete with inorganic fertilizers. Attention will be paid to getting manure into a better competitive position.

HANDLING, TREATMENT, AND DISPOSAL OF ANIMAL WASTES

Messrs. G. E. Hazen and E. R. Baumann
Iowa State University
Ames, Iowa
Grant No. EF-00410-01

Scope of Work: To determine the physical, chemical, and bacteriological characteristics of animal manure and to devise and test economically feasible methods of rendering the manure safe from the standpoint of public and animal health protection. Anaerobic digestion, incineration, and stabilization ponds will be among the methods investigated.

INCINERATION OF AUTOMOBILE BODIES AND BULKY WASTE MATERIALS

Mr. Elmer R. Kaiser
Senior Research Scientist
College of Engineering
New York University
New York, New York
Grant No. RG-6760

Scope of Work: The investigation of present methods and facilities used by cities to incinerate bulky waste materials. Development of design parameters for incinerators capable of consuming bulky wastes not normally handled in conventional municipal incinerators

was also carried out. This work has been completed and the results published. [23]

PYROLYSIS OF MUNICIPAL REFUSE

Mr. Elmer R. Kaiser
Senior Research Scientist
College of Engineering
New York University
New York, New York
Grant No. EF-00530-01

Scope of Work: To determine the nature and quantity of the volatile matter from the pyrolysis of refuse constituents, such as paper, wood, fats, oils, waxes, garbage, sewage sludge, etc. From the data it will be possible to calculate the possibilities for gasifying refuse to produce hot, raw combustible gas for boiler firing. The fundamental nature of the data will permit other uses related to refuse burning, such as calculation of combustion air requirements for incineration.

FACTORS CONTROLLING UTILIZATION OF SANITARY LANDFILL SITE

Mr. Robert C. Merz
Professor of Civil Engineering
University of Southern California
Los Angeles 7, California
Grant No. EF-160-03

Scope of Work: To study the effects of physical and chemical phenomena on the rate of decomposition of organic matter in a sanitary landfill. The investigators will include practical field tests at a large disposal operation in the vicinity of Los Angeles. The field tests will consider the influence of moisture, soil admixture, depth of fill, type of soil, aeration, and temperature. Preliminary results of this work have been published. [24]

AEROBIC DECOMPOSITION OF ORGANIC WASTE MATERIALS

Dr. Karl L. Schulze
Associate Professor of Civil Engineering
Michigan State University
East Lansing, Michigan
Grant No. RG-4180

Scope of Work: To investigate the process of aerobic decomposition of organic waste materials, including a study of:

1. The effect of moisture, temperature, and air supply upon the end product; and

2. The utilization rates and breakdown of solid protein material under aerobic conditions.

Thermoelements and solenoid valves will be used to control the temperature by controlling the air supply for the first study. Casin will be absorbed on vermiculite and placed under aerobic conditions at optimum temperature and moisture. Paper chromatography will then be used to study the breakdown products obtained in the second study. Results of some of this work have been published. [25]

The Public Health Service has conducted research on a number of solid waste handling methods. Examples of such research are: the practicality of using the sanitary landfill method of disposal in cold climates,[16] the effects of community-wide installation of household garbage grinders on environmental sanitation,[26] the effects of food waste grinders on septic tank systems, [27] the effect of improving refuse handling facilities on community fly populations, [28] the field study of small-scale windrow and bin composting operations, [29] and laboratory studies of aerobic thermophilic decomposition including the effect of heating and cooling on the composting process. [30]

Research efforts were recently reviewed by the American Public Works Association in their report, Solid Wastes Research Needs.[31] This study indicated that a comprehensive research program is definitely needed in the solid wastes field. It suggests many worthy projects and points out that "the annual expenditures in this field--using industry standards as a guide--justify the annual investment of at least $7.5 million in research." It also indicates that the Federal Government has already set a precedent of financing research on liquid and gaseous wastes and that it should logically support a broad, well-conceived research program in the solid wastes field.

Since only introductory courses on solid wastes engineering are offered by a few colleges and universities, even professionally trained public works officials receive little formal training in this field. Rensselaer Polytechnic Institute has applied for a Public Health Service research training grant to prepare a graduate training program. Although this application was approved, unfortunately, it could not be funded.

THE METROPOLITAN-WIDE APPROACH

The question which so frequently confronts communities that are considering metropolitan-wide refuse services is, "What level of the local government should provide refuse collection and disposal services?" One of the biggest obstacles to organizing efficient refuse collection and disposal systems in metropolitan areas is the multitude of local governmental units. In Allegheny County, Pennsylvania, for example, there are 129 local political subdivisions. 32/ These local political subdivisions may be separated by natural boundaries, such as rivers or mountains, or by the political boundaries of satellite communities that surround a central city. The provision of economical refuse service under such conditions is complicated and may be further hampered by State or international boundaries.

Traditionally, small and large cities have provided their own "total" service. During the last few years, however, there is a trend in metropolitan areas toward each community continuing to provide collection service, with disposal service provided on an area-wide basis. The increasing population and higher population density has resulted in a shortage of land for disposal sites, an increase in the quantities of refuse that must be collected, and longer hauling distances to disposal sites that may even be located beyond the limits of the urbanized area.

Area-wide refuse disposal service is being provided in a few metropolitan areas by special purpose districts, by counties, or by cooperative agreements between cities and other local political subdivisions. Unfortunately, many States do not have enabling legislation,

which permits special purpose districts to be formed or counties to provide these services, with the result that investments are needlessly duplicated and some areas are not provided adequate service. The scarcity of disposal sites and the economic advantages gained by using transfer stations with fewer and larger scale disposal facilities are forcing more metropolitan areas to consider the establishment of some type of metropolitan-wide refuse disposal service. In a recent Refuse Study, [33] conducted for the Connecticut Capitol Region, for example, it was pointed out that a regional operation could lead to "more suitable, efficient, and economical disposal practices." It was estimated that savings of up to 15 percent would be possible with region-wide disposal service.

This fragmentation of responsibility for providing refuse collection and disposal services and other functions of local governments was recognized as a problem worthy of study by the Advisory Commission on Intergovernmental Relations.[34] Hopefully, new methods of organizing such essential services can be devised.

STATE AND LOCAL ACTION

State leadership is essential to successfully attack solid waste problems in metropolitan areas. Two recent studies have concluded that State legislation must compliment local governmental action in order to make it possible to provide adequate refuse disposal services for metropolitan areas. These studies [1, 33] were made in the Northeastern Illinois and the Hartford, Connecticut, metropolitan areas. Both reports point out the need for area-wide refuse disposal agencies. Unfortunately, few States have delegated the authority necessary to establish area-wide refuse collection and/or disposal systems. The Census of Governments: 1962,[35] for example, reports that only nine States--California, Connecticut, Kentucky, Michigan, New Jersey, Ohio, South Carolina, Tennessee, and Washington--have provisions for the formation of districts or authorities to organize and operate such area-wide systems.

In September, 1963, a questionnaire concerning the status of State health department solid wastes programs, was sent to the States via the Public Health Service Regional Offices. The four questions asked and the answers received are tabulated below. For the individual State tabulations, see page 31.

			No.	0/0
1)	Does the State agency consider that it has a responsibility in the solid waste field?	Unqualified yes	43	86
		Little	4	8
		No	3	6
2)	Is the State responsibility covered by specific legislative authority? If so, please furnish copies of applicable statutes.	Unqualified yes	25	50
		Qualified yes	7	14
		No	18	36

			No.	o/o
3)	Is there a specific State program directed at this problem?	Unqualified yes	16	32
		Partial program	3	6
		Program being developed	2	4
		No	29	58
4)	How much professional time does the State agency devote to this activity? (Number of man years).	Equal to or less than 0.25	10	20
		Equal to or less than 0.5	22	44
		Less than 1	26	52
		1	7	14
		Greater than 1	7	14
		Unknown	10	20

In many cases the State's legislative authority is not clearly defined or lacks adequate power. The authority for some States in the "qualified yes" group is based on general health or nuisance laws or for the control of dumping refuse on public and private property without permission. This last group could be considered anti-litter laws. Only a few of the States have specific legislation giving authority to the State health department for the control of the storage, collection, and disposal of solid wastes.

The amount of time spent by the State health departments indicates the inadequate amount of work being devoted to solid wastes. Fifty-two percent of the departments spend less than one man-year per year and forty-four percent less than one-half man-year, whereas New York devotes fifteen to twenty man-years per year.

This survey indicates that most State health departments have a lack of clearly defined responsibility and adequate programs directed at solid wastes problems which are currently facing incorporated and unincorporated communities.

Region	State	Responsibility	Legislative Authority	State Programs	Man Years
I	Connecticut	Yes	Yes	Yes	Unknown
	Maine	No	No	No	Less than 1
	Massachusetts	Yes	Yes	Partial	2
	New Hampshire	Yes	Yes	No	0.25
	Rhode Island	No	No	No	1/12
	Vermont	No	No	No	Unknown
II	Delaware	Yes	Yes	Being developed	Less than 1
	New Jersey	Yes	Yes	Yes	1.5
	New York	Yes	Yes	Yes	15-20
	Pennsylvania	Yes	Qualified yes	Yes	7
III	Kentucky	Yes	Yes	Yes	0.5
	Maryland	Yes	Yes	Being developed	0.75
	North Carolina	Yes	No	Yes	0.5
	Virginia	Yes	No	Yes	1.75
	West Virginia	Yes	Yes	No	0.5
IV	Alabama	Yes	No	No	1/12
	Florida	Yes	No	No	1/12
	Georgia	Yes	No	No	1/12
	Mississippi	Yes	No	No	1/12
	South Carolina	Yes	No	No	1/12
	Tennessee	Yes	No	No	1/12
V	Illinois	Yes	Qualified yes	No	1
	Indiana	Yes	Qualified yes	Yes	0.5
	Michigan	Yes	Yes	Partial	0.33
	Ohio	Yes	No	No	0.5
	Wisconsin	Yes	Yes	No	0.7
VI	Iowa	Yes	Yes	No	Unknown
	Kansas	Yes	No	No	Unknown
	Minnesota	Little	No	No	Unknown
	Missouri	Yes	Qualified yes	Yes	Unknown
	Nebraska	Yes	Yes	Yes	Unknown
	North Dakota	Yes	Yes	Yes	Unknown
	South Dakota	Yes	No	No	Unknown
VII	Arkansas	Yes	Yes	No	0.1
	Louisiana	Yes	Yes	No	1.0
	New Mexico	Yes	Qualified yes	No	0.5
	Oklahoma	Yes	Qualified yes	No	1.0
	Texas	Yes	Yes	No	1.0
VIII	Colorado	Little	No	No	0.5
	Idaho	Yes	Yes	No	1.0
	Montana	Little	No	No	0.02
	Utah	Yes	Yes	No	0.25
	Wyoming	Little	No	No	0.04
IX	Alaska	Yes	Yes	Partial	Unknown
	Arizona	Yes	Yes	Yes	1
	California	Yes	Yes	Yes	4
	Hawaii	Yes	Yes	Yes	1
	Nevada	Yes	Qualified yes	No	0.5
	Oregon	Yes	Yes	Yes	2
	Washington	Yes	Yes	Yes	0.5

Several States have, however, made important contributions toward the solution of solid waste problems. New York and New Jersey, for example, have recently revised their State sanitary codes to control the use of open dumps for refuse disposal. Extensive studies of ground water pollution by refuse fills have been sponsored by the State of California.

Local governmental officials have used a variety of legal provisions and technical approaches to solve solid waste problems in some metropolitan areas. The Los Angeles County Sanitation Districts, for example, made a detailed study and report, [36] which led to the establishment of a system of transfer stations and sanitary landfills, which now serve more than fifty cities and a large unincorporated area in the county. In neighboring Orange County, the Highway Department prepared a Master Plan of Refuse Disposal, [37] which anticipated the county's disposal needs up to the year 2000. The county-wide system of transfer stations and sanitary landfills was subsequently established with the support of all the cities and other local governmental units.

A recent survey by the Housing and Home Finance Agency [38] reports that twenty-four planning agencies have completed seventeen solid waste disposal studies, fourteen others are underway, and six more are anticipated. The planning agencies doing these studies are evenly divided between three types--multi-jurisdictional, city-county, and county.

Comprehensive planning is an essential step in the design of efficient area-wide refuse collection and disposal services. Local conditions must be evaluated, the possible solutions investigated, and the best methods of providing service determined. Such engineering studies can be made by either local public works agencies or consulting engineering firms.

ROLE OF THE PUBLIC HEALTH SERVICE

Under provision of the Public Health Service Act of 1944, the Public Health Service supplies technical assistance, guidance, and consultation to State and local governmental agencies, individuals, and professional organizations concerned with solid waste handling. This work is performed by three full-time professional staff personnel in Headquarters and two full-time and one half-time regional consultants. In addition, the Public Health Service awards research grants for the investigation of various aspects of solid waste handling methods, as shown by the projects that are described in detail in the preceding section on Research and Training.

The Environmental Sciences and Engineering Study Section, one of the Advisory Committees on research matters to the Public Health Service, proposed a national conference to stimulate research on solid wastes storage, collection, and disposal. The conference was supported by a Public Health Service grant (EF-00549-01) and conducted in cooperation with the American Public Works Association and the Division of Environmental Engineering and Food Protection of the Public Health Service. It was held at the University of Chicago Center for Continuing Education on December 2-4, 1963. Over 200 university, public works, public health, and industry officials, as well as representatives of two European countries, participated in the conference.

The Public Health Service, in cooperation with the Tennessee Valley Authority, is planning to assist in the design and operation of a full-scale composting plant and study the public health aspects

of the operation. In addition, the Tennessee Valley Authority plans to study the marketability and fertilizer value of the finished compost. Preliminary efforts are underway to locate the plant in a city within the area served by the Tennessee Valley Authority. Many communities are interested in this process and are looking increasingly to the Public Health Service for recommendations concerning the applicability of this refuse disposal method.

The Public Health Service is cooperating with a variety of public and private organizations to improve solid wastes handling. Assistance, for example, was provided to the American Public Works Association in the preparation of Municipal Refuse Disposal [39] and Refuse Collection Practice,[40] which are manuals presently serving both health and public works officials as major guidelines for designing and evaluating refuse collection and disposal systems. In addition, the American Public Works Association is conducting or has conducted several other studies, including: an inventory of current solid waste handling practices, the use of paper bags for refuse storage and collection, [41] and a delineation of solid waste research needs. [31] Many other organizations are interested in various aspects of solid waste handling. They include: the American Public Health Association, the American Society of Civil Engineers, The Conference of State Sanitary Engineers, the Building Research Advisory Board, the American Society of Agricultural Engineers, and Keep America Beautiful, Inc.

Even a casual perusal of the technical literature indicates that all aspects of solid waste handling technology have received increased

attention during recent years. This growing interest becomes clearly evident by comparing the number of items listed in the series of annotated bibliographies on refuse collection and disposal that have been prepared by the staff of the Division of Environmental Engineering and Food Protection. The 1958 - 1959 bibliography,[42] for example, lists 358 items while the 1960 - 1961 bibliography [43] lists 627 items.

In order to realistically meet the present and foreseeable needs in the solid waste field all levels of government--local, State, and Federal--will have to devote more attention to this subject. The role of the Public Health Service would be to:

1. Increase research and development work in both extramural and intramural programs. Legislation and additional funds would be needed to establish a larger research grants program.

2. Increase technical assistance, basic data collection, and dissemination of technical information to States and local governmental agencies. Additional funds would be required to place solid waste consultants in each of the nine regional offices.

POLICY QUESTION--SOLID WASTE PROBLEM

1. In some metropolitan areas the responsible agency collects only the garbage and the householder is responsible for arranging for collection and disposal of all other refuse. Therefore, should local government agencies be urged to assume responsibility for the collection and disposal of all household refuse?

2. What should be the role of local agencies with regard to the collection and disposal of commercial and industrial wastes?

3. What should be the role of the States with respect to local solid waste collection and disposal?

   a) Should States authorize their local units to jointly and cooperatively provide refuse service?

   b) Should they authorize transfer of solid waste functions from municipalities to the county agencies?

   c) Should they provide more technical assistance to local agencies on solid wastes than they currently do?

   d) Are current State regulations on solid wastes adequate?

4. What should be the role of the local health agency (county, municipal, etc., to other local agencies (e. g., public works) in connection with solid wastes?

5. Should solid wastes functions be urged upon the smallest possible local jurisdiction that can be persuaded to accept the responsibility--or should it be urged upon the largest jurisdiction that can efficiently perform the service?

6. Are waste disposal site decisions sufficiently coordinated with land use plans and should metropolitan regional planning agencies be required to include planning for location and acquisition of land for future disposal sites for all parts of the metropolitan area?

7. Should private solid waste operations be considered as similar to utilities--with regard to monopoly, public service, health and welfare, State-wide licensing, etc.?

8. Should Federal grants be made to encourage regional or area-wide solid waste handling operations?

9. Is it feasible to develop multi-purpose districts to encompass several jurisdictions and services?

10. What should be the role of the Public Health Service in improving solid waste operations?

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