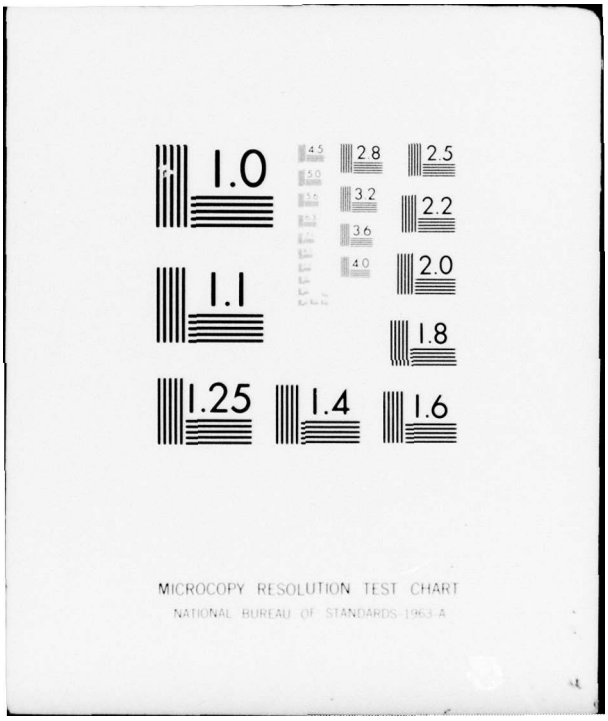
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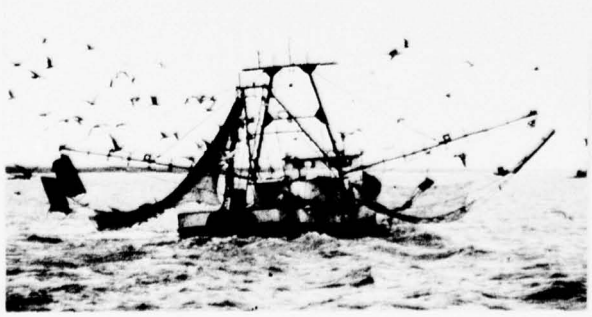



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Lower Mississippi Region
Comprehensive Study







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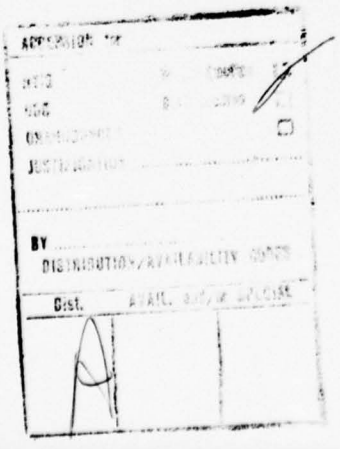
Appendix M
Health Aspects
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This appendix is one of a series of 22 documents comprising the complete Lower Mississippi Region Comprehensive Study. A list of the documents is shown below.

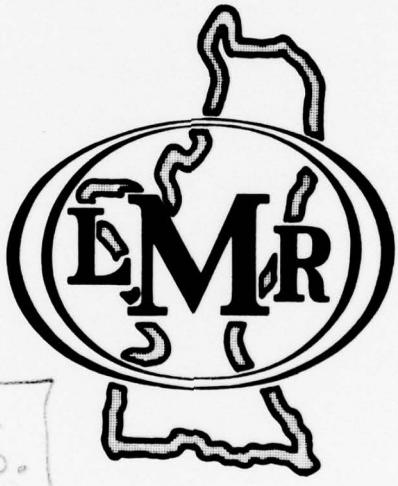
Main Report

Appendixes

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B	Economics	L	Water Quality and Pollution
C	Regional Climatology Hydrology & Geology	M	Health Aspects
D	Inventory of Facilities	N	Recreation
E	Flood Problems	O	Coastal and Estuarine Resources
F	Land Resources	P	Archeological and Historical Resources
G	Related Mineral Resources	Q	Fish and Wildlife
H	Irrigation	R	Power
I	Agricultural Land Drainage	S	Sediment and Erosion
J	Navigation	T	Plan Formulation
		U	The Environment



HEALTH ASPECTS.



(11) 1974 (12) 115 p.

(6) LOWER MISSISSIPPI REGION COMPREHENSIVE STUDY.

Appendix M.

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This report was prepared at field level by the Lower Mississippi Region Comprehensive Study Coordinating Committee and is subject to review by interested Federal agencies at the departmental level, Governors of the affected States, and the Water Resources Council prior to its transmittal to the President of the United States for his review and ultimate transmittal to the Congress for its consideration.

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I N T R O D U C T I O N

PURPOSE AND SCOPE

The purpose of this report is to present information on the human health aspects of water resources development in the Lower Mississippi Region. It discusses the health of man as it relates to such development directly through drinking water and recreational water, and indirectly through insects and other vectors which breed on the water and land of the region. The activities of State health agencies in the Lower Mississippi Region are analyzed and future needs in connection with health aspects of water resources development are outlined.

RELATIONSHIP TO OTHER APPENDIXES

This report has a direct relationship to four other appendix reports of the Lower Mississippi Region Comprehensive Study. It is a close companion to Appendix L, Water Quality and Pollution, in that it deals with water quality for the domestic consumer. Likewise, the report acts as a companion discussion of drinking water quality to Appendix K, Municipal and Industrial Water Supply, and Appendix C, Regional Climatology, Hydrology, and Geology. The report can also be associated with Appendix N, Recreation, because of its discussion of primary water contact recreation and disease vector control in the region.

PRESENTATION OF MATERIAL

The presentation of material in this report deviates from the established format for the Lower Mississippi Region Comprehensive Study. The nature of health aspects is predicated on activities of State health agencies. Presentation on a State basis was determined to best fit the needs of this report because following the Water Resource Planning Area (WRPA) basis would result in needless repetition among sub-areas. In addition, the needs developed by this report are primarily qualitative and do not necessarily lead to quantitative measurement.

REGIONAL SUMMARY

GENERAL

The Lower Mississippi Region includes most of Louisiana, almost half of Arkansas, a large part of Mississippi, and lesser portions of Tennessee, Kentucky and Missouri. The region also includes the southern tip of Illinois, but because the total land area of Illinois in the region is so small, it is not discussed herein. The limits of the region are shown on Figure No. 1.

The 1970 population of the region was 6,302,030. The region has only two large metropolitan areas - New Orleans and Memphis. However, these urban centers along with other small metropolitan areas contain almost 60 percent of the Region's population. The remainder of the region is predominantly rural.

The topography of the Lower Mississippi Region generally consists of the flood plains of the Mississippi River and its tributaries with intervening higher ground. The only areas of high elevation in the region are the Ouachita Mountains in the vicinity of Hot Springs, Arkansas. The principal low lands of the region are in coastal Louisiana, a belt of marsh extending approximately 30 miles inland.

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PRESENT STATUS

Epidemiological Assessment

Waterborne Disease

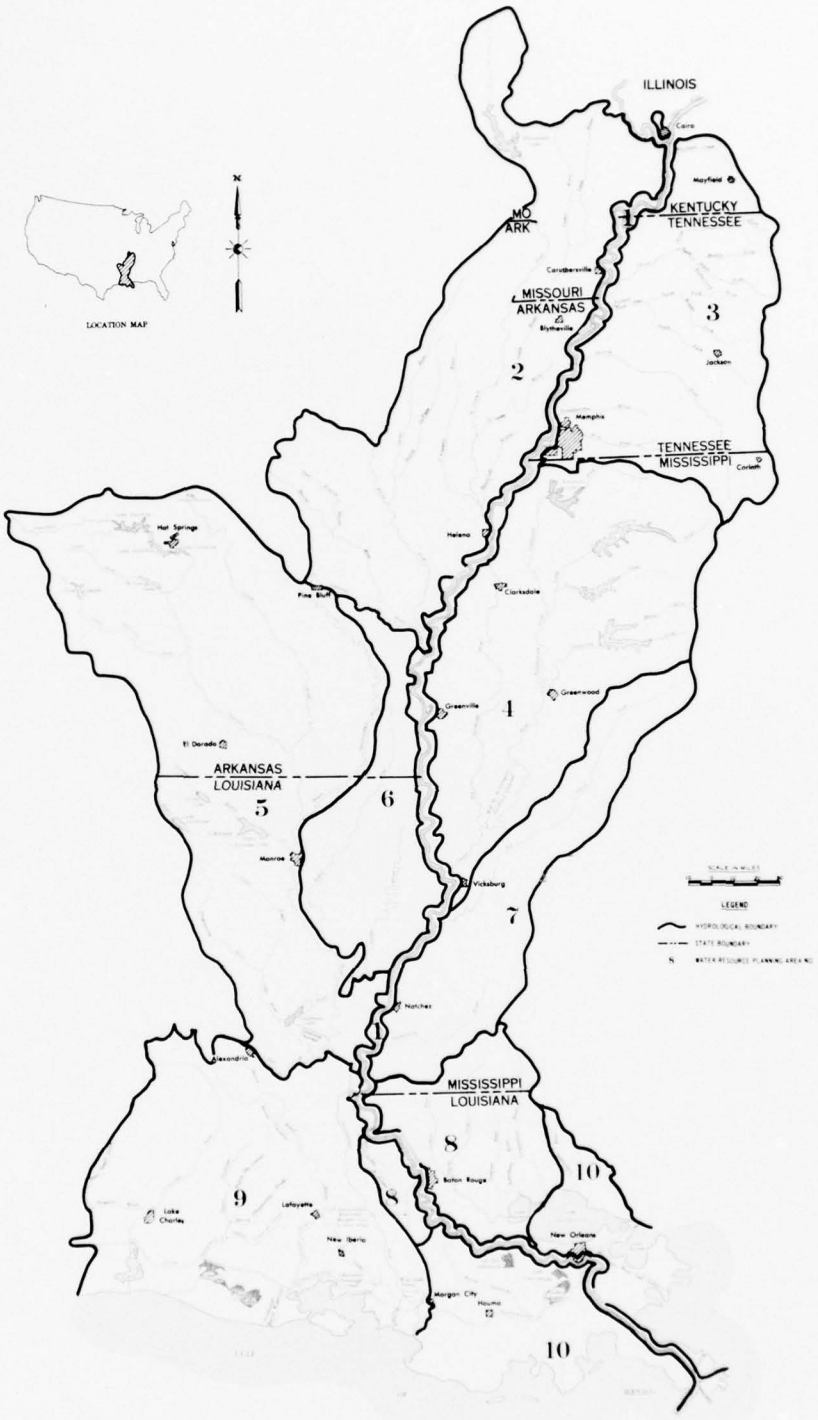
Since the middle of the nineteenth century, when Dr. John Snow did his classical study on the transmission of cholera through a water supply, it has been generally recognized that disease epidemics can, and do, result from consumption of water containing pathogenic microorganisms. Diseases most commonly associated with drinking water are typhoid fever, dysentery, infectious hepatitis, amebiasis, salmonellosis, and shigellosis. Spread of these diseases occurs most commonly when body wastes from the infected persons are ingested by others. While person-to-person contact is recognized as the more common method of transmission for low incidence levels currently found in this country, the potential for catastrophic epidemics transmitted by drinking water supplies which serve thousands of people remains and demands constant vigilance.

In recent years, concern has also been directed to the possible chronic illness which may result from use of water containing certain chemicals. These potentially dangerous chemicals include heavy metals, pesticides, and other toxic industrial products. Few clinical cases are recorded because health agency statistics are usually limited to communicable diseases and because affected individuals may have unrecognized symptoms. Increased reuse of water by municipal, agricultural, and industrial users indicates vigilance against chemical contamination must be maintained.

Human body wastes from infected persons, when present in inadequately treated drinking water, have caused waterborne disease outbreaks in the Lower Mississippi River Region. In all, thirteen outbreaks have been reported during the last 25 years which directly implicate drinking water as the source of disease transmission. Fortunately, none of the outbreaks resulted in a fatality.

From data assembled from Center for Disease Control (CDC) Reports (1)1/, table 1 presents significant potential waterborne diseases and a comparison of the number of cases occurring in the Lower Mississippi River Region versus the number occurring nationwide for the past 11 years.

1/ Number refers to Bibliography



LOWER MISSISSIPPI REGION
COMPREHENSIVE STUDY

REGIONAL MAP

FIGURE 1

Table 1 - Incidence of Potential Waterborne Disease, 1960-1970, Lower Mississippi Region [1/]

Year	Amebiasis	Hepatitis [2/]	Salmonellosis	Shigellosis	Typhoid
1960					
Reported LM [1/] Cases	80	1,238	251	287	97
Reported US Cases	3,424	41,666	6,929	12,487	816
Percent in LM	2.3	3.0	3.6	2.3	11.9
1961					
Reported LM Cases	71	2,996	335	269	57
Reported US Cases	2,850	72,651	8,542	12,571	814
Percent in LM	2.5	4.1	3.9	2.1	7.0
1962					
Reported LM Cases	71	1,811	351	356	56
Reported US Cases	3,048	53,016	9,680	12,443	608
Percent in LM	2.3	3.4	3.6	2.9	9.2
1963					
Reported LM Cases	38	1,178	464	355	57
Reported US Cases	2,886	42,974	15,390	13,009	556
Percent in LM	1.3	3.2	3.0	2.7	10.0
1964					
Reported LM Cases	48	1,178	390	356	28
Reported US Cases	3,304	37,740	17,144	12,984	501
Percent in LM	1.4	3.2	2.3	2.7	5.6
1965					
Reported LM Cases	41	974	483	339	27
Reported US Cases	2,768	33,856	17,161	11,027	454
Percent in LM	1.5	2.9	2.7	3.1	5.9
1966					
Reported LM Cases	44	1,025	406	277	22
Reported US Cases	2,921	32,859	16,841	11,888	378
Percent in LM	1.5	3.1	2.4	2.3	5.8
1967					
Reported LM Cases	37	1,232	434	292	35
Reported US Cases	1,157	38,909	18,120	13,474	396
Percent in LM	1.2	3.2	2.4	2.2	8.8

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Table 1 - Incidence of Potential Waterborne Disease, 1960-1970, Lower Mississippi Region (Con) 1/

Year	Amebiasis	Hepatitis 2/	Salmonellosis	Shigellosis	Typhoid
1968					
Reported LM Cases 3/	45	1,285	358	232	27
Reported US Cases	3,005	45,893	16,514	12,180	395
Percent in LM	1.5	2.8	2.2	1.9	6.8
1969					
Reported LM Cases	46	1,363	458	221	25
Reported US Cases	2,950	48,416	18,419	11,946	364
Percent in LM	1.6	2.8	2.5	1.9	6.9
1970					
Reported LM Cases	32	1,201	558	204	18
Reported US Cases	2,888	56,797	22,096	13,845	346
Percent in LM	1.1	2.1	2.5	1.5	5.2
Totals					
Reported LM Cases	553	15,481	4,488	3,188	449
Reported US Cases	31,201	504,777	166,836	137,854	5,628
Percent in LM	1.8	3.1	2.7	2.3	8.0

1/ Source "Morbidity and Mortality Reports," Center for Disease Control, Atlanta, Georgia

2/ Includes serum hepatitis for years 1960-1965

3/ Lower Mississippi Region data include the sum portions of each state's total, based on population in the region

The Lower Mississippi Region has approximately 3.2 percent of the Nation's population.

By comparing the incidence of the five diseases in the Lower Mississippi Region with their incidence on a nationwide basis, a higher incidence of typhoid fever and a lower incidence of all other diseases is evident. An attempt was made to include gastroenteritis in this disease occurrence summary, but sufficient data was not available. The disease is not a required reportable disease by CDC. However, limited data does indicate that the disease occurs in significant numbers in the Lower Mississippi Region.

The data in table 1 are not intended to imply that all reported cases were waterborne. It is intended, however, to point out that a portion of these cases, plus an unknown number of unreported cases, may have been waterborne. In addition, it is significant to note that body wastes from persons infected by these diseases pose the constant threat of contaminating public drinking water with pathogenic microorganisms.

Vectorborne Disease

Historically, the control of vectorborne diseases has been of extreme importance in this country and in the Lower Mississippi Region in particular. The scourges of malaria, yellow fever, and dengue have, for the most part, been successfully curtailed by control practices. Many of the control practices were associated with water resources development. However, the region still contains aquatic and other habitats favorable to the production of vectors of public health importance.

Vectorborne and vector related diseases which are presently significant in the region are listed in table 2 and discussed in the following paragraphs.

Encephalitis. The viral encephalitides are the most important mosquitoborne diseases within the region at the present. The occurrence varies from area to area, and from year to year. St. Louis encephalitis (SLE), Western encephalitis (WE), and California encephalitis (CE) are all apparently established in the region.

Present knowledge concerning the natural history of the encephalitis viruses indicates that there are two basic groups--one with a bird reservoir (WE, SLE) and the other with a rodent-rabbit reservoir (CE). Normally, the infection chain is limited to birds and small animals (reservoirs) and mosquitoes. Under certain conditions, the virus spills over into humans and horses. The large animals, while subject to severe illness or death, do not develop a sufficiently high level of viruses in the peripheral circulatory system to, in turn, infect the mosquito vectors. The mosquito vectors manifest considerable specificity for the different viruses. Humans and horses are accidental and dead-end hosts.

The convenient and succinct resume presented above for SLE, WE, and CE was precipitously jolted, however, during the summer of 1971 when yet another virus, Venezuelan equine encephalitis (VEE), spread from Mexico in epidemic

Table 2 - Incidence of Vectorborne Disease 1960-1970, Lower Mississippi Region 1/

Year	Arboviral Encephalitis 2/ SLE	WE	CE	Malaria	Tularemia	Rocky Mountain Spotted Fever	Leptospirosis
1960	-	-	-	6	165	26	19
1961	-	-	-	3	150	29	15
1962	-	-	-	9	136	35	9
1963	2	-	-	11	144	39	15
1964	30	2	-	7	144	37	13
1965	4	4	-	9	126	38	14
1966	22	1	-	58	99	44	11
1967	-	-	3	257	80	61	19
1968	1	-	10	192	42	61	7
1969	1	-	1	331	35	68	7
1970	-	-	-	294	63	39	4
Totals	60	7	14	1,177	1,184	477	133

1/ Source: Epidemiology Program, Center for Disease Control, Public Health Service

2/ St. Louis encephalitis (SLE), Western encephalitis (WE), and California encephalitis (CE)

proportions into southern Texas and beyond. This virus had been reported from the United States on only two previous occasions. Each involved one human case in Florida. The first case occurred in September, 1968 and the second in November, 1968. The Florida cases are reported as being caused by an endemic type II strain of VEE virus, while the 1971 Texas epidemic was due to a different type, IB, epidemic strain. The epidemic cycle of the IB antigenic subgroup of VEE (Texas outbreak) involves primarily horses and secondarily man and is probably transmitted by a number of species of mosquitoes which feed readily on these vertebrates. Unlike WE, the IB epidemic strain of VEE produces very high levels of virus in horses--sufficient to cause infection of mosquitoes. Although small mammals apparently serve as a reservoir for the endemic type II strain of virus found in Florida, horse-mosquito-horse (or man) transmission apparently was the mode which was operative under epidemic conditions in Texas in 1971.

Malaria. Worldwide, malaria remains the most important human disease transmitted by mosquitoes, and probably has had a more profound influence on world development than any other disease. Malaria was introduced into the United States during colonial days and spread with the settlement of the country, being particularly prevalent in the South. In the early 1930's over 100,000 cases were reported annually, but the number dropped to about 60,000 by the time of U. S. entry into World War II.

During World War II, malaria control work, mostly larviciding and drainage, was conducted on and around military bases by the various services and the PHS. The CDC was created in 1946 to broaden the scope of this program. Using military-proven DDT, the CDC, in cooperation with state departments of health, conducted the National Malaria Eradication Program. Efforts were based largely upon residual spraying of homes to kill infected Anopheles mosquitoes and break the chain of malaria transmission. About 1,365,000 homes were sprayed in 1948 during which year approximately 10,000 cases of malaria were reported. The number of reported cases was down to 7,023 by 1952, of which only about 50 gave evidence of being contracted within the United States. The residual spray program was curtailed after 1950, but surveillance continues. From 1957 to 1965 less than 200 cases were reported per year nationally, with almost all of them acquired overseas. Beginning in 1965, the number of cases reported within the country rose to 678, with 563 in veterans who served in malarious regions. In 1967, 2,855 cases were reported of which 2,698 were in military personnel.

This number has continued to climb to about 4,000 reported cases in 1969, 1970 and 1971 as more servicemen returned, mainly from Vietnam.

Although 10 species of Anopheles mosquitoes have been recorded for the states within the Lower Mississippi Region, only Anopheles quadrimaculatus is considered to be a significant vector. This species, however, is widespread and frequently locally abundant throughout the region.

While the vector is abundant and the human population susceptible, most malaria cases are imported from abroad into the United States. There have been since 1944 only 10 episodes of introduced malaria, i.e., malaria locally transmitted from indivuduals who acquired the infections abroad. A consideration of all factors indicates that surveillance remains important. All of these cases listed in table 2 were contracted abroad, the majority of them in Vietnam, with primary attacks or relapses in the veterans after returning to this country.

Tularemia. Tularemia is a highly infectious, plague-like disease which is reputed to be contracted usually by exposure to infected rabbits, hares, and rodents. Studies in Arkansas and Missouri, among the six states (including Tennessee), with the highest incidence of tularemia reported during the period 1959-1963, have indicated that transmission of the disease agent, Franciscella tularensis by ticks is the most common mode of infection to humans. The disease agent possesses the capability of penetrating the unbroken skin of man enhancing infection as a result of handling diseased animals.

As a consequence of the 1948 Arkansas studies and the high incidence of tularemia in the State, CDC and the State Department of Health cooperated on studies in 1951-1952 of the role of various species of ticks in the transmission of tularemia. The lone star tick, Amblyomma americanim, was found to be by far the most abundant tick, especially in the more mountainous and wooded areas. For the first time, this species was found in nature harboring the tularemia organisms. No other species of ticks were found to be positive, although the American dog tick, Dermacentor variabilis, collected with infected lone star ticks from the same animal, were tested. Probably the lone star tick is important as a vector of tularemia wherever it is abundant throughout the region.

Rocky Mountain Spotted Fever. Rocky Mountain spotted fever is a febrile disease caused by a rickettsia (Rickettsia rickettsii). It is characterized by sudden onset with fever which ordinarily persists for two to three weeks, headache, chills, and a rash which may cover most of the body. Fatality is about 20 percent in untreated cases. Spotted fever occurs throughout the region, but with less frequency than in the mountainous and wooded areas of the Southwest and West where the vector is more abundant.

In the region, two ticks, the lone star tick (Amblyomma americanum) and the American dog tick (Dermacentor variabilis) are the most important vectors of the disease from the small animal reservoir to man. The rabbit tick (Haemaphysalis leporis palustris) spreads the infection among small animals. The ticks also help to preserve the infection in nature (reservoir) as the organisms may be passed from one stage (egg, larva, nymph, adult) to another and from one generation (through the egg) to the next.

Leptospirosis. Leptospirosis (Wells' disease) is a group of acute infections with fever, headache, chills, severe malaise, nausea, muscular aches, conjunctivitis, and infrequently, jaundice, renal insufficiency, rash and hemorrage in the skin and mucus membranes. Clinical illness lasts from a few days to three weeks; relapses may occur. Fatality is low but increases with advancing age. It may reach 20 percent or more in patients with jaundice or kidney damage.

The reservoir for leptospirosis may be a number of large and small animals, both domestic and wild. The Norway rat is important in the maintenance of the disease in close proximity to man. The infection is transmitted by contact with water contaminated with the urine of infected rats and other animals. Outbreaks occur among swimmers and such occupational groups as sewer workers, farmers, veterinarians, abattoir workers, and military troops. The distribution of reservoirs of infection is worldwide in both urban and rural areas. Rat control in recreational and urbanized areas is a major preventive and control measure.

Epidemiological Surveillance

The national disease surveillance responsibility rests with the CDC , U. S. Public Health Service, in Atlanta, Georgia. However, the key to the disease surveillance activity is the state epidemiology program and its contact with local physicians. The state epidemiologists and local physicians are responsible for collecting, interpreting,

and transmitting data and epidemiological information and statistics in weekly, monthly, and yearly reports.

Each of the states in the Lower Mississippi Region has a State Epidemiologist who conducts a disease investigation and reporting program within the State Department of Health. Each does a fine job within the limit of their resources and contact with local physicians.

Drinking Water Supply

Introduction

President Kennedy set the basic objective of water resources planning when he said, "well-being of all of the people shall be the overriding determinant in considering the best use of water and related land resources." Planning for domestic water supply use is one of the most important phases in water resource allocation because the well-being of every human being depends on drinking water for life support. The delivery of a safe and adequate supply of water to each consumer requires sound planning, skilled engineering, and constant surveillance from the source to the free flowing outlet.

The fundamental document used in making a public health evaluation of drinking water is the "Public Health Service 1962 Drinking Water Standards"(Standards) (2). The Standards are used nationwide as either guidelines or regulations by health agencies at all levels of government. The American Water Works Association has endorsed the Standards as minimum standards for all public water supplies. The Environmental Protection Agency has adopted the Standards as regulations for all supplies which serve the interstate or foreign carriers. The states in the Lower Mississippi Region use the Standards as a guide and two, Kentucky and Arkansas, have adopted the Standards, or modifications thereof, as State Regulations.

Another document used in the evaluation of water supplies is the "Manual for Evaluating Public Drinking Water Supplies"(3). This publication broadens the engineering base established by the Standards. Also used are the National Technical Advisory Committee's "Water Quality Criteria"(4) and the "Health Guidelines"(5) which establish basic raw water quality for public water supply use.

Water Supply Situation

Before outlining individual water supply needs in the region, it is first necessary to discuss the present and potential sources of water in the region. With the exception of Southeastern Louisiana (eight parishes centered around New Orleans) and the Ouachita Mountains of Arkansas, practically all public and rural domestic water supply is obtained from groundwater. A tabulation of public and rural domestic water supply data is presented in table 3. Important statistics drawn from this table are that the 972 public water supplies in the Lower Mississippi Region serve 72.3 percent of the region's population. The remaining rural population of 1.7 million people rely on groundwater resources to satisfy their drinking water needs.

A detailed analysis of municipal water supply in the Lower Mississippi Region along with projections for future demands is presented in Appendix K and is not repeated here. Suffice to say, the Lower Mississippi Region is a water-rich area. It has a yearly average rainfall which ranges from 44 inches near Cairo, Illinois, to 64 inches near the Gulf of Mexico. The Lower Mississippi River receives the drainage of 1.24 million square miles of mid-America. In addition to the abundance of surface water in the Lower Mississippi Region, it is also blessed with large quantities of groundwater located in deep fresh water aquifers or in the shallow alluvium of the river valleys. Appendix C., Regional Climatology, Hydrology, and Geology, contains a detailed discussion of the groundwaters of the region.

Water Quality

Following the identification of water availability for human use, water quality, with its direct effect on human health, must be determined. In general, raw water quality of ground and surface waters in the region is suitable for use by public and rural domestic water systems.

Analysis of limited groundwater data compiled by the U.S. Geological Survey (6) revealed that iron, color and total dissolved solids are the primary objectionable constituents in the region. These constituents are commonly found at high levels in groundwater and can be reduced to acceptable levels for drinking water by conventional water treatment methods (aeration, chlorination, coagulation, and/or filtration) or by blending waters from different wells.

Surface water quality in the region is generally acceptable for drinking water systems after treatment by conventional processes (coagulation, sedimentation, filtration,

Table 3 - Water Supply in the Lower Mississippi Region

State	1970 Population in Region	Public Water Supplies - PWS Totals						Rural Domestic Water Supply
		No. of Surface Supplies	Population Served (Surface)	No. of Groundwater Supplies	Population Served (G. W.)	No. of Public Supplies	Population Served (P. W. S.)	Population Served
Arkansas	926,772	15	92,000	175	443,000	190	535,000	391,772
Kentucky	52,740	0	-	21	35,000	21	35,000	17,740
Louisiana	3,162,806	45	1,410,000	280	1,050,000	325	2,460,000	702,806
Mississippi	850,864	0	-	278	500,000	278	500,000	350,864
Missouri	185,919	2	8,000	69	118,000	71	126,000	59,919
Tennessee	1,114,132	1	2,000	86	887,000	87	889,000	225,132
Totals	6,293,233 1/	63	1,512,000 (24.1%)	909	3,033,000 (48.2%)	972	4,545,000 (72.3%)	1,748,233 (27.7%)

1/ Excluding 8,797 people in the flood protected area at Cairo, Illinois

and disinfection). A troublesome characteristic of surface waters in many areas of the region is its taste and odor-producing properties. Attempts are made by the water purveyor to remove taste and odor-producing substances, but variable raw water quality often causes difficult treatment problems. Although the taste and odor characteristics are not a direct measure of the safety of drinking water, they are related to consumer acceptance of the water. Experience has shown that under such circumstances, many people turn to alternate supplies which may be less safe. A detailed discussion of water quality and pollution in the region is given in Appendix L.

By far the most significant health threat to the surface waters of the Lower Mississippi Region are waste discharges, agricultural runoff, and accidental spills of toxic materials. Industrial metals and chemicals, agricultural pesticides, and petroleum products are but a few of the harmful substances which are discharged to the waters of the region, either accidentally or intentionally. Due to lack of data, a more complete discussion of this subject is not possible at this time. To combat these hazards, the public water suppliers must rely on the various State Stream Pollution agencies to control these waste discharges.

The "Public Health Service Drinking Water Standards" are the basis of evaluating finished drinking water quality. They define the bacteriological, chemical, and physical parameters which must be met to insure the water is suitable for human consumption. The maintenance of good bacteriological quality in public water supplies has received the most emphasis over the years. In general, the bacteriological quality of finished drinking water in the region is good. There are some bacteriological problems but generally all are the result of ineffective treatment and not a deficiency in the water source. The bacteriological quality of the rural domestic water system is a different story. Most rural domestic systems utilize groundwater sources which are normally of good quality. However, practically all rural domestic systems have little to no treatment of the water and most were constructed improperly and not protected from surface contamination. Therefore, the results of surveys of rural individual water systems in Tennessee (7) and Kentucky are not surprising when they showed that two-thirds to three-fourths of all rural individual water supplies are contaminated with coliform organisms to the level that they are considered

unsuitable for human consumption. These results are believed to be representative of rural domestic water systems in the entire Lower Mississippi Region.

The chemical quality of the drinking water of 12 large cities in the Lower Mississippi Region is presented in table 4 (8). The chemical quality for these supplies is good with a few individual constituents exceeding the limits. This situation can be extended to include most of the public water supplies in the region. Again, many deviations in chemical quality are the result of ineffective or inadequate treatment necessary to reduce these constituents to acceptable levels. The lack of complete chemical water quality information is a significant problem for many drinking water systems in the region. Most chemical analyses of drinking water supplies examine only a partial number of the 26 constituents listed in the"Drinking Water Standards." The constituents normally omitted in chemical analysis are those trace metals (arsenic, barium, cadmium, chromium, cyanide, lead, selenium, and silver) which have medical significance. These trace metals are listed in the"PHS Drinking Water Standards"with the statement that the presence of these substances in excess concentrations shall constitute grounds for rejection of the drinking water supply. The occurrence of these dangerous elements in our nation's waters was brought to light by a national trace element study (9) conducted by the U. S. Geological Survey in 1970. The study showed only isolated occurrences of trace metals at significant concentration in the region. However, the existence of these constituents at significant levels indicates real cause for concern. Trace metals are particularly significant because conventional water treatment processes do a poor job of removing these elements, especially if they are in solution.

State Health Surveillance Programs

The responsibility for maintaining health surveillance of drinking water supplies in the Lower Mississippi Region rests with the various State Health Departments. The surveillance activity is normally directed by the Sanitary Engineering or Environmental Health Division within the Health Department. A tabulation of the legislative status of these programs and major requirements is given in table 5. The State surveillance programs generally include engineering surveillance, plans review, water quality monitoring, and training. The success of the State surveillance program is dependent on sufficient staff and resources. Most of the states in the Lower Mississippi Region are doing

Table 4 - Chemical and Physical Quality Data from Water Supplies in Lower Mississippi Region 1/

Water Supply	Fulton Ky.	Memphis Tenn.	Natchez Miss.	Vicksburg Miss.	Ironton Mo.	Jonesboro Ark.	Helena Ark.	Monroe La.	Alexandria La.	Lk. Charles La.	Lafayette La.	N.O. La.
Source of Supply	Wells	Wells	Wells	Wells	Shepard Mt. Lk.	Wells	Wells	Bayou DeSiard	Wells	Wells	Wells	Miss. River
Date of Analysis	8/70	9/70	3/68	9/69	5/69	6/70	8/69	7/68	9/67	10/68	4/70	11/70
Constituent												
Arsenic, mg/l	0.00	0.01	0.01		0.000		0.01		0.001	0.001	0.000	0.001
Barium, mg/l		0.01							0.0	0.0	0.0	0.0
Cadmium, mg/l	0.00	0.000	0.001		0.000		0.000			0.000	0.000	0.00
Chromium, mg/l	0.00	0.001	0.001		0.002		0.000			0.000	0.000	0.005
Copper, mg/l	0.0	0.038	0.011		0.000		0.011		0.05	0.02	0.0	0.005
Lead, mg/l	0.00	0.004			0.000	0.000	0.021			0.000	0.000	0.00
Nitrates, mg/l	2.	1.	1.3		0.0	1.0	0.0	0.1		0.0	0.	5.2
Silver, mg/l		0.001	0.001				0.002			0.001	0.000	0.001
Selenium, mg/l	0.00	0.002	0.002		0.00		0.002			0.000	0.000	0.005
Sulphates, mg/l	3.	7.	12.	9.5	45.	22.		17.		0.0	8.	63.2
Zinc, mg/l	0.0	0.034	0.01		0.6		0.04		0.09	0.45	0.01	0.007
Alkalinity, mg/l	40.	53.9		88.	50.	71.	344.		319.4	175.	84.9	57.7
Hardness, mg/l	26.	42.7		64.	102.	84.	34.	20.	5.	126.	81.6	131.
Chlorides, mg/l	5.	6.	6.	11.	7.	16.	88.	11.	34.	29.1	12.5	33.8
TDS, mg/l	66.	79.	213.	121.	145.	163.	524 2/	73.	434.	289.	157.	213.
Color, s.u.	5.	3.0		5.0		1.0	7.0	5	0.0	10.	10.	10.
Turbidity, s.u.	0.0	3.1		5.0	0.1	6.0 2/	0.7		1.0	5.0	0.0	2.0
Fluorides, mg/l	0.4	0.95	0.2	0.2	0.1	0.1	0.2	0.1	1.5	0.17	0.3	0.4
Iron, mg/l	0.0	0.017	0.12	0.1	0.0	0.1	0.3	0.01	0.1		0.06	0.14
Manganese, mg/l	0.00	0.002	0.01		0.00	0.00	0.00		0.01		0.00	0.00
pH	7.2	7.9	9.2	8.4	7.5	6.9	7.7	7.3	7.8		8.5	9.9

1/ Source: EPA interstate carrier water supply activity maintains surveillance over all water systems which serve drinking water to planes, trains, buses, etc. operating interstate.

2/ Exceeds Standards

Table 5 - Status of Water Supply Program, Lower Mississippi Region

State Agency	Water Supply Law	Use of Drinking Water Stds.	Chlorination Requirement	Operator Certification Program	Fluoridation Program
Arkansas (Arkansas State Department of Health, Bureau of Environmental Engineering)	Arkansas Act 96 of 1913	Adopted as Regulation	Recommendation required if necessary	Mandatory	None
Kentucky (Kentucky State Department of Health, Division of Sanitary Engineering)	Kentucky Revised Statutes Chapter 211	Adopted as Regulation with modification	Mandatory for all public supplies	Mandatory	Mandatory for all public supplies
Louisiana (Louisiana State Department of Health, Engineering Division)	Legislative Act 79 of 1921, Sanitary Code of La.	Guideline	Recommendation required if necessary	Voluntary	None
Mississippi (Mississippi State Board of Health, Division of Sanitary Engineering)	None	Guideline	Recommendation required if necessary	None	None
Missouri (Department of Public Health & Welfare of Missouri Division of Health)	Laws of Missouri 1959, Chapter 192 as revised, 1962	Guideline	Recommendation required if necessary	Voluntary	None
Tennessee (Tennessee State Department of Public Health, Division of Sanitary Engineering)	Tennessee Code Annotated, Sec. 53-2001-53-2008	Guideline	Mandatory for all supplies	Voluntary	Mandatory for all supplies

a commendable job but lack the full complement of staff and funds to adequately cover all responsibilities. There is some contact among state agencies in the region, but for the most part, health surveillance activities are restricted by state boundaries.

A major threat in the Lower Mississippi Region that requires the attention of water supply officials is that of natural disasters. Natural disasters in the Lower Mississippi Region take the form of hurricanes and tropical storms which primarily threaten the coastal areas, and floods and tornadoes which threaten the entire region. A summary of the natural disasters which have occurred in the region in the last six years illustrates the frequency of the threat.

1965 - Hurricane Betsy, South Louisiana
1968 - Tornado and flooding, Western and Southwestern Arkansas
1969 - Hurricane Camille, Southeast Louisiana and Mississippi Gulf Coast
1971 - Tornadoes, Northwest Mississippi

Experience with the destructive effects of natural disasters has shown that water supply systems, even those utilizing groundwater, are susceptible to damage and contamination.

Primary Contact Recreation Waters

Recreation uses of water have received increased importance in water resources planning and are now officially recognized as a benefit and purpose for planning. With the transition of our society from rural to urban, increased demands are being made for outdoor recreation activities, particularly water-based recreation.

Experience has demonstrated that whenever a large number of persons are concentrated in one place, health problems are accentuated. The increasing number of visitors to recreation areas creates a need for competent health-related water resources planning. Of prime importance in this planning is the relationship between human health and primary water contact recreation. Primary contact recreation is defined as activities in which there is prolonged and intimate contact with the water involving considerable risk of ingesting water in quantities

sufficient to pose a significant health hazard. Examples are wading and dabbling by children, swimming, diving, water skiing, and surfing.

It is extremely important that the health of the recreationist be protected. There have been some health problems associated with swimming waters and recreational areas. The principal requirement for primary contact recreation is maintenance of water quality that will not subject the user to disease organisms or harmful substances.

The majority of water-based recreation in the Lower Mississippi Region involving primary contact recreation occur at large fresh-water impoundments. Some of the major reservoirs in the region are Wappapello in Missouri, Blakely Mountain in Arkansas, Reelfoot Lake in Tennessee, Arkabutla, Sardis, Enid and Grenada in Mississippi, and Lake Claiborne and Bayou D'Arbonne Lake in Louisiana, and the numerous oxbow lakes on either side of the Mississippi River. The region does not have a large number of these impoundments because the topography is generally unsuitable for their development and the need for additional multi-purpose reservoirs has not yet been established. In addition, the citizens of the region have access to several large reservoirs which border the region.

The coastal area of Louisiana has limited recreational use for primary contact recreation, but the majority of the estuarine area is more adaptable for fishery and shellfish production and wildlife propagation. It is also generally known that most all of the natural lakes and streams in the region (including the main stem of the Mississippi River) are used for primary contact sports to some degree.

A detailed listing of recreational use of water-based recreational facilities and projections for future need is covered in Appendix N. However, it can be stated here that large fresh water bodies, developed with modern sanitary facilities are most desirable for the health protection of the recreationist.

Health Criteria for Swimming and Primary Contact Recreation

The most important water quality parameter for determining human health acceptability of recreation water is bacteriological water quality. Bacteriological quality is generally expressed in terms of total coliform organisms or fecal coliform organisms per 100 ml of water. The various State pollution control agencies in the Lower

Mississippi Region have adopted bacteriological criteria for primary contact recreation in their State Water Quality Standards. These criteria are generally as follows:

Arkansas - 1000 total coliforms/100 ml, monthly average

Louisiana - 1600 total coliforms/100 ml, monthly median

Kentucky - 1000 total coliforms/100 ml, monthly average

Mississippi - 1000 fecal coliforms/100 ml, monthly average

Missouri - 200 fecal coliform/100 ml, geometric mean, not applicable when stream is affected by storm water runoff

Tennessee - 1000 fecal coliforms/100 ml, not to be exceeded in two consecutive samples during recreation months

While the Arkansas, Louisiana, and Kentucky State Standards do consider total coliforms, recent federal water quality criteria have been developed which consider the fecal coliform as a more reliable indicator of human or animal contamination. *In* addition, the proposed federal criteria, based on fecal coliforms, is significantly more restrictive than the Mississippi and Tennessee State Standards. The Missouri State Standards contain the proposed federal criteria, but have a qualifying statement which tends to dilute the health protection afforded the recreationist.

Primary contact recreation criteria are presented in the NTAC "Water Quality Criteria" as follows:

"The fecal coliform content of primary contact recreation waters shall not exceed a log mean of 200/100 ml, nor shall more than 10 percent of the total samples during any 30-day period exceed 400/100 ml."

Additional parameters for primary contact recreation waters are also established by these federal water quality documents:

1. pH - 6.5 - 8.3

2. clarity - secchi disk visible at minimum depth of 4 feet

3. color - 15 s.u.

4. turbidity - 30 s.u.

5. temperature - less than 85°F

Little is known about water quality in the Lower Mississippi Region for primary contact recreation. At the present time, the following interstate streams are classified for primary contact recreation:

Arkansas	-	Lower White River Basin Ouachita River Basin
Louisiana	-	Calcasieu River Amite River Tangipahoa River Bogue Chitto Pearl River Coastal Waters
Kentucky	-	Mississippi River (Proposed)
Mississippi	-	Tallahatchie River, St. Hwy. #7 to U.S. 51
Tennessee	-	Mississippi River, Kentucky state line to above Memphis Hatchie River Wolf River

An attempt was made to gather water quality information for this report, but too little information, particularly bacteriological data, was available on major streams in the region. Reference is made to Appendix L. The data in that document indicates that the physical water quality is generally acceptable for primary contact recreation, but no data on bacteriological quality is listed.

Vector Control

Great expansion in the development of water resources during the last two decades has evolved renewed interest in the prevention and control of insects and other vectors which create public health hazards. Vectors are considered as species which carry human disease organisms or which affect man's comfort, mental equanimity, and economic welfare.

The public health importance of insect problems associated with water resource developments is increasing due to (a) the rapid increase in vector populations in existing irrigated areas where little or no attention has been given to control or prevention, (b) the man-made aquatic habitats created by construction of new projects, (c) the increasing exposure of man to insects of public health importance due to expanded public use of water-related recreational areas, (d) the development of resistance to insecticides, and (e) the public demand for a more healthful environment. It is therefore urgent that programs for the prevention and control of insect-vector problems keep pace with the various other matters involved in the development and utilization of water and related land resources.

The Lower Mississippi Region has the climate and topography which is conducive to insect-vector propagation. The region comprises parts of seven states and extends from the mouth of the Mississippi River northward to the mouth of the Ohio River. Although the states within the Lower Mississippi Region contain hills or mountains, these land forms are not extensive within the region. Much of the land is level, slowly draining, and subject to occasional flooding, or is swampy. Coastal Louisiana which lies almost wholly within the region is a belt of marsh extending approximately 30 miles inland. In this area is contained 3,381,500 acres of salt marsh, or about half of the total salt marsh of the entire United States. The marsh occupies roughly one-ninth of the land area of Louisiana and contains approximately one-half of the State's population.

Historically and presently, the region is characterized by a combination of vector problems which equal or exceed in magnitude and variety any in the nation. Ravages by hoards of salt marsh mosquitoes in the coastal area are legendary. These species are not restricted to the coastal area, however, as prodigious populations have been associated with salt water wastes from south Arkansas, north Louisiana oil fields, and elsewhere. Irrigated rice fields in the flat lands of southwestern Louisiana and the Grande Prairie of Arkansas produce flood water mosquitoes in numbers which equal or transcend any found elsewhere in the United States. The principal species produced was found more frequently infected with the virus of Venezuelan Equine encephalitis than any species encountered in the 1971 epizootic areas of Mexico. The many swamps, lake margins, and sluggish streams produce large numbers of malaria mosquitoes. Until World War II malaria was the most important disease in this area and imposed great hardship,

suffering, and economic burden upon the states of the region until its eradication became feasible with the advent of DDT. Yellow fever repeatedly ravaged the major river cities before its vector relationship became known. Dengue was also a frequent scourge. The last continental epidemics of both yellow fever (1905) and dengue (1945) occurred in southern Louisiana. The vector continues to abound in portions of the region. The ubiquitous southern house mosquito is the principal vector of St. Louis encephalitis. The Ouachita Mountains comprise a part of the area of the U.S. in which tularemia is principally a vector-borne disease. In this area, ticks have been implicated to a greater extent in tularemia transmission than the handling of infected rabbits. In addition to these diseases, the region has an abundance of flies, fleas, bugs, and the stinging, biting and urticating arthropods, many of which can harass or even suffocate large animals by the sheer weight of their numbers.

Types of Vectors

Mosquito Vectors. The distribution and relative importance of recorded species of mosquite vectors for each state within the region is shown in table 6 and biological data on the important mosquito species is given in table 7. Certain of the species may not occur or may not have been reported for that portion of each state which is within the region. Generally, however, that portion of each state which is within the Lower Mississippi Region is conducive to the occurrence of most of the species reported from the state.

Anopheles quadrimaculatus. The malaria mosquito, and the principal vector east of the Rocky Mountains, occurs throughout the region. The many fresh water swamps, marshes, lake margins, irrigated rice fields and slowly-moving streams and the relatively mild climate result in the development of maximum populations of this species.

The larvae prefer permanent or semi-permanent water containing floating debris or surface-growing or emergent vegetation which provide harborage. A preference is shown for clear, quiet waters which are neutral to alkaline. Breeding seldom occurs in water with pH below 6 or in water heavily polluted with plant or animal matter.

During the summer, the larval period is relatively short, about 12 to 14 days. The pupal period requires

Table 6 - Genera and Species and Relative Prevalence and Importance of Mosquitoes Occurring in States of the Lower Mississippi Region

Genus and Species	Occurrence Recorded in Miss.	La.	Ark.	Tenn.	Mo.	Ky.	Prevalence and Importance 1/
Aedes:							
aegypti	+	+	+	+	+2/	+2/	1
atlanticus	+	+	+	...	+	+	2
atropalpus	...	...	+	+	+	...	4
canadensis canadensis	+	+	+	+	+	+	2
flavenscens	...	...	...	...	+	...	4
cinereus	+	+	+	+	+	+	4
dorsalis	+	+	...	...	+	+	4
dupreei	+	+	+	+	+	+	4
fulvus pallens	+	+	+	+	...	+	4
grossbecki	+	+	+	+	+	+	4
hendersoni	...	+	...	...	+	...	4
infirmatus	+	+	+	+	+	+	2
mitchellae	+	+	+	+	+	+	4
nigromaculis	...	+	...	...	+	+	4
riparius	...	...	...	...	+	...	4
sollicitans	+	+	+	+	+	+	1
sticticus	+	+	+	+	+	+	4
stimulans	+	...	...	...	+	...	4
taeniorhynchus	+	+	+	...	+	...	1
theleter	+	...	...	...	+	+	4
thibauto	+	+	+	+	+	+	4
tormentor	+	+	+	...	+	...	4
triseriatus	+	+	+	+	+	+	1
trivittauts	...	+	+	+	+	+	4
vexans	+	+	+	+	+	+	1
zoosophus	...	+	+	...	...	...	4
Anopheles:							
atropos	+	+	...	...	...	...	4
barberi	+	+	+	+	+	+	4
bradleyi	+	+	...	...	...	...	4
crucians	+	+	+	+	+	+	3
georgianus	+	+	...	...	...	...	4
perplexens	...	...	...	+	...	...	4
pseudopunctipennis	+	+	+	+	+	...	4
punctipennis	+	+	+	+	+	+	3
quadrimaculatus	+	+	+	+	+	+	1
walkeri	+	+	+	+	+	+	4
Culex:							
erraticus	+	+	+	+	+	+	3
nigripalpus	+	+	+	+	...	+	3
peccotur	+	+	+	+	+	+	4
pilosus	+	+	...	...	...	+	4
p. pipiens	+	...	+	+	+	+	4
p. quinquefasciatus	+	+	+	+	+	+	1
restuans	+	+	+	+	+	+	3
salinarius	+	+	+	+	+	+	2
tarsalis	+	+	+	+	+	+	3
territans	+	+	+	+	+	+	3
Culiseta:							
inornata	+	+	+	+	+	+	3
melanura	+	+	+	+	+	+	2
Mansonia:							
perturbans	+	+	+	+	+	+	2
Orthopodomyia:							
alba	+	+	+	+	+	+	4
signifera	+	+	+	+	+	+	4
Psorophora:							
ciliata	+	+	+	+	+	+	2
confinnis	+	+	+	+	+	+	1
cyanescens	+	+	+	+	+	+	3
discolor	+	+	+	+	+	+	2
ferox	+	+	+	+	+	+	2
horrida	+	+	+	+	+	+	4
howardii	+	+	+	+	+	+	4
longipalpis	...	+	+	...	+	...	4
signipennis	...	...	+	+	+	+	4
varipes	+	+	+	+	+	+	2
Toxorhynchites:							
rutilus septentrionalis	+	+	+	+	+	+	4
Uranotaenia:							
anhydor syntheta	...	...	+	...	...	...	4
lowii	+	+	+	...	...	...	4
sapphirina	+	+	+	+	+	+	3
TOTAL	53	56	53	46	54	47	

1/ 1=important economic or medical species
2=locally abundant and annoying, principally out of doors
3=common species, not very troublesome
4=usually rare or of very restricted distribution

2/ Species has not been found in recent years

Table 7 - Biological Data on Some Important Species of Mosquitoes in the Lower Mississippi Region

Mosquito Species	Eggs	Broods Per Year	Overwinter	Preferred Larval Habitat	Effective Flight Range
Anopheles quadrimaculatus	Singly on water	Many	As adult female	Clean, partically shaded water; some vegetation	1 mile
Culex pipiens and quinquefasciatus	Rafts on water	Many	As adult female	Permanent water with organic matter or pollution	1 mile or more
tarsalis	Rafts on water	Many	As adult female	----	----
Culiseta melanura	Rafts on water	Many	As adult female	Permanent, shaded pools in swamps	100-1,000 yards
Mansonia perturbans	Rafts on water	One	As larvae	Permanent water with some aquatic vegetation	1-5 miles or more
Aedes aegypti	Singly on sides of containers or tree holes	Many	As eggs	Artificial containers	1 block (usually less than 1/2 mile)
triseriatus	Singly on sides of containers or tree holes	Many	As eggs	Tree holes, artificial container	1/2 - 1 mile
sollicitans	Singly on ground	Many	As eggs	Temporary pools, usually brackish or with sulfates	5 - 20 miles
tacniorhynchus	Singly on ground	Many	As eggs	Temporary pools, usually brackish	5 - 20 miles
vexans	Singly on ground	Many	As eggs	Temporary pools	5 - 20 miles
Psorophora ciliata	Singly on ground	Many	As eggs	----	----
confinnis	Singly on ground	Many	As eggs	Temporary pools, rice fields	5 miles or more

another two to six days. From eight to ten or more generations per year can be expected in the region.

Culex pipiens. Culex pipiens quinquefasciatus, the southern house mosquito, is found abundantly in most of the region. In the northern reaches of the region, the northern house mosquito, C. pipiens pipiens also can be found. This species (both subspecies) is a major vector of St. Louis encephalitis. While its preferred hosts are birds, the house mosquito readily enters houses and feeds upon man in the region. The abundance and feeding habits adapt the species very well to the role of transmitting SLE from bird reservoir to man.

The C. pipiens complex is a foul-water mosquito. It breeds in roadside ditches, catch basins, sewage oxidation ponds, septic tanks and sewage treatment plant effluent, water contaminated with wastes from vegetable and meat processing plants, and in man-made containers. Somewhat paradoxically, the greatest numbers are often encountered during prolonged dry spells when evaporation exceeding replenishment of water results in the concentration of pollution. This is by no means invariably true. The epidemics of SLE which occurred in Dallas and Corpus Christi, Texas, in 1966 were preceded by a great increase in populations of the southern house mosquito breeding in floodwater (polluted with sewage in Dallas). Thus, the C. pipiens complex can be seen to present a threat under conditions of both drought and flood.

Culiseta melanura. This is probably the most important vector of the enzootic and epizootic cycles (bird to bird) of eastern encephalitis. Also, it has been found to harbor in nature the viruses of Western and California encephalitis. As the species is known to bite man with extreme reluctance, other mosquitoes probably serve as vectors from the bird reservoirs to man and horses. Three species which may play this role in the region, Aedes sollicitans, Aedes vexans, and Mansonia perturbans, are discussed in greater detail later. Culiseta melanura is recorded from all states of the region; however, abundance is restricted to localized fresh water swamps.

Larvae of Cu. melanura are found most often in small permanent bodies of water, particularly in swamps. Little is known of the habits of the adults other than they are attracted to lights (hence light traps), and feeding upon man is exceedingly rare.

Aedes aegypti. The yellow fever mosquito is the urban vector of yellow fever and dengue throughout the tropical and subtropical regions of the world. It is permanently established in the southern portion of the United States. The most intensive distribution of the species is to the east of the Lower Mississippi Region. It also occurs west of the region in greater numbers and in wider distribution than is presently found within the region. This is perhaps a transitory situation as Ae. aegypti historically has been abundant and widespread throughout the southern portion of the region. In fact, prior to 1950, it was recorded in abundance from all parishes of Louisiana. During the 50's and most of the 60's, Ae. aegypti could not be found in most parts of Louisiana and extreme southeastern Mississippi. The reasons for this diminution are not understood. Presently, the species has reinvaded many of the areas of Louisiana and Mississippi from which it was apparently absent during the last decade.

Aedes aegypti is the most domestic of the U. S. mosquitoes wherever it occurs. Larvae develop in tree-holes and man-made containers (notably discarded vehicle tires) usually in close proximity to human habitations. Frequently, larvae develop in vases and other containers within homes. The adult female prefers the blood of man to that of other animals. It is a very stealthy mosquito, often succeeding in taking blood meals from the ankles or wrists of man, even when he is aware of its presence in the immediate area. The larvae are likewise furtive, descending to the bottom of their breeding container upon the passage of light or upon being physically disturbed. They will remain motionless, often long enough to be overlooked.

Although no cases of yellow fever have occurred in the region since 1905, and no cases of indiginous dengue since 1945, the presence of both diseases in Central and South America (only a few hours airplane flight, or a few days' boat time, from major cities in the region) poses disease threats of considerable magnitude to the region.

Dengue epidemics numbering in the thousands of cases have continued to occur periodically in the Caribbean Islands and, in a more virulent form (hemorrhagic fever) in the Orient, with some introduction of cases into the United States. Lack of recent experience in recognizing these tropical diseases, a susceptible population, and a relaxed attitude toward the presence of Ae. aegypti could predispose much of the region to the hazard of introduced cases resulting in local transmission.

Aedes vexans. This is a floodwater and temporary-rain-pool breeding mosquito of paramount importance throughout the region (as well as the rest of the Nation). The uncertain natural history of eastern encephalitis involves this species as a likely vector in the bird-to-man cycle. Also, the virus of California encephalitis has been isolated from Ae. vexans in Ohio. It is not generally considered one of the more efficient vectors of these arboviruses; however, when viremia within the reservoir is sufficiently high, an inefficient vector in large numbers, and possessing aggressive and persistent biting habits, may transmit the viral agents. Aedes vexans is considered to be an important mosquito in much of the region because of its abundance and painful bite - as well as its potential as a vector of the encephalitides.

The Aedes vexans adults are common from April until October. Winter is passed in the egg stage. All eggs do not hatch with a single flooding, but larvae appear periodically following alternate flooding and drying of the eggs during the season. The species manifests a single generation per year with the delayed hatching mechanism accounting for a more or less continuous supply of adults in some areas of the United States. In the region, however, several generations occur each year. Adults migrate long distances from their breeding places, 5 to 10 miles being rather common.

Aedes triseriatus. The tree-hole mosquito, although traditionally a woodland mosquito, has come to coexist, or possibly compete, with Aedes aegypti for the same ecological niche around human habitations in urban areas in the region. The species is frequently found breeding in such man-made containers as discarded tires, buckets, and even beer cans and soft drink bottles.

The bite is painful and the species is frequently troublesome in urbanizations and in the woods. Aedes triseriatus has been associated with California encephalitis by virus isolation from wild-caught specimens in the Midwest, and is currently considered to be a likely vector in that area. Larval development is slower than that of Ae. aegypti and the latter species may predominate in most of its range during the warmest season. Aedes triseriatus, however, is more cold-hardy and ordinarily is most abundant early and late in the season. This species deserves considerably more study with regard to its public health importance, especially in the region.

Mansonia perturbans. This is a troublesome species, biting especially in the evening and early part of the night, but occasionally during the daylight hours in the shade near its breeding area. The females readily enter houses and bite viciously. They are strong fliers. The virus of eastern encephalitis has been recovered from wild-caught M. perturbans. Its role in the epidemiology of EE has not been established.

Species of the genus Mansonia have a unique morphological adaptation--a sharpened structure on the breathing protuberances of larvae and pupae--which enables them to penetrate the underwater roots and stems of emergent plants, to attach there and secure oxygen from the plant tissues. The aquatic stages, thus, are passed entirely submerged. Detection of breeding sites is very difficult as the larvae quickly detach themselves from host plants whenever they are disturbed. Carefully executed procedures are required to capture the immature stages of Mansonia.

Breeding of M. perturbans takes place in marshes, ponds and lakes which have a thick growth of aquatic vegetation. Larvae have been found associated with pickerel weeds, cattail, water lettuce, arrowhead, aquatic sedges, and other plants. Larval development is slow, usually requiring several months. Larvae which hatch one season ordinarily do not complete their development until the following spring. The adults emerge in late spring or early summer. Throughout most of its range, M. perturbans appears to have only one generation per year.

Psorophora confinnis. This is known as the dark rice field mosquito in Arkansas and adjacent rice-producing areas and the glades mosquito in Florida, is the most widespread and important species of Psorophora in the United States. It occurs throughout the region and beyond, and reaches its greatest abundance in the rice fields of Arkansas and Mississippi. The females are fierce biters, attacking any time during the day or night. In large numbers, they occasionally kill livestock and make it practically unbearable for people to remain outdoors. For the above reasons, this species would qualify as one of the most troublesome and economically important. Its importance was enhanced during the summer of 1971 when epidemic Venezuelan equine encephalitis invaded the United States.

Virus isolates, with characteristics compatible with VEE, were made from P. confinnis at almost twice the rate of the next most frequently infected species, Aedes

sollicitans, in Mexico south of Brownsville, Texas. The tan rice field mosquito, Psorophora discolor, yielded VEE virus third most frequently of 11 species in five genera found infected.

Psorophora confinnis breeds in temporary rain pools, irrigation and flood waters, and seepage pools. Eggs are deposited on ground which is subject to flooding from rainfall, overflow, or irrigation. Situations with low, rank vegetation seems to be ideal for egg deposition. Drained rice fields are among the most favorable sites. Eggs flooded soon after deposition will hatch in four or five days. If they remain on the soil for two or three weeks before being flooded, hatching may begin within a few minutes. Overwintering is in the egg stage. The larval period is very short. During midsummer in Arkansas, it may be completed in as little as four days. The pupal stage requires another one or two days. The number of generations per year varies from few to many, depending upon suitable hatching conditions. Areas which dry up and are then flooded a few days later may produce a brood with each flooding. Rice culture in Arkansas provides such conditions. Adults may live as long as one to two months. They have a flight range of up to 10 miles or more.

Aedes sollicitans. The salt-marsh mosquito, is the most important salt-marsh species and one of the most severe mosquito pests known. It has long been suspected of figuring in the transmission of eastern encephalitis from bird to man or from bird to horse. During the 1971 epidemic of Venezuelan equine encephalitis, Ae. sollicitans was the species most often found infected with the virus in Texas.

Aedes sollicitans occurs along the Gulf coastal plains and in inland areas where brackish waters are available, usually as waste from oil production. The species has been recorded from all states of the region, but in the case of Kentucky and Missouri and possibly Tennessee, the species has been found in areas outside the Lower Mississippi Region.

The eggs of Ae. sollicitans are laid on the mud of marshes where they remain until flooded by high tides or rains. Breeding occurs on the parts of the marshes not flooded daily by tides; usually pot holes and depressions are utilized, but breeding may also occur over extensive level areas. The eggs require 24 hours or more of drying in order to hatch when flooded. After a week or more of drying, eggs will hatch within a few minutes when submerged.

Development of the aquatic stages requires seven to ten days during warm weather. Several generations are produced each year in the northern portions of the region. Along the Gulf, coast breeding is interrupted only briefly by cool weather.

The adults are strong fliers often migrating in large swarms from the breeding areas into communities miles away. They commonly fly five to ten miles and may travel up to 40 miles or more. Migration flights take place during darkness. During the day the mosquitoes rest among the grass. They will readily attack anyone (or practically any animal) who disturbs them, even in full daylight. They literally make certain areas uninhabitable for humans and large animals. Fortunately, Ae. sollicitans seldom enters houses.

The black salt-marsh mosquito, Aedes taeniorphynchus is not as prevalent in the region as Ae. sollicitans. Nevertheless, it is sufficiently abundant to constitute a serious problem at times in the coastal area and in inland situations where surface waters have become contaminated with salt.

Mosquito Annoyance Problems. Invariably, vector control specialists are reluctant to relegate mosquitoes into categories of either vectors (or species of public health importance) or pests. Primarily, medical entomology is progressing so rapidly that species which were considered as pests a short while back are now recognized as major transmitters of human diseases; viz, Culex quinquefasciatus and St. Louis encephalitis. Within the past few months the notorious pest, Psorophora confinnis, has emerged as a prime suspect vector in the recent epidemic of Venezuelan equine encephalitis along with other severe pests such as Aedes sollicitans, Aedes taeniorphynchus, Psorophora discolor, Psorophora ciliata, and others. Even the diseases, especially various encephalitides, are being recognized as new entities or previously identified strains in new locations, with remarkable regularity.

To equate a mere absence of known disease agent transmission with a status of little or no public health importance is inconsistent with the facts. When man's activities or disasters multiply breeding areas of mosquitoes (or other pests) sometimes hundred-fold, or when man encroaches into existing breeding areas, and when these manifold numbers of insects inflict bites or stings which result in serious allergic traumatic, or infectious manifestations which may interfere with, or prevent, food production, essential

sanitation activities, or recreational usages of areas; then the so-called pest insects have a health hazard significance overshadowing their nuisance potential. Few places in the world experience more prodigious production of mosquitoes than coastal Louisiana or the rice fields of Arkansas and Mississippi.

Most of the species of mosquitoes discussed previously with respect to their potential as vectors, are also troublesome pests. A notable exception, already discussed, is Culiseta melanura, which while reluctant to bite humans, is apparently of major importance in the maintenance of Eastern encephalitis in the bird reservoir. Conversely, inefficient vectors may assume importance when they are numerous and voracious, and the level of infectious agents is high in the reservoir. Tularemia and some of the encephalitides may be transmitted mechanically by mosquitoes and other arthropods.

Culex salinarius. This species probably reaches its greatest abundance in the Gulf and Atlantic coastal regions. During 1969, 60 percent of all adult mosquitoes identified by the New Orleans Mosquito Control Program was of this species. The females bite readily out-of-doors, and occasionally enter dwellings. The larvae breed in fresh and brackish water in a number of situations. Along the coast breeding occurs mostly in the fresh and brackish marshes. Elsewhere throughout the region the larvae may be found principally in either fresh or foul water in ponds, pools, ditches, and occasionally in barrels or bilge water in boats.

While generally regarded as a pest species, and not yet a proven vector, its disease transmission potential cannot be dismissed. Earlier work associating C. salinarius with possible transmission of Eastern encephalitis has been largely discounted by subsequent laboratory work which indicates that the species is refractory to EE, and suggests that the virus was recovered from an engorged blood meal rather than occurring in the mosquitoe's tissues. Laboratory findings have, however, suggested that sylvan (enzootic) transmission of St. Louis encephalitis virus to wild birds and fowl is possible, as the vector potential was demonstrated to be excellent in the laboratory. For the present, C. salinarius can be regarded as one of the more severe pest mosquitoes which invades the most populous portion of the region.

Psorophora cyanescens. Psorophora cyanescens is one of the most severe biters of all the Psorophora. During the

30-year period, 1929-1959, the species, although widespread throughout Louisiana, never was reported in great abundance. In late October of 1964, however, as a result of heavy rains accompanying Hurricane Hilda, at least five parishes, with the city of Baton Rouge as the hub, experienced a plague of P. cyanescens which greatly harassed the population for two or more weeks. Like the other Psorophora, cyanescens breeds in temporary fresh water.

Other Important Arthropods

Domestic Flies. The causal relationship of water resources to domestic flies is not as apparent as that to mosquito production. It bears, nevertheless, direct relationship. The development of water and related land resources allows expansion of urbanizations, agriculture, recreational areas, and certain industries, the wastes from which support flies. Contact between humans and flies is frequently increased as a result of water resources development.

Domestic flies have considerable impact upon the welfare of man. They may seriously affect his health, that of domestic animals, and wildlife. The omnivorous and promiscuous feeding habits of many species (notably the housefly, Musca domestica) qualify them as potential vectors of a number of human diseases. Feeding first upon filth such as excrement or sewage, flies may then infect food intended for human use. Thus, they may be of significance during outbreaks of intestinal diseases such as typhoid or the dysenteries. Several species of domestic flies also may cause myiasis in man. Myiasis is the presence of, and resulting disturbance caused by, fly larvae living parasitically on the tissues of man (and other animals). The larvae of some species (the primary screwworm fly Cochliomyia hominovorax) are obligate parasites which initiate wounds and are thus able to infest areas of unbroken skin as well as existing lesions. The larvae of other species; e.g., the green bottle fly, Phaenicia sericata, cause semispecific myiasis. The latter larvae do not cause lesions; however, gravid females may be attracted to existing wounds where eggs will be deposited. The larvae live in and extend such lesions. Also, myiasis may occur within the intestines of man as well as within his body openings. The stable fly, Stomoxys calcitrans, is a biting fly often found associated with houseflies (which it superficially resembles) in and around man's dwellings or in windows of wet decaying

vegetation along the sea coast and lake shores. Both the males and females are vicious biters, particularly during warm, humid weather.

Buffalo Gnats or Black Flies, Family Simuliidae. The southern buffalo gnat, Cnephia Pecuarum, causes serious injury to livestock in some parts of the region, mainly eastern Arkansas, during most years. The most serious outbreaks apparently originate in the White, St. Francis, and lower Arkansas River bottoms. There are many records of horses and mules being killed by this species. Indications are that, in addition to the bite and exsanguination, the animals are sometimes smothered by huge numbers of the gnats packing the nostrils and blocking air passages. Motorists driving through the delta region of Arkansas when buffalo gnats populations are at their peak, frequently must remove the blooded crushed gnats from the windshields in order to maintain adequate visibility.

The immature stages of the buffalo gnat, with rare exceptions, are spent in water with some current where larvae and pupae attach to submerged objects. The classic description of the habitat of family Simuliidae, a rushing mountain stream is not met in the region. Adult gnats may appear at any time between late January and May in Arkansas but the heaviest emergence usually occurs between February 15 and April 30. Serious outbreaks may last only one week but frequently are of longer duration.

Horse Flies and Deer Flies, Family Tabanidae. Horse flies and deer flies, by virtue of their persistence and painful bites, cause great annoyance to humans, livestock, and wildlife. Localized problem areas occur throughout the region. Most species encountered are in the genera Tabanus (horse flies) and Chrysops (deer flies). Deer flies, particularly when interrupted while feeding (and consequently visiting several hosts), may transmit the bacterial agent of tularemia. Both groups are capable of inflicting painful puncture wounds which may continue to bleed after the fly has departed the host. Wounds may attract other types of flies which can cause myiasis and are also subject to becoming infected by bacteria.

The breeding grounds for horse flies and deer flies include both fresh and salt-water marshes and margins of ponds, lakes, and streams. The adults frequently leave the breeding sites and move to uplands, especially in wooded areas, where they constitute a severe daytime annoyance. The problem

associated with these insects may be enhanced by water and related land resources development unless control measures are also developed.

Biting Midges, Family Ceratopogonidae (Heleidae). Biting midges of the genus Culicoides, commonly called sandflies in coastal areas or punkies or no-see-ums elsewhere, frequently become serious pests wherever they occur. The genus is represented by several species throughout the region; however, the coastal area is most severely plagued by vicious salt marsh species. Important species which breed in salt or alkaline water include Culicoides furens, C. canithorax, C. haematopotus, and C. melleus. Culicoides haematopotus also will breed in sand or mud at the edge of fresh water ponds and streams. Several species including C. arboricola, and C. obsoletus breed in tree holes or stump holes. Culicoides obsoletus and C. stellifer are found in damp terrestrial habitats in such sites as manure piles, damp rotting leaves, and ooze from tree wounds.

The adults are usually abundant near breeding sites during most of the warmer months. They have a flight range usually less than one mile. Flight is slow and occurs only under near calm condition.

Adults of many species of Culicoides readily bite man. Only females take a blood meal. To many people, the lesions produced by the bites of Culicoides last longer and are more painful than those of most mosquitoes.

Non-biting Midges, Family Chironomidae. Although short-lived and non-biting, the chironomid midges become a significant problem in some areas. Fresh water containing a heavy load of organic material favors midge production. The larvae, some of which are called blood worms, are produced in the bottom detritus of shallow lakes, ponds, sewage oxidation lagoons, and slow-moving streams. Occasionally the larvae will breed in treated water in holding tanks in municipal water systems. Considerable consternation resulted when living blood worms were observed (some twenty years ago) in the swirling water basin in a dental office and elsewhere in the distribution system in El Dorado, Arkansas. How the larvae survived the passage through a pump which lifted the water from the partially buried tank (with broken screening at its above ground portion) to an elevated tank was never understood.

During periods of peak emergence, adult midges, by their sheer numbers, can produce great annoyance. Often

when the chironomid midges are interspersed with mosquitoes (which they superficially resemble), people become unduly alarmed, believing that all of the myriad insects on the wing are capable of inflicting painful bites. Few painters have been frustrated by midges imbedding themselves in freshly applied paint.

Fleas. Many people are concerned about fleas because of their persistent attacks upon man and domestic animals, causing irritation, loss of blood, and extreme irritation. Public health workers are concerned with the fleas that can transmit the organisms of bubonic plague and murine typhus from rats to man. During the last year, a significant increase was recorded in the percentage of rat sera positive for murine (endemic) typhus in the Port of New Orleans, and rats with ectoparasites have averaged 1.5 oriental rat fleas (Xenopsylla cheopis), the principal vector of typhus and plague, per animal.

Murine typhus in humans has reappeared in New Orleans with one case late in 1970 and a second case in early 1971. Both cases were associated with the port area.

Ticks. Ticks are capable vectors of tularemia and Rocky Mountain spotted fever. The principal species involved are the lone star tick Ambylomma americanum, and the American dog tick, Dermacentor variabilis. These ticks are generally distributed throughout most of the region, being especially prevalent in the wooded and hilly portions. The dog tick is also capable of causing tick paralysis probably by the introduction of neurotoxin in the tick's saliva into nervous tissues of the host (especially at the base of the skull). Death of man and other animals may result if the tick remains attached. Complete recovery, however, is usually remarkably rapid when the tick is removed.

The dark woods ticks (Genus Ixodes) and others may become severe pests of wildlife and livestock in certain areas. Even large animals occasionally die as a result of massive tick infestations.

Most ticks are typically found in wooded and brushy areas, particularly along pathways and animal runs. Campsites, picnic grounds, nature trails, and other outdoor recreational areas constructed in association with water resources developments present unusual opportunities for bringing man and his pets into close association with ticks.

Other Stinging and Biting Arthropods. Spiders are common within the region. The vast majority are harmless. The black widow Lactrodectus mactans, is widely distributed and considerably feared. Bites are uncommon, but serious. Fatality from their systemic neurotoxin, in untreated cases, may reach five percent. The brown recluse (also fiddle-back) spider, Loxosceles reclusa, reaches maximum abundance in the six states in the region and appears to be expanding its range throughout the region. The venom of the brown recluse spider is haemolytic and may, in severe cases, cause red blood cell destruction as well as severe ulceration at the site of the spider bite.

Lice seldom have come to public attention since World War II. Outbreaks of head and body lice may occur from time to time, usually when personal cleanliness is neglected. Each year at the opening of schools, particularly in rural areas, it is not uncommon to find several children infested with head lice. Wigs of human hair imported from the Orient have been found to contain nits (eggs) which have survived several processing steps.

State and Local Vector Control Programs and Resources

In this section, a vector control program will be referred to as organized when: (a) it operates for the sole or major purpose of abating vectors, (b) it is ordinarily a line budget item, (c) it frequently is supported by a specific tax, (d) it is under the guidance of a vector control specialist (usually an entomologist or engineer), (e) its operations are based upon entomologic or epidemiologic data (as opposed to complaints), and (f) comprehensive operations (as opposed to insecticidal applications only) are practiced.

Ideally, vector control is performed at the local level by mosquito or vector abatement districts, legally constituted under state-enabling legislation, and financed from specific local revenues. At the state level, usually within the state health department, is a vector control section (frequently combined with solid waste management) which provides some or all of the following: coordinating services; research; technical consultation; training and, through cooperation with other divisions of the state health department, epidemiologic and laboratory services. In several states (not in the region), the state health department provides subvention on some type of matching basis for local control operations usually of the permanent (source reduction) type.

Enabling legislation for the creation and operation of vector abatement districts has been enacted in Arkansas (1953), Kentucky (1956), Louisiana (1958), and Mississippi (1928). Missouri and Tennessee lack such state enabling acts. Enabling legislation permits a local area to vote for or against the formation of an organized vector abatement program, and provides for local financing of the work. Under the authority of these acts, mosquito abatement districts have been formed within the region only in Louisiana. Kentucky's first mosquito abatement district was formed in Hopkins County in 1968. This western Kentucky county is not within the Lower Mississippi Region. Mississippi has three contiguous county mosquito abatement districts along the Gulf coast. These also are outside the region. Mississippi's enabling act limits the formation of vector abatement districts to the coastal counties. Arkansas has not organized vector control districts.

State-level vector control programs are weak or nonexistent in the region. The State Department of Health provides considerable guidance, consultation, and assistance in Louisiana, but not commensurate with the problems. Very limited assistance or none are provided by the other states of the region.

Vector control of course is closely related to the control of breeding conditions wherever possible. A breeding site that is in proximity to all populated areas is the solid waste disposal facility. The conduciveness to breeding relates to the method of disposal. Therefore any vector control program should take into consideration solid waste disposal in the area. This report does not attempt to evaluate the status of each state's solid waste program.

FUTURE NEEDS

While epidemiological records do not show widespread incidence of waterborne or vector-borne disease, this may actually reflect incomplete reporting, inaccurate diagnosis and the fact that much enteric or vector-induced illness is not treated by physicians. This had led some authorities to suggest that cases of such diseases may actually be far greater than the number reported. Therefore, the primary need in epidemiological assessment is:

> Improved epidemiological programs in all states of the region with specific emphasis on water and vector-borne diseases.

Most water supplies in the region are producing a safe product, but many are marginal or are delivering an aesthetically inferior product. With the increased attention being given to environmental matters today, very little of this attention has been directed to protecting drinking water. Many of the state health agencies are handling approximately twice the workload that they were ten years ago with the same or a reduced staff. Therefore, the major needs for drinking water protection in the region are:

1. Improved protection of surface and groundwater sources of water supply from municipal, industrial and agricultural waste discharges. The accomplishment of this need will require increased emphasis by State pollution control agencies.

2. Increased water quality monitoring of drinking water by water purveyors and state and local health agencies. Particular emphasis is needed on trace metals in drinking water.

3. Expanded state water supply programs so that essential surveillance and technical assistance can be provided to all water supplies. Estimates on programs in the region have indicated that each program should be increased three to four times the present level of staff and funding to adequately provide services to all water supplies in the region.

4. Adequate treatment of all water supplies so as to comply with the PHS "Drinking Water Standards."

5. New or expanded water districts or community water systems to serve rural individual domestic users.

6. Improved water system operator training and certification programs in each state.

7. Planning to protect water supply systems in the event of natural disaster with these provisions:

a. Accurate record of all water systems.

b. Warning network.

c. Auxiliary power supply at each water system.

d. Stockpile of essential chemicals available to all water systems.

e. Chlorination capability of all water systems.

The responsibility for safeguarding human health in the primary contact recreational waters of the Lower Mississippi region is invested in the various state health agencies. However, their limited staffs and resources have prevented any comprehensive programs for the water based recreationist. The maintenance of healthful conditions involving primary contact recreation in the region is dependent on satisfying the following major needs:

1. Uniform water quality standards for all primary contact recreation waters in the region which employ the fecal coliform parameter outlined in NTAC "Water Quality Criteria." Development of these criteria will require a coordinated action by all state water pollution agencies in the region.

2. Improved state programs for surveillance of recreational waters in the region.

3. Routine monitoring of all primary contact recreation waters in the region, particularly during the recreation season, with effective enforcement mechanisms for closure of those areas with unsatisfactory water quality.

4. Development of water quality data throughout the region to facilitate stream classifications (interstate and intrastate) for primary contact recreation.

Health protection from vector-borne diseases and vector related nuisances was established as being directly related to water resources development in the Lower Mississippi Region. The presence of mosquitoes and other vectors capable of transmitting disease and personal discomfort is clearly evident. The region has numerous land water areas which present a favorable habitat for vectors. The primary vector control need of the region are the following:

1. Enabling legislation for the creation and operation of vector abatement districts in Missouri and Tennessee, and revised enabling legislation for Mississippi to permit the operation of vector abatement districts wherever desired throughout the state.

2. Development of a comprehensive vector control program within each state health agency in the region.

3. Development of local vector abatement districts within the region. It is estimated that 67 local vector abatement districts will be needed by the year 2020.

4. Incorporation of vector control activities as an integral part of the planning, construction, and operation of federal water resources developments.

5. Future research and studies on:

a. Epidemiology of major vector-borne disease, especially the encephalitides.

b. Continued surveillance of the epidemic Venezuelan equine encephalitis which struck Texas in 1971.

c. Vector bionomics of the yellow fever mosquito, dengue mosquito, Aedes vexans, and Culex salinarius.

d. Abatement methodology through ground ultra low volume insecticide dispensing equipment, and biological antagonists.

6. Future control of salt marsh mosquitoes.

A summary of regional and state drinking water and vector control needs is projected in table 8.

Table 8 - Drinking Water and Disease Vector Control Need, Lower Mississippi Region

	Base Year Satisfied Needs	1980 Net Needs	2000 Net Needs	2020 Net Needs
REGION NEEDS				
State Drinking Expansion Water Program 1/	1970	19	31	43
Vector Abatement Districts 2/	1970	50	67	67
ARKANSAS				
State Drinking Expansion Water Program 1/	1970	3.0	5.0	7.0
Vector Abatement Districts 2/	1970	9	16	16
KENTUCKY				
State Drinking Expansion Water Program 1/	1970	4.0	6.0	8.0
Vector Abatement Districts 2/	1970	0	0	0
LOUISIANA				
State Drinking Expansion Water Program 1/	1970	3.0	5.0	7.0
Vector Abatement Districts 2/	1970	30	32	32
MISSISSIPPI				
State Drinking Expansion Water Program 1/	1970	3.0	5.0	7.0
Vector Abatement Districts 2/	1970	10	16	16

Table 8 - Drinking Water and Disease Vector Control Need Lower Mississippi Region (Con)

	Base Year Satisfied Needs	1980 Net Needs	2000 Net Needs	2020 Net Needs
MISSOURI				
State Drinking Expansion Water Program 1/	1970	2.0	4.0	6.0
Vector Abatement Districts 2/	1970	0	0	0
TENNESSEE				
State Drinking Expansion Water Program 1/	1970	4.0	6.0	8.0
Vector Abatement Districts 2/	1970	1	3	3

1/ Table figures indicate expansion of 1970 drinking water program to meet federal standards.

2/ Legal measures needed in Missouri, Kentucky, and Mississippi to authorize creation of vector abatement districts.

A R K A N S A S

GENERAL

The Lower Mississippi Region encompasses portions of 46 Arkansas counties or approximately 65 percent of the state's total land area. The Arkansas portion of the Region is distributed into four of the region's ten Water Resource Planning Areas (WRPA's). The main stem of the Mississippi River (WRPA 1) touches six Arkansas counties and forms the state's eastern border. All or parts of 24 Arkansas counties are in WRPA 2, that portion of the region West of WRPA 1 and North of the Arkansas River. All or portions of 26 Arkansas counties are in WRPA 5, that portion of the region bounded on the North by the Arkansas River, on the East by WRPA 1, and on the South by the Red River. Portions of six Arkansas counties South of the Arkansas River and West of WRPA 1 are in WRPA 6.

Forty-eight percent of the Arkansas' 1970 population, or 926,772 persons resided in the Lower Mississippi Region in 1970. The Arkansas portion of the region varies from flat, low-lying plains in the Mississippi alluvial valley to the steep hills in the Ouachita Mountain area. The plains are ideally suited for growing cotton, soybeans, and rice, and constitute the best agricultural land in Arkansas.

PRESENT STATUS

Epidemiological Assessment

Historically, diseases associated with water or transmitted by vectors have been important in Arkansas. Data assembled from CDC Reports (1960-1970) are presented in table 9. The table allows a comparison of possible waterborne disease occurrences in the Arkansas portion of the region and the waterborne disease which occurs throughout the nation. A check of waterborne disease outbreaks which directly implicated drinking water as the transmitter showed that none were documented as occurring in the Arkansas portion of the region.

Data for vectorborne disease by subarea was not available. It was presented for the entire Lower Mississippi Region earlier in this report. Specifically, the malaria mosquito is known to be present in the Mississippi Delta area. The incidence of tularemia, primarily a tick-borne disease is high in Arkansas.

Drinking Water Supply

Ninety-two percent of the public water supplies in the Arkansas subarea of the region use groundwater as their raw water source. The population served by these public groundwater supplies was 443,000 in 1970. Fifteen surface water supplies in the Arkansas subarea serve approximately 92,000 people. The remaining 391,772 people are served by some type of rural water system.

The bacteriological and chemical quality of the groundwater in Arkansas is generally good, and most of the groundwater supplies are potable without any sort of treatment other than disinfection. Disinfection is recommended because even though the source may be bacteriologically safe, there is always the possibility of some extraneous contamination. As is typical of this area, levels of iron and hardness are often high enough to detract from the aesthetic quality of the water. Iron and hardness do not pose a health hazard. However, they are economically removable and such removal is very important to the consumer acceptance of drinking water.

Surface waters are of course subject to any and all means of contamination. A study by the U.S. Geological

Table 9 - Incidence of Potential Waterborne Disease 1960-1970, Arkansas [1]

Year	Amebiasis	Hepatitis [2]	Salmonellosis	Shigellosis	Typhoid
1960					
Reported Ark [3] Cases	8	127	31	56	25
Reported US Cases	3,424	41,666	6,929	12,487	816
Percent	0.23	0.30	0.44	0.44	3.1
1961					
Reported Ark Cases	13	487	35	68	16
Reported US Cases	2,850	72,651	8,542	12,571	814
Percent	0.45	0.67	0.40	0.54	2.0
1962					
Reported Ark Cases	21	276	35	85	16
Reported US Cases	3,048	53,016	9,680	12,443	608
Percent	0.68	0.52	0.36	0.68	2.6
1963					
Reported Ark Cases	3	148	62	83	16
Reported US Cases	2,886	42,974	16,390	13,009	556
Percent	0.10	0.34	0.40	.63	2.9
1964					
Reported Ark Cases	3	144	70	79	9
Reported US Cases	3,304	37,740	17,144	12,984	501
Percent	0.09	0.38	0.40	0.60	1.8
1965					
Reported Ark Cases	5	168	72	78	8
Reported US Cases	2,768	33,856	17,161	11,027	454
Percent	0.18	0.49	0.41	0.70	1.8
1966					
Reported Ark Cases	4	141	76	52	3
Reported US Cases	2,921	32,859	16,841	11,888	378
Percent	0.13	0.43	0.45	0.43	0.79
1967					
Reported Ark Cases	4	138	92	62	7
Reported US Cases	1,157	38,909	18,120	13,474	396
Percent	0.34	0.35	0.50	0.46	1.8

Table 9 - Incidence of Potential Waterborne Disease, 1960-1970, Arkansas [1] (Con)

Year	Amebiasis	Hepatitis [2]	Salmonellosis	Shigellosis	Typhoid
1968					
Reported Ark [3] Cases	7	79	79	36	9
Reported US Cases	3,005	45,893	16,514	12,180	395
Percent	0.23	0.17	0.47	0.30	2.3
1969					
Reported Ark Cases	1	91	74	52	9
Reported US Cases	2,950	48,416	18,419	11,946	364
Percent	0.03	0.20	0.40	0.43	2.5
1970					
Reported Ark Cases	0	147	88	41	4
Reported US Cases	2,888	56,797	22,096	13,845	346
Percent	0	0.25	0.39	0.30	1.20
Totals					
Reported Ark Cases	69	1,946	714	692	122
Reported US Cases	31,201	504,777	166,836	137,854	5,628
Percent	.22	.38	.42	.50	2.2

[1] Source: "Morbidity and Mortality Reports," Center for Disease Control, Atlanta, Georgia

[2] Includes serum hepatitis for years 1960-1965

[3] Arkansas data is a part of the State's total, calculated as follows:

$$\frac{\text{Population of Ark in LMR}}{\text{Population of LMR}} \times \text{Total Ark Cases of Specific Disease.}$$

Survey in 1970 revealed high levels of two toxic chemicals as shown in the table below:

Sample Location	Constituent Exceeding Standards
Mississippi River at Cottonwood Point, Missouri	Cadmium - 0.015 mg/1
Arkansas River near Lock & Dam #3 below Pine Bluff, Arkansas	Arsenic - 0.090 mg/1
Hot Springs Reservoir on Bull Bayou, Arkansas	Cadmium - 0.020 mg/1
Ouachita River near Malvern, Arkansas	Cadmium - 0.018 mg/1
Hurricane Creek near Sheridan, Arkansas	Cadmium - 0.015 mg/1

Drinking Water Standards: Cd-0.01 mg/1, As-0.05 mg/1

The Hot Springs, Arkansas results are noteworthy since the sample represents the raw water source for a public water supply. Water treatment systems are not designed to remove these constituents. Fortunately, the Hot Springs system has additional sources of raw water and acceptable drinking water quality has been maintained at Hot Springs.

Health surveillance of water supplies in Arkansas is provided by the Bureau of Environmental Engineering of the State Department of Health. The state program operates on an annual budget of $60,000. Thus Arkansas spends approximately 3.6 cents per capita for health surveillance of drinking water. Conservatively, one-third of Arkansas' Public Water Supplies do not meet the U. S. Public Health Service"Drinking Water Standards." Chemical, physical, and radiological sampling are very inadequate. State control efforts are an estimated 60 percent of that necessary to provide comprehensive engineering and water quality surveillance for all water systems in the state. Personnel in the state program are capable but there are too few professionals to conduct the necessary inspections, review plans and conduct training courses. The 1970 staff included three professionals who were responsible for that portion of Arkansas in the Lower Mississippi Region.

Primary Contact Recreation

Arkansas has some of the major water-based recreation areas in the Lower Mississippi Region, including Blakely Mountain Reservoir, Lake Hamilton, and Lake Catherine on the Ouachita River; De Gray Reservoir on the Caddo River; and Narrows Reservoir on the Little Missouri River. All of these multi-purpose impoundments are in WRPA 5.

The responsibility for health protection of the recreationist is vested in the state health agency. However, there is no comprehensive program to provide the field surveillance and water quality monitoring necessary to implement this responsibility.

State "Water Quality Standards" for Arkansas established bacteriological criteria for primary contact recreation water as 1000 total coliforms per 100 ml, monthly average. While the total coliform is considered an acceptable parameter for this criteria, recent federal standards have been developed which consider the fecal coliform as the more reliable indicator of human or animal contamination. The proposed federal criteria based on fecal coliforms, is significantly more restrictive than the Arkansas Standard.

Little is known about water quality of primary contact recreation waters in Arkansas. At the present, the Lower White River and Ouachita River are the only interstate streams in Arkansas classified for recreational use.

Vector Control

From the mid 1940's to the early 50's the U.S. Public Health Service, through the Malaria Control in War Areas and its successor, the CDC, cooperated with the Arkansas State Department of Health in conducting extensive vector control operations and investigations throughout the region portion of the state. With the cessation of CDC participation, however, most of these programs ceased to function although enabling legislation for mosquito abatement districts has been secured to permit transition of local programs from a wartime to a permanent basis.

Fifty-three species of mosquitoes in nine genera are recorded for Arkansas. The dark rice field mosquito, Psorophora confinnis the tan rice field mosquito, Psorophora discolor, and the malaria mosquito, Anopheles quadrimaculatus, attain prodigious numbers in the rice

growing Grande Prairie. The southern house mosquito Culex p. quinquefasciatus, is distributed in heavy concentrations throughout the region within Arkansas. The yellow fever mosquito, Aedes aegypti, is restricted to localized infestations in the southern portion of the state.

In July 1970, civic organizations and the local health department in the city of Stuttgart in WRPA 2 cooperated with the PHS and industry in conducting a demonstration of the effectiveness of ultra low volume (ULV) aerial application of technical malathion to the city and a surrounding buffer zone. Stuttgart, which is jutifiably proud of its title, "Duck Capitol of the World," smarts frequently from its other title, "Mosquito Capitol of the World." The residents were so impressed by the 99.93 percent reduction in mosquitoes that interest has again been generated in establishing an organized mosquito abatement program based upon comprehensive control procedures mainly involving changes in rice culture supplemented by the use of insecticides when needed.

At the state level, support for vector control is practically non-existent. There are no personnel in the State Department of Health assigned to this activity. The Department requested, prior to March 1971, activation of a Vector Control Division to be staffed by a sanitarian administrator, two additional sanitarian supervisors, and clerical personnel. Thus far, the Department of Administration and Legislative Council have approved the request; however, it has not been acted upon by the legislature nor by the Governor. The University of Arkansas, which conducted significant studies in the past, has taken a much less active part during latter years. About two years ago, a vector control consultant was hired by the University to conduct some cooperative studies in mosquito control with selected communities. To date, this activity has been restricted to smaller communities and has evaluated only conventional materials and procedures.

FUTURE NEEDS

The improvement of the human health environment in the Arkansas subarea of the Lower Mississippi Region is dependent principally upon actions by the State Health Agency. The primary health needs in Arkansas are:

1. Improvement of the state epidemiology program of the State Department of Health through the development of consistent local contacts and increased emphasis on water and vector-borne diseases.

2. Expanded water supply program for the State Department of Health to provide essential surveillance and technical assistance to all water systems in the state. Estimated needs for this activity are a threefold increase of staff over the 1970 level and budget by 1980 to a total budget of $300,000. Beyond 1980, the program should, as a minimum, be doubled every 20 years.

3. Improved protection of ground and surface sources of drinking water supply from municipal, industrial, and agricultural waste discharges by health and water pollution control agencies.

4. Planning for assistance and action to protect water supply systems in the event of natural disasters.

5. Revised water quality criteria for primary contact recreation waters based on the fecal coliform parameter as recommended in NTAC "Water Qaulity Criteria."

6. Development of a comprehensive state program to protect the health of the primary contact recreationist, including water quality monitoring and enforcement powers to restrict public usage of unsafe waters.

7. Improved vector control program at the state level to direct the disease vector surveillance throughout the state.

8. Establishment of nine vector abatement districts in Arkansas by 1980. All districts should be funded at a level of $150,000 per annum per vector abatement district. Seven additional vector abatement districts (five in WRPA 2 and four in WRPA 5) are needed by 2020.

K E N T U C K Y

GENERAL

The Lower Mississippi encompasses portions of seven Kentucky counties which are located in the southwestern corner of that state, and in the northwestern corner of WRPA 3. The main stem of the Mississippi River (WRPA 1) touches three Kentucky counties and forms the state's western border. The land area of the four counties is predominantly rural with an economy based on agriculture. Their combined 1970 population was 52,740.

PRESENT STATUS

Epidemiological Assessment

Historically, diseases associated with water or transmitted by vectors have been important in Kentucky. Waterborne disease data from CDC records are presented in table 10. Because of the small population residing in the Kentucky portion of the region, no comparison of disease incidence could be made. In addition, a check of specific waterborne disease outbreaks which directly implicated drinking water showed that none were documented in the Kentucky portion of the region.

Data for vectorborne disease by subarea was not available. It was presented for the entire Lower Mississippi Region in the Regional Summary section of this report. There are no mosquito vectors of major significance in the Kentucky portion of the region.

Drinking Water Supply

Drinking water in the Kentucky subarea of the region is supplied entirely from groundwater sources. There are 21 public water systems in the subarea which supply approximately 35,000 people or 66 percent of the population of the subarea. The remaining 34 percent obtain their drinking water through rural individual systems.

The bacteriological and chemical quality of groundwater in Kentucky is generally acceptable for drinking water systems with disinfection. Groundwater data compiled by the U. S. Geological Survey for this study indicated the general occurrence of iron and low pH as chemical-physical constituents which require additional treatment.

Health surveillance of water supplies in Kentucky is provided by the Division of Sanitary Engineering, Kentucky State Department of Health. The state program operates on an annual budget of $83,000. Thus, Kentucky spends approximately 2.6 cents per capita for health protection of drinking water. The Water Supply Program has a central office in Frankfort and a field office in Earlington. The Kentucky portion of the Lower Mississippi Region is covered by the one-man field office in Earlington.

Table 10 - Incidence of Potential Waterborne Disease, 1960-1970, Kentucky[1/]

Year	Amebiasis	Hepatitis[2/]	Salmonellosis	Shigellosis	Typhoid
1960					
Reported Ky[3/] Cases	0	37	0	1	1
Reported US Cases	3,424	41,666	6,929	12,487	816
Percent	0	.89	0	.08	.12
1961					
Reported Ky Cases	0	58	57	0	0
Reported US Cases	2,850	72,651	8,542	12,571	814
Percent	0	.08	.67	0	0
1962					
Reported Ky Cases	0	43	1	0	0
Reported US Cases	3,048	54,016	9,680	12,443	608
Percent	0	.08	.01	0	0
1963					
Reported Ky Cases	0	21	8	1	0
Reported US Cases	2,886	42,974	15,390	13,009	556
Percent	0	.05	.05	0	0
1964					
Reported Ky Cases	0	17	3	1	0
Reported US Cases	3,304	37,740	17,144	12,984	501
Percent	0	.05	.02	0	0
1965					
Reported Ky Cases	0	16	3	1	0
Reported US Cases	2,768	33,856	17,161	11,027	454
Percent	0	.05	.02	0	0
1966					
Reported Ky Cases	0	17	20	1	0
Reported US Cases	2,921	32,859	16,841	11,888	378
Percent	0	.05	.12	0	0
1967					
Reported Ky Cases	0	20	9	1	1
Reported US Cases	1,157	38,909	18,120	13,474	396
Percent	0	.05	0.5	0	.02

Table 10 - Incidence of Potential Waterborne Disease, 1960-1970, Kentucky[1/] (Con)

Year	Amebiasis	Hepatitis[2/]	Salmonellosis	Shigellosis	Typhoid
1968					
Reported Ky[3/] Cases	0	21	2	1	0
Reported US Cases	3,005	45,893	16,514	12,180	395
Percent	0	.04	.01	0	0
1969					
Reported Ky Cases	0	23	3	1	0
Reported US Cases	2,950	48,416	18,419	11,946	364
Percent	0	.05	.02	0	0
1970					
Reported Ky Cases	0	23	66	1	0
Reported US Cases	2,888	56,797	22,096	13,845	346
Percent	0	.04	.30	0	0
Totals					
Reported Ky Cases	0	296	172	9	2
Reported US Cases	31,201	504,777	166,836	137,854	5,628
Percent	0	.05	.10	.0065	.0355

1/ Source: "Morbidity and Mortality Reports," Center for Disease Control, Atlanta, Georgia

2/ Includes serum hepatitis for years 1960-1965

3/ Kentucky data is a part of the State's total, calculated as follows:

$$\frac{\text{Population of Ky in LMR}}{\text{Population of LMR}} \times \text{Total Ky Cases of Specific Disease}$$

A special Environmental Protection Agency evaluation of the Kentucky Water Supply Program was conducted in 1970. The study revealed that Kentucky has excellent statutory authority and program policies to conduct a comprehensive drinking water program, but lacks the staff and resources to carry out an effective program. The study indicated inadequacies in program implementation and demonstrated serious water quality and facility deficiencies which existed in the water systems of the state. The State Department of Health is using this study as the basis for program expansion for drinking water protection.

Primary Contact Recreation

Kentucky has no major water-based recreation areas in the Lower Mississippi Region. However, the region's major water-based recreation areas are easily accessible to the people of the Kentucky subarea.

The responsibility for health protection of the recreationist is vested in the state health agency. However, the state health agency does not have a comprehensive program to provide the field surveillance and water quality monitoring necessary to implement this responsibility.

State "Water Quality Standards" for Kentucky have established bacteriological criteria for primary contact recreation waters as 1000 total coliforms per 100 ml based on a monthly average. While this criteria is useful, recent federal water quality criteria have been developed which consider the fecal coliform as a more reliable indication of human or animal contamination.

Little is known about water quality of primary contact recreation waters in Kentucky. An attempt was made to gather water quality information for Kentucky waters, but too little information, particularly bacteriological data, was available on major streams in the state. Reference is made to Appendix L. The data in that document indicate that physical water quality is generally acceptable for primary contact recreation; but no data on bacteriological quality are listed.

At the present time, the only interstate stream in Kentucky which is classified for recreational use is the Mississippi River. Several intrastate streams are also known to support primary contact recreation.

Vector Control

Kentucky has an enabling act for the creation and operation of vector abatement districts, and the state's first district was formed in 1968 in Hopkins County which is outside the region but nearby. The State Department of Health has no vector control program. The Kentucky Department of Agriculture, through its Division of Pest and Noxious Weed Control, has competency in vector control and operates an aerial mosquito control program concentrating much of its efforts on the area around Lakes Barkley and Kentucky (outside, but near the region). The annual budget for this activity is about $110,000. The University of Kentucky Agricultural Experiment Station in Lexington carried out studies during 1966-1967 in which several candidate insecticides were tested in aerial Ultra-Low-Volume application against mosquitoes found in western Kentucky.

Forty-seven species of mosquitoes in nine genera have been recorded for the state. The most important species in the very small portion of Kentucky which lies within the Lower Mississippi Region include the malaria mosquito, Anopheles quadrimaculatus, and the vector SLE, the house mosquito, Culex pipiens complex. Vector control problems have not been acute in this area. Nearby areas to the east, however, experience some of the nation's most severe inland infestations of the (normally coastal) salt marsh mosquito, Aedes sollicitans, in water wasted from strip coal mines.

FUTURE NEEDS

The improvement of the human health environment in Kentucky is dependent principally upon actions by the state health agency. The primary health needs in Kentucky are:

1. Improvement of the epidemiological program of the State Department of Health through the development of consistant local contacts and with specific emphasis on water and vector-borne diseases.

2. Expanded water supply program of the State Department of Health to provide essential surveillance and technical assistance to all water systems in the state. Estimated needs for this activity are a fourfold increase of staff by 1980 and a total budget of $400,000. Beyond 1980 the program should, as a minimum, be doubled every 20 years.

3. Improved protection of water supply sources from municipal, industrial and agricultural waste discharges by health and water pollution control agencies.

4. Revised water quality criteria for primary contact recreation waters based on the fecal coliform parameter at the level recommended in NTAC "Water Quality Criteria."

5. Development of a comprehensive state program to protect the health of the water-oriented recreationist, including water quality monitoring and enforcement powers to restrict public usage of unsafe waters.

6. Improved vector control program at the state level to provide statewide surveillance of vector problems. No local vector abatement districts are needed in the Kentucky portion of the Lower Mississippi Region.

L O U I S I A N A

GENERAL

Except for portions of seven parishes along the western border and portions of two parishes in the southeastern corner of Louisiana, the entire state is in the Lower Mississippi Region. WRPA 5 includes most of the area north of Red River, west of the Ouachita River and east of the regional boundary. WRPA 6 is the area between the Ouachita and Mississippi River. WRPA 8 includes all or parts of 13 parishes around the Baton Rouge Area. The coastal area is roughly divided into WRPA 9, west of the Atchafalaya River and WRPA 10, east of the same, which includes New Orleans and the Mississippi outlet into the Gulf of Mexico. Eighty-six percent (3,162,806) of Louisiana's population lives in the Lower Mississippi Region. Topography is greatly varied, ranging from low hills in the north (WRPA 5) to rolling alluvial land along the Mississippi (WRPA 6) to marshes along the Gulf Coast (WRPA 9 and 10).

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PRESENT STATUS

Epidemiological Assessment

Historically, diseases associated with water or transmitted by vectors have been significant in Louisiana. Data assembled from CDC Reports (1960-1970) are presented in table 11. The table allows a comparison of possible waterborne disease occurrences in the Louisiana portions of the region and the waterborne disease occurrences throughout the nation. A check of waterborne disease outbreaks revealed three in Louisiana, two of these documented since 1960.

In 1947, 11 persons in Vermilion Parish, Louisiana, (WRPA 9) contacted typhoid fever. Epidemiological evidence indicated a contaminated private well as the cause of the disease. The following year a similar outbreak occurred in Catahoula Parish, Louisiana, when 15 persons contacted typhoid fever.

In 1961, two persons in rural Jefferson Davis Parish, Louisiana, (WRPA 9) contacted typhoid fever. Epidemiological evidence indicated a contaminated private well as the cause of the disease.

In 1968, an outbreak of gastroenteritis affected nine people at a Boy Scout Camp in St. Bernard Parish, Louisiana (WRPA 10). Drinking water was the suspected vehicle of disease transmission.

Data for vector-borne disease by subarea was not available. It was presented for the entire Lower Mississippi Region earlier in this report. Specifically, the malarial mosquito is known to be present in the Mississippi Delta area.

Nine confirmed and 13 presumptive human cases of SLE occurred in Louisiana during the summer of 1966, concurrently with epidemics in Dallas and Corpus Christi, Texas. Although this marked the first reported SLE from Louisiana, there is evidence of its prior existence. Subsequent cases have been reported. California encephalitis was first re-reported in Louisiana in 1967 when two human cases occurred in the southeastern portion of the state.

Table 11 - Incidence of Potential Waterborne Disease, 1960-1970, Louisiana[1/]

Year	Amebiasis	Hepatitis[2/]	Salmonellosis	Shigellosis	Typhoid
1960					
Reported La[3/] Cases	56	173	166	38	50
Reported US Cases	3,424	41,666	6,929	12,487	816
Percent	1.6	0.41	2.4	0.30	6.1
1961					
Reported La Cases	27	490	204	108	22
Reported US Cases	2,850	72,651	8,542	12,571	814
Percent	0.94	0.67	2.4	0.85	2.7
1962					
Reported La Cases	27	479	262	125	27
Reported US Cases	3,048	53,016	9,680	12,443	608
Percent	0.88	0.90	2.7	1.0	4.4
1963					
Reported La Cases	21	515	330	123	22
Reported US Cases	2,886	42,974	15,390	13,009	556
Percent	0.72	1.2	2.1	0.94	4.0
1964					
Reported La Cases	28	610	219	93	9
Reported US Cases	3,304	37,740	17,144	12,984	501
Percent	0.84	1.6	1.3	0.71	1.8
1965					
Reported La Cases	20	407	330	116	10
Reported US Cases	2,768	33,856	17,161	11,027	454
Percent	0.72	1.2	1.9	1.1	2.2
1966					
Reported La Cases	22	393	215	83	9
Reported US Cases	2,921	32,859	16,841	11,888	378
Percent	0.75	1.2	1.3	0.70	2.4
1967					
Reported La Cases	16	563	185	85	16
Reported US Cases	1,157	38,909	18,120	13,474	396
Percent	1.4	1.4	1.0	0.63	4.0

Table 11 - Incidence of Potential Waterborne Disease, 1960-1970, Louisiana[1] (Con)

Year	Amebiasis	Hepatitis[2]	Salmonellosis	Shigellosis	Typhoid
1968					
Reported La[3] Cases	22	649	153	65	5
Reported US Cases	3,005	45,893	16,514	12,180	395
Percent	0.73	1.4	0.92	0.53	1.3
1969					
Reported La Cases	15	754	300	36	3
Reported US Cases	2,950	48,416	18,419	11,946	364
Percent	0.50	1.6	1.6	0.30	0.82
1970					
Reported La Cases	16	515	81	26	8
Reported US Cases	2,888	56,797	22,096	13,845	346
Percent	0.55	0.90	0.36	0.18	2.3
Totals					
Reported La Cases	270	5,548	2,445	898	181
Reported US Cases	31,201	504,777	166,836	137,854	5,628
Percent	.86	1.1	1.5	.65	3.2

[1] Source: "Morbidity and Mortality Reports," Center for Disease Control Atlanta, Georgia

[2] Includes serum hepatitis for years 1960-1965

[3] Louisiana data is a part of the State's total, calculated as follows:

$$\frac{\text{Population of La in LMR}}{\text{Population of LMR}} \times \text{Total La Cases of Specific Disease}$$

A devastating epidemic of Eastern Encephalitis struck Louisiana in 1947 when ten human cases with nine deaths were recorded. A fatal case occurred in a six-year old girl in September 1971, in Springfield, Livingston Parish. Two pools of mosquitoes, Culiseta melanura, collected in adjacent Tangipahoa Parish several weeks earlier were positive for EE virus. Studies in this region in 1952 and 1953 disclosed that approximately 25 percent of certain birds, such as cardinals and crows, had antibodies to EE. Western encephalitis occurred within the region with some regularity during 1964 to 1966. Encephalitis, although comparatively rare, is a serious disease because it has high epidemic potential, there is no specific treatment known, the disease may cause permanent brain damage, and the incidence is high among children and young adults.

Drinking Water Supply

Eighty-six percent of the public water systems in the Louisiana subarea of the region utilize water from groundwater sources. The population served by these public groundwater supplies is 1,050,000. Louisiana's largest cities use surface water. Although there are only forty-five surface supplies in the Louisiana portion of the region, they serve 1,410,000 people. The remaining 702,806 are served by some type of private water system.

The bacteriological and chemical quality of the groundwater in most of Louisiana is generally suitable for potable purposes. Communities in the coastal areas must rely on surface water because groundwater in these areas is very brackish. Most of the groundwater supplies do not require any sort of treatment other than disinfection. Disinfection is recommended, for even though the source may be bacteriologically safe, there is always the possibility of some extraneous contamination. Levels of iron and hardness are often high enough to detract from the aesthetic quality of the water but these constituents pose no health hazard and are economically removable. However, these constituents are very important to the consumer acceptance of drinking water.

Surface waters of course are subject to any and all means of contamination. Near the coast many fresh water streams and canals receive intermittent salt water intrusion, making them poor sources of drinking water. On the Mississippi River an effective monitoring and warning system for water quality is presently in effect from Baton Rouge to the

Gulf. It covers all the water supplies which utilize the Mississippi River and has proved a valuable tool in safeguarding drinking water in southeastern Louisiana.

Health Surveillance of water supplies in Louisiana is provided by the Bureau of Environmental Health of the State Department of Health. The state program operates on an annual budget of $139,000. Thus Louisiana spends approximately 3.8 cents per capita per year for health surveillance of drinking water. Of 594 public supplies which serve seventy-seven percent of the state's population an estimated 550 do not meet the U. S. Public Health Service "Drinking Water Standards." Chemical, physical, and radiological sampling are very moderate. Less than 10 percent receive satisfactory inspection and surveillance. Ninety percent are not sampled regularly to determine bacteriological quality as set forth in the "Drinking Water Standards."

The New Orleans Standard Metropolitan Statistical Area was included in the national "Community Water Supply Study" in 1969. Major findings of this national study were indicative of water system status in the New Orleans SMSA and the state.

1. Only 59 percent of the 969 water systems in the National Study delivered drinking water that met "Drinking Water Standards."

2. Fifty-six percent of the systems were deficient in one or more of the following: source of protection, disinfection and/or control of disinfection, clarification and/or control of clarification, and pressure in the distribution system.

3. Small water systems have more water quality and facility deficiencies than large systems.

The "Community Water Supply Study" also found that the abundance of small water systems causes special problems for state health surveillance programs. The same situation exists throughout Louisiana and the Lower Mississippi Region. The number of small water systems has greatly increased over the last decade, mostly because of the impetus of federal funding for urban, rural, and economically depressed areas. These systems have made drinking water available to many citizens who formerly relied on unsafe rural domestic supplies. However, because they are generally small and have a marginal economic base, the small water system is

difficult to operate and maintain in accord with sound water supply practice. Hence, the state surveillance program must cope with many borderline water systems.

A major threat in Louisiana that requires the attention of water supply officials is that of natural disasters. Hurricanes and tropical storms are a perennial hazard for Louisiana's coast. Hurricane Betsy (1965) and Hurricane Camile (1969) did significant damage to coastal water systems.

Primary Contact Recreation

Other than the coastal lakes, there are not many large impoundments in the Louisiana portion of the region. Louisiana's largest impoundments are further West. There are some small to moderate size lakes within regional boundries including numerous oxbow lakes along the Mississippi River that are used for water contact recreation. In addition, the Mississippi River and the Gulf coast are used to some degree for this purpose.

The responsibility for health protection of the recreationist is vested in the state health agency. However, there is no comprehensive program to provide the field surveillance and water quality monitoring necessary to implement this responsibility.

State "Water Quality Standards" for Louisiana establised bacteriological criteria for primary contact recreation water based on total coliforms at a level of 1600 per 100 ml, monthly median. Recent federal water quality criteria have been developed which consider the fecal coliform as a more reliable indicator of human or animal contamination.

Little is known about water quality of primary contact recreation waters in Louisiana. At the present time, the following interstate streams are classified for primary contact recreation:

Calcasieu River	Coastal Waters
Amite River	Bogue Chitto River
Tangipahoa River	Pearl River

Vector Control

The annoyance in coastal Louisiana by both salt and

fresh water marsh mosquitoes is legendary. Mosquito-borne malaria, yellow fever, and dengue have plagued the area from its earliest settlement into the present century. These diseases are presently eradicated or under control. The vectors and a susceptible human population remain, making vigilance of paramount importance.

Louisiana is the Nation's largest producer of rice. This crop cultivated mainly in the southwestern portion of the state, in irrigated fields, is associated with the frequently prolific production of malaria mosquitoes (Anopheles quadrimaculatus) and several other species including Psorophora confinnis and Aedes vexans.

Fifty-six species of mosquitoes in nine genera are recorded for the state, surpassing the reported number of species of other states in the region. All sections of Louisiana have significant mosquito problems, although the nature of the problems and the species of mosquitoes involved may vary from area to area. The state is the wettest in the region in terms of normal and hurricane-associated rainfall, marshes, swamps, and bayous.

The rat problem in New Orleans, and especially in the port area, deserves special mention. The Port of New Orleans is reported to be the second largest in the United States in water-borne foreign commerce and is the leading port in the world in grain exports. The port facilities are old, and a recent survey revealed that 100 percent of the wharves inspected were infested by rats and that rat-stoppage is not feasible. The port handles relatively little containerized freight and industrial products. Much of the material is grain and other food products, which combined with ample moisture and extensive areas of protective harborage, along with the subtropical climate, provide a haven for a prodigious population of rats. The wharves with a variable daily population estimated at more than 10,000 persons, not including support personnel such as truck drivers and railroad workers, partially encircle the heart of the city.

As previously mentioned epidemiologic conditions for an outbreak of murine typhus exists, and two cases have occurred recently in dock workers. This port is a point of great vulnerability as one case of introduced plague could paralyze the city and have serious economic effect throughout the state and far beyond. Recent significant reductions in the activities of the U. S. Foreign Quarantine Program enhance the danger. The New Orleans Health Department has

performed rat-killing operations and maintained surveillance on rat populations, their ectoparasites, and rat sera for evidence of typhus infection for years. The problems presented by the construction and operation of the Port render these efforts palliative at best. Hope is in sight, however, as work as begun, although modestly, on a completely new port in a new location. With careful planning, most of the features which preclude rat extermination in the present facilities can be avoided in the new port. The new facility is planned to be in operation and the present site converted to other uses, perhaps a riverfront park, in about 15 years. The new port presents a case in which proper design and development of a water resource and related land will be of utmost significance in eliminating a present vector-borne disease threat and preventing its recurrence throughout the time frame of this study.

The Louisiana State Department of Health, the Nation's oldest state health organization, had its beginning in connection with a vector-borne disease (yellow fever), and has maintained some program in vector control since its inception. This activity, however, has not kept pace with general developments in public health or with public demand. In 1970-1971 the vector control staff consists of three full-time people, a public health entomologist, a rodent control specialist, and a vector control specialist (sanitarian).

In 1969 the State Department of Health developed a plan for a comprehensive vector control program. It has not been implemented yet; however, the State Health Officer stated publicly in late 1971 that implementation of this program has highest priority. A senior vector control specialist was scheduled to join the Department in February 1972, as a first step in augmenting the program.

During the last ten years, local programs to abate a wide range of vector problems have increased greatly, attesting the awareness of citizens of the public health and economic significance of the problem. In the New Orleans metropolitan area (including Slidell), there are five organized mosquito abatement districts with a total annual budget for 1971 of approximately $1,356,000. These districts afford vector control and surveillance to more than one million people. Also, there are more than one hundred other locally financed vector control projects throughout the State with an annual expenditure of approximately $550,000. These city, parish, or community programs are provided limited technical support by the State Health Department, but are administered at the local level.

Three of the above "unorganized" vector control programs are parish-wide and are operated by the respective parish health units. These include Caddo-Shreveport (outside the Region), East Baton Rouge (Baton Rouge), and Calcasieu (Lake Charles) Parishes. The annual budget for such parish programs vary from $50,000 to $75,000. The operations are much less comprehensive than those of the organized abatement district. Portions of the areas served by "unorganized" vector control programs may receive service only on a complaint basis.

The Louisiana Mosquito Control Association (LMCA) was organized in 1957 and functioned at the outset principally as an organization to conduct field research. Presently, it contracts for research with university groups, provides technical consultation, and performs other functions which are the usual responsibilities of the State Department of Health. The LMCA has received funds to defray the costs of this program as contributions from several parish governments, from the state contingency fund, and from individual members and member organizations. Its annual budget is presently about $50,000, but has been about twice this in some previous years. This budget will support only a token amount of research, and there is no assurance of the continuation of funds from sources other than members and member organizations--a small percentage of the total budget. Hopefully, the vector control program of the State Department of Health will be expanded to take over these functions, afford more services, and provide assurance of their continuity. The LMCA could then function solely as a professional organization dedicated to the furtherance of technical excellence through the exchange of ideas and experiences.

In late 1964, there was formed the Gulf States Council on Wildlife, Fisheries and Mosquito Control. This organization strives to preserve the best interests of both wildlife management and mosquito control, resolve divergent approaches to program objectives, and preserve the coastal environment.

On July 1, 1971, the city of New Orleans was one of three cities added to the original 26 in the Nation which receive federal funds (PHS 314(e)) for rat control. The grant of almost $300,000 will allow the City Health Department to conduct intensive rat control through public education, improvements in premises sanitation, and rat-killing in three target areas including the Port of New Orleans. The target areas have a population of approximately 147,000, a majority of whom are disadvantaged.

FUTURE NEEDS

The improvement of the human health environment in the Louisiana subarea of the Lower Mississippi Region is dependent principally upon actions by the state health agency. The primary health needs in Louisiana are:

1. Improvement of the epidemiology program of the State Department of Health through the development of consistent local contacts and with specific emphasis on water and vector-borne diseases.

2. Expanded water supply program for the State Department of Health to provide essential surveillance and technical assistance to all water systems in the state. Estimated needs for this activity are a threefold increase of staff by 1980 with a total budget of $300,000. Beyond 1980 the program should, as a minimum, be doubled every 20 years.

3. Improved protection of ground and surface sources of drinking water supply from municipal, industrial, and agricultural waste discharges.

4. Planning to protect water supply systems in the event of natural disasters.

5. Revised water quality criteria for primary contact recreation waters based on the fecal coliform parameter as recommended in NTAC "Water Quality Criteria."

6. Development of a comprehensive state program to protect the health of the primary contact recreationist, including water quality monitoring and enforcement powers to restrict public usage of unsafe waters.

7. Improved vector control program at the state level to direct the disease vector surveillance throughout the state.

8. Establishment of 30 vector abatement districts in Louisiana by 1980. These districts are 13 in WRPA-9, 5 in WRPA-10, 6 in WRPA-8, and 6 in WRPA-6. All districts should be funded at a level of $150,000 per annum per vector abatement district. Two additional districts in WRPA-5 are needed by 2020.

M I S S I S S I P P I

GENERAL

The Lower Mississippi Region occupies all or portions of 44 Mississippi counties or approximately half of the state of Mississippi. Two Water Resources Planning Areas, WRPA-4 and WRPA-7, lie entirely in Mississippi. Small sections of WRPA-3 and WRPA-8 also lie in this state.

Forty-three percent of Mississippi's population or 850,864 people live in the Lower Mississippi Region. The majority of the land area is river bottom land of the Mississippi and Yazoo Rivers with a rural economy based on agriculture.

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PRESENT STATUS

Epidemiological Assessment

Historically, diseases associated with water or transmitted by vectors have been important in Mississippi. Data assembled from CDC Reports, 1960-1970, are presented in table 12. The table allows a comparison of five potential waterborne diseases occurring in the Mississippi portion of the region with the same waterborne diseases occurring nationwide. The comparison reveals a higher incidence of typhoid fever in Mississippi and a lower incidence of the other four diseases. In addition, a check of specific waterborne disease outbreaks which directly implicated drinking water as a source of disease transmission showed that none were documented to have occurred in the Mississippi portion of the region.

Data for vectorborne disease is not available for this subarea. Composite data are presented for the entire Lower Mississippi Region earlier in this report. The malaria and yellow fever mosquitoes are known to be present in most of the Mississippi delta north of Vicksburg. The existence or non-existence in the rest of the region has not yet been established.

Drinking Water Supply

Drinking water in the Mississippi subarea of the region is supplied entirely from groundwater. There are 278 public water supplies in the subarea which supply approximately 500,000 people or 58.8 percent of the subarea population. The remaining 41.2 percent obtain their drinking water through rural individual systems.

The bacteriological and chemical quality of the groundwater in Mississippi is generally acceptable for drinking water systems with disinfection. Groundwater data compiled by the U. S. Geological Survey for this study indicated the general occurrence of iron and hardness as chemical constituents which require additional treatment. Although these constituents are not of major health significance, they are very important to the consumer acceptance of drinking water.

Health surveillance of water supplies in Mississippi is provided by the Division of Sanitary Engineering, Mississippi State Board of Health. The state program operates on an annual budget of $100,000. Thus, Mississippi spends approximately 4.5 cents per capita for health surveillance of

Table 12 - Incidence of Potential Waterborne Disease, 1960-1970, Mississippi [1/]

Year	Amebiasis	Hepatitis [2/]	Salmonellosis	Shigellosis	Typhoid
1960					
Reported Miss [3/] Cases	7	237	23	23	3
Reported US Cases	3,424	41,666	6,929	12,487	816
Percent	0.20	0.56	0.33	0.18	0.36
1961					
Reported Miss Cases	23	655	11	25	4
Reported US Cases	2,850	72,651	8,542	12,571	814
Percent	0.80	0.90	0.12	0.20	0.50
1962					
Reported Miss Cases	20	377	14	28	3
Reported US Cases	3,048	53,016	9,680	12,443	608
Percent	0.65	0.71	0.14	0.22	0.50
1963					
Reported Miss Cases	8	245	16	32	9
Reported US Cases	2,886	42,974	15,390	13,009	556
Percent	0.27	0.57	0.10	0.24	1.6
1964					
Reported Miss Cases	6	115	25	34	3
Reported US Cases	3,304	37,740	17,144	12,984	501
Percent	0.18	0.30	0.14	0.26	0.60
1965					
Reported Miss Cases	1	127	16	32	4
Reported US Cases	2,768	33,856	17,161	11,027	454
Percent	0.03	0.32	0.09	0.30	0.88
1966					
Reported Miss Cases	4	138	22	41	3
Reported US Cases	2,921	32,859	16,841	11,888	378
Percent	0.13	0.41	.13	.34	.79
1967					
Reported Miss Cases	7	207	3	38	7
Reported US Cases	1,157	38,909	18,120	13,474	396
Percent	0.60	0.53	0.01	.28	1.7

Table 12 - Incidence of Potential Waterborne Disease, 1960-1970, Mississippi [1/] (Con)

Year	Amebiasis	Hepatitis [2/]	Salmonellosis	Shigellosis	Typhoid
1968					
Reported Miss [3/] Cases	2	196	24	33	6
Reported US Cases	3,005	45,893	16,514	12,180	395
Percent	0.06	0.42	.14	.27	1.5
1969					
Reported Miss Cases	3	178	38	23	6
Reported US Cases	2,950	48,416	18,419	11,946	364
Percent	0.10	.36	.20	.19	1.6
1970					
Reported Miss Cases	10	104	55	34	1
Reported US Cases	2,888	56,797	22,096	13,845	346
Percent	0.34	.18	.24	.24	.28
Totals					
Reported Miss Cases	91	2,579	247	343	49
Reported US Cases	31,201	504,777	166,836	137,854	5,628
Percent	.28	.51	.148	.248	.87

1/ Source: "Morbidity and Mortality Reports," Center for Disease Control, Atlanta, Georgia

2/ Includes serum hepatitis for years 1960-1965

3/ Mississippi data is a part of the State's total, calculated as follows:

$$\frac{\text{Population of Miss in LMR}}{\text{Population of LMR}} \times \text{Total Miss Cases of Specific Disease}$$

drinking water. The water supply program operates out of Jackson with a professional staff of six. The absence of essential program elements such as statutory authority, drinking water quality criteria, and water system operator certification, has led to a generally poor status of water systems in Mississippi.

Hurricane Camille struck Mississippi in 1969, and caused widespread contamination of public water supplies in an area outside the region. Post-emergency restoration was severely hampered by pre-emergency water system deficiencies. This experience convinced the state to endorse chlorination of all public water supplies.

The state is gradually improving their health surveillance program, but the number of water systems in Mississippi particularly the federally supported rural water districts, are growing at a faster pace. Consequently the health protection for water supplies is being diluted even further.

Primary Contact Recreation

Mississippi has some of the major water-based recreation areas in the Lower Mississippi Region. Arkabutla, Sardis, Enid, and Grenada Reservoirs offer a great deal in the way of a healthy environment for the primary contact recreationist.

The responsibility for health protection of the recreationist is vested in the state health agency. However, the state health agency does not have a comprehensive program to provide the field surveillance and water quality monitoring necessary to implement this responsibility.

State "Water Quality Standards" for Mississippi have established bacteriological criteria for primary contact recreation waters as 1000 fecal coliforms per 100 ml, monthly average. While the fecal coliform is considered the best parameter for this criteria, the level is five times higher than the recommended federal criteria.

Little is known about water quality of primary contact recreation waters in Mississippi. However, experience in many areas of the south has indicated that bacteriological quality of streams and small lakes and ponds is quite variable and may exceed established standards. The warm climate and relatively flat topography of Mississippi support high

bacteriological levels. Studies have also shown that impoundments can improve the bacteriological quality of impounded waters. The trend of reduction in both total and fecal coliform levels from reservoir inlet to reservoir outlet should be applicable. A large reservoir would be expected to affect a greater reduction with greater retention time and travel distance, provided no pollution enters the reservoir directly.

At present, the only Mississippi interstate stream classified for recreation use is the Tallahatchie River, State Highway No. 7 to U. S. 51. Several other intrastate streams are also known to support primary contact recreation.

Vector Control

Enabling legislation in Mississippi for the creation and operation of mosquito abatement districts, applicable only to the coastal counties, will not permit the formation of districts within the region. Inasmuch as enabling legislation merely permits a local area to vote for or against the formation of a vector abatement district, and to provide for local financing, the reasons for including restrictive phrasing in the act are difficult to understand.

Fifty-three species of mosquitoes in nine genera have been recorded for the state with the rice field mosquitoes, Psorophora confinnis and Psorophora discolor, the malaria mosquito, Anopheles quadrimaculatus the southern house mosquito, Culex P. quinquefasciatus, and the yellow fever mosquito, Aedes aegypti, of greatest importance within the Mississippi delta.

The second rise on the Mississippi River usually subsides in June. At this time, there are ordinarily produced many mosquitoes, mostly in the genera Culex and Psorophora. All delta communities have an abundance of the southern house mosquito, Culex p. quinquefasciatus, which is a major vector of urban St. Louis encephalitis.

The yellow fever mosquito, Ae. aegypti, has remained relatively abundant in Vicksburg, and has recently become re-established in Natchez following several years of unexplained absence. The species appears to be increasing in range and abundance throughout southern Mississippi.

Mississippi's delta region is mainly agricultural with rice a significant factor in vector-related problems. This crop's irrigation practices have produced major mosquito problems for many years, and insecticide resistance, initially to DDT, developed early in the malaria mosquito and in Psorophora confinnis. The southern portion of Mississippi's area within the region is mainly forest where vector problems have not affected a large number of people.

A number of other problem species warrant mention. Deer flies have been especially troublesome in the delta area and midges have been numerous in association with reservoirs. Tick populations are reported to be increasing. This is of most significance in the wooded southern portion of Mississippi's Region area.

At the state level, Mississippi is almost totally without a vector control program. As a result of changing priorities, qualified vector control personnel have been diverted to other activities. Therefore, the resultant program has been diluted not only in numbers but also in experience.

FUTURE NEEDS

The improvement of the human health environment in the Mississippi subarea is dependent principally upon actions by the state health agency. The primary health needs in Mississippi are:

1. Improvement of the epidemiological program of the State Board of Health through the development of consistent local contacts and with specific emphasis on water and vector-borne diseases.

2. Expanded water supply program of the State Board of Health to provide essential surveillance and technical assistance to all water systems in the state. Estimated needs for this activity are a threefold increase of staff by 1980 with a total budget of $300,000. Beyond 1980, the program should, as a minimum, be doubled every 20 years.

3. Improved protection of sources of water supply from municipal, industrial and agricultural waste discharges.

4. Planning to protect water supply systems in the event of natural disasters.

5. Revised water quality criteria for primary contact recreation waters based on information in NTAC Criteria.

6. Development of a comprehensive state program to protect the health of the water-oriented recreationist, including water quality monitoring and enforcement powers to restrict public usage of unsafe waters.

7. Revised enabling legislation to permit the operation of vector abatement districts throughout the state.

8. Establishment of ten vector abatement districts in Mississippi by 1980. All districts are needed in WRPA 4 and should be funded at a level of $150,000 per abatement district. Six additional districts are needed in WRPA 4 by 2020.

M I S S O U R I

GENERAL

The Lower Mississippi Region encompasses all or portions of 14 counties in the southeastern corner of Missouri. The entire area is included in WRPA 2. Five percent of Missouri's population or 185,919 people live in the Lower Mississippi Region. The topography of the area is predominantly flat. The economy is primarily based on agriculture.

PRESENT STATUS

Epidemiological Assessment

Historically, diseases associated with water or transmitted by vectors have been important in Missouri. Data assembled from CDC Reports for potential waterborne diseases are presented in table 13. The table allows a comparison of potential waterborne diseases occurring in the Missouri portion of the region and waterborne diseases occurring nationwide. The comparison reveals a slightly higher incidence of typhoid fever in Missouri and a lower incidence of the other four diseases. In addition, CDC records contain one documented waterborne disease outbreak which occurred in the Missouri portion of the region.

In 1958, 61 persons in Wayne County, Missouri contracted gastroenteritis. A contaminated public water supply was suspected as the cause of the outbreak.

Data for vectorborne disease by subarea was not available. It was presented for the entire Lower Mississippi Region earlier in this report. However, tick-borne tularemia has been known to have occurred in the Missouri subarea.

Drinking Water Supply

Drinking water in the Missouri portion of the region is supplied almost entirely from groundwater. There are 71 public water systems in the subarea which supply approximately 126,000 people or 68 percent of the population of the subarea. The remaining 32 percent obtain their drinking water through rural individual systems.

The bacteriological and chemical quality of groundwater in Missouri is generally acceptable for drinking water systems with disinfection. Groundwater data compiled by the U. S. Geological Survey for this study indicated the general occurrence of iron, total dissolved solids, and hardness as chemical constituents which require additional treatment.

Health surveillance of water supplies in Missouri is provided by the Division of Health, Department of Public Health and Welfare. The Water Supply Program operates out of the central office in Jefferson City and five district offices. The Missouri portion of the Lower Mississippi

Table 13 - Incidence of Potential Waterborne Disease, 1960-1970, Missouri 1/

Year	Amebiasis	Hepatitis 2/	Salmonellosis	Shigellosis	Typhoid
1960					
Reported Mo 3/ Cases	0	37	0	1	1
Reported US Cases	3,424	41,666	6,929	12,487	816
Percent	0	.08	0	0	.12
1961					
Reported Mo Cases	1	66	2	3	1
Reported US Cases	2,850	72,651	8,542	12,571	814
Percent	0	.09	.02	0	.12
1962					
Reported Mo Cases	0	33	2	3	1
Reported US Cases	3,048	53,016	9,680	12,443	608
Percent	0	.06	.02	0	.16
1963					
Reported Mo Cases	0	27	4	4	1
Reported US Cases	2,886	42,974	15,380	13,009	556
Percent	0	.06	.02	.03	.17
1964					
Reported Mo Cases	0	22	8	5	1
Reported US Cases	3,304	37,740	17,144	12,984	501
Percent	0	.05	.04	.03	.19
1965					
Reported Mo Cases	0	18	5	3	0
Reported US Cases	2,768	33,856	17,161	11,027	454
Percent	0	.05	.02	.02	0
1966					
Reported Mo Cases	0	42	5	9	1
Reported US Cases	2,921	32,859	16,841	11,888	378
Percent	0	12	.02	.06	.26
1967					
Reported Mo Cases	0	57	16	11	0
Reported US Cases	1,157	38,909	18,120	13,474	396
Percent	0	.14	.08	.08	0

Table 13 - Incidence of Potential Waterborne Disease, 1960-1970, Missouri [1] (Con)

Year	Amebiasis	Hepatitis [2]	Salmonellosis	Shigellosis	Typhoid
1968					
Reported Mo [3] Cases	0	36	7	13	1
Reported US Cases	3,005	45,893	16,514	12,180	395
Percent	0	.61	.04	.10	.25
1969					
Reported Mo Cases	2	3	6	9	0
Reported US Cases	2,950	48,416	18,419	11,946	364
Percent	.06	0	.03	.07	0
1970					
Reported Mo Cases	0	32	7	7	0
Reported US Cases	2,888	56,797	22,096	13,845	346
Percent	0	0.05	0	.05	0
Totals					
Reported Mo Cases	3	373	62	68	7
Reported US Cases	31,201	504,777	166,836	137,854	5,628
Percent	0	.07	.037	.049	.12

1/ Source: "Morbidity and Mortality Reports," Center for Disease Control, Atlanta, Georgia

2/ Includes serum hepatitia for years 1960-1965

3/ Missouri data is a part of the State's total, calculated as follows:

$$\frac{\text{Population of Mo in LMR}}{\text{Population of LMR}} \times \text{Total Mo Cases of Specific Disease}$$

Region is served by the Poplar Bluff District Office. The Water Supply Program is adequately staffed to provide most of the services to the drinking water systems of the state. However, the increasing number of water systems and their associated water quality problems will require continued growth by the Water Supply Program to keep pace in the future.

Primary Contact Recreation

Wappapello Reservoir is Missouri's major water-based recreation area in the Lower Mississippi Region. The responsibility for health protection of the recreationist at this reservoir as well as other recreation areas is vested in the state health agency. However, the state health agency does not have a comprehensive program to provide the field surveillance and water quality monitoring necessary to implement this responsibility.

State "Water Quality Standards" for Missouri have established bacteriological criteria for primary contact recreation waters which is consistent with recommended Federal criteria. However, the criteria also has a limiting statement which invalidates the criteria during periods of storm water runoff. This qualifying statement tends to dilute the health protection which the basic criteria symbolizes.

Little is known about water quality of primary contact recreation waters in Missouri. An attempt was made to gather water quality information for Missouri waters, but too little information, particularly bacteriological data, was available on major streams in the state. Appendix L indicates that physical water quality is generally acceptable for primary contact recreation, but no data on bacteriological quality are listed.

Vector Control

Missouri does not have enabling legislation for the creation and operation of vector abatement districts. There is no discrete vector control program in the State Department of Health. A need exists for state-level direction and assistance to communities which conduct limited vector control programs. Also, St. Louis (outside the region) is one of the cities which receives Federal funds for rat control.

Fifty-four species of mosquitoes in nine genera have been recorded for the state. The most important species include the house mosquitoes, Culex pipiens complex which can transmit St. Louis encephalitis (SLE), and the malaria mosquito, Anopheles quadrimaculatus.

St. Louis is the city from which SLE derived its name as a result of the epidemic there during the summer of 1933. This city has experienced SLE outbreaks several times subsequently and may again, as may any community in the state as the vector mosquito occurs abundantly and generally. The small portion of the state which is within the Lower Mississippi Region does not ordinarily experience serious vector problems, although mosquitoes, midges, and ticks are among the forms which may become seasonally abundant.

FUTURE NEEDS

The improvement of the human health environment in Missouri is dependent principally upon actions by the state health agency. The primary health needs in Missouri are:

1. Improvement of the epidemiological program of the State Department of Public Health and Welfare, through development of consistent local contacts and with specific emphasis on water and vector-borne diseases.

2. Expanded water supply program at the State Department of Public Health and Welfare to provide essential surveillance and technical assistance to all water systems in the state. Estimated needs for this activity are for double the staff by 1980 and a total budget of $500,000. Beyond 1980, the program should, as a minimum, be doubled every 20 years.

3. Improved protection of water supply sources from municipal, industrial, and agricultural waste discharges by health and water pollution control agencies.

4. Development of a comprehensive state program to protect the health of the water-oriented recreationist, including water quality monitoring and enforcement powers to restrict public usage of unsafe waters.

5. Improved vector control program at the state level to provide statewide surveillance of vector problems. No local vector abatement districts are needed in the Missouri portion of the Lower Mississippi Region.

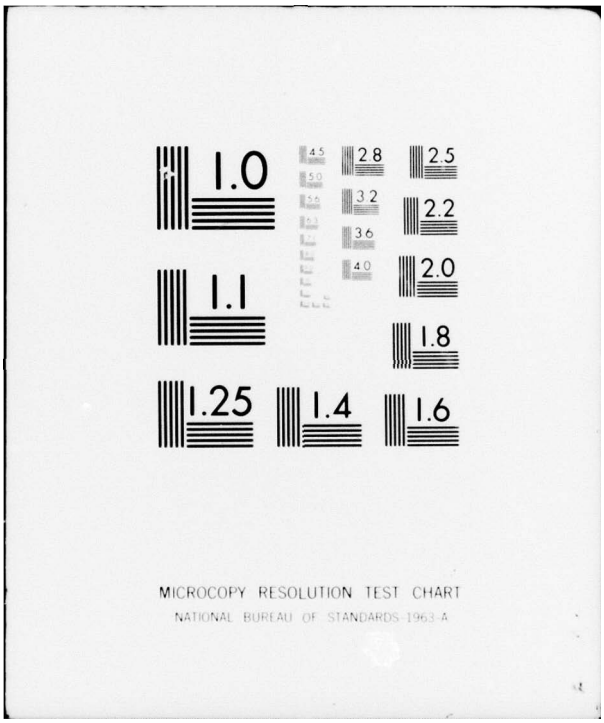
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T E N N E S S E E

GENERAL

The Lower Mississippi Region encompasses all or portions of 18 counties in western Tennessee. The entire Tennessee area is part of WRPA 3. Twenty-nine percent of Tennessee's population or 1,114,132 people live in the Lower Mississippi Region, most in the Memphis metropolitan area. The entire land area consists of well-drained rolling hills between the Mississippi and Tennessee Rivers. Memphis is the most industrialized area in the region. The remainder of the Tennessee portion of the subarea has an agriculturally based economy.

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PRESENT STATUS

Epidemiological Assessment

Historically, diseases associated with water or transmitted by vectors have been important in Tennessee. Data assembled from CDC reports, 1960-1970, are presented in table 14. The table allows a comparison of potential waterborne diseases occurring in the Tennessee portion of the region and waterborne diseases occurring nationwide. The comparison reveals a higher incidence of typhoid fever, infectious hepatitis and shigellosis in Tennessee and a lower incidence of the other two diseases. In addition, records of waterborne disease outbreaks which directly implicate drinking water as the source of disease transmission reveals two outbreaks.

In 1952, an outbreak of gastroenteritis affected 122 people at a church camp in Tennessee. This outbreak was followed three weeks later by infectious hepatitis which affected 104 persons in the same group. A sewage contaminated spring at the church camp was implicated as the cause of these diseases.

In 1969, three persons suffered pesticide poisoning in Lauderdale County, Tennessee. Epidemiological investigations revealed the pesticide entered the supply through a cross-connection.

Data for vectorborne disease by subarea were not available. Data were presented for the entire Lower Mississippi Region earlier in this report. However, the yellow fever mosquito is known to be present in the Memphis area.

Drinking Water Supply

Drinking water in the Tennessee subarea of the region is supplied almost entirely from groundwater. There are 87 public water supplies in the subarea (one of which utilizes surface water) which supply approximately 889,000 people or 80 percent of the population of the subarea. The remaining 20 percent obtain their drinking water through rural individual systems.

The bacteriological and chemical quality of groundwaters in Tennessee is generally acceptable for drinking water systems with disinfection. Groundwater data compiled

Table 14 - Incidence of Potential Waterborne Disease, 1960-1970, Tennessee[1]

Year	Amebiasis	Hepatitis[2]	Salmonellosis	Shigellosis	Typhoid
1960					
Reported Tenn[3] Cases	9	622	29	165	17
Reported US Cases	3,424	41,666	6,929	12,487	816
Percent	0.26	1.5	0.41	1.3	2.1
1961					
Reported Tenn Cases	7	1,240	26	65	14
Reported US Cases	2,850	72,651	8,542	12,571	814
Percent	0.24	1.7	0.30	0.51	1.7
1962					
Reported Tenn Cases	3	603	37	115	9
Reported US Cases	3,048	52,016	9,680	12,443	608
Percent	0.09	1.1	0.38	0.92	1.48
1963					
Reported Tenn Cases	6	429	44	112	9
Reported US Cases	2,886	42,974	15,390	13,009	556
Percent	0.20	1.0	0.28	0.86	1.6
1964					
Reported Tenn Cases	11	270	65	144	6
Reported US Cases	3,304	37,740	17,144	12,984	501
Percent	0.33	0.71	0.37	1.10	1.2
1965					
Reported Tenn Cases	15	238	57	109	5
Reported US Cases	2,768	33,856	17,161	11,027	454
Percent	0.54	0.70	0.33	1.0	1.10
1966					
Reported Tenn Cases	14	294	68	92	6
Reported US Cases	2,921	32,869	16,841	11,888	378
Percent	0.47	0.89	0.40	0.77	1.6
1967					
Reported Tenn Cases	10	247	129	95	4
Reported US Cases	1,157	38,909	18,120	13,474	396
Percent	0.86	0.63	0.71	0.70	1.0

Table 14 - Incidence of Potential Waterborne Disease, 1960-1960, Tennessee [1/] (Con)

Year	Amebiasis	Hepatitis [2/]	Salmonellosis	Shigellosis	Typhoid
1968					
Reported Tenn [3/] Cases	14	304	93	81	6
Reported US Cases	3,005	45,893	16,514	12,180	395
Percent	0.46	0.66	0.56	0.74	1.5
1969					
Reported Tenn Cases	25	314	37	100	7
Reported US Cases	2,950	48,416	18,419	11,946	364
Percent	0.84	0.64	0.20	0.83	1.92
1970					
Reported Tenn Cases	6	380	261	95	5
Reported US Cases	2,888	56,797	22,096	13,845	346
Percent	0.20	0.66	1.18	0.68	1.4
Totals					
Reported Tenn Cases	120	4,941	846	1,173	88
Reported US Cases	31,201	504,777	166,836	137,854	5,628
Percent	.38	.98	.51	.85	1.53

1/ Source: "Morbidity and Mortality Reports," Center for Disease Control, Atlanta, Georgia

2/ Includes serum hapatitis for years 1960-1965

3/ Tennessee data is a part of the State's total, calculated as follows:

$$\frac{\text{Population of Tenn in LMR}}{\text{Population of LMR}} \times \text{Total Tenn Cases of Specific Disease}$$

by the U. S. Geological Survey for this study indicated the general occurrence of iron and low pH as chemical-physical constituents which require additional treatment.

Health surveillance of water supplies in Tennessee is provided by the Division of Sanitary Engineering, Tennessee State Department of Public Health. The state program operates on an annual budget of $79,000. Thus, Tennessee spends approximately two cents per capita for health surveillance of drinking water. The water supply program operates out of a central office in Nashville and devotes approximately 3.5 man-years of professional time to surveillance of water systems in the state. The western part of Tennessee is considered by state officials to present few water system problems because of its abundance of groundwater.

A special EPA evaluation of the Tennessee Water Supply Program (7) indicated inadequacies in program implementation and demonstrated serious water quality and facility deficiencies in the water systems of the state. As a result of the EPA study, Tennessee is moving forward with a vigorous program to protect the drinking water supplies in the state.

Primary Contact Recreation

Tennessee has none of the major water-based recreation areas in the Lower Mississippi Region. Most of these recreation areas are located just outside the region or in neighboring states. However, major water-based recreation areas are easily accessible to the people of the Tennessee subarea.

The responsibility for health protection of the recreationist is vested in the state health agency. However, the state health agency does not have a comprehensive program to provide the field surveillance and water quality monitoring necessary to implement this responsibility.

State "Water Quality Standards" for Tennessee have established bacteriological criteria for primary contact recreation waters as 1,000 fecal coliforms per 100 ml, not to be exceeded in two consecutive samples during recreation months. While the fecal coliform is considered the best parameter for this criteria, the level is five times higher than the recommended federal criteria.

Little is known about water quality primary contact recreation waters in Tennessee. An attempt was made to gather water quality information for Tennessee waters, but too little information, particularly bacteriological data, was available on major streams in the state. Reference is made to Appendix L. The data in that document indicates that physical water quality is generally acceptable for primary contact recreation, but no data on bacteriological quality was listed.

At the present time, the following interstate streams in Tennessee are classified for recreational use:

Mississippi River, Kentucky State Line to above Memphis

Hatchie River

Wolf River.

Several other intrastate streams are also known to support primary contact recreation.

Vector Control

Forty-six species of mosquitoes in nine genera are recorded for Tennessee. The carriers of all major vector-borne diseases are present in abundance, except the yellow fever mosquito which is restricted to a few small foci in Memphis at the present.

The city of Memphis has operated a mosquito control program for a number of years. Presently it is much less active than it was during the last decade. Work mostly is restricted to larviciding ditches and catch basins, performing some spraying to abate adult mosquitoes when they are numerous, and answering complaints.

Tennessee does not have legislation authorizing the creation and operation of vector abatement districts. Apparently the need for this legislation has not been considered acute by the State Department of Health.

The State Department of Health has two men knowledgeable and experienced in vector control. They are presently advanced to positions encompassing much broader areas of responsibility, and vector control as discrete activity has no identity. A need exists, however, for a vector control section in the State Department of Public Health, as

Tennessee is subject to periodic problems as are all states. Moreover, Nashville (outside the region) is one of the cities federally funded for rat control, and other communities have small vector control programs, usually operated by the local health departments, which could profit from state-provided technical guidance. Without organized vector abatement districts, there is no first line of defense in the event of epidemics or disasters.

FUTURE NEEDS

The improvement of the human health environment in Tennessee is dependent principally upon actions by the state health agency. The primary health needs in Tennessee are:

1. Improvement of the state epidemiological program of the State Department of Public Health with specific emphasis on water and vector-borne diseases.

2. Expanded water supply program of the State Department of Public Health to provide essential surveillance and technical assistance to all water systems in the state. Estimated needs for this activity are a fourfold increase of staff by 1980 with a total budget of $400,000. Beyond 1980, the program should, as a minimum, be doubled every 20 years.

3. Improved protection of water supply sources from municipal, industrial, and agricultural waste discharges. Through control activities of health and water pollution control agencies.

4. Revised water quality criteria for primary contact recreation waters based on information in NTAC "Water Quality Criteria."

5. Development of a comprehensive state program to protect the health of the water-oriented recreationist, including water quality monitoring and enforcement powers to restrict public usage of unsafe waters.

6. Enabling legislation to permit the establishment of vector abatement districts in Tennessee.

7. Establishment of one vector abatement district by 1980 in Shelby County (Memphis). Two additional districts are needed in Tennessee by 2020.

METHODOLOGY

The development of this report on human health aspects of water resources in the Lower Mississippi Region was based on many factors. To get a proper perspective of drinking water, primary contact recreation water, and disease vector control, it was necessary to consult many agencies, individuals, and other reliable sources.

Data and information were gathered from other study elements, federal and state records, literature reviews, and personal interviews with state and local officials. All data was analyzed and compared to accepted standards of public health practice. Reference standards included "Public Health Service Drinking Water Standards," National Technical Advisory Committee's "Water Quality Criteria," and EPA's "Health Guidelines for Water Resources and Related Land Use Management." Personal knowledge and experience with drinking water and vector control conditions in the region were also utilized.

The development of needs for drinking water and vector control in the region was based on previous studies and analysis of study data. Satisfaction of existing needs is expected to provide essential services through 1980. Future needs are projected to provide expanded service of a similar nature through 2020.

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