POSTATTACK SANITATION
WASTE DISPOSAL, PEST AND VECTOR CONTROL
REQUIREMENTS AND PROCEDURES

Prepared For

OFFICE OF CIVIL DEFENSE
OFFICE OF THE SECRETARY OF THE ARMY
DEPARTMENT OF THE ARMY

Subtask 3441A
Contract No. OCD-PS-64-9
February 1965

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By

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ABSTRACT

In the event of a nuclear attack on the United States, environmental disease control measures will be interrupted with the surviving population exposed to the ensuing disease hazards. This report considers the probability of the occurrence of some 14 diseases that might develop, evaluates the effectiveness of available control measures and determines the total operational requirement for recovery of environmental sanitation in terms of manpower, equipment and material.

The enteric infections (Shigellosis, Infectious Hepatitus, Salmonellosis, Typhoid and Amoebiasis), especially Shigellosis (bacillary dysentery), are assigned a leading role among the diseases to be controlled, thus indicating a compelling need for the prompt removal and sanitary disposal of human feces and of spoiled food and other decomposable fly breeding potential organic material. Pending the establishment of sanitary disposal of organic wastes, the control of houseflies by adulticiding is indicated when climatic conditions favor fly production.

The hazard of mosquito-borne encephalitis in those parts of the United States where encephalitis is endemic necessitates early postattack operations, as climatic conditions dictate, to rid the areas of adult mosquitoes by adulticiding with larvicidal treatment to follow.

Diseases of secondary concern are Rabies, Murine Typhus, Plague, Leptospirosis, Rocky Mountain Spotted Fever, Dengue, Malaria and Yellow Fever. The endemicity of these diseases is related to the geographical location and climatic as well as the sanitary condition with timing and extent of control related to these factors.

The control of the domestic rodents in the United States west of the 100° Meridian to reduce the hazard of Plague and control in the Southeastern United States and Southern California to reduce the hazard of Murine Typhus is indicated where a condition of structural damage and fallout results in sheltering for an appreciable period of time.

Significantly effective control of these disease hazards in the postattack environment is possible through the utilization of material and equipment properly positioned for prompt postattack operations. The magnitude of these needs (material, equipment and manpower) is developed for an estimated metropolitan population of 88 million.

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SUMMARY

Of the 51 diseases considered in this study to be related to man's environment, it is determined that 14 are related to environmental sanitation conditions that will be significantly influenced by a nuclear attack and the waste disposal, and pest and vector conditions in the postattack period. The five enteric infections (Shigellosis, Infectious Hepatitus, Salmonellosis, Typhoid and Amoebiasis), especially Shigellosis, are of primary concern for all United States metropolitan areas for all seasons (although not of uniform intensity). Mosquito-borne encephalitis is of equal importance, on a selective seasonal basis, in those parts of the United States where encephalitis is endemic.

The endemicity of the 8 remaining diseases (Rabies, Murine Typhus, Plague, Leptospirosis, Rocky Mountain Spotted Fever, Dengue, Malaria, and Yellow Fever) is related to the geographic location and climatic condition as well as the sanitary environment postattack. The conditions that are conducive to the transmission of these environmental diseases, especially the vector and host growth and reproduction, will differ for the various metropolitan areas and the season, thus the evaluation of the consequences takes these conditions into consideration.

Modification of the postattack environment, as it relates to the transmission of disease, may be accomplished through the use of recognized methods that have proven effective under peacetime environmental conditions. The operational requirements for doing this (including material, equipment, and manpower), is determined for a United States metropolitan population postattack of 88 million. While this is done on the basis of population units of 100,000 size, no indication is warranted at this time, of the size and placement of operational units in the nation to maintain a ready to act capability other than to indicate in the functional planning for advanced preparation and postattack operations, levels of responsibility that are broadly defined as Federal, State, Regional and Local.

It is estimated that:

A. Without effective application of postattack countermeasures,

1) 75% of the population may experience enteric infections within a 3 month period;

2) 0.15% of the population may experience encephalitides;

3) 0.1% of the population may experience leptospirosis;

4) 0.05% of the population may experience Dengue and a like percentage rat bite fever.

B. With the application of methods known to be effective in the control of disease hazard through the modification of the sanitary environment (countermeasures),

1) Not more than 10% of the population will experience enteric infection under the most adverse condition of material damage, and this may be expected to not exceed 0.1% under the conditions of fallout alone.

2) Not more than 0.02% of the population in very limited metropolitan areas will experience encephalitides.

The morbidity rate for the other environmental diseases will not increase significantly above the peacetime levels when considered for the United States metropolitan population, as a whole. Nevertheless there will continue to be the small localized outbreaks just as there are in peacetime (confinement to this level of disease is the objective).

The requirements for postattack recovery operations in local areas having a total metropolitan population of 88 million is estimated to be:

A. MANPOWER (12 months period)[(a)]

ACTIVITY	(1) Workmen per 100,000	(2) Workmen for United States 88 Mil.[(b)]	(3) Total Man-Months (First year Postattack)
Refuse Sanitation (c)	90	80,000	1,000,000
Tactical Fly Control	10	10,000	40,000
Tactical Mosquito Control	10	5,000[(d)]	15,000
Rodent Control	5	6,000	40,000
Rabies Control	3	4,000[(e)]	5,000
TOTAL	118	105,000[(f)]	1,100,000

(a) These values (columns 1 and 2) are to be doubled for operations immediately following sheltering, for a period equal to the shelter period.

(b) Assumed metropolitan population in areas experiencing material damage and/or fallout.

(c) Nightsoil collection is included in "refuse" collection.

(d) For areas of nation where mosquito-borne disease is endemic.

(e) For areas totaling 44 mil. population.

(f) Approximately 25% to be knowledgeable trained personnel.

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B. EQUIPMENT (12 months period)[a]

Equipment	Units
Trucks	
Packers	25,000
Garbage & Swill	5,000
Dump	3,000
Flat Bed (2 ton)	3,000
Pick Up	6,000
Bulldozers	2,000
Skiploaders	2,000
Draglines	500
Light Generators	2,000
Vehicle with mist sprayer	3,000
Dust Pumps, Cyanide	2,000
Duster-hand	1,000
Spray gun 300' hose	500
Sprayer (3 gal) hand	1,000
Spreader-Granule	1,000
Shotguns	1,000
Shells	500,000
Rat Traps	90,000
Bait Boxes	70,000

(a) Special clothing needs, handtools, etc. not listed.

C. MATERIAL (12 months period)[a]

Material	Units
Pesticides-Larvicides	
Rodenticides	
Anti-Coagulant Poison Bait	800,000 lbs
Anti-Coagulant 1 oz Conc.	900,000 packets
1080 Conc.	20,000 lbs
Zinc Phosphate Conc.	20,000 lbs
Calcium Cyanide Dust	30,000 lbs
DDT 25% Emul. Conc.	25,000 gals
Malathion 8#/gal Emul. Conc.	15,000 gals
Tossits	200,000
Larvicide Oil 50% AR.	300,000 gals
Fenthion Granules 1%	200,000 lbs
Diazinon 25%	2.7 mil gals
Fuel	
Gasoline	115 million gals
Diesel	15 million gals
Miscellaneous	
Land	
Dump Sites	1,000
Total Acreage	10,000 acres

(a) See Appendix for Alternate Pesticides, Larvicides and Rodenticides.

The ready availability of these materials and equipment supplies is not known. Some of the local areas studied indicated work has been done in an effort to determine available inventories as a part of the local advance preparation; however, information available to us in this regard is not adequate for a meaningful determination of such inventories.

Knowledgeable personnel have generally been assigned responsibilities for planning and direction of advance preparation for postattack operations. Such plans contemplate in part the use of workmen now familiar with sanitation, waste disposal, and pest and vector control methods and the peacetime operations. Beyond this relatively few of the needed workmen appear to have received training for disaster operations in a postattack environment.

To effectively carry out the environmental sanitation measures, an estimated 25% of the workmen will need advance training for safe and effective operation in a post nuclear attack environment. Training of 25,000 men for the various postattack sanitation activities, in the ratio of the number of workmen indicated in column (1) of the Manpower listing, is indicated. Even though radiological decontamination is not a part of these sanitation measures, the procedures are to be time-phased with controlled entry time and stay time as indicated by radiological conditions. The procedures suggest the use of airplanes in the early postattack period for adulticiding and larviciding to accomplish early fly and mosquito control without exposure of ground workmen to heavy radiation.

It is recommended that follow-up local-type detailed analysis be made of environmental sanitation measures under various hypothetical post nuclear attack conditions, including the following significant considerations:

1) The availability of suitable equipment and material positioned for use;

2) The availability of knowledgeable workmen;

3) The effectiveness of control measures in various geographic locations and climatic conditions;

4) The directional controls for coordinating a time-phased sanitation recovery program with other local CD efforts, especially radiological decontamination and inorganic debris clearance;

5) The reliability of the specific disease endemicity factor (postattack) as a guide for priority and placement of effort in postattack environmental sanitation operations; and,

6) Assessment of the likelihood of the various available control measures themselves, resulting in hazard to workmen and surviving population.

CHAPTER I

INTRODUCTION

In the event of a nuclear attack upon the Continental United States, there will be varied degrees of damage and of early radioactive fallout; the resulting adverse environmental conditions will favor increases in disease vector populations and dispersion of their animal reservoirs together with impairment of prevailing control programs. This study concerns itself primarily with countermeasures to minimize the duration and effect of adverse postattack environmental conditions and with a determination of the material, equipment and manpower needs to accomplish essential environmental engineering functions in a post nuclear attack environment. Secondarily, the study concerns itself with an evaluation of the proposed countermeasures and the establishment of methods for deriving the total operational requirement for sanitation, waste disposal and pest and vector control.

The approach presented in this study begins with consideration of the peacetime levels of environmental diseases, their vector and hosts, geographic distribution of the diseases, and a summary of their environmental control measures.

Chapter III presents information on peacetime sanitation measures with special considerations that go into judgment decisions for their use in a postattack environment. Organizational considerations for countermeasure operations are reviewed in Chapter IV. The essential items to be provided in the operations are listed. Chapter V discusses the logistical requirements needed to implement the countermeasures; while Chapter VI discusses postattack operations and the use of the Disease Endemicity Factor to assist in the placement of control effort.

The functional plan and the operational plan are developed around three assumed categorical postattack conditions:

(1) Isolation of a community or region in the form of interruption of ingress and egress, utility services, and logistical supply;

(2) Areas affected by fallout; and

(3) Areas subjected to structural damage, with or without fallout.

Each of these three categories can be further classified into several degrees of severity; slight, moderate, and severe; however, a high degree of refinement in this regard is not considered justified in light of the present status of planned procedures.

The report continues with a consideration of the human disease incidence and assessment of postattack disease hazard in the United States. In Chapter VIII, the total operational requirements (manpower, equipment and material) for a one year postattack recovery operation is developed.

STATEMENT OF WORK

The contract provides that specific work and services include, but not necessarily be limited to, the following:

a. The Contractor shall gather, summarize and collate available data on sanitation, waste disposal, and pest and vector problems that could arise in the postattack period and develop data for the evaluation of the consequences of these problems for various postattack situations over various time periods.

b. The Contractor shall summarize and collate available data on proposed postattack procedures for sanitation, waste disposal, and pest and vector problems, develop methods for evaluating the effectiveness of the countermeasures; and establish methods for deriving the total operational requirement of these methods (including supplies, equipment, manpower, training, and other factors).

c. In performing a. and b. above, the Contractor shall first study selected locations in the country and selected ranges of postattack conditions and environments. The information from the local-type detailed studies will then be generalized to make evaluations for postattack conditions in large areas over the country after hypothetical nuclear war.

OBJECTIVES

(1) To determine the total operational requirement for post nuclear recovery.

(2) To evaluate the effectiveness of countermeasure procedures to be used in the event of a nuclear attack.

SCOPE

Postattack conditions may be favorable for a rapid increase in insect and rodent populations as a result of disruption of sanitary services and creation of extensive breeding and harborage areas Survivors may be exposed to endemic diseases capable of rapid development in an uncontrolled environment. The surviving population (including sanitation workers) may be confined to shelters for protection from radioactive fallout for many days during which time fecal material and other organic wastes may accumulate in the shelter or in the area adjacent thereto, resulting in hazard of exposure to the "filth" diseases. In communities experiencing blast and material damage, sewerage facilities may be damaged. Stoppages may occur so that sewage pours out of breaks and manholes, basements are flooded, and ponding occurs in natural depressions. There will be added during the time of sheltering, deposits of decomposable animal and vegetable refuse wastes from damaged food processing and storage facilities. Flies, mosquitoes, and other disease vectors may multiply rapidly as a result of cessation of controls and the creation of environmental conditions favorable to their growth. The transfer of disease carrying parasites to humans will be accelerated by the death or rodent hosts from injuries or radiation sickness.

This study is concerned with countermeasures to minimize the hazards to survivors in the postattack environment and includes the determination of material, equipment, and manpower requirements for the handling and disposal of decomposable animal and vegetable waste material and for the control of environmental disease vectors and their host.

Within the scope of this study, the terms "sanitation" and "sanitary services" are defined as environmental conditions and activities related to disease vectors, pests and solid organic wastes, including nightsoil. The study does not encompass food sanitation, shelter sanitation during the shelter period, water supply or water-carried sewage except to the extent that interruption of such sewerage services creates vector and pest problems and need for nightsoil collection and disposal.

A previous OCD contract study by Engineering-Science (OCD-OS-62-106) dealt with problems of damage to sources of potable water supplies, including treatment plants, due to nuclear attack. Because the most important disease category (enteric diseases) involved in this study has multiple modes of transmission which take in houseflies, nightsoil, water supply and delivery in general and piped sewage, need for a further study to take in missing elements is indicated. Additional test area studies might also take in further detailed exploration into community-wide spoilable food quantities and insecticide inventories.

METHODS OF STUDY

A comprehensive study of communicable diseases in the Continental United States related to environmental factors was performed. Fifty-one (51) separate diseases (including three strains of arthropod borne encephalitis) are considered, of which 14 are considered to be important and amenable in toto or to an important degree to environmental engineering control measures.

The present status of solid wastes disposal and pest and vector control measures in American cities was studied as a basis for predicting the consequences of a nuclear attack upon the environmental conditions that could contribute to the epidemic spread of any of the aforementioned 14 diseases. This portion of the study included the total operational requirements needed to perform the functions of environmental engineering under normal conditions.

To complete the review of present conditions, existing civil defense postattack planning and responsibility assignments of a few selected political subdivisions (states, counties, and cities) were analyzed from an environmental sanitation perspective.

Because of the nature of the various diseases, hosts, and vectors being considered in this study, it becomes apparent that the particular problems which people will encounter are importantly affected by the severity and types of conditions imposed by nuclear attack. Areas may be subject to a wide range of effects varying from simple isolation to complete devastation. To facilitate analysis of the postattack conditions, a series of probable situations of environmental engineering importance were chosen and results are presented in terms of these situations.

Considering the various postulated conditions, and the epidemiology and biology of the reservoir host-vector-disease relationships, a method for determination of manpower, equipment, supplies, and training needs is developed, and the operational procedures for the nation were determined. In addition, this requirement was compared to existing civil defense postattack plans to develop an evaluation of the relative preparedness.

CHAPTER II

NATIONWIDE ENVIRONMENTAL HEALTH

DISEASES OF THE ENVIRONMENT

The survival of individuals in a postattack period is dependent, in part, upon minimum exposure to environmental disease hazards. The existence of these hazards is affected by natural barriers, especially climatic conditions, by other environmental factors and by the measures of protection against infection that are applied either by the individual or by the community as a whole. Disease incidence will increase in a sporadic or epidemic form following a nuclear attack. The severity of potential epidemics will be a function of the degree to which suppression of vectors and host is accomplished in a postattack situation in those areas where disease reservoirs[1] are established or become established.

In the Continental United States, occurrence in man of the following diseases is known to be related to inadequate environmental sanitation:

Water, Fecal, or Food Borne

Amoebiasis
Ancylosotomiasis (Hookworm)
Ascariasis
Conjunctivitis, Acute Bacterial
Diphyllobothriasis
Echinococcosis
Food Poisoning, Staphylococcal
Hepatitis, Infectious
Keratoconjunctivitis, Epidemic
Salmonellosis
Shigellosis
Staphlococcal Infection
Trachoma
Tuberculosis
Typhoid Fever

Vector Borne

Colorado Tick Fever
Conjunctivitis, Acute
Dengue
Malaria
Mosquito Borne Encephalitides
 Eastern
 Western
 St. Louis
Pediculosis
Plague
Relapsing Fever, Tick Borne
Rickettsialpox
Rocky Mountain Spotted Fever
Scabies
C. Tularemia
Typhus Fever, Murine
Yellow Fever

Dust Borne

Blastomycosis, North American
Coccidioidomycosis
Cryptococcosis
Histoplasmosis
Q Fever
Sporotrichosis

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1. The term "disease reservoir" takes in human carriers and infectious cases

Zoonoses (with no significant arthropod vectors)

Anthrax
Brucellosis
Cat Scratch Fever
Glanders
Larva Migrans
Leptospirosis
Lymphocytic Choriomeningitis
Psittacosis
Rabies
Rat-Bite Fever
Ring-Worm
Strongyloidiasis
Taeniasis & Cysticercosis
Toxoplasmosis
Trickinosis

Consideration of present programs in environmental engineering and the overall impact of the various diseases on survivors of a nuclear attack leads to the conclusion that 14 of the diseases, as listed in Table I, are significant in this study.

DISEASES OF CONCERN FOLLOWING NUCLEAR ATTACK

The significant diseases that could become epidemic thus creating a problem in the postattack operations are divided into two groups, primary and secondary. In the secondary group, endemic diseases which are limited in geographic scope are marked (G), those which require importation from outside the Continental United States are marked (I).

TABLE I

DISEASES OF CONCERN UNDER POSTATTACK CONDITIONS

Diseases of Primary Significance

Shigellosis
Infectious Hepatitis
Salmonellosis
Typhoid
Amoebiasis
Encephalitides - Mosquito Borne
Rabies
Leptospirosis

Diseases of Secondary Nationwide Significance

Murine Typhus (G)
Plague (G)
Rocky Mountain Spotted Fever (G)
Dengue Fever (I)
Malaria (I)
Yellow Fever (I)

All of the enteric diseases listed are shown as having leading importance. This is due to the immediate, continued close contact of human survivors under primitive conditions. Several diseases of historic past importance in the United States are either not included or are placed low on the list, because of present total absence or extreme rarity in man and host. Since this study deals with the effects of the cessation of environmental health engineering control programs, many of the judgments which must be made are affected by the debilitating effects of the diseases upon the surviving population. An assessment of estimated disease attack rates in the absence of countermeasures is given later in Chapter VII.

Epidemiological information for the diseases considered in this study to have postattack significance is presented in Appendix A.

GEOGRAPHIC DISTRIBUTION OF DISEASES

The diseases deemed to be important in the postattack period can be grouped according to host, vector or both. A vector grouping, as distinguished from an individual disease classification, generally enhances the picture of aggregate disease hazard and of geographic scope. Table II, depicts this grouping and the number of states in which occurrences were recently reported in man or host. The number of cases reported is not considered to be significant in this study as normal control measures drastically restrict the disease rate. However, the fact that cases do occur is significant in that it does indicate that normal reservoirs are present and the disease could become epidemic in a post nuclear attack situation.

CLIMATIC AND SEASONAL CONSIDERATIONS

Climatic factors, especially temperature, precipitation and humidity, importantly affect the seasonal occurrence and geographic scope of some of the diseases listed in Tables I and II. The five enteric diseases in the primary list of Table I, however, are considered to be readily capable of epidemic occurrence at any season of the year throughout the Continental United States, irrespective of present or past endemic pattern. The same applies to rabies and leptospirosis. The remaining diseases tend to be seasonal in pattern as well as regional in distribution, chiefly through the effect of climate on vector populations and habits. Without particularizing on each individual disease in the latter category, it is noted that control measures for a particular disease problem may or may not be needed under postattack conditions in a given community or at a given time of year.

VECTOR AND HOST CONTROL METHODS

1. Rodents. Domestic rodent control is concerned with the control of the Norway rats, the roof rat, and the house mouse. It includes measures that are used to prevent the establishment of rodent infestation within our outside of buildings by environmental manipulation and by methods used to rapidly bring rodent populations under control.

Presently the greatest part of rodent control in the United States is by the creation of environmental obstacles which limit the access of the rodent population to harborage, food, and water. The use of poisons and trapping is resorted to whenever the environmental conditions are such that other control methods are not possible or effective.

The most commonly employed rodent poisons are the anti-coagulants, including warfarin, Pival, diphacinone, Fumarin, and PMP. Warfarin is the most commonly used. These poisons kill by causing internal hemorrhages following successive feedings on baited materials and take about two weeks to kill. They are safer to larger animals such as cats, dogs, and children mainly because they can vomit, but rodents can not. Anti-coagulants are preferred in those places where people live and work. Formulation strengths vary from 0.003% to 0.05%, depending upon the species of rodent and the poison being used. A median dosage concentration of 0.025% can destroy all species of domestic rodents. Cornmeal is the usual proprietary bait for these anti-coagulants. Where rodent food is readily available, cornmeal may not be attractive and it may be necessary to use a water formulation. Baited poisons are usually placed in protected bait stations.

TABLE II

VECTORS, DISEASES AND PRESENT EXTENT OF DISEASES[1]

Vector	Disease	Number of States of Diseases' Occurrence	Number of States Receptive to Diseases' but Non-Occurring
Flies & cockroaches	Shigellosis	49	
	Hepatitis	49	
	Salmonellosis	49	
	Typhoid	44	
	Amoebiasis	37	
Rodents	Murine Typhus	8	
	Plague		6-8
	Leptospirosis	36	
	Salmonellosis	49	
Mammals other than Rodents	Rabies		37
Mosquitoes	Encephalitis	29	
	Malaria		22
	Yellow Fever		9
	Dengue		9
Ticks	Rocky Mountain Spotted Fever	30	

1. Source: Communicable Disease Center, Public Health Service for 1962.

Sodium monofluoracetate (1080) is the most effective and rapid killing rodenticide, but is extremely hazardous to man and animals and for this reason is little used. It is especially useful where rat populations are heavy and hazard to pets and man is minor. It must always be used with special precautions by specially trained personnel, as no antidote is known.

Some agencies use other poisons, such as red squill, zinc phosphide, Antu, thallium sulfate, and others. Many use calcium cyanide dust for destroying rats in their burrows by its fumigating action.

When properly used, rat traps are very effective in reducing rat populations inside infested buildings. It is usually necessary to supplement traps with poison baits for serious rat infestations.

2. Rat Fleas. Because rat fleas are responsible for transmitting murine typhus and plague among rats and from rat to man and migrate to man from live and dead rats, specific rat flea control measures also may be carried out for human disease control, generally in conjunction with rodent control measures. Application of 5% or 10% powdered DDT in pyrophyllite dust along rat runs, entrances, and harborage areas has been found effective for rat flea control. This procedure requires an average of 2.5 lbs of DDT dust and 0.5 manhours for each infested property treated.

3. Houseflies.[1] The control of houseflies involves several approaches. Most basic is the deprivation of food supply or moisture, which means proper disposal and handling of nutrients such as garbage, animal and other organic wastes. This basic sanitation involves comprehensive programs of sewage disposal, garbage and trash disposal.

In the event of unsatisfactory environmental conditions such as the accumulation of feces and other organic waste in a postattack period when normal handling operations are suspended it becomes necessary for the prevention of fly breeding to use insecticides of various kinds. Larvicides for this purpose have limited usefulness under peacetime conditions and require large dosages to be effective. They find greatest use when applied to infested manures and garbage receptacles that cannot be easily removed, or that are removed infrequently. Materials most successful at present are some of the organophosphorous compounds, DDVP, Diazinon, Ronnel, and malathion. Adulticides most useful at the present time are the organophosphorous compounds and include fenthion, Diazinon, Naled, dimethoate, malathion, Ronnel, DDVP and Bayer 13/59. Space sprays provide temporary immediate control and are most useful in enclosed areas designed to exclude flies. Use of pressurized containers with suitable insecticide is the most common example. Bait sprays or granules and DDVP on resting strips (residual fumigant), are longer lasting and provide effective control in restricted areas. Residual sprays are most effective and economical for control in larger areas.

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1. The term Houseflies, as used in this entire report, refers to all species of domestic flies, that is, those flies capable of developing in household, industrial or agricultural wastes and are found attracted to human foods or body excretions. This would include flies, such as *Musca domestica* the common housefly; *Phaenicia* spp. the green bottle flies, *Sarcophaga* spp. the flesh flies; *Callitroga* spp. the screw-worm flies; *Calliphora* the blue blow fly; *Fannia* spp. lesser houseflies; *Muscina* spp. the false stable flies; *Drosophila melanogaster* the pomace fly.

Progress is being made in biological control methods, particularly in the development of compounds to induce sterility so that reproductive capacity is greatly reduced. Practical field use of this method is still several years away, however.

4. Mosquitoes. Mosquito control methods currently used involve source reduction procedures (both temporary and permanent), biological, and chemical control. Ideally, elimination of sources of breeding or change of ecology provides the most satisfactory control. Much work has been and is being done in this respect. Elimination or management of marginal salt marshes, drainage, and properly designed and constructed water carrying and storage structures are examples of past and current source reduction programs.

When water exists in stagnant ponds and containers which cannot be efficiently drained or modified, various insecticides may be used.

Larvicides are the most successful means of chemical control. Long-lived residual larvicides such as the halogenated hydrocarbons are a first choice if not contra-indicated by reasons of insecticide resistance or danger to people, wildlife, or domestic animals. Because of the growing insect resistance to some insecticides, organophosphorous insecticides are the ones most commonly used in chemical control of mosquito larvae. These include fenthion, parathion, methyl parathion, and malathion. Several new effective organophosphorous compounds will be available in the next few years. Two older materials are still very effective as larvicides--larvicidal oils (high in aromatic compounds), and Paris green. Both are widely used.

When larvicidal procedures have failed or are not practical, adulticides are useful. Effective adulticidal programs are costly and only partially effective, but are indicated when disease vector mosquitoes are problems. Pressurized container space sprays are useful in enclosed areas. Insecticides useful as adulticides are malathion, DDVP, and DDT.

When insecticide resistance is not a factor, DDT, Dieldren, and Lindane are excellent residual materials and may last for months. One organophosphorous compound, fenthion, provides residual activity up to several weeks. DDVP embedded in resin strips and used as a residual fumigant, can be effective against adult mosquitoes in interior spaces for up to six months. It is currently being used in catch basins, but has not yet been cleared for interiors of occupied buildings.

5. Ticks. Large scale control of Rocky Mountain Spotted Fever by destruction of the ticks or reservoir animals has not proved to be very successful. Land clearance, control of small rodents and the use of insecticides such as DDT, Lindane, and malathion may be useful for control of ticks in restricted local areas. If entrance into tick infected areas is required, reliance should be placed on the use of repellants such as diethyltoluamide or dimethylphthalate on clothing and prompt removal of ticks found on skin and clothing. In high risk areas it may be necessary to take appropriate vaccine for protection against the disease. Treating tick-infected dogs with insecticides may be helpful in reducing the number of ticks that may bite man.

DISEASE HAZARDS IN TERMS OF POSTATTACK ENVIRONMENT

Because many of the environmental diseases have multiple modes of transmission, it is necessary in the interest of providing perspective, to give some recognition to environmental health conditions and problems outside of the solid wastes and vector areas.

All three categories of response to nuclear attack, (isolation, fallout, material damage) will have an impact on existing sanitation services affecting enteric disease incidence. This impact will vary in degree between the three categories and within the categories themselves, depending on relative severity.

Enteric Diseases

The five enteric diseases of concern under postattack conditions (Amoebiasis, Infectious Hepatitis, Salmonellosis, Shigellosis, and Typhoid Fever) are considered as a group, because they have much in common in terms of the scope of this study. All are basically filth-borne diseases, with human infection taking place through various intermediate routes between the anus (and also the bladder in the case of typhoid fever) of an infected person and the mouth of a person receiving the infection. Hepatitis probably can be transmitted by another route as well.

The specific sanitation services which play a role in preventing enteric disease transmission and conversely, whose absence encourages transmission, are services involved in the:

(1) Production and delivery of potable water for drinking and for personal and household hygiene.

(2) Collection, modification or other safe disposal of body wastes, generally by the water carriage method.

(3) Collection, modification or other safe disposal of solid organic wastes serving as potential fly breeding media.

(4) Production, processing and delivery of solid and liquid foods under sanitary conditions.

(5) Domestic fly abatement measures supplementary to organic wastes sanitation services.

The actual incidence and rates of spread of these five diseases under adverse environmental conditions depends primarily on such factors as sanitary conditions, carrier rates, incubation periods, massiveness of infective dose, susceptibility of the surviving population and survival characteristics of the infective organism in nature. The principal transmission modes and incubation periods of the five listed enteric diseases are given in Appendix A.

Encephalitis

The environmental effect of nuclear attack on the incidence of mosquito-borne encephalitis will vary in different parts of the United States, depending on the habitat of the several mosquito species serving as vectors in different parts of the nation for the three strains of the disease. Because the principal mosquito vectors of Western and St. Louis encephalitis are more commonly found in the casual collections of polluted water which are expected to be commonly found in blast areas, these strains are expected to pose a substantially greater hazard than that of Eastern Equine Encephalitis with the problem reaching its greatest potentiality in California, but not limited to that state.

Rabies

Increased rabies hazard is likely to occur as a result of major increase in stray dog populations as a result of disruption of normal living conditions and food shortages; possible predation for food supply by stray dog packs on nearby wild animal life serving as a rabies reservoir; possible migration of surviving humans to areas frequented by bats, and lack of available rabies vaccine supply for dog and man. To an unknown degree, these hazards will be offset by dog mortality, due to the direct effects of nuclear attack.

Leptospirosis

The importance of environmental changes from nuclear attack on an increased prevalence of leptospirosis in man is essentially nationwide and is basically keyed to the existing substantial infection rate in domestic rats and to closer contact between rats and man which will develop due to disturbed living conditions. As burrowing animals and because of a degree of tolerance to irradiation, the fatality rate among rats from nuclear attack is expected to be lower than for other urban mammals, but still substantial, due to use of other harborages.

Rocky Mountain Spotted Fever

Environmental changes in urban areas due to nuclear attack are not expected to increase human tick-borne disease hazards, including Rocky Mountain Spotted Fever and Colorado Tick Fever. Such increased hazards, to the extent they develop, will be associated rather with population migration from damaged urban areas.

Plague and Murine Typhus

Increased hazard to man of plague and murine typhus infection as a result of nuclear attack is expected as a result of closer contact between man and domestic rodents due to disturbed shelter conditions for both; and as a result of movement of infected fleas from sick and dead rats to man. In the case of plague, these factors may be augmented by closer contact between domestic rats and infected fleas in wild rodent burrows in peripheral areas, following destruction of existing harborages of the domestic rats. The present geographic distribution of both diseases in rodent natural reservoirs in the United States indicates that the hazard under post nuclear attack conditions will be sharply limited. Plague is found in rodents west of 100° Meridian which passes through Eastern Texas and Western Kansas, whereas murine typhus is found in rodents in scattered foci in Southeastern U.S.A. and in Southern California.

Dengue Fever, Malaria and Yellow Fever

Dengue fever, malaria and yellow fever presently are neither endemic nor epidemic in the United States and the opportunity for them to become re-established following nuclear attack is basically dependent on importation of the infection by a human carrier in the infective stage into a receptive area under environmental conditions which would result in transmission of the infection by the mosquito vectors. The possibility of yellow fever becoming established following nuclear attack is considered remote. Malaria cases are imported into the United States each year and dengue cases are imported in those years when the disease is prevalent offshore, but neither disease has become established or re-established either endemically or epidemically by this route within the past 10 to 12 years. Environmental changes consisting of increased breeding places for malaria mosquitoes in the vicinity of communities as a result of changes in topography and disruption of drainage, and greater prevalence of dengue fever mosquitoes in some urban areas through increased use of man-made water-holding containers in a postattack environment, is a condition which must be evaluated in the postattack plan

CHAPTER III

ENVIRONMENTAL SANITATION MEASURES

The procedures for sanitation, waste disposal, rodent and pest and vector control is presented in two phases. The first phase considers the basic operations that are indicated in all parts of the United States at essentially all times of the year, although not at the same activity level under all conditions or seasons (solid wastes sanitation and rodent control). The second phase considers those operations that may be indicated by assessment of the environmental conditions and is expected to be influenced by conditions of the environment at the time.

BASIC MEASURES, RECURRENT OPERATIONS

Organic Wastes Management

The collection, transportation, and disposal of solid organic wastes from communities is one of the most important phases of environmental sanitation for the control of insects and rodents that may spread diseases. The kinds of organic wastes, methods of on-premise storage and manner by which wastes are disposed of will determine whether fly and rodent breeding and feeding in these media will become of public health concern.

Organic waste sources under Isolation Conditions will be those that existed prior to attack and will include residential, commercial, industrial, and agricultural activities within insect flight range of communities and the ambulatory range of domestic rodents. Under Fallout Conditions, in the initial postattack period the additional waste sources will be sheltered survivors, community-wide spoiled food and animal carcasses The pattern under Structural Damage Conditions with Fallout will simulate that for Fallout but with different values for the various waste sources.

Flies are controlled by removing breeding habitats (basic), or by killing the larvae or mature flies. Normally, control consists of sanitary sewage disposal and the collection of other solid organic wastes at least once weekly and disposal in such manner that fly eggs do not develop into adult flies. This may be accomplished by burying (sanitary landfill), burning (incinerators), offshore disposal at sea, depositing in open dumps at selected location adequately removed from surviving population, or in other ways. All of these measures require manpower, equipment and supplies.

Under some climatic conditions, collection of solid organic wastes in the postattack period under either Fallout or Structural Damage, necessarily can and must be largely deferred, thus providing a time lag for improved logistical capability. Deferral could last several months, as in the case of urban areas in all or part of some Canadian boundary states with frozen wastes in December concealed by snow cover; however, a period of up to a week might be acceptable in much of the United States during the colder season of the year.

Essentially the operation can be divided into two elements: collection and disposal.

1. Collection

Production of residential organic waste, such as garbage, will be substantially reduced below the pre-attack quantities under Fallout and Structural Damage Conditions, but can be unchanged under Slight and Moderate Isolation conditions. The quantity of paper wastes that constitute a large portion of peacetime refuse should be enormously reduced under the more adverse Postattack Conditions. Furthermore, such paper material should not require collection in the early postattack period except when it is integrally mixed with putrescible organic materials.

The handling of feces (nightsoil) from the population sheltered under Fallout conditions, where the normal sewerage system does not continue to adequately dispose of such sewage material, is of primary concern as it presents a source of infection for the filth diseases. In addition, where fallout and material damage results in death to exposed animals and people, there will be animal carcasses and human bodies which present a threat of fly breeding and rodent food. Nightsoil production is likely to continue under some structural damage conditions for a substantial length of time in the postattack period, the early collection of human feces is especially important because of the danger of exposure of survivors to fly-borne infection where flies have access to such fecal material. The early collection and sanitary disposal of animal carcasses is indicated to prevent heavy fly production.

The actual collecting can be conducted entirely by unskilled help, but dispatchers or supervisors organizing local operations are needed. The collection operation must also have mechanics to keep the equipment functioning. Lastly, sufficient fuel must be provided for vehicles.

Further discussion and data on solid wastes collection appears later in this report.

2. Disposal

Sanitary Landfill

The most common and most convenient method of solid organics disposal (other than by grinding and disposal into sewers) is the sanitary landfill; if properly planned and operated it can serve hundreds of thousands of people in a metropolitan area.

Crawler tractors with bulldozer blades are the primary equipment used for handling community refuse at landfill sites. These usually weigh about 35,000 pounds and are used for scraping earthfill, moving and compacting refuse, and finishing the cells of refuse. If soil conditions are suitable a tractor can be operated by an operator-supervisor and two unskilled helpers. (One man on a bulldozer can handle from 250 - 300 tons per 8-hour day). The helpers will direct truck traffic and keep the dozer oiled, fueled, and operating.

Incineration

An undetermined number of municipalities in the United States use incinerators. (The last national survey in 1951 indicated that at least 120 cities were using incinerators). Some urban areas with air pollution problems are abandoning them and other expanding metropolitan areas are losing disposal sites and are compelled to build incinerators. The capacity of municipal incinerators varies considerably but they are usually from 75 to 400 tons capacity per 24 hours, requiring 2 to 4 men per shift.

This method of disposal may require fuel to start the refuse oxidation and to maintain it if the paper content is low. The fuel may be gas, oil or any burnable petroleum derivative. If the fuel source is cut off the operation will stop; therefore two alternatives exist. One is to stockpile fuel for the operation of the incinerator. The other is to pre-plan and stock supplies for the operation of nearby dumpsites.

Open Dumpsite

Some communities dispose of solid organic wastes in open dumps. These dumps are generally located a considerable distance from any populated area and are provided with fly and rodent control. The continued operation of these or other like dumps that may be established after postattack will require increased fly and rodent control measures under a condition where the material so dumped contains wastes such as nightsoil and especially where material damage results in greater exposure of surviving population to flies and rodents.

After a nuclear attack it is possible that landfill equipment may fail, that the landfills will degenerate to open dumps and that incinerators will be inoperative. For this reason it is essential that supplies be kept on hand so that the dumpsite personnel may spray the waste daily with 14 ounces 25% Diazinon Emulsion concentrate per 1,000 square feet (fly larval control) or with alternative insecticides to keep the fly population under control. It will also be necessary to stock the dumps with traps and poisons to control rats.

Ocean Disposal of Garbage

This method of garbage disposal, once popular in several large seaport cities generally has been abandoned. The garbage is barged about 20 miles out to sea and dumped. Often times the garbage and papers would be carried back by currents to land resulting in insanitary conditions on the beaches. Some food industries grind their garbage into swill and then barge the swill out to sea.

Composting

Several communities have large aerobic compost plants and the same plants salvage tin cans, metals, cardboard, and bottles from municipal refuse. Their capacities vary from 50 to several hundred tons daily capacity. Under proper conditions, the compost will not support flies or rodents.

Mosquito Control

Recurrent mosquito control operations should be assigned a secondary status to those of solid wastes sanitation and emergency housefly control in the absence of indigenous dengue, malaria, and yellow fever, and mosquito-borne encephalitis. Where mosquito control resources remain locally available under postattack conditions, their diversion to assist in emergency phases of solid wastes sanitation, direct housefly control measures and, under some local and state civil defense plans, in decontamination work, is generally indicated. Mosquito control work would be resumed either after environmental and supply conditions become more normal (or as actual transmission of mosquito-borne disease appears) with much of the activity seasonal in character.

Rodent Control

In the postattack environment, the governmental program may well increase due to lessened commercial operations. Also, citizen participation is contemplated, so it is proposed to establish decentralized supply stations where persons may obtain rat poisons for their own use. Anti-coagulants and traps are recommended for indoor use because of their low hazard to humans.

In areas where prevailing rodent populations are low to moderate in density, no serious problem should develop for several months, since the reproductive cycle of rodents is relatively long compared to that of insects. Re-establishment of recurrent control measures may be phased accordingly, as well as in proportion to the severity of the isolation and/or fallout condition with respect to over-all resources. Different sets of conditions than these are covered in the next section dealing with Special Operations.

However, some stockpiling of supplies is necessary for use during time there is a break in supply chain. Shelf-life and extent of normal availability are significant factors in selecting materials for stockpiling.

SPECIAL MEASURES, NON-RECURRENT OPERATIONS

If fallout or structural damage occurs during or after a nuclear attack it will be necessary to assess the condition and adopt the appropriate operations. Special vector control operations are also indicated under special vector-borne disease conditions, special rodent conditions, and seasonal conditions.

In some metropolitan areas under peacetime conditions, the problem of rats biting sleeping infants is of more concern to health departments than are rodent-borne diseases. Under shelter conditions, areas with heavy rat populations could have a greatly increased problem of this type and could subsequently have major losses of scarce food supplies, both warranting special measures. Special conditions consisting of prevailing or newly introduced vector-borne disease incidence in a local area, would warrant undertaking special measures during post-shelter periods which are not directly provided for under recurrent operations plans. Special consideration will need be given to possible rodent harborages in or near shelters and the likelihood of migrating rodents entering the shelter area.

(1) Organic Wastes Cleanup

The removal of accumulated organic wastes should be started promptly when the population first leaves the shelters. This accumulated material will comprise:

(a) Food Residues from Shelter Occupancy (Essentially nil in public shelters).
(b) Excreta accumulations from Shelter Occupancy.
(c) Small animal carcasses.
(d) Large animal carcasses.
(e) Spoiled food in commercial and industrial establishments.

Special burial details that may be necessary for corpses are not a part of this operation. In addition to these non-recurrent accumulated items, generation of organic refuse by survivors will commence immediately at a low-level rate on a continuing basis. These accumulated materials will vary greatly in quantity and public health importance, with the disposal of excreta being of primary importance. While transportation of excreta to a mass disposal site will be preferable, under exigency conditions it can be buried in the nearest unpaved site by pick and shovel or traxcavator.

Except in urban areas with large stockyards or adjacent feed lots where large animal carcasses or large cage-type poultry establishments may be a major problem, the largest quantity of debris is expected to comprise spoiled perishable food (refrigerated food and perishable produce) from commercial and industrial establishments. Such food will not only serve as food supply for domestic rodents, but also as a production medium for houseflies, whereas the animal carcasses should not present a housefly problem, but rather a non-biting non-vectorial blowfly problem.

(2) Fly & Mosquito Adulticiding

If ambient temperatures are above 60°F, in many areas it will be necessary, following the shelter period, to conduct a single space-spraying of the entire area either by air or by fogging-vehicles. This treatment should materially reduce the adult domestic fly and mosquito populations. Where warranted by vector-borne disease incidence and species population levels, a special hand larviciding procedure should be immediately implemented. In addition to the adulticiding, trained vector control operators in light vehicles should go directly to known major sources of mosquito and fly production and conduct special programs using granules, fossits and sprays where necessary to stop the next generation. The activities described under this heading could be short-term, or continuing, depending on a more thorough assessment of the problem.

In some cases, depending on vector species and breeding habitat, selective control measures can be carried out which may materially reduce logistical requirements. Among these are residual contact sprays to control dengue fever, yellow fever, malaria, and encephalitis mosquito vectors and residual fumigants and baits for control of adult flies. However, because these tend to be special situations, logistical requirements in succeeding sections have been set up on a "typical project" basis in order to more fully provide for needs.

(3) Structural Damage

Using a fallout without structural damage postattack condition on the preceding page as a baseline, added sanitary problems which will be created by structural damage will depend largely on degree and extent of damage. In the event piped sewerage systems are made inoperative in areas inhabited by survivors, a continuing excreta disposal problem will develop in addition to the shelter accumulations. As an emergency expedient, public pit latrines with earth cover after they become filled is probably the most practical solution if the damage is extensive, but may be found difficult in some locations where exposed soil surfaces are largely lacking.

In areas where damage is not so great as to cause total abandonment, it is likely to be important enough to require an all-out early effort to remove debris blocking main transportation arteries. An acute sanitation problem would be presented by mass accumulations of spoiled food at commercial and industrial establishments and by exposed feed supplies, little or none of which in collapsed structures would be adequately coped with during the early effort period. Partial relief might be realized by setting fire to the rubble, with or without the aid of auxiliary fuel (including used tire casings and waste motor oil), where the conflagration could be confined to unoccupied areas.

During the early effort period and subsequently to a lesser extent, it is difficult to conceive as practical, any attempt to separate spent organic debris from inorganic debris in large masses of rubble. During the early effort period, small quantities of organic debris would be mixed with debris from thoroughfare blockages, principally animal carcass. These would not impose any mass accumulation problem at rubble disposal sites and would be ignored from a sanitation standpoint. However, in any continuing major rubble removal operation, mixed organic and inorganic debris containing mass accumulations of organics in rubble should be segregated from run-of-the-mill debris. Where feasible, the most practical disposal methods to limit housefly and rodent problems in such material would be: (1) burning (where combustible content is adequate), (2) extra-distance hauling (2 or 3 additional miles), (3) dumping in bodies of water not used as potable water supplies and (4) deep fills to limit surface exposure or to simplify placement of 2 feet of compacted earth cover.

No logistical estimates have been developed for these added postattack structural damage conditions in this study because of the multi-purpose nature of the remedial actions and the great variability of conditions. On the other hand, detailed logistical estimates have been developed for removal of spoiled food under post-fallout conditions and from damaged buildings which are reusable after repair and in which the rubble content of the refuse is modest compared with that in more severely damaged structures.

In terms of solid wastes sanitation, this means that specialized refuse collection services and their vehicles will tend to serve inhabited areas which are undamaged or lightly damaged, and in some cases, for carcass collection. Depending on climatic factors at the time, there may be much need for emergency chemical control measures to control housefly populations in habitated areas and at the disposal sites for organic wastes and for the mixed debris. Depending on the condition and available resources, these might include adulticiding by space spraying (airplane or power sprayer), on a weekly basis for adult fly control, residual sprays and/or baits for adult fly control, and treatment of disposal sites for larval control.

Uninhabited areas which have been abandoned either temporarily or for a longer time period, and which have peripheral inhabited areas, should be sealed off insofar as practicable with respect to migrating animal life, especially domestic rodents and dogs. Guards with shotguns and use of quick killing and more hazardous chemicals for rodent control (such as Compound 1080), will be useful. Where the peripheral human population is nearby and houseflies in the damaged areas are very numerous, space spraying by airplane may be indicated.

CHAPTER IV

ORGANIZATIONAL ASPECTS OF COUNTERMEASURE OPERATIONS

This study is nationwide in scope, with the ultimate objective of developing assessment of various postattack conditions in large populated areas over the country after hypothetical nuclear wars and evaluations of available countermeasures. To reduce consideration to a practical scale, the study deals with urban complexes of 100,000 population or some multiple thereof. Such complexes are encountered in the United States in the form of individual cities, metropolitan areas composed of a central city girdled by satellite cities with or without unincorporated suburban areas, or a central city with only unincorporated suburban areas.

Although the metropolitan area complex is used for study, it is not implied that responsibility for carrying out the sanitation countermeasures involved in this study should be vested in a single local general government or a single department of government. Rather, because of the variety of organizational conditions, the concept of adopting the metropolitan area as the "study unit" generally should be applied in terms of organization limiting responsibility at the metropolitan area level to general program coordination including mutual aid. Such general coordination can best be realized through civil defense, health department and public works organizations at the county level where the metropolitan area is contained within a single county, or at the regional and/or state levels where the metropolitan area is composed of more than one county or is located in more than one state. For intrastate situations involving more than one county, the choice between the regional and the state level will largely be based on the presence or absence of appropriate regional organizations and their degree of development.

ORGANIZATIONAL PATTERNS FOR ENVIRONMENTAL SANITATION MEASURES

There is shown here the "usual" prevailing functional pattern of different local organizations and groups, as well as brief mention of certain "atypical" situations, together with a brief review of the functional role of health agencies, local, regional, and state. At present, direction of local environmental services in an area may be provided either by separate city and county health departments, by a combined city-county health department, or by a district health department serving several counties including some or all of the cities located within them. An individual city health department may carry out its environmental engineering and sanitation functions through a centralized staff or through decentralized health centers in the city with sanitation personnel under medical direction. Such sanitation services generally are supplemented by a centralized environmental health engineering staff which handles the more technical matters. For purposes of this discussion, the term "local health department" applies to any health department service rendered at the local level, irrespective of organizational structure. It is noted, however, that these structural differences have substantial bearing on any organizational plan for metropolitan area countermeasures.

It is further noted that, under prevailing low peacetime levels of environmental disease, the role of health departments at all levels of government in this area of public health is largely one of community leadership in evaluating and assessing sanitation conditions and in achieving problem correction and satisfaction of needs by other governmental agencies and private individuals through persuasive processes, supplemented at times by ordinance enforcement through legal action. Under these conditions, the "typical" local health department is seldom engaged in direct operations (utilities service and direct vector control operations). One basic reason for this is the relative adequacy of sanitation services in terms of prevailing environmental disease levels, as provided by other local governmental agencies, commercial enterprises, and individual citizens.

While it is desirable that the prevailing organizational pattern of sanitation services is maintained as far as possible under post nuclear attack conditions in order to more readily utilize available local resources, it is also noted that health departments in the United States and elsewhere have historically carried out direct operations for environmental disease control under emergency conditions (such as urban human plague), or under high endemic disease levels (such as those posed by malaria and murine typhus fever in earlier years). It is also noted that many local health department staffs (backstopped by regional and state health departments), have the technical capability of directing the more specialized fly and vector control operations (as distinguished from utilities service), under emergency conditions. For this reason, the local health department often may be given a backstopping role in some operational activities, in connection with developing organizational plans to meet emergency conditions.

In the following organizational listings by function, recognition is given to mosquito abatement and other vector control organizations. Because these organizations, and their functions, are less well known than local health and public works departments, brief mention is made of them. Such organizations are found in only about a dozen states and are extensively organized in only five states (California, Florida, New Jersey, Illinois and Utah). All of these districts are self-contained "operating" type organizations, engaged in direct vector control operations. Principally concerned with mosquito control by source reduction measures and by application of chemicals, some also carry on housefly and gnat control and in one major state, operation of sanitary landfills. All of them in general, have the technical capability, and much of the resources, to carry out tactical operations against any disease vector.

ENVIRONMENTAL SANITATION OPERATIONS

Usual Prevailing Control Pattern

Local Health Department

Evaluates and assesses problems and needs in terms of disease incidence and of disease hazards in terms of epidemic intelligence, vector populations, and general sanitary conditions. Possesses capacility of evaluating effectiveness of control measures. These responsibilities should be assigned to such personnel under post nuclear attack conditions in nearly all cases.

City Public Works Department (or Equivalent Name)

Customarily responsible for refuse collection and disposal and for construction and maintenance of drainage in cities. Such activities occasionally extend beyond city limits, and should usually be responsible for these functions under post nuclear attack conditions.

City Building Department

Generally plays secondary role in urban rodent control (ratproofing) in connection with issuing building permits for new construction and alterations. Effectiveness widely variable Continuation of these functions where exercised, are indicated in recovery stage of post nuclear attack.

Mosquito Abatement District (MAD)

Generally concerned with vector control operations (chiefly mosquitoes) in large areas, to protect population concentrations. Depending on problem and presence or absence of other local operating agencies, may carry on municipal mosquito control as well. Mosquito Abatement Districts also perform vector evaluation and assessment functions for operations control previously listed under "Local Health Department" within MAD jurisdictional areas. MAD's provide an available local operational resource for all direct vector control activities (including housefly control) and not merely for the specific vector control operations they may happen to be carrying on.

Pest Control Operators (PCO's) (Commercial Enterprise)

Perform much of the recurrent chemical application work in buildings and premises for control of domestic rodents, cockroaches, fleas and miscellaneous insects, paid for by private citizens, with the remaining, generally greater portion, plus rodent trapping, performed directly by citizens. To a much more limited degree, PCO's perform specialized minor building repair and alteration work for rat stoppage and for on-premises sanitary storage of refuse and food supplies attractive to rats.

Depending on the nuclear attack condition, PCO's could be relied on for continuation without interruption provided chemical supplies are available; on the other hand their operations could be completely disrupted with gradual recovery during postattack period. Dependence should be placed on this resource to the extent possible, with local governmental operation by health department or abatement district staff on a mass area basis indicated during period of disruption if urgently needed because of high rodent populations and/or rodent-borne disease.

Private Agricultural Pest Control Operators (Crop Dusters)

Operate primarily in rural agricultural areas. Operators generally knowledgeable in vector control operation and especially in the handling of toxic chemicals. Material and equipment should be considered available for the highest priority needs.

Private Refuse Collectors (Commercial Enterprise)

Mainly operate in suburban areas of metropolitan complexes, on a monthly service charge basis paid by customers. Private collectors often are required by health department to use approved city operated sanitary landfills.

Agricultural Agencies

State agricultural departments through local or regional staffs are generally responsible for some aspect of food inspection and control, often involving elements of food sanitation, including rodents and flies, in urban areas as well as elsewhere. Agricultural extension and soil conservation services through local offices may be involved within metropolitan areas in giving technical advice on manure disposal (fly breeding source) at dairies and chicken and hog farms. In general, services by agricultural agencies in these fields are analogous to peacetime health department functions with respect to these sanitation elements, but are less comprehensive. Under post nuclear attack conditions, the role of agricultural agencies in solid organic waste sanitation and vector control is considered secondary and outside of the sphere of direct operations.

Private Citizen Participation

A very large, but unmeasurable amount of activities in solid organic wastes sanitation and direct vector control is carried on during peacetime throughout all cities by private citizens. These activities include general premises sanitation, especially garbage sanitation, rodent trapping and application of chemicals for rodent, housefly, cockroach and flea control. These activities may be motivated by public educational activities, including persuasive and regulatory activities of health departments.

Under post nuclear attack conditions, the resources of private citizens should not be overlooked and should be used. This resource, however, has distinct limitations in coping with mass area problems and in the effective application of vector control chemicals.

Public Health Service (USDHEW)

At present, this federal public health agency is initiating an operational program for the species eradication of *Aedes aegypti*, the mosquito vector of dengue and yellow fever, in the ten states of its occurrence plus Puerto Rico and the Virgin Islands. Current operations (1964) are in two states plus the two outlying areas.

This operational program will be carried on by area supervisors at the local project level under state health department management and will involve premises sanitation and residual spraying to kill *Aedes aegypti* larvae and adults.

In the event of nuclear attack, there will be available on this program supplies of vehicles, power sprayers and insecticides (DDT and malathion) for local area vector control in the *Aedes aegypti* "positive" areas. Hopefully, this vector of dengue and yellow fever will be eradicated from the Continental United States within the next several years. The program has already furnished emergency aid to Houston, Texas for epidemic encephalitis control.

Atypical Variations in Control Pattern

Health Departments

Occasionally, health departments may directly perform vector control operations analogous to those cited previously under mosquito abatement districts, and domestic rodent control operations in urban areas. Formerly quite extensive, these health department activities have tended to disappear with decline in peacetime disease incidence.

The presence of a "housing" program in local health department in the interest of general housing hygience, also has significant bearing on the adequacy of premises inspection in the interest of garbage storage sanitation and rodent control. In general, fully adequate housing programs in local health departments are atypical.

County Governments

Within the scope of this study, county governments (other than the health departments and mosquito abatement districts), are sometimes involved in drainage construction and maintenance programs having vector abatement significance and in the operation of county refuse collection and/or disposal services, either on a county wide basis outside of incorporated municipalities, or in special sanitary districts.

Continuation of these functions, where exercised, is indicated under post nuclear attack conditions.

Private Refuse Collection Services

While the characteristic pattern is for local government to provide public refuse collection services in incorporated municipalities, this does not follow for unincorporated areas where many areas are served by private collectors. Basic refuse collection service where provided by private collectors usually operates under regulation and direction making such resource equally available to that of a public operation in time of disaster.

Continuation of this arrangement, where it is in effect, is indicated under post nuclear attack conditions.

ASSIGNMENT OF RESPONSIBILITIES

Responsibility for determining the phasing and priority of specific environmental control measures where indicated on a basis of disease incidence postattack is now clearly that of the health department at the local or state level or both.

Responsibility for determining such phasing and priority on a basis of environmental sanitation is the responsibility of state or local health departments, as applicable and as called for in state and local civil defense plans developed in consultation with health agencies and mosquito abatement districts. On the other hand the actual postattack operations are to be performed by local operating agencies or commercial enterprise groups themselves.

The environmental sanitation control plan should provide a comprehensive program plan covering the following considerations:

PROGRAM OPERATIONS

1. Federal Activities

Pre-attack

a. Research and development of environmental health control technology applicable to disaster circumstances which will include special tools, equipment, material, and insecticidal formulations. (Such R and D work also takes in private enterprise (pesticide materials and equipment manufacturers and universities).

b. Provide adequate funds for program development for environmental health control disaster planning consultation and training at State and Area levels.

Postattack

a. Provide nationwide epidemiological intelligence to State governments.
b. Coordinate movement of manpower and supplies to especially hard-hit states where indicated.

2. State Activities

Pre-attack

a. Provide direction training and guidance to regional (Area) level, covering programming and technology of disaster activities.

b. Provide training staff and equipment to regional (Area) level.

c. Provide master Statewide plan as guideline for local plan development.

Postattack

a. Provide epidemiological information to regional (Area) and local level and if epidemics or vector build-up occurs; coordinate movement of personnel and equipment to those regions as needed.

b. Coordinate movement of manpower and equipment to hard-hit regions where strengthening of local resources is indicated.

3. Regional (Area) Level

Pre-attack

a. Provide direction and guidance to local levels in plan development.
b. Provide training services to local levels.

Postattack

a. Coordinate the movement of personnel, equipment, and supplies to buttress program in hard-hit local areas where recovery has been slow.

b. Direct control activities of extremely hard-hit areas where local plans are not effectively implemented.

4. Local Level

Pre-attack

a. Develop plan. Locate and establish necessary inventory of manpower, supplies and equipment in the event of nuclear attack.

b. Conduct needed training activities and assign functional responsibilities.

Postattack

a. Carry out Damage Assessment and Program Operation including waste disposal, fly control, mosquito control, rodent, pest and other vector control as conditions indicate need for.

b. Integrate requested assistance from Regional (Area) level as necessary.

A time-phased schedule for these postattack sanitation operations follows. Except for the initiation of adult housefly (and mosquito where indicated) control by chemical measures to the extent found feasible before general exodus from shelters, "D" Day would make the onset of other operations (D+0).

Phase I (D+0 to D+7)

Collection and disposal of shelter nightsoil and of accumulated organic refuse would be initiated at this time as outlined in Chapter VI, with Phase I completed within seven days. The nightsoil element would have highest priority where competition existed, with need for carrying it out contingent on lack of opportunity for water-carriage disposal at shelter sites. Essentially, the nightsoil operations are considered needed under all Structural Damage Conditions and under Fallout conditions requiring an extended shelter period; the other refuse sanitation activities under both Fallout and Structural Damage Conditions.

Housefly adulticiding would be continued to the extent indicated by fly populations.

Phase II (D+8 Initiation)

Phase II would be initiated not longer than eight days after Phase I and is predicated on the completion of the emergency need for the collection and disposal of nightsoil and accumulated refuse in Phase I.

Under Fallout Conditions, it is anticipated that housefly adulticiding would terminate or be materially reduced by the end of Phase I and that collection and disposal of solid organic wastes from households and commercial establishments would revert to a subnormal rate due to low paper content, limited food supply and emphasis on concentrated and otherwise prepared foods.

Under Structural Damage Conditions, continuing housefly adulticiding would be needed during the fly production season due to solid organics in unremoved rubble. Low-level collection and disposal of organic-content household and commercial refuse would be carried on as indicated for Fallout, but limited to occupied structures. As an activity outside of the content of this report, general rubble removal would be carried out at an unpredicted rate.

In communities where assessment of disease hazard indicates mosquito larva control would be initiated not later than the end of Phase I with the activity contingent on season and on the epidemiological criteria given in Chapter VII, under either Fallout or Structural Damage Conditions.

Under either Fallout or Structural Damage Conditions, emergency rat-killing measures and the killing of stray dogs would be initiated at some time within Phase II, dependent on severity of problem and community resources. Under exceptional conditions, based on epidemiological criteria (Chapter VII), rodent ectoparasite control would be initiated.

Phase III (D+31 to D+365)

During this phase, there would be a return toward normal conditions; rapidly under Fallout Conditions, slowly under severe Structural Damage Conditions, with the impact of these conditions on a community being related to their national and regional as well as their local extent and severity.

Per capita quantities or organic-content refuse would revert toward normal levels from Phase II sublevels. Under Structural Damage Conditions, much of the rubble containing organics would be removed from rehabilitable areas and most of the organics in unrehabilitable areas will have been converted into humus with consequent lessening of housefly and rodent problems. Logistical resources, including fuel and repair parts for vehicular equipment should revert toward normal supply levels.

Early during Phase III, comprehensive and systematic rodent control measures would supplant the stop-gap measures and the stray dog problem would diminish toward normal levels.

Under Fallout Conditions, special need for housefly adulticiding should terminate by the end of Phase II, with a continuing need under Structural Damage Conditions extending into Phase III and with phaseout during Phase III depending on severity of local damage, rubble cleanup rate and season of year.

Under either Fallout or Structural Damage Conditions, the general status of mosquito control and rodent ectoparasite control in Phase III would be as indicated by epidemiological assessment of current disease hazard.

The postattack sanitation operations, as presented, do not have as a part thereof radiological decontamination. The radiological decontamination is expected to be a separate staffed and equipped operation. Nevertheless the sanitation procedures as applied will take into consideration the entry time and stay time in the scheduling of personnel. The handling of inorganic debris will also importantly influence the sanitation operations in areas of material damage.

CHAPTER V

ANALYSIS OF POSTATTACK - LOGISTICAL REQUIREMENTS

PEACETIME OPERATIONS

The peacetime requirements of solid organic wastes sanitation and vector control operations are discussed and presented herein as a reference frame for these needs under postattack conditions. To the extent practical, they are given as ranges and as averages (typical).

Solid Organic Wastes

More data are available on the supply, equipment and manpower requirements of urban refuse collection and disposal than on any other control operation considered in this study. Numerous studies and other data collecting activities have been carried out by the American Public Works Association, public health agencies, university investigators, and others as indicated in the attached reference list.

The logistical requirements of refuse collection and disposal operations are affected by several primary variables, among them being quantity of refuse generated, frequency of collection, length of haul, method of disposal, and types of vehicles and earth-moving equipment used, including their capacities. Some basic values are listed in Tables III to V.

For perspective, the term "refuse" requires definition because of its many possible different meanings. Solid wastes collection in municipalities can consist of garbage (putrescible animal and vegetable wastes from food handling, with limited non-putrescible content),(household refuse other than garbage which can be placed in garbage cans of 20 to 30 gallons capacity), commercial and industrial solid wastes and refuse other than swill, domestic rubbish and trash and rubble from domestic and non-domestic sources. Collection from residential, commercial and industrial premises may be separate or combined with respect to type of waste and type of premises. Depending on whether the collection service performed by an areawide operation is comprehensive or specialized, per capita quantities of solid wastes can vary over a wide range.

Although solid wastes of all categories possess nuisance characteristics of one type or another, our attention is focused on those organic constituents which are readily putrescible and which may serve as production media for houseflies and as food supply for domestic rodents, primarily sewage,garbage, and commercial swill. The values for this refuse shown in Table IV are for combined domestic refuse (contents of 20 to 30 gallon garbage cans under a combined refuse collection service), plus variable provision in cited values for container-collected general commercial refuse which may or may not include commercial swill. This is necessary in using published data because combined refuse collection is the prevailing mode of collection for garbage cans and commercial refuse containers. Rubbish is generally collected as a separate operation from combined domestic refuse collection. Total rubbish includes junk, ashes, street sweepings, grass, leaves, brush, construction rubble, etc., and is not considered appropriate for postattack sanitation baseline considerations. On a basis of total solid waste (not including sewage) the putrescible material considered here as refuse represents an estimated 40% of the total rubbish.

Combined Domestic Refuse Collection

Following Table III, data sheets and a list of references are supplied as documentation supporting the Table III detail. In reviewing that portion of the data based on experience of some years ago, we have taken into consideration the fact that the per capita quantity of residential garbage has been declining for many years, due to changes in diet and increased use of prepared foods. In some communities the quantity collected has been further reduced by use of home garbage grinders. On the other hand, the quantity of paper products in garbage and more particularly in combined refuse and rubbish has been increasing. The per capita ranges listed are based on published reports involving many variables. The values given in Table III are for population units of 100,000.

Refuse Collection and Disposal Under Average Peacetime Conditions

Since covered landfills are a common disposal method under peacetime conditions and would find greatly increased application under postattack emergency conditions due to simpler logistical requirements, flexibility in capacity and use of public parks and blast areas as emergency disposal sites, this disposal method has been selected for use in Table IV.

Since cities tend to use specialized vehicles (compactor and Dempster types etc.) in the collection of combined refuse from residential and commercial containers, whereas the collection of miscellaneous rubbish and street sweepings, etc. (essentially non-putrescible), commonly entails use of multi-purpose vehicles for hauling debris to dumps. Tables IV and V have been prepared on the basis of such specialized equipment in the calculation of truck and manpower requirements.

Nightsoil (Feces) Collection and Disposal

Nightsoil collection and disposal were formerly carried on by many United States municipalities when open-back privies were in relatively widespread use, but recent data on the logistics of this operation are lacking and are not included in Table IV as an element of the logistics of municipal refuse collection and disposal. For this reason, basic data on nightsoil must be developed by other procedures for logistical purposes.

Rodent Control

Under peacetime conditions less than 10% of rodent control in the United States is carried out by governmental agencies. Normally, commercial establishments subject to rodent infestations hire private pest control operators to exterminate rodents and insects which are nuisances to their operations and/or to "build" rats out of buildings. The logistical information presented in Table VI is a composite of the public and private efforts in such programs.

Mosquito Control

Mosquito control operation in the United States generally utilize the following methods:

a) Eliminating or otherwise changing the breeding habitat;
b) Killing mosquito larvae with chemicals (larviciding), and in some cases with mosquito fish;
c) Killing adult mosquitoes with chemicals (adulticiding).

TABLE III

COMBINED REFUSE DISPOSAL VALUES GENERATED IN URBAN POPULATIONS

	Range	Representative Value
1. Per Capita Production Combined Refuse (lbs/day)	1.0 to 4.0	2.3
2. Monthly Variation-Combined Refuse	70% to 150%	86% to 116%
3. Per Capita Production Garbage (lbs/day)	0.2 to 0.9	0.4
4. Monthly Variation-Garbage Production	50% to 200%	80% to 125%
5. Per Capita Production Total Solid Community Wastes (lbs/day) (Combined Rubbish)	1.35- 4.6	3.9
6. Commercial Refuse (lbs/establishment/day)	N.A.	250
7. Lbs/capita-day of Commercial Refuse	N.A.	0.5
8. Net Residential Container Refuse	N.A.	1.4
9. Density (lbs/cu yd)		
(a) Commercial Refuse		150
(b) Residential-Combined Container Refuse		370
(c) Residential-Garbage		1,000
10. Compacted Density-Residential Combined Contained Refuse (lbs cu yd)		480

FOOTNOTES, LINE ITEMS

Line Item 1 and Line Item 3 - See Data Sheet on following page.

2 - Value based on Chicago, Los Angeles, Philadelphia, Kansas City.

4 - Garbage prod. is subject to wide seasonal variation (low in winter, high in summer). The representative value is for Washington, D.C. residential garbage.

5 - This value includes rubbish and street sweepings based mainly on 1955 data for 85 cities in Table 4, Ref. No. 8.

6 - From Table 6, Ref. No. 1. Aver. 8 Calif. cities in study 1950-51.

7 - Based on 5% commercial services of total services (Ref. No. 10) and 3.5 Persons/residential service.

8 - Approximation of non-garbage content of residential containers, based on municipal wide combined container refuse less Line Items 3 and 7.

9 - (a), (b), and (c). Commercial value based on Table 6, Ref. No. 1. Residential combined value based on pertinent values in Table XXXI Ref. No. 15. Residential garbage value based mainly on page 49 (1955) Ref. 8. Combined rubbish of all types varies from 60 lbs/cubic yard (p. 49 - Ref. 8) to 1,500 lbs (Ref. 6).

10 - Compaction ratio varies widely with material uncompacted density.

DA' SHEET FOR TABLE III

I. PER CAPITA PROD. COMBINED REFUSE (CONTAINERS FOR NORMAL PICKUP OPER.) (LINE ITEM 1)

Location	Year	Ref.	No. Cities	Lbs/Capita-Day Range	Av.	Remarks
U.S.-Scattered	1954	15	24	1.0 to 8.6	2.66	Table XX-A
				(Vol. Cy/Cap/Day)		
U.S.-Scattered	1954	15	17	(0.001 to 0.028	0.007)	Table XX-A
U.S.-Scattered	1954	8	24	1.0 to 3.8	2.3	Table B-8
Savannah, Ga.	1954	10	1		2.56	p.35 Includes all commercial.
Savannah, Ga.	1963	City Report	1		2.0	Includes all commercial.
Columbus, Ga.	1954	10	1		2.85	p.35 Includes all commercial.
Baltimore, Md.	1963	City Report	1		2.0	Residential and commercial.
Chicago, Ill.	1963	City Report	1		1.65	Residential and small commercial.
California	1950-1	1	13	1.3 to 4.14	2.05	Table 5 Residential only.
				(Vol. Cy/Cap/Day)		
				(0.004 to 0.12	0.005)	
Los Angeles	1959-60	9	1		1.82	Combined rubbish.

II. PER CAPITA PRODUCTION OF GARBAGE (LINE ITEM 3)

Location	Year	Ref.	No. Cities	Lbs/Capita-Day Range	Av.	Remarks
U.S.-Scattered	1954	8	15	0.20 to 0.78	0.42	Fig. 8, p.25
U.S.-Scattered	1954	8	18	0.06 to 2.3	0.57	Table B-8
U.S.-Scattered	1954	15	17	0.06 to 0.92	0.43	Table XXI
				(Vol. Cy/Cap/Day)		
U.S.-Scattered	1954	15	7	(0.0004 to 0.0047	0.002)	Table XXI

TABLE IV

PREATTACK REFUSE HANDLING
(100,000 Population)

1.	Total combined container refuse	134 tons/day, 6 day work week
2.	Number of 3-man crew packer trucks	16
3.	Number of 1-man 43,000 GVW Dumpmasters	3
4.	Collection force (including supervision)	53 men
5.	Disposal-2 tractors-39,000 to 45,000 GVW	2
6.	Disposal force (including supervision & helpers)	6 men
7.	Shop Force	6 men
8.	Total Force	65 men

FOOTNOTES

Line Item 1 Line Item 1, Table III converted to 6-day operating week.

Line Item 2 Average of Baltimore, Chicago, Denver and Savannah experience, adjusted to reflect commercial pickup where indicated. Based on 20 cu yd capacity trucks. Average haul 5 to 7.5 miles. Includes reserve vehicles.

Line Item 3 Average of Baltimore and Savannah experience.

Line Item 5 TD-18 to 20 class. One with loader, one with blade. In some situations, a 3/4 yd dragline or shovel with dump trucks would be substituted for the tractor loader. Basic value derived from Ref. 5 and 12.

Line Item 7 Engineering-Science estimate.

All three categorical control methods require personnel and supply vehicles of one type or another. The first method generally requires earth moving equipment. The second and third methods generally require hand and/or power spraying and dusting equipment, and insecticide materials. The logistical needs of a peacetime operation are shown in Table VII.

POSTATTACK LOGISTICAL REQUIREMENTS

The typical peacetime logistical requirements of solid wastes collection and disposal shown in Tables IV and V rodent control in Table VI and of various vector control activities in TableVII are for an urban community for periods of actual project operation.

The active production season of disease vectors in the United States ranges from as little as two months to as long as twelve months in the year, depending on species and environmental factors, and the domestic rodent reproductive cycle also has seasonal characteristics which directly affect the rodent problem, and to a lesser extent, control measures. The application of specific countermeasures within the scope of this study may vary from year-round operations in all aspects (solid wastes sanitation), to only the actual seasonal production period, including some

TABLE V

PREATTACK SOLID ORGANIC WASTES SANITATION
(100,000 Population)

		Units[4]
Collection		
Equipment		
Trucks - 16 yd packer[1] (3 man crew)		16
- Dumpmasters[1] (1 man crew)		3
Fuel - Gasoline (for 10 days)[2]		3,000 gallons
Personnel		
Drivers and helpers	51	
Supervisors	2	
Subtotal		53
Disposal		
Equipment		
Tractors[3]		2
Diesel Fuel (10 days)		800 gallons
Personnel		
Operators	2	
Helpers	2	
Checker & Supervisor	2	
Subtotal		6
Shop Force		
Mechanics, Helpers & Supervisor		6

Summary

Total No. Pieces Equipment	21
Total Personnel	65
Total Fuel (10 days)	3,800 gallons

FOOTNOTES

1. Capacities of packers range from 12 to 20 cubic yards. Types of equipment listed are typical. Other types of vehicles can be used.
2. If equipment uses Diesel fuel, gallonage will be less.
3. Based on 39,000 to 45,000 GVW tractors for spreading, compaction and earth movement, consisting of dozers, loaders or both, equivalent to Class TD 18 & 20. Equipment of other classes may be substituted.
4. Quantities are based on normal quantities of combined household and commercial refuse, exclusive of rubbish, rubble and street sweepings.

TABLE VI

PREATTACK RODENT CONTROL OPERATIONS
(Serving 100,000 People)

	Minimal	Optimal	Usual
Manpower			
Administrative	10% of time Director of Sanitation	One rodent or vector control specialist	10% of time Director of Sanitation
Technical	25 sanitarians (10% of their time)	25 sanitarians (10% of their time)	25 sanitarians (10% of their time)
Clerical	0	1 steno/clerk	1/4
Operations	0	1 Field Supervisor	1
	0	1 Asst. Field Supervisor	0
	1	10 Rodent Control Operators	5
Materials			
Anti-coagulants	100#	1-1/2 ton	3/4 ton
Other rodenticides	0	400#	200#
DDT Tracking Powder	0	500#	0
Traps	0	1,000 snaps	100
Bait Boxes	0	250	100
Calcium Cyanide Dust Pumps	0	6	3

TABLE VII

PREATTACK MOSQUITO CONTROL OPERATIONS
(Serving 100,000 People)

Manpower

Administrative	1 Manager (Engineer or Biologist)
Technical	1 Entomologist 1 Source Reduction Specialist (Engineer)
Clerical	1 Bookkeeper-Stenographer
Operations	1 Airplane Pilot 1 Field Supervisor 1 Asst. Field Supervisor 10 Permanent Inspector-Operators 10 Temporary Inspector-Operators 1 Mechanic 1 Heavy Equipment Operator

Equipment and Supplies	Units
Ditching Equipment, Back Hoe or Dragline	1 (½ cubic yard)
Grading Equipment, Tractor with Blade	1 (D-7 size)
Hand sprayers 5-gallon capacity	25
Power sprayers (ground 10 25 gallon/minute capacity) Vehicle mounted	15 - 20
Power sprayers (airplane)	1 - 2
Dusters (hand)	25
Granule spreaders (hand)	25
Granule spreaders (power)	10
Halogenated hydrocarbons	3,000 - 5,000 pounds
Organophosphorous compounds	3,000 - 10,000 pounds
Tossits	20,000
Larvicide oils	10,000 - 30,000 gallons

measures against insect vectors in short season areas of the United States. Different postattack conditions also can have important effects upon control needs and logistical requirements. With some insect species, reimportation of the infection (dengue, malaria and yellow fever), must take place before there is real need for control measures under emergency conditions; with other indigenous vector-borne infections, complex trigger mechanisms must fit into the right time-place pattern or local reservoirs of infection must become re-established before disease trasnmission hazards become important enough to warrant special control measures under postattack conditions.

For these reasons, the materials and equipment necessary for postattack environmental control activities can cover a very wide range, depending on whether the most adverse, or the most favorable, set of circumstances prevail.

In contrast to the more or less "special" vector control situations, certain basic needs are likely to develop under all, or nearly all, postattack conditions which can be more reliably predicted and justified from a standpoint of organized community recovery including the public health element. Primarily, these are:

1. Solid organic wastes collection and disposal;
2. Tactical measures against houseflies and mosquitoes;
3. Domestic rodent control (where rodent populations exceed a certain "floor" level).

The following statements of needs are based on local operational requirements for certain sets of assumed conditions. The materials and equipment elements of these needs represent over-all requirements for the operations and not stockpiling needs. Such needs might be met from a variety of sources, including undamage inventories of existing operating agencies and commercial operators, locally warehoused inventories of commercial outlets and general community stockpile. Undamaged inventories in "Mutual Aid" areas near areas of need could be drawn on, because, unlike the casualty problem, immediate response to the attack is not indicated. Insecticides, earthmovers and general purpose trucks, comprising most of the physical requirements, generally will be found more available in urban communities serving as supply points for agriculture and heavy construction than in centers of finance, light industry and soft goods commerce.

In planning the logistical support of those operations which are tied-in with vector-borne disease hazards, prospective logistical resources should extend beyond those of the local community and should take in state, regional, and national resources. Vector-borne diseases are inherently subject to an appreciable time lag due to allowance for vector population or disease reservoir build-up, thus permitting recovery of some local transportation facilities to permit utilization of assistance available through mutual aid.

The statement of needs is developed in accordance with two basic concepts. Under the first concept environmental control countermeasures are developed for (a) Continuing Operations and, (b) Short-term Emergency "Special Operations". Under the second concept, some countermeasures are recognized as "Basic", others as being contingent on problem development, and they are so labeled under the first concept classification to the extent feasible. Greater weight has been given on a nation-wide basis to enteric disease hazards than to other vector-borne disease hazards. It is noted, however, that considerations other than public health criteria, may influence the phasing and "needs" priority of some countermeasures. An abundant domestic rodent population can destroy large quantities of scarce food supplies under postattack conditions and some species of "savage-biting" mosquitoes can reach such high population levels as to retard recovery after early state postattack conditions.

Lastly, it must be recognized that any nationwide study of the nature of this one, can only outline the general dimensions of local program and logistical requirements. The quantitative effects of the many variables involved can be pinpointed only by intensive individual analysis of each state and urban community under the state-local organizational framework established within the national Civil Defense program.

Stockpiling

Solid organic wastes and vector control activities must largely rely on general community resources for some logistical needs, such as vehicular fuel and manpower, rather than on specialized inventory or stockpile resources. Some vehicles used in solid organic wastes sanitation are of a specialized type (such as packer-type refuse collection trucks). Such equipment is listed in postattack logistical needs because available local equipment of this type under postattack conditions can be used more effectively for this purpose than for any other use. However, other types of trucks from a general transportation pool could be used if necessary for the same purpose.

In general, planning should contemplate the use of material and equipment of a type that is used in the area at time of emergency. In this manner the so-called stockpiling will be only supplemental to the inventories normally maintained in the going program.

For these reasons, it seems rational to direct attention to the fullest utilization of potential logistical resources which might be available under the organizational concepts of the Civil Defense program for mutual aid than to provide special local stockpiles of equipment and supplies. In principle, such mutual aid would be provided from varying distances and with varying time delay, depending on extensiveness of damage and other postattack conditions.

Under emergency conditions, many substitutions can be made in housefly and mosquito control with respect to insecticides, application technique and, to a lesser extent, in control method, although at some loss of effectiveness or efficiency in certain instances. There are also alternative methods of domestic rodent control and rabies control. See Appendix B.

As indexes of the availability of insecticides under pre-nuclear attack conditions in possession of manufacturers, retail and commercial outlets and users, more than 100 million acres in the United States were treated in 1958 for control of agricultural and vector insects. Manufacturer's inventories of pesticides alone as of September 30, 1962 amounted to 142,000 tons and the bulk of the inventories in the rest of the pipeline is located outside of central target areas From 1954 to 1962, United States production of synthetic organic pesticides (exclusive of other insecticides), rose from 210,000 tons to 364,000 tons, with a 1962 value of $426 million (USDA statistics). Production and inventories of the longer established inorganic and botanical insecticides, petroleum derivatives and rodenticides are additional to these cited values and there are also non-chemical methods of controlling flies, mosquitoes and domestic rodents. These data indicate that, although geographical distribution is not uniform, pesticide inventories are widely dispersed in the United States and that essential requirements for vector control purposes under postattack conditions are small in proportion to pipeline resources.

However, because as previously mentioned, adequate local inventory data are available only on a limited basis, the development of local inventories, as an element of advance preparation is proposed as one baseline toward determining stockpiling needs if any. We would expect some stockpiling to be called for, particularly rodenticides with a suitable shelf life, because of the relative lack of general purpose inventories. This would especially be true of compound 1080 because of its limited peacetime use even as a rodenticide.

Previous citation was made of the 60 or so different generic synthetic organic insecticides used for agricultural-horticultural-sylvatic purposes, not all of which are presently used for vector control. This list does not include inorganic and botanical insecticides. As an index of the applicability of synthetic organics for vector control under postattack emergency conditions, the list was submitted to an entomologist specialist in the technical development of pesticides, who advised that about 40 of them could be variously used for housefly and mosquito adulticiding and/or mosquito or housefly larviciding provided local insect populations were not highly resistant to some. A substantial number are presently used for vector control and economic purposes, including protection of stored agricultural products. Only a few, however, were judged effective as housefly larvicide. Some alternate insecticide and rodenticide formulations, with application rates and program quantities, are shown in the Appendix B.

SOLID ORGANIC WASTES

Nightsoil (Feces) Collection and Disposal

Nightsoil collection is not expected to be needed under isolation conditions alone. Although shelters will be used for fallout (without structural damage), the shelters are almost entirely believed to be located in structures served by or close to sanitary sewers. In the immediate post-shelter, post-decontamination period, the excreta accumulated in reused CD water and sanitary containers would be emptied into nearby manholes or building connection outlets. Under structural damage conditions involving inoperative piped sewerage, fecal material handling would involve burial where possible near shelter area, or hauling for sanitary disposal at selected locations along with other refuse material with due consideration of priority of environmental hazard.

Some human feces production values are cited by Henderson[1] as derived from other cited sources. One value was 52 g/capita-day, dry weight, with a 77% moisture content and a wet weight of 226 g/capita-day (p.339). Another cited value was 150 g/capita-day wet weight (p.342). According to Spector[2] (p.341) the urine production of man ranges from 9 to 29 ml/Kg of body weight/capita-day, with an indicated average of 18 g. For a 150 lb man (68 Kg), the average would amount to 1.2 liters/capita-day. Using the higher of the two fecal values, the combined excrement would come to 1.43 liters and 1.43 Kg/capita-day or 0.38 gal and 3.15 lb/capita-day.

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1. Agricultural Land Drainage and Stream Pollution, Henderson, J.M., Transactions American Society of Civil Engineers, 128,1963, Part III. Paper No. 3495.
2. Handbook of Biological Data, Spector, W.S., Editor W.B. Saunders Co., 1956.

After volumetric and weight allowances for C.D. container weight, sanitary napkins and paper, we have adopted round values of 0.4 gal and 4 lb/capita-day, or 400 gal and 4,000 lb/1,000 population/day in shelters. (The adopted per-capita value of 0.4 gal compares with a C.D. public shelter drinking water ration of 0.5 gal.) It is much lower than recent Russian nightsoil collection experience as reported by Miller[1] - 1.6 m^3/capita-yr, or 1.15 gal/capita-day, but is considered more realistic. Miller reports 0.33 gal/capita-day for Russian refuse with a 22% paper content, which is very low and is around 1/7th of United States experience. (Assuming that the two values in Miller's article were transposed in translation or publication, they would both be in line.)

The adopted values for two assumed shelter periods are given below.

Excreta Containers per 1,000 Shelter Population

	Cubic Yards	Tons
Fallout Period - 2 weeks	27	28
Fallout plus Decontamination - 3 weeks	41	42

For 100,000 population the values would be 2,700 and 4,100 cubic yards and 2,800 and 4,200 tons respectively.

The CD standard sanitary and water shelter containers which are scheduled to receive nightsoil have a net capacity of 17.5 gallons. They provide excess capacity for this purpose, in fact the water containers alone are adequate because the volume of mixed feces, urine and sanitary paper should not greatly exceed the water-content volume and water intake by the shelter population will be partly lost through perspiration and respiration.

Packer trucks scheduled for solid organic wastes collection will be largely unusable for hauling the filled nightsoil containers from the shelters because of the spewing of contents due to action of the compactor mechanism. This problem has occurred where parasitological laboratories have attempted to dispose of compressable containers with fecal samples via refuse collection services. For this reason, use of stake body trucks is indicated, the containers have sufficient strength for double stacking when filled.

A nominally rated 1-1/2 ton stake body truck generally has a payload capacity of 3 tons or 6,000 lb and bed dimensions of 12 ft in length by about 82 inches inside width and a stake height of 42 inches. The filled containers will weight about 150 lbs and the truck has a payload capacity of 40 containers. In two tiers, the truck has a volumetric capacity of 32 containers/tier or 64 containers, with the 40 container criterion controlling.

The following calculations are based on a round-trip time of 2 hours/truck load for loading, unloading and round-trip travel time, for removal of shelter nightsoil containers in 7 operating days in the post-shelter period and for a shelter population

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1. Treatment of Refuse in the Soviet Union. Miller, M. (East Germany). Compost Science. 5(2): 17-19 (Summer 1964).

of 100,000. Because the entire population of a city will not be entering public shelters, an appropriate multiplier might be applied to convert these results to the total pre-shelter population. If stake body trucks are not available alternative types of vehicles can be used.

TABLE VIII

NIGHTSOIL VALUES FOR 100,000 POPULATION IN SHELTERS

Item	Shelter Period 2 weeks	Shelter Period 3 weeks
Volume of nightsoil-gal	675,000	1,000,000
No. of filled containers (17.5 gal)	38,500	57,000
No. of truck loads (40 containers)	965	1,430
Truck trips/day (single shift)	4	4
Truck trips/7-days (single shift)	28	28
No. trucks required (single shift)	35	51
No. trucks required (double shift)	18	26
No. trucks required (triple shift)	9	13
Manpower - Assume 1 driver and 2 helpers/truck		

These results indicate relatively modest logistical requirements for post-shelter nightsoil disposal under structural damage postattack conditions. Based on 8 mi/gal and 10 mile round trip haul, the fuel requirements for collection are 1,200 and 1,800 gallons respectively for the two assumed shelter periods.

In the event of a disaster condition in which fuel or vehicles are not available, burial of containers by pick and shovel adjacent to shelters would require 8,100 or 12,300 cu yds of earth excavation/100,000 population for pits having three times the net volume of the night soil and would require in the order of 4,000 to 6,000 man-days at the equivalent of 2 cubic yards/man-day for the over-all operation.

OTHER SHELTER SOLID WASTES

Public shelters are being stocked with several different types of filled containers for water, compressed biscuits (basic food ration), carbohydrate-vitamin supplement (hard candy) and sanitary purposes. Emptied containers not used for excreta are scheduled for use as litter receptacles and housekeeping plans provides for floor cleanup. The two food items are 100% edible. In spite of this, some crumbs are expected to drop on the floor. Discarded food should be at a minimum due to the limited ration and its packaging. The quantity of food litter is estimated in the order of 1% to 5% of the biscuit ration of 0.5 lb/capita-day. This compares with a peacetime garbage value of 0.4 lb, which includes some non-putrescibles. Non-putrescible shelter litter will include waxed paper and polyethylene wrappings and liners from the CD containers, tobacco residues, discarded lipstick containers, Kleenex, etc. Using the highest value for the food residue, the combined refuse from public shelters should not exceed 0.1 lb/capita-day, a negligible quantity compared with the three plus lbs of nightsoil. For a public shelter population of 100,000, this would come to 70 tons at the end of 14 days and 105 tons at the end of 3 weeks.

This litter will be relatively inoccuous. The small particles of dried food in the litter may be a mouse attractant but is not likely to be a rat food supply compared with other food sources. In place, it will not create any housefly production problem. For these reasons, there is little point in removing little from shelters until it becomes convenient to do so from a logistical standpoint unless immediate restocking of the shelters is contemplated; a procedure which is impractical until supplies for restocking are shipped in.

An unestimated number of people will use private shelters, with an unknown number of survivors. Per capita generation of putrescible and non-putrescible solid wastes other than nightsoil will be higher in this group than in the public shelter group and is estimated at twice as much on both counts. Again, no provision is indicated for emergency cleanup during the early post-shelter period. Although the per capita waste quantities are higher, the population/shelter will be small. All or most of the combustible litter in public and private shelters could be burned on or near the premises should need for early destruction develop.

ANIMAL CARCASSES

As previously indicated, animal carcasses are not expected to create either a major or a special disposal problem for reasons cited except in special situations, where there are mass accumulations of the animals.

For perspective, however, limited data are provided on the logistics of animal carcass collection under peacetime conditions. Baltimore uses two small specialized vehicles for individual pickup calls and in 1963 collected 18,479 small dead animals or 2,000 per 100,000 population.

In 1955-56, 1,174 tons of dead animals were picked up in Los Angeles by specialized collection service (Ref. 8). Of the total number of 850,945 carcasses, 48 were large animals, 1,317 were medium animals and 849,500 were small animals. By number and weight, carcass collections were predominantly chicken (615,112 carcasses). 1,115 tons were collected in 1959-60, equivalent to 305 tons/100,000 population. The number of animals in 1955-56 averaged 2.8 lbs/carcass and amounted to 38,000 animals/100,000 population. In six cities cited in Ref. No. 5 (p.36), the number of dead animals collected/100,000 population ranged from 1,400 in New York to 15,400 in Los Angeles.

SPOILED COMMUNITY FOOD SUPPLIES

Spoiled community food supplies should comprise the great bulk of solid organic wastes requiring early collection and disposal in a post-shelter period following fallout (alone or with structural damage). Spoiled food should not be a problem under postattack isolation conditions because if the isolation is sufficiently extended to result in exhaustion of fuel for electric power production and consequent lack of refrigeration, the community probably will have consumed its perishable food stocks and there will be no structural damage affecting non-perishables.

Under fallout conditions without structural damage, electric power failure may occur due to lack of operation and maintenance, although it may not be immediate in all cases. Some automatic gas refrigeration could continue to function throughout the fallout period, but is not an important element in most communities and commonly requires public electric service for ignition. These fallout conditions are expected to result in spoilage of perishable food supplies.

Under structural damage conditions, spoilage of non-perishable food supplies as well as perishables is expected to occur. Spoilage of both types can occur in blast areas outside of the central core in which total destruction will take place. Spoilage of perishables alone may occur in a peripheral fallout zone bordering the blast damage zone.

The quantities of perishable and non-perishable foods which are subject to spoilage are those contained in two food pipelines: (1) the food production-transportion pipeline and (2) the food distribution-consumption pipeline. The quantity in the first pipeline is very variable and can be determined for a community only by local inventory. It takes in the food products industry as well as agricultural production, shipping and warehousing of farm products.

The quantity in the distribution-consumption pipeline can be approximated by obtaining estimates of turnover time of edible foods by local wholesale and retail trade and in the household and by applying these values to USDA statistics on the nationwide per capita consumption of different food categories. The greatest variable in this procedure is that in the individual household; one household may buy on a day-to-day basis, another may utilize periodically stocked large capacity deep freeze facilities as well as refrigerators. It is also noted that there is no direct relationship between frequency of marketing by householders for partial replenishment and over-all total household inventory holding period. There are also community geographical and seasonal variables such as for seafood and fresh produce.

In the following tables, an estimate has been made of per capita food pipeline quantitites based on: (1) survey of the food trade in a selected community (Savannah, Georgia), (2) an estimate of average household storage period, and (3) USDA basic per-capita food consumption statistics (p.682, 1964 World Almanac). The annual USDA data have been converted to a weekly basis.

Major differences can be expected to occur in the proportion of non-perishable foods which will spoil when exposed to blast damage and weather (i.e., flour and sugar versus canned goods). Also, the USDA per capita food quantities are on a net weight basis; spoiled food refuse collection values would be on a gross weight basis.

Because the calculations which follow are based on annual per capita food consumption which takes in the ingredients of processed foods, the logistical results partially reflect the food production pipeline. That is, a bakery with only a local market might receive flour, etc., directly from primary suppliers, with a turnover time possibly comparable to that in the local wholesale-retail pipeline and would be part of the over-all local area food distribution pipeline.

SUMMARY OF SOLID WASTES PRODUCTION UNDER DIFFERENT POSTATTACK CONDITIONS

Isolation

As previously indicated, solid wastes production, collection and disposal conditions would be similar to peacetime conditions, fuel being controlling. In some communities with sewage lift stations, failure due to lack of repair parts or of electric energy supply under severe conditions, might necessitate some emergency method of nightsoil disposal and possibly collection.

TABLE IX

PER CAPITA WEIGHTS OF DIFFERENT FOODS IN LOCAL FOOD DISTRIBUTION AND HOUSEHOLD FOOD PIPELINE (LBS.)

Type of Food	Av. Pipeline Time (Weeks)				Weekly	Pipe-
	Whole-saler	Re-tailer	House-holder	Total weeks	Consump-tion	line Weight
Perishable Foods						
Fresh Meats	1	1	1	3	1.6 (1)	4.8
Fresh Fish	0.15	0.30	0.15	0.6	0.1	0.1
Poultry-Ready to Cook	1	1	1	3	0.7	2.1
Cheese	1.7	1	2	4.7	0.2	.09
Fluid Milk & Cream	0.1	0.2	0.3	0.6	6.0	3.6
Butter	1	1	1	3	0.1	0.3
Margarine	2	2	1	5	0.2	1.0
Ice Cream Products	0.4	0.5	1	1.9	0.3	0.6
Fresh Fruits	0.2	0.3	0.5	1	1.6 (2)	1.6
Fresh Vegetables & Melons	0.2	0.3	0.5	1	2.4 (2)	2.4
Frozen Fruits	4	3	1	8	0.2	1.6
Frozen Vegetables	4	3	1	8	0.3	2.4
Eggs	0.2	0.5	1	1.7	1.0	1.7
Subtotal					14.7	23.1
Spoilable (Weather Exposure & Damage)						
Grain Products	2	2 (3)	1 (3)	6	3.0 (3)	15.0
Sugar	1	2	2	5	1.9	9.5
Milk Solids & Canned Milk (4)	2	3	2	7	1.5	10.5
Edible Fats & Oils (All)	4	3	3	10	0.6	6.0
Shelled Peanuts	3	3	3	9	01	0.9
Cocoa	3	3	3	9	0.08	0.7
Canned Fruits & Vegetables	3	3	3	9	1.6	14.4
Canned Fish	3	3	3	9	0.1	0.9
Cured & Canned Meat	2	2	2	6	0.6	3.6
Subtotal						61.5
TOTAL						84.6

FOOTNOTES

(1) USDA reported 3.2 lbs/capita-week of total meat consumption for 1962, with rising trend. 1964 projected consumption is 3.47 lbs. This quantity was on a carcass weight basis and has been cut back by 1.8 lb to 1.6 lbs to exclude inedible portions, cured pork (0.4 lb) and canned meat, of which 0.6 lb is restored in Line Item "Cured & Canned Meat".

(2) 1960-62 trend projected to 1964.

(3) Wheat flour (2.2 lbs) is principal grain products item (total 3.0 lbs). While many liquid and solid grain products in household probably have a 3 to 4 weeks turnover period, including flour, average turnover time has been reduced to 1.0 week to reflect major use of flour in commercial bread and other fresh bakery products. Retailer's turnover has been reduced from 3 weeks to 2 weeks for same reason.

(4) Milk solids 84%, canned milk 16%.

TABLE X

RECAPITULATION OF PER CAPITA FOOD WEIGHTS

	Net Weight (lbs)	Gross Weight (lbs) (125% of Net)
Perishable Foods		
Wholesalers	6.2	7.7
Retailers	6.5	8.1
Subtotal	12.7	15.8
Households	9.3	11.7
Total	22	27.5
Spoilable Foods (If Damaged)		
Wholesalers	20.1	25.2
Retailers	22.9	28.6
Subtotal	43	53.8
Households	18.4	23
Total	61.4	76.8
Perishable and Spoilable Foods		
Wholesalers	26.3	32.6
Retailers	29.4	36.8
Subtotal	55.7	69.4
Households	27.7	33.6
Total	83.4	103

Fallout

In the immediate post-shelter period, there would be little accumulation of refuse predating the nuclear attack (average about 1.5 days) accumulation and none produced within the shelter period. Shelter litter would be a negligible problem. Public shelter nightsoil would be an important problem although not of critical importance because the containers are covered with tight fitting lids. A deoderant-disinfectant supplied for use in them should partially alleviate aesthetic objections. The logistical requirement for publi. shelter nightsoil collection are given in the text.

The greatest problem in terms of magnitude would arise from decomposed perishable food due to refrigeration failure and to overtime storage in the case of fresh produce, in households and food marketing channels. The net weight of these accumulated spoiled organics is approximated at 22 to 23 lbs/capita, compared with a normal organic production of 0.2 to 0.3 lb/capita-day in garbage and a gross weight of 27.5 lbs/capita compared with 0.4 lb/capita-day for all-inclusive garbage and of 2.3 bls/capita-day for combined refuse excluding rubbish. In terms of net weight, about 9 lbs of these accumulated perishables would be in households and about 13 lbs in commercial food facilities. The estimated respective per capita gross weights are 12 and 16 lbs respectively. The decomposed organics in commercial hands would be about equally divided between a few large wholesaling centers and a much larger number of retailers.

Combined refuse collection in residential areas is customarily twice weekly, with an average pickup of (2.3-0.5) 7/2 or 6.65 lbs, after deducting 0.5 lbs/capita day produced at commercial establishments. By going into a double or triple shift operation, existing refuse collection equipment (undamaged under fallout) could remove the accumulated household spoiled food within a week without difficulty especially in view of the diminished quantity of current refuse production due to shortages of normal foods and paper and the increased efficiency of collection due to larger quantities picked up per stop and related shorter travel distances. Disposal by landfill and to a lesser extent by incineration could be similarly stepped up.

Accumulations of spoiled materials at retail food establishments would be around 13 times normal daily production, with daily collections normally made. Under early post-shelter conditions, daily production of new commercial refuse should be very low. Accumulated spoiled materials could be collected by regular services in about 10 days time by around-the-clock 7-day operation. Logistics needs for commercial refuse collection at retail establishments could be greatly reduced by emergency burial of accumulated spoiled perishables at the site vicinities for large retail establishments in the suburban areas where they tend to be located.

Because of the tremendous quantities of spoiled material at larger individual wholesale food establishments, emergency burial at adjacent sites, rather than removal by regular collection service, would be in order. Because the assumed fallout condition does not include structural damage (discussed later), an adequate supply of earth-handling equipment, trucks and fuel should be available for this purpose or for other disposal methods. Lacking available landsites, locally available dump trucks and loaders could be employed to load and haul the decomposed material on a bulk basis. In the event this latter method is used, it could be extended to take in large retail food establishments with an estimated 75% of the accumulated waste from this category

The estimated truck net loader requirements for 100,000 population would be:

From Wholesale Food Establishments	335 tons
From Retail Food Establishments (75%)	300 tons
Total	635 tons

Truck Payload Capacity	3 tons
Number trips-shift	8
Tonnage/Truck-Day	24
Number of Truck-Days	27
Tractor-Loaders (days)	3

The equipment requirements might be twice those indicated above due to the need for shifting equipment to different locations, but the over-all requirements would still be very small. Due to time required to move the spoiled material from building interiors to loading points, and the number of establishments involved, several days would be needed for the total operation, with the trucks used part-time. These gross requirements are, accordingly, 54 dump truck days and 6 tractor loader days/100,000 population.

Structural Damage

Although structural damage could occur in some parts of the total blast area without fallout, depending on wind direction, it is assumed that the characteristic pattern in a metropolitan area receiving a direct nuclear attack would comprise:

(A) An area(s) of total destruction in which no organic refuse would remain,

(B) Blast damage area(s) with varying degrees of structural damage and with fallout, and

(C) A fallout area(s) without structural damage.

From a solid wastes logistical standpoint, the principal differences between the previously assumed fallout conditions and the structural damage condition are:

(1) Addition of spoiled non-perishable foods in Area B to the accumulated refuse.

(2) Shortages of supplies and equipment for refuse collection and disposal due to losses in Areas A and B and higher priority demands for use of remaining supplies and equipment to restore vital services (primary transportation access, water, food, and in some cases, shelter).

The per capita weights of spoilable foods outside of the perishable category have been listed in the preceding table and amount to 2.8 times the estimated per capita gross weight of perishable foods in the distribution-consumption pipeline. Thirty percent of these materials by weight are in households and 70% in commercial channels.

The proportion of the total spoilable non-perishables which will be damaged to the point of exposure to spoilage in Area B and the proportion of Area B in size to Areas A and C can only be guessed at, but the following points seem reasonably valid.

(3) The proportion of spoilage will tend to be greater in commercial structures than in residences because exposure to the elements of such major spoilables as bagged flour, sugar and of cardboard-packaged milk solids will be greater in unroofed or moderately damaged food warehouses and other storage rooms than in similarly damaged residential structures.

(4) The proportion of spoiled food in bags and cartons will be far greater than that of canned food.

For these reasons, we are assuming the following proportions and per capita gross weight quantities in Area B.

(5) Loss of perishable foods will be the same as under Fallout Conditions (100%).

TABLE XI

PER CAPITA SPOILED FOOD*

Category	Gross Pipeline Weight (lb)			Percent Spoiled		Spoiled Food Weight (lb)		
	Com.	Res.	Total	Com.	Res.	Com.	Res.	Total
Spoilables								
Canned	16.2	6.8	23	25%	15%	4.	1.	5.
Other	37.6	16.2	53.8	75	50	28.	8.	36.
Subtotal	53.8	23.0	76.3			32.	9.	41.
Perishables	15.8	11.7	27.5	100	100	15.8	11.7	27.5
Total	69.6	34.7	104.3	-	-	47.8	20.7	68.5
Accumulated Pre-Attack Refuse (3 days max.)						1.5	5.4	6.9
Total (Rounded)						50	26	76

* Derived from Basic Data in Tables IX and X Canned goods are 30% of total Spoilables.

The foregoing results indicate that about two-thirds of the total spoiled materials (76 lbs/capita) will be located at commercial establishments (50 lbs) and about one-third at residences in Area B

It might be assumed further that some 60% of the commercial structures and 40% of the residences in Area B will be unrepairable, the proportion being higher in commercial structures due to the location of the wholesale establishments. Under such circumstances, solid organic refuse in the unrepairable Area B structures would be eventually removed as an element of the over-all rubble and would constitute an estimated 25% of the commercial rubble and 1% of the residential rubble or 250 and 2,600 lbs/capita of total rubble respectively. For an Area B population of 100,000 this would come to 142,500 tons of rubble (12,500 tons commercial and 130,000 tons residential). Although these values are very approximate, it is apparent from the magnitude of the operation nature of the material and other factors that: (a) first attention would be paid to the commercial problem especially wholesale establishments and (b) disposal would be by burial at site and/or hauling by heavy duty construction vehicles. The logistical requirements of this operation are not included in any subsequent calculations.

Collection of the accumulated refuse from the repairable structures would be in order whenever conditions permitted. These accumulated quantities would amount to 15.6 lbs/capita for the assumed total pre-attack population in Area B at residences and 20 lbs at commercial establishments or 36 lbs/capita total.

Under these existing conditions, the desirable cleanup period from a sanitation standpoint will vary, as is brought out in other chapters of this report, but which can be approximated at 30 days post-shelter time from a domestic rodent standpoint outside of the housefly production season and as short as 1 week post-shelter, post-decontamination period during the height of the housefly season, with the shorter period being an objective rather than a practical time period.

Several assumptions which are made under these exigency conditions are:

(1) Collections from residential areas in Area B would be made by the same types of specialized vehicles in regular present use mainly because they have only limited use for other purposes.

(2) The postattack inventory of such vehicles would be reduced from present levels by 100% in Area A, by 50% in Area B and not at all in Area C.

(3) Refuse collection service in Area C (mutual aid to Area B) would be immediately curtailed to garbage pickup only and the normal quantity of garbage production would be reduced by 50% from 0.4 lb/capita-day to 0.2 lb/capita-day due to food shortage and consumption of more prepared and concentrated foods. This would reduce collections by over 90% from a normal value of 2.3 lbs to 0.2 lb/capita-day but there would be accumulated refuse in Area C as described under Fallout Conditions.

(4) Fuel supplies permitting, all specialized refuse collection and disposal vehicles and facilities in Areas B and C would immediately operate on a 3-shift, 7-day/week basis (21 shifts/week), compared with a normal average of around 7 shifts/week for vehicles serving residential and commercial areas. Under these conditions, we estimate that up to one-third of the Area C equipment used for residential pickup could be diverted to Area B for the same type of service.

The adequacy of this equipment, added to the surviving inventory in Area B, toward meeting Area B needs, would depend on the relative size of population in Areas

B and C. Generally, the total fallout area is assumed as being much larger than the secondary blast area (Area B). Assuming that portion of Area C which is within mutual aid reach of Area B to have twice the pre-attack population of Area B, the total vehicular resources available to Area B would be 50% plus 2 x 33% or 117% of normal. Because the Area B territory being dealt with is residential (including small commercial equivalent to residential) (6 shifts/week under normal conditions), the weekly per capita collection potentiality under 21 shifts/week would be in the following order:

Capabilities

Normal - 2.1 lbs/capita-day combined refuse or 14.7 lbs/week.
Exigency - 117% x 21/6 x 14.7 or 60 lbs/week.

Production

Accumulated - Repairable Residential	26 lbs
- Repairable Small Commercial (10% of 50 lbs)	5 lbs
Current Production - 0.2 x 7	1.4 lbs
Total	32.4 lbs

The foregoing calculations indicate that accumulated solid organic material could be collected within a week under the plan outlined, fuel supply permitting, from the assumed 60% repairable residential structures in Zone B. They also demonstrate a capability to continue the collection of current production, on a combined refuse basis (garbage can contents) rather than on a garbage only basis if it should be found impractical in some areas to obtain customer compliance on short notice. Because combined refuse has a paper content of over 50% by weight (similar to combined rubbish after excluding ashes - Table III Ref.18 and others), and paper will be in short supply, combined refuse production should not exceed 1.5 lbs/capita-day or 10.5 lbs/week, increasing total collection requirements in the first week to 41 lbs/capita versus a capability of 60 lbs. However, large quantities of non-putrescible rubbish and rubble will be encountered on the premises of repairable residences outside of garbage containers, none of which would be collected or need to be collected under these exigency conditions.

Because landfill disposal equipment is balanced with collection equipment with respect to normal inventory and operating hours, the foregoing analysis also demonstrates the adequacy of disposal equipment to meet exigency requirements, but with some difficulties experienced in practice due to the smaller number of units involved, thus complicating mutual aid aspects. Most incinerators, however, operate longer hours than the collection equipment they serve, and the moisture content of the accumulated organics will be materially higher than that of normal refuse and rubbish. For this reason, supplementation of incinerator capacity by new emergency landfills and by earthmoving equipment would be needed for both residential and other refuse.

Refuse in Repairable Commercial Structures

Accumulated refuse in these structures would aggregate 20 lbs/capita of which collection of 5 lbs from scattered small commercial establishments by vehicles serving residential areas have been accounted for, leaving a net of 15 lbs concentrated in wholesale and in the larger retail establishments. On a bulk handling basis, we estimate that the accumulated organics would be mixed with an equal weight of unseparable debris in these repairable structures, 30 lbs/capita or 1,500 tons/100,000 population. This value compares with 635 tons under Fallout Conditions, including small establishments under fallout, i.e. roughly twice as much.

Because it will be an important component of the accumulated waste, mass accumulations of damaged sugar might be disposed of by flushing it into drains with fire hoses, where practicable; other material would be disposed of with bulk handling equipment as described under Fallout Conditions.

Logistical requirements from a fallout baseline is estimated to be:

Truck-days (3 ton dump) 2.36 x 54	127
Tractor-Loader days 2.36 x 6	15

Current decomposible organic refuse production in the food distribution pipeline should be negligible under post-structural damage conditions within any cleanup period of accumulated spoiled materials lasting up to 30 days, due to shortages of fresh produce and other perishables. Such food replenishment as reaches local areas during this period is expected to consist of staples and concentrates. For this reason, no provision has been made for such production. No current non-decomposables would be collected during the emergency period until after higher priority needs had been met.

If collection by bulk-handling methods were to be made from all reusable commercial establishments under Structural Damage Conditions, the rubble factor would apply to small as well as larger food distribution establishments and the gross quantity of accumulated organic-content material is estimated to be 2,000 tons/100,000 pre-attack population.

Collection of spoiled food from large retail and all wholesale commercial establishments would require 54 dump truck-days, single shift, plus 6 tractor loader-days provided the truck scheduling utilized loader capacity. At two tons/man-day, 378 man-days of labor plus available forkloaders at wholesale and large retail food establishments, would be needed to move spoiled material to tractor-loader points from building interiors (635 tons/2).

The commercial spoiled food is equal in weight to the entire combined refuse production for one week under normal conditions, with an indicated 2 additional tractors needed at disposal sites for one week on a single shift basis.

The three Dumpmaster trucks shown under Isolation Conditions and normally used for commercial pickup, are arbitrarily assigned to care for the small quantity of new refuse produced at commercial establishments in the first post-shelter week, but would participate in the over-all commercial cleanup operation.

For most efficient equipment utilization, the dump truck-loader operation would be phased over 3 days, with the buildings cleanup phased over 4 days and leading the pickup operation by 2 days and the disposal operation phased over 7 days.

A summary of supply, equipment and manpower requirements for the entire first week's operations under Fallout Conditions follows; in subsequent weeks refuse collection equipment as required in pre-attack operation would suffice.

Summary of First Week's Requirements for Solid Organic Wastes Collection under Fallout Conditions - 100,000 Population.

TABLE XII

SHORT TERM EMERGENCY NEEDS
SOLID ORGANIC WASTES COLLECTION-FALLOUT CONDITION

Equipment	Units
Trucks - Packer Type - continuing service	16
" - Dumpmaster Type " "	3
" - Dump-Commercial Spoiled Food	19
Tractors - Disposal - continuing service	2
" " - spoiled commercial food	2
Light generators - emergency disposal	2
Tractor-loaders - bulk commercial spoiled food	2
Total (exclusive of personnel vehicles)	46
Personnel	
Regular continuing service	65
" service - 2nd shift	65
Commercial Bldgs. cleanup	80
Commercial Spoiled Food Collection Disposal	60
Expeditors and Special Supervisors - 4/shift	8
Total	278
Fuel	**Gallons**
Regular Equipment - 2 shifts - 7 days	4,200
Spoiled Food Equipment - 63 unit days	1,300
Personnel vehicles - various	200
Subtotal - gasoline	5,700
Diesel fuel - Regular disposal - 2 shifts	400
- Temporary disposal equip.	200
Subtotal - Diesel fuel	600
Total fuel	6,300

In the second and ensuing weeks, equipment needs would revert back to the normal inventory as one shift operation pre-attack operation is restored. In the absence of mutual aid demands, shelter litter and accessible animal carcasses could be picked up in the second week. During the third and fourth weeks, some operating equipment could be assigned to reserve status to conserve fuel and to provide backlog protection from shortage of repair parts, or collection of accumulated nonputrescible litter placed in containers could be stepped up.

Structural Damage Condition

In the analysis of the logistical needs under Structural Damage conditions earlier in this chapter, three postattack zones were postulated for a metropolitan area -- Area A - total destruction and disappearance of culture, including solid organic wastes (primary blast area); Area B, with structural damage ranging from severe to slight (secondary blast area) and Area C (Fallout). Solid organic wastes problems and logistical requirements accordingly would differ from those of fallout for a metropolitan area to the extent that Areas A and B displace Area C from a fallout baseline, with no problem at all existing in Area A and a greater problem in Area B than in Area C. When this approach narrows down to a particular community, such as a metropolitan area, the logistical significance becomes apparent when it is realized that the baseline logistical calculations were developed for a unit of 100,000 population in Area B and not for combinations of Areas A, B and C in terms of population.

The following calculations are for a metropolitan area of an indeterminate size exceeding 300,000 population and are based on an arbitrary assumption that one-third of the wastes population-equivalent will be in Area A, two-thirds in Area B, with Area C in the "isolation" affected area located outside of the damage area and available for mutual aid to the more severely affected areas.

On this basis, the values developed for a unit population of 100,000 are still valid when we further assume that the loss of equipment and material parallels the damage in the urban area.

In relation to logistical requirements given for Fallout, the following conditions apply:

(1) Nightsoil removal from shelters would be needed.

(2) Other refuse collection and disposal procedures unchanged for repairable buildings in Area B, with quantities augmented by spoiled non-perishable food.

(3) No provision made for refuse collection separate from rubble removal in unrepairable buildings of Area B and no logistical calculations developed.

Logistical requirements shown in the following table for residential and commercial refuse collection and disposal reflect the assumptions, procedures and values developed earlier under Structural Damage Conditions.

Because of rubble content, bulk-handling of accumulated putrescible refuse would be necessary at small as well as large commercial establishments. Accumulated materials to be collected by packer-type truck (residential only) would be reduced by 5 lbs to 36 lbs/capita in the first week. Rubble-mixed putrescible material from the commercial establishments would amount to 2,000/tons/100,000 pre-attack population.

Under normal conditions, the normal inventory of refuse collection vehicles collects 16 lbs of combined refuse/week (2.3 x 7), operating an average of 6 shifts/week. Operating double shift, 7 days/week or 14 shifts/week (2.33 times greater), it could collect the first week's production -- accumulations of 35 lbs from all residential structures (2.2 times greater). However, based on the assumption that only 60% of the residential structures will be reusable, the equivalent production will be 21 lbs (60% of 35 lbs), with the remaining 14 lbs of refuse buried under heavy rubble. Theoretically, this could be collected by the regular equipment inventory operating a total of 8 shifts/week @ 2.67 lb/capita/shift, but due to green crews, 10 shifts are provided, requiring 1-2/3 the normal manpower.

The commercial bulk-handled mixed refuse and rubble would amount to 2,000 tons/100,000 Area B population from refuse recoverable structures (40%) and would require 84 net truck-days (single shift) or 168 gross truck-days. (24 @ 7 days).

Collection and Disposal of Nightsoil from Public Shelters (100,000 popl.)

Basis: All population in public shelters. 3 weeks use of shelter facilities including decontamination period. Collection completed in 7 days (post-shelter) -- double shift operation.

Collection		Quantity
Trucks - Stake Body - 3-ton payload		26
Fuel - gasoline		1,800 gallons
Personnel per Shift		
Drivers and helpers	72	
Supervisors	2	
Subtotal		74
No. of Containers hauled		57,000
Weight hauled		4,200 tons

Disposal

Disposal weight is approximately 5 times that of combined refuse (2.3 lbs/capita-day) produced and disposed of by equipment listed under Isolation Conditions operating single shift, 6 days per week, but density would be much greater (about 2,000 lbs/cubic yard versus 480 lbs for compacted combined refuse. Net disposal rate would be 300 cubic yards/shift (14 shifts in 7 days). Indicated disposal method would be uncompacted placement in pits dug preferably by dragline, with compacted earth backfill. Gross excavation 8,400 cubic yards or 600 cubic yards/shift.

Equipment requirements are based on 3 disposal sites/100,000 Area B population, with same dragline requirements for 1 or 2 sites and 1 tractor/site.

Equipment	Quantity
Draglines - 3/4 or 1 yd	3
Tractors - track type, 39,000 lb GVW	3
Truck mounted generator (lighting)	3

Personnel per Shift		Quantity
Operators	3	
Helpers	3	
Supervisor-Dispatchers	3	
Subtotal		9
Diesel Fuel (14 shifts/week)		3,500 gallons

Summary (Nightsoil Collection and Disposal)

Trucks	26
Tractors	3
Draglines	3
Truck Generators	3
Gasoline	1,800 gallons
Diesel fuel	3,500 gallons
Personnel	166

Summary of First Week's Requirements for Solid Organic Wastes Collection and Disposal under Structural Damage Conditions -- per 100,000 population.

TABLE XIII

SHORT-TERM EMERGENCY NEEDS
SOLID ORGANIC WASTES COLLECTION-STRUCTURAL DAMAGE

Equipment	Units
Trucks - Packer type - continuing service	16
" - Dumpmaster type " "	3
" - Stake Body - nightsoil	26
" - Dump-commercial bulk - single shift	24
Tractors - Disposal - continuing service	2
" - Spoiled Food and Nightsoil	6
" - Loaders - bulk commercial	4
Total (Exclusive of Personnel Vehicles)	81

Fuel	Gallons
Gasoline - Regular Equipment - 10 shifts/week	3,000
" - Nightsoil Trucks - 15,000 miles	1,000
" - Dump Trucks	1,000
Diesel Fuel - 90 tractor shifts	2,700
Total	7,700

Personnel	
Regular Collection Vehicles - 1-2/3 x 65	109
Nightsoil Collection and Disposal	80
Bulk Food Collection and Disposal	78
Commercial Buildings Cleanup - 7 days	140
Special Expeditors and Supervisors	10
Total (1 week)	417

CONTROL OF VECTOR CAUSED DISEASES

Flea - Rodent Borne Diseases

Plague and murine typhus will be controlled by local rodent control personnel who will supplement the basic rodent control operations with a program for ectoparasite control by the use of 5% and 10% DDT dust. This program will be under the immediate direction of the regional vector control specialist. Rodent control operators will be augmented by additional personnel assigned by the Regional Medical Coordinator. These additional men will be obtained from communities experiencing minimal rodent control activities.

TABLE XIV

EQUIPMENT AND MATERIALS REQUIRED FOR ECTOPARASITE-RODENT FLEA CONTROL[a]

3,000 Premises[b]

8,000 pounds 5% and 10% DDT Dust
10 Rotary Hand Dusters plus 5 spares
5 vehicles with 200 gallons gasoline provided.

It is anticipated that this operation will be completed in 15 days.

TABLE XV

SHORT-TERM EMERGENCY NEEDS

EQUIPMENT	MATERIALS	MANPOWER
	ADULT FLY CONTROL[a] (and concurrent incidental mosquito control)[2]	
2 Mist sprayers, vehicle-mounted with 300 gallon tank, 10 gallon/minute capacity.	28 55-Gallon drums of 25% E.C. Diazinon diluted 11 gallons to 34 gallons water. (Similarly for fenthion)	1 Supervisor, 4 Spray men, 2 Mixer men (two shifts)
2 Two-ton flatbed trucks	170 gallons gasoline	4 Drivers work (two shifts)
	RABIES CONTROL	
2 Twelve-gauge shotguns.	1,000 shotgun shells	2 men to work 14 days killing stray dogs and overt wild animals.

2. Aerial spraying--one airplane (agricultural pesticide spray equipped) can be used to mist control area for five - 100,000 population units.
(a) See Appendix B Alternate Materials.
(b) This assumes that 15% of the Metropolitan Area would be treated.

It will be observed that in the foregoing equipment, materials and manpower tables only principal items are listed. For the purposes of this study, needs of parts supplies, administrative forms and supplies, and housekeeping items are assumed as known and available. Similarly, facilities such as buildings, warehouses, storage tanks, shop and vehicle tools and facilities are assumed as known and available.

TABLE XVI

MOSQUITO CONTROL NEEDS[1]
(Equipment etc. used for short-term emergency needs included in this Table)
(Per 100,000 population)

EQUIPMENT (Per Year)	MATERIALS (Per Year)	MANPOWER (Per Year)
2 CJ-5 Jeeps or Scout trucks (4 wheel drive) with 60 gallon pressure tanks and compressors (6 cubic feet/minute) either vehicle engine driven or auxiliary gasoline engine driven	600 feet oil service spray hose with spray gun 250 gallons 25% E.C. DDT	1 Manager (Engineer of Entomologist) 1 Storeskeeper
2 One-half ton pickup trucks	125 gallons 8# Malathion per gallon Emulsion	1 Supervisor--Source Reduction Specialist 1 Mechanic
4 Hand-operated 5# capacity granule spreaders	2500 Tossits (Lindane--DDT) 3500 Gallons larvicide oil (50-60% aromatics)	4 Mosquito control operators
4 Hand sprayers 3-gallon capacity	2500 pounds 1% Fenthion granules	
4 Hand dusters	2500 gallons gasoline	

(1) Certain source reduction programs require large equipment not economically feasible for a population unit of 100,000. Aerial spraying -- one airplane (agricultural pesticide spray equipped can be used) for five - 100,000 population units.

See Appendix B Alternate Materials.

TABLE XVII

DOMESTIC RODENT CONTROL NEEDS

(per 100,000 population)

Materials	
Anti-coagulant poison-bait -- Loose[5]	900 lbs
Anti-coagulant 1 oz. concentrate-packets	1,000 packets[6]
1080 Concentrate	20 lbs
Zinc Phosphide Concentrate	20 lbs
Calcium Cyanide Dust	30 lbs
Snap Traps	100
Bait Boxes	75
Calcium Cyanide Pumps	2
Manpower	
Field Supervision	1
Rodent Control Men	4
Vehicles	
1/4 ton trucks	5
Gasoline	5,000 gallons

5. Governmental effort expected to at least triple (normally would use 300 lbs).
6. May be handed out to untrained indivisuals with directions "To be diluted at rate of 1 packet to one pound of flour or meal--follow directions for use."

See Appendix B Alternate Materials.

CHAPTER VI

POSTATTACK OPERATIONS

INTRODUCTION

The postattack procedures depend upon the guide lines established from federal through state and regional levels to the operating local level. On the other hand the character, extent, and timing of local operations are determined by assessment of local needs. Needs may be considered under two categories, basic and special.

BASIC OPERATION NEEDS

Solid Organic Waste Collection and Disposal

The collection and disposal of nightsoil will have first priority followed by other organic wastes to reduce housefly build-up together with denial of food supply to domestic rodents.

Tactical Measures for Control of Houseflies

Fly control measures should be initiated before general exodus from shelters where sewage fecal material is exposed. In other instances such measures may be initiated concurrently with the start of post-shelter early cleanup activities for solid organic wastes sanitation.

Domestic Rodent Control

Rodent control is classed as both a basic and a Special Need. Satisfaction of the Basic Need comprises a continuing operation, with a time lag before initiation if pre-attack rodent populations are low and with the required intensity of the continuing operations contingent on the quantities of spoiled-damaged food and feed created by the attack and on the degree and rate at which these materials are removed and disposed of or otherwise made innocuous. Need for emergency short-term operations would be present in the event of high pre-attack rodent populations and/or development of a significant problem not coped with by continuing operations, such as rodent-borne disease, damage to edible food stocks and rat bites.

SPECIAL OPERATION NEEDS

Certain serious vector-borne diseases are potentially important in relatively restricted areas in the Continental United States.

Vector-Borne Diseases

1. Preparation for outbreaks of endemic vector-borne diseases including the encephalitides, plague, and murine typhus, will involve continuing epidemological survey and suitable stockpile (inventory) that can be utilized where needed.

2. Three important mosquito-borne diseases not endemic in the United States are malaria, yellow fever and dengue. Re-establishment of one or more of these diseases would first develop in limited areas. Control measures directed from the State level would involve localization and prevention of reintroduction.

3. Mosquito larval control activities are indicated on a contingency basis, subject to development of a human disease problem. Need for mosquito control is also climate dependent, ranging from 2 to 12 months per year. Under minor postattack conditions, or during late recovery stages under more severe conditions, mosquito control in existing control areas also would be carried on for "pest control" or as insurance against disease hazard occurrence. In the absence of structural damage with consequent increase in mosquito problems, there should be no important need for mosquito control in any given local area beyond prevailing peacetime activities, unless special disease problems should develop.

4. Rabies Control

Under important Structural Damage postattack conditions, need may develop for destroying roving dog packs, depending partly on presence or absence of a nearby wild animal rabies reservoir. In some situations, this need may extend to destruction of bats, foxes, and skunks. A program will include advance preparation, and postattack plans.

5. Mosquito-Borne Encephalitides

Mosquito production is seasonal in occurrence in nearly all of the United States, varying in different areas with climate and mosquito species. The extent of the measures needed for mosquito control under postattack conditions would be importantly affected by these factors.

Any existing mosquito control programs in operation at time of attack will be supplemented by mist spraying. DDT will be used unless mosquito populations are known to be DDT-resistant, in which case many alternative insecticides can be substituted. This program will be under the direction of the regional vector control specialist, with equipment and material procured at the regional level. The area to be sprayed will include the community and two-mile additional periphery. The program for short-term adult fly control will be used. Area to be sprayed will be a total of 64 square miles including the periphery area of the community. A suitable fenthion dosage used will be about 480 gallons of 4 lbs per gallon E.C. diluted at the rate of one gallon E.C. to 79 gallons water sprayed at the rate of one gallon per acre.

6. Rocky Mountain Spotted Fever

No control of vector. Population will be restricted from infected areas.

7. Introduced Diseases

Malaria, yellow fever and dengue fever will be limited in the early phases of introduction to certain geographical areas. Control will be directed at these relatively small foci of infection by State or regional personnel who will augment local programs. Equipment, materials, and manpower will be assigned on basis of extent of the outbreak.

DIRECTION OF POSTATTACK OPERATIONS

At the local level, it is imperative that a knowledgeable individual be assigned the responsibility of coordination and direction of the operations. He must be backed up in sufficient depth by a staff of knowledgeable individuals, any one of whom is able to take over his functions of coordination and direction.

Disease Endemicity Factor

In order to determine the relative hazard of disease epidemic in a postattack environment and thus the placement of preventive effort, use may be made of the Disease Endemicity Factor. This factor would indicate the prevalence of those conditions favoring the transmission of environmental diseases. Gross characteristics are used for rapid assessment of postattack conditions. The elements to be taken into consideration in developing such factors are:

A. Previous experience of such human disease in the specific sectional area[1];

B. Natural environmental conditions prevailing at time of specific determination;

C. Environmental conditions over which man has an influence, i.e. postattack sanitation, individuals exposure, etc.

D. Likelihood of origin of transport from epidemic focus.

The product of values assigned these characteristics represents the endemicity factor. Such values may be:

A - None	Value	0
Sporadic, scattered cases		1
Sporadic epidemics in circumscribed areas		3
Predictable annual occurrence at a significantly high level		5
B - Unfavorable (exclusive)		0
Becoming favorable		1
Favorable		2
C - Not conducive		0
Same as pre-attack		1
High potential		2
D - Not likely		1
Subject to introduction or already present		5

For these assigned risk values, the endemicity factors may vary from 0 to 100 depending upon the relative assessment of the characteristics. Many of the considerations that go into such assessment are not changed by the attack and thus can be determined in advance of the attack. (This of course is not the same for all diseases).

HUMAN TOXOCOLOGIC HAZARDS

All insecticides and rodenticides are toxic to man to some degree, including such long used household materials as kerosene which can be fatal through choking

1. This characteristic in itself weighs the inter-relationship of all related factors.

when the liquid is inhaled. This poses the question as to how extensively and in what manner various insecticides can be used under postattack conditions and to what extent widely available stocks of agricultural and horticultural pesticides can be used to meet postattack emergency health needs.

As one reference frame of toxicologic hazards under peacetime conditions, W. J. Hayes, Jr. toxicologist with the Communicable Disease Center, Public Health Service[1] listed only 152 deaths caused by 21 different pesticides in the United States in 1956, of which 62% were in children. Deaths among children are cited because they provide an index of pesticide hazards in the home, as distinguished from occupational or general environmental hazards. The greatest number of deaths (54) was due to arsenical pesticides and the next greatest number was due to long-established inorganic household phosphorus, both predating synthetic organic pesticides in use. Among the newer pesticides, the largest number of deaths was charged to parathion (11) of which 5 were in children. Of the 122 deaths which were identified as to specific pesticide, 28 were caused by the synthetic organic pesticides developed within the past 22 years and 84 by long established compounds.

As an index of the occupational hazard of insecticidal application, Hayes reported that the sick leave absentee rate in the United States pest control industry was only 3 days/man-year, below the average for all occupations.

Under emergency postattack conditions, there will be some slackening of normal peacetime precautions in the use of insecticides and consequently some increase in human, other mammalian and wildlife hazards. The order of increased hazard to man should be recognized and given due consideration in the planned operations. It is anticipated that extensive reliance can be placed on the utilization for emergency health needs of such undamaged stocks of agricultural-horticultural-sylvan insecticides as may be available locally or regionally in the hands of primary manufacturers, formulators, wholesalers, retailers and end-users. Such utilization may well include synthetic organic pesticides not normally used for vector control purposes because some 60 different generic insecticides are in use[2] and there are over 10,000 pesticide product listings.[3]

One reason for this judgment is that under postattack conditions primary reliance is placed on the application of insecticides for non-household purposes either by trained operators drawn from surviving commercial pest control personnel and local governments or by other workers under trained supervisors drawn from the same sources. A second reason is that pesticides will be needed under postattack conditions to meet a range of different situations. This means that a highly toxic agricultural pesticide such as parathion, rated for non-urban use, would still be restricted to contiguous rural and unoccupied urban area use under postattack conditions.

As an index of the relaxation of peacetime precautions which can be expected to take place under more severe postattack conditions, experience in Houston, (Harris Co.)

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1. Agricultural Chemicals 19(3): 20-22, 139-140 (March 1964)
2. Pesticides and Bees. Johansen, C., Agricultural Chemicals 19(3):40 (March 1964).
3. Pesticide Handbook 16th Ed. 1964, Frear, D.E.H., Editor.

Texas is cited. A total of 692[1] suspected cases of mosquito-borne encephalitis cases were reported from this county in July-Sept. 1964. (1960 census pop. 1,243,158). In addition to emergency public agency mosquito control operations, 200,000 gallons of 0.5% malathion liquid insecticide were given to the public by the City of Houston[2]. Although this organophosphorus pesticide has a relatively low mammalian toxicity and is considered safe for use by trained operators in households as well as other places, it is not normally available to the general public.

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1. Morbidity and Mortality Weekly Reports, Communicable Disease Center, Public Health Service, Sept. 25, 1964.
2. Texas PCDs Teamup with City as Encephalitis Strikes Houston. Staff article, Pest Control 10(32): 18-19, 50-60 (Oct. 1964).

CHAPTER VII

FINDINGS

The information developed by detailed local type study and presented in the preceding sections of this report was reviewed in its application to theoretical postattack conditions in metropolitan and statewide areas in various parts of the Continental United States.

ASSESSMENT OF POSTATTACK DISEASE HAZARDS AND HUMAN DISEASE INCIDENCE

In this section, consideration is mainly directed to those vector-borne and animal reservoir diseases which are considered to have present significance, as distinguished from historic significance, in the United States.

ENTERIC DISEASE HAZARDS

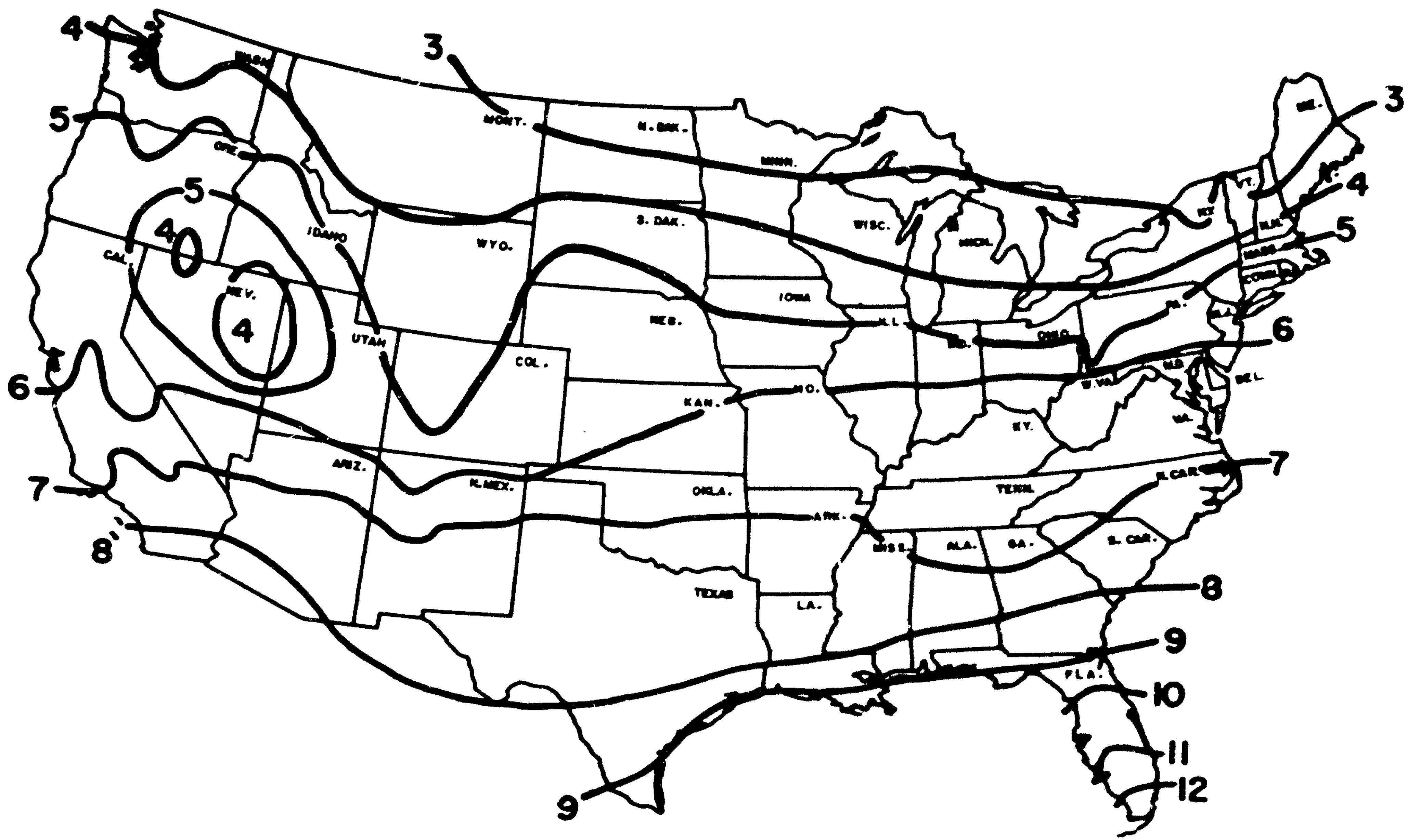
Fly-Borne Enteric Infections

Of the several categories of infections within the scope of this study, enteric disease hazards are assigned by far the greatest role of importance from the standpoints of probability of spread in man and of total number of cases and deaths under post nuclear attack conditions (isolation condition excluded unless extremely prolonged), and in the absence of effective countermeasures. It is for this reason, supplemented by its role in controlling domestic rodent populations, that solid organic waste sanitation is classed as a basic need and is assigned ranking priority within the list of countermeasures. Under post nuclear attack conditions, the function of solid organic waste sanitation includes the collection and disposal of human feces as well as normal domestic refuse with an organic content. As a supplementary measure, provision also has been made for short-term tactical housefly control. Such measures will be particularly needed under Structural Damage Conditions because of the impracticability of prompt removal of solid organics in major rubble accumulations. Figure 1 shows the prevalence of the housefly under favorable habitat conditions.

Of the different enteric diseases (chiefly typhoid fever, acute infectious hepatitis, bacillary dysentery or shigellosis, amoebic dysentery or amoebiasis, and Salmonellosis), the greatest threat under post nuclear attack conditions is considered to be shigellosis. Although present incidence is low compared with past levels, morbidity and mortality from this infection are thought to be grossly under-reported, and shigellosis is recognized as the most widespread and prevalent of the cited clinical enteric infections. The reservoir of shigellosis cases and carriers existing in all urban areas provides a baseline for quick takeoff under post nuclear attack conditions which is not possessed by exotic infections and not equalled by the other cited enteric infections.

Although typhoid fever possesses a lower spread potentiality than shigellosis under post nuclear attack conditions, due to smaller seedbed and longer incubation time, it is a more serious disease and complements the shigellosis problem in the over-all enteric disease picture. Like shigellosis, typhoid fever is a mass-spread disease as well as a fly-borne disease. Although more prevalent than typhoid, the role of acute infectious hepatitis in terms of transmission mode and spread potentiality is more difficult to appraise, even though it, like amoebiasis, has explosive capabilities when introduced into drinking water through fresh sewage pollution.

FIGURE 1



NUMBER OF MONTHS/YEAR OF HOUSEFLY PREVALENCE IN U.S. UNDER FAVORABLE HABITAT CONDITIONS

-MAP IS BASED ON ISOTHERMS-

FIGURE 1

Because a shigellosis seedbed is recognized as being ubiquitous in United States cities and its prevalence and distribution are largely revealed by special scattered surveys rather than by morbidity and mortality reporting, Figure 2 should be judged in context with the true situation. In spite of under-reporting, however, and the effective reporting of typhoid fever, more than 20 cases of shigellosis were reported in 1962 for each case of typhoid fever.

Figures 3 and 4 show distribution and prevalence of reported cases of typhoid fever and hepatitis (acute infectious and serum) in 1962-63 and in 1961 respectively. It is noteworthy that less than 10% of the hepatitis cases reported were of serum origin.

Like shigellosis, acute infectious hepatitis cases and carriers may be accepted as ubiquitous insofar as United States cities are concerned. Although typhoid fever was reported from every state except one in the two year period 1962-63, the relatively small number of cases reported from some states, plus the fact that the infection was acquired elsewhere in some instances, indicates that all United States cities were not necessarily involved. In appraising this situation, however, it should be kept in mind that, due to the lifetime persistence of a carrier state among some carriers and higher incidence rates in past years, typhoid carriers greatly outnumber new typhoid cases in major cities

In our opinion, these enteric infections, particularly shigellosis, are the only infections within the scope of this study which are reasonably capable of approaching or exceeding predicted casualty rates from burns, radioactivity, blast effects and shock under certain post nuclear attack conditions. (For an individual city, such values may range from 10% to 90% of the total population, depending on the assumed post nuclear attack conditions.) (See Supporting Statement Appendix C).

It is emphasized that in the United States, we are dealing with almost totally non-immune populations for the diseases within the scope of this study. The role of the housefly in transmitting enteric infections during such episodes is directly related to the factors of accessibility to infected human feces and equal access to prepared human food and food-related facilities. Under normal United States peacetime conditions in urban areas, the housefly is an unimportant vector for apparent reasons. However, in Egyptian villages where sanitary conditions are comparable to potential post nuclear attack conditions, it has been observed that the presence or absence of effective fly control, without change in other transmission modes, had a sharp effect on infant mortality rates (principal index of Shigella infection in an immune population with insanitary surrounds).* For this reason, we estimate that solid organic waste sanitation for feces removal (in the absence of operable water carriage) and environmental fly control, in combination with tactical fly control, might reasonably be assigned a credit of one-third of the total job of enteric disease prevention under post nuclear attack conditions. In evaluating the importance of the housefly in enteric disease transmission, as well as that of the other transmission modes, it should be noted that all enteric disease transmission modes are mechanical and do not involve the time lags characteristic of vector-borne diseases with biological cycles outside of man. This favors rapid spread of the enteric infections, particularly shigellosis due to its short incubation time and short reinfectivity time in man.

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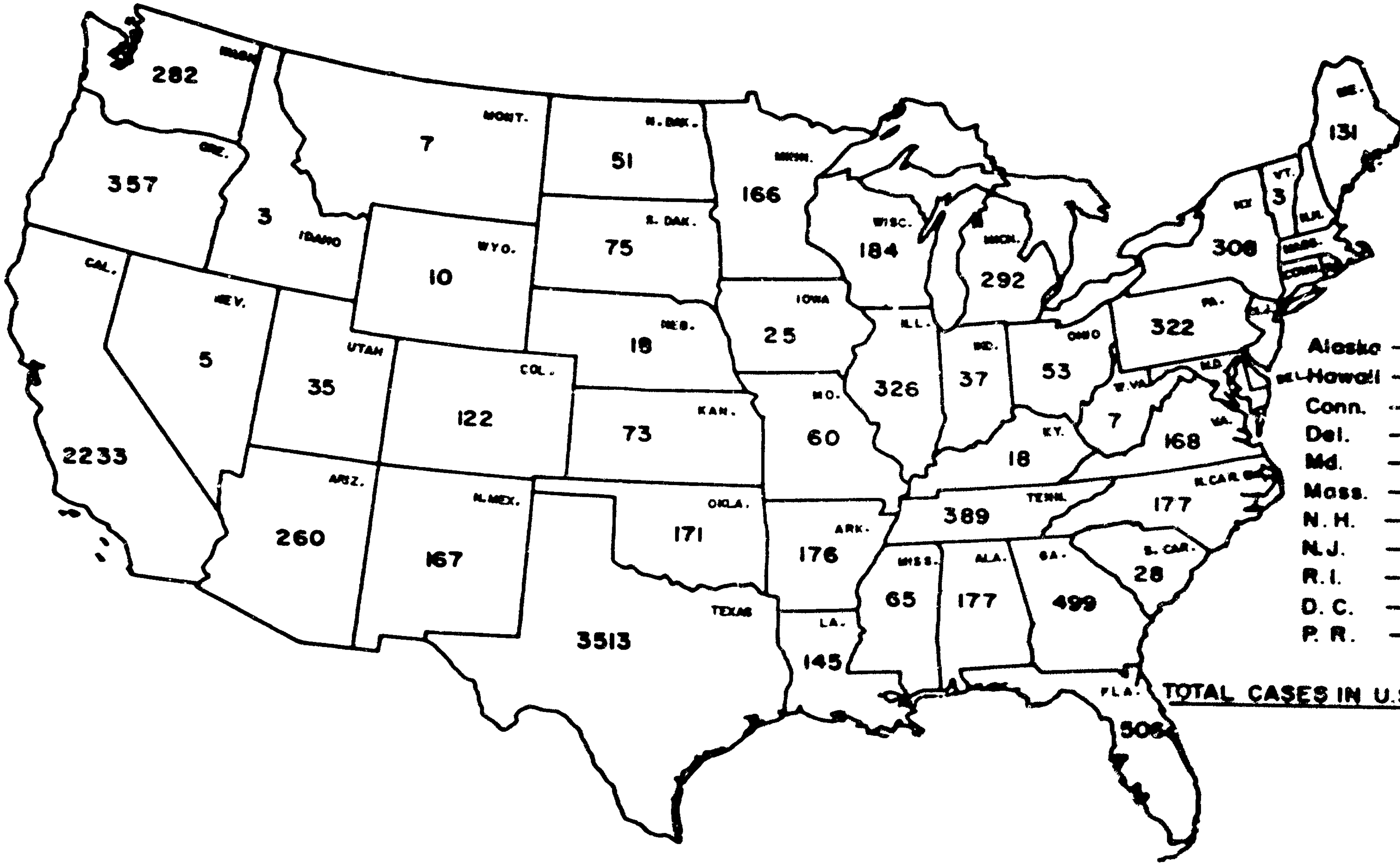
* An Evaluation of Health and Sanitation in Egyptian Villages. 1952. Weir, J.M. et al. Jnl. Egyptian Public Health Assn. 27:56-114.

The Present Status of Sanitary Engineering in the Tropics (Special Review Article). 1957. Henderson, J.M. Am. Jnl. Tropical Med. & Hygiene 6(1):1-2D



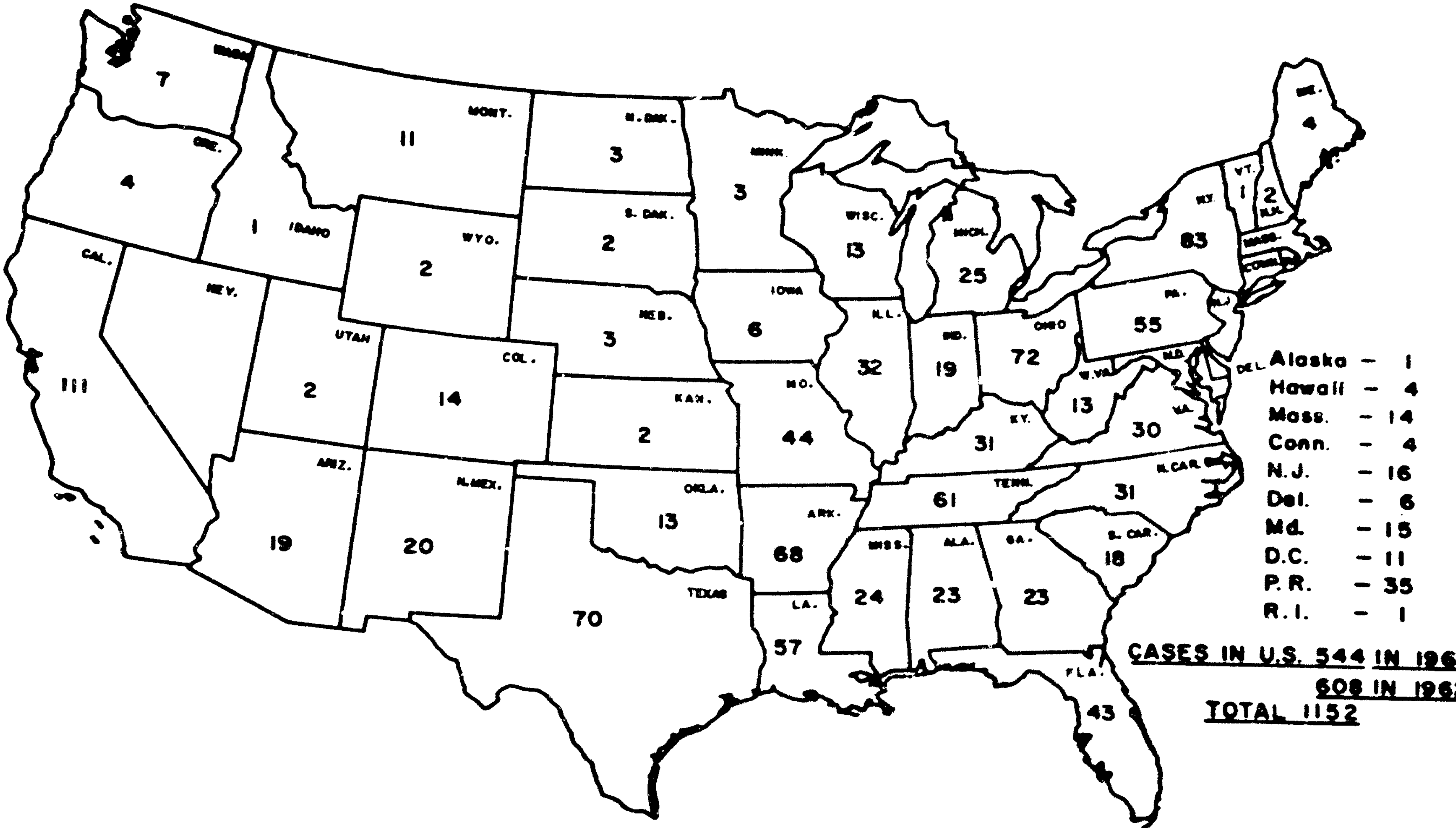
Alaska	—	1
Hawaii	—	110
Conn.	—	76
Del.	—	25
Md.	—	179
Mass.	—	173
N. H.	—	8
N.J.	—	115
R.I.	—	8
D. C.	—	104
P. R.	—	18

TOTAL CASES IN U.S. 12,332

PREVALENCE AND DISTRIBUTION OF REPORTED CASES OF SHIGELLOSIS IN 1962

SOURCE: Communicable Disease Center, Public Health Service, USDHEW.

FIGURE 2

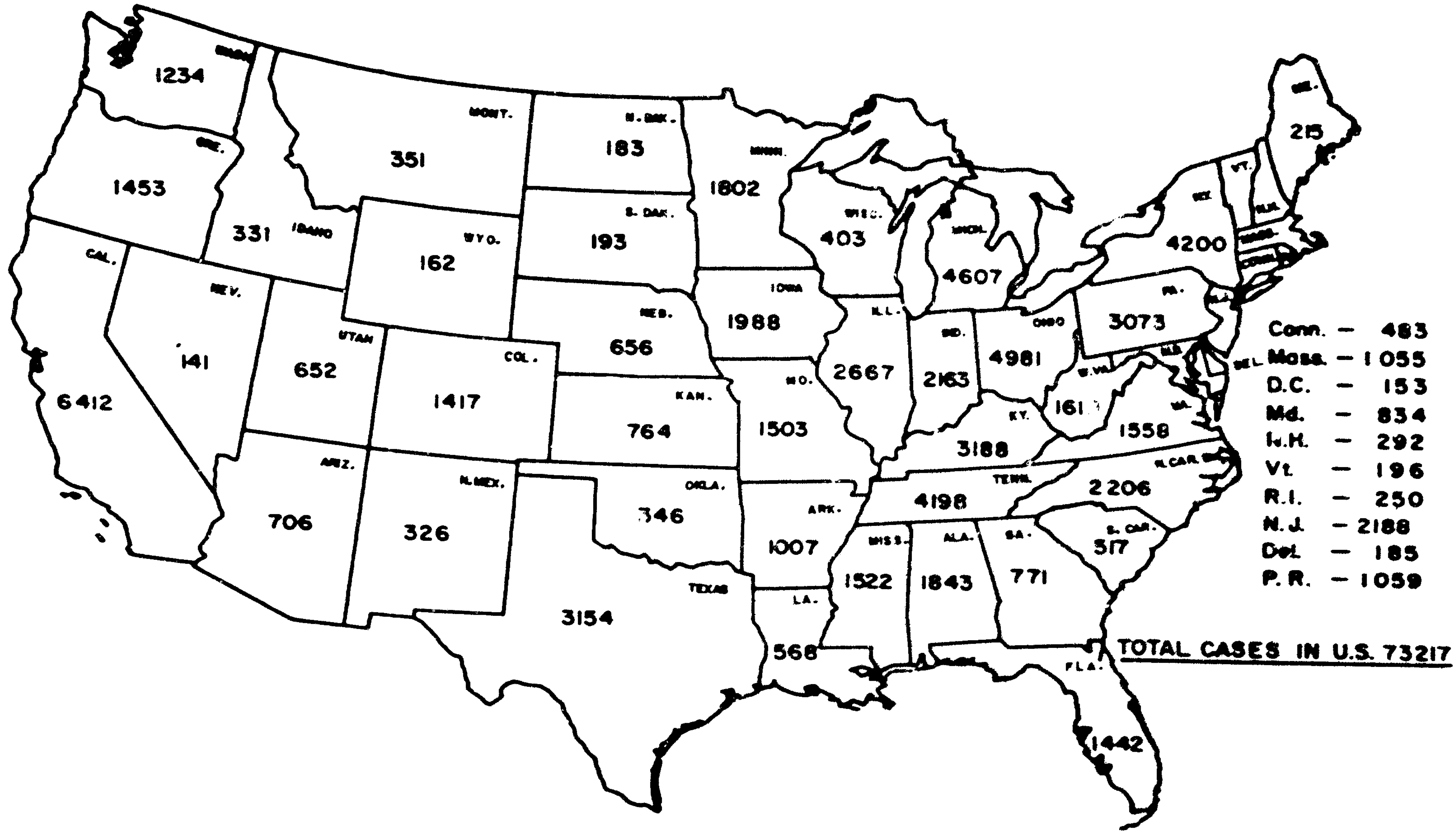


REPORTED CASES OF TYPHOID FEVER IN 1962 AND 1963*

*1963 Preliminary Data

SOURCE: Communicable Disease Center, Public Health Service, USDHEW.

FIGURE 3



REPORTED CASES HEPATITIS IN 1961
(INFECTIOUS AND SERUM)

SOURCE: Communicable Disease Center Reports, Public Health Service, USDHEW.

FIGURE 4

Summary of Enteric Disease Hazard

Estimated Attack Rate in Absence of Countermeasures - Up to 75% of total population in 3 months period - irrespective of season.

Estimated Proportion Due to Solid Organic Waste-Housefly Hazard - 25% during fly prevalence season ranging from 3 to 12 months annually.

DOMESTIC RODENT & RODENT-BORNE DISEASE HAZARDS

Potential problems under post nuclear attack conditions include food damage, rat bites, leptospirosis and lesser rodent-borne disease hazards from a probability standpoint. The present number of hospital treated rat bites which are annually reported to health authorities, is in the range of 50 to 100 per million population; the actual number is thought to be much larger. Infants and aged adults are the principal sufferers.

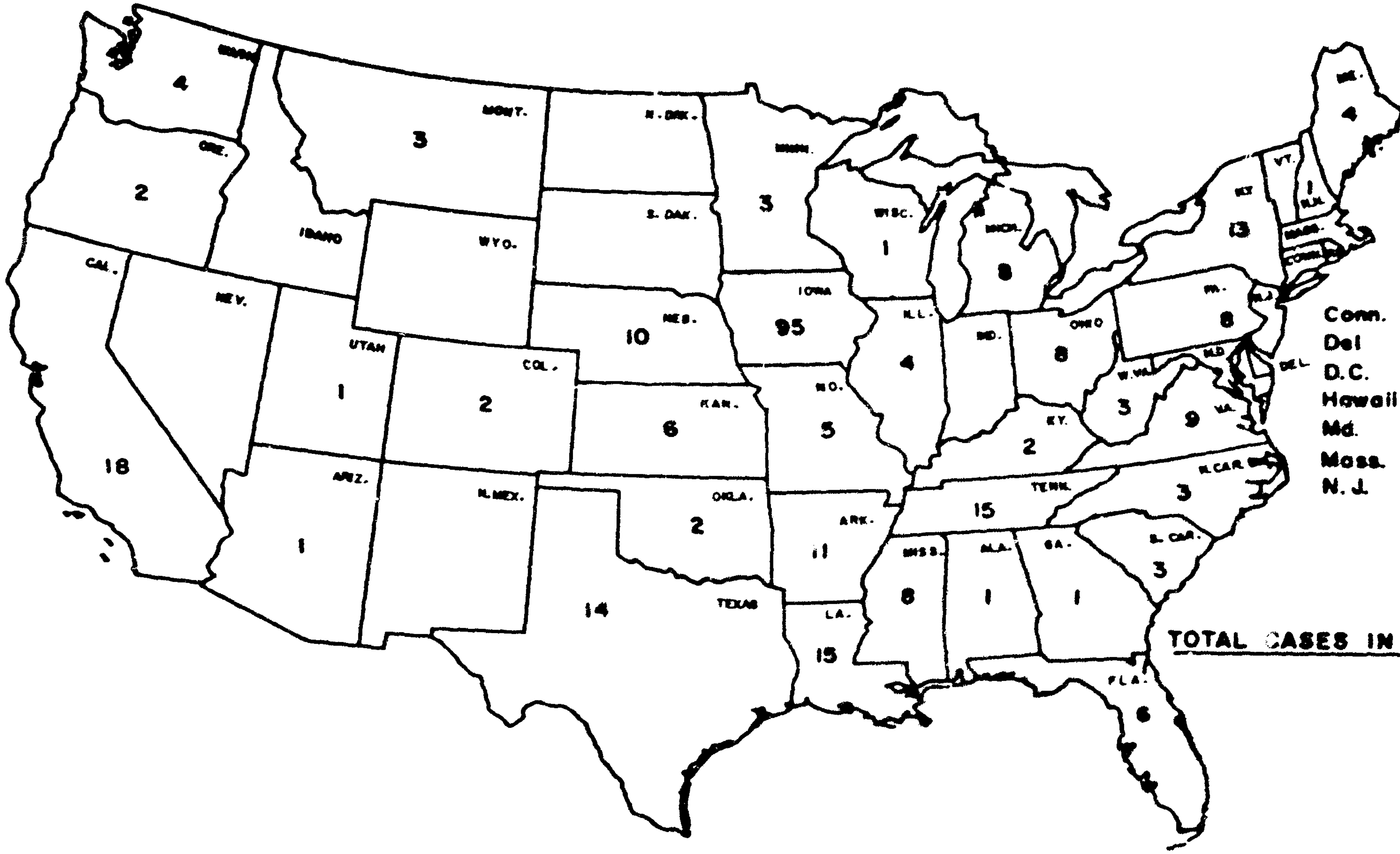
As an index of rat population growth under post nuclear attack conditions favoring such growth, observations indicate that the population would double in 6 to 12 months, depending on season of the year and other ecological factors. The number of young produced annually would theoretically permit as much as an 18-fold increase in a year, but this increase rate is largely offset by a high natural mortality rate, even in the absence of environmental population saturation conditions. The fact that the population growth rate of rats is very modest compared with insects, provides a substantial time lag for logistical purposes.

Leptospirosis

Figure 5 shows the number of cases of this disease reported in 1958-62. Morbidity from this disease is known to be grossly under-reported because the proportion reported deaths to reported cases is far greater than the true case-fatality rate; nevertheless it is a rare disease in peacetime. Attention is directed to leptospirosis, however, because it is the only rodent-borne disease in the United States at present which is both widely distributed and highly prevalent in rats. As an index, a survey of urban rats presently underway in a major city indicates an infection rate of around 50% (Source - Communicable Disease Center). Also, leptospirosis, unlike some other rodent-borne diseases, can be transmitted directly to man throughout the year. Under post nuclear attack conditions, closer exposure of man to rats, plus an expected greater incidence of minor skin breaks among human survivors, provides grounds for assuming that a large increase in leptospirosis is likely to take place under fallout and bomb damage conditions. However, one would not expect the incidence to amount to more than a small fraction of 1% of the surviving population over even a year's time. An attack rate of only 0.1%, for example, would represent 1,000 cases per million population, which is astronomically higher than the present true rate.

Murine Typhus

Figure 6 shows the distribution of the 29 human cases of murine typhus reported in the United States in 1963. Twelve of these cases were reported from Texas, where there is a localized focus of infected rats in the Rio Grande Valley. The remaining 17 cases were scattered over 10 states and it should not be assumed that the infection was necessarily contracted where the cases were reported. Formerly, murine typhus fever was moderately prevalent in 10 southern states, from which 95 to 99% of the total number of United States cases were reported during the



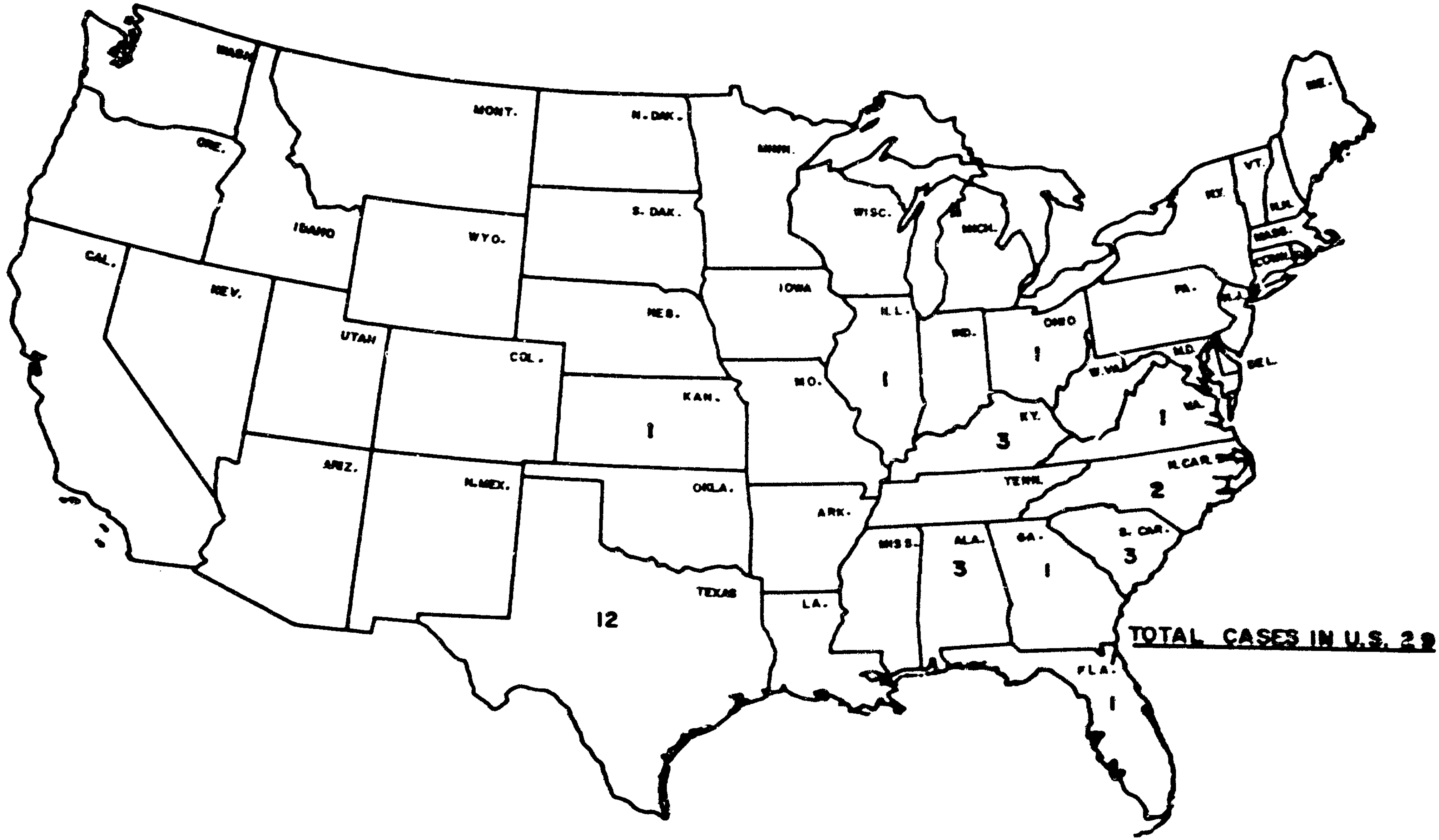
Conn.	—	4
Del	—	1
D.C.	—	2
Hawaii	—	39
Md.	—	3
Mass.	—	1
N. J.	—	1

TOTAL CASES IN U.S. 341

REPORTED CASES OF LEPTOSPIROSIS, 1958-1962

SOURCE : Communicable Disease Center Reports, Public Health Service, USDHEW.

FIGURE 5



REPORTED CASES OF MURINE TYPHUS IN 1963*

*Preliminary Data

SOURCE: Communicable Disease Center Reports, Public Health Service, USDHEW.

FIGURE 6

prevalence period. The peak year of occurrence was in 1944 (5,338 reported cases), with spot checks indicating at least twice that number of actual cases. The disease was largely concentrated in rural areas and small urban communities, with a negligible rate in the larger urban places in the 10-state area. During the following decade, human murine typhus declined very rapidly, due to lower infection rates in the rat reservoir. In 1945, extensive surveys in the 10-state area showed 45% of the rats infected; by 1952 the infection rate had declined to 6.7% and the extensive surveys were discontinued shortly afterward due to lack of a public health problem and absence of rat infection. Nevertheless, occasional, limited local surveys indicate that typhus infection in rats has not totally disappeared from all United States communities, even where no human cases are being reported, and it also may be assumed that a few human cases are unreported.

Under post nuclear attack conditions and generalizing for the United States, our assessment is that murine typhus can hardly be expected to be a significant problem in metropolitan areas, even in the 10-state area in which it was formerly present. This is in spite of the greater exposure of man to rat fleas under fallout and bomb damage conditions. Basically, this assessment is due to absence of a significant reservoir of infection in local rats, difficulty in reseeding from remote sources and the lengthy time period which would be needed for infection buildup in local rat populations. This infection process would not proceed in a straight line or logarithmically, but would be determined by seasonal variations in vector flea populations. Nevertheless, in those few communities where a local rat reservoir of infection can be demonstrated, avoidance of a human murine typhus hazard becomes an added reason for rodent control, basically justified on other grounds.

<u>Plague</u>

Figure 7 shows the location of the single case of human plague reported in the United States in 1963. In view of the known presence of plague infection in wild rodents elsewhere than in Arizona, it is apparent that any assessment of plague hazard under post nuclear attack conditions must be based on criteria other than human disease incidence in peacetime. The post nuclear attack plague hazard is expected to be limited to Southern California and San Francisco, where plague exists in wild rodents in proximity to peripheral human and domestic rodent populations. Although the number of human plague cases in these areas under post nuclear attack conditions is unlikely to be large, the severity of the infection is such as to warrant provision for its control. Control measures would include a stepped-up attack against rats along containment area lines and ectoparasite (flea) control. Because the spread of plague infection in rats is subject to the same biological time checks as that of murine typhus, any additional supplies and equipment which might be needed for plague control, as contrasted from rat control for other purposes, could logically be provided from statewide, rather than local, inventories in plague-hazard areas.

Rodent control measures are considered warranted (although not of first priority in the absence of disease) under post nuclear attack conditions on grounds of food protection and avoidance of rat bites alone, and because the basic control measure - solid organic waste sanitation - is multipurpose. The amount of food damage which could take place can only be speculated on and depends importantly on the degree of rodent access to human food.

REPORTED CASES OF PLAGUE IN 1963*

*1963 – Preliminary Data

SOURCE : Communicable Disease Center Reports, Public Health Service, USDHEW.

FIGURE 7

Summary of Rodent-Borne Disease Hazard

Estimated attack rate in the absence of countermeasures -

Leptospirosis - 0.1% of surviving population.

Murine Typhus - slowly developing epidemic proportions in very limited isolated locations

Rat Bite Fever - 0.05% of surviving population.

Plague - not likely to be a problem unless artificially introduced.

MOSQUITO-BORNE DISEASE HAZARDS

The only autochthonous mosquito-borne diseases presently in the United States are the arthropod-borne encephalitides. Although from certain highly technical standpoints it can be questioned whether malaria has met all of the criteria of the World Health Organization concerned with final proof of eradication, from a practical standpoint it may be said that malaria is no longer an indigenous mosquito-transmitted infection in the United States. Although miniature outbreaks can develop from imported infective human malaria carriers, it is also noted that, due to the biology of the vectors, malaria is characteristically a rural disease, not a potential hazard to metropolitan areas. In 1929, for example, when 587 malaria deaths were reported in Georgia and the state health department estimated there were over 100,000 cases, malaria was not a public health problem in any city of 25,000 population or over.

Encephalitides (Mosquito-Borne)

There are three distinct strains of this viral disease. The general geographic distribution of each strain is shown on Figure 8. This general distribution map is based on total virus activity in recent years in man and animals. It should not be concluded that this distribution map is indicative of actual human cases, rather it depicts the general hazard area to horses, in which the disease is far more common than in man. Furthermore, larger cities within the shaded areas may be free of significant hazard for biological reasons and in some fully shaded states, as little as 15% of the total area may have had a significant human encephalitis experience.

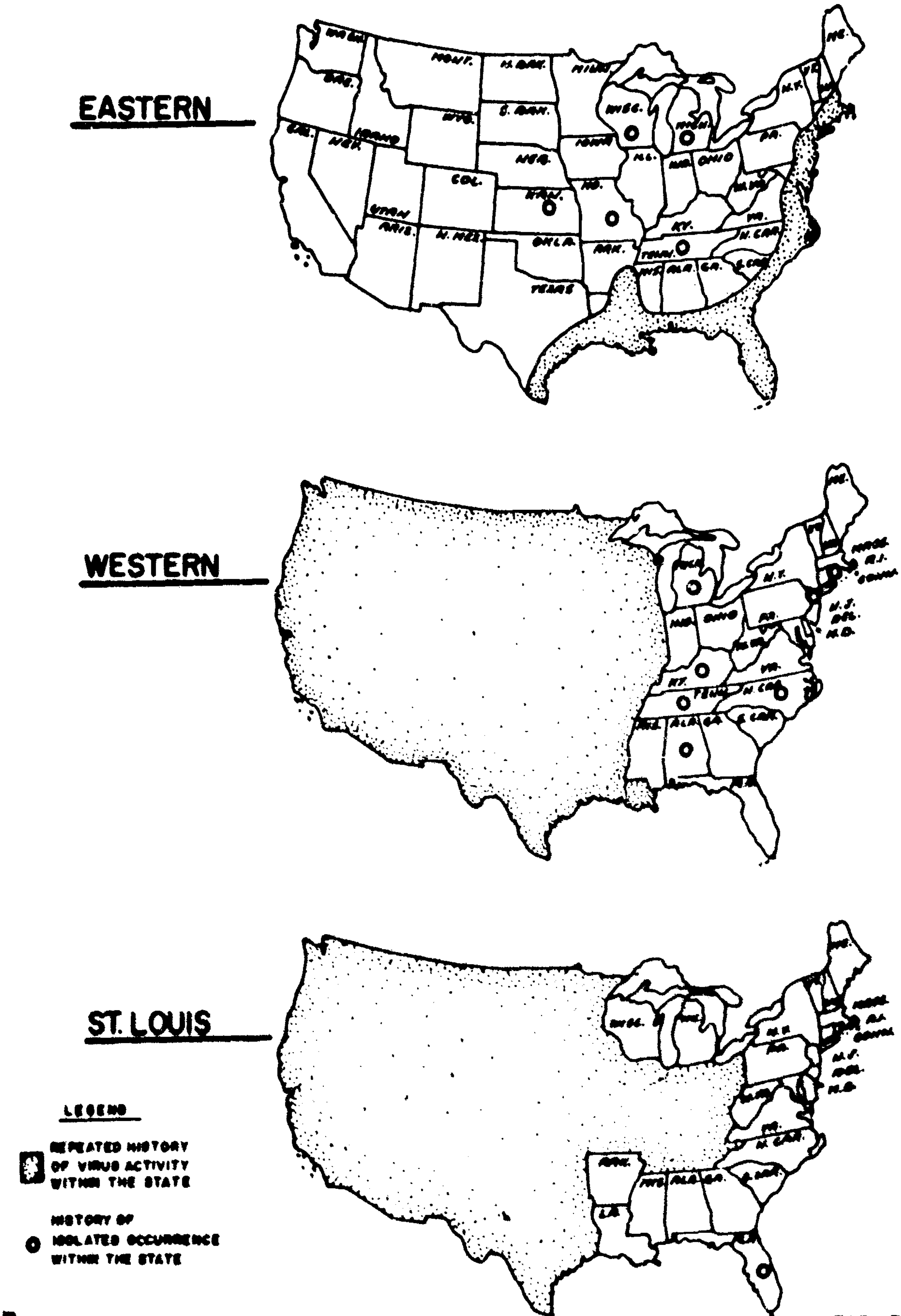
Of the three strains, one strain, Eastern Equine Encephalitis (EEE), may be excluded from consideration in this assessment of urban problems under post nuclear attack conditions. This is mainly because the significant vector, Culiseta melanura, is a fresh water swamp mosquito with limited flight range and because of absence of migratory wild swamp bird EEE reservoirs in principal metro. areas. It is also because EEE occurs in men only in the form of miniature epidemics, and the largest number of cases ever recorded from an entire state in a year's time was 34 (Mass. 1938).

Epidemiologic factors pertinent to assessment of the Western Equine Encephalitis (WEE) and the St. Louis strain (SLE) are:

(1) During the transmission season involving man, birds are the significant virus reservoir, with transmission to man by mosquito species which can be readily infected and which feed on both man and the infected bird species. Adequate densities of infected birds, mosquitoes and people and adequate common accessibility of bird and man to mosquito are required for significant transmission to take place.

GEOGRAPHICAL DISTRIBUTION OF THE ARTHROPOD-BORNE ENCEPHALITIDES IN THE UNITED STATES

(TOTAL VIRUS ACTIVITY IN MAN AND ANIMALS)



*1963-Preliminary Data

FIGURE 8

SOURCE: Communicable Disease Center Reports, Public Health Service, USDHEW.

(2) Hot dry weather is pe-requisite to a human encephalitis outbreak. In California, which has both WEE and SLE, significant transmission does not take place unless average daily ambient temperatures (av. of min. and max.) are over 80°F, and this has been the general observation elsewhere for these two strains.* On this basis, under average year conditions, only 29 cities in the United States with 1960 populations of over 100,000 have an average temperature in July (hottest month), of 80° or over, and in only one case does the central city population approach a million. The 29 cities are: Phoenix and Tucson, Ariz., Little Rock, Ark., Mobile and Montgomery, Ala., Oklahoma City and Tulsa, Okla., Jackson, Miss., Fresno, Calif., Jacksonville, Miami, St. Petersburg and Tampa, Fla., Columbus, Macon and Savannah, Ga., Baton Rouge, New Orleans and Shreveport, La., and Austin, Beaumont, Corpus Christi, Dallas, El Paso, Ft. Worth, Houston, Lubbock, San Antonio and Wichita Falls, Tex. Of these 29 cities, 12 lie outside of the WEE-SLE zones depicted in Figure 8, and 17 cities including St. Petersburg and Tampa, Fla., lie inside. During abnormally hot, dry years, the 80° temperature zone expands northward, especially in the Plains states, with the reverse holding true in cool, wet years.

(3) Unlike the enteric diseases, WEE and SLE are self-limiting seasonal infections without accumulative characteristics. WEE mosquito isolations can be made over a six (6) months period (May-Oct.), with human incidence over about four (4) months and with an early summer-mid summer peak. SLE isolations can be made over four (4) months (June-Sept.), with human cases concentrated in late summer. In localities satisfying temperature criteria in only a single month, the active transmission season is necessarily shortened.

(4) Human encephalitis can be urban or rural, depending on the local mosquito vector, with Culex tarsalis being the primary vector of both strains on the west coast and northern plains states and Culex pipiens-quinquefasciatus elsewhere. In California, an important "encephalitis" state, where significant transmission of encephalitis to man is confined to the Central Valley, a large proportion of the cases are rural and are associated with waste irrigation water, which provides the vector habitat. Under postattack conditions, creation of abnormal quantities of pooled water simulating waste irrigation water in large urban areas within the geographic range of C. tarsalis, could result in urban encephalitis problems provided infected wild birds were also locally present and ambient temperatures satisfactory. C. pipiens-quinquefasciatus, on the other hand, is equally prevalent in rural and urban areas wherever highly polluted water is found. It is most prevalent under dry weather conditions when there is less dilution of polluted water. Under postattack conditions during the warm season, its numbers could greatly increase in urban areas in the event of sanitary sewer system disruption.

(5) As an index of maximum hazard in a single city under certain postattack conditions, the 1130 cases of SLE occurring in the St. Louis epidemic of 1933 are cited, representing a rate of about 1,500 per million or 0.15% of the total population. This was the largest number of cases ever reported from a single city and exceeds the total number of encephalitis cases for the entire United States in most years. This outbreak represented a disease level in the absence of control measures, due to the fact that the vector was unknown in 1933, and was under abnormally favorable dry, hot weather conditions. At that time, domestic poultry were

*Proceedings and Papers - Ann. Conferences of California Mosquito Control Assn.

relatively common in St. Louis and provided the infection reservoir. In the absence of such a reservoir under present conditions in cities, it cannot be reasonably postulated that an outbreak of this magnitude would take place even with a superabundance of vectors.

Dengue and Yellow Fever

Over the past 20 years a great natural reduction has taken place in the geographic distribution and local prevalence of the mosquito vector of these diseases (Aedes aegypti) in the Continental United States. In 1963, the vector was known to be present only in the following 12 central cities of the United States of 100,000 population and over and in most of them it is very scarce even at the height of the production season: Birmingham, Mobile and Montgomery, Ala., Jacksonville, Miami, St. Petersburg and Tampa, Fla., Atlanta, Columbus and Macon, Ga., Baton Rouge, La. and San Antonio, Texas.

Dengue fever is indigenous in the Caribbean Islands and cases were imported into the Continental United States as recently as 1964. During previous United States urban outbreaks (1922 and 1934), as many as 10% or more of the total population of a city became ill from dengue over a six (6) weeks period. Under postattack conditions, it is our assessment that a slight hazard of dengue importation in warm weather months into the 12 cited cities may exist. The primary limiting factor during such periods is likely to be in the presence or absence of arriving travellers from those Caribbean Islands in which dengue happens to be prevalent at the time, with their presence excluded by definition under the Isolation Condition. If dengue did become established in any receptive United States City under postattack conditions, we would assess the maximum incidence at around 1% of the surviving population, due to prevailing vector scarcity. We would not expect vector prevalence to increase under postattack conditions because of limited favored breeding places in the United States.

We would assess the yellow fever importation hazard as negligible under postattack conditions, partly for epidemiological reasons cited above. It has now been 59 years since yellow fever was last imported into the United States (New Orleans outbreak in 1905). Many changes have taken place in foreign yellow fever countries since then, among them being the eradication of urban yellow fever from most of them in the Western Hemisphere along with eradication or disappearance of the vector in human beings, absence of problem in other airport and seaport areas and effective international quarantine independent of United States foreign quarantine.

Summary of Mosquito-Borne Disease Hazard

Estimated attack rate in absence of countermeasures:

Human Encephalitis - 0.15% of the surviving population.
Dengue Fever - 1% of surviving population
Malaria - not likely to be a problem
Yellow Fever - not likely to be a problem.

MISCELLANEOUS DISEASE PROBLEMS

A marked change in the environment of the domestic animals especially the dog may result in unattended animals and the formation of dog packs increasing the incidence of animal rabies through contact with animals harboring sylvatic rabies in the wild animal reservoir adjacent metropolitan areas, and in turn human rabies especially if an unenlightened population emerging from shelters attempts to administer to sick and dying dogs. In addition there is the likelihood of such dog packs attacking the sick and injured, especially small children. The peacetime practice of requiring rabies vaccination of dogs as a part of annual licensing and the use of serum to treat dog bite victims (where indicated) controls this hazard under normal conditions. However, some metropolitan areas are thought to have a greater number of unlicensed animals than licensed (vaccinated) dogs. This condition is especially bad in the lower socioeconomic groups. The stray animals picked up in those communities studied averaged 15,000 per year per million population. The total dog population in such areas at any one time is estimated to average 30,000 per million population. The reported geographic distribution of animal rabies is shown in Figure 9.

The contact with tick infected dogs or other reservoir animals is not expected to increase in the postattack period, so long as there is no movement of appreciable populations from the cities into tick infected areas. Figure 10 shows the distribution of reported cases of Rocky Mountain Spotted Fever in the United States for the year 1962.

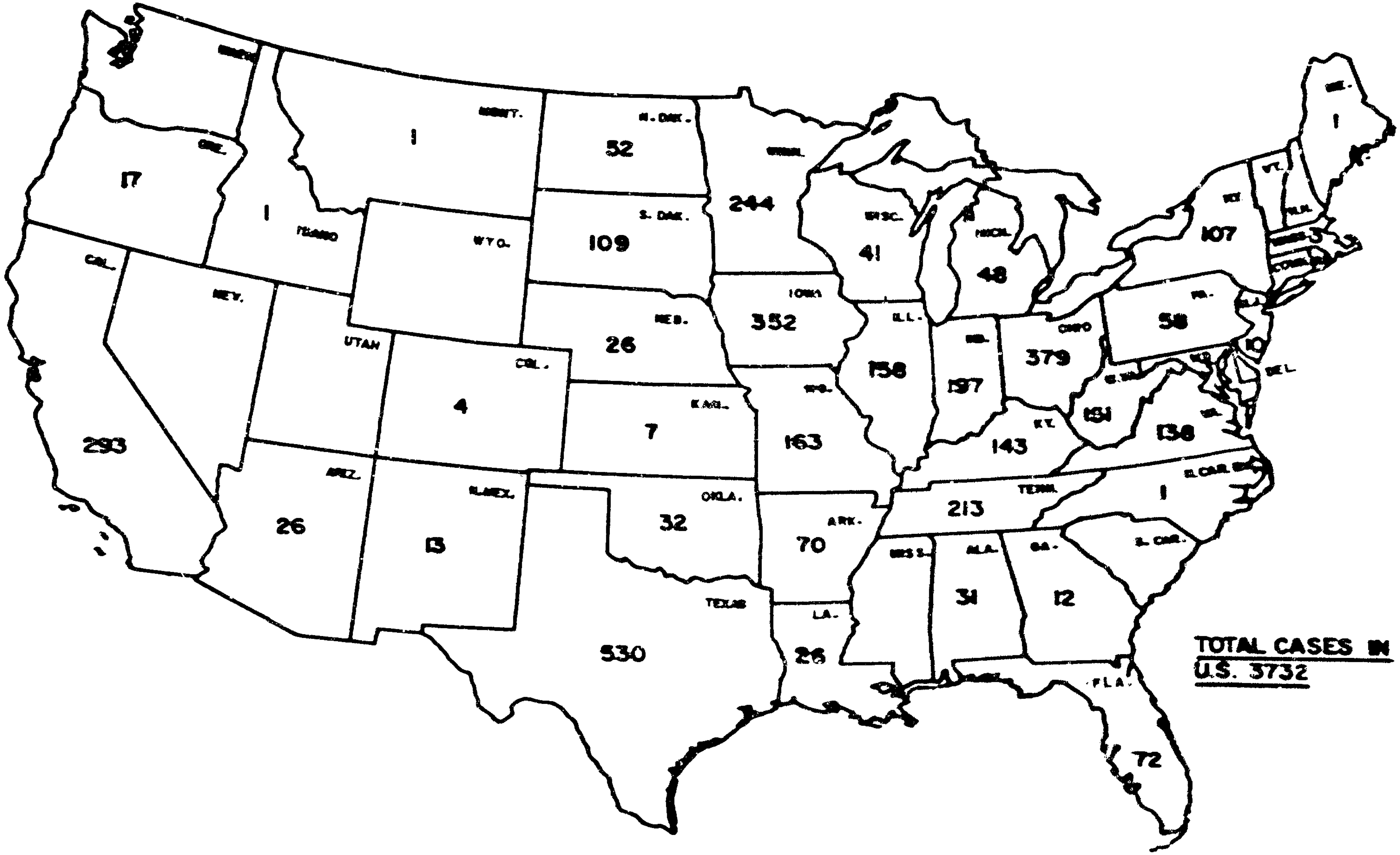
Summary

The control of animal rabies and, in turn, human rabies will likely be a significant problem in the postattack period in some communities, depending on whether there is an adjacent sylvatic reservoir. Rocky Mountain Spotted Fever is not expected to be a problem in urban areas in a postattack period.

POSTATTACK ENVIRONMENTAL SANITATION NEEDS

The control of postattack environmental conditions as it pertains to sanitation, waste disposal and pests and vectors will influence the ability to recover as well as the rate of recovery. The prevention of exposure of human feces to flies that in turn may deposit infective organisms in susceptible foodstuffs is of primary importance in all disasters where normal living with developed safeguards are interrupted. For a condition of fallout and sheltering, as well as the one that includes material damage, the hazard of outbreaks of some filth-borne diseases will be limited only by the measures taken in the early postattack period. The extent of these hazards will be influenced by the current environmental conditions. Also important in the early postattack period is the control of disease vectors, such as mosquitoes, fleas and ticks, in areas experiencing epidemic or endemic outbreaks at time of attack. The early postattack measures in this regard should be geared to the current disease incidence and known vector involvement at time of attack.

The role of houseflies as enteric disease vectors plus the shigellosis reservoir are considered of sufficiently general importance to indicate need for special control measures in all situations where exposed organic materials have accumulated due to interruption of sewerage and refuse collection service as a result of sheltering, provided the nuclear attack takes place during the fly production season. In the event of structural damage resulting in additional accumulations of organic materials under rubble, the need for special housefly control measures becomes proportionately greater. These special chemical control measures will be directed against the adult fly and will also control adult mosquitoes. Their time duration can be very short (one application), under Fallout Conditions where collection and disposal of solid organic wastes proceeds according to schedule, or extended indefinitely in the event of slow progress in wastes sanitation or where spoilable

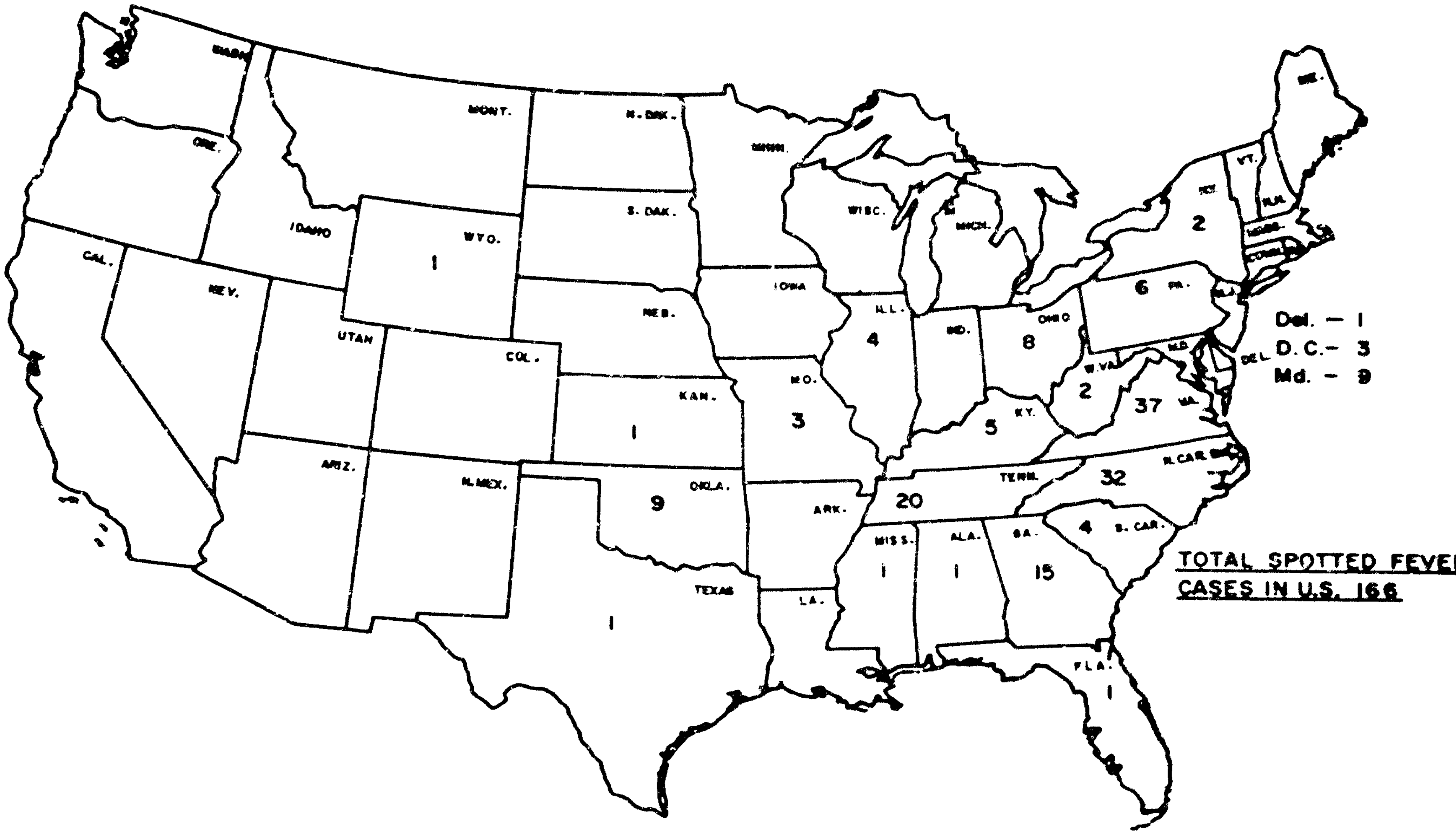


TOTAL CASES IN U.S. 3732

REPORTED CASES OF ANIMAL RABIES IN 1962

SOURCE: Communicable Disease Center Reports, Public Health Service, USDHEW.

FIGURE 9



REPORTED CASES OF ROCKY MOUNTAIN
SPOTTED FEVER IN 1963*

*1963 Preliminary Data

SOURCE: Communicable Disease Center Reports, Public Health Service, USDHEW.

FIGURE 10

food supplies are in large accumulations of rubble under some Structural Damage Conditions. Measures for the control of houseflies (adulticiding) should be initiated prior to general exodus from shelters (or as soon thereafter as possible); the early control of mosquitoes is equally important in areas of epidemic or endemic mosquito-borne disease at time of attack.

ASSESSMENT OF EFFECTIVENESS OF CONTROL MEASURES

The high level of public health in the United States and particularly the generally low morbidity rate for those fourteeen (14) diseases of concern in this study (Table I) confirms that there are controls that are effective for peacetime conditions. To assess the effectiveness of available controls in a postattack environment, we have considered the historical distribution of the several diseases, the environmental conditions that influence the distribution and rate, the environmental conditions that may prevail postattack, and the effectiveness of available control measures under such environmental conditions. In this consideration we have assumed that the resistance of infective material, vectors, and hosts will in no way be increased by the attack itself. Furthermore, we have assumed that knowledgeable people, at least equal to those normally making judgment decisions and directing such programs, staff the postattack operations. The information presented in Table XVIII is developed using these general assumptions; and is applicable to nationwide (sizeable metropolitan populations) postattack conditions.

TABLE XVIII

POSTATTACK HAZARD OF ENVIRONMENTAL DISEASE

DISEASE	POSTATTACK HAZARD	
	Without Countermeasures	With Countermeasures
Enteric (Shigellosis, Infectious Hepatitus, Salmonellosis, Typhoid, Amoebiasis)	Up to 75% population within 3 month period	0.1 to 10% morbidity rate (depending on response of environment and advance preparation)
Mosquito Borne		
Encephalitides	0.15% of population	Only 0 to .02% in very limited locations
Dengue Fever	1.0% of population in 5% of the U.S.	Not likely
Malaria	Not likely	-
Yellow Fever	Not likely	-
Rodent-Borne		
Leptospirosis	0.1% of population	Not likely
Rat Bite Fever	0.05% of population	Not likely
Murine Typhus	In limited isolated locations, developing slowly.	Not likely
Plague	Not likely	-
Rocky Mountain Spotted Fever	Not likely	-
Rabies	Likely in limited low socioeconomic areas.	Not likely

SUMMARY OF POSTATTACK DISEASE HAZARD

The fly-borne enteric diseases (so-called filth diseases) may become a hazard in the postattack environment and will be limited only by the effectiveness of measures for the handling of human feces and the control of adult flies in the early postattack period. Also important in the early postattack environment is the control of mosquitoes (encephalitides), and fleas and ticks (leptospirosis, typhus) in areas experiencing epidemic or endemic outbreaks at time of attack. There are procedures that can be effectively applied under postattack conditions with advance preparation for minimizing the hazard of such diseases.

EVALUATION OF RELATIVE PREPAREDNESS

A limited study of Civil Defense and Emergency Operational Plans as now adopted, or actively in the formulation-proposal stage, for a relatively few metropolitan areas of the Continental United States indicates responsibility for the planning and development of a Civil Defense capability and readiness to act program has been assigned in all those instances examined. Furthermore, staffing and programming for the development of operational plans and procedures for sanitation, waste disposal and vector control has generally been accomplished by the assignment of knowledgeable individuals having pre-attack responsibilities in such disciplines. It appears generally that organizational plans for postattack sanitation operations have been established with assignment of personnel (with provision for succession of command). In doing this, the personnel of existing governmental environmental sanitation operations have generally been utilized to staff the plan. Some in this planning, have actively engaged the help of personnel other than public employees (such as, private pest control operators, private refuse collectors, etc.) and are entering into formal agreement for the use of the material, equipment, and personnel available from such sources.

It is our considered opinion that the advance preparation, including staffing and training for operations under conditions of structural damage and fallout, have not progressed sufficiently to now be considered adequately ready to act for the control of critically essential environmental sanitation in an early postattack period.

It appears that additional advance planning is needed for a determination of the now available material and equipment inventories and an arrangement worked out for effective utilization on the highest priority needs in postattack operations. Furthermore, recruitment and training of workmen for the specialized postattack operations is essential to the development of adequate effective functional plans.

CHAPTER VIII

TOTAL OPERATIONAL REQUIREMENTS

One of the two objectives of this study provides that -- "The Contractor shall -- establish methods for deriving the total operational requirement of proposed post-attack procedures for sanitation, waste disposal and pest and vector problems (including supplies, equipment, manpower, training and other factors)." Chapter V which deals with postattack countermeasures under various aspects covers this methodology requirement in the Statement of Work. Because vector-borne disease problems, a significant element of the study, are related to local and regional environmental conditions and are not nationwide in many of their manifestations, it has been judged preferable to deal with them in their respective geographical and climatic settings.

In this chapter, a different approach is taken. An attempt is made to assess these local and regional problems on a nationwide basis and to integrate them into the logistical requirements of the other study element which is considered nationwide under postattack conditions, namely solid organic waste disposal.

URBAN POPULATIONS, NATIONWIDE

Operational requirements for postattack conditions within the scope of the study are definitely needed on a nationwide, seasonal and/or regional climatic basis, or conditionally needed in the event of the abnormal development of adverse environmental and ecological conditions having a wide range of probability of occurrence. For the purpose of establishing a nationwide reference frame, all cities with a 1960 census population of 25,000 or over have been considered.

The following Table, XIX shows the numbers and populations of cities classified as to size which are contained within this assumption. In estimating the 1964 populations, it has been assumed that in the 4 years since 1960 there was an average zero population growth in cities over 500,000 population and an average 15 percent total growth within the corporate limits of cities between 25,000 and 500,000 population.

TABLE XIX

POPULATIONS OF UNITED STATES CITIES ACCORDING TO SIZE FROM A 1960 CENSUS BASELINE OF 25,000

Population Classification	No. of Cities (1960)		Population (millions) 1960		1964	
1 million or more	5		17.5		17.5	
500,000 to 1 million	16		11.1		11.1	
250,000 to 500,000	30		10.8		12.4	
100,000 to 250,000	81		11.7		13.5	
Subtotal		132		51.1		54.5
50,000 to 100,000	201		13.8		15.9	
25,000 to 50,000	432		15.0		17.3	
Subtotal		633		28.8		33.2
TOTAL		765		79.9		87.7

The estimates of nationwide operational needs which appear later in this chapter are given in terms of Range of Need (Minimum and Maximum) and Probable Need. These terms require explanation of the procedure followed in obtaining the listed values. It is again noted that these needs are total inventory needs and not stockpile needs.

The Minimum Need for each type of postattack measure within the scope of this study is expressed as zero and in general, may be considered as representing a Minimum Isolation Condition lasting, perhaps, two to four weeks outside of the fly and mosquito prevalence season. Such a Zero Inventory Condition slightly understates the situation when it is applied to municipal refuse collection and disposal operations, but the time period is so short and the operating conditions will be so nearly normal that the activity is expected to utilize its own internal resources in all respects. The Minimum Condition is theoretical only because it is not expected to occur on a nationwide basis.

The Maximum Need (theoretical) for each type of postattack measure is that in which all 765 of the United States cities experience at the same time, the most adverse possible set of damage conditions continuing for a maximum time period, and in which these damage conditions are accompanied by the most adverse possible combination of environmental disease conditions. While the over-all probability of these two sets of conditions occurring simultaneously throughout the United States cannot be appraised statistically with any degree of precision, it is likely to be in the order of 10^{-6} to 10^{-9}, even in a postattack environment because of the natural barriers that will continue to control in localized areas.

Determination of the Probable Need requires that an arbitrary assumption be made of the number of metropolitan areas which would be directly affected by nuclear attack and of the severity of the attack condition. The adopted assumption is that a total of 200 of the 762 cities would be affected beyond the "isolation" level and would have a 3 months disaster need and that these 200 cities would include all 21 cities of over 500,000 population and a higher proportion (about twice) of those between 100,000 and 500,000 population than of those below 100,000. Table XX shows the nationwide population in the assumed 200 cities to be 47 million.

TABLE XX

ESTIMATE OF POPULATIONS EXPERIENCING "PROBABLE" POSTATTACK OPERATIONAL NEEDS

Population Classification	No. of Cities		Population (Millions) 1964	
1 million or more	5		17.5	
500,000 to 1 million	16		11.1	
Subtotal		21		28.6
250,000 to 500,000	14		5.7	
100,000 to 250,000	38		6.2	
Subtotal		52		11.9
50,000 to 100,000	40		3.2	
25,000 to 50,000	87		3.5	
Subtotal		127		6.7
TOTAL		200		47.2

When the activity needs of each specific sanitation countermeasure are superimposed on the preceding basic assumption, there results a wide variation between Probable Need and Maximum Need. This is because Solid Organic Refuse Collection and Disposal, for example, would be carried on routinely in all postattack cities. Conversely, tactical fly control operations would be carried on only during the period of housefly prevalence (See Figure 1) and the need for mosquito control would vary not only with season of the year but also with locally prevailing disease hazard and disease incidence conditions.

The probability factors involved in mosquito-borne disease conditions illustrate one aspect of their variability. The probability of each strain of arthropod-borne encephalitis occurring in man at some place in the United States every year is 100 percent and the same may be said of the occurrence of the Western and St. Louis strains at one or more places in California. Yet the probability of this happening in any given year throughout all of the shaded areas shown in Figure 8 is remote. This is one reason for the low order of probability assigned previously to the Maximum Need Condition. Figure 8 shows the general areas where virus activity has been found in some species of birds, horses or in man at one time or another over a period of many years and not in any single year. Since arthropod-borne encephalitis involves birds primarily, horses secondarily and man as a spillover manifestation, Figure 8 principally reflects virus activity in animals, not in man. It thus depicts historically where there has been an actual or potential hazard to man. Also, because the map depicts general areas, it includes urban and rural localities where virus activity or any type has never been demonstrated.

In Table XXI the number of cities and their populations are shown which are contained in the combined shaded areas for St. Louis and Western Equine Encephalitis (Figure 8). Table XXI also includes the populations of St. Petersburg and Tampa, Florida in view of the repeated occurrence of human anthropod-borne cases in the urban or suburban areas of these cities.

TABLE XXI

POPULATIONS AND NUMBERS OF CITIES ABOVE 25,000 POPULATION IN 1960 WHICH ARE LOCATED IN STATES HAVING ST. LOUIS AND/OR WESTERN EQUINE ENCEPHALITIS VIRUS ACTIVITY

Population Classification	No. of Cities (1960)		Population (Millions) 1960		1964	
1 million or more	2		6.0		6.0	
500,000 to 1 million	9		6.8		6.8	
Subtotal		11		12.8		12.8
100,000 to 500,000	63		14.0		16.1	
25,000 to 100,000	316		14.0		16.1	
Subtotal		379		28.0		32.2
TOTAL		390		40.8		45.0

EFFECT OF SEASONAL OCCURRENCE ON OPERATIONAL NEEDS

Solid Organic Waste Collection and Disposal

With rare exceptions, this operation under postattack conditions would be carried out independently of the season of the year

Tactical Domestic Fly Control Measures

As shown in Figure 1, the season of housefly prevalence ranges from 3 to 12 months and averages about 6 months for the United States. Under Maximum Need Conditions lasting one year, up to 6 months of tactical fly control operations would be required from a seasonal prevalence standpoint. Under Probable Need Conditions lasting 3 months the calculated probable operating time would be (0.25 x 0.5 x 12) or 1.5 months However, because the control of houseflies by chemicals is viewed largely as a short-term emergency measure, not more than one month's operations should be needed under either Maximum or Probable Postattack Conditions, when considered on the over-all national need (it must be recognized localized areas of damage will require chemical control for an extended period) with a seasonal probability factor of 0.5 applied to one month's operations under Probable Postattack Conditions for the major portion of the United States.

Domestic Rodent Control

Transmission of rodent-borne diseases is affected by season and by ambient temperatures in relation to latitude and elevation through their effect on flea vectors. Rodent reproduction also has seasonal characteristics. However, rodent control work is deemed necessary for other reasons than disease transmission. Generally, there would be a time lag of about a month in starting rodent control following nuclear attack for areas other than those that are experiencing rodent-borne diseases For these reasons, 11 months of operation would be needed under Maximum Postattack Conditions

Mosquito Control

The average mosquito breeding season for species of greatest interest is about the same as the season of housefly prevalence as shown in Figure 1. However, tactical mosquito control operations under postattack conditions would be needed mainly for encephalitis control (St. Louis and Western strains). Referral to preceding urban population tables will show that about half of the number of cities above 25,000 population and of the total population in these cities are located in "virus activity" states for the two strains. In gross number, this would amount to about 390 cities (See Table XXI under Maximum Postattack Conditions and about 0.5 x 200 or 100 cities under Probable Postattack Conditions. After making exclusions for climatic and other environmental reasons and in relation to history of extent of urban occurrence in "virus activity" States under "worst year" conditions, the estimated net number of affected cities would be about 25 percent of the gross number under Maximum Conditions and about 10 percent under Probable Conditions. The actual number of cities, accordingly, would be 0.25 x 390 or about 100 for Maximum Conditions and 0.1 x 100 or about 10 cities under Probable Conditions.

The encephalitis transmission season varies from one to four months over the climatic range of the "virus activity" States, averaging about two months. The average control season is about one month longer, or three months. On a probability basis in relation to control season and Postattack Condition, three months of control work would be needed under Maximum Conditions in the 100 cities and 0.25 x 0.25 x 12 (equivalent to three weeks) in each of 10 cities under probable conditions.

Rabies Control

Rabies control is classed as a short-term emergency operation. Under maximum postattack conditions, it might be carried on for two weeks in about half of the 765 cities (about 380 cities totalling 44 million population). In the remaining cities, rabies control presumably would not be carried on, due to absence of a natural rabies reservoir. Under probable postattack conditions, operations are postulated in 100 cities with 24 million population.

EFFECT OF SIZE OF CITY ON OPERATIONAL REQUIREMENTS

The term "size of city" applies to population and not to area. In Chapter V data were presented for typical control operations for each 100,000 population. Actual logistical requirements per unit of 100,000 people tend to vary with size of city as well as with many other variables. However, except for certain mosquito control operations, the estimates in this chapter can reasonably be applied on a straight line basis to all urban populations. That is, the operational requirements of a city of 1 million may be considered as 10 times that of a population of 100,000 for a given activity.

For the control of mosquito breeding the operational requirements for cities are largely on an individual city basis, depending mainly on the extent and nature of breeding places in peripheral areas and species flight range. Thus, the magnitude of the job of controlling mosquito breeding can be as great for a city of 25,000 as for one of 100,000. On the other hand, in highly urbanized cities of 500,000 or more, the breeding control problem tends to be more in proportion to population, because the principal vector species is likely to be found mainly in catch basins and associated water carrying structures, at least under peacetime conditions. The total problem may be no greater than in a much smaller size of city with different vector species. This situation is one of the many reasons for the observation made earlier in this report that needs of communities should be locally determined. Accordingly, our estimate of mosquito breeding control requirements in this chapter is on a uniform basis per city, without respect to population size. On the other hand, short-term requirements for adult mosquito control, which have been merged with equally short-term adult fly control activities, earlier in this study, tend to be more closely related to population size of city.

EFFECT OF TYPE OF POSTATTACK CONDITION ON LOGISTICAL REQUIREMENTS

As will be noted in Chapter V (Table V and subsequent discussion) and the basic data in Chapter V both the type of postattack condition (Isolation, Fallout, Structural Damage) and the degree and type of Structural Damage (Primary Blast Area, Secondary Blast Area with unoccupiable structures and Secondary Blast Area with occupiable structures), have important bearing on the logistical requirements of organic content refuse collection and to a lesser extent, collection and disposal of nightsoil from shelters.

Some arbitrary assumption must be made of the pattern of these postattack conditions in developing an estimate of nationwide requirements. For this reason, in developing manpower, supply, and equipment requirements which follow, the following assumptions have been made for both Maximum and Probable Attack Conditions. However, values for any other proportion of assumed conditions can be readily made by referring to data in Chapter VII.

Postattack Condition	Percent of Total	Population Affected (Millions) Probable	Maximum
Isolation	0	0	0
Fallout Only	67	31.6	58.7
Structural Damage with Fallout	33	15.6	29.0
TOTAL	100	47.2	87.7

The two total population values listed above are those given in Tables XIX and XX.

For the Structural Damage population, we have used values listed in Chapter V namely one-quarter of the pre-attack population in a zone of total devastation (Area A-primary blast) and three-quarters in a zone of structural damage (Area B-secondary blast), with 60 percent of the commercial structures and 40 percent of the residential structures unrepairable (unoccupiable) and the remainder repairable (reoccupiable) in Area B.

TRAINING NEEDS

The Statement of Work calls for "methods of deriving ...... training needs". Training needs are not included in the Summation of Operational Needs which follows; however, the approximately 16,000 men designated as supervisory and skilled and an estimated 8,000 of the unskilled and semi-skilled men for a total of 24,000 men should be trained. Even though it is assumed that the bulk of the manpower will be unskilled with knowledgeable supervisory and skilled operator personnel drawn from survivors engaged in similar peacetime activities. Special training for disaster operations in a postattack environment is considered to be essential for advance preparation.

SUMMATION OF NATIONWIDE OPERATIONAL NEEDS

The postattack manpower needs are presented in Table XXIII and for the logistical support needs of the listed activities in Table XXIV. The geographical distribution of these needs over the nation is not indicated. Generally the distribution is similar to that of population (over 100,000 units in metropolitan areas). The principal exception to this is that for mosquito control and plague as discussed earlier.

TABLE XXII

NATIONWIDE CONTROL NEEDS

	No. of Cities		Population (millions)		Seasonal Control Prob-ability Factor	Gross Control Period (Mos.)	
	Max.	Prob.	Max.	Prob.		Max.	Prob.
Refuse Sanitation	765	200	88.	47.	1.0	12	12
Tactical Fly Control	765	200	88.	47.	0.5	1	0.5
Rodent Control	765	200	88.	47.	1.0	11	2
Rabies Control	380	100	44.	24.	1.0	0.5	0.5
Tactical Mosquito Control	100	10	-	-	0.25	3	0.75

TABLE XXIII

MANPOWER REQUIREMENTS NATIONWIDE METROPOLITAN AREAS
(For 1 yr Postattack period)

Control Activity	Men per 100,000 Population(1)			Total Number of Men					
				"Maximum" Needs 88 Mil. Popl.			"Probable" Needs 47 Mil. Popl.		
	Sup.	Skilled	Unsk.& Semi-Sk.	Sup.	Skilled	Unsk.& Semi-Sk.	Sup.	Skilled	Unsk.& Semi-Sk.
Refuse Sanitation	3	3	84	2,000	3,000	74,000	1,000	1,400	40,000
Tactical Fly Control	2	4	4	2,000	4,000	4,000	500	1,400	1,000
Rodent Control	1	4	-	1,000	3,500	-	500	1,900	
Rabies Control	1	2	-	500	1,000	-	-	500	
Tactical Mosquito Control	4*	6*	-	2,500	2,500	-	250	300	
TOTAL	11	19	88	8,000	14,000	78,000	2,250	5,500	41,000

MAN-MONTHS

	88 Mil. Popl.			47 Mil. Popl.		
	Sup.	Skilled	Unsk. & Semi-Sk.	Sup.	Skilled	Unsk. & Semi-Sk.
Refuse Sanitation	24,000	36,000	948,000	12,000	17,000	480,000
Tactical Fly Control	1,000	3,000	2,000	500	1,500	1,000
Rodent Control	11,000	38,500		1,000	4,000	
Rabies Control		500			250	
Tactical Mosquito Control	1,500	1,500		200	250	
TOTAL	37,500	79,500	950,000	13,700	23,000	481,000

FOOTNOTES:

* For only a portion of Nation and not per 100,000 population. Nightsoil Collections are included in Refuse Sanitation where sewers are damaged.

(1) Manpower will need to be double that indicated for a period following sheltering equal to the shelter period; and, tripled for longer periods, possibly 3 months, in areas of extensive material damage.

TABLE XXIV

SUMMATION OF NATIONWIDE OPERATIONAL NEEDS BY TYPE OF POSTATTACK OPERATION EQUIPMENT, SUPPLIES, LAND

		Vehicular Equipment									Land Needs		Fuel	
ACTIVITY	Popl. in Mil.	Trks. 12 yds Packers	Trks. Garbage & Swill	Dump Trks.	Trks. 2 ton Flat-bed	1/2 ton Pick Up	Trks. 1/4 ton	Bull-dozer & Skip-loaders[2]	Drag-lines	Light Gener-ators	Dump Sites No.	Dump Acres	Gasoline Million Gallons	Diesel Million Gallons
Refuse Management	88	25,000	5,000	3,000				4,000	500	2,000	1,000	10,000	110.50	13.8[illegible]
	47	14,000	3,000	2,000				1,500	250	500	500	5,000	59.47	7.4[illegible]
Tactical Fly Control	88				3,000								0.29	
	47				2,000								0.16	
Domestic Rodent Control	88						5,000						4.38	
	47						3,000						2.36	
Rabies Control	88													
	47													
Tactical Mosquito Control	88					500	500[1]						0.50	
	47					50	50[1]						0.050	
TOTALS	88	25,000	5,000	3,000	3,000	500	5,500	4,000	500	2,000	1,000	10,000	115.22	13.89
	47	14,000	3,000	2,000	2,000	50	3,050	1,500	250	500	500	5,000	62.04	7.48

1. Each vehicle mounted with a 60 gal pressure and associated compressor (6 cubic feet per minute capacity).
2. Equal number of bulldozers and skiploaders.

TABLE XXIV (continued)

SUMMATION OF NATIONWIDE OPERATION NEEDS BY TYPE OF POSTATTACK OPERATION EQUIPMENT, SUPPLIES, LAND

		Vector Control Equipment										
ACTIVITY	Popl. in Mil.	Mist Sprayer on vehicle + 300 gal tank	Snap Traps	Bait Boxes	Cyanide Dust Pumps	Shot-guns 12 ga	Shot-gun shells	Granule Hand Spreader	Sprayer Hand, 3 gal	Duster, Hand	300 ft Spray Hose & Gun[4]
Refuse Manage-ment	88										
	47										
Tactical Fly Control	88	3,000									
	47	2,000									
Domestic Rodent Control	88		90,000	70,000	2,000						
	47		50,000	35,000	1,000						
Rabies Control	88					1,000	500,000				
	47					500	250,000				
Tactical Mosquito Control	88							1,000	1,000	1,000	500
	47							200	200	200	100
TOTALS	88	3,000	90,000	70,000	2,000	1,000	500,000	1,000	1,000	1,000	500
	47	2,000	50,000	35,000	1,000	500	250,000	200	200	200	100

4. Each 300-foot hose is considered a unit.

TABLE XXIV (continued)

SUMMATION OF NATIONWIDE OPERATION NEEDS BY TYPE OF POSTATTACK OPERATION
EQUIPMENT, SUPPLIES, LAND

		Pesticides										
ACTIVITY	Popl. in Mil.	25% Dia-zion Million Gallons	Anti-coagulant poison bait lbs	Anti-coagu-lant 1 oz cone packets	1080 Conc. lbs	Zinc Phos Conc. lbs	Calcium Cyanide Dust lbs	DDT, 25% Emul Conc Gals	Mala-thion 8 lb/gal Emul Conc. Gals	Tossits	Larvi cide Oil 50+ % AR Gals	Fenthion Granules 1% lbs
Refuse Manage-ment	88											
	47											
Tactical Fly Control	88	2.70										
	47	1.5										
Domestic Rodent Control	88		900,000	900,000	20,000	20 000	30 000					
	47		425,000	500 000	10,000	10 000	15 000					
Rabies Control	88											
	47											
Tactical Mosquito Control	88							25,000	15,000	200,000	300,000	200,000
	47							2,500	1,500	20,000	50,000	20,000
TOTALS	88	2.70	900,000	900,000	20,000	20,000	30,000	25 000	15,000	200,000	300,000	200,000
	47	1.5	425,000	500,000	10,000	10,000	15,000	2,500	1,500	20,000	50,000	20,000

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APPENDIX A

EPIDEMIOLOGICAL INFORMATION FOR SIGNIFICANT ENVIRONMENTAL DISEASES

A. Shigellosis (Bacillary Dysentery)

An acute bacterial infection of the alimentary tract caused by organisms of the *Shigella* group. Mortality is low in most groups, but shigellosis is often the principal cause of death among infants in areas where sanitary conditions are poor.

1. Reservoir and source of infection - Man; source of infection is feces from infected individual.

2. Mode of transmission - from ingesting contaminated milk, water, food; by infection through the mouth from hands or other objects contaminated by feces of patients and carriers, by flies.

3. Incubation Period - One to seven days, usually less than four.

B. Acute Infectious Hepatitis (Intecticus Jaundice, Epidemic Hepatitis, Epidemic Jaundice, Catarrhal Jaundice)

An acute, generally mild infection caused by a virus, transmissible mainly to man as a result of poor sanitation, also by blood transfusions. Fatality rate high for serum hepatitis, low for naturally acquired infections. It is a disease which may be of long duration. Little is known about the prevention and treatment of this disease.

1. Reservoir and source of infection - Man; the feces from an infected person; nasal pharyngeal discharges may be involved.

2. Mode of transmission - Mode uncertain in many situations, possibly through intimate contact with infected person through nasal pharyngeal discharges, fecal contamination and hands, food and milk; water has been definitely incriminated in some instances

3. Incubation Period - 10 to 40 days, commonly 25 days.

C. Salmonellosis (including Paratyphoid)

A common, acute intestinal infection caused by numerous species of Salmonella bacteria pathogenic to animals and man, spread by improper cooking or poor sanitation of foodstuffs particularly those of animal origin.

1. Reservoir and source of infection - Man and animals; carriers, acutely infected patients and domestic pets, meat and meat products, commonly poultry, eggs; rodents.

2. Mode of transmission - multiple means.

   a. Meat products prepared under insanitary conditions.
   b. Improperly cooked foods containing duck and hen eggs; powdered egg is more often incriminated than fresh egg.

c. Improperly pasteurized milk contaminated by cow feces or by handlers.
d. Contamination of food by infected persons.
e. Food contaminated by rodent feces, flies and cockroaches.
f. Infection acquired from household pets.

3. Incubation Period - 6 to 48 hours, usually about 12 hours.

D. Typhoid Fever

Generalized, debilitating bacterial infection (Salmonella typhi) with a currently moderate fatality rate. Poor sanitation is responsible.

1. Reservoirs and source of infection - Man is the reservoir, comprising acutely infected individuals and carriers.

2. Mode of transmission - by direct contact with patient or carrier, with urine or feces being the source of the infection, by indirect contact through contaminated water, milk, milk products, raw vegetables, fruit and other foods; contamination of water supplies may be from sewerage systems, contamination may be from flies, roaches, or infected persons handling food.

3. Incubation Period - 1 to 3 weeks, usually 2 weeks.

E. Murine Typhus (Flea Borne Typhus, Endemic Typhus)

A rarely fatal (2%) though disabling rickettsial disease (Rickettsia mooseri), primarily transmitted by rodent fleas.

1. Reservoir and source of infection - Roof rat (Rattus rattus), Norway rat (Rattus norvegicus), Southern cotton rat (Sigmodon hispidus), deer mouse (Peromyscus polionotus), are the common reservoirs. Sources of infection are certain infected arthropods particularly Xenopsylla cheopis through the rat-flea-rat cycle.

2. Mode of transmission - Feces of infected fleas enter puncture wound depositing the rickettsiae. Other modes of rickettsial transmission may be by inhalation of infected rat urine. Infected fleas retain infection for up to 52 days and rats may retain infection for longer periods.

3. Incubation Period - 6 to 14 days, commonly 12 days.

F. Plague

An acute, very severe, short course bacterial disease (Pasteurella pestis) transmitted from rodents to man, usually by fleas, having a mortality rate of about 60% in the United States, commonly demonstrated by the appearance of a bubo in lymph nodes of neck, groin, armpit - hence "bubonic" plague; virtually always fatal when in septicemic, tonsillar and primary pneumonic forms.

1. Reservoir and source of infection - Essentially it is a flea transmitted disease among wild rodents, and is of considerable public health concern in situations where intermingling of wild and domestic rodents occurs, such as city dumps located in undeveloped areas. Infected Xenopsylla cheopis fleas occurring on domestic

rats may transmit the disease to man. All human cases since 1924 in the United States were attributed to contact with wild rodents, usually ground squirrels (Citellus spp.) and their fleas.

2. Mode of transmission - There are two means of transmitting this disease: a) By flea bites resulting in Bubonic plague. X. cheopis fleas having fed upon an infected rat may become infected but usually are not infectious from a few days to 3 or 4 weeks, until the P. pestis multiply and block the esophagus. In attempting to feed, the plague bacilla are regurgitated and are inoculated into the site of the bite. Infections may occur by flea feces being scratched into the site of the bite. Infectious fleas usually die of starvation in from 3 to 5-1/2 days. Wild rodent fleas probably transmit plague to man in a similar manner. Sylvan plague may be also transmitted by direct contact with the infected animals. b) By droplet infection from a plague victim who has developed a pneumonic infection, thus "pneumonic plague".

3. Incubation Period - 2 to 6 days.

G. Encephalitides - Arthropod Borne -

Viral diseases of the brain, spinal cord and meninges of which the important ones in the United States are Eastern Equine, Western Equine and St. Louis types transmitted primarily by mosquitoes from birds to man.

1. Reservoir and source of infection - More than likely reservoirs are certain wild and domestic birds with winter carry-over in adult mosquitoes and probably wild snakes (Ref. Communicable Disease Center 1964).

a. Eastern Equine. Host birds include certain wild migratory and resident birds as well as domestic birds such as chickens. Mosquitoes likely to be vectors to man from birds include Culiseta melanura Culex salinarius and possibly Anopheles crucians.

b. Western Equine. Migratory, resident and domestic birds are involved in this disease. Mosquitoes incriminated in spread of the disease include certain Aedes, Anopheles, Culiseta and Culex spp. particularly Culex tarsalis.

c. St. Louis. The reservoir is primarily an avian-culicine one with mosquitoes, primarily Culex tarsalis and Culex pipiens-quinquefasciatus complex.

2. Mode of transmission - The viral infections are spread by the named mosquitoes which most likely obtained the virus from birds. Man to man or horse to man transmission is not a factor in spread.

3. Incubation Period - 5 to 15 days.

H. Rocky Mountain Spotted Fever

A severe febrile disease with a high fatality rate if untreated, caused by a rickettsia (Rickettsis rickettsii) transmitted by ticks from small mammals to man.

1. Reservoir and source of infection - It is reservoired by small mammals, and occasionally by birds, living in dense, low vegetation. In the mountainous areas of Western United States, wild rodents, rabbits, and skunks carry several Ixodid or hard shell tick vectors of which Dermacentor andersoni is the significant one of man; in the eastern seaboard states dogs and commensal rodents moving through dense brush in urban lots or in open areas near habitation carry the tick vector, usually the dog tick D. variabilis. In the southeastern United States, the Lone Star Tick, Amblyomma americanum is the vector found on small wild mammals.

2. Mode of transmission - It is transmitted by the bite of a tick which has acquired the infection from a reservoir mammal. The same or other species of ticks may transmit ,the disease among the reservoir animals. The disease may be acquired by the larva, nymph, or adult tick and retained throughout its life, or it may be transmitted from the female adult to the egg and thence through the larva, nymph and adult. The disease may also be acquired by crushing an infected tick into an abraded area or puncture of the skin.

3. Incubation Period - 3 to about 10 days.

I. Leptospirosis (Hemorrhagic Jaundice, Spirochaetosis, Icterohemorrhagica, Canicola Fever (Weil's Disease))

An acute infectious debilitating disease caused by a spirochete, Leptospira icterohemorrhagiae, L. canicola, L. autumnalis, and L. pomona, in the urine of commensal rats and mice, generally confined to occupations where waters and foodstuffs may be contaminated, viz: Sewerage workers, miners, slaughterhouse men, and bathers. The fatality rate has varied from 4 to 48%.

1. Reservoir and source of infection - Rats, dogs and cattle most commonly implicated; also found occasionally in mice, swine, fox, and cats. Ten to 45% of Norway rats in communities are often infected. More information on distribution in rat population needed. Rats are asymptomatic whereas dogs have a high mortality rate. Dogs seem to be assuming a more important role in the transmission of the disease.

2. Mode of transmission - Through contact with water or food contaminated with urine of infected animals; through contact directly with infected animals. Disease agent may enter by ingestion or through injured skin or mucous membranes.

3. Incubation Period - 4 to 19 days, usually 10 days.

J. Rabies (Hydrophobia)

A viral encephalitic disease for which there is no treatment, except palliative treatment. Vaccine treatment may produce active immunity and anti-rabies serum administered simultaneously with vaccine in severe bites of the head, face and neck may give a passive immunity.

1. Reservoir and source of infection - Spread by numerous species of animals including dogs, foxes, coyotes, cats, skunks, vampire and insectivorous bats and other biting animals. Greatest hazard to man is from rabid stray dogs.

2. Mode of transmission - is from the infected saliva deposited by the bite of a rabid animal.

3. Incubation Period - 2 to 6 weeks.

K. Amoebiasis

A chronic infection of the colon by a protozoa, Entamoeba histolytica rarely causing death directly. Disease may follow an insidious course leading to chronic discomfort. Occasionally epidemics of acute amoebiasis have a high fatality rate.

1. Reservoir and source of infection - In the United States, man usually is an asymptomatic chronic carrier. Few carriers show clinical symptoms in the United States.

2. Mode of transmission - Fecal contamination with fecal cysts on hands of carrier; contaminated vegetables usually served fresh; fecal contaminated water supplies; flies and roaches may at times play a role as vectors.

3. Incubation Period - 5 days to several months, commonly 3-4 weeks.

L. Malaria

A disease characterized by periods of chill alternating with longer febrile intervals caused by infection with certain plasmodia (Plasmodium vivax, P. falciparum, P. malariae, and P. ovale).

1. Reservoir and source of infection - Man is the important reservoir.

2. Mode of transmission - is from man to certain anopheline mosquitoes to man.

3. Incubation Period - 12 to 30 days.

M. Yellow Fever

An acute infectious mosquito-borne viral disease with characteristic jaundice in many cases. Death rate varies from 5-50% depending upon endemicity with lower rates in areas of highest endemicity.

1. Reservoir and source of infection - In the United States man would be the reservoir with vector the Aedes aegypti mosquito. At the present time no infection exists in the human population in the United States although there are foci of the virus in the monkey and other sylvan animal populations of Mexico, Central and South America.

2. Transmission of the disease is from man to the mosquito to man.

3. Incubation Period - 3 to 6 days.

N. <u>Dengue (Breakbone Fever)</u>

A viral mosquito-borne disease characterized by joint pains with low fatality rate but very debilitating with prolonged convalescence.

1. Reservoir and source of infection - Man and the *Aedes aegypti* mosquito. No substantial transmission in Continental United States since the 1930's, when there were tons of thousands of cases in southern states in a single year. Cases were imported from the Caribbean in 1963 and 1964.

2. Mode of transmission - is from an infected patient to the *Aedes aegypti* mosquito to man.

3. Incubation Period - 3 to 15 days, commonly 5.

APPENDIX B

ALTERNATE VECTOR CONTROL MATERIALS
FLY CONTROL PESTICIDES

Pesticide	Formulation	Rate of Application	Number of Gallons of Pesticide Required for Program (population unit-100,000)
Diazinon, 25% Emulsion Concentrate (2 lb/gallon)	11 gallons EC per 34 gallons water	15 gallons per mile with 150 ft swath	28, 55-gallon drums (1,540 gallons)
Diazinon, 47.5% EC (4 lb/gallon) (most common commercial EC)	11 gallons EC per 68 gallons water	15 gallons per mile with 150 ft swath	14, 55-gallon drums (770 gallons)
Malathion 55% EC(5 lb/gallon)	5 gallons EC per 41 gallons water	20 gallons per mile with 150 ft swath	17, 55-gallon drums (935 gallons)
Malathion 80% EC(8 lb/gallon)	5 gallons EC per 60 gallons water	20 gallons per mile with 150 ft swath	10, 55-gallon drums (550 gallons)
Fenthion(Bayer 29493,Baytex) 4 lb/gallon	11 gallons EC per 68 gallons water	15 gallons per mile with 150 ft swath	14, 55-gallon drums (770 gallons)
Dichlorvos (DDVP,Vapona) 50% EC	6 gallons EC per 44 gallons water	15 gallons per mile with 150 ft swath	151, 5-gallon cans (755 gallons)
Naled (D.brom) 65% EC (8 lb/ gallon)	15 gallons EC in 50 gallons water	15 gallons per mile with 150 ft swath	37, 5-gallon cans (185 gallons)
Dimethoate (Cygon) 50% EC (4 lb/ gallon)	3 gallons EC in 50 gallons water	20 gallons per mile with 150 ft swath	95, 5-gallon cans (475 gallons)

ALTERNATE VECTOR CONTROL MATERIALS
MOSQUITO CONTROL PESTICIDES

Pesticide	Formulation	Rate of Application (Larvacide)	Number of units of Pesticide Required for Program (Population unit-100,000)
Larvacide Oil 50-60% chromatics	2 ounces Triton X-45 spreader per 100 gallons oil	5-10 gallons/acre	500 gallons(short term) 3000 gallons(long term)
Weed oils 50-90% chromatics	4-6 ounces Triton K-45 spreader per 100 gallons oil	10-15 gallons/acre	800 gallons(short term) 4800 gallons(long term)
Diesel No. 2	---	15-25 gallons/acre	1000-1500 gallons (short term) 6000 gallons(long term)
Fenthion granules 1%	1 pound Fenthion per 99 pounds granules (15 mesh)	0.1 pounds/acre(10 pounds granules)	200 pounds(short term) 2000 pounds(long term)
Malathion granules 5%	5 pounds Malathion per 95 pounds granules (15 mesh)	0.5 pounds/acre (10 pounds granules)	200 pounds(short term) 2000 pounds(long term)
DDT-25% EC (2 lb/gallon)	1 gallon EC to 99 gallons water	0.2 pound/acre (10 gallons of formulation	250-275 gallons (long term)
Fenthion 4 lb/gallon)	1 quart EC to 99-3/4 gallons water	0.1 pound/acre (10 gallons of formulation	125 gallons (long term)
Malathion 8 lb/gallon	2 quarts EC to 79-1/2 gallons water	0.5 pound/acre (10 gallons of formulation	300 gallons (long term)

ALTERNATE VECTOR CONTROL MATERIALS
RODENTICIDES

Rodenticides	Formulation	Rate of Bait* Application per Infected Area	Number units of Rodenticides Requires for Program (Population unit-100,000)
#1:Anticoagulants (Warfarin, Pival, diaphacione, Fumarin)	50 lb 0.5% conc.per 950 lbs bait (corn meal)	600 lbs per square mile in residential area and food establishments @ rate 2.5 lbs per place.	900 lbs 0.5% conc.
#2:Sodium monofluoracetate (1080)	1/4 lb conc."1080" per 195 gallons of water For Sewers 1/2 lb conc."1080" per 200 lb bait (cereal, ground meat, fish) may be made into wax blocks bait-cereal)	Under strict supervision 195 gals per square mile in indoor infestations, placed at rate 25-2 oz souffle cups/premises. For Sewers 200 lb bait/sq mile or 2 lbs bait/sewer manhole	20 lbs concentrate
#3:Zinc phosphide	2 lbs poison conc. per 150 lbs bait (cubed dry bread, vegetable-or cereal mixed with ground meat, fish)	150 lbs per square mile for indoor infestation Under supervision. 5 lb/acre on dumps	20 lbs concentrate
#4: Calcium cyanide dust	As is	1/2 oz per rat burrow about 35 burrows/pound	30 lbs

* It is standard practice to pre-bait without poison to test the rats acceptance of food bait. 1080 should be placed at protected identified bait stations because of acute hazard. Anti-coagulants should be placed in identifiable feeding stations for refilling if time permits. Other baited poisons will be placed out in units of 80 teaspoonful per premises. They may be wrapped in wrapper or other paper and tossed into infested areas.

ALTERNATE RODENTICIDES

Rodenticides	Formulation	Rate of Bait* Application per Infected Area	Number units of Rodenticides Required for Program (Population unit - 100,000)
Thallium sulfate (Substitute for #2 & #3).	1 lb poison per 200 lb bait(cereal & ground meat, fish) For Sewers - 1 lb per 200 lbs/bait.	150 lb per sq mile for indoor infestations under supervision. 5 lbs per acre at Dumps. For Sewers - 200 lb per sq mile or 2 lbs bait per sewer manhole.	50 lbs conc.
Red squill (Substitute for #1).	50 lbs poison per 550 lbs bait (vegetables, fresh fruit, cereal, ground meat, fish).	600 lbs per sq mile, in residential areas and food establishments @ rate of 2.5 lbs per place.	1,800 lbs formulated concentrate.
Sodium fluoracetate (Substitute for #2).	4 lbs poison per 200 lbs bait (cereal, ground meat, fish) May be made into wax blocks with cereal bait.	For Sewers only 200 lbs bait per sq mile or 2 lbs bait per sewer manhole.	80 lbs
Strychnine sulfate (Substitute for #3).	2 lbs poison conc. per 150 lbs bait in cereal, ground meat, fish, fresh fruit, vegetables.	150 lbs. per sq mile for indoor infestation under supervision - 5 lbs/acre at dumps.	30 lbs
Arsenic trioxide (Substitute for #3).	6 lbs poison conc. per 150 lbs bait (bread, cereal, vegetable, ground meat, fish). May add 1 part tartar-emetic to 4 parts poison.	150 lbs per sq mile for indoor infestations. Under supervision 5 lbs/ acre at dumps.	60 lbs
DDT dust - 50% Substitute for (#3 & #4)	As is.	700 lbs per sq mile @ rate of 1/4 lb per burrow or 2-3/4 lbs per premises. 15 lbs per acre on dumps.	7,000 lbs

ALTERNATE VECTOR CONTROL MATERIALS
FLEA CONTROL MATERIAL

1% Lindane Dust -	700 lbs/square mile
5% Malathion Dust -	700 lbs/square mile
2 or 4% Chlordane Dust -	700 lbs/square mile
10% Methoxychlor Dust	700 lbs/square mile

APPENDIX C

PREDICTED FLY-BORNE ENTERIC DISEASE ATTACK RATES

In the absence of countermeasures, the predicted attack rate of 10% to 90% of the surviving population by enteric infections, almost entirely shigellosis, is an estimate, based on the potentialities of shigellosis under varying conditions of mass exposure to infection (including strain factors), immunity, resistance and time. A wide range is cited because of the many variables involved. Published data on clinical attack rates are largely generalized and qualitative for the upper attack levels in the predicted range because the circumstances under which they occur are such that diagnostic laboratory and morbidity reporting services tend to be non-existent. Where published data are available, they are largely or wholly limited to mortality rates, due to exigency conditions. An upper limit of 90% is given because even where an infection appears to affect everyone, a few are not attacked for one reason or another.

Even the lowest rate of 10% is rarely if ever approached in an effluent, sanitated society on a communitywide basis, although fecal swab survey rates among special groups, such as migrant farm labor, American Indians and depressed Appalachian coal mining communities, have been several times above this floor in recent years.

Historically, the highest shigellosis clinical attack rates have occurred among population groups exposed to changed environment, crowding, insanitation, particularly among refugees, prisoners of war and military forces engaged in particularly arduous campaigns. Among military forces, the higher rates in severely exposed commands are often diluted by statistics for theaters of war or entire armies. In World War II, the highest rates among American forces most likely occurred in such situations as among prisoners of the Japanese in the Philippines and forces engaged in the Burma and New Guinea campaigns but such undiluted rates are not available.

During the post-shelter period and in the presence of severe and extensive structural damage and absence of countermeasures, it is readily conceivable that survivors may be exposed to conditions of privation and infection spread approaching those previously cited. Under more favorable general conditions but with exposure to some infection hazards, values in the lower part of the range would tend to apply.

As a qualitative index of shigellosis potentialities under adverse conditions, the following excerpts are cited from pp. 541-576 of Reference 38.

"History- Epidemics of dysentery have been noted since ancient times, the widespread and fulminating nature of such outbreaks in times of war and famine have impressed observers in all ages. The disease is apparently referred to in the Ebers Papyrus (1600 B.C.) -- Bacillary dysentery tends to appear in extensive epidemics spreading over temperate as well as tropical and subtropical parts of the world. (p. 541).

"The occurrence of the disease in epidemic form is influenced by the sanitation of the region, being more prevalent in communities where fly suppression and garbage disposal are not properly controlled. (p. 543).

"Dysentery and War - In times of war, with large forces of soldiers, bacillary dysentery tends to become the most important disease encountered by military surgeons. -- In its epidemic form -- it has been particularly a disease of armies in the field -- it was the most important disease in the British Armies in the eastern Mediterranean area, Macedonia and Gallipoli (in World War I) -- in Gallipoli it was said to be largely responsible for some 100,000 casualties -- it was bacillary dysentery and not the Turk which drove the British troops out of Gallipoli (p.543)

"-- outbreaks are particularly influenced by hygienic conditions and the presence of flies -- Manson-Bahr also notes that epidemics of houseflies coincide very closely with epidemics of bacillary dysentery. (p.544).

"In military barracks, as well as other institutions where large numbers make use of the same water-closet accommodations, the chances of contamination of the seat by a patient responding to the frequent and imperious demands for evacuation are most probable, with subsequent transference of the infectious material to others. (p.551).

"Fly transmission is usually of much greater importance -- It has been well recognized that dysentery bacilli will live for several days in the intesting of the fly and be passed in the dejects." (p.552).

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