FEDERAL SECURITY AGENCY
Public Health Service - Communicable Disease Center (U.S.)
Atlanta, Georgia

RECONNAISSANCE MALARIA AND ENCEPHALITIS CONTROL SURVEY REPORT ON THE PROPOSED GAVINS POINT RESERVOIR NEAR YANKTON, SOUTH DAKOTA

JUNE 1949

Report prepared by Midwestern CDC Services
and the
Impounded Water Branch of the Engineering Division

in cooperation with the

Nebraska State Department of Health
and the
South Dakota State Board of Health

Sponsored by the Omaha District, Corps of Engineers, Department of the Army

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I. INTRODUCTION

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II. PROJECT DATA AND DESIGN

The primary purposes of this impoundment are for flood control, navigation, and the generation of hydroelectric power. Auxiliary uses will include recreation, wildlife conservation, irrigation and other downstream water requirements. The main body of water created by this impoundage will extend for about 32 miles to the confluence of the Missouri and the Niobrara Rivers. This dam will raise the water level in the Missouri River all the way up to the Fort Randall Dam, but for the most part it will be confined to the original river banks above the mouth of the Niobrara. The lake shoreline at normal summer operation level will be approximately 100 miles. The capacity of this reservoir at elevation 1210,* the maximum pool limit, will be 525,300 acre-feet and the area in acres 32,338.

The normal operating pool will be at elevation 1208 with minor daily pool fluctuations on the order of less than 1 foot. However, from approximately April 15 to July 31, the pool will be maintained at a constant elevation of 1204.5 except for short intermittent periods of impoundment of flood flows originating in the 16,000 square miles of drainage area

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above the dam site or in the Fort Randall Reservoir Basin.

III. PHYSICAL CHARACTERISTICS OF THE AREA

The Missouri River Basin at Gavins Point is cut deeply through the gently rolling central plains. Deposits of alluvium, silt loam, loess, shale and glacial till comprise the river bottom soil and the valley walls. The flood plain in certain areas is relatively wide and this accounts for the 34 percent of flat shoreline with 0-5 percent slope which, in general, will be found in the middle one-third of the reservoir, and constitutes the major problem area. The 48 percent steep shoreline is mostly in the lower one-third of the reservoir where the water near the dam is deep enough to completely cover the flood plain and reach the surrounding valley walls, or is in the upper one-third where the water remains within the original river banks. The remaining 18 percent of sloping shoreline (from 5 to 30 percent) will be more evenly distributed throughout the reservoir. Several hundred acres of flood plain bottom land will be barely covered by this impoundage in the middle one-third of the reservoir and numerous islands will be in evidence in this flat shallow willow infested area, which is within mosquito flight range of the greatest centers of population (see photographs 7, 8, 9, 10 and 11).

Growths of timber in this reservoir basin are moderately dense. The total acreage to be cleared will be approximately 9,765 below the 1210 contour and it is estimated that one-half of this amount will be stands of willow trees. Unlike some of the other reservoirs in this area, the timber is not confined to the river bank. The predominant species in the flood plain are willow, cottonwood, elm, ash, box elder, and hackberry. A scattering of scrub oak crowns the basin walls. (See photographs 3 and 4).

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The population within mosquito flight range of Gavins Point Reservoir is estimated at 2,000. Aside from the cities of Springfield and Niobrara and the communities of Santee and Bon Homme Mennonite colony located on the banks of this impoundment, about 100 rural homesteads

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V. INCIDENCE OF MALARIA AND ENCEPHALITIS

Malaria is not considered indigenous in this area. According to reports submitted by practicing physicians, 5 cases (Yankton 4, Knox 1) and no deaths were reported from the counties contiguous to the project during the period of record, 1932 through 1947. There is little likelihood of the occurrence of malaria epidemics in the area.

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VI. PREVALENCE OF MALARIA AND ENCEPHALITIS VECTORS

Anopheles quadrimaculatus, the recognized vector of malaria in eastern United States, is known to occur in the region in small numbers. When field reconnaissance of the area was made, it was too early in the year to make a complete mosquito inspection. (Aedes sticticus mosquitoes were observed biting in abundance near a marginal flood plain pool near Gavins Point--see photograph #5.) No specimens of the malaria vector were found during this survey.

Although several species of mosquitoes have been incriminated as transmitters of the encephalitides, it is the consensus of epidemiologists that Culex tarsalis is the principal vector for the western equine encephalomyelitis.[2] C. tarsalis is known to be a common species in the reservoir area.

VII. PREDICTION OF MALARIA AND ENCEPHALITIS HAZARDS

Malaria.- Malaria is not endemic in the area; the season in which the vector might breed is short; and the population is relatively sparse; therefore, it is unlikely that this reservoir will result in a malaria hazard provided the reservoir basin is properly prepared.

Encephalitis.- Human encephalitis has been shown to be a public health problem in the region. The reservoir is expected to create habitats which will breed species of mosquitoes incriminated as transmitters of the encephalitides. Therefore the reservoir will likely increase the probability of encephalitis becoming more of a problem.

VIII. RECOMMENDATIONS FOR MALARIA AND ENCEPHALITIS CONTROL

A. Construction

1. Clearing.- The Corps of Engineers propose to clear 9,763 acres up to elevation 1210 as a safety factor in navigation and for the public welfare when utilizing recreational facilities. These clearing limits from the stream bed to elevation 1210 will be adequate for mosquito control and are recommended. Clearing between the above limits should include the removal of all brush and flotable material that would intersect the water line in the main reservoir as well as all of its bights and indentations. Stumps should be cut flush with the ground in the flat areas of the reservoir where the water will be shallow following impoundment. Clearing limits in the upper reaches of the reservoir should be extended to parallel the back-water curve at normal stream flow. Trees and bushes above the clearing limits that may fall into the reservoir due to erosion should be removed prior to impoundment. The clearing schedule should provide, if possible, for completion of clearing just prior to impoundment. Otherwise, provisions should be made to remove coppice and secondary

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[2] Culex tarsalis may not be the principal vector of St. Louis encephalitis (a virus which probably occurs in the area).

growth above the minimum water level just prior to impoundment. The willow growth that will be encountered in this reservoir should be cut and the regrowth of coppice poisoned with 2,4-D or some equally effective herbicide. It seems practical and feasible to eliminate this obnoxious regrowth by aircraft application of 2,4-D. It is noted that commercial planes equipped to do this work are located within the area.

2. Drainage.- Some ponds, swamps, and marshes are in evidence in this reservoir basin, and marginal pools were observed in the zone of fluctuation. It is desirable for mosquito control purposes that all potential residual pools in the zone of water level fluctuation within mosquito flight range of significant population be connected with the main impoundage by suitable drainage ditches so that no pools will be left after the recession of the lake level, but will fluctuate with the main body of water. The drainage details and requirements for this reservoir have not been determined and cost estimates cannot be given at this time.

3. Shoreline improvement.- Through further studies and investigations, it may be determined that some of the potential mosquito breeding and problem areas can be permanently eliminated through shoreline alterations or improvements such as deepening and filling to eliminate shallow-water areas. Other measures to help mosquito control operations would be the removal of stumps and logs in flat shallow-water areas of the reservoir. Application of insecticides by aircraft is practical and feasible on this reservoir; therefore, tall trees along the shorelines in line of flight should be removed.

B. Management

1. Water level management.- The fluctuation of water levels has proved to be the most desirable mosquito control measure to be employed on impounded water projects. The attached graph shows the sponsor's proposed water level operating schedule together with recommendations for mosquito control, in which the desirable features of water level management are pointed out. The constant water level to be maintained from April 15 to July 31 will permit mosquito breeding to occur in this reservoir. If possible, the initial filling of a new reservoir should be done during the winter when mosquitoes are hibernating and the vegetation is dormant. During the winter and spring period the water levels will normally be at a very high elevation due to winter floods. This condition is an aid to mosquito control since these high levels will strand drift and flotage above the normal operating level of the pool where it can be piled and destroyed, thus assuring a clean shoreline after the

recession of the lake level. During the plant growth period from April 1 until May 15 the water should be held at a constant level in order to retard the growth of terrestrial vegetation which invades the lake shoreline. This procedure is also recommended by the Fish and Wildlife Service since it permits the spawning of fish during this time. From May 15 until July 1 a cyclical fluctuation of approximately 1 foot at weekly or 10 day intervals is recommended. Then from July 1 until October 1, during the time of heaviest mosquito production, fluctuations with recessions of about one-tenth foot per week are most desirable. This keeps the lake shoreline clean and always below the invading vegetation. During the winter low rainfall period, the reservoir will normally be at a low elevation ready for flood control storage the following spring. (See Hypothetical Hydrographs, Appendix #2).

2. Recreation and wildlife areas.- Because of the proximity of this reservoir to population centers, it is expected that recreational developments will receive considerable attention. In order that the use of the developed areas will be preferred to others on the lake certain provisions are desirable. The recreational areas should be located beyond the flight range of mosquito breeding habitats. Sanitary facilities such as a safe drinking water and adequate sewage disposal should be provided.

Wildlife areas which will create mosquito breeding habitats should be located beyond flight range of centers of population such as towns or recreational developments. It is believed that such suitable areas for development are numerous along the shores of this proposed lake. Tree and shrub planting to benefit wildlife is not deterimental to disease control, provided the location of such plantings is beyond mosquito flight range of centers of population. It has been shown that flood waters rising up into shrub and forest will breed mosquitoes sufficient to cause a disease hazard.

The location and development of recreational and wildlife areas should have the concurrence of State Health Department officials.

C. Maintenance and Other Recurrent Measures

It is envisioned that recurrent control measures at this project will normally include (1) aquatic plant control, (2) flotage and drift removal, and (3) removal of secondary growth. Additional (emergency) control measures would be required if transmission of malaria or mosquito-borne encephalitis is demonstrated in the reservoir area.

1. Aquatic plant control.- Aquatic plants which favor the production of mosquitoes are expected to appear in certain ponds and marshes in the reservoir area. It is recommended that an effort be made to eliminate them or prevent their spreading to the 100 miles of reservoir shoreline. Willow control in this reservoir will be the greatest problem in the reservoir preparation. It is estimated that about 5,000 acres of willows are growing on the flood plain of this reservoir basin, some of them over 50 feet high. It is recommended that willows be cut flush with the ground in shallow-water areas and hack-girdled in deep areas and the stumps poisoned with an appropriate herbicide at the time of cutting. If this treatment does not kill all of the willows, it is recommended that the coppice be treated by aircraft with 2,4-D prior to impoundage.

2. Flotage and drift removal.- The problem of flotage and drift removal is not expected to be a major problem in this reservoir. A clean shoreline in all bights and indentations should be maintained to prevent mosquito breeding. If drift and flotage is not stranded by high water levels during the winter, it should be removed by hand operation in the spring.

3. Removal of secondary growth.- Secondary growth of coppice and annual plants should be removed as often as necessary to insure a clean shoreline. The methods to use will depend upon field conditions and facilities available. If the shoreline has been properly prepared, the removal of secondary growth may be done by local farmers with mowing machines. Area burning following this operation is considerably cheaper than hand removals or hand application of herbicides.

4. Emergency insecticidal control.- In case transmission of malaria or mosquito-borne encephalitis is demonstrated in the reservoir area, the character, timing, extent and indications of the emergency control measures to be employed would vary in accordance with the disease, and are, therefore, treated separately.

(a) Emergency malaria control.- Although the probability of outbreaks of malaria in this area is extremely unlikely, upon such reports within a 1½-mile range of the reservoir, based on diagnoses satisfying the State Health Departments, the emergency control program would in addition to routine larvicidal control require adulticidal measures. In order to prevent immediately, further transmission, mosquitoes should be killed in all homes and premises presumably involved in the epidemic. This may be accomplished periodically either by airplane aerosoling, fogging with ground generators, freon-type individual insecticide dispensers, or other

approved method of spray killing adult mosquitoes in houses, premises, and inhabited areas. Meanwhile, equipment, insecticide, and manpower should be assembled to complete DDT (or other approved insecticide) residual spraying of all occupied houses and associated buildings within 1½ miles of the reported cases. If malaria becomes established in the region, it may be necessary to continue a malaria mosquito control program for at least 2 years to suppress vector production.

(b) Emergency encephalitis control.- In the event of actual occurrence of one of the types of mosquito-borne human encephalitis or equine encephalomyelitis in the vicinity (as determined by the State Health Departments) the emergency control program would consist essentially of (1) adulticiding--particularly space spraying of inhabited areas--and (2) larviciding of surrounding breeding areas. Airplane application of DDT is an efficacious and economical method to kill simultaneously infected adult mosquitoes and larvae within drift distance of the plane. In areas where airplane application is not possible, insecticidal fogs and sprays applied by ground machines and boat units are recommended to accomplish the same purpose. Delineation of the areas to be treated should be based upon epidemiological and entomological findings. On the basis of past experience and control-demonstration programs, residual insecticiding of premises has failed to influence transmission of this disease and the natural infection of adult mosquitoes. Therefore, DDT residual spraying alone is not yet recommended as a satisfactory method of encephalitis control.

D. Epidemiological Surveillance

Although the area in the vicinity of the Gavins Point Reservoir would hardly justify intensive and constant epidemiological surveillance, the Nebraska State Department of Health and the South Dakota State Board of Health should be attentive at all times to the mosquito-borne disease hazard in the region by reviewing periodically during the summer months (1) cases of malaria and human encephalitis reported by practicing physicians and (2) cases of equine encephalomyelitis reported to the State Health Departments or to the Bureau of Animal Industry by veterinarians. The reporting of infected horses or other animals with encephalomyelitis in the region should be a forewarning that an outbreak of human encephalitis might follow; however, sporadic human cases might occur without warning.

Once it is definitely established that appreciable malaria (based on confirmed diagnoses) or mosquito-borne encephalitis has occurred in the reservoir area, this information should be transmitted to the Corps of Engineers, together with recommendations for mosquito control measures to be carried on by them in cooperation with the State Health Departments.

E. Provision for Qualified Personnel for Mosquito Control

It is recommended that this reservoir be kept under surveillance by a qualified individual from the Corps of Engineers to determine the extent of mosquito breeding and the best method of control. The individual employed could furnish adequate surveillance for more than one reservoir in the district. When mosquito control measures become necessary as evidenced by entomological inspections, work may be done by maintenance crews working on a part-time basis under the general supervision of a Mosquito Control Engineer employed by the district. The State Health Departments may be able to assist in procuring and training personnel for this work. Cost of supervisory personnel is estimated at $1,100.

IX. SUMMARY OF COST ESTIMATES

The estimated cost for malaria and encephalitis control on this impoundment is summarized below. These estimates are based on an appraisal of potentid problems which are expected to develop and it may be necessary to revise the recommendations and cost estimates after impoundment. It is recommended that a budget be established in the amount shown and adjusted annually after impoundment as necessary.

Supervisory personnel	$1,100	
Aquatic growth removal and willow poisoning.....	1,500	
Flotage and drift removal.....	500	
Secondary growth removal.....	500	
Emergency malaria and encephalitis control.....	1,200	
Total annual.....		$4,800
Equipment.....		200
Total first year.....		$5,000

X. STATE HEALTH DEPARTMENTS REVIEW AND APPROVAL

This report has been reviewed and approved by the Nebraska State Department of Health and the South Dakota Board of Health.

XI. SOURCES OF DATA

The data used in this report have been obtained from the Corps Engineers, Omaha District, and U. S. Public Health Service reports. Field data were obtained by a reconnaissance survey trip to the reservoir area by personnel from the office of Midwestern CDC Services, working in co-operation with the Missouri River Basin Office of the U. S. Public Health Service, Kansas City, Missouri.

XII. FINAL MALARIA AND ENCEPHALITIS CONTROL SURVEY REPORT

Further preimpoundment studies in this reservoir basin will be necessary to complete the biological investigations data. However, another report is considered unnecessary at this time and no final survey report is proposed. If the design or scheduled plan of operation of the project is considerably altered, further studies and recommendations will be made upon request.

pbb 6-21-49

APPENDIX

Photographs Portraying Conditions
in the Gavins Point Reservoir Basin

Appendix # 1

Gavins Point Dam Site

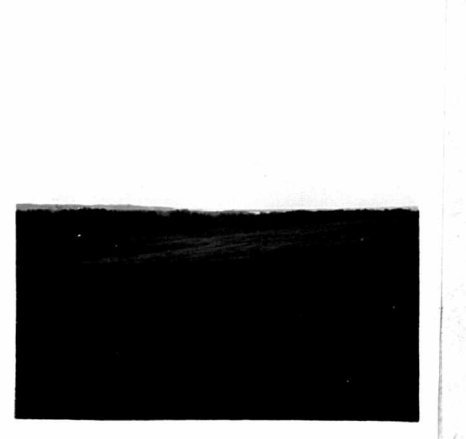
Recreation Area

Photograph # 1

Photograph # 2

Showing the proposed Gavins Point Dam Site and Recreation Area

Photograph # 3



Photograph # 4

General views of the reservoir area showing topography and a considerable amount of clearing to be done.

Same Location

Photograph # 5

Photograph # 6

View looking west from Gavins Point - Photograph # 5

Marginal drainage problem in zone of fluctuation - Produced enormous numbers of A. stictious mosquitoes. - Photograph # 6
An estimated number of 100 per sq. ft. of biting surface were observed.

Photograph # 7

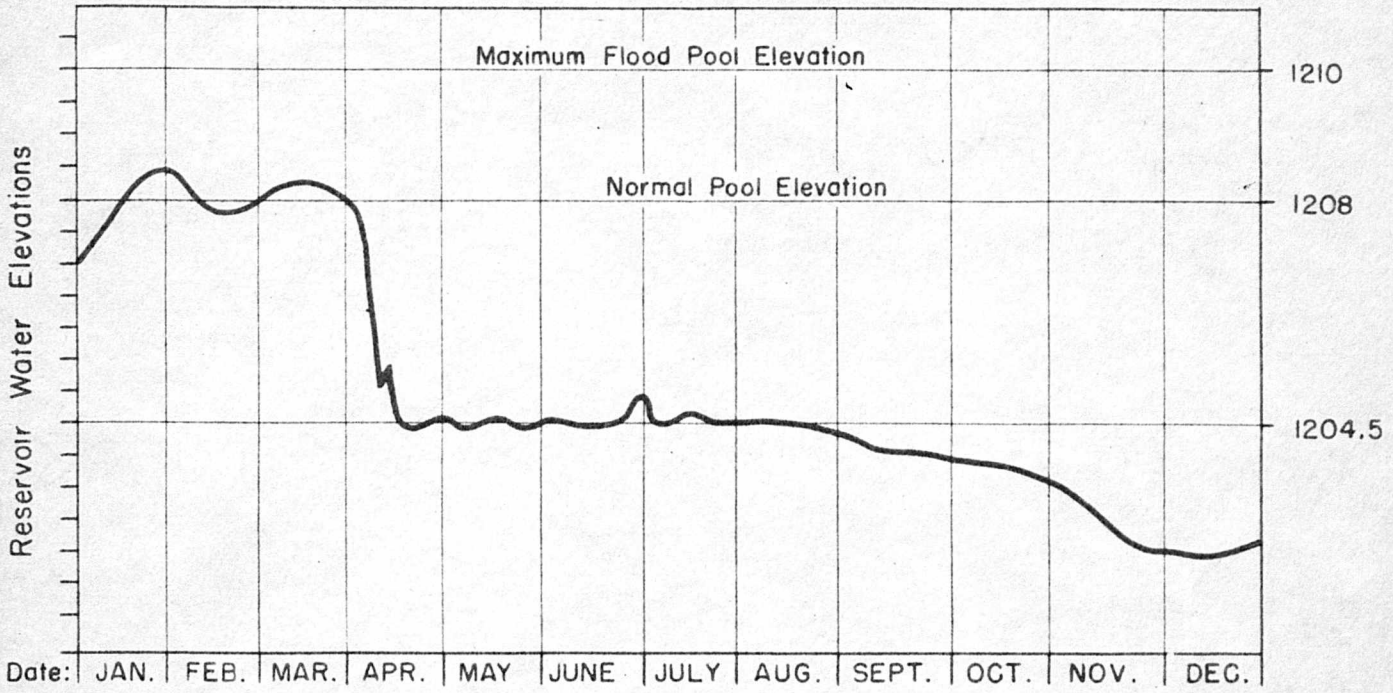
Photograph # 8

Showing extensive flat shallow areas on the southside of the river across from Running Water Ferry and near the town of Niobrara, Nebraska.

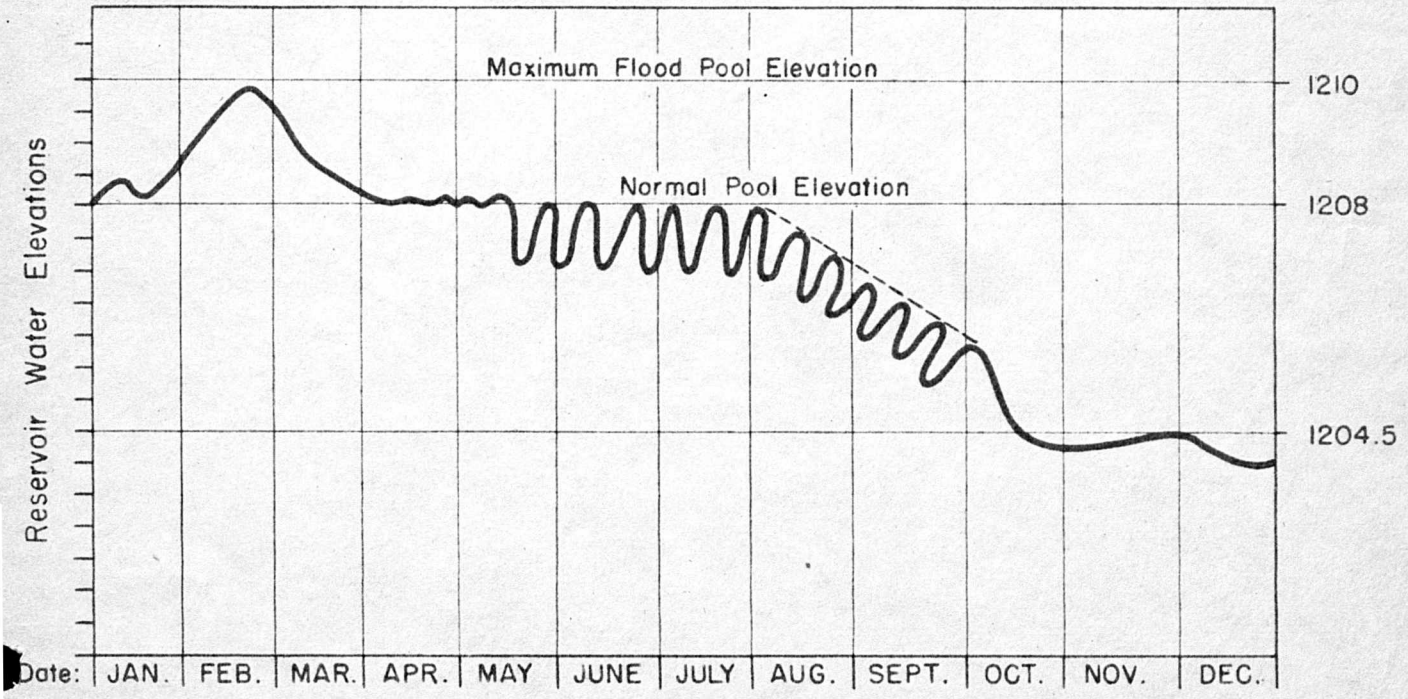
GAVINS POINT RESERVOIR Appendix No. 2

HYPOTHETICAL HYDROGRAPHS

Projected Water Levels



Graph Showing Proposed or Probable Water Level Operating Schedules



Graph Showing Recommended Water Level Management For Mosquito Control

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VI. PREVALENCE OF MALARIA AND ENCEPHALITIS VECTORS

Anopheles quadrimaculatus, the recognized vector of malaria in eastern United States, is known to occur in the region in small numbers. When field reconnaissance of the area was made, it was too early in the year to make a complete mosquito inspection. (Aedes sticticus mosquitoes were observed biting in abundance near a marginal flood plain pool near Gavins Point--see photograph #5.) No specimens of the malaria vector were found during this survey.

Although several species of mosquitoes have been incriminated as transmitters of the encephalitides, it is the consensus of epidemiologists that Culex tarsalis is the principal vector for the western equine encephalomyelitis.[2] C. tarsalis is known to be a common species in the reservoir area.

VII. PREDICTION OF MALARIA AND ENCEPHALITIS HAZARDS

Malaria.- Malaria is not endemic in the area; the season in which the vector might breed is short; and the population is relatively sparse; therefore, it is unlikely that this reservoir will result in a malaria hazard provided the reservoir basin is properly prepared.

Encephalitis.- Human encephalitis has been shown to be a public health problem in the region. The reservoir is expected to create habitats which will breed species of mosquitoes incriminated as transmitters of the encephalitides. Therefore the reservoir will likely increase the probability of encephalitis becoming more of a problem.

VIII. RECOMMENDATIONS FOR MALARIA AND ENCEPHALITIS CONTROL

A. Construction

1. Clearing.- The Corps of Engineers propose to clear 9,763 acres up to elevation 1210 as a safety factor in navigation and for the public welfare when utilizing recreational facilities. These clearing limits from the stream bed to elevation 1210 will be adequate for mosquito control and are recommended. Clearing between the above limits should include the removal of all brush and flotable material that would intersect the water line in the main reservoir as well as all of its bights and indentations. Stumps should be cut flush with the ground in the flat areas of the reservoir where the water will be shallow following impoundment. Clearing limits in the upper reaches of the reservoir should be extended to parallel the back-water curve at normal stream flow. Trees and bushes above the clearing limits that may fall into the reservoir due to erosion should be removed prior to impoundment. The clearing schedule should provide, if possible, for completion of clearing just prior to impoundment. Otherwise, provisions should be made to remove coppice and secondary

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[2] Culex tarsalis may not be the principal vector of St. Louis encephalitis (a virus which probably occurs in the area).

growth above the minimum water level just prior to impoundment. The willow growth that will be encountered in this reservoir should be cut and the regrowth of coppice poisoned with 2,4-D or some equally effective herbicide. It seems practical and feasible to eliminate this obnoxious regrowth by aircraft application of 2,4-D. It is noted that commercial planes equipped to do this work are located within the area.

2. Drainage.- Some ponds, swamps, and marshes are in evidence in this reservoir basin, and marginal pools were observed in the zone of fluctuation. It is desirable for mosquito control purposes that all potential residual pools in the zone of water level fluctuation within mosquito flight range of significant population be connected with the main impoundage by suitable drainage ditches so that no pools will be left after the recession of the lake level, but will fluctuate with the main body of water. The drainage details and requirements for this reservoir have not been determined and cost estimates cannot be given at this time.

3. Shoreline improvement.- Through further studies and investigations, it may be determined that some of the potential mosquito breeding and problem areas can be permanently eliminated through shoreline alterations or improvements such as deepening and filling to eliminate shallow-water areas. Other measures to help mosquito control operations would be the removal of stumps and logs in flat shallow-water areas of the reservoir. Application of insecticides by aircraft is practical and feasible on this reservoir; therefore, tall trees along the shorelines in line of flight should be removed.

B. Management

1. Water level management.- The fluctuation of water levels has proved to be the most desirable mosquito control measure to be employed on impounded water projects. The attached graph shows the sponsor's proposed water level operating schedule together with recommendations for mosquito control, in which the desirable features of water level management are pointed out. The constant water level to be maintained from April 15 to July 31 will permit mosquito breeding to occur in this reservoir. If possible, the initial filling of a new reservoir should be done during the winter when mosquitoes are hibernating and the vegetation is dormant. During the winter and spring period the water levels will normally be at a very high elevation due to winter floods. This condition is an aid to mosquito control since these high levels will strand drift and flotage above the normal operating level of the pool where it can be piled and destroyed, thus assuring a clean shoreline after the

recession of the lake level. During the plant growth period from April 1 until May 15 the water should be held at a constant level in order to retard the growth of terrestrial vegetation which invades the lake shoreline. This procedure is also recommended by the Fish and Wildlife Service since it permits the spawning of fish during this time. From May 15 until July 1 a cyclical fluctuation of approximately 1 foot at weekly or 10 day intervals is recommended. Then from July 1 until October 1, during the time of heaviest mosquito production, fluctuations with recessions of about one-tenth foot per week are most desirable. This keeps the lake shoreline clean and always below the invading vegetation. During the winter low rainfall period, the reservoir will normally be at a low elevation ready for flood control storage the following spring. (See Hypothetical Hydrographs, Appendix #2).

2. Recreation and wildlife areas.- Because of the proximity of this reservoir to population centers, it is expected that recreational developments will receive considerable attention. In order that the use of the developed areas will be preferred to others on the lake certain provisions are desirable. The recreational areas should be located beyond the flight range of mosquito breeding habitats. Sanitary facilities such as a safe drinking water and adequate sewage disposal should be provided.

Wildlife areas which will create mosquito breeding habitats should be located beyond flight range of centers of population such as towns or recreational developments. It is believed that such suitable areas for development are numerous along the shores of this proposed lake. Tree and shrub planting to benefit wildlife is not deterimental to disease control, provided the location of such plantings is beyond mosquito flight range of centers of population. It has been shown that flood waters rising up into shrub and forest will breed mosquitoes sufficient to cause a disease hazard.

The location and development of recreational and wildlife areas should have the concurrence of State Health Department officials.

C. Maintenance and Other Recurrent Measures

It is envisioned that recurrent control measures at this project will normally include (1) aquatic plant control, (2) flotage and drift removal, and (3) removal of secondary growth. Additional (emergency) control measures would be required if transmission of malaria or mosquito-borne encephalitis is demonstrated in the reservoir area.

1. Aquatic plant control.- Aquatic plants which favor the production of mosquitoes are expected to appear in certain ponds and marshes in the reservoir area. It is recommended that an effort be made to eliminate them or prevent their spreading to the 100 miles of reservoir shoreline. Willow control in this reservoir will be the greatest problem in the reservoir preparation. It is estimated that about 5,000 acres of willows are growing on the flood plain of this reservoir basin, some of them over 50 feet high. It is recommended that willows be cut flush with the ground in shallow-water areas and hack-girdled in deep areas and the stumps poisoned with an appropriate herbicide at the time of cutting. If this treatment does not kill all of the willows, it is recommended that the coppice be treated by aircraft with 2,4-D prior to impoundage.

2. Flotage and drift removal.- The problem of flotage and drift removal is not expected to be a major problem in this reservoir. A clean shoreline in all bights and indentations should be maintained to prevent mosquito breeding. If drift and flotage is not stranded by high water levels during the winter, it should be removed by hand operation in the spring.

3. Removal of secondary growth.- Secondary growth of coppice and annual plants should be removed as often as necessary to insure a clean shoreline. The methods to use will depend upon field conditions and facilities available. If the shoreline has been properly prepared, the removal of secondary growth may be done by local farmers with mowing machines. Area burning following this operation is considerably cheaper than hand removals or hand application of herbicides.

4. Emergency insecticidal control.- In case transmission of malaria or mosquito-borne encephalitis is demonstrated in the reservoir area, the character, timing, extent and indications of the emergency control measures to be employed would vary in accordance with the disease, and are, therefore, treated separately.

(a) Emergency malaria control.- Although the probability of outbreaks of malaria in this area is extremely unlikely, upon such reports within a 1½-mile range of the reservoir, based on diagnoses satisfying the State Health Departments, the emergency control program would in addition to routine larvicidal control require adulticidal measures. In order to prevent immediately, further transmission, mosquitoes should be killed in all homes and premises presumably involved in the epidemic. This may be accomplished periodically either by airplane aerosoling, fogging with ground generators, freon-type individual insecticide dispensers, or other

approved method of spray killing adult mosquitoes in houses, premises, and inhabited areas. Meanwhile, equipment, insecticide, and manpower should be assembled to complete DDT (or other approved insecticide) residual spraying of all occupied houses and associated buildings within 1½ miles of the reported cases. If malaria becomes established in the region, it may be necessary to continue a malaria mosquito control program for at least 2 years to suppress vector production.

(b) Emergency encephalitis control.- In the event of actual occurrence of one of the types of mosquito-borne human encephalitis or equine encephalomyelitis in the vicinity (as determined by the State Health Departments) the emergency control program would consist essentially of (1) adulticiding--particularly space spraying of inhabited areas--and (2) larviciding of surrounding breeding areas. Airplane application of DDT is an efficacious and economical method to kill simultaneously infected adult mosquitoes and larvae within drift distance of the plane. In areas where airplane application is not possible, insecticidal fogs and sprays applied by ground machines and boat units are recommended to accomplish the same purpose. Delineation of the areas to be treated should be based upon epidemiological and entomological findings. On the basis of past experience and control-demonstration programs, residual insecticiding of premises has failed to influence transmission of this disease and the natural infection of adult mosquitoes. Therefore, DDT residual spraying alone is not yet recommended as a satisfactory method of encephalitis control.

D. Epidemiological Surveillance

Although the area in the vicinity of the Gavins Point Reservoir would hardly justify intensive and constant epidemiological surveillance, the Nebraska State Department of Health and the South Dakota State Board of Health should be attentive at all times to the mosquito-borne disease hazard in the region by reviewing periodically during the summer months (1) cases of malaria and human encephalitis reported by practicing physicians and (2) cases of equine encephalomyelitis reported to the State Health Departments or to the Bureau of Animal Industry by veterinarians. The reporting of infected horses or other animals with encephalomyelitis in the region should be a forewarning that an outbreak of human encephalitis might follow; however, sporadic human cases might occur without warning.

Once it is definitely established that appreciable malaria (based on confirmed diagnoses) or mosquito-borne encephalitis has occurred in the reservoir area, this information should be transmitted to the Corps of Engineers, together with recommendations for mosquito control measures to be carried on by them in cooperation with the State Health Departments.

E. Provision for Qualified Personnel for Mosquito Control

It is recommended that this reservoir be kept under surveillance by a qualified individual from the Corps of Engineers to determine the extent of mosquito breeding and the best method of control. The individual employed could furnish adequate surveillance for more than one reservoir in the district. When mosquito control measures become necessary as evidenced by entomological inspections, work may be done by maintenance crews working on a part-time basis under the general supervision of a Mosquito Control Engineer employed by the district. The State Health Departments may be able to assist in procuring and training personnel for this work. Cost of supervisory personnel is estimated at $1,100.

IX. SUMMARY OF COST ESTIMATES

The estimated cost for malaria and encephalitis control on this impoundment is summarized below. These estimates are based on an appraisal of potential problems which are expected to develop and it may be necessary to revise the recommendations and cost estimates after impoundment. It is recommended that a budget be established in the amount shown and adjusted annually after impoundment as necessary.

Supervisory personnel	$1,100	
Aquatic growth removal and willow poisoning	1,500	
Flotage and drift removal	500	
Secondary growth removal	500	
Emergency malaria and encephalitis control	1,200	
Total annual		$4,800
Equipment		200
Total first year		$5,000

X. STATE HEALTH DEPARTMENTS REVIEW AND APPROVAL

This report has been reviewed and approved by the Nebraska State Department of Health and the South Dakota Board of Health.

XI. SOURCES OF DATA

The data used in this report have been obtained from the Corps Engineers, Omaha District, and U. S. Public Health Service reports. Field data were obtained by a reconnaissance survey trip to the reservoir area by personnel from the office of Midwestern CDC Services, working in co-operation with the Missouri River Basin Office of the U. S. Public Health Service, Kansas City, Missouri.

XII. FINAL MALARIA AND ENCEPHALITIS CONTROL SURVEY REPORT

Further preimpoundment studies in this reservoir basin will be necessary to complete the biological investigations data. However, another report is considered unnecessary at this time and no final survey report is proposed. If the design or scheduled plan of operation of the project is considerably altered, further studies and recommendations will be made upon request.

APPENDIX

Photographs Portraying Conditions
in the Gavins Point Reservoir Basin

Appendix # 1

Gavins Point Dam Site

Recreation Area

Photograph # 1

Photograph # 2

Showing the proposed Gavins Point Dam Site and Recreation Area

Photograph # 3

Photograph # 4

General views of the reservoir area showing topography and a considerable amount of clearing to be done.

Same Location

Photograph # 5 Photograph # 6

View looking west from Gavins Point - Photograph # 5

Marginal drainage problem in zone of fluctuation - Produced enormous numbers of A. stictious mosquitoes. - Photograph # 6
An estimated number of 100 per sq. ft. of biting surface were observed.

Photograph # 7 Photograph # 8

Showing extensive flat shallow areas on the southside of the river across from Running Water Ferry and near the town of Niobrara, Nebraska.

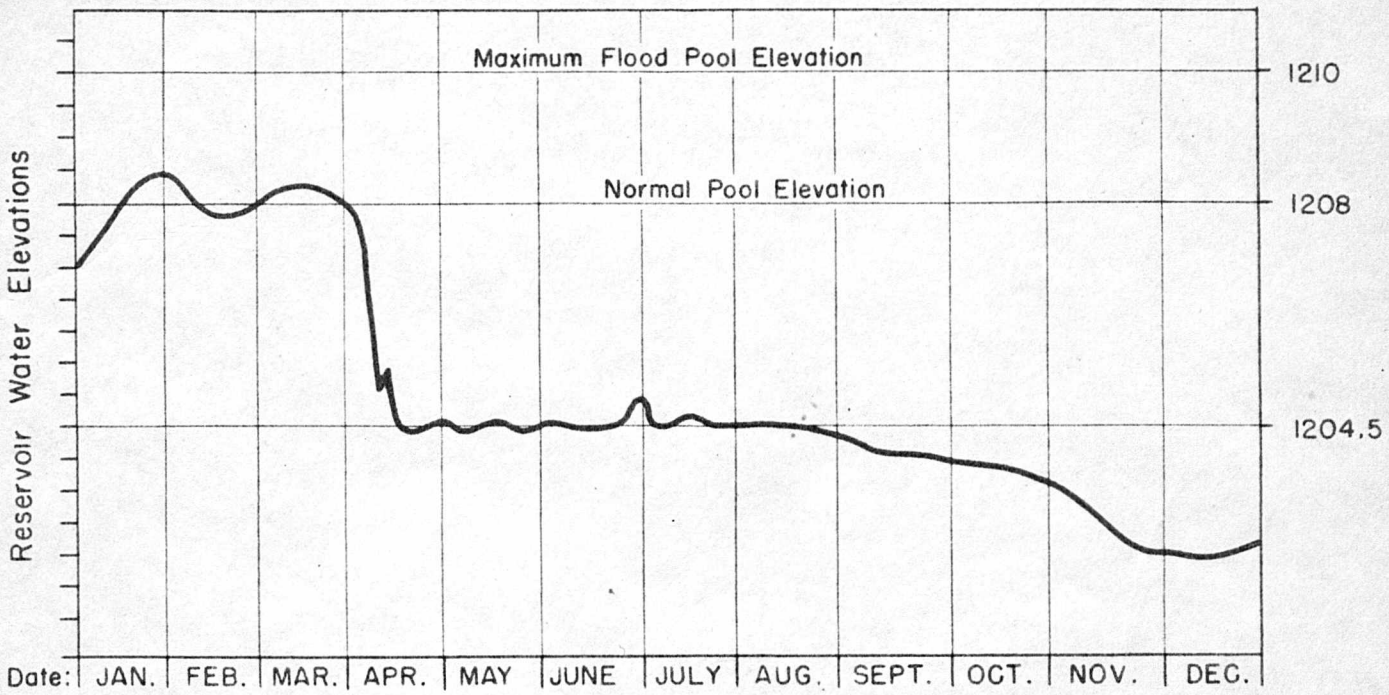
Photograph # 9 Photograph # 10 Photograph # 11

A panoramic view showing the willow growth, lake, and a part of the flat, shallow mosquito breeding potential in the bottomland directly below the city of Springfield, South Dakota.

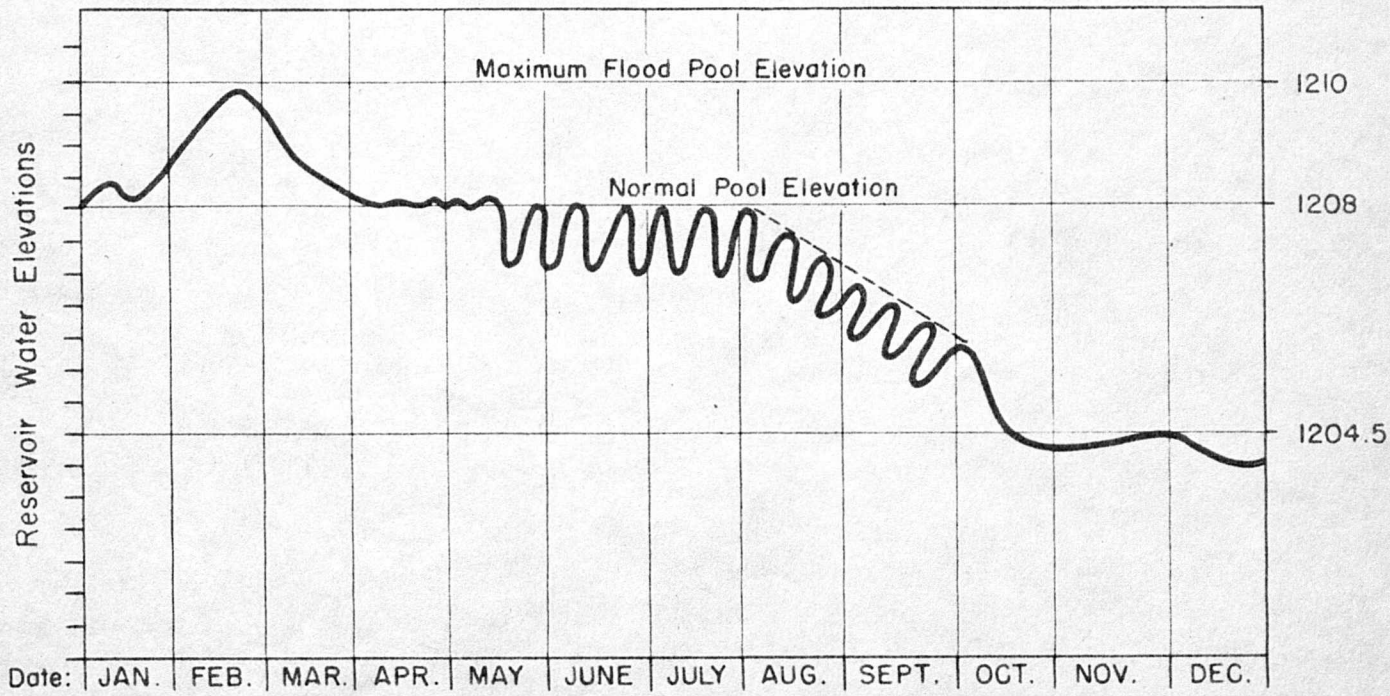
GAVINS POINT RESERVOIR Appendix No. 2

HYPOTHETICAL HYDROGRAPHS

Projected Water Levels



Graph Showing Proposed or Probable Water Level Operating Schedules



Graph Showing Recommended Water Level Management For Mosquito Control