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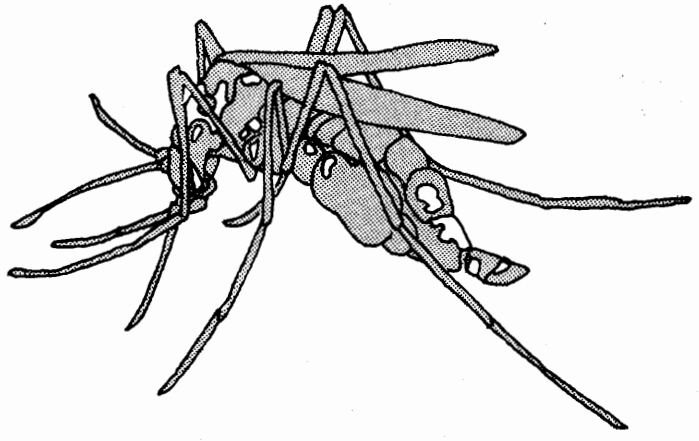
OPTIONS FOR CONTROL TO THE YEAR 2000



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METROPOLITAN MOSQUITO CONTROL DISTRICT
FINAL ENVIRONMENTAL IMPACT STATEMENT
OPTIONS FOR CONTROL TO THE YEAR 2000

Prepared For
THE MINNESOTA ENVIRONMENTAL QUALITY BOARD
CAPITOL SQUARE BUILDING
ST. PAUL, MINNESOTA

By The:
METROPOLITAN MOSQUITO CONTROL DISTRICT
DR. ROBERT D. SJOGREN, DIRECTOR
1802 COMO AVENUE, ST. PAUL, MINNESOTA 55108

In Cooperation With:
JOHN P. AND M. MICHELE GENEREUX
RESEARCH AND CONSULTING IN THE SOCIAL SCIENCES
CARRIAGE HOUSE
372 SUMMIT AVENUE, ST. PAUL, MINNESOTA 55102

Submitted November, 1977

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contributors

PRIMARY AUTHORSHIP

Dr. Robert D. Sjogren, Director, Metropolitan Mosquito Control District
John P. Genereux, Consultant
M. Michele Genereux, Consultant

RESEARCH

William J. Caesar, Assistant to the Director, Metropolitan Mosquito Control District
Edmund C. Bowler, Assistant to the Director, Metropolitan Mosquito Control District

Ralph H. Doble, Business Administrator
Anthony M. Frank, Laboratory Technician
Vicky B. Schandle, Laboratory Technician
Sandra J. Brogren, Entomologist
Hubert Yamamoto, Entomologist
Raymond A. Fields, Supervisor Anoka County
Roy E. Rademacher, Supervisor Dakota County
William I. Barton, Supervisor Hennepin County
Martin Gallagher, Supervisor Ramsey County
Ernest P. Wermerskirchen, Supervisor Scott County
Vernon R. Loren, Supervisor Washington County
Robert B. Idziorek, Foreman Hennepin County
Bruce R. Paulson, Foreman Dakota County
John Thompson, Foreman Hennepin County
Wayne Johnson, Foreman Hennepin County
Ross Green, Foreman Hennepin County
Marcus Peterson, Foreman Ramsey County
Bruce Catlin, Foreman Dakota County
Patricia J. Fontaine, R.N.

GRAPHIC DESIGN

Terri Alwell
Clarence H. Rabold, Foreman Dakota County

PRODUCTION

Rosemary A. Nitti, Secretary
Sharyn V. Joyce, Secretary
Maxine W. Brown, Typist

TECHNICAL CONTRIBUTORS

Twin Cities Ecology
Dan E. Huff, Ph.D.

Twin Cities Hydro-geology
Hans Olaf Pfannkuch, Ph.D

Twin Cities Climate
Bruce Watson

Twin Cities Recreation Behavior
John P. Genereux M. Michele Genereux
John M. Laughlin

Mosquito Control Effectiveness: Statistical Analysis
Thomas Miller, Ph.D. John P. Genereux
Anthony M. Frank

Human Toxicology
Wayland I. Hayes, Jr., M.D., Ph.D.

Insecticide Allergy
Louis Enkema, M.D.
Lowell Henderson, M.D.

Pesticides
E. E. Kenaga, Ph.D.

Apiology
E. Laurence Atkins

Invertebrate Aquatic Toxicology
Mir S. Mulla, Ph.D.

Vertebrate Wildlife Toxicology
Maurice Provost, Ph.D.

Insect Bio-control
Duane Biever, Ph.D.

Insecticide Resistance
George P. Georghiou, Ph.D.

Residue Chemistry
Paul Lichtenstein, Ph.D.

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Minnesota Department of Health

Minnesota Pollution Control Agency

Minnesota Energy Agency

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U.S. Fish and Wildlife Service

The District is grateful to the following individuals who shared their expertise and experience with technical staff responsible for preparation of this report:

Norman B. Akesson, Ph.D.
University of California, Davis

John Andrews, M.D.
Minnesota Department of Health

H. H. Balfour, M.D.
University of Minnesota

Dick Behrens, Ph.D.
University of Minnesota

Sam Breeland, Ph.D.
Communicable Disease Center
Atlanta, Georgia

Karl E. Bremer
U.S. Environmental Protection Agency
Washington, D.C.

William Brunnel, D.V.M.
Anoka West Pet Hospital

David N. Byrne, Ph.D.
American Cyanamid Company
Princton, New Jersey

James Cooper, Ph.D.
University of Minnesota

Lewis M. Cowardin, Ph.D.
U.S. Bureau of Sport Fisheries and Wildlife
Jamestown, North Dakota

C. Warren Curtis
Soil Conservation Service
St. Paul, Minnesota

Laurence K. Cutkomp, Ph.D.
University of Minnesota

Howard M. Deer
Minnesota Department of Agriculture

Maartin DeVries, Ph.D.
S.B. Penick Company
Orange, New Jersey

Robert Dingel, D.V.M.
Glen Lake Animal Hospital

James B. Elder, Ph.D.
U.S. Fish and Wildlife Service
Fort Snelling

M. Y. Frost
Agricultural Stabilization and Conservation Service
St. Paul, Minnesota

Basil Furgala, Ph.D.
University of Minnesota

Robert Glazer
Minnesota Department of Natural Resources

Henry Gray, Ph.D.
Dow Chemical U.S.A.
Midland, Michigan

Rizwanul Haque, Ph.D.
Environmental Protection Agency
Washington, D.C.

Richard O. Hayes, Ph.D.
Colorado State University
Fort Collins, Colorado

Carrol L. Henderson
Minnesota Department of Natural Resources

James Hoy, Ph.D.
California Department of Agriculture

Richard Hyser
Minnesota Department of Agriculture

Sandy Ives
Minnesota Livestock Sanitary Board

Robert B. Janssen
Ornithologists Union, Minnesota

Roger Johnson
Minnesota Department of Natural Resources

George E. Keller, D.V.M.
Minnesota Livestock Sanitary Board

James Kinsey
Minnesota Pollution Control Agency

Howard F. Krosch
Minnesota Department of Natural Resources

E. Fred Legner, Ph.D.
University of California, Riverside

Bob Liese
U.S. Environmental Protection Agency
Minneapolis, Minnesota

John A. Lofgren, Ph.D.
University of Minnesota

Carl Madsen
U.S. Fish and Wildlife Service
Fort Snelling

Victor S. Meyers, D.V.M.
Stillwater Veterinary Clinic

Roger F. Monroe
Dow Chemical USA
Midland, Michigan

Thomas Morley, Ph.D.
University of Minnesota

Richard J. Nielsson, Ph.D.
American Cyanamid Company
Princton, New Jersey

David M. Noetzel, Ph.D.
University of Minnesota

Mike Osterholm
Minnesota Department of Health

Alfonso C. Perez
Minnesota Pollution Control Agency

Harold O. Perry, M.D.
Mayo Clinic
Rochester, Minnesota

Henry Philman, D.V.M.
Minnetonka Animal Hospital

Frederick J. Preiss, Ph.D.
McLaughlin Gormley King Company
Minneapolis, Minnesota

J. R. Sandve
Minnesota Department of Agriculture

John C. Schlotthauer, D.V.M.
University of Minnesota

George K. Schumaker, Ph.D.
S.B. Penick Company
Orange, New Jersey

Charles Settle
Minnesota Department of Health

L. F. Steppel
Agricultural Stabilization and Conservation Service
St. Paul, Minnesota

William H. Stickel, Ph.D.
U.S. Fish and Wildlife Service
Laurel, Maryland

George A. Swanson
U.S. Bureau of Sport Fisheries and Wildlife
Jamestown, North Dakota

Richard L. Wade, Ph.D.
Minnesota Department of Health

Dale Wichory
Minnesota Pollution Control Agency

Thomas Winter, D.V.M.
Inver Grove Heights, Minnesota

Jack Zweig, Ph.D.
Environmental Protection Agency
Washington, D.C.

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Dr. Richard O. Hayes, formerly CDC, Fort Collins. 329
Dr. Lowell Henderson, Mayo Clinic. 330
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Mr. Lawrence Atkins, Apiologist. 352
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Mr. Carrol L. Henderson, Wildlife Specialist .387
Dr. L. K. Cutkomp, University of Minnesota . .389
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Mr. Howard F. Krosch, Ecological Monitoring Coordinator. 463
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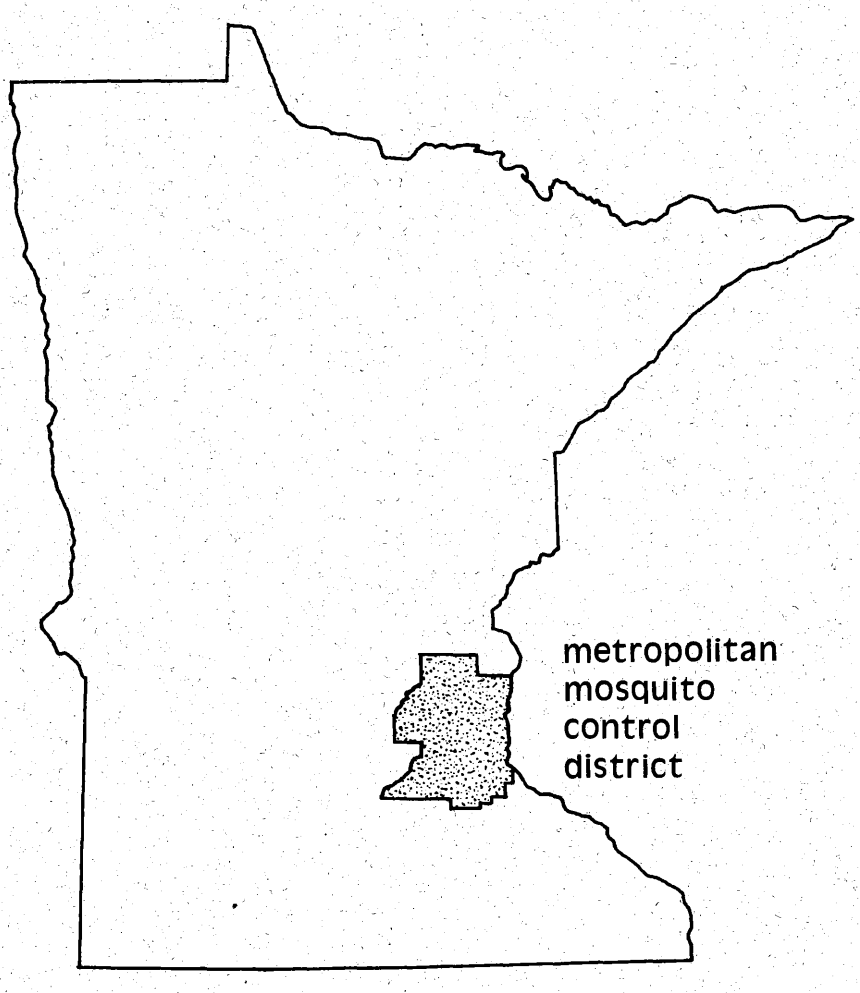


executive summary

EXECUTIVE SUMMARY

INTRODUCTORY COMMENT

The Metropolitan Mosquito Control District provides a public service to residents of six counties in the Twin Cities Metropolitan Area. It is the function of the MMCD to minimize mosquito annoyance, control disease vectors and accomplish these ends in a cost-effective, unobtrusive and environmentally sound manner. The District has assumed the responsibility to promote research and development of feasible alternatives to the use of insecticides as mosquito control agents.

The techniques employed by the Metropolitan Mosquito Control District to effect these objectives and their impacts upon the Twin Cities environment are the subject of the Environmental Impact Statement. A summary of the salient points discussed in this report follows.

1. The climate of the Twin Cities area is 'humid continental' characterized by severe extremes in temperature and summer rain storms.

2. Five glacial periods have left a regional topographic surface of rolling knolls and shallow depressions.

3. These depressions generally are formed of silt and clay deposits. The bottoms of these depressions are impermeable and their drainage systems poorly developed. During summer storms, rainfall and runoff collect in these depressions for some time, then they go dry, largely through a process of evaporation. Roughly 10% of these sites hold water almost constantly through July 1 after which time their water levels are rainfall dependent.

4. Other depression areas, particularly those in woodlands, retain water during the spring in the form of snowmelt.

5. A third depression area is that associated with marshes and open bodies of permanent and semi-permanent water. These dry up in normal years in late summer or fall.

6. Mosquito breeding occurs annually in each of these wetland sites. The MMCD refers to these areas as Types I, II and III breeding sites respectively. In general, smaller sites produce the greatest number of mosquitos per acre.

7. In addition to mosquitos, these sites are habitats for other forms of flora and fauna. The greatest number and variety occur in Type III, permanent and semi-permanent water sites.

8. Fifty species of mosquitos are active in the Twin Cities Area. Ten are important pests. Aedes vexans is the most numerous pest mosquito species, and the mosquito Coquillettida perturbans has the most persistent biting characteristics.

9. Mosquito breeding sites in Anoka, Dakota, Hennepin, Ramsey, Scott and Washington counties have been chemically treated by the Metropolitan Mosquito Control District since its inception in 1959.

10. Although the area served by the District includes 2633 square miles, larval control measures are confined to a core area of 900 square miles. Adulticiding is conducted throughout the District, in outlying residential areas, public recreation areas and for special outdoor events upon request.

11. The District program is based upon chemical control of mosquitos using five of the fifteen EPA-registered materials; chlorpyrifos, temephos, resmethrin, malathion and fuel oil. These materials are applied in ULV liquid and granule forms by air and by ground. The District employs 40 permanent and 120 seasonal staff to administer and implement control operations.

12. At the dosage rates applied in District operations, these materials are safe for use where applied and do not have a negative effect upon non-target flora, fauna or humans.

13. As a result of the current larval control program mosquito annoyance has been reduced at the center of the District (Minneapolis/ St. Paul) by an estimated 87%. The effectiveness of larval control diminishes outward from the center of the District. Control is 65% effective in inner suburban residential areas at an approximate 8 mile radius from the center of the District and 43% effective at the periphery of the larval control area approximately 15 miles from the center.

    These geographical bands are similar to the central cites and Ring I and Ring II designations developed by the Metropolitan Council in its Development Framework Guide.

14. As a result, households in the outlying areas of the Twin Cities find it necessary to augment public mosquito abatement measures through personal expenditures for insect sprays and repellents. These expenditures averaged$3.18 per household during the summer, 1976--a year of abnormally low mosquito activity.

15. The current program of the M.M.C.D., however, has resulted in the savings of 1.2 million dollars annually in private control expenses during normal years and provided area residents with an additional twenty-seven million hours of comfortable outdoor activity, based on 1976 data.

16. Approximately 64% of the area residents surveyed in 1976 (1920) believe that additional funds should be directed towards mosquito control, if a higher level of effectiveness could be guaranteed.

17. Roughly one fourth of these persons believe chemical control has a serious negative effect upon the Twin Cities environment. Less than three percent (2.5) have been actually

bothered by MMCD control activities.

18. MMCD operatives are currently denied access to 1227 privately owned mosquito breeding sites (3891 acres) which produce 4% of the area mosquito population. The MMCD also does not treat breeding sites within some state administered lands or near licensed bee hives, mink and turkey farms. The District is empowered with the rights of eminent domain, but has never exercised this privilege.

19. Research conducted by the MMCD, since 1974 and reports from elsewhere in the country, suggest feasible alternatives to chemical mosquito control are possible. Biological, and physical control are possible alternatives involving the use of natural enemy complexes or site modification to reduce mosquito breeding areas.

20. Use of a controlled-release insecticide formulation in lieu of several larval applications of chlorpyrifos and temephos liquid and granule materials is another alternative to the current program techniques.

21. Twenty-five years after the inception of a biological, physical or controlled-release chemical program, mosquito reduction at a radius of 10 miles from the center of the District is projected to be 5%, 60% and 95% respectively.

22. A fourth alternative -termed an optimum program - combining physical, biological, chemical and controlled-release control methods would achieve 95% effective control in all areas 10 miles from the outer edge of the District in 25 years and result in a program only marginally dependent on insecticides.

23. The current MMCD program is publicly financed at a rate of 80 cents per capita. This figure is expected to remain essentially constant to the year 2000. Per capita

expenditures for insect sprays and repellents averages $1.10 per year. Many persons annoyed by mosquitos do not buy repellents or sprays.

Costs of proposed alternatives projected at the year 2000 are estimated as follows:

	Per Capita Costs, Year 2000	
	Public	Private
No Control Option	-	$3.11
Biological Option	.40	2.97
Physical Option	.80	1.42
Controlled Release Formula	1.80	.44
Optimum Program	1.30	.44

As can be easily seen from these figures, only an optimum program option would result in savings over time. A second benefit would be the reduction of insecticide use by the District and citizens alike.

24. Program alternatives discussed in items 19-23 above are technically feasible, pending further habitat-specific field investigations. Each alternative has been selected with an appreciation of cost-effectiveness and long-term biological productivity. The significance of these alternatives on Twin Cities ecology is shown in the matrix, Executive Summary included in this section (See table B, Page 13 for key).

25. Implementation of physical site modifications (limestone treatments to upland Type I sites; island/moat construction in Type III sites and slope modification in Type III sites) proposed in alternative programs requires approval of the Minnesota Department of Natural Resources, and the Minnesota Pollution Control Agency.

Future site modification and mosquito control activities may require negotiations between the MMCD and the Metropolitan Council or local units of government, should wetland management ordinances be adopted by these organizations.

26. Unavoidable negative impacts of the current mosquito control program include:

    a) The temporary suppression of aquatic insects and crustacean populations in sites treated with chlorpyrifos and temephos;

    b) Noise generation (below state and municipal standards) during early morning and evening hours caused by helicopters and cold fog equipment;

    c) Energy consumption at a level of .007 percent of total Metropolitan gasoline consumption.

    d) Occasional, temporary standing fogs created by ULV spray.

27. Mitigative measures which could be adopted to ameliorate these program effects include:

    a) The suspension of chlorpyrifos as a pre-hatch in favor of additional treatments with temephos at an added cost of some $150,000.

    b) The fitting of helicopters with muffler systems. The mechanical effect of this is to require additional trips and added fuel consumption.

    c) Suspension of ULV spraying in favor of additional reliance on granular formulations which would increase program costs three-fold for acres thus treated.

28. Mitigative measures which have been incorporated into the current program as part of normal policy include:

a) adoption of a policy to respect requests from public and private parties to by-pass breeding acres on their land when conducting field operations;

b) alerting local police of helicopter flight schedules to avoid concern by area officials and residents over their presence;

c) restricting control operations to within 1/4 mile of bee hives, mink ranches, and turkey farms;

d) limiting larval control materials in sensitive areas to temephos;

e) mosquito identification prior to treatment to insure that resources are directed to control of pest species;

f) use of granular formulations in urban areas to reduce exposure to insecticides although liquid materials are equally effective and less costly during the first half of the season;

g) treating Type IA breeding sites (those type I sites which retain water until July 1) with temephos prior to July 1 to permit aquatic fauna to reach maximum densities thus protecting food for nesting waterfowl;

h) phasing malathion out of the adult control program as a precaution against mosquito resistance;

i) allowing natural enemy complexes to control mosquito larvae in sites which can support these populations.

29. Unavoidable negative impacts of alternative programs include those listed in item 26 with the addition

a) mosquito annoyance in a no-control program alternative;

b) possible reduction of waterfowl nesting habitat in a physical control program;

c) reduction of waterfowl food supplies in a controlled release chemical program.

The significance of unavoidable negative impacts resulting from alternative programs at the time of maximum program benefit is outlined on Table A.

30. The Metropolitan Mosquito Control District recommends the following actions:

a) approval by the Minnesota Department of Natural Resources and the Minnesota Pollution Control Agency allowing the District to make applications of limestone to 300 Type I breeding sites to permit a large scale field evaluation of this method of improving water infiltration. These sites should be distributed throughout the District primarily in areas where larval control has already proven effective.

b) adoption of an inter-agency program of field. laboratory and statistical research to determine

.actual dependence of waterfowl upon mosquito breeding sites (especially MMCD Types I, II);

.long-term effects of limestone treatments on soil and water conditions and maintenance of wildlife habitats;

.effectiveness and impacts of physical alterations which have been implemented by other agencies, firms and researchers to effect programs whereby mosquito control is not intentional but incidentally results.

.the variety and density of non-target insect populations in MMCD Type I sites.

c) Continuance of the current chemical control program for mosquito abatement with the inclusion of controlled release formulations (as they become registered and as appropriate

for use in the Twin Cities area) until other alternatives not dependent upon the use of chemicals become more dependable measures for equally effective control (87% at core, 65% at 10 miles, 45% at 15 miles).

d) maintenance of the MMCD boundaries as they exist today with the understanding that the eastern portion of Carver County should be considered for eventual inclusion into the District as a means of providing further control elsewhere within the District, especially in Hennepin County.

The summary matrix presented on pages 10 and 11 is an overview of projected environmental impacts of alternate mosquito control programs. Impacts are projected for each program on environmental parameters at three stages of program development - 5 years, 15 years and 25 years. Program inception is assumed as 1978 in all cases.

The degree of program impact on each parameter is ranked according to a scale of 1 to 7 wherein the values are:

VALUE	DEFINITION	NEGATIVE IMPACT MITIGATION
■=	insignificant impact	no mitigation required
1=	minor impact	inexpensive mitigation only
3=	significant impact	adjust methods and materials, while maintaining effective control.
5=	major impact	mitigation essential
7=	extreme impact	suspend program until corrective measures are found.

The definition of each value for each parameter is stated in the key entitled Table B.

executive summary
environmental impacts of alternate mosquito control programs
degree of impact at stages of program development

subject of impact	current MMCD program			no control option			biological control option			physical control option			controlled release chemical[a]			optimum mosquito control		
	5 years	15 years	25 years	5 years	15 years	25 years	5 years	15 years	25 years	5 years	15 years	25 years	5 years	15 years	25 years	5 years	15 years	25 years
freedom from mosquito annoyance	5	5	5	■	■	■	■	■	■	■	1	4	6	7	7	6	7	7
public health	3	3	3	■	■	■	■	2	3	■	2	3	5	5	5	5	5	5
animal health	3	3	3	■	■	■	■	■	1	■	1	3	5	6	6	5	6	6
non-target organisms																		
aquatic micro-organisms	1	1	1	■	■	■	■	■	■	2	2	2	1	1	1	1	1	1
crustaceans	3[c]	3[c]	3[c]	■	■	■	■	■	■	■	■	■	4	4	4	4	2	1
aquatic insects	1	1	1	■	■	■	■	■	■	■	■	■	2	2	2	2	1	■
terrestrial insects	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
pollinating insects	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
terrestrial flora	■	■	■	■	■	■	■	■	■	■	1	1	■	■	■	■	1	1
aquatic flora	■	■	■	■	■	■	■	■	■	3	3	3	■	■	■	3	3	3
birds	■	■	■	■	■	■	■	■	■	2	2	2	■	■	■	2	2	2
waterfowl	1	1	1	■	■	■	■	■	■	1-2[b]	1-2[b]	1-2[b]	2	2	2	1-2[b]	1-2[b]	1-2[b]
fish	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
amphibians & reptiles	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
aquatic mammals	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
terrestrial mammals	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
humans	■[d]	■[d]	■[d]	■	■	■	■	■	■	■	■	■	■[d]	■[d]	■[d]	■[d]	■[d]	■[d]
physical environment																		
hydrologic cycle	■	■	■	■	■	■	■	■	■	1	1	1	■	■	■	1	1	1
surface water quality	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
ground water quality	■	■	■	■	■	■	■	■	■	1[e]	1[e]	1[e]	■	■	■	■	■	■
solid waste	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
air quality	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
noise	2	2	2	■	■	■	■	3	3	3	3	3	1	1	1	3	3	3
wetlands (MMCD)																		
type I	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
type II	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■

type III	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
topography	■	■	■	■	■	■	■	■	■	■	1	1	■	■	■	■	1	1
insecticide residue																		
bio-magnification	1	1	1	■	■	■	■	■	■	■	■	■	1	1	1	1	1	1
degradation products	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
synergism & potentiation	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
re-synthesis	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
soil residue	1	1	1	■	■	■	■	■	■	■	■	■	1	1	1	1	1	1
resistance																		
mosquito	■	■	■	■	■	■	■	■	■	■	■	■	■	1	3	■	■	■
other pest arthropods	■	■	■	■	■	■	■	■	■	■	■	■	■	■	1	■	■	■
non-pest arthropods	■	■	■	■	■	■	■	■	■	■	■	■	■	■	1	■	■	■
energy use	1	1	1	■	■	■	■	■	■	1	1	1	2	1	1	2	2	1
cost-benefits																		
per capita cost																		
public ($)	.80	.80	.80	3.11	3.11	3.11	.20	.40	.40	.80	.80	.80	3.20	1.80	1.80	2.40	2.40	1.30
private ($)ⓕ	1.10	1.10	1.10	1.33	1.33	1.33	3.11	2.97	2.97	3.11	2.55	1.42	.44	.44	.44	.86	.58	.44
% MMCD acres controlled	35%	35%	35%	0	0	0	0	5%	5%	11%	33%	55%	95%	95%	95%	87%	94%	100%
% mosquito reduction 10 mile radius from core	65%	65%	65%	0	0	0	0	5%	5%	0	20%	60%	95%	95%	95%	80%	90%	95%
added adult residential hours of outdoor evening recreation/ total dollars spentⓕ	7.4	7.4	7.4	—	—	—	—	.3	.3	1.2	1.2	5.7	5.5	9.0	9.0	5.2	6.4	11.5

key:

■	insignificant
1	minor
3	significant
5	major
7	extreme

qualifying notes:

ⓐ it is understood that formulation changes may be necessary to compensate for mosquito resistance.

ⓑ accurate estimation of impacts requires a site-by-site study. generally impacts are both positive (increased habitat) and negative (possible loss of food supply).

ⓒ impact is greatest in temporary water sites (I, II).

ⓓ impacts are limited to allergies in hypersensitive persons.

ⓔ limestone treatments are proposed for type I upland sites. testing will precede any use in sites where ground water tables lie near the surface.

ⓕ all figures are conservative due to low mosquito season used for calibration.

TABLE A

SIGNIFICANCE OF UNAVOIDABLE NEGATIVE IMPACTS EXPECTED THROUGH ABATEMENT ALTERNATIVES AT TIME OF MAXIMUM PROGRAM BENEFIT

IMPACT	MOSQUITO CONTROL PROGRAM ALTERNATIVES					
	Current Program	No Control	Biological Control	Physical Control	Controlled Release	Optimum Program
Maximum Benefit	1977	-	1992	1990	1980	2000
Aquatic Insects	1	■	■	■	2	■
Crustaceans	3	■	■	■	5	1
Waterfowl	1	■	■	1-2	2	1-2
Noise	2	■	3	3	1	3
Energy Use	1	■ *	■ *	1*	2	1

*Assumes mitigative measures to control mosquito annoyance.

Key
- ■ Insignificant
- 1 Minor
- 3 Significant
- 5 Major
- 7 Extreme

TABLE B

KEY TO INTERPRETATION OF VALUES RECORDED
IN MATRIX:EXECUTIVE SUMMARY

ENVIRONMENTAL PARAMETER	VALUE	DEFINITION
Freedom from mosquito annoyance	■	Residents cannot use most parks in the day without annoyance (July).
	1	Parks can be used in the daytime with minimum mosquito annoyance.
	3	Parks can be used at night with minimum annoyance.
	5	70 of 90 summer nights with mosquito bite counts of 1 or less per five minutes at the District's center.
	7	70 of 90 summer nights with mosquito bite counts of 1 or less per five minutes in all areas of the District.
Public Health		
	1	Fewer than 25 cases confirmed per annum.
	3	Fewer than 10 cases confirmed per annum.
	5	Cases are sporadic, confined to the outer fringes of the District and number fewer than 5 per year.
	7	Diseases not reported.

ENVIRONMENTAL PARAMETER	VALUE	DEFINITION
Animal Health	■	Incidence of heartworm and equine encephalitis equal with the current norm in areas beyond the controlled boundary of the District.
	1	The incidence of mosquito-borne animal disease = 25% less than the current norm outside the controlled area of the District.
	3	Disease cases occur at the periphery of the District and = 50% of the current norm beyond the controlled area of the District.
	5	Disease cases occur entirely at the periphery and = 75% fewer than the current norm in uncontrolled areas beyond the District boundaries.
	7	Disease in domestic animals is uncommon in the District.
NON TARGET ORGANISMS Aquatic Micro-organisms	■	No change.
	1	Temporary suppression of some populations of aquatic micro-organisms.
	3	Temporary wholesale suppression of all populations of aquatic and soil micro-organisms during the period of mosquito control.

ENVIRONMENTAL PARAMETER	VALUE	DEFINITION
	5	Temporary elimination of aquatic and soil micro-organisms in the area of treatment (i.e. for up to 1 year following treatment).
	7	Permanent elimination of aquatic and soil micro-organisms in the area of treatment (i.e. 10 years or longer following treatment).
Crustaceans Aquatic insects Terrestrial insects Pollinating insects	■	Populations reduced by 1% or less within a median square mile without elimination of the species; populations reduced 5% or less in any given square mile.
	1	Populations reduced 5% or less within a median square mile and 50% or less in any given square mile.
	3	Populations reduced 25% or less within a median square mile without elimination of the species and 75% or less in any given square mile.
	5	Populations reduced by 50% or less within a median square mile; elimination of populations in several square mile areas.
	7	Populations eliminated within a median square mile.

ENVIRONMENTAL PARAMETER	VALUE	DEFINITION
Aquatic flora Terrestrial flora	■	No change.
	1	One-time disruption of 25% - 50% of the vegetation in the area of treatment.
	3	One-time disruption of 50% or more of the vegetation in the area of treatment.
	5	Killing of an individual of a rare species or elimination of vertebrate habitat in the treatment area.
	7	Elimination of a rare species.
Birds Waterfowl Fish	■	Elimination of food, shelter, nesting and loafing space for 1% or less of the population in a median square mile.
	1	Elimination of food, shelter, nesting and loafing space for 5% of the population in a median square mile.
	3	Elimination of food, shelter, nesting or loafing space for 20% of the population in a township.
	5	Direct toxicity to 50% or elimination of habitat for 50% of the population within a township.
	7	Elimination of a species within a township by direct toxicity or alteration of habitat.

ENVIRONMENTAL PARAMETER	VALUE	DEFINITION
Aquatic mammals Terrestrial mammals	■	No change of habitat.
	1	1% reduction of population within a square mile.
	3	5% reduction of populations within a square mile.
	5	30% reduction of populations within a square mile.
	7	Elimination of a species within a square mile by direct toxicity or alteration of habitat.
Humans	■	Fewer than 5 cases of reported skin irritation each year.
	1	Five or more reported cases of skin irritation each year.
	3	Medically certified illness (including laboratory confirmation) in employees or general public as a result of the program.
	5	Accidental death due to physical causes.
	7	Medically certified death due to toxicological effects
PHYSICAL ENVIRONMENT		
Hydrologic Cycle	■	No change.

ENVIRONMENTAL PARAMETER	VALUE	DEFINITION
	1	Water retention time reduced in median MMCD Type I site treated with limestone to five days.
	3	Elimination of all but semi-permanent and permanent water sites.
	5	Elimination of all but permanent water sites.
	7	Localized lowering of surface water levels below depth required for terrestrial plant growth.
Surface Water Quality	■	No change.
	1	Annual phosphate loading in a permanent body of water increased by 5% or less.
	3	Phytoplankton blooms make water unfit for vertebrate populations.
	5	Water is unfit for human recreation.
	7	Water is toxic to humans.
Groundwater Quality	■	No change.
	1	Percolation of pre-existing pollutants into groundwater.
	3	Introduction of non-toxic pollutants into aquifer headwaters.
	5	Introduction of toxic materials into groundwater supply.

ENVIRONMENTAL PARAMETER	VALUE	DEFINITION
	7	Introduction of toxic materials into groundwater used for drinking.
Solid Waste	■	No change.
	1	Accumulation of insecticide carrier residues to one part in one thousand in the top 6" of soil in the treated area.
	3	Accumulation of insecticide carrier residue to one part in ten in the top 6" of soil at the treatment site.
	5	Solid waste is visible at the treatment site or is equal to 1% or more of the solid waste in the Twin Cities.
	7	Solid waste is unavoidably visible.
Air Quality	■	No change.
	1	Visibility is limited in the median recreation areas being treated for 5 minutes or more.
	3	Materials are emitted into the air which could combine with other pollutants to form sub-lethal toxic substances.
	5	Fog conditions result creating the probability of automobile accidents.
	7	Materials are emitted into the air at levels toxic to mammals.

ENVIRONMENTAL PARAMETER	VALUE	DEFINITION
Noise	■	No change in ambient noise levels.
	1	Noise causes momentary surprise and diverts attention. Wildlife leave the area and return when noise subsides.
	3	Noise causes momentary disorientation, or noise is continuous at 80 dBA or more in several locations.
	5	Noise at or in excess of pain threshold.
	7	Noise results in permanent hearing damage.
Wetlands MMCD I,II,III	■	No change.
	1	Change does not alter wetland classifications as stated in the U. S. Fish and Wildlife Service Circular 39 or ongoing revisions to that classification system.
	3	Wetlands (MMCD classification)are reduced by 1% to 20%.
	5	Wetlands (MMCD classification) are reduced by 20% or more.
	7	Wetland breeding sites are eliminated in a township.

ENVIRONMENTAL PARAMETER	VALUE	DEFINITION
Topography	■	No change.
	1	Change in topography from one acceptable appearance to another, equally acceptable appearance.
	3	Erosion is caused by physical changes which results in site specific hill and gully topography.
	5	Construction leaves open cuts in the earth or flattens rolling terrain.
	7	Physical changes destroy an area considered to be uniquely beautiful.
INSECTICIDE RESIDUE		
Bio-magnification	■	No change in normal processes.
	1	Organism absorbs insecticide or its degradation products, stores materials without adverse effects, and excretes non-toxic metabolites.
	3	Insecticide is held in the food chain for an extended period of time with no adverse effects.
	5	Insecticide accumulation shortens the normal life-span of any vertebrate species.

ENVIRONMENTAL PARAMETER	VALUE	DEFINITION
	7	Insecticide products accumulate in the food chain interfering with reproduction or causing mortality in any vertebrate species.
Degradation Products	■	No change.
	1	Insecticide degrades quickly into non-toxic, non-persistent by-products.
	3	Degradation products are 50% less toxic than the parent compound.
	5	Parent and degradation products have equivalent toxicity.
	7	Degradation products are more persistent and more toxic than parent compound.
Synergism and Potentiation	■	Insecticide interacts with a material in the pre-existing environment. The interaction increases the toxicity of dosage now in use by 1% or less.
	1	Interaction between an insecticide and a pre-existing condition increases toxicity of a current dosage by 1 to 5%.
	3	Insecticides are shown to reduce safe-use margins by 15% or more when combined with other substances.

ENVIRONMENTAL PARAMETER	VALUE	DEFINITION
	5	Insecticides combine with other materials to result in chronic toxicity which shortens human life spans by 2 years or more.
	7	Insecticides are shown to combine with other materials in the environment to produce mortality in animals or man.
Re-synthesis	■	No change.
	1	Degradation products recombine at non-toxic trace levels.
	3	Degradation products recombine at levels 80% less toxic than parent compounds.
	5	Degradation products recombine at levels 40% less toxic than the parent compound and have a duration of 1 year.
	7	Degradation products readily re-combine in the original parent materials with equal toxic strength.
Soil Residue	■	Residues are not measurable in ppb 60 days or more after application.
	1	Trace levels are measurable 60 days or more after treatment but in levels insufficient to cause mortality in any organism.
	3	Residues are present 60 days after release equal to 50% of the original application.

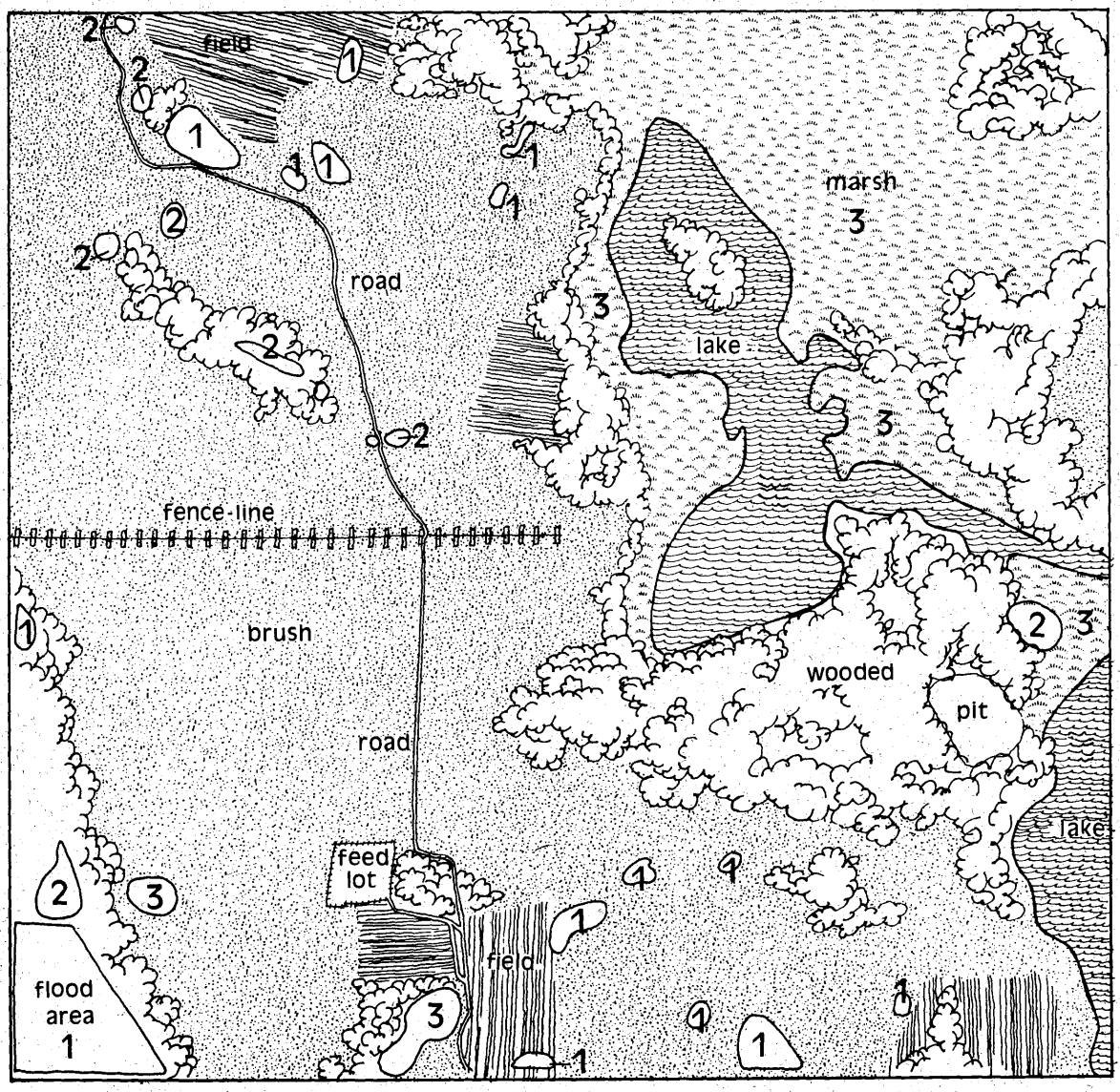
ENVIRONMENTAL PARAMETER	VALUE	DEFINITION
	5	Residues present 60 days after application are equal to 100% of the original application.
	7	An insecticide - soil relationship evolves whereby the insecticide does not degrade. Release after multiple treatments can occur at a concentration twice that achieved by a single application.
RESISTANCE by Mosquitos and Pest Arthropods	■	No resistance.
	(*+) 1	The probability exists that resistance will develop as a response to a larval control material in the area most intensely treated.
	(*+) 3	Resistance is expected to develop as a response to larval control materials in use.
	(*+) 5	Resistance occurs in response to all but the most expensive larval control materials.
	(*+) 7	Resistance occurs as a response to all insecticides approved for the larval control of mosquitos.

*+before the numerical value indicates non-pest arthropods.

ENVIRONMENTAL PARAMETER	VALUE	DEFINITION
ENERGY CONSUMPTION	■	Energy consumption, measured in gasoline, is equivalent to .001% of total metropolitan consumption.
	1	Energy consumption, measured in gallons of gasoline, is equivalent to .01% of total metropolitan consumption.
	3	Energy use, measured in gallons of gasoline, is equivalent to .1% of total metropolitan consumption.
	5	Energy use, measured in gallons of gasoline, is equivalent to 1% of total metropolitan consumption.
	7	Energy use, measured in gallons of gasoline, is equivalent to 10% of total metropolitan consumption.

COST BENEFITS

Cost benefits analyses are based on current figures. Current public expenditures are $.81 per capita. Current private expenditures ($1.10 per capita) are based upon responses of 1920 households in a survey conducted by the District in 1976. Hours spent outdoors per dollar spent are based upon historical mosquito light trap and bite count recordings and responses by adults to survey questions in 1976.



environmental setting

NATURAL ENVIRONMENTAL SETTING

INTRODUCTORY COMMENT

A detailed discussion of the general environmental setting of the Twin Cities Metropolitan Area has been omitted from the main body of this Environmental Impact Statement. Preference is given here to a discussion of those environmental features which have a significant bearing upon mosquito production in the region and the selection of mosquito control techniques.

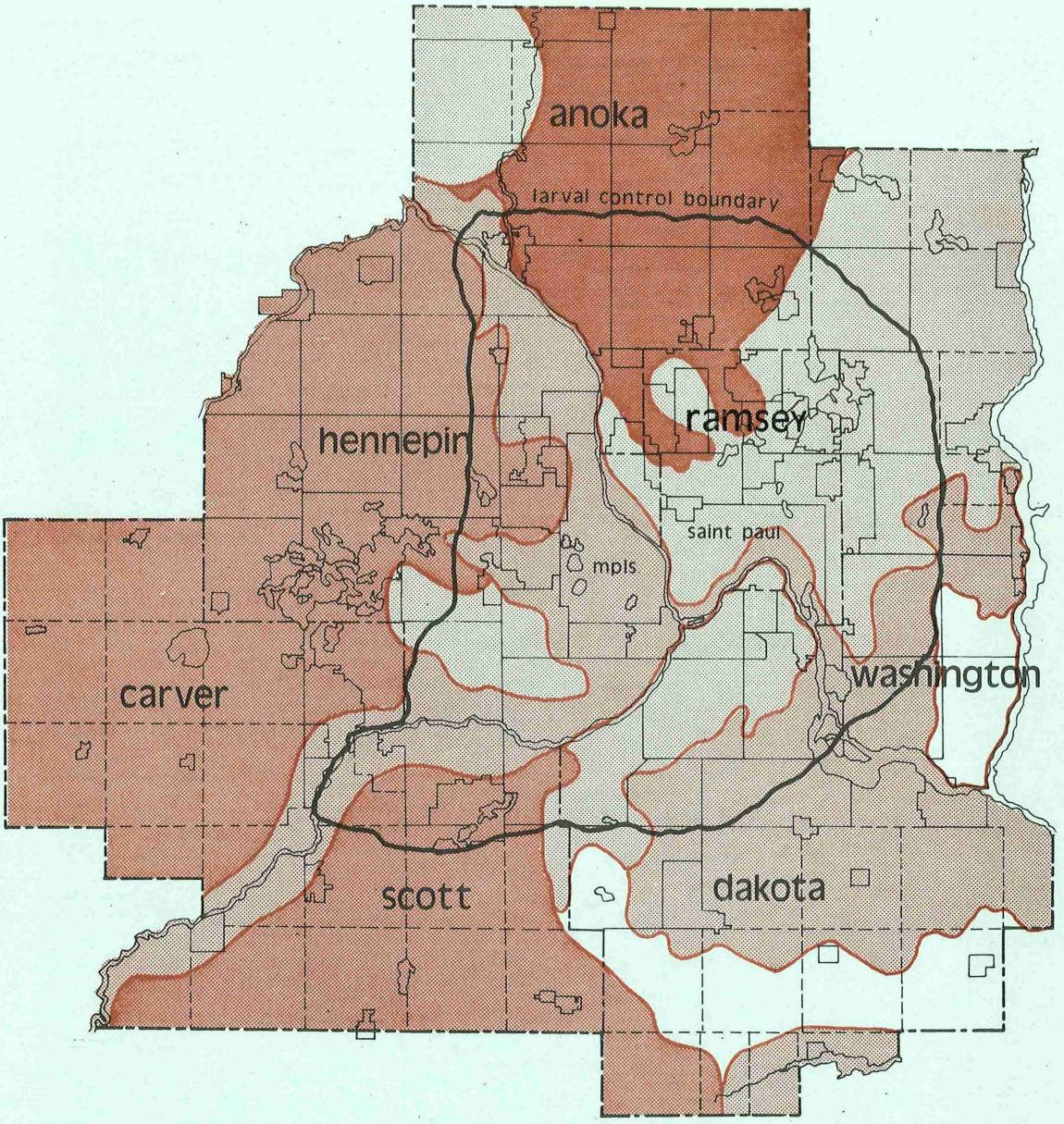
In compliance with the requirements of the Minnesota Environmental Quality Board for the preparation of Environmental Impact Statements, a fuller discussion of the physiography, climate, geology, hydrology and ecology of the seven county Metropolitan area is included in Appendix ES (Exhibit A) which accompanies this text.

CLIMATE, HYDROGEOLOGY AND MOSQUITO PRODUCTION

The Twin Cities Metropolitan Area is situated in mid-continental North America and is subject to extremes of temperature characteristic of a 'humid-continental' climate. Average annual precipitation is 27 inches of which 18 normally result from summer thunderstorms (Watson, 1976).

Past glacial activity has created an irregular topography evident in moraines and depressions. The soils of these formations consist primarily of till materials having a low infiltration capacity. In many areas, surface drainage systems are not well developed. Other areas are characterized by high water table levels, especially the Anoka Sand Plain. (Pfannkuch, 1976)

Any one or a combination of these physical and hydrologic characteristics contributes to the surface retention of water resulting from snow melt, summer rainfall or fluctuations in the water table. The density of mosquito breeding sites correlates positively with the



river outwash
owatonna moraine
rochester till plain
anoka sand plain
twin cities formation

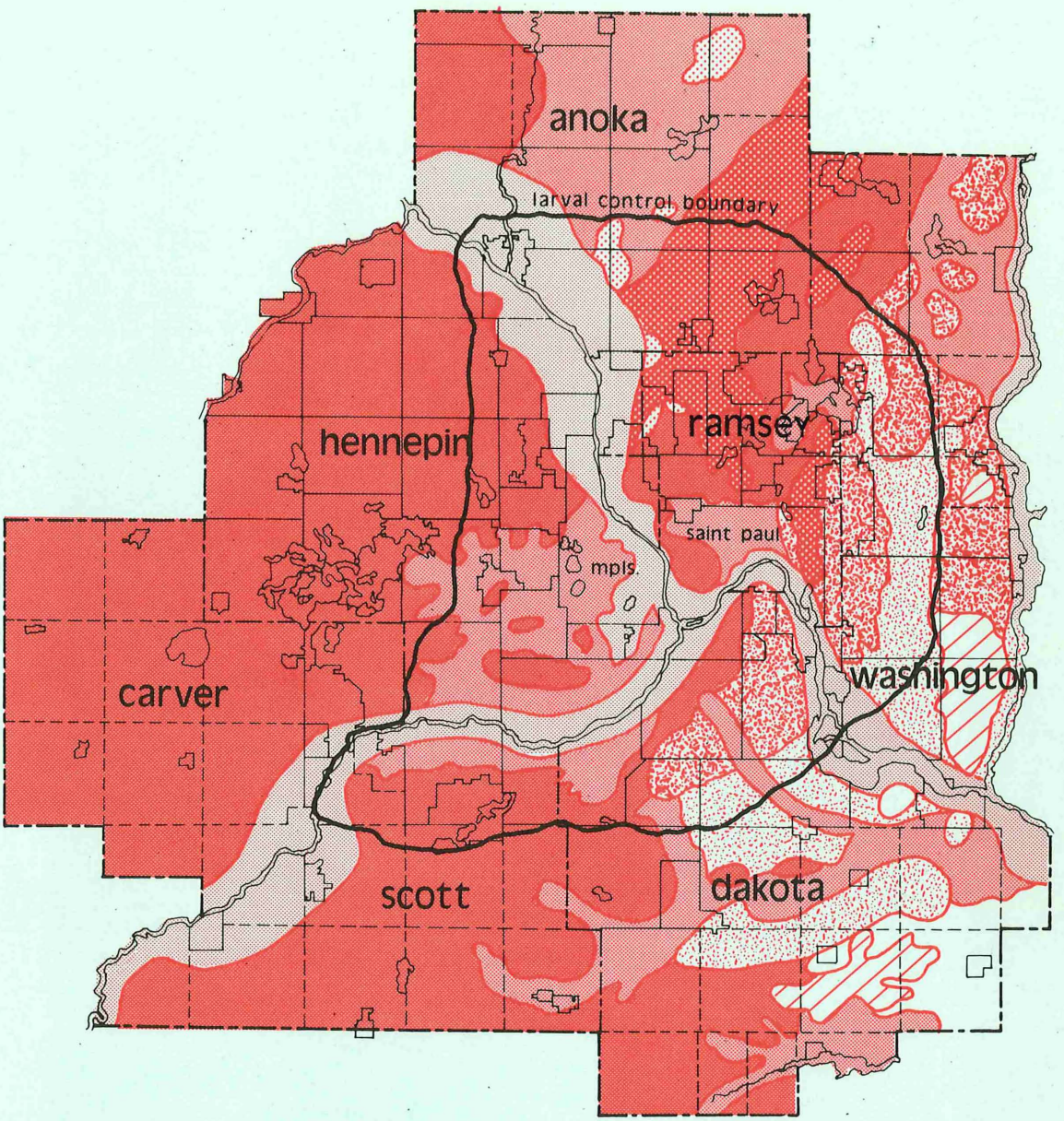
source: Harms et al., 1975.

figure 1.

physiographic landforms and soil associations

miles 0 5 10 15 20 n

john and michele genereux



- gray till
- outwash from gray till (sand and gravel)
- red till
- outwash from red till (sand and gravel)
- undifferentiated drift
- terrace deposits and alluvium (sand and gravel)
- lake deposits (sandy)
- wind deposits
- bedrock at or near surface

source: Parham et al., 1974.

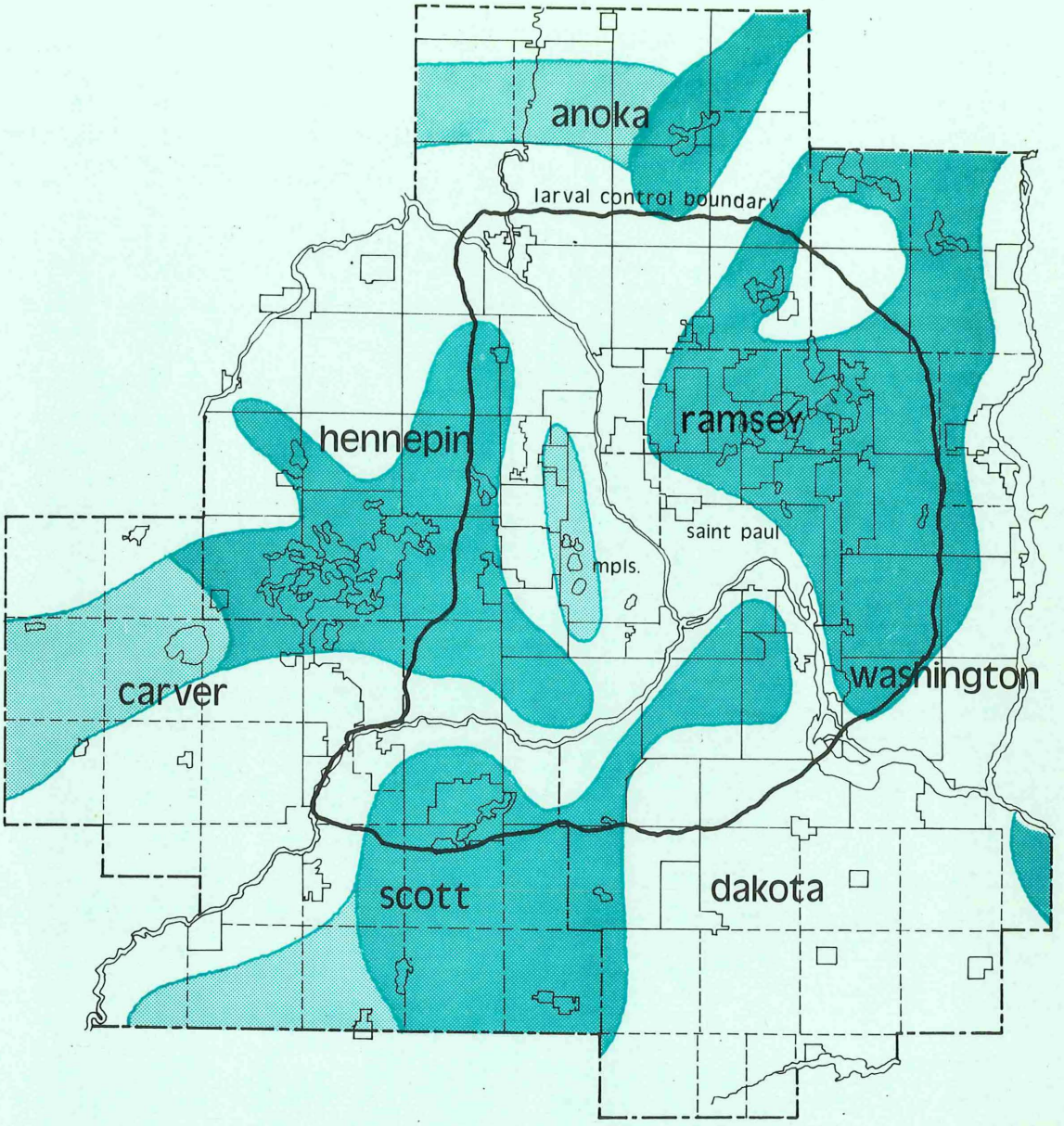
figure II.

generalized surficial geology

miles 0 5 10 15 20

n

john and michele genereux



low density
medium density
high density

source: Brown et al., 1975, and Daley and Carlson, 1967.

figure III.

generalized lake distribution

miles 0 5 10 15 20 n

john and michele genereux

TABLE 1

LAKE DISTRIBUTION IN THE SIX-COUNTY METROPOLITAN MOSQUITO CONTROL DISTRICT

County	Lakes of 10 Acres plus No.	No. all or partly dry	Lake Area in Acres	Acres in County	% County in lakes 10 acres plus
Anoka	143	57	16,168	283,520	5.7
Dakota	83	8	10,255	376,320	2.7
Hennepin	200	39	36,814	389,760	9.4
Ramsey	83	21	10,871	109,440	9.9
Scott	144	92	15,407	232,960	6.6
Washington	168	6	20,605	268,160	7.7
Total	821	223	110,120	1,660,160	

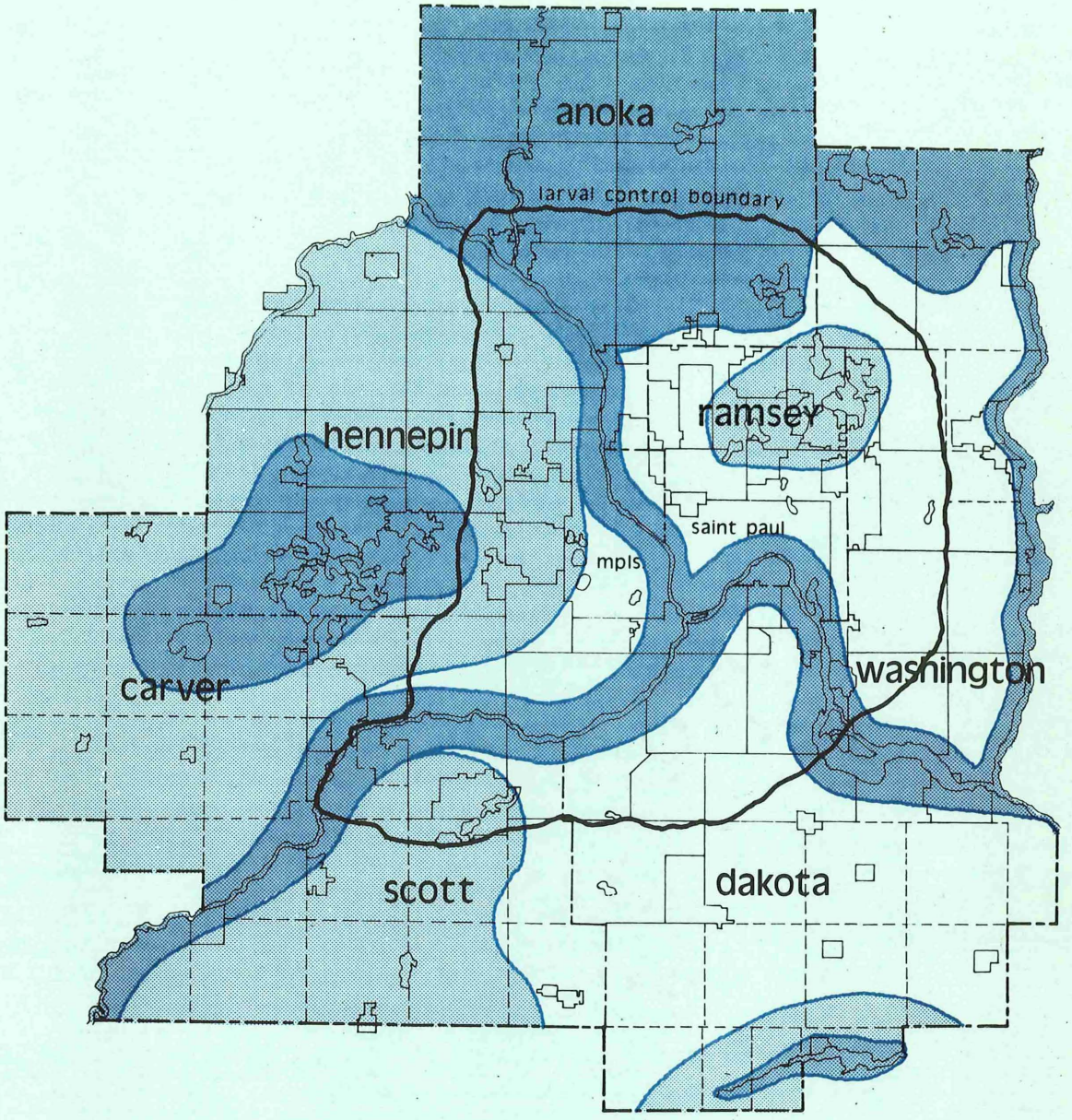
TABLE 2

LAKE CLASSIFICATION BY ACREAGE

County	10-25	25-50	50-75	75-100	100-150	150-200	200-500	500-1000	1000-5000	No. Total
Anoka	49	24	16	15	10	6	17	5	1	143
Dakota	43	20	7	1	3	0	5	2	1	83
Hennepin	67	31	22	19	8	23	23	5	2	200
Ramsey	30	13	10	6	8	4	7	3	1	82
Scott	16	31	26	16	29	10	13	3	-	144
Washington	64	55	15	12	7	5	6	0	4*	168
Total	269	174	96	69	65	48	71	18	9	820

*Includes 1 which is mostly in Wisconsin.

Source: Minnesota Division of Waters, Soils and Minerals of the Minnesota Conservation Department. An Inventory of Minnesota Lakes, St. Paul. 1968.



depth in feet:

deep (>50)

moderate (15-50)

shallow (0-15)

source: Olaf Pfannkuch, 1976.

figure IV.

generalized water table depth

miles 0 5 10 15 20

n

john and michele genereux

occurrence of these characteristics. The actual breeding of mosquitos depends upon the amount and duration of water retention in depression breeding sites thus formed.

Generalized illustrations of regional physiography, surfical geology, lake distribution and proximity of water table levels to surface topography are presented in accompanying figures I-IV. A detailed discussion of the information presented in these maps is included in Appendix ES (Exhibit A). Lake distribution in the six county MMCD service area is presented in Tables 1 and 2.

MOSQUITO BREEDING IN THE TWIN CITIES

Of some 2000 species of mosquitos which occur in tropical and subtropical regions of the world, 300 are found in the United States, Canada, Northern Europe, Greenland and non-tropical Asia. Sixty species occur in Canada and fifty in the Twin Cities Metropolitan Area (Gillett, 1972).

Nine of the ten most annoying pest mosquitos in the Metropolitan Mosquito Control District are in the genus Aedes. The tenth is Coquillettidia perturbans. Aedes vexans account for 52% of the entomological collections by the District. The ten pest species account for 97.6% of all mosquitos identified. The nuisance value of these pests is shown in Table 3.

Anytime water collects in normally dry depressions, or raises the water level in marshes, mosquito eggs hatch. If accumulated water remains during warm weather for more than seven days, immature mosquitos can complete development.

The mosquito control season in the Metropolitan Area begins in mid March when snow melt water collects in woodland depressions and stimulates the univoltine or spring Aedes to begin hatching. The season ends in September when eggs of multi-brooded Aedes species, enter diapause, or over-wintering.

Although differences in soil type, topography and annual rainfall have conditioned marked regional differences in mosquito production

TABLE 3

ANNOYANCE VALUE OF PROMINENT MOSQUITOS

SPECIES	% ANNOYANCE	BREEDING SITE
UNIVOLTINE--SINGLE BROOD IN THE SPRING		
Aedes abserratus	- 1	II
Aedes excrucians	4.4	II
Aedes fitchii	6.4	II
Aedes stimulans	10.5	II
MULTIVOLTINE--SEVERAL BROODS THROUGHOUT SUMMER		
Aedes triseriatus	1.3	Tree holes; Containers
Aedes sticticus	3.3	Some I, river bottom
Aedes trivittatus	5.1	I, some river bottom.
Aedes cinereus	6.6	I;II
Aedes vexans	52.8	I; II; III: some river bottom
UNIVOLTINE, SPECIAL --EMERGES THROUGHOUT SUMMER		
Coquillettidia perturbans	4.9	III; marshes; lakes with cattail margin

Source: MMCD Records, 1969-1973

capability (see Figure V-VIII), flight capability of certain mosquito species permits dispersal from 100 yards to 60 miles from breeding sites. This dispersal is random and subject to restriction by high temperature, low humidity, high winds, exposure to predators and physical abrasion. Locally dominant A. vexans and C. perturbans species have a flight range of 15 miles and 3 miles respectively (Clarke, 1943; Brust, 1976). Dispersal procedes for approximately five days after adult emergence, after which time mosquitos become resident in the area penetrated.

Aedes vexans mosquitos lay between 150-300 eggs in their lifetime (Barr, 1958, Breeland and Pickard, 1967). These eggs may survive adverse conditions and remain viable for up to 28 site floodings over a six year period (Breeland and Pickard, 1967; Cook 1974). In an average year, six broods (simultaneous hatching of eggs) of Aedes vexans are produced in the Twin Cities area. In other years the number of broods produced may range between three and fourteen.

Contrary to popular opinion, the major cause of the mosquito problem in the Metropolitan Area is not lakes and marshes, but the smaller, more shallow, temporary snow melt and summer rain pools. Aedes mosquitos, the chief pest genus, lay their eggs in the moist depressions which are later covered with water. When and how often the eggs hatch depends upon the peculiarities of each species and the duration and depth of water retention in the breeding site. The greatest larval densities are found in water depths of one to six inches (Barton, 1977).

There are 240,000 acres of mosquito breeding grounds in the study area. Approximately one third of this area is contained in sites of less than three acres in size. Roughly two-thirds (60%) of the mosquito population originate in these smaller sites (MMCD annual records). It is estimated that there are 21 breeding sites per square mile in the study area (54,000 sites).

After each major rainfall the sites become active. Mosquito production per acre varies between one and nine million after each rainfall event.

The 54,000 known breeding sites in the study area are of three types classified according to the length of time water is retained at the surface and the number of generations produced by the mosquito species which breeds in the site. Every site is an intermittent water site: Pothole depression (Type I); woodland pool (Type II); intermittent marsh (Type III). The relative density of breeding sites in the study area is shown in accompanying Figures V - IX and in Table 4.

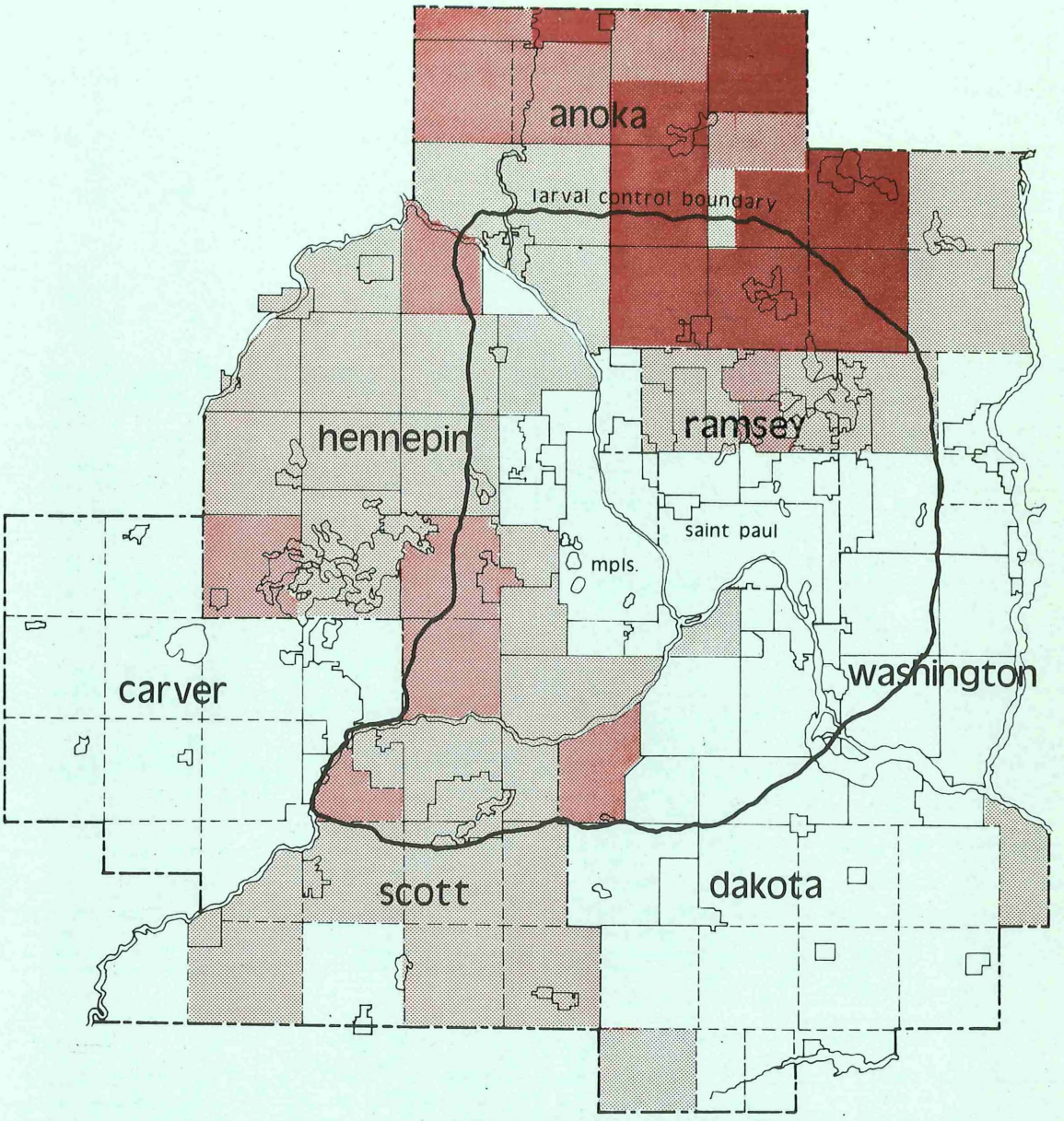
Univoltine and multivoltine species of Aedes mosquitos breed in potholes and woodland pools. These sites are active in the early spring (woodland pools) and after major rainfalls (potholes).

TABLE 4

SUMMARY OF MOSQUITO BREEDING SITE SIZE AND DENSITY IN THE METROPOLITAN MOSQUITO DISTRICT

	Average Area of Breeding Sites Acres/Site		Relative Area of Total Surface Occupied by Breeding Sites (%)		
County	Type I & II	Type III	Type I & II	Type III	All Sites
Anoka	9.48	19.72	29.04	1.71	30.75
Dakota	2.85	8.73	8.45	2.24	10.69
Hennepin	3.45	4.32	19.24	0.26	19.50
Ramsey	1.91	8.26	8.15	5.97	14.12
Scott	3.12	21.52	6.76	1.91	8.65
Washington	3.61	6.51	11.22	0.26	11.48
District	4.10	11.00	14.47	1.51	15.98

SOURCE: MMCD Records, 1976.



0-10 %
10-20 %
20-30 %
>30 %

source: MMCD records, 1974.

figure V.

relative area covered by breeding sites

type I, II and III

miles 0 5 10 15 20 n

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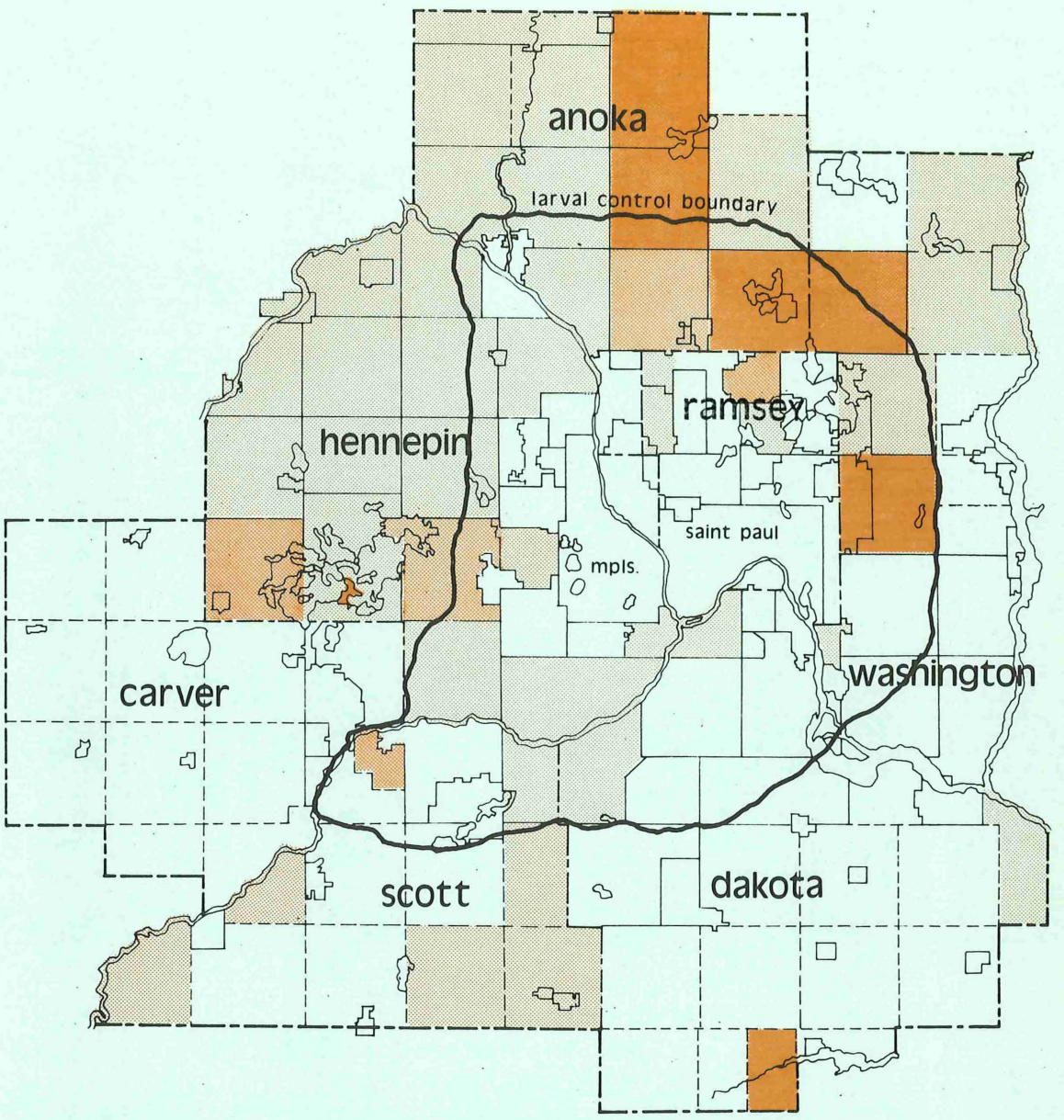


figure VI.

land area in type I sites

0-10 %
10-20 %
20-30 %
30-40 %

miles 0 5 10 15 20 n

source: MMCD records, 1974.

john and michele genereux

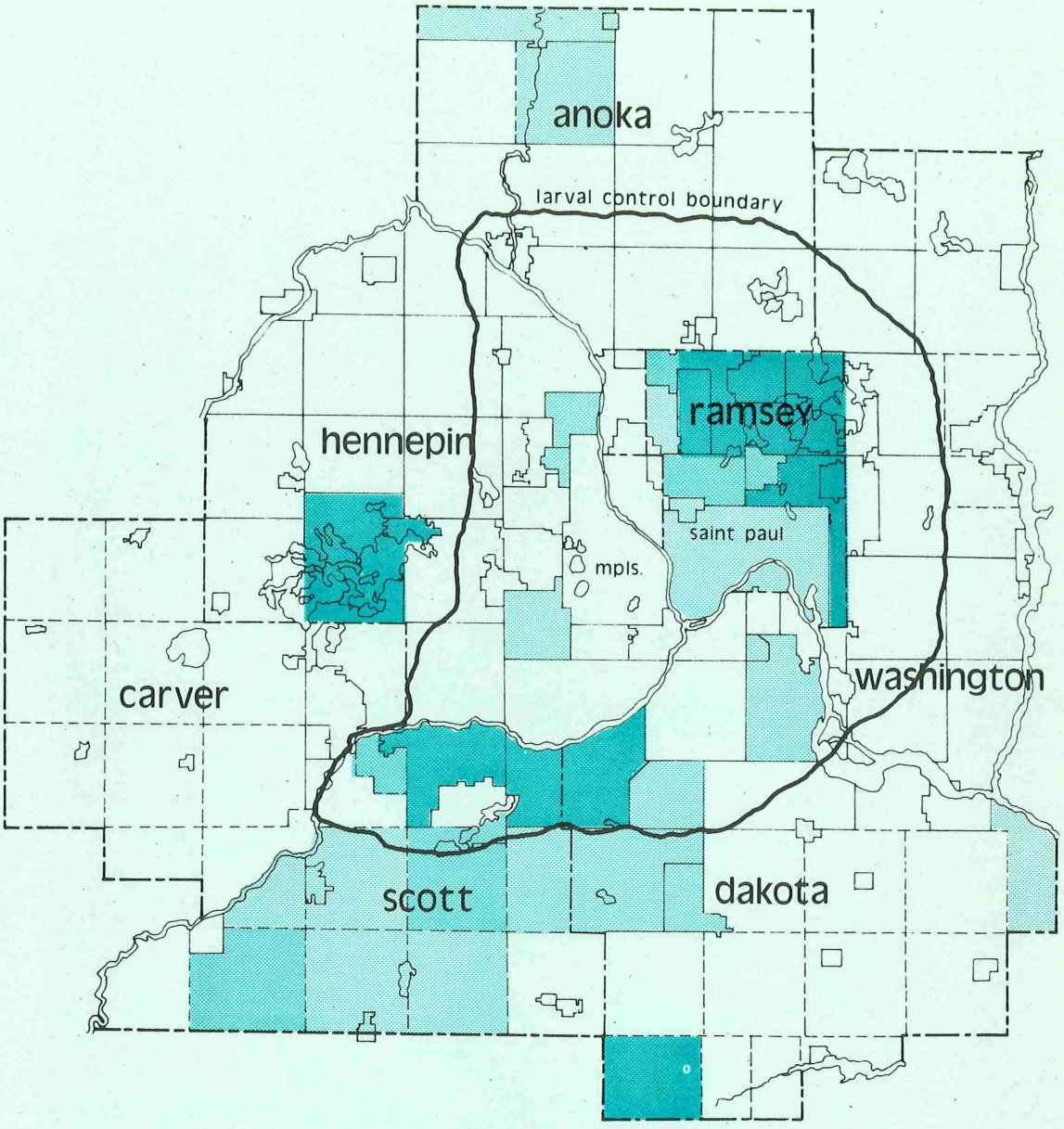


figure VII.

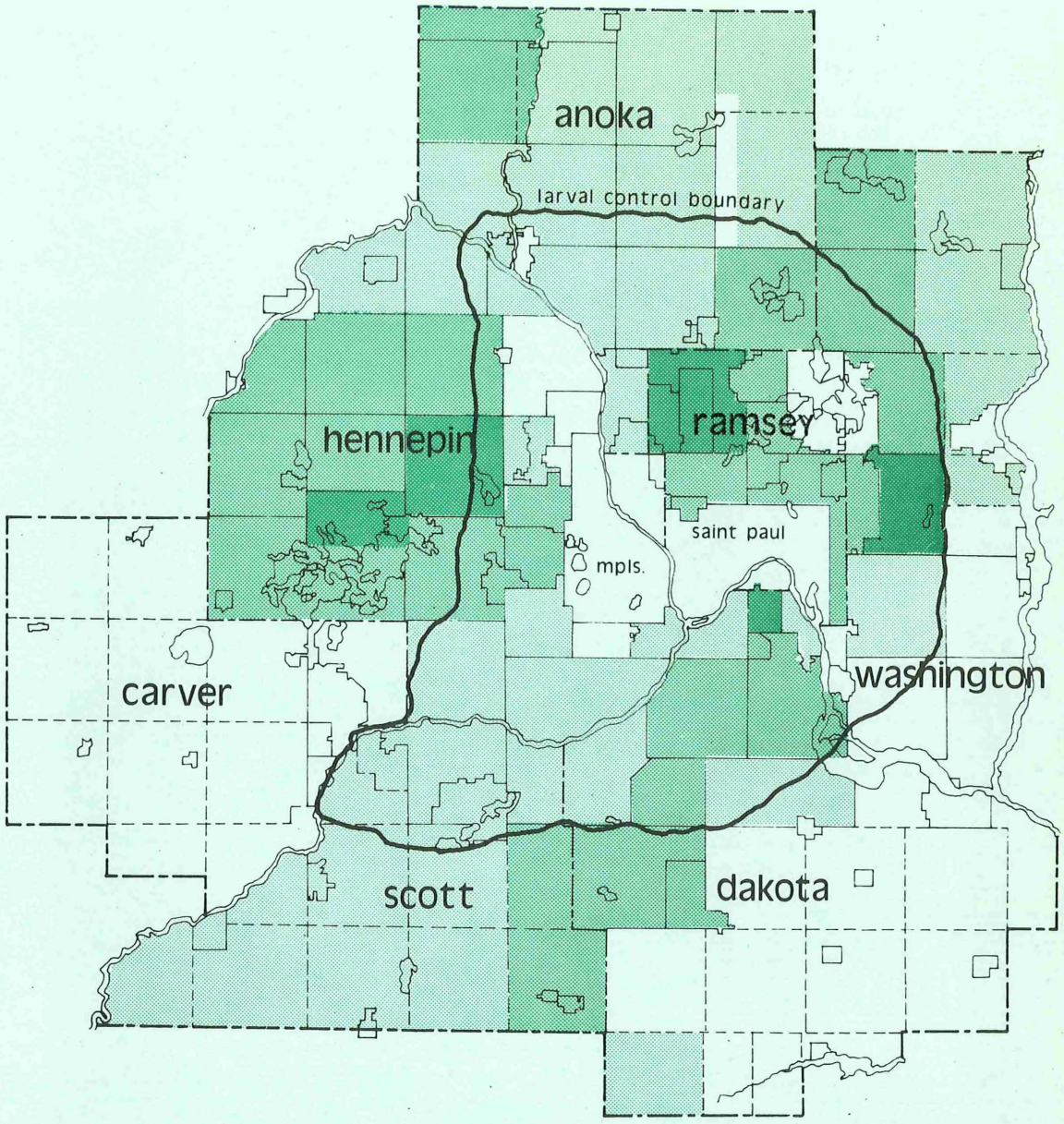
land area in type III sites

0-1 %
1-3 %
3-6 %
>6 %

miles 0 5 10 15 20 n

source: MMCD records, 1974.

john and michele genereux



number of sites per square mile:

0 - 10

10 - 25

25 - 50

>50

source: m m c d records, 1974.

figure VIII.

density of breeding sites

miles 0 5 10 15 20 n

john and michele genereux

One notes the density of breeding sites in Anoka County, northern and southwestern Hennepin County and northern Washington County. Conversely, the density of breeding sites is proportionately low in Dakota and southern Washington Counties as well as within the city limits of Minneapolis and St. Paul.

In total area, Type III sites represent a smaller proportion of breeding sites (1.3%) than Types I and II. Combined, the latter cover approximately 14.5% of the six county area. These sites average about 4.10 acres in size (the median is 3.6 acres). Type III sites are generally larger, averaging 11.00 acres. An exception is noted in Anoka County where the size of each site is approximately double the average.

Breeding of C. perturbans is confined to vegetated areas (especially cattails) associated with shallow marshes and the perimeters of lakes. The female lays rafts of eggs on the water's surface. The larvae hatch and submerge to a depth of 6 inches to 2 feet and attach to the roots of marsh plants and there over-winter. This mosquito has one adult emergence per year occurring about mid-summer (Barr, 1958).

The vector of Western Equine Encephalitis, Culex tarsalis, normally breeds at low density in Type III sites (MMCD Records). Above average spring rainfall (e.g., 1975) saturates many low lying Type I sites which hold water longer than normal and become favorable C. tarsalis breeding areas. This results in high adult populations and can lead to encephalitis outbreaks. The vector of California Encephalitis breeds in tree holes and artificial containers such as tires and cans discarded in wooded areas (Barr, 1958).

Both Aedes vexans and C. perturbans have significant nuisance value. Both migrate from breeding sites and feed on mammals. Coquillettidia perturbans is a particularly avid biter of humans, a habit confined to evening hours and shadowy wooded areas. Culex tarsalis feeding is confined to birds in the early summer and mammals in the later summer (Tempelis, 1964). Due to normally low population levels it is not a significant pest mosquito.

MOSQUITO BREEDING SITES: WETLANDS

According to the U. S. Fish and Wildlife Service (Shaw and Fredine, 1971) there are twenty distinct categories of wetlands in the United States. Eight of these are known to the Twin Cities Metropolitan Area and total 265,000 acres.

Nationally, wetland sub-cateogries fall under four major classifications: Inland fresh areas; Coastal inland saline areas; Fresh areas and Coastal saline areas. Wetlands in the Twin Cities area are all inland fresh areas. In terms of mosquito breeding, the eight regional wetland categories can be reduced to three breeding area types according to their hydrology.

Using hydrologic characteristics as an identifying parameter, the three breeding site types are sorted as upland intermittent water sites (Types I and II) and those associated with shallow permanent or semi-permanent bodies of water (Type III marshes). The relationship between these site characteristics and those designated by the U. S. Fish and Wildlife Service are shown in Tables 5 and 6.

Hydrologically, both of the upland depression sites (Type I and II) are not connected to general and efficient surface drainage systems. They are impermeable, either permanently through pre-existing fine or clay materials, or through inwash of fines from local runoff (Type I), or temporarily through ground frost (Type II). Both Type I and Type II sites are perched. (Pfannkuch, 1976).

Type I and Type II sites are <u>not</u> marshes.

Type I sites are commonly referred to as potholes. They generally occur in open areas and vary in size from 0.01 to over 100 acres. These sites cyclically retain water and then dry out several times during the spring and summer, depending on soil moisture and rainfall. Water retention is generally directly related to impermeable surface conditions or proximity to temporarily high water tables. Type I sites are active mosquito production sites all during the summer season.

TABLE 5

CHARACTERISTICS AND COUNTY DISTRIBUTION OF REGIONAL WETLANDS

Wetland Type	General Characteristics	County Acreage (thousands)							
		Anoka	Carver	Dakota	Hennepin	Ramsey	Scott	Wash.	Total
(1) Seasonally flooded basins or flats (MMCD I)*	Most visible on agricultural land where cultivation removes the grass and weed cover. Soil is waterlogged during seasonal periods but is well drained during much of the growing season. Temporarily submerged shallow basins usually have no vegetation.								
(2) Inland fresh meadows (MMCD I)	Wet, grassy meadows where the soil is without standing water during the growing season but waterlogged within a few inches of its surface.	30	6	8	10	3	10	7	74
(3) Inland shallow fresh marshes[v] (MMCD I)	Usually waterlogged during the growing season, often covered with as much as six inches of water. Areas constantly fluctuate between wet and dry.	10	4	5	12	3	8	5	47
(4) Inland deep fresh marshes (MMCD III)	From a distance these areas appear as scattered clumps of cattails in open water. The soil is generally covered with six inches to 3 feet of water during the growing season. These areas attract diverse and productive plant and animal water-related species.	10	6	4	18	4	5	5	52

v This FWS category most closely describes MMCD Type I sites especially in terms of vegetation. MMCD Type I sites are not waterlogged, however, having lense-trapped water retention.

Table 5 (Continued)
Characteristics and County Distribution of Regional Wetlands

Wetland Type	General Characteristics	County Acreage (thousands) Anoka	Carver	Dakota	Hennepin	Ramsey	Scott	Wash.	Total
(5) Inland open fresh water (MMCD III)	Free of emergent vegetation, these areas have a water depth of less than 10 feet and are fringed by cattail, bullrush and burreed.	2.5	2	1.5	10	1.2	2	2	21.2
(6) Shrub swamps (MMCD III)	The soil here is usually waterlogged during the season and covered with up to six inches of water. The swamp condition is a relatively rapid stage of plant succession from wet to dry.	20	4	4	7	.8	8	12	55.8
(7) Wooded swamps (MMCD III)	Soil here is waterlogged to within a few inches of the surface during the growing period and often covered with up to a foot of water. Occur in the floodplains of the Minnesota and Mississippi Rivers in association with seasonal flooding.	4	1	3.5	1	-	1	1	11.5
(8) Wetland bogs (MMCD III)	Bogs in the region are various. The water pH is not as acidic as in the truer bogs of the north. A very few true tamarack bogs are found in Anoka County. Plant species of wetland bogs are usually found nowhere else.	2.5	-	-	-	-	-	1	3.5

*FWS and corresponding MMCD mosquito breeding classification of wetland sites. MMCD Type II do not readily approximate any FWS classification. They do occur in the wooded areas of wetland Types (1), (2) and (3) described in this table. Mosquito breeding areas designated by the MMCD are described fully in Table 6 of this text.

SOURCE: Shaw and Fredine, 1971 and MMCD Records, 1973.

TABLE 6

FLORA AND FAUNA COMMON TO FOUR MAJOR HABITAT GROUPS FOUND IN THE TWIN CITIES AREA AS CORRELATED TO MOSQUITO BREEDING SITES

Mosquito Breeding Type*	General Description	Habitat Group	Sub Group	Common Flora	Common Vertebrates
MMCD I	Open upland depressions intermittently containing water in response to precipitation and local run-off. The persistence of water in the site and conditions of mosquito breeding depend upon antecedent soil moisture and the magnitude of individual precipitation events.	Aquatic	Bogs	Smartweed, wild millet, panic grass, heath, sedges, reed canary grass, leatherleaf, labrador tea, cranberry, equisetums, sphagnum, and other mosses	Deer, songbirds, mice, moles, shrews, shorebirds before June, ducks and other water fowl.
		Forest	Floodplain^	Elm, ash, cottonwood, box elder, oaks, basswood, soft maple, willow, aspen, hackberry	Similar to wooded and shrub swamps
			Oak Savanna	Oaks, pines, aspen (seral), elm, basswood	Pheasant, deer, skunks, fox, and others similar to Upland Hardwoods

Table 6 (Continued)
Flora and Fauna Common to Four Major Habitat Groups Found in the Twin Cities Area as Correlated to Mosquito Breeding Sites

Mosquito Breeding Type*	General Description	Habitat Group	Sub Group	Common Flora	Common vertebrates
MMCD I		Grasslands	Prairie	Grasses, golden rods, asters, willows, misc. forbs	Ground squirrels, jack rabbit, pocket gophers, snakes, song-birds, Hungarian partridge, pheasant, raptors
MMCD II	Upland depressions the hydrology of which is dependent on ground frost conditions which impermeabilize the bottom of the depression. Active only once annually in response to spring snow melt and runoff.	Forest	Upland Hardwoods	Oaks, elm, bass-wood, maple, ash hornbeam, aspen birch, cherry, hickory, butter-nut, black wal-nut, hazelnut, nettles, june-berry	Fox, squirrels, raccoons, deer, snakes, salaman-ders, frogs, songbirds, raptors, ruffed grouse
MMCD III	** Directly connected with permanent bodies of more or less open water. Their hydrologic regime is mainly controlled by surface drainage and runoff pat-terns as well as the site's proximity and connection to the groundwater table.	Aquatic	Fish Lakes	Submergent: Elodea, Chara, Ceratophyllum, Eleorchis, Pota-mogeton. Emergent: bullrushes, cattails	Northern pike, walleye, large-mouth black bass, crappie, bluegill, green sunfish, black bullhead
			Shallow and Freeze-out Lakes	Similar to Fish Lakes (greater percentage of emergents)	Bullheads, frogs, salamanders, toads, newts, common water-snake, wood ducks, turtle, ducks, geese and swans (during migration) coots, loons, muskrats, beaver.

**Backwater marshes of fish lakes are usually shallow and choked with emergent vegetation. Runoff and fluctuation in lake levels result in hatching of mosquitos. When treated, these areas are designated "sensitive' and temephos is used in granule form.

Table 6 (Continued)
Flora and Fauna Common to Four Major Habitat Groups
Found in the Twin Cities Area as Correlated to
Mosquito Breeding Sites

Mosquito Breeding Type*	General Description	Habitat Group	Sub Group	Common Flora	Common Vertebrates
MMCD III		Aquatic	Wooded and shrub swamps	Alder, willow, dogwood, tamarack, white cedar, black spruce, red maple, black ash	Beaver, mink, raccoon, rabbits, woodcock, march songbirds, frogs, wood ducks, herons, deer, mice, shrews
		Wetlands	Permanent deep marshes (1-3 feet of water)	Similar to Shallow Lakes and Wooded and Shrub Swamps	Similar to Shallow Lakes and Wooded and Shrub Swamps
			Shallow Marshes and Wet Meadows	Grasses, rushes cattails, arrow-head, pickerel weed, rice cut grass, sedges, burr marigold, swamp marigold, skink cabbage, willows, mints	Waterfowl including diving and dabbling ducks, shorebirds, frogs, toads, salamanders, turtles, deer, pheasant, song-birds, muskrat, beaver, mice, shrews

*MMCD = Metropolitan Mosquito Control District Classification
FWS = Fish and Wildlife Classification (Table 1)

^These areas do not approximate exactly M.M.C.D. Type I Classifications as they are rarely treated under the normal mosquito control program. Approximately once annually, in times of normal seasonal flooding, backwaters flood minor depressions along river banks and stimulate development of mosquito eggs. These areas are treated as normal Aedes vexans sites, using temephos granule formulations.

SOURCE: MMCD Records, and Huff, D.E., 1976a.

Type II upland sites, on the other hand, are active as breeding areas only in the spring. The ability to retain water in these sites is a function of ground frost. The water held is snow melt. Type II sites are generally located in wooded areas where trapped snow and shade inhibit the spring time warming action of the sun. They are considered as woodland pools of intermittent water.

Type III breeding sites are directly connected with permanent (vegetated river backwashes; river flood reaches; and densely vegetated marshes connected to lakes) or semi-permanent bodies of water (cattail marshes which normally dry out in the late summer). These areas may be active breeding sites seasonally (flood areas) and are major sources of C. perturbans mosquitos; a species which cannot be chemically controlled in the immature stages.

The actual and relative density of breeding sites in the six county study area is shown in Figures V - VIII. Figures I - IV show generalized regional topographic, physiographic and hydrologic features which effect the density and distribution of breeding sites. The information in Tables 5 and 6 describe the characteristics of wetlands as identified by the U. S. Fish and Wildlife Service and the Metropolitan Mosquito Control District.

The micro-dynamics of mosquito breeding in a generalized portion of section 28, Louisville Township, Scott County is shown in Figure IX.

Photographs of several representative Type I potholes, Type II woodland pools and Type III intermittent marshes are included in the following pages.

Typical sites located within easy viewing distance from major metropolitan highways include those listed on the following pages.

Five categories of breeding sites are identified. MMCD Type I, II and III have been defined above. Two sub-categories are listed. Type IA, which involves roughly 10% of Type I breeding sites, has the tendency to retain water until July 1. A sub-category of Type III breeding sites (Type III A) has physical characteristics (e.g. stable water level; steep banks) which are not favorable for mosquito breeding. These sites are monitored by the District but are not treated.

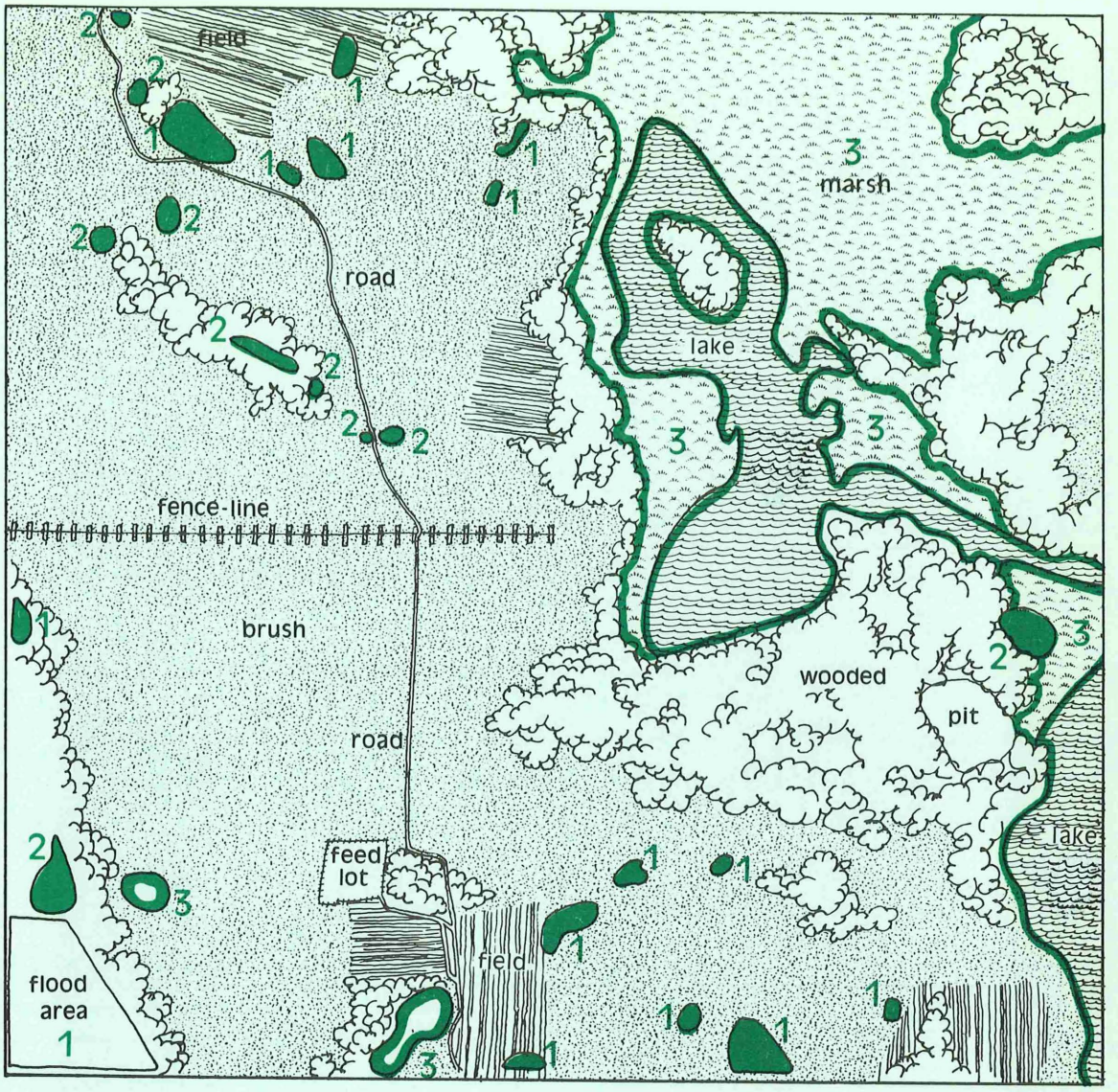


figure IX.

breeding site dispersal

typical area of Louisville Township, Scott County

1 intermittent site, rainfall dependent

2 snow melt site, spring only

3 permanent water sites, ground water dependent

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ANOKA COUNTY

TYPE I Intermittent Depression	Coon Rapids	100 ft. south of 121 Avenue on east side of Xeon St.
	Coon Rapids	S.W. corner at intersection Hwy. 242 and Round Lake Blvd. N. E. corner of electrical sub-station.
	Blaine	Raddison Rd., go 6 miles north of 105 Ave. on E side of road. (Also 0.1 mile S and across road from main bldg., Northern Asphalt Co.).
	Columbia Heights	N.W. corner of 46½ Ave. and Central Ave. Between Hwy and Spruce Road.
TYPE IA Intermittent Depressions Dry completely by July 1.	Coon Rapids	119th Ave. N.W. E. to Undercliff. N. one block to end of Undercliff. Site is 50 yds. N.W.
	Andover	N. side of Co. Rd. 116 - 0.3 mile W. of Co. Rd. 9. Site is across street from intersection of 30 St. and 12 Ave.
	Blaine	101 Ave., 250 ft. W. of intersection with Naples. Site on So. side of road.
	Fridley	N. W. corner 53 Ave. and Central Ave. Site is W. of Target store across parking lot road.
TYPE II Woodland Pools	Coon Rapids	11801 Xeon St. N.W. across from driveway 150 ft. N.E.
	Coon Rapids	Evergreen Blvd., 0.1 mile north of Co. Rd. 132 there is a trail. Go 0.1 mile on trail. Site is 25 yds N. of trail.

Type II Woodland Pools	Blaine	109 Ave. W. to Buchanan. So. to end of Buchanan. Site is 60 ft. S.W. in woods.
	Fridley	71 Ave., 0.1 mile E of Univ. Ave. service rd., Site is N. of Columbia Arena.
TYPE III Associated with Permanent Marshes	Coon Rapids	Olive St. NW and Hwy. 242, Site is on side of 242.
	Ramsey	Magnesium St. and Industrial Blvd. 200 ft. W. on S. side of Industrial Blvd. (Just west of driveway for 1140 Industrial Blvd.)
	Blaine	95 Ave.,0.1mile E. of Xylite Ave., site is on N. side of road.
	Lino Lakes (Centerville)	Co. Rd. 14 (Main St.) 0.3 mile N. of Mound Trail. Site is on both sides of road.
TYPE IIIA Associated with Permanent Marshes; Do not Breed Aedes Mosquitoes	Anoka	Green Haven Rd. to Green Haven Clubhouse-Left thru parking lot to overflow parking lot.
	Ramsey	Anoka Co. Rd. 57, 0.2 miles W. of Hwy 47. Site is 150 ft. N. of Road W. of driveway to KANO Radio Station.
	Columbia Heights	Between 40 Ave. and 42 Ave. 1 blk. E. of Central Ave. Site is E. of 41 Ave. and W. of Hartman Terrace.

DAKOTA COUNTY

TYPE I Intermittent Depression	Burnsville	Dakota Co. Rd. 42, 1.4 miles E. of I35W. Site is 25 ft. S. of the E. bound lane of Co.Rd.42.
	West St.Paul	Wentworth, 0.4 miles W. of S. Robert (Hwy 52). Site is 40 ft. N. of Wentworth on E. side of private driveway at 75 Wentworth.
	Inver Grove Heights	Bishop Ave. 0.1 mile So. of Hwy 110. Site is 50 ft. S. of intersection of Bishop Avenue and 53 St.
	Eagan	N.W. corner of intersection of Cliff Rd. (Co.Rd. 32) and Cedar Ave. (Co.Rd.23).
TYPE IA Intermittent Depressions Dry Completely by July 1	Burnsville	Dakota Co. Rd. 42 1.9 miles E. of I35W. Site is 50 ft. S. of the S. bound lane of Co.Rd. 42.
	West St.Paul	Wentworth 0.35 mile W. of S. Robert (Hwy 52). Site is 30 ft. S. of Wentworth W. of driveway at 59 Wentworth.
	Rosemount	Bacardi Ave., 0.25 miles N.of Dakota Co. Rd. 38. Site one side of Bacardi.
	Apple Valley	W. on Dakota Cty. Rd. 38 (125th St.W.) to entrance of Lebanon Hills Golf Course. 0.15 miles N. on entrance rd. Site is W. of entrance rd.

TYPE II Woodland Pools	Burnsville	Garden View Dr. and Palomino Dr. (Co.Rd.38) (0.4 mile W. of Co.Rd.11) Site is 150 ft N. of intersection in a wooded area.
	West St.Paul	Humboldt Ave. S. to entrance of Marthaler Park. Site is o.1 mile W. of main parking lot at end of a cleared trail off N. side of the blacktop trail.
	Rosemount	Dakota Co. Rd. 38 (125 St.) 0.7 mile E. of Dakota Co. Rd. 31 (Pilot Knob Rd.). Site is 30 ft. S. of Co. Rd. 38 in a wooded area.
	Eagan	Dakota Co. Rd. 32 (Cliff Rd.) and Black Hawk Rd. Site is 100 ft. S. on intersection in a wooded area.
TYPE III	Burnsville	Dakota Co. Rd. 11 and High Drive. Site is 250 ft. N.W. of intersection.
	West St.Paul	Runge La. and Galvin Ave. is 20 ft. S. of intersection at N.E. corner of Weschcke Park.
	Inver Grove Heights	Minn. Hwy. 3, 0.3 mile W. of Dakota Co.Rd.71. Site is 100 ft S. of Hwy 3.
	Inver Grove Heights	Minn. Hwy. 55 and College Trial, E. to main entrance of Inver Hills Jr. College. 0.2 miles N. on entrance rd. Site is 40 ft on entrance road.

TYPE IIIA Associated with Permanent Marshes; Do not Breed *Aedes* Mosquitos	Burnsville	Kennelly Road, 1.0 mile S. of Cliff. Site is on E. side of road.
	West St.Paul	Humboldt, 0.2 mile S. of Wentworth. Site is 40 ft. W. of Humboldt in Marthalen Park.
	Rosemount	Corner of 129 Way and 130 St.W., 0.6 miles E. of Minn. Hwy.3. Site is 30ft. E. of corner.
	Eagan	Galaxie Ave. 0.15 mile N. of 127 St. W. Site is 150 ft W. of Galaxie Ave.
HENNEPIN COUNTY		
TYPE I Intermittent Depression	New Hope	45 Ave. N. 50 ft. W. of Winnetka Ave.(road-side ditch).
	Golden Valley	Minn. Hwy. 100 and Glen-wood Ave. Site is 200 ft S. on service road on SW side.
	Richfield	66 St. and 21 Ave. Site is 500 ft. S.E. of inter-section.
	Edina	Henn. Co. Rd. 18, 0.2 miles S of 5 St. Site is on E. side of Co. Rd. 18.
TYPE IA Intermittent Depressions Dry Completely by July 1	New Hope	Henn. Co. Rd. 18 and Co. Rd. 9. Site is 100 ft. N of Co. Rd. 9. Exit on Co. Rd. 18 in SE triangle of cloverleaf.

TYPE IA Intermittent Depressions dry completely by July 1.	Crystal	Valley Place and Jersey Ave. Site is 200 ft. S.E. of intersection bordering a city park.
	Edina	73 St., W. of Ohms Lane, Site is 150 ft. W of Culdusac.
	Minnetonka	1/4 mile E. of Ridgedale Shopping Center, S. of Hwy. 12.
TYPE II Woodland Pools	Crystal	Site is E. of Hamshire, W. of Florida, N. of 32 Ave., S. of 34 Ave.
	Golden Valley	Theodore Wirth Parkway, 100 ft. S. of Mn. Hwy. 55. Site is 50 ft. W. of Parkway
	Minnetonka	Oakland Rd. 0.25 mile N. of Essex Rd. Site is on NE side of Oakland Rd.
	Minnetonka	Henn. Co. Rd. 73 and Henn. Co. Rd. 16. Site is 100 Ft. NW of corner.
TYPE III Associated with Permanent Marshes	Brooklyn Center	Xerxes and 69 Ave. N. Site is marshland surrounding Palmer Lake.
	Brooklyn Park	Brookdale Dr., 0.3 mile E. of Xerxes Ave. N. Site is 150 ft N. of Brookdale Dr.
	Orono	U. S. Hwy. 12 and Old Crystal Bay Road. Site is 1/3 mile W of intersection.
	Bloomington	France Ave. and 90 Avenue site is 0.25 mile S.E. of intersection.
TYPE IIIA Associated with Permanent Marshes; Do not breed Aedes mosquitos	Golden Valley	Minn. Hwy. 55 between Boone Ave. and Winetka Ave. Site is 150 feet S. of Hwy. 55

TYPE IIIA Associated with Permanent Marshes; Do not breed *Aedes* mosquitos	New Hope	Winetka Ave, 200 ft. N. of Bass Lake Rd. Site is 50 feet W. of Winetka.
	Minnetonka	Co. Rd. 16, 0.2 mi. W. of Co. Rd. 18 and Railroad Tracks. Site is 0.3 Mi. S of Co. Rd. 16, behind Braemar Apartment Complex.
	Bloomington	W. 94th St. and Nesbit Ave. Site is 200 ft. E. of St. Edwards Church.
RAMSEY COUNTY		
TYPE I Intermittent Depression	Arden Hills	Hamline Ave. and Mn. Hwy. 96. Site is on SE corner of intersection.
	Arden Hills	Lake Johanna Blvd. 100 ft. W. of Old Hwy. 10. Site is on N. side of road.
	Roseville	Cleveland Ave. 400 ft. S. of Roselawn Ave. Site is on E. side of Cleveland.
	Maplewood	Ramsey Co. Rd. B. and Kenard Ave. Site is on SW corner.
TYPE IA Intermittent Depression dry completely by July 1.	Arden Hills	Red Fox Rd, 600 ft. W. of Lexington Ave. Site is 100 ft. N. of Red Fox Rd.
	Shoreview	Reiling Lane, 100 ft. S. Snail Lake Blvd.
	Shoreview	Arborgast St., 600 Ft. W. of Victoria Ave. Site is on S. side of street.
	Shoreview	Ramsey Co. Rd. E., 300 ft. W. of Kent St. Site is on N. side of Co. Rd. E.

TYPE II Woodland Pools	Vadnais Heights	McMenemy Road, 0.1 mi. S. of Hwy. 96 Site is on W. side of road.
	Shoreview	Baldwin Lake Rd. 200 ft. S.E. of Co. Rd. J.
	Shoreview	E. on Island Lake Rd. from Lexington Ave. to Milton Ave. site is 600 ft. end of Milton Ave.
	Shoreview	Lexington Ave. 0.1 mile N. of Co. Rd. I. Site is on the E. side of Lexington.
TYPE III Associated with Permanent Marshes	Arden Hills	Ramsey Co. Rd. F, 400 ft. W. of Lexington Ave. site is on N. side of Co. Rd. F.
	Roseville	Intersection of Cleveland Ave. and Roselawn Ave. Site is on SE corner.
	North Oaks	Birch Lake Blvd., 0.04 mi. N.W. of Centerville Rd. Site is on E. side of Birch Lake Blvd.
	North Oaks	Intersection of Rice St. and Hwy. 96. Site is on N.E. corner.
TYPE IIIA Associated with Permanent Marshes; Do not breed *Aedes* mosquitos.	White Bear	Centerville Rd., 100 ft. N of Hwy. 96. Site is on W. side of rd.
	White Bear	Hwy. 96, 0.2 mi. W. of Centerville Rd. Site is on N. side of Hwy. 96.
	Vadnais Heights	Hwy. 96, 0.2 mi. W. of Centerville Rd. Site is on S. side of Hwy. 96.
	Roseville	Intersection of Roselawn Ave. and Cleveland Ave. Site is on NW corner of intersection.

SCOTT COUNTY

TYPE I Intermittent Depression	*Eden Prairie	Eden Prairie Rd. 0.3 mile S. of U. S. Hwy. 169. To a field road 0.2 mi. W. on the field rd. Site is 300 ft. N. of the field rd.
	*Eden Prairie	Intersection I494 and U.S. Hwy. 169. Site is on N.E. corner, E. of billboard.
	*Eden Prairie	Intersection Mn. Hwy. 101 and Lotus View Dr. Site is on SE corner of intersection.
	*Eden Prairie	Entrance to camp frontier, 0.2 mile E. from Mn. Hwy. 101. Site is 320 ft. N. of Camp Flag Pole.
TYPE IA Intermittent Depressions Dry Completely by July 1.	Glendale	Intersection Scott Co. Rd. 16 and Scott Co. Rd. 27. Site is 100 ft. N. of intersection.
	Glendale	Scott Co. Rd. 16, 0.1 mi. E. of Minn. Hwy. 13. Site is 40 ft. N. of Co. Rd. 16 between 2 private driveways.
	Glendale	Trost Road 0.65 mi. S. of Scott Co. Rd. 16. Site is 40 ft. E. of Trost Road under power line.
	Glendale	Intersection of Scott Co. Rd. 42 and Scott Co. Rd. 27. Site is on S.E. corner of intersection.
TYPE II Woodland Pools	St. Lawrence	Quarry Campground Rd. to campsite A-38, 0.1 mi. N of Scott Co. Rd. 57. Site is 135 ft. E. on parking lot rd., then 50 ft. N. in a wooded area.

*This is in Hennepin County but under Scott County jurisdiction for mosquito control.

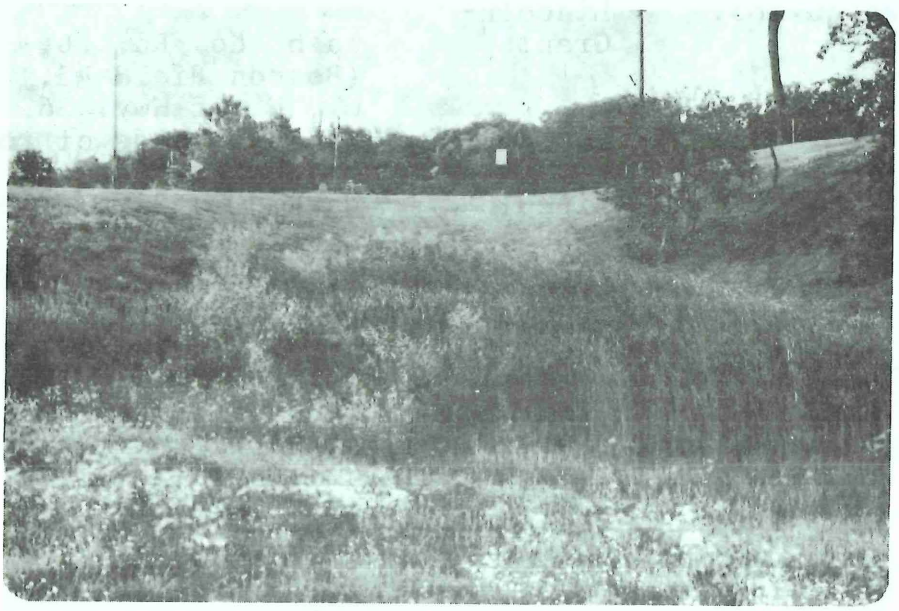
TYPE II Woodland Pools	Sand Creek	Scott Co. Rd. 8, 1.4 mile E of Minn. Hwy. 21, 0.7 mi N. on the Township Rd. Site is 50 ft. E. of road in a wooded area.
	Sand Creek	Scott Co. Rd. 8, 0.9 mi. E. of Mn. Hwy. 21. Site is 30 ft. N. of Co. Rd. 8, directly N. of Chesopeak Bay Dog Kennel.
	Sand Creek	Scott Co. Rd. 8, 0.4 mile N. on a private driveway, 20 ft. N. of driveway.
TYPE III Associated with Permanent Marshes	Spring Lake	Northwood Rd., 0.4 mi. N.E. of Scott Co. Rd. 12. Site is N. of Northwood Rd.
	Eagle Creek	Scott Co. Rd. 83, 0.6 mi. S. of Scott Co. Rd. 42. Site is E. of Co. Rd. 83.
	Eagle Creek	Scott Co. Rd. 25, 0.9 Mi. N.E. of Mn. Hwy. 101. Site is W. of Co. Rd. 25.
	Eagle Creek	Ridgemont Ave. N. E., 0.4 mile N. of Mn. Hwy. 13. Site is 30 ft. W. of Ridgemont Ave.
TYPE IIIA Associated with Permanent Marshes; Do not breed Aedes mosquitos	Spring Lake	Northwood Rd., 0.2 mi. N.E. of Scott Co. Rd. 12. Site is 300 ft. E. of Northwood Rd.
	Spring Lake	Scott Co. Rd. 23, 0.5 mi. S. of Minn. Hwy. 13. Site is W. of Co. Rd. 23.
	Eagle Creek	Pike Lake Trail, 0.5 mi. S of Scott Co. Rd. 42. Site is 0.3 mile S. on a private road.

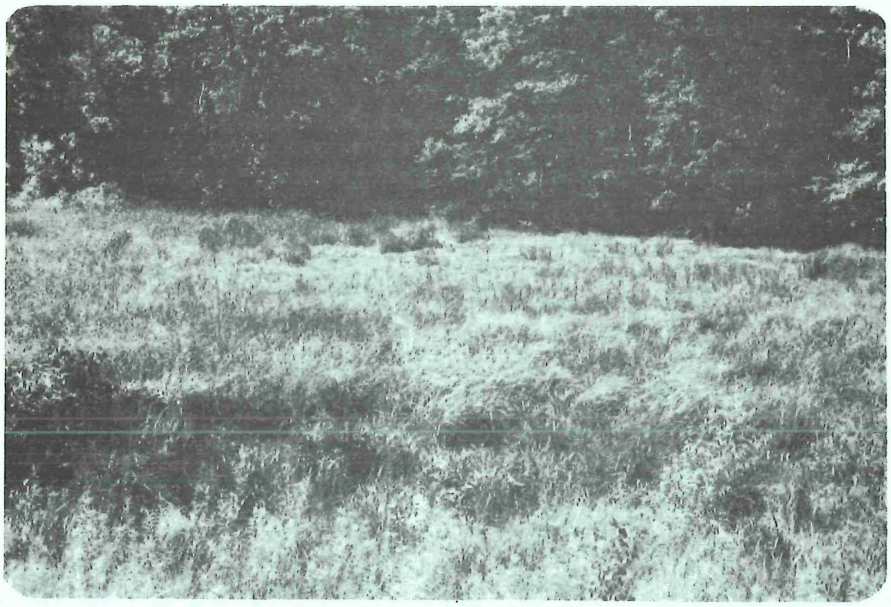
TYPE IIIA Associated with Permanent Marshes; Do not breed mosquitos	Eagle Creek	Scott Co. Rd. 42, 0.4 mi. W. of Scott Co. Rd. 21. Site is S. of Co. Rd. 42.
WASHINGTON COUNTY		
TYPE I Intermittent Depression	Lincoln-Grant	Quail Rd. S. of Hwy. 96. Site is in ditch on E. side of Quail N. of 2nd Driveway from Hwy. 96.
	Lincoln-Grant	60 St. N., 0.7 mi. E. of Hwy. 120. Site is N.W. of open water that road curve around, and 120 ft from fence.
	Lincoln-Grant	Hwy. 96, 200 ft. E. of Hwy. 244. Site is on S. side of Hwy. 96.
	Lincoln-Grant	Hwy. 244, 0.25 mi. E. of Hwy. 120. Site is on N. side of Rd. N. of cotton-wood tree.
TYPE IA Intermittent Depressions Dry Completely by July 1,	Lincoln Grant	Hwy. 96, 200 ft. E. of Hwy. 244. Site is on N. side of Hwy. 96.
	Oakdale	Stillwater Blvd. Site is on S. side of Rd. across from addresses 6408 and 6424.
	Oakdale	Stillwater Blvd. Site is in front of house at 6180, 150 ft. from road.
	Lincoln-Grant	Hwy. 244 0.1 mile E. of Hwy. 120. Site is at SE corner of Wildwood Shopping Center parking lot.

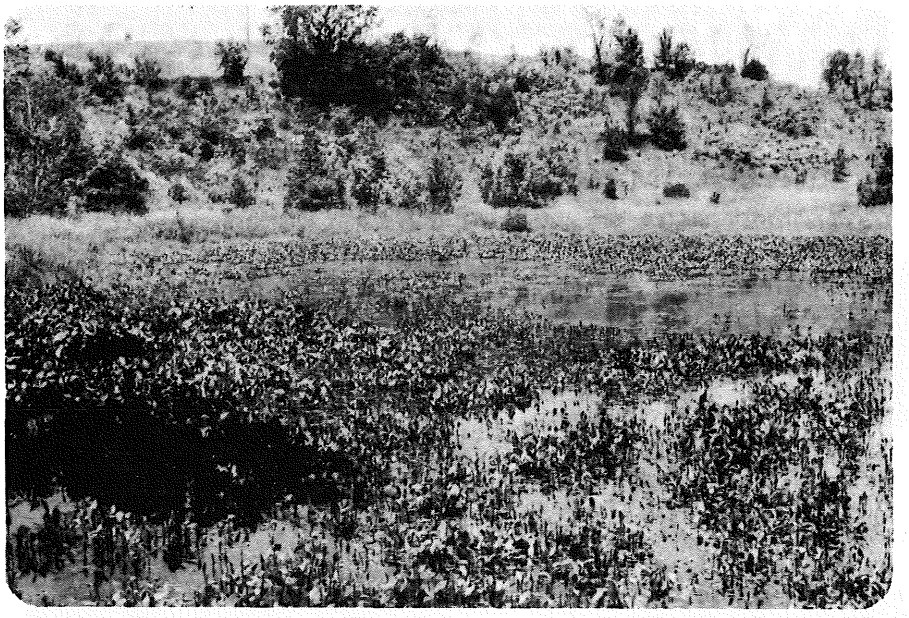
TYPE II Woodland Pools	Oakdale	Demontreville Trail, 0.1 mi. S. of Hwy. 36. Site is on E. side of road, near woods.
	Oakdale	Demontreville Trail, 0.2 mi. S. of Hwy. 36. Site is on N. side of Rd. just as road turns W. 90°.
	Oakdale	Demontreville Trail, 1.4 mi. S. of Hwy. 36. Site is hidden in woods 300 ft. from rd.
	Oakdale	Hidden Bay Trail, 0.7 mi. E. of Wash. Co. Rd. 13. To driveway on left. At end of driveway path goes right. 50 yards to fallen tree. Site is 50 ft. N.
TYPE III Associated with Permanent Marshes	Lincoln-Grant	Hwy. 244, 0.1 mi. of Penninsula Rd. Site is W. of Hwy. 244, on N.E. corner of White Bear Lake.
	Lincoln-Grant	Hwy. 36, 0.7 Mi. E. of Co. Rd. 36 (Beacon Field Rd.) Site is N of Hwy. 36 along service rd.
	Oakdale	Hidden Bay Trail and Co. Rd. 13. Site is on E. side of Hidden Bay Trail, 300 ft. N. of Deer Pond Trail.
	Lincoln-Grant	Quail Rd, 0.5 mi. S. of Hwy. 96. Site is on W. side of road at intersection of Quail and Laurel.
TYPE IIIA Associated with Permanent Marshes; Do not breed Aedes mosquitos.	Lincoln-Grant	Wash. Co. Rd. 9, 0.3 mi. N. of Hwy. 96. Site is 300 ft. from W. side of road.

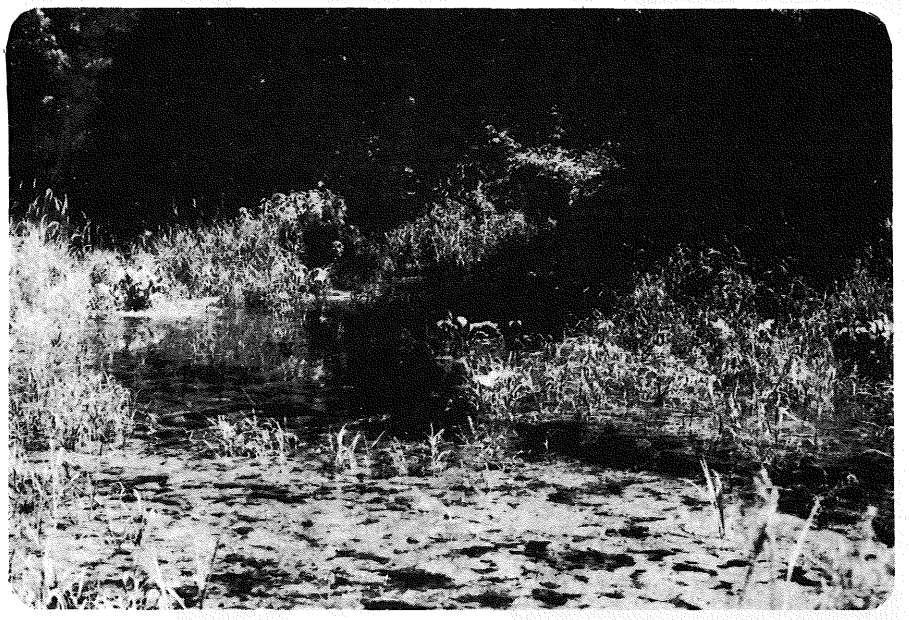
TYPE IIIA Associated with Permanent Marshes; Do not breed aedes mosquitos.	Lincoln-Grant	Wash. Co. Rd. 36, 0.6 mi. N. of Mn. Hwy. 36. Site is on E. side of Road.
	Lincoln-Grant	Wash. Co. Rd. 36, (Beacon Field Rd.) 0.2 mi. N. of Hwy. 36. Site is on W. side of road.
	Lincoln-Grant	Wash. Co. Rd. 36(Beacon Field Rd.) 0.2 mi. N. of Hwy. 36. Site is on E. side of Road.

MMCD TYPE I SITES



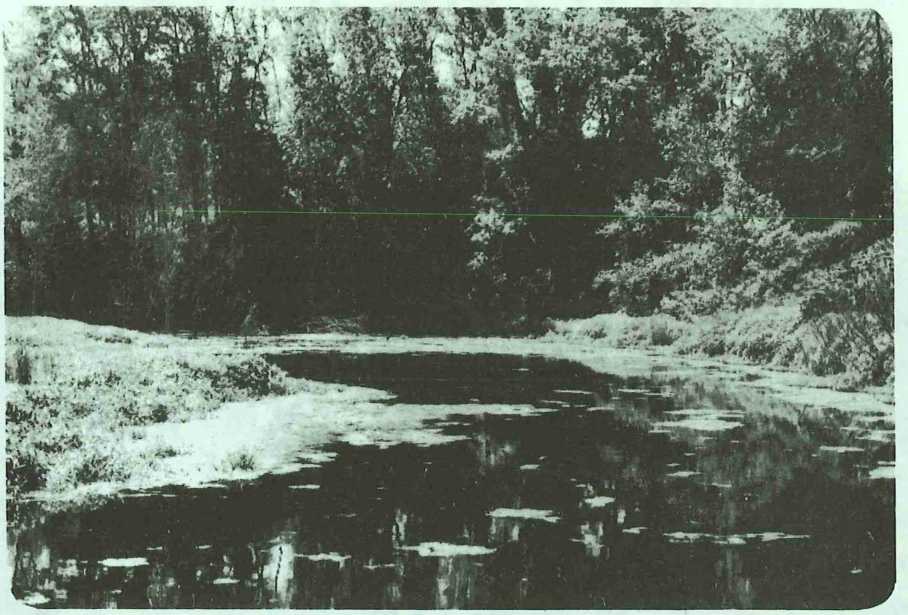






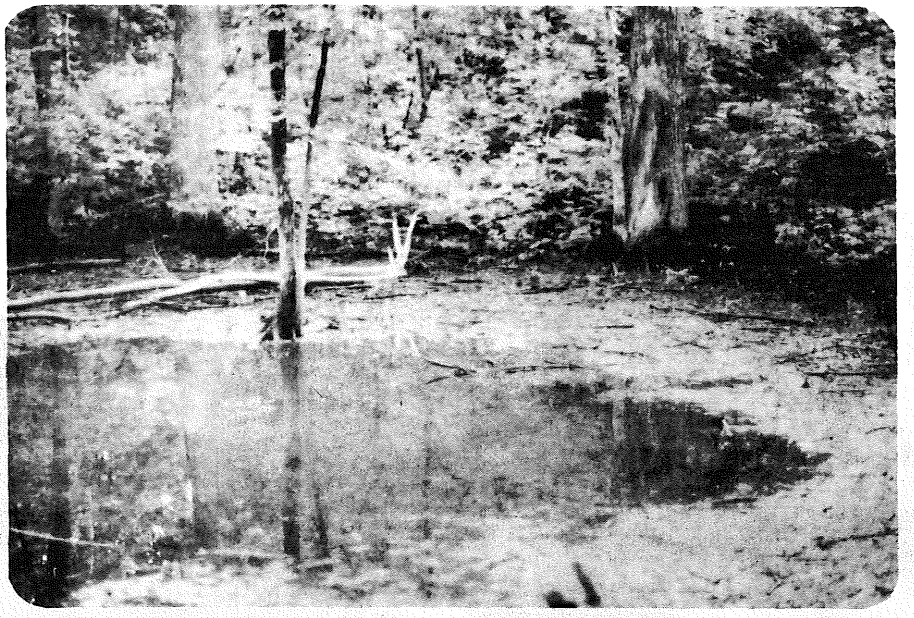
- pothole depression
- retain intermittent runoff
- average size in MMCD 4 acres
- breed multivoltine Aedes species

MMCD TYPE IA SITES



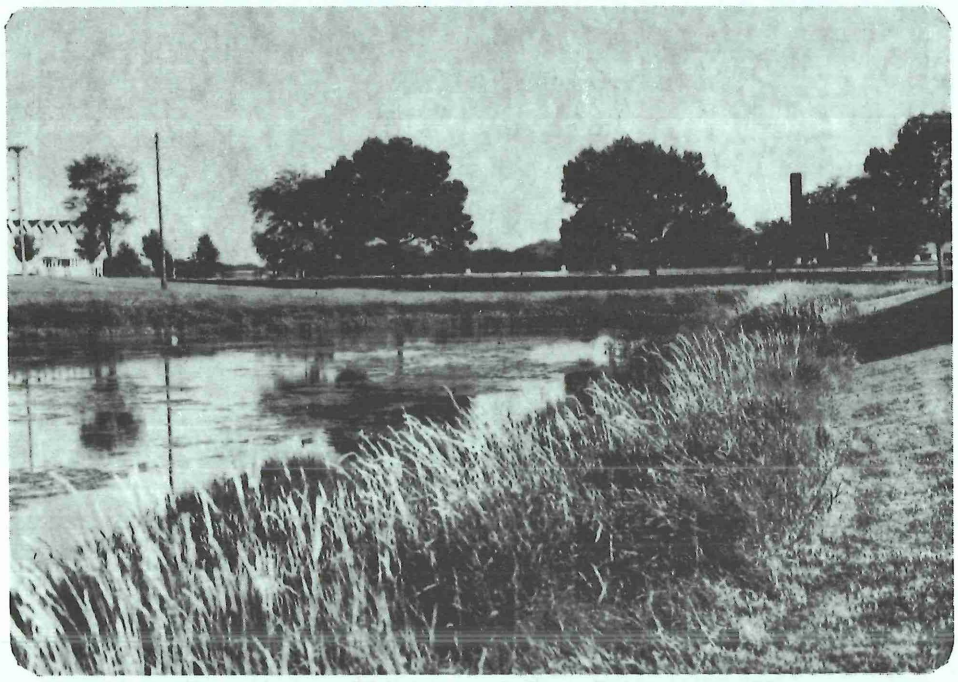
- normally retain water until July 1, then intermittently for the balance of the season
- 10% of MMCD Type I breeding sites

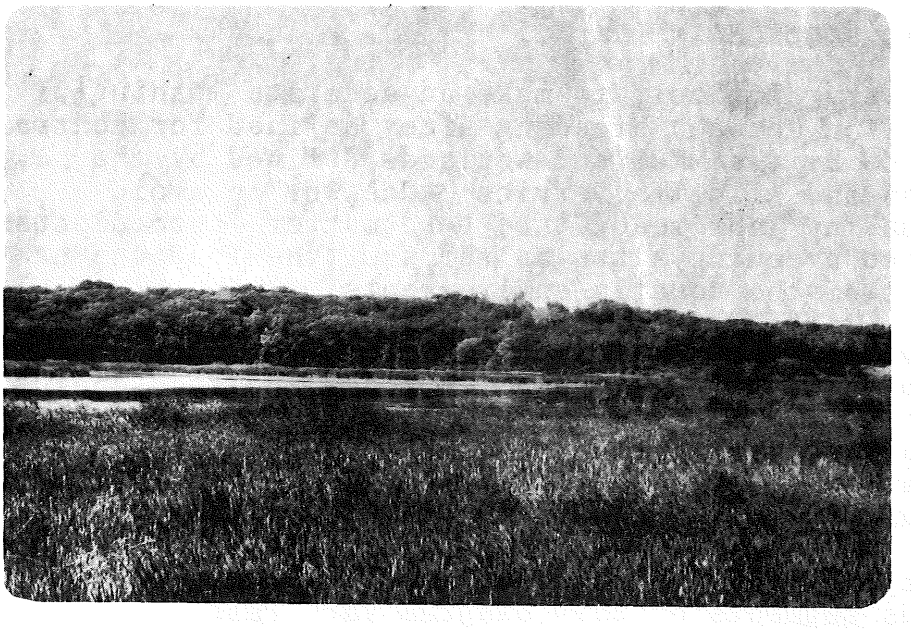
MMCD TYPE II SITES



- woodland pools
- active once per season in early spring, dependent on snowmelt
- average size in MMCD .75 acres
- breed univoltine Aedes species

MMCD TYPE III SITES





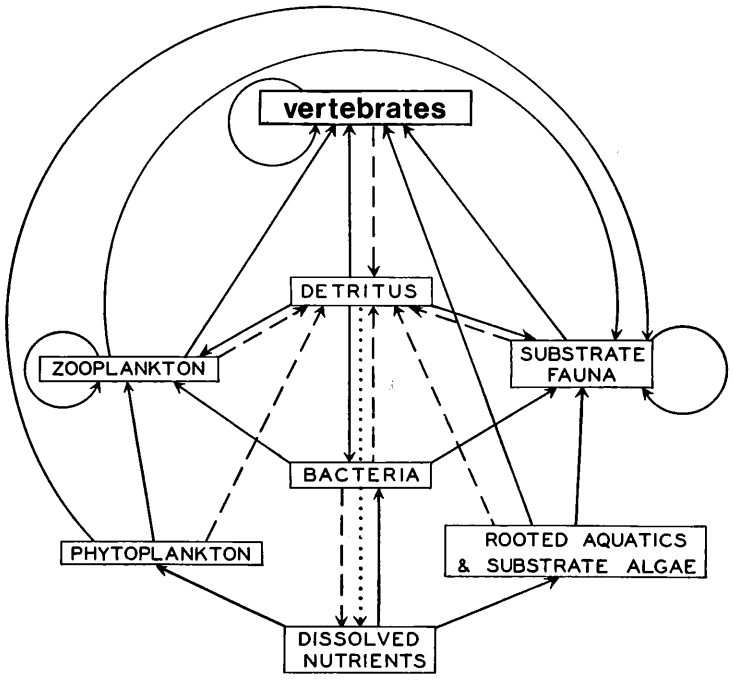
- shallow marshes associated with permanent water
- average size in MMCD 11 acres
- breed multivoltine Aedes and Coq. perturbans (cattail marshes)

WETLAND FOOD CHAIN

It is very difficult to make an accurate meaningful comparison between breeding sites defined for control purposes by the MMCD and wetlands defined by the US Fish and Wildlife Service. One way to avoid compounding an already ambiguous matter is to discuss mosquito breeding sites in terms of the food chain habitat of the aquatic environments.

"...even in the simplest aquatic habitats the determination of pyramids of numbers and food chains (or better, "food webs") is an involved problem, and only a very few thorough and inclusive studies have been attempted. In a schematic fashion the following diagram shows the fundamental food interrelationships of any aquatic habitat, regardless of size and complexity. The significance of the role played by various segments of this diagram vary (sic) enormously from one habitat to another."(Pennak, R. 1953).

AQUATIC FOOD WEB



SOURCE: Adapted from R. W. Pennak, 1953.

The listings in Table 6(previous section) are limited to common flora and vertebrates of wetland habitats in the Twin Cities. The diversity and density of invertebrate fauna is dependent upon nutrient levels present in the site. The nutrient availability in natural aquatic habitats increases in proportion to the rate of bacterial decomposition of organic matter. This process is accelerated as water margins fluctuate and oxygen stimulates aerobic bacterial action.

Contrary to popular belief, "...stability of water levels means a lake - type ecosystem which may be productive of fish but not conducive to marsh birds and muskrats. The usual product of stability is a centrally open marsh with a perimeter of dense cattail or other robust emergent vegetation that is generally low in productivity of vertebrate and invertebrates life ... ...a static marsh cannot be considered either a logical or desireable goal when managing for diversity or productivity." (Weller and Fredrickson, 1973).

Maximum diversity and complexity of aquatic habitat is associated with temporary and seasonal wetlands. As described by Swanson, et al. (1974) and Serie and Swanson (1976), these wetlands are presented as wetland basins ranging in size from 2.5 to 250 acres. Most areas studied by the authors had water depth of less than 30 inches. A few were in excess of 75 inches.

Swanson (1974) describes these wetlands as "knob-and-kettle topography with closely spaced knolls alternating with water - filled depressions." The invertebrate fauna identified by Swanson et al. (1974) correspond closely to those found in Type III wetland sites as designated by the MMCD and named in Table 6.

MMCD III sites in the metropolitan area are very like Swansons's seasonal wetlands and share the following characteristics:

they usually contain water year-round but dry out during periods of below normal precipitation;

they contain species of submerged aquatic and vascular plants and deep-marsh emergent plants;

invertebrate fauna vary from site to site and are dependent on site-specific nutrient levels and physical characteristics.

MMCD III marshes support the most diverse aquatic food web in the Twin Cities area. The key to productive capability is three-fold:

1. permanence of water within the marsh;
2. Broad shallow margins along the shoreline;
3. water fluctuation at the margins.

The absence of permanent water restricts development of diverse fauna. The diversity of organisms which develop in intermittent water sites (MMCD I and MMCD II) and their relative densities are determined by other less predictable factors: (Pennak, 1953).

1. temperature
2. light
3. volume and duration of water in the site
4. nutrient levels

Shallow-bottom sites of this type are conducive to retention of runoff and related spring snow melt. Dark organic surface materials absorb heat and stimulate melting. Warm temperatures and strong light in open spaces prompt development of early emerging invertebrate forms. Crustacea, mosquitos and several species of water beetle hatch from drought-resistant eggs when ambient temperatures approximate 45^{o}F.

These are the only invertebrate groups which develop in these habitats in the early spring. Other invertebrate forms require water in the fall and winter to survive from one year to the next. Intermittent water sites are dry during these seasons. When the water and air temperature of permanent water sites warm to about 60^{o}F (usually in early May) adult forms of the insects which have over-wintered begin to fly and populate intermittent water sites. Eggs are laid and a first generation of insects emerges (4-6 weeks). The sites normally dry out before a second generation develops (July 1).

As the sites dry out, adverse conditions force adult forms of insects from the first generation to disperse to other water sites. Consequently, invertebrate densities achieved in intermittent water sites rarely exceed 25% of the experienced in the seasonal wetland areas (marshes) described by Swanson.

Intermittent water sites are alternately wet and dry from early April to freezing. The duration and frequency of wet cycles depends upon the frequency, intensity and volume of rainfall. There are usually five to seven rains during the summer which are sufficient to fill breeding sites for the seven days required for complete mosquito development.

Zooplankton, and mosquitos are the only frequent permanent inhabitants of intermittent water sites. These organisms complete their life cycles within the span of a normal wet period. Their eggs survive dry spells.

Egg density of mosquitos and water beetles at any one site during the season is conditioned, however, by the mobility of adult forms.

Crustaceans would serve as the best biological indicator species in intermittent water sites. No one species is a prime indicator of marsh life in Type III permanent water sites. The diversity of insect species is the best indication of the viability of marsh habitat.

During the last eighteen months, the Metropolitan Mosquito Control District has conducted a study to identify non-mosquito insect species in Type III marsh breeding sites. Analysis of the data has yet to be completed on this research project. Nonetheless, preliminary data is available for these sites. Summary findings for one representative site are shown in table 7.

Maximum insect diversity of this site was recorded in June. Seven of 27 orders of insects were recorded. Forty-two distinct species were found distributed as follows:

Ephemeroptera	1	Coleoptera	12
Zygoptera	3	Diptera	13
Anisoptera	5	Tricoptera	2
Hemiptera	6		

TABLE 7

PRELIMINARY SUMMARY DATA: INSECT COLUMN SAMPLE FOR A MMCD TYPE III MARSH SITE 1975 - 1976.

Date	No. Sp.	No. Individuals Immature	Adult	Total No. Sp.	Average Number Individuals Immature	Adult
4-21-76	17	201	8	17	201	8
5-05-76	20	179	11	32	164	13
5-19-76	24	149	15			
6-12-75	24	765	8	42	715	8
6-26-75	30	665	8			
7-10-75	22	313	1	33	175	6
7-24-75	18	36	11			
8-07-75	30	150	35	42	142	24
8-21-75	24	133	12			
9-04-75	21	252	16	26	171	11
9-18-75	12	90	6			
10-02-75	19	226	9	25	196	6
10-16-75	16	167	3			

Source: MMCD Records, 1977

NATURAL MOSQUITO CONTROL AGENTS

As noted above, mosquito eggs are induced to hatch when rising water levels cover them. The water must remain for the seven days required for development or the immature mosquitos become stranded and die before adult emergence.

Once hatched, the immature mosquito in the water, and the adult mosquito on land are subject to coexisting natural predators. The survival and development of many of these natural enemies is also influenced by water fluctuations. Aquatic natural enemies rarely occur in temporary water Type I sites due to the long development period required for most predators. They rarely occur in densities sufficient to substantially reduce spring Aedes mosquitos in Type II sites, due to the cold water and the fact that the sites are dry in the fall, preventing over-wintering.

Since natural predator populations re-establish themselves in temporary water sites at a slower rate than mosquitos, natural mosquito control has not been dependable. Nonetheless, it is estimated that two-thirds of the Metropolitan marsh habitats are capable of supporting food chains necessary for the survival of natural enemy complexes.

Naturally occurring aquatic predators include varieties of backswimmers (Notonectidae), water beetles(Dytiscidae, Gyrinidae, Hydrophilidae), true water bugs (Belostomatidae), flatworms (planaria), fresh water polyps (hydra) and damselfly (Zygoptera) and dragonfly nymphs (Anisoptera) in the order Odonata. Type III breeding sites, which rarely go dry, are sites most suited to control by aquatic predators.

The impact of natural enemies upon adult mosquitos has not been critically studied and is thus difficult to predict. The MMCD is currently preparing an inventory of aquatic predators in the Twin Cities. Near Type III sites, damselflies are believed to exert the greatest natural control among insect predators. These insects occur primarily around aquatic habitats where nutrient levels are sufficient to support other aquatic predators as well, which tends to reduce immature mosquito survival and thus diminish the impact of mature damselflies on adult mosquitos.

As an adult mosquito predator, the adult dragonfly has been reported (Hodson, 1976) to markedly reduce mosquito populations in localized areas. During the period immediately following synchronous emergences of dragonfly adults from lakes or other bodies of water supporting high nymphal populations, good control

may occur with certain species due to the adult dragonflies' territorial flight behavior. As such emergences occur only once or twice each year, the duration of notable control may be confined to the 1-3 week period of maximum dragonfly density following emergence and prior to adult dispersal.

The impact of insectivorous birds upon mosquito populations varies with mosquito density. Most birds prefer to feed on larger bodied insects and thus mosquitos are a smaller part of their diet when other food is available. The swallow family which includes the purple martin (Progne subis) is a reported mosquito predator. Its effectiveness as a control agent is limited by the flight behavior of the mosquito as well as its size. Few mosquitos fly before sundown and few birds feed at night.

Beal (1918) reported his analysis of the stomach contents of 205 purple martins. He found no mosquitos in any of the stomachs. Johnston (1967) substantiates this finding. In his study seven birds out of a sample of 34 had 3% Culicine mosquitos in their stomachs. All seven had been collected in April. In both studies, insects found in the stomachs were larger bodied than mosquitos.

Flight behavior of both the mosquito and the purple martin probably accounts for the lack of mosquitos in the bird's diet. Martins are active from shortly after dawn until shortly before dusk, whereas most mosquitos spend the day resting in vegetation close to the ground. In addition, mosquitos seldom fly above the tree canopy which is the purple martin's feeding ground. Thus mosquitos would only be available to the purple martin for brief periods before sunrise and after sunset, if the bird happens to be feeding near the ground (Kale, 1968).

Bats, like insectivorous birds, have been considered as predators of adult mosquitos. Howard (1922) quotes a Mr. Seiss who dissected one common brown bat from near Philadelphia and found its stomach "full of mosquitos". In 1925, C.A.R. Campbell stated, "the bat...relentlessly destroys the malarial mosquito, that insect being its natural and principal food". Dr. Campbell went to the extent of building numerous artificial bat roosts. Of these, one was inhabited by a highly gregarious species, Tadarida mexicana.

Other investigators studied this roost and its bats and came to the opposite conclusion.

Storer (1926) examined microscopically the droppings which accumulate at the bottom of the roost and found mosquitos to be a negligible part of the diet. Micro-moths, 5-9 mm in length, made up 90-95% of the diet. Others have come to the same conclusion from dissection of bats and examination of droppings. Nelson (1926) points out that even in localities where bats are numerous, mosquitos may also be plentiful.

A study of a different genus, Eptesicus produced similar results: 76% of stomach contents were beetles, wasps, flying ants and various flies; 0% were mosquitos (Hamilton, 1932).

According to a discussion in Mohr (1976), bats take prey of a size range in relation to their own size. The larger bats, with larger mouths, take the insects of larger size. In addition, the above mentioned bat species are active late at night while moths are flying, whereas mosquitos are not (Knight and Henderson, 1967). And finally, bats fly at higher altitudes than mosquitos which tend to stay below tree top level, except during dispersal flights.

Of the indigenous bat species of Minnesota, there are three species smaller than Eptesicus fuscus, a genus mentioned above that does not feed on mosquitos. Even our smallest bat, Pipistrellus subflavas, avoids mosquitos. Ross (1967) found their diet to consist of Cicadellidae (leafhoppers) (80%) and Formicidae (flying ants) (20%). In a earlier study Sherman (1939) found they ate Anthomyiidae (flower flies) and Formicinae (reproductive flying ants). As can be seen in the above example, all of the food items mentioned are larger bodied than mosquitos.

Provided bats did feed on mosquitos two more problems complicate their use as predators in an organized urban mosquito control program. First, few species are gregarious or willing to vacate old roosts for man made roosts. And, probably more important, bats are known to transmit rabies (Allen, 1939 and Mohr, 1976).

WATERFOWL DEPENDENCE ON WETLAND HABITATS

Both intermittent and permanent water sites contribute to the ecological requirements of transient and territorial vertebrate species such as those listed in Table 6 earlier in this text.

Migratory and nesting ducks and shorebirds are the most prominent transitory population dependent upon wetland feeding and egg laying habitat.

The most common regularly occuring waterfowl in the Twin Cities are the blue-winged teal (49% of the breeding population); the mallard; the ring-necked duck and the wood duck. Each is both migratory and a summer resident.

Other regularly occurring waterfowl and shorebirds which have been identified by Green and Janssen(1975) include those listed in Table 8.

In recent years studies have proven the importance of temporary, seasonal wetlands as feeding areas for breeding ducks. Swanson et al. (1974) state,"Seasonal and temporary wetlands retain water long enough to develop an invertebrate population that is diverse in species structure, large, and readily available. The surface waters of these shallow wetlands warm early and provide food items at a time when the larger and deeper wetlands are frozen. For this reason, seasonal and temporary wetlands are extensively utilized by resident and migrating dabbling ducks during the early spring." Blue-winged teal (Anas discors) return to the upper midwest in mid-April and nesting begins in early to mid-May (Swanson et al., 1974). "The egg laying period requires increased protein consumption. Although the hen can borrow to some extent from her body tissues when the diet is not adequate in protein or essential amino acids, this ability to borrow is very limited and will allow her to produce only one or two eggs - and these eggs will be much smaller than normal." (Scott, 1973). Holm and Scott (1954) have determined that a diet of 18.6% protein is needed for satisfactory egg production and hatchability. Egg laying in the Twin Cities area normally is concluded by July 1. Some nesting continues through July 20 if the hen's earlier efforts were unsuccessful (Glazer, 1977).

Table 8

WATERFOWL AND SHOREBIRDS COMMON TO THE TWIN CITIES AREA

Golden plover	Common	Migrant
Black-bellied plover	Common	Migrant
Piping plover	Common	Migrant
Semipalmated plover	Common	Migrant
Killdeer	Common	Migrant & summer res.
Ruddy turnstone	Common	Migrant
Woodcock	Common	Migrant & summer res.
Common snipe	Common	Migrant & summer res.
Long-billed curlew	Casual	Migrant
Upland sandpiper	Uncommon	Migrant & summer res.
Spotted sandpiper	Common	Migrant & summer res.
Solitary sandpiper	Common	Migrant
Greater yellowlegs	Uncommon	Migrant
Lesser yellowlegs	Common	Migrant
Willet	Uncommon	Migrant
Red knot	Very rare	Migrant
Pectoral sandpiper	Common	Migrant
White-rumped sandpiper	Uncommon	Migrant
Baird's sandpiper	Uncommon	Migrant
Least sandpiper	Common	Migrant
Dunlin	Common	Migrant
Semipalmated sandpiper	Common	Migrant
Western sandpiper	Rare	Migrant
Sanderling	Common	Migrant
Short-billed dowitcher	Rare	Migrant
Long-billed dowitcher	Uncommon	Migrant
Stilt sandpiper	Uncommon	Migrant
Buff-breasted sandpiper	Casual	Migrant
Marbled godwit	Rare	Migrant
Hudsonian godwit	Rare	Migrant
LOONS		
Common loon	Common	Migrant & summer res.
Red-throated loon	Uncommon	Migrant
GREBES		
Red-necked grebe	Common	Migrant & summer res.
Horned grebe	Common	Migrant
Pied-billed grebe	Common	Migrant & summer res.

Table 8 (continued)

HERONS AND EGRETS		
Great blue heron	Common	Migrant & summer res.
Green heron	Common	Migrant & summer res.
Great egret (common egret)	Common	Migrant & summer res.
Black-crowned night heron	Common	Migrant & summer res.
Yellow-crowned night heron	Uncommon	Migrant & summer res.
Least bittern	Uncommon	Migrant & summer res.
American bittern	Common	Migrant & summer res.
SWANS, GEESE, DUCKS		
Whistling swan	Common	Migrant
Canada goose	Common	Migrant & summer res.
White-fronted goose	Common	Migrant
Snow goose	Common	Migrant
Black duck	Common	Migrant & summer res.
Gadwall	Common	Migrant & summer res.
Pintail	Common	Migrant & summer res.
Green-winged teal	Common	Migrant & summer res.
American wigeon	Common	Migrant & summer res.
Redhead	Common	Migrant & summer res.
Canvasback	Common	Migrant & summer res.
Greater scaup	Uncommon	Migrant
Lesser scaup	Common	Migrant & summer res.
Common goldeneye	Common	Migrant & summer res.
Barrows goldeneye	Casual	Migrant
Bufflehead	Common	Migrant
Ruddy duck	Common	Migrant & summer res.
Hooded merganser	Common	Migrant & summer res.
Red-breasted merganser	Common	Migrant
Common merganser	Common	Migrant

Source: Green, J. C. and Janssen, R., 1975.

Invertebrates possess high percentages of protein. Krapu and Swanson (1975) note the following protein content of common wetland invertebrates.

	% Protein by dry weight
Fairy shrimp	71.9
Earthworm	60.2
Midge larva	66.4
Snail	58.9

The incidence of such invertebrates is reported to increase in the hen's diet during the laying season (Krapu, 1974; Swanson et al., 1974; Serie and Swanson, 1976).

Invertebrates (% of hen's diet)

	Pre-laying	laying	Post-laying
Gadwalls (Anas strepera)	47.7	72.0	46.3
Pintails (Anas acuta)	56.0	77.1	28.9
Blue-winged teal (Anas discors)	45.0	95.0	-a

[a] information not available.

The actual invertebrates predominant in the hen's diet varies with the species of duck (feeding apparatus differ between species) and the relative availability of food (Krapu, 1974; Swanson et al., 1974; Serie and Swanson, 1976).

% of diet by volume of laying hens

	A. discors (blue-winged teal)	A. acuta (Pintails)	A. strepera (Gadwalls)
Invertebrates	91	79.2	72.0
Gastropods	36	22.5	-
Crustaceans	16	14.1	19.6
Insects	36	31.7	52.4
Vegetation	8	20.8	28.0

Some ducks such as Northern shovelers (Anas clypeata) feed on greater proportions of microcrustaceans than other ducks; this due to finer lamellae on the bill (Swanson et al., 1974).

Recognizing the importance of invertebrate protein in the hen's diet does not preclude the fact that other factors play a significant role in successful waterfowl production. Furthermore, it is acknowledged that invertebrate populations of MMCD Type III intermittent marshes are diverse, substantial and relatively permanent during the nesting season (MMCD, 1976).

The diversity of invertebrate forms found in MMCD Type I and II is restricted. The presence of these forms is temporary. The relative biomass between

MMCD Type I and II and MMCD Type III sites is unknown. Swanson and Meyer (1973) state that, "the feeding ecology of a species cannot be adequately assessed without some knowledge of the kinds, abundance, distribution and behavior of the food organisms that influence availability and ultimately selection."

Huff (1977) reports that while ephemeral wetland sites are important spatially as waterfowl breeding habitat, food supplies in these sites are restricted much of the time:

> "Since the sites are often free of standing water by June 1 (almost always by July 1), insect populations are, of course, reduced and spring densities of most all aquatic invertebrates are much lower than those found in permanent water bodies. Plant species which are well adapted to intermittent flooding (such as burr marigold and the smartweeds) grow profusely immediately following "dry-up" and produce huge quantities of seeds. These seeds usually fall to the soil surface and may remain viable under water during ephemeral flooding or even for years during periods of abnormally high precipitation. Since insect-producing permanent water areas are often found in close proximity to the ephemeral ones, it is my opinion that the greatest contribution to waterfowl production provided by these intermittent water bodies is the nesting, loafing, and brooding space; the great quantity of vegetative foods produced; and, to a lesser degree, the production of animal foods.
>
> Adequate spring supplies of high-protein foods (such as crustaceans, molluscs, and insects) are necessary for maximum production of waterfowl (and many other bird species). I do not believe that this factor is presently limiting to wetland production of waterfowl (and many other bird species). I do not believe that this factor is presently limiting to waterfowl production in Fridley or the Twin City Metropolitan Area, though it could become so if other factors were removed.
>
> The metropolitan duck is a mixture of cosmopolitan year 'round residents and drop-in migrants. With the increase in artificial lake aerations, artificial feeding programs, and formation of captive flocks,

the urban waterfowl population has increased greatly in recent years and in many areas is dependent on wholly unnatural foods during periods of the year. The high mortality of ducks and ducklings which I have observed in spring is due greatly to typical urban hazards such as predation by free-ranging dogs and cats, traffic confrontations,and poor nest site selection (within enclosed yards, gardens, etc.). The relative importance of optimal natural food production for waterfowl in urban areas seems quite low assuming the impacts of these other factors on productivity.

Again, these ideas will certainly yield to hard data but I'm sure the factors affecting urban waterfowl production are not well understood and probably fluctuate in relative importance from year to year."

RELEVANT COMMERCIAL LAND USES IN THE STUDY AREA

The flora and fauna communities which depend upon Types I, II and III intermittent water and marsh habitats as either permanent or migratory residents are listed in Table 5.

In addition to these native communities, other, artifically introduced plant and animal communities are distributed throughout the metropolitan area which may be sensitive to environmental changes. Commercial interests include mink ranches, turkey farms, beekeeping operations and farming. Agriculture is pursued throughout the region, (44.9% of the land use in the seven county area in 1973) (Metropolitan Council, 1977).

None of these activities is a major commerical interest in the Twin Cities. Facilities are not concentrated in a specific geographic area but are scattered in outlying, semi-rural portions of the region. Beekeeping is not permitted within the city limits of Minneapolis. The city of St. Paul is processing ordinances prohibting beekeeping in that city.

State law requires that no person "...shall own, possess, or operate bees without registering his bees with the Commissioner of the State Department of Agriculture..." (State of Minnesota Apiary Law Section

19.19 Licenses). Apiary, as used in this law is defined as a "place where one or more colonies of bees are kept, together with all equipment used in maintaining and operating the same " (Ibid., Section 19.18 Subd. 2).

A person owning fewer than ten colonies (hives) is not required to pay an annual inspection fee, but is required to register (Ibid., Section 19.19 Subd. 2).

As of 1976, 2025 beekeepers were registered to operate in Minnesota. Most of these persons are considered hobby beekeepers (1876). A hobby beekeeper manages fewer than 200 hives. There were 27,847 hives registered in this category in 1976. Semi-professional and commercial beekeepers (149) managed a total of 118,291 hives that year (Hyser, 1976).

Bee hives are preferably sited in protected areas within a mile of food sources. Bees will forage profitably up to a distance of 2½ miles from the hive. When nectar supplies are short, they will fly as far as 5 miles from the hive. Long distance foraging, however, is undesirable as poor honey production results (Hyser, 1977).

An average hive contains between 45,000 and 50,000 bees. One-third of the population are honeybee workers. Active foraging begins approximately June 15 and continues through August 15 (Hyser, 1977). The ambient temperature within the hive is 97°F Outside temperatures must exceed 76°F before bees will venture more than a few feet from the hives (Esch, 1976). Bees generally do not emerge from the hive before 9:00 A.M. or after sundown (Hyser, 1977; Atkins, 1976).

During a honey flow foragers may make between eight to ten trips per day gathering 30-40 mg. of nectar in less than 30-60 minutes (Robinson, 1977). The bees usually work a food source until it is depleted.

The first honey flow in the metropolitan area is in May (Haydak, 1968). The main honey flow occurs in July and 80% of the honey is produced and collected during this month (Haydak, 1968; Hyser 1977). Primary

feeding sources are willows, maples, elms and dandelions (spring); fruit trees, ornamental bushes, black locust, raspberry, white and alsike clover, sweet clover, alfalfa and basswood (development and honey sources) (Haydak, 1968). The only known wetland plant food source is the purple lusctrife (Hyser, 1977).

In 1974, 331 turkey farms in Minnesota (with sales in excess of $2,500) produced over 20,000,000 birds for market (U. S. Dept. of Commerce 1974). Minnesota is the nation's foremost producer of turkeys (Taylor, 1977). Seventeen growers in the metropolitan area (six county) reported sales over $2,500 in 1974:

Anoka	5 farms	232,480 birds
Dakota	3	63,243
Hennepin	5	69,050
Ramsey	-	-
Scott	1	250
Washington	3	21,020

One hundred thirty-six mink ranches were operating in Minnesota in 1974 reporting a total inventory of 306,766. Regulations prohibiting disclosure of information for individual operators makes it difficult to identify the location of ranches. Sixteen counties are named in census reports as having mink producers. No metropolitan county is included in this listing.

RARE AND ENDANGERED SPECIES

Metropolitan wetlands provide permanent habitats for rare and endangered species. Species of birds, amphibians, reptiles and protected plants which may be affected by wetland alterations have been identified by Huff (1976) as adapted from Hughes and Halman (1973, 1974). Twenty species are noted:

1. Great Blue Heron (Ardea herodias)
2. Great egret (Casmerodius albus)
3. Cooper's hawk (Accipiter cooperii)
4. Marsh hawk (Circus cyaneus)
5. Yellow tail (Coturnicops noveboracensis)
6. LeContes sparrow (Passerherbulus caudacutus)
7. Henslow's sparrow (Passerherbulus henslowii)
8. Jefferson's salamander (Ambystromia
9. Common newt (Notophtalmus viridesceus)

10. Wood turtle (Clemmys insculpta)
11. Blandings turtle (Emys blandingii)
12. Showy, pink and white lady slippers (Cyprepedium spp).
13. Other orchids (Orchidacea family)
14. Trillium (Trillium spp.)
15. True lilies (Lilium spp.)
16. American lotus (Nelumbo lutea)
17. Trailing arbutus (Epigala repens)
18. Gentians (Gentiana spp.)
19. Black walnut (Juglans nigra)
20. Yellow birch (Betuda lutea)

The orchid Habenaria obtustata found locally in Anoka County is pollinated by female Aedes canadensis and A. communis mosquitos (Northern, 1970 and Thien 1969).

Ten species of Habernaria occur in the six county MMCD but the H. obtusata is found only in a small patch in the Cedar Creek Natural History area in north Anoka County (Distribution maps, University of Minnesota Herberium).

Both the A. canadensis and A. Communis mosquitos are present in the Twin Cities metropolitan area but are seldom collected in light traps located in the MMCD or outlying areas (MMCD records 1959-1976).

In field and laboratory tests, 14 species of Minnesota mosquitos have been observed visiting flowers for nectar feedings (Sandholm and Price, 1962). Moths (Xanthorhoe munitata)have been captured carrying pollen of the H. obtusata (Thein, 1969).

Mosquitos found in Minnesota which feed on flower nectar are (Sandholm and Price, 1962):

Aedes vexans
Aedes cinereus
Aedes fitchii
Aedes trivittatus
Aedes punctor
Aedes sticticus
Aedes canadensis
Aedes dorsalis
Aedes abserratus
Coquillettidia perturbans
Culex restuans
Culex tarsalis
Culiseta inornata

THE FUTURE OF METROPOLITAN WETLANDS AND MOSQUITO BREEDING SITES

The following projections have been made by the Upper Mississippi River Basin Commission in its Level B study concerning the future of wetlands in the seven county Metropolitan area of the Twin Cities (1976).

By the year 2000 the Metropolitan area is projected to lose 100,000 acres of wetlands. Approximately 74,000 acres of these wetlands will be similar to those in Type I and II classifications used by the MMCD, (potholes, woodland pools). The remaining 26,000 acres will be similar to the Type III classification used by the District (marshes). The following figures represent the amount and type of wetlands expected to be lost in each of the counties in the District. Carver County is included because the reduction of wetlands will also reduce the mosquito population contributed to the District from breeding sites beyond its area of jurisdiction.

TABLE 9

PROJECTED CHANGES IN METROPOLITAN WETLANDS BY THE YEAR 2000.

County	Current Acres	Expected Loss Type I & II Sites	Expected Loss Type III Sites	Total Acres Lost	Projected 2000 Acres
Anoka	81,000	30,000	3,700	33,700	47,300
Dakota	25,600	8,000	3,700	11,700	13,900
Hennepin	57,000	10,000	3,700	13,700	43,300
Ramsey	13,400	3,000	3,700	6,700	6,700
Scott	32,200	10,000	3,700	13,700	18,500
Washington	32,200	7,000	3,700	10,700	21,500
Total	241,400	68,000	22,200	90,200	151,200
Carver	23,000	6,000	3,700	9,700	

Source: Upper Mississippi River Basin: Level B Study, 1976; MMCD records.

Assuming an even rate of reduction, one can expect 3,760 acres of wetlands in the District will be lost annually until the year 2000. Included in the annual loss are 2,830 acres of Type I or II breeding sites which are the breeding ground of the Aedes vexans, the most common pest mosquito in the Metropolitan Twin Cities Area.

The Metropolitan Council (1977) has published a draft proposal regarding alternate future developments of wetlands in the Twin Cities Area.
Portions of the model ordinances proposed by the Council would enable local government units to adopt resolutions providing for wetlands management within their area of jurisdiction or to adopt those to be administered by the Council. Under either condition, permits would then be required by any 'person' seeking to 'develop' (alter) existing wetland areas thus regulated.

HUMAN ENVIRONMENTAL SETTING

INTRODUCTORY COMMENT

Mosquitos common to the Twin Cities metropolitan area are particularly active during the evening hours when area residents are likely to be outdoors. Area residents are thereby susceptible to the two major effects of mosquitos upon humans: Annoyance and transmission of disease.

As shown in Figures V-VIII in a previous subsection, natural land formations conducive to mosquito breeding are well distributed throughout the seven county area. Approximately 50% of productive breeding sites coincide with residential areas of roughly three-fourths of the metropolitan population.

For purposes of this study, aspects of the human environmental setting which are directly related to mosquito behavior and mosquito control have been selected for discussion: Health; outdoor recreation; public recreation sites; the use of insecticide by metropolitan consumers; regulations governing the use of insecticides; noise and fuel consumption.

EFFECTS OF MOSQUITO ACTIVITY ON PUBLIC HEALTH AND WELL BEING

Accurate counts of the incidence of mosquito borne diseases in humans is incomplete due to similarities between early stages of illness and other common, less serious viruses. In addition, fewer than 20% of the cases in Minnesota are reported to the State Health Department (Settle, 1977). Nonetheless, it is known that three forms of encephalitis occur locally. Statistics reflecting incidence of disease are shown in Table 10.

The transmission cycle is similar for most mosquito borne diseases. The disease agent multiplies in the mosquito, eventually reaching the salivary glands. While securing the blood meal usually necessary for reproduction, the mosquito injects and transmits the causal agent. Humans are incidental, dead-end hosts in the transmission between the reservoir host and mosquito. Local disease vectors and their transmission cycles are summarized

TABLE 10

REPORTED INCIDENCE OF ENCEPHALITIS IN MINNESOTA

HUMAN*

DISEASE	# REPORTED CASES	YEAR
California Encephalitis	128	1967-1975
(LaCrosse Strain)	5	1976
	6	1977
St. Louis Encephalitis	1	1970-1975
	4	1976
	0	1977
Western Equine Encephalitis (WEE)	1	1970-1974
	17	1975
	0	1976
	7	1977

EQUINES**

Western Equine Encephalitis	210	1968-1973
	85	1974
(19 in District)	497**	1975
(1 in District)	4	1976
(7 in District)	106	1977

CANINES

Heartworm in Dogs***		
Minnesota Cases (86% of those reported were in Hennepin County)	4,164	1950-1960

*SOURCE: Balfour, 1974, Andrews, 1976, Osterholm, 1977.

**SOURCE: Ives, 1977

**High figures for this period reflect a major incidence of WEE in Minnesota

***SOURCE: Schlotthauer and Griffiths, 1964.

in Table 11. A full discussion of this topic is included in Appendix ES, (exhibit B).

None of the diseases normally transmitted to humans by mosquitos is an annual threat to Minnesota residents. The flight range of Aedes triseriatus is restricted, thus the mosquito remains confined to wooded areas (Barr, 1958; Balfour,1974). Culex tarsalis does not represent a significant percentage of the total mosquito population except during years of abnormal rainfall and flooding (1975 in Minnesota and North Dakota for example). Heartworm in dogs, however, is a serious continuing problem in the metropolitan area.

Allergy to mosquito bites is a less serious but common health problem related to mosquitos in this region. Most reactions are minor with welts appearing on the surface of the skin soon after the mosquito has bitten. Scratching the surface of the skin can induce minor infections. More severe allergic reactions occur in a small minority of the general population (Goma,1966; Frazier,1974). Reliable statistics on the number of persons thus afflicted are not readily available. A discussion of symptoms and research on this topic is included in Appendix ES, (exhibit B)which accompanies this text.

Natural desensitization to the effects of mosquito bites has long been recognized. Early settlers in this country suffered greatly the first year here but lost their sensitivity later on. Some persons develop seasonal immunity; usually ten days after the onset of mosquito activity, but have reactions the following year although less violently (Frazier, 1973). Often children under one year of age suffer the greatest reactions indicating that as one matures, a natural desensitization does occur (Balfour, 1976).

TABLE 11

DISEASE TRANSMISSION BY LOCAL MOSQUITO SPECIES

Disease	Mosquito Carrier	Normal Breeding Environment	Location	Transmission Cycle	Susceptibility
California Encephalitis (La Crosse Strain)	*Aedes triseriatus*	Basal holes in hardwood trees; old tires and artifical containers	S. W. Hennepin County N. E. Carver County and wooded area	Mosquito-chipmunk Mosquito-human or Mosquito-her eggs-hatched mosquito-human	Children 6 months to 17 years of age
St. Louis Encephalitis (SLE)	*Culex tarsalis*	Summer flood areas	Statewide	Bird-mosquito human	Elderly
Western Equine Encephalitis (WEE)	*Culex tarsalis*	Summer flood areas	Statewide	Bird-mosquito-human or Bird-mosquito-horse	General population
Dirofilariasis (Heartworm)	*Aedes* *Culex* *Anopheles*	Wetlands; flood areas	General, but especially recognized in Hennepin County around Lake Minnetonka	Dog-mosquito-dog	All carnivors, dogs, some cats and rarely in humans.

SOURCE: Goma, 1966; Hoeprich, 1972; Center for Disease Control, 1975; Andrews, 1976, Dingel, 1976; Harrison, 1976; Myers, 1976; Schlotthauer, 1976; Shupe, 1976; Winter, 1976; MMCD records.

MOSQUITO ANNOYANCE AND THE OUTDOOR BEHAVIOR OF TWIN CITIES RESIDENTS

Results of a residential survey conducted on behalf of the Metropolitan Mosquito Control District in 1976 confirm their assumption that area residents place a high value upon outdoor recreation during summer months.[1] Ideally, area residents (adults) would like to spend an average of 1.88 hour (median is 2.0 hours) outdoors during the evening hours when mosquitos are particularly active (7-9 P.M.). Adults actually spent 1.42 hours outdoors (median 1 hour) during the summer, 1976. The reason for the half hour difference (denied time outdoors) is mosquito annoyance.

While area residents were responding to survey questions, MMCD personnel monitored mosquito activity in their neighborhoods in a series of bite count recordings.[2] The general relationship between mosquito bite counts and percent denied time outdoors (adults) is given by the formula:

$$\% \text{ Adult Time Denied} = 2.26\ (\text{5 minute bite count}) + 14.64$$

As a result of the survey, an additional relationship is evident between the amount of money spent each year by householders to control, or protect themselves against mosquitos (insect sprays and repellents) and the number of mosquito bites recorded in a five minute collection period. Householders living in areas where mosquito density has been consistently high in recent years spend more on personal control than other area residents. The best approximation of this

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[1] Research methodology and detailed findings of this survey among 1930 area households are presented in Appendix ES (exhibit C).

[2] Procedures followed in the generation of this information are common to normal District operations and are detailed in Appendix ES (exhibit C) accompanying this text.

relationship, within surveyed communities to date, is shown in Figure X. Affected communities include Gem Lake, Mounds View and Excelsior.

The time children spend outdoors is less restricted by the presence of mosquitos. Most children would have spent an additional 15 minutes outdoors each evening under ideal conditions last summer.

Generally it can be stated that the further away one lives from the center of the Minneapolis/ St. Paul city limits, the more one is annoyed by mosquitos during evening hours. Areas of the region in which residents were interviewed are shown in Figure XI. Individuals living in Gem Lake, Excelsior and Mounds View spent roughly one third less time outdoors than they desired during the summer, 1976. Conversely, residents of Minneapolis were denied 15% of the time they wished to spend outdoors in the evening. Denied time was 11% in East St. Paul.

Individual householders in Gem Lake spent an average of $4.03 last summer on insect sprays and repellents vs $1.52 in Minneapolis.

The demand by area residents (as reflected in the survey) for improved public mosquito control does not directly reflect variations in mosquito density. Sixty-four percent of all survey respondents favor an increase in public expenditures to effect mosquito control.

Forty-three percent of area residents surveyed identified a favorite outdoor activity which is hampered by the presence of mosquitos. These persons would be willing to spend an average of $28.00 per household (median is $10.00) to be free of the bother of mosquitos while engaging in this activity.

Most residents (92%) spend the hours between 7-10 P.M. in their own yards. Nonetheless, public recreation areas are frequented by local citizens from time to time during the summer months.

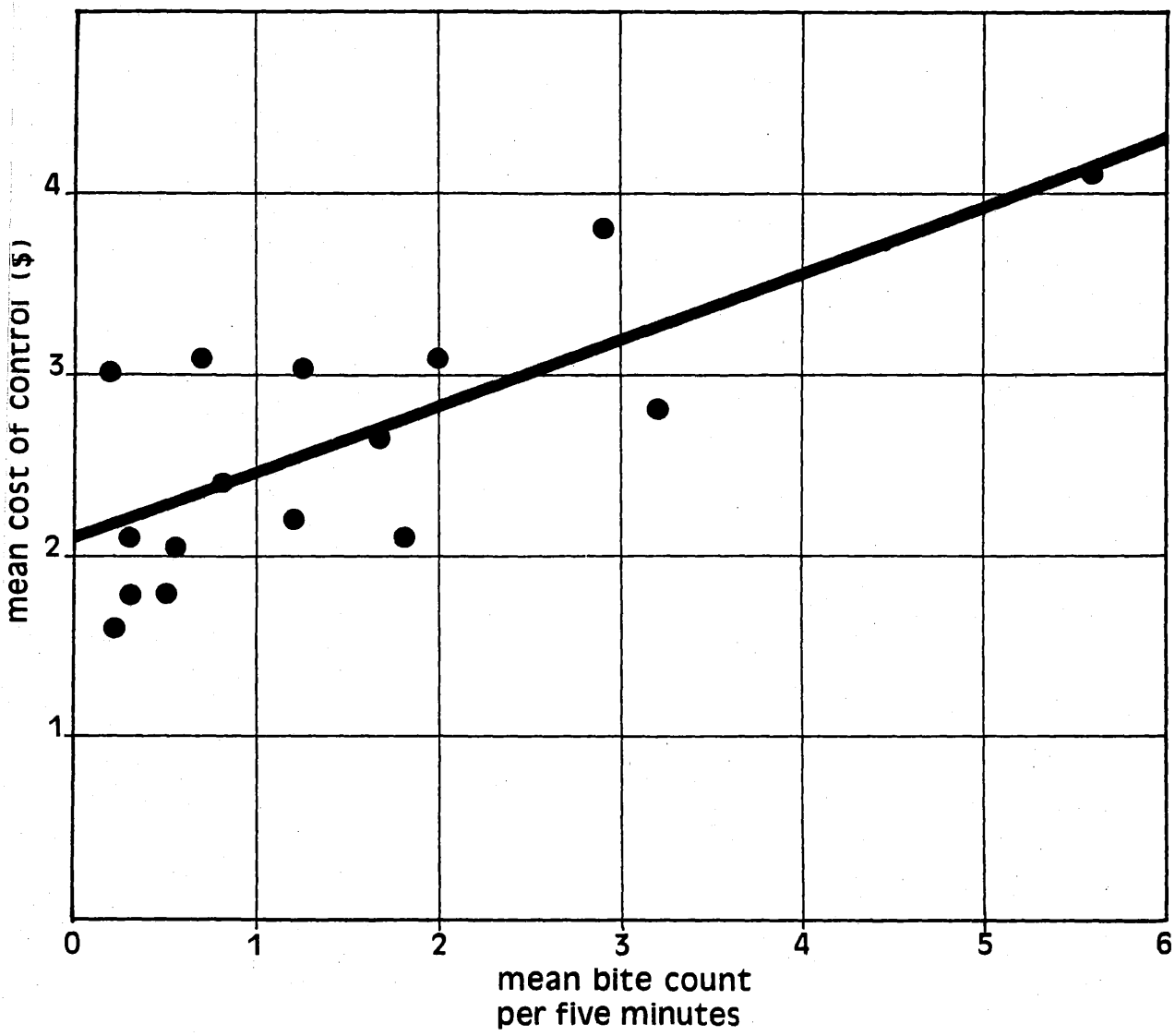

figure X.

scatterplot of mean costs of personal control and bite counts recorded in 1976

costs greater than $50 were calculated to equal $50.

source: household surveys and bite count collections, summer, 1976.

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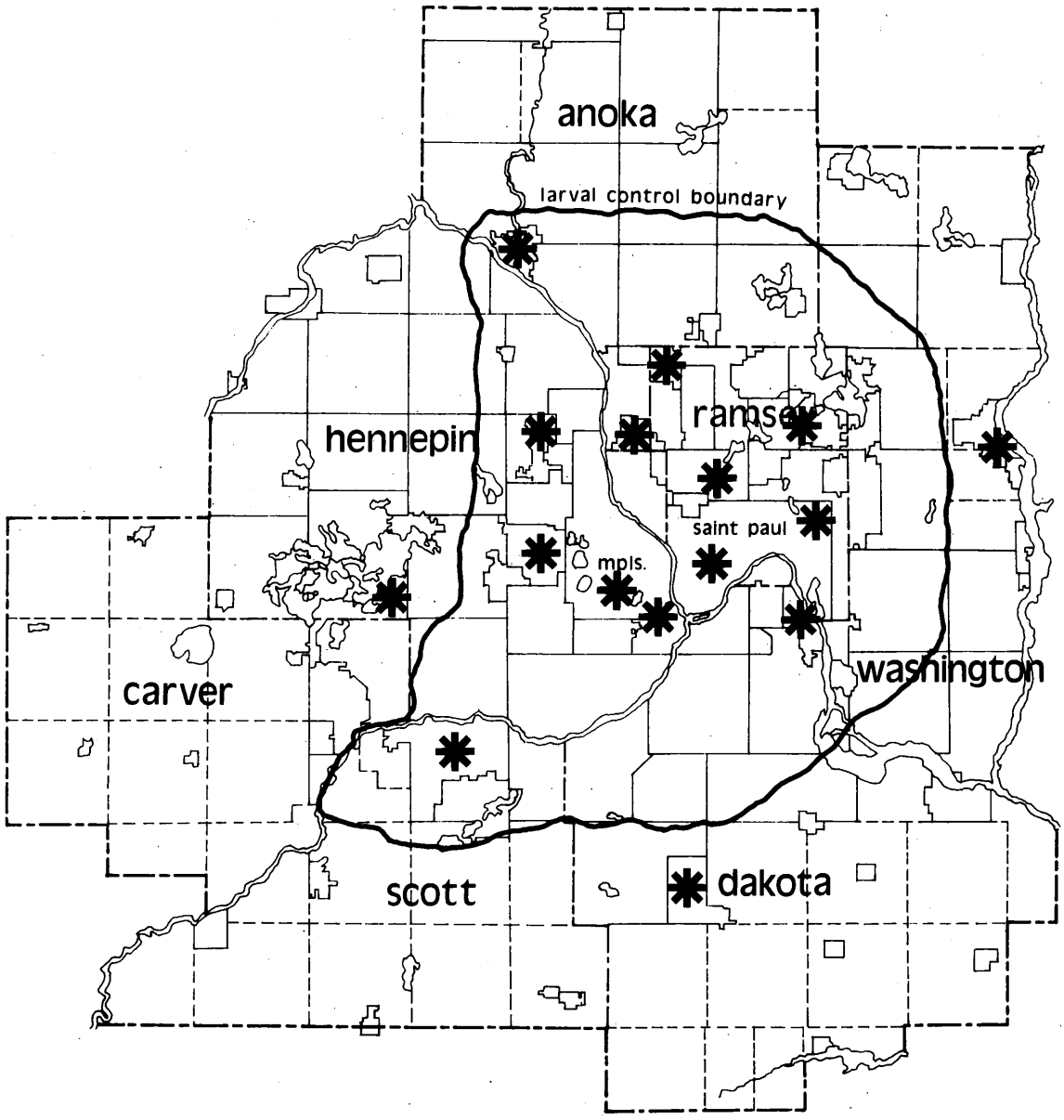

figure XI.

survey locations

summer, 1976

* household survey census tract locations

miles 0 5 10 15 20

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The six county metropolitan area (excluding Carver County) comprises 2633 square miles. Roughly 2.2% of this area is devoted to county and municipal parks or 22 acres per 1000 population.

Dr. Thomas Goodale divides outdoor recreation activities in Minneapolis into six basic categories (Goodale, 1965).

1. Quick Pace Physical Activities (tennis, jogging, bicycling, swimming)

2. Communion with Nature (camping, fishing, canoeing)

3. Resort Set (golfing, skiing, equestrian shows)

4. Nature with Power Steering (pleasure driving, biking, picnicking)

5. Ballgames, Buckshot and Black Bass (driving ranges, gun clubs, speedways)

6. Arts and Education (concerts, fairs, nature exhibits)

He notes that geographical distinctions in social and economic characteristics of neighborhood populations account for 35% of the variance in the type of activity preferred. This finding has limited applicability here, but does support the selection of like census tracts for studies in outdoor behavior, and suggests the need for evaluation of mosquito control in public recreation areas.

To assess the effect of mosquito activitv on the enjoyment of these facilities, the MMCD sponsored a survey of public and private recreation areas during the summer of 1976. The instrument used in this survey and a detailed discussion of findings are included in Appendix ES (exhibit C). The population was selected from areas shown on Table 12. Forty directors were interviewed. Supervisors (75%) stated that mosquitos affected evening use of facilities prior to initiation of the MMCD. One fourth (25%) augment public control measures.

TABLE 12

DISTRIBUTION OF RECREATIONAL LAND-USE IN METROPOLITAN COUNTIES

Recreation	Anoka		Dakota		Hennepin		Ramsey		Scott		Washington		Total	
Facilities	No.	Acres	No.	Acres	No.	Acres	No.	Acres	No.	Acres	No.	Acres	No.	Acres
Regional Parks	2	25	6	1,147.4	16	14,321	2	19	8	4,832	13	3,056.4	47	23,400.8
Parks under 25 acres	140	982	158	1,035.9	572	3,676.6	80	1,232.	16	158.4	18	268.4	984	7,353.3
Parks over 25 acres	36	4,099.7	29	5,054.5	108	10,106.3	41	9,548	5	809	20	1,366.7	239	30,984.2
Private golf clubs	2	663	15	1,243.3	10	1,367.5	6	486	3	990	9	2,119.0	45	6,868.8
Municipal golf clubs	2	202	1	200	26	3,348.2	9	8,972	0	0	0	0	38	12,722.2
Gun related facilities	7	805.7	6	120	0	0	2	14	1	5	5	1,629.5	21	2,574.2
Horse stables	6	394.3	5	340	7	569	2	461.5	3	2,669.8	6	799	29	5,233.6
Daycamps Campgrounds Resorts	15	2,640.9	8	441	7	372	4	11	8	1,717.1	22	2,715.2	64	7,996.2
Public access points	12	16.1	6	21.7	50	116.4	6	25.1	18	22.2	36	990.7	128	1,192.2
Nature preserves	3	15,050.1	3	725	14	1,448.6	4	1,390	6	617.2	3	259.5	33	19,490.4
County Totals	225	24,878.8	237	10,328.8	810	35,325.6	156	22,257.6	68	11,820.7	132	13,204.4	1,628	117,815.9

Source: Minnesota Department of Natural Resources, SCORP Inventory 1973; Metropolitan Council, Open Space & Recreation Development Guide and Policy Plan, 1975. MMCD Staff, 1977.

USE OF INSECTICIDES IN THE TWIN CITIES METROPOLITAN AREA

According to findings presented in a recent study sponsored by the U. S. Environmental Protection Agency, the homeowner is the major user of pesticides in urban environments.[1] Using statistics compiled for Lansing, Michigan as representative of pesticide use in the Twin Cities Area, the expected annual home use of insecticides is 226,333 pounds.

As a result of its national study, the EPA researchers concluded that insecticide uses in Lansing, Michigan were exactly equal to the norm for the U.S. Thus, it is assumed for purposes of this study, that the materials purchased by Michigan households approximate those used in the Twin Cities (Lofgren, 1977). EPA findings for Lansing, Michigan are presented in Table 13.

Statistics found in "General Farm Use of Minnesota Pesticides" (U.S. Dept of Agriculture and Minnesota Dept. of Agriculture, 1975) and "Minnesota Agricultural Statistics" (U.S. Dept. of Agriculture and Minnesoa Dept. of Agriculture, 1976) indicate that the local farmers are also large users of insecticides in the metropolitan area. The principal crops grown in the six counties that comprise the M.M.C.D. are corn, soybeans, small grains, and potatoes. The most commonly used insecticides are shown in Table 13.

According to Kierig (1977), 40 to 50 percent of all pesticides are used in home and urban areas. Over 160 tons of domestic and agricultural insecticides are used in the Twin Cities metropolitan area annually. By way of immediate comparison, the Metropolitan Mosquito Control District uses approximately three tons of insecticides during a season of normal operations.

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[1]The combined suburban uses in Philadelphia, Dallas and Lansing were 750,000 pounds in 1971 of which 609,000 pounds were applied by homeowners in the form of herbicides, insecticides and fungicides. The most commonly used insecticides were dicofol, dimethoate and malathion (National Academy of Sciences, 1976).

TABLE 13

MAJOR INSECTICIDES USED BY HOUSEHOLDERS IN LANSING, MICHIGAN

		% of Total
1.	Malathion	35%
2.	Chlordane (suspended 1976)	19%
3.	Diazinon	6%
4.	Carbaryl	4%
5.	Dimethoate	2%
6.	Dieldrin (sold only by licensed dealers)*	2%
7.	Dicofol	2%
8.	Methoxychlor	1%
9.	Other	29%

*Use rate nearly 0% since 1975 in Twin Cities (Lofgren, 1977).

SOURCE: U. S. EPA, 1972

According to Lofgren (1977), the "...estimate of 2% used by the MMCD is, if anything, high compared to other uses in the area." Lofgren also has observed that, "most of the household sprays and aerosols for indoor use contain Pyrethrins. On a poundage basis this may not amount to much in the percent column but it does account for quite a large volume of total formulation used. There has also been an increasing use of the bacterial products containing Bacillus thuringensis in gardens and on trees."

EPA REGISTERED MATERIALS FOR THE CHEMICAL CONTROL OF MOSQUITOS

As of 1976, the U. S. Environmental Protection Agency has registered 15 materials as environmentally safe for use in the control of mosquitos when applied at recommended dosages and in accordance with federal labeling instructions. Sample labels are included in Appendix ES (exhibit D) accompanying this text. Names of approved insecticides, treatment uses, dosage, mammalian toxicity and application methods for mosquito control are shown in Table 15.

Federal labels and registration are prepared with an intent to protect the health and safety of individuals using chemical materials or having other contact with them as well as to protect non-target organisms from unreasonable adverse effects.

TABLE 14

AGRICULTURAL INSECTICIDES USED IN THE TWIN CITIES AREA*

Insecticide	Use Rate
1. Carbofuran	54%
2. Diazinon	18%
3. Dyfonate	7%
4. Dasanit	6%
5. Other▲	15%

*An average of 102,004 acres are treated during an average year with 98,566 lbs. of active ingredient. The average dosage rate per acre is .96 lbs. of insecticide.

SOURCE: General Farm Use of Minnesota Pesticide,1974 U. S. Dept. of Agriculture, Mn. Department of Agriculture, 1975.

▲Including Carbaryl, Phorate, Disulfoton, Endosulfan, Dimethoate, Methomyl (Lofgren, 1977)

Under Reorganization Plan No. 3 (1970), the U. S. EPA is responsible for pesticide programs formerly designed in enabling legislation of other federal agencies:

1. Pesticide registration formerly administered by the U. S. Department of Agriculture under the Federal Insecticide, Fungicide and Rodenticide Act;

2. Determination of tolerance for residue on food and feed formerly within the jurisdiction of HEW under the Federal Food, Drug and Cosmetic Act and the Public Health Service;

3. Functions formerly assigned the Department of the Interior under the Federal Water Pollution Control Act;

4. Functions formerly assigned the Department of the Interior under the Pesticides Research Act and activities of the Gulf Breeze Biological Laboratory

(Holms and Anderson, 1971).

The pesticide registration process involves years of study to determine effectiveness, residue and safety in use, storage and shipment (U.S. Department of Agriculture, 1964). Registration permits are effective for five years and may be cancelled at any time in all or part (as was the case with DDT in 1969 and 1970) (Holmes and Anderson, 1971).

Applications for registration and supporting data are filed with the EPA. A computer print-out listing all the data filed with the EPA in support of materials registered for mosquito control in use by the District is available at the main offices of the Metropolitan Mosquito Control District in St. Paul.

According to Robert Leis of the U. S. EPA, many insecticides registered for pest control in the past would not meet current standards (Leis, 1977). Evidence of the impact of current standards is available in Federal Register publications of:

Wednesday June 25, 1975 Vol.40 #123 pp26802-928
Thursday July 03, 1975 Vol.40 #127 pp28242-286
Tuesday Feb. 17, 1976 Vol.41 #32 pp7218 -375

TABLE 15

EPA APPROVED CHEMICALS FOR USE IN MOSQUITO CONTROL

Insecticide	Stages Treated Adult-A, Larval-L Pupal-P	Approved Uses (Dosage lb. AI/A) Larvicide	Adulticide	Mammalian mg/kg Oral LD_{50} (Rats)	Approved Application Methods Aircraft-A, Ground-G, Liquid-L Granule-Gn, Fogging-F
Parathion	L, A	.1	.1	3-13	A, G, L, Gn
Methyl Parathion	L, A	.1	.1	9-25	A, G, L, Gn
Dichlorvos (DDVP)	A	-	.1	84-151	A, G, L
Lethane 384	A	-	.1	90	G, L
Baygon®	A	-	.05-.07	128	A, G, L, F[1]
Chlorpyrifos (Dursban®)	L, A	.0125-.1	.025 -.05	135-163	A, G, L, Gn, F
Fenthion (Baytex®)	L, A	.05 -.1	.05-.08	215-298	A, G, L, Gn, F
Naled (Dibrom®)	A	-	.1	250	A, G, L, F
Carbaryl (Sevin®)	A	-	.8	500	A, G, L
Malathion	L, A	.5	.5	1,375 -5,843	A, G, L, Gn, F
Pyrethrum (Synergized)	A	-	.004	680 - 2,600	G, L, F
Resmethrin	A	-	.007	4,240	G, F, A[1]
Dimilin®	L	.025	-	>10,000	A[1], G[1], L[1], Gn[1]
Methoprene (Altosid®)	L	.025	-	>34,600	A, G, L, Gn
Temephos (Abate®)	L	.025-.2	-	8,600 -13,000	A, G, L, Gn
Petroleum Oil	L, P	2 gals	-	-	A, G, L

[1]Pending Registration

SOURCE: Review of E.P.A. registration literature

TABLE 16

ACUTE LETHAL CONCENTRATIONS (LD_{50} IN PPM) OF THREE INSECTICIDES FOR MEMBERS OF FOUR VERTEBRATE GROUPS

Organism	Temephos (Abate®)	Chlorpyrifos (Dursban®)	Malathion
Amphibia			
Bullfrog	>2000	>400	
Birds			
Bluejay	<30		
Bobwhite	<30		
Canada Goose	92;1540		
Cardinal		>80	
Chukar	76		
Common Grackle	270	61	
Cortunix		13	
Crow	84;260	16	2962
House Sparrow		>32	
Leghorn Chick	47	10-21	
Lesser Sandhill Crane		23;80	
Mallard		25-50	
Pheasant	80;894	76	5000
Pigeon	31;162	8	2639
Red Winged Blackbird	50	27	
Starlings		13	
		75	
Fish*			
Bluegill	54		
Green Sunfish	>25		
Fathead Minnow	>10		
Largemouth Bass	>200		
Mosquito Fish	>200		
Perch			
Rainbow Trout	<1		
Striped Bass	1		
Mammals			
Rat(oral)	8600	155	
Rat(dermal)	>4000	202	
Rat(oral)	13000	82	
Rat(dermal)	>4000		

*LC_{50} values

Source: See Table 30 in this text.

Acute lethal concentrations of insecticides used for mosquito control in the Metropolitan Area (LD_{50}) for amphibia, fish, birds and mammals are shown in Table 16.

SAFETY PRECAUTIONS REGULATING APPLICATORS' HANDLING OF TOXIC MATERIALS

Methods of mixing, applying and handling toxic insecticides are regulated at the Federal level. Both the U. S. EPA and the U. S. Department of Agriculture have published standards and guidelines governing the handling of these materials. Excerpts from the following documents are included in Appendix ES, (exhibit F:)

(1) Federal Insecticide Fungicide and Rodenticide Act, as ammended in 1972 to read Federal Environmental Pesticide Control Act.

(2) U. S. EPA and U. S. Department of Agriculture Bulletin, "Apply Pesticides Correctly: A Guide for Commercial Applicators," 1975.

It should be noted that Federal Standards (FIFRA) referenced above have been suspended pending further hearings. EPA guidelines remain in force. Legal restrictions governing the handling of insecticides which have been promulgated at the state level in Minnesota are included in the Minnesota Pesticide Control Law, 1976. A copy of this law is included in Appendix PD, (exhibit E).

NOISE

Occupational Safety and Health Act Standards for exposure to noise must not exceed the following levels for hearing damage.

90 dBA	8 hrs/day
95 dBA	4 hrs/day
100 dBA	2 hrs/day

Non-impulsive noise must not exceed 115 dBA.

Impulsive noise must not exceed 140 dBA.

Noise generated by a helicopter traveling 60 M.P.H. registers 92-101 dBA and approximates that of a garbage truck (EPA, 1974). Although the duration of the noise is momentary and the sound is not unique to either urban or rural environments, the element of surprise or the time of day may startle humans and penned or grazing animals.

It is difficult to discuss wild animals in the environment except to say that they have varied hearing mechanisms and acuities.

Residential noise reception levels authorized by the State of Minnesota for the Twin Cities Metropolitan Area after November 1974 are categorized according to the following Noise Area Classification System, (Table 17).

These regulations have been adopted by the State with the following caveat, "...these standards describe the limiting levels of sound established on the basis of present knowledge for the preservation of public health and welfare...however, these standards do not, by themselves, identify the limiting levels of impulsive noise needed for the preservation of public health and welfare "(Minnesota Pollution Control Agency, 1974).

Noise Area Classification (1) promulgated by the State, includes permissable levels for receivers in these areas:

Household units (Incl. farms)
Group quarters
Residential hotels
Mobile home parks

Transient lodgings
Other residential, (NEC)*
Motion picture production
Medical & other health services
Correctional institutions
Educational services
Religious activities
Cultural activities and nature exhibitions
Entertainment assembly
Camping and picnic areas
Resorts and group camps
Other cultural, entertainment and recreation (NEC)

*NEC - Not elsewhere coded. Parks are included in NAC - 2.

TABLE 17

MINNESOTA STATE NOISE RECEPTION STANDARDS

	Day (0700-2200)		Night (2200-0700)	
NAC	*L_{50}	L_{10}	L_{50}	L_{10}
1	60	65	50	55
2	65	70	65	70
3	75	80	75	80

*L_{50} L_{10} - Sound level exceeded (50%) and (10%) of the time for a 1 hour survey.

SOURCE: Minnesota Pollution Control Agency, 1974

As of January 1977, the following standards are in effect limiting the operation of light vehicles in the City of Minneapolis.

TABLE 18

NOISE LEVEL LIMITS FOR LIGHT VEHICLES OPERATED IN THE CITY OF MINNEAPOLIS ON OR AFTER JANUARY 1977

	Measurement Distance		
Posted Speed Limit	20ft.	25 ft.	50 ft.
25 mph or less	69 dBA	67dBA	61dBA
30	71	69	63
35	73	71	65
40	75	73	67
45	77	75	69
50	79	77	71
55	81	79	73
60 mph or more	83	81	75

SOURCE: City of Minneapolis, 1972

State and municipal ambient noise standards apply only to those noise-producing operations which achieve maximum allowed levels for a consecutive period of more than six minutes (State) or 10 minutes (City).

The State of Minnesota has no specific noise limitation standards for either helicopters or spraying equipment. The spraying equipment used by the District (other than helicopters) have engines which approximate those of lawn mowers. State standards which would most appropriately apply to the MMCD operations are those specific to motorcycles, as shown in Figure XII.

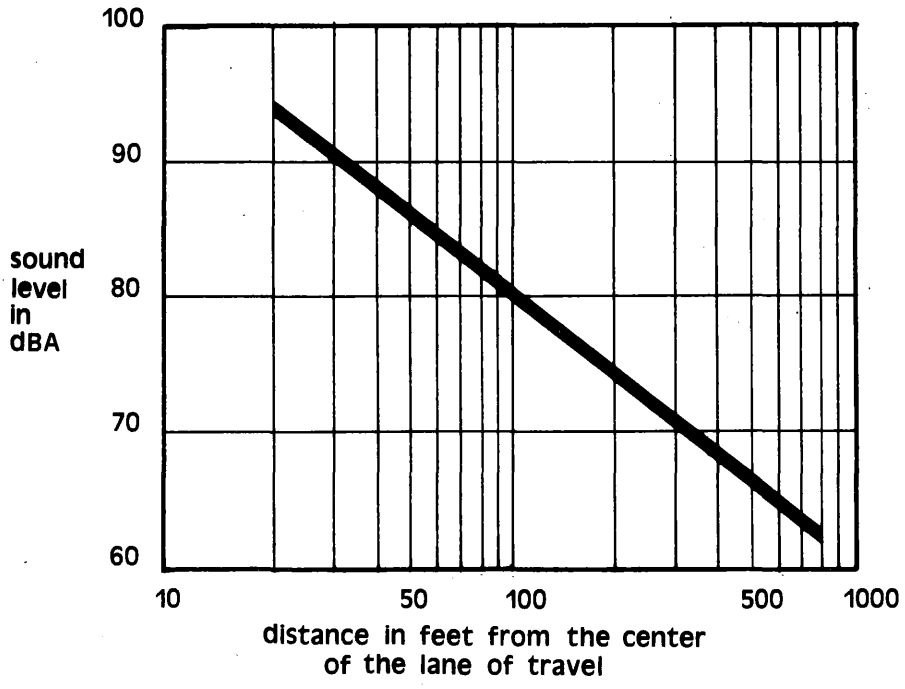

figure XII.

motor vehicle noise limits for motorcycles

source: motor vehicle noise limits (MPC-4)
Minn. Pollution Control Agency

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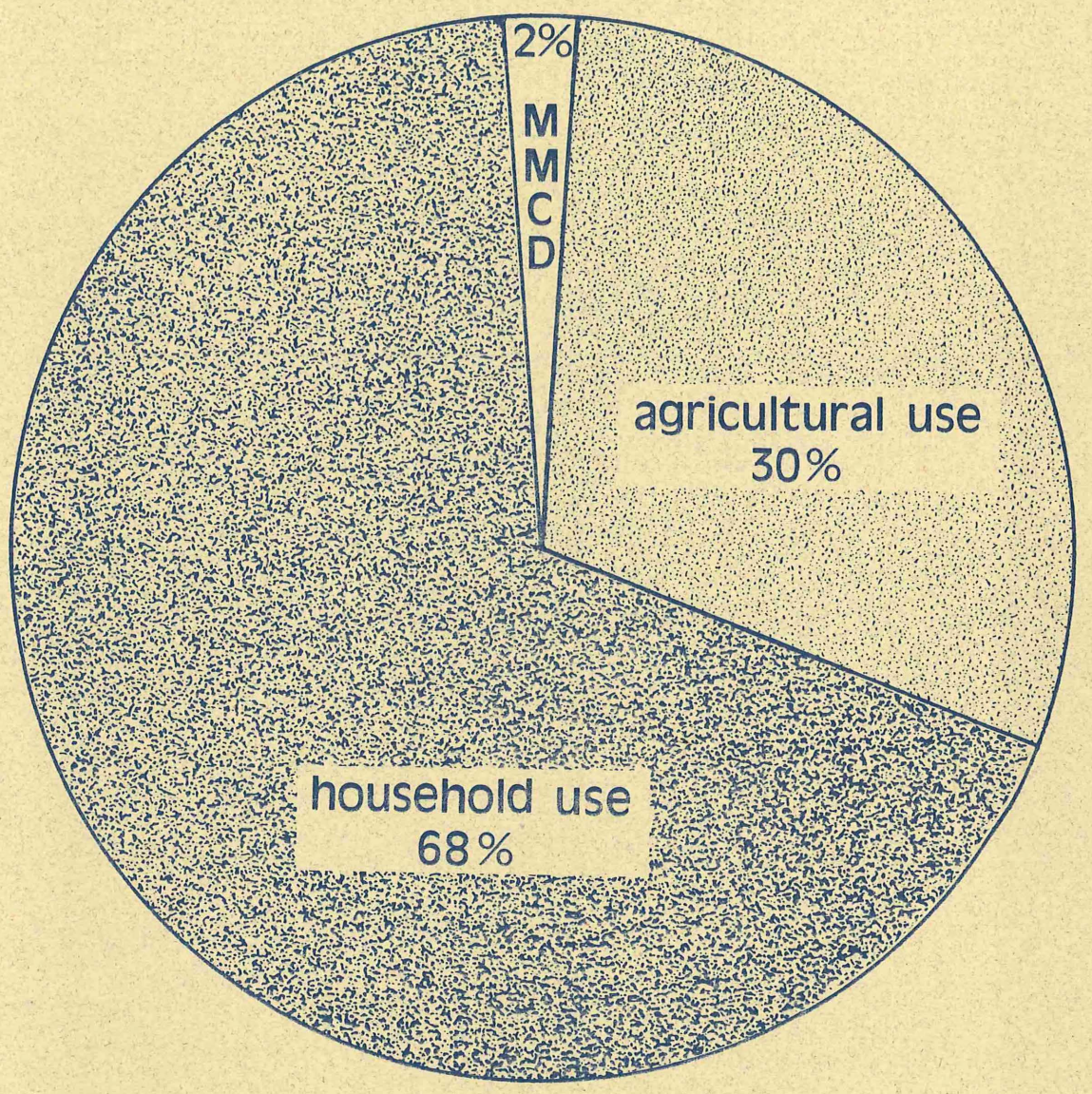
FUEL CONSUMPTION IN THE TWIN CITIES AREA

The growing demand for products derived from petroleum, natural gas and their distillates has been of increasing concern. Federal and State officials have publically encouraged conscientious use of these products by their employees and constituents. Consumption of gasoline in Minnesota increased sharply in 1976, with total annual consumption in the state at 830 billion gallons in the first five months. This figure represents a return to the high levels experienced before 1974. The rate of consumption in 1976 represents a 6% increase over 1975, 7% over 1974 and 1.7% over 1973. Useage rates in 1973 were the highest ever recorded(Minnesota Pioneer Press, June 19, 1976). According to Minnesota Energy Agency officials, gasoline consumption in the seven county area for 1976 was approximately 940,000,000 gallons. Total consumption in the metro area was 934,000,000 gallons in 1975. The rate of growth between 1970-1976 is 3.2%.

Nationally, natural gas will be increasingly in short supply in the foreseeable furture. While some supply sources (notably coal feedstocks and imported LNG) will respond to increased paces, conservation will remain the watchword as wells dry up.



relative insecticide use
within MMCD

program description

CURRENT M.M.C.D. MOSQUITO CONTROL PROGRAM

HISTORY AND CHARACTERISTICS OF THE METROPOLITAN MOSQUITO CONTROL DISTRICT

Public mosquito control was first effected in Minnesota in 1949 under the provisions of MS 18.041 - 18.161 which enabled cities, towns, or village boroughs to establish mosquito abatement boards either through resolutions adopted by local governing boards or public referendum. Control operations were allocated tax-based financing not to exceed one mill. Local governments were empowered to contract with one another to form joint abatement programs.

County programs were not specifically provided for under this law. County control could be provided only when each subordinate unit of government adopted a local resolution and then effected contracts for joint control with every other governmental unit within the county. No single Minnnesota coummunity has ever availed itself of enabling law MS 18.041 - 18.161.

Rainfall was excessive in 1957 and mosquito populations abnormally high. Public demands for mosquito control prompted the promulgation of state law MS 18.022 enabling counties to provide individual or joint control of 'noxious pests' including mosquitos. Financing was provided for at 50 cents per capita.

Subsequently, six metropolitan counties (Anoka, Dakota, Hennepin, Ramsey, Scott, and Washington) formed a jointly administered Metropolitan Mosquito Control District, staffed by a director and permanent professionals under the direction of a commission representing member county boards. A history of the laws enacted in Minnesota enabling mosquito control is included in Appendix PD (exhibit A).

Public financing changed over the years from 50 cents per capita in 1958 to 81 cents for 1977 operations. During the early 1960's the District operated on a fixed annual budget of $751,969.50.

The 1977 budget is $1,539,400 or $1,710 per square mile within the larval control area. This budget provides for larval control in 34% of the District

and approximately 40% of mosquito breeding sites. This 'core control' area includes 900 square miles in the interior of the District.

At its inception, the District philosophy was closely related to a static budget. Control operations were generally threefold: location and inventory of breeding sites; identification of mosquito species; preventative chemical control of mosquito larvae. DDT was the least expensive and most effective control agent available and was used almost exclusively. Fuel oil was applied as a pupacide, and in ecologically sensitive areas such as pastures. Malathion was occasionally substituted for DDT as an adulticide.

Chemical control methods were substantially altered with the suspension of DDT use in 1968. The impact of this action is evident in levels of effective mosquito control and in current philosophy and program techniques.

From a purely technical viewpoint, DDT was not only inexpensive, it was also so effective as a larvicide and adult mosquito control agent that a one-time application at each site was usually sufficient per month. The transfer to alternate, environmentally compatible insecticides of less dosage and shorter duration increased costs and reduced the acreage which could be effectively treated each season.

INSECTICIDE REGISTRATION PROCESS

No insecticide is used by the MMCD unless it is registered by the U. S. EPA. Before a material is so registered, field tests are conducted with the compound which has been screened for effective mosquito control and toxicological safety to non-target organisms.

The MMCD has participated in these experimental field tests in cooperation with the University of Minnesota extension service and manufacturers. Determination of minimum dosage rates necessary to control mosquitos without endangering local non-target life is a particular function of these tests.

Information generated in national testing programs of this kind is shared among mosquito district technicians. Thus both laboratory experience and professional field expertise support the label use directions and limitations which accompany mosquito control materials.

After a compound is registered, the MMCD is able to tailor the selection of an insecticide and application methods to best suit the breeding sites in which it will be used to avoid negative environmental side effects.

Selection of an insecticide from among registered compounds is a function of cost-effectiveness, test results, relative merits of the compound compared to those currently in use, and anticipated effects of the material on the local environment. Each decision reflects a judgement on a habitat by habitat basis; thus the need for a variety of insecticides in a single program.

A compound judged to merit inclusion in the MMCD program is adopted on a season-long experimental basis. Materials are frequently excluded from full-time operational use because they are found ineffective or undesirable for use locally at registered dosage rates.

Current development costs for registration of a pesticide approximate 8 to 10 million dollars. This expenditure is generally made over a five to ten year period necessary to adequately prove compound reliability and safety. This cost factor coupled with a limited market for mosquito control has resulted in few pesticides being registered exclusively for mosquito abatement. As a result, compounds evaluated for agricultural use are incidentally screened against mosquitos. Those showing promise are subjected to further tests to determine their merits for mosquito control. If test results meet EPA criteria, the compound is granted experimental registration for a minimum of one year to permit field testing prior to full registration.

ORGANOPHOSPHATE INSECTICIDES

Fifteen insecticides are currently registered for use in mosquito control. As a result of the selection process noted above, the MMCD has adopted five of these for use in its program: chlorpyrifos, malathion, temephos, resmethrin and petroleum oil. The first three materials are organophosphates. Resmethrin is a synthetic pyrethrin.

A detailed examination of organophosphate chemistry and mode of action is considered to be beyond the scope of this EIS. The following discussion is intended as a brief introduction to the subject. Much of the material presented has been gleaned from several detailed sources. The reader is particularly referred to Eto (1974) for a comprehensive analysis of pesticide chemistry.

As the name implies organophosphates are chemically derived from carbon and phosphoric acids. "The target of organophosphorus esters, including insecticides and nerve gases, is acetylcholinesterase, which is one of the hydrolytic enzymes for acetylcholine. The inhibition of the enzyme disturbs the normal nervous function, finally resulting in death" (Eto, 1974).

According to Quaraishi (1977), "...initial interest in organophorus compounds started because of their neurotoxicity..." and was intensified when it was learned that "...this group has also yielded compounds showing extremely low toxicity to mammals while possessing very good insecticidal properties."

Quaraishi (1977) cites the following as desirable properties of organophosphorus compounds:

1. degradation to products non toxic to higher forms of life;

2. low dosage with rapid action on insects;

3. relatively rapid metabolism in and low chronic toxicity to mammals.

The empirical formulas of the materials used by the MMCD in its mosquito abatement program are shown below:

a) chlorpyrifos $C_9 H_{11} N_1 O_3 PS$

b) temephos $C_{16} H_{20} O_6 P_2 S_3$

c) malathion $C_{10}H_{19}O_6PS_2$

d) resmethrin $C_{22}H_{26}O_3$

e) petroleum oil - varies with crude source.

Toxicity of an organophosphate is directly dependent upon the strength and stability the carbon - phosphoric acid bond. As the bond deteriorates, toxic properties of the material diminish. Eto (1974) states that, "the hydrolysis rates of organophosphorus pesticides and their metabolites are of great importance, because the hydrolysis results in the detoxication of the pesticides and, moreover, their susceptibility to alkaline hydrolysis relates to their biological activity."

Eto (1974) also notes that, "among the physical forces that are responsible for the chemical change of pesticides in the environment, solar radiation is the most powerful... sufficient energy exists within the range of ultraviolet (UV) sunlight wavelengths (290 - 450 nm) to bring about many chemical transformations... the products of photo chemical reactions and their rate of formation are greatly affected by many factors such as light intensity, the wavelength of the light, irradiation time, the state of the chemicals (e.g. thin film or in solution), the kind of supporting medium or solvent, pH of solution, and the presence of water, air and photosensitizers."

Eto (1974) adopts the common categorization of pesticides as: a) highly persistent, b) moderately residual and c) rapidly decomposing and concludes that organophosphates are much less persistent than some chlorinated hydrocarbons and normally dissipate within 2-4 weeks, although they do not always completely degrade within this time frame. In field tests with some organophosphates, (e.g. phorate) "derivatives persisted in the silt loam beyond 16 weeks, although the biological activity was lost by strong absorption to soil constituents."

INSECTICIDE SELECTION PROCESS

"The evolution of research on chemical control strategies is governed by the availability and use pattern of chemical control agents and the general trend in other areas of scientific research. Some of the major factors which stimulate continued research on the development and application of mosquito control agents are:

1. Biological activity - the effectiveness of chemical control agents against mosquitos...;

2. Specificity - Researchers have always sought after chemicals which possess a narrow range of activity, inducing mortality or response in target species only...;

3. Acquired Resistance - this feature of the biological species is probably the most important consideration in the development of substitute materials and alternate vector control technologies;

4. Safety - The extent of toxicity to man and his domestic animals determines the use pattern of chemical control agents under various conditions...;

5. Hazards to Nontargets;

6. Environmental Impact;

7. Economics" (Mulla, 1976).

Reasons other than cost considerations, which might influence the use of any of the EPA registered insecticides correspond to those criteria cited by Mulla (1976). A brief discussion of desirable characteristics of these materials in mosquito control follows.

PARATHION has been used effectively for mosquito control in various areas of the United States, including extensive use in California since approximately 1955. This insecticide while extremely toxic in its concentrated form has a long, safe-use record for mosquito control when applied in both liquid and granule form by aerial and ground application. Its principle advantage is its low cost and relatively rapid rate of breakdown.

METHYL PARATHION has basically the same features as parathion with a slightly lower mammalian toxicity. It also has an extensive safe-use record in both liquid and granule form.

DICHLORVOS is an effective adult control material when used under calm conditions which allow the insecticide vapor to reach the concentration needed to obtain control (this is the material contained in a popular pest strip).

LETHANE 384 is an adult control insecticide which has not been widely used in recent years.

PROPOXUR (BAYGON^{R}) is a carbamate insecticide which is one of the most effective adult mosquito control materials available. It controls through both vapor and contact action and has a residual control of 3 to 5 days.

CHLORPYRIFOS is used because it enables prehatch treatments to be made in advance of storms. No other material registered for larval control provides the prehatch capability and duration of control of chlorpyrifos.

FENTHION is an effective larval and adult mosquito control material with an extensive use history in mosquito control in the western United States as a replacement for malathion and parathion.

NALED is a low cost, effective adult control material which converts to dichlorvos upon application providing both contact and vapor action.

CARBARYL is a flowable powder carbamate with a moderate mammalian toxicity and short residual life.

MALATHION is a well known organophosphorus insecticide with a wide spectrum of activity against insects. It has a very low mammalian toxicity and short life span in the environment. Malathion has been widely used in domestic and public insect control programs longer than most other insecticides. Therefore, much is known about the material and its effects, prompting its general use.

SYNERGIZED PYRETHRUM AND RESMETHRIN are used for adult control due to their rapid rate of breakdown after application, effectiveness and relative low cost. Resmethrin is effective locally at rates approximately 1/2 of that listed on the label.

DIMILIN is a new mosquito control material which has been in development for approximately 5 years and has experimental registration for limited use for evaluation purposes pending full registration. It is one of the third generation insecticides, commonly termed an insect developmental inhibitor which inhibits chitin synthesis. It is effective at dosage rates averaging .025 lb AI/acre, and loses its biological activity after 3 to 7 days.

METHOPRENE, known more commonly by its trade name Altosid^{R} is also a third generation insecticide commonly termed a juvenile hormone insecticide. This material mimics the juvenile hormone present in the body of mosquito larvae and when absorbed by the larvae in sufficient amounts, prevents the over-riding or blocking of the juvenile hormone by the molting hormone thus causing the insect to die in the pupal stage. It is not used operationally in the District program principly due to its short period of effectiveness, impact on non-target aquatic insects similar to that of temephos and high cost.

TEMEPHOS is used due to its wide safety margins for fish and wildlife, rapid rate of breakdown, temporary effect on non-target invertebrate aquatic life and relative low cost. It is used in all runoff areas and MMCD Type III sites.

PETROLEUM OIL is used for pupal control in sites during the pupal period. Petroleum oils are the only materials approved for pupal control.

A chemical mosquito control program combining larval and adult control necessitates a combination of insecticide formulations adapted to habitat characteristics. Material and application costs are balanced against environmental costs in selecting the material used. The MMCD treats mosquitos in three distinct habitats of varying degrees of biological productivity which are distributed in a highly urbanized metropolitan area.

Chemicals selected for use in these areas are chosen with a consideration for the current level of natural mosquito control existing in each site, historical larval density of each site, the site's proximity to residential areas, the wildlife supported by the site and the history of water retention at each site in addition to costs. The materials which favor non-target organisms have been selected conscientiously by the MMCD although often at costs well above those for less compatible though equally effective compounds.

Comparative costs for alternate larval control materials are shown in Tables 19 and 20.

Parathion, methyl parathion, dichorvos lethane and propoxur are not used for mosquito control by the MMCD because of their relatively high mammalian toxicity. Fenthion has been excluded from the program due to its toxicity to birds. Naled is not used by the District because of its corrosive properties and its irritating effect upon the eyes and mucus membranes of persons coming in contact with it. Carbaryl is considered to be less effective as a control agent than other formulations.

In the current MMCD chemical control program chlorpyrifos (Dursban^{R}), malathion, petroleum oil, resmethrin and temephos (Abate^{R}) are used in the amount and percent noted in Table 21. It should be noted that malathion is being phased out of the M.M.C.D. adulticiding program to reduce mosquito population exposure to organophosphates and lighten selection pressure for resistance. Malathion and methoprene are the only materials registered for use in pastures.

A fuller description of these formulations and their uses in the program is provided in Tables 22 and 23. Procedures followed in the mixing and handling of the formulations is included in Appendix PD (exhibit C) which accompanies this report.

The mosquito control season begins on March 15 and normally ends September 15 when Aedes eggs enter diapause. During a normal season, the District treats some 68,000 breeding acres with roughly 6,000 pounds of active insecticide ingredients.

TABLE 19

LARVAL CONTROL MATERIALS:
COST OF AERIAL APPLICATIONS

	HIGH VOLUME			ULTRA LOW VOLUME			GRANULE		
	Per Acre Material Cost	Air Application cost this Formulation	Total	Per Acre Material Cost	Air Application cost this Formulation	Total	Per Acre Material Cost	Air Application cost this Formulation	Total
Parathion	$ .27	$3.00	$3.27	$ .27	$1.00	$1.27	$1.75	$1.53	$3.28
Methyl Parathion	.25	3.00	3.25	.25	1.00	1.25	1.75	1.53	3.28
Chlorpyrifos	.55	3.00	3.55	.55	1.00	1.55	1.55	1.53	3.08
Fenthion	.90	3.00	3.90	.90	1.00	1.90	2.30	1.53	3.83
Malathion (5 lb.)	1.23	3.00	4.23	1.23	1.00	2.23	-	1.53	-
Dimilin	1.50 est.	3.00	4.50	-	N.A.	-	2.00 est.	1.53	3.53
Methoprene	2.34	3.00	5.34	-	N.A.	-	-	N.A.	-
Temephos	.63	3.00	3.63	.60	1.00	1.60	2.40	1.53	3.93
Petroleum Oils	1.20	3.00	4.20	-	N.A.	-	-	N.A.	-

TABLE 20

LARVAL CONTROL MATERIALS
ANNUAL COSTS PER ACRE OF GROUND APPLICATIONS

	Parathion	Methyl Parathion	Chlorpyrifos	Fenthion	Malathion	Dimilin	Methoprene	Temephos	Petroleum Oil
Average # of treatments per year	6	6	2-3	6	6	6	6	6	6
Labor cost per year for ground application ($)	12.36	12.36	6.18	12.36	12.36	12.36	12.36	12.36	12.36
Limitations on use under certain circumstances	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Material cost/acre/year ground application (granule applications where available)	10.50	10.50	4.65	13.80	8.86	12.00	14.04	9.60	7.20
Cost of controlling one acre for one year	22.86	22.86	10.83	26.16	21.22	24.36	26.40	21.96	19.56

TABLE 21

AMOUNT OF ACTIVE INGREDIENTS IN INSECTICIDES USED BY THE MMCD: AVERAGED FOR 1975-76 SEASONS

Material	Amount of Active Ingred. Used	% of Total
57% Malathion liquid concentrate	1,346 lbs.	4.0%
1% Chlorpyrifos sand granules	1,054 lbs.	3.2%
1% Chlorpyrifos celatom granules	1,054 lbs.	3.2%
40% Resmethrin liquid concentrate.	814 lbs.	2.5%
43% Temephos liquid concentrate	680 lbs.	2.1%
41% Chlorpyrifos liquid concentrate	455 lbs.	1.4%
No. 2 Fuel Oil*	26,512 lbs.	81. %
	32,765 lbs.	100%

* 1 gallon fuel oil = 7.8 lb.

NOTE: In contrast with other insecticides, fuel oil must be applied full strength therefore the 81% is misleading Fuel oil is only used for larval control in pastures and against pupae. In real numbers it is a small portion of the total materials used.

Chlorpyrifos and temephos granule and liquid formulations are major materials used in the MMCD operations. The rationale for using one over the other is mainly a function of their residual characteristics. The residual control of chlorpyrifos is approximately 20 days in the summer in contrast to 12 hours for temephos (MMCD records, 1976).

Chlorpyrifos is used by the MMCD in Type I sites which do not drain into any lake or stream. Its long residual effect (40-60 days during the spring and early summer at 0.05 lbs. AI/acre and 20-30 days during mid-summer at 0.1 lbs. AI/acre) make it an economical labor saving control agent against Aedes vexans. Most Type I sites can be controlled with three annual applications, and Type II sites with one annual application of chlorpyrifos either before or after snow melt. Six to eight applications of temephos would be required to control Type I sites and two to control Type II sites.

The value of chlorpyrifos in the MMCD program is in its use as a prehatch. Granular treatments made between March and July at one-half the registered dosage provide a distinct economic advantage as applications can be made between storms which are effective in the post storm period of mosquito development. Seasonal treatment of 60,000 acres with chlopyrifos costs approximately $192,000 (1977 figures). A temephos substitute would cost $250,000 more due to additional material and labor costs.

Temephos is used in Type I and Type II sites which drain into lakes or streams after each rainstorm. Numerous applications are required as temephos will not control mosquito larvae hatching 24 hours after initial treatment.

Temephos is also used to treat Type III breeding sites poorly controlled by natural mosquito predators. Both temephos (at 0.05 lbs. AI/acre) and chlorpyrifos (at 0.025 lbs. AI/acre) are used to control the massive broods of floodwater Aedes species which are produced in river bottom back water areas during flooding periods. Band treatments are made along the shoreline concentrations of larvae, which are isolated rather than block treatments of the river bottom.

In addition to chlorpyrifos and temephos, malathion and petroleum oils are also used for larval control in pastures.

Resmethrin, which leaves negligible insecticide residue is used in ground cold fogging.

Field applicators are trained in the proper use of insecticide materials under varying conditions. Insecticides are subject to specific application by virtue of registration. Examples of guidelines used by the MMCD to determine need for insecticide application are included in Appendix PD (exhibit B).

TABLE 22

INSECTICIDE FORMULATIONS AND USES IN THE MMCD PROGRAMS

5 lb. Malathion

57% emulsifiable liquid, EPA Reg. No. 2393-203

o, o-dimethyl phosphorodithioate of diethyl mercaptosuccinate	57%
Xylene	30%
Inert Ingredients	13%
	100%

The MMCD phased out the use of malathion for adult control in 1976. It will continue to be used for larval control at 0.5 lb. AI/acres (i.e., 13 oz. per acre) in pastures until supplies are depleted.

1% Chlorpyrifos

Sand granules EPA Reg. No. 5481-121

Chlorpyrifos (o, o-diethyl o-(3,5,6 trichloro -2- pyridyl) phosphoro-thioate)	1%
Silica sand 15 mesh	99%
	100%

The MMCD uses this formulation at 0.05 lb. AI per acre during spring months and at 0.1 lb.AI for summer prehatch treatments.

1% Chlorpyrifos

Celatom Granules EPA Reg. No. 2393-229

Chlorpyrifos (o, o-diethylo o-(3,5,6-trichloro -2- pyridyl) phosphorothioate)	1%
Eagle-Pitcher Company Celatom MP-82 Diatomaceous earth	99%
	100%

The MMCD uses this formulation at 0.05 lb. AI per acre during spring months and at 0.1 lb. AI per acre for summer treatments.

1% Temephos

Celatom granules EPA Reg. No. 2392-223

o,o,o',o', tetramethyl o, o' thiodi-p-phenylene phosphorothioate	1%
Eagle-Pitcher Company Celatom MP-82 Diatomaceous earth	99%
	100%

The MMCD uses this formulation at 0.025, 0.05 and 0.075 lb. AI per acre for larval control.

Resmethrin

SBP-1382-40MF (3.34 lbs. per gallon) synthetic pyrethroid EPA Reg. No. 432-502.

(5-benzyl-3-furyl) methyl 2,2-dimethyl -3- (2- methylpropenyl) cyclopropane-carboxylate	40.00%
Related compounds	5.45%
Aromatic petroleum hydrocarbon	52.95%
Inert ingredients	1.60%
	100%

The MMCD uses resmethrin for adult control at 0.0035 lbs. AI in 1.5 oz. total finished spray material per acre. The carrier is Klearol mixed with toluol or hysol to increase formulation stability at low temperatures.

4 lb. Temephos

Liquid concentrate, EPA Reg. No. 6900-120

o,o,o',o' - tetramethyl o,o' thiodi-p-phenylene phosphorothioate	43%
Aromatic petroleum solvent	39%
Inert ingredients	18%
	100%

The MMCD uses temephos in poly propylene glycol for larval control at 0.05 lb. AI in 6.0 oz. total finished spray material per acre.

4 lb. Chlorpyrifos

Liquid concentrate, EPA Reg. No. 464-368

Chlorpyrifos (o, o-diethyl o-(3,5,6 trichloro -2- pyridyl) phosphoro-thioate)	41.2%
Aromatic petroleum derivative solvent	29.5%
Emulsifiers and chlorinated solvent	29.3%
	100%

The MMCD uses chlorpyrifos for larval control at 0.025 and 0.05 lb. AI in 6.0 oz. total spray material per acre. The carrier is agricultural grade white mineral oil or fuel oil. On rare occasions, chlorpyrifos is applied by aircraft for adult control at 0.025 AI in 10 oz. of agricultural grade white mineral oil per acre.

Fuel Oil

The MMCD uses fuel oil with 1/10 percent Triton X-100 for larval control at rates up to 3 gallons per acre.

TABLE 23

INSECTICIDE CARRIERS, DILUENTS AND SURFACTANTS USED BY THE M.M.C.D.

Material	Uses
Sand	Carrier for chlorpyrifos granules (ground application)
Eagle-Pitcher Company Celatom MP-82 (Diatomaceous earth)	Carrier for temephos and chlorpyrifos granules (aerial application)
Klearol (food grade white mineral oil)	Diluent for cold fog adulticiding material
Agricultural grade white mineral oil	Diluent for chlorpyrifos ULV aerial treatments Also used as an alternative diluent for resmethrin
Poly-glycol (P-400) Dow Chemical Company	Diluent for temephos liquid ULV aerial applications
Toluol (toluene)	Solvent to dilute 40% resmethrin material (1.0% to 2.3% of total depending on temperature).
Hysol (4-1) Ashland Chemical Co.	Solvent to dilute 40% resmethrin material (2.5% to 9.0% of total, depending on temperature)
Triton X-100	Fuel oil surfactant (1/10th percent of final mixture)

The most effective way to control mosquitos is through larval treatments. Larval control by the MMCD covers approximately 68,000 acres within the core area of the six county region. Roughly 90% of these acres are temporary water sites (61,000 acres). Insecticides used in larval control

are applied in dry formulations (80%) and liquid formulations (20%) at an average rate of 0.08 pounds per acre active ingredient.

In adult mosquito control liquid materials are used exclusively. Roughly 233,900 acres are treated each year with 844 pounds of active ingredient at an average dosage rate of 0.0036 pounds per acre.

Materials used in larval and adult mosquito control treatments are shown in Table 24.

TABLE 24

MATERIALS USED BY THE MMCD FOR LARVAL AND ADULT MOSQUITO CONTROL.

Average Acreage Treated for Larval Control 68,000

Acres Treated	Material	% of Total
35,000	1% Chlorpyrifos granules	53%
17,400	1% Temephos granules	26%
9,200	41% Chlorpyrifos liquid	13%
2,700	57% Malathion liquid	4%
2,000	43% Temephos liquid	2%
1,700	Fuel Oil	2%
	20% liquid material	
	80% dry material	

Average Acreage Treated for Adult Control 233,900

Acres Treated	Material	% of Total
232,580	40% resmethrin liquid	99.4%
1,355	41% Chlorpyrifos liquid	0.6%
	100% liquid material	

Methods used in the application of insecticides by the MMCD in 1975 and 1976 are shown in Table 25.

TABLE 25

ACREAGE TREATED BY APPLICATION METHOD

	1975[1]	1976[2]	Average Per Yr.	% of Total Acres Treated
Air larviciding acreage				
Liquid 40 PSI	20,808	6,230	13,519	20%
Granule	27,299	32,975	30,137	44%
Ground larviciding acreage (granule)	22,450	26,168	24,309	36%
Total larviciding acreage	70,557	65,373	67,965	100%
Air adulticiding acreage				
Liquid 450 PSI[3]	2,070	640	1,355	0.6%
Ground adulticiding acreage	286,536	178,618	232,577	99.4%
Total adulticiding acreage	288,606	179,258	233,932	100%

[1]Record high mosquito production year (14 broods)

[2]Record low mosquito production year (3 broods)

[3]Applications require approval of Director

Different mosquito species require different types of control measures. Specific costs for the control of each vector species vary with annual rainfall patterns. In general the control of Aedes triseriatus mosquitos is the least expensive with costs limited to the labor required to locate and correct or eliminate tree hole and artificial container breeding sites in wooded areas. Control of Culex tarsalis is only required during years favorable for the development of above normal populations. Above normal rainfall is often associated with high populations of this species. When control measures are called for, the cost is approximately the same as it is under the current control program as the square miles of larval control are equivalent.

During years Culex tarsalis populations rise above normal, entomological monitoring of this species is intensified in association with monitoring of suspected equine cases of encephalitis by the State Livestock Sanitary Board. When adult populations of this mosquito reach 30 per light trap in a given week the potential for further population increase is assessed. If it is determined that the population will increase, the normal Aedes pest control program is converted to one of vector control and C. tarsalis control is intensified.

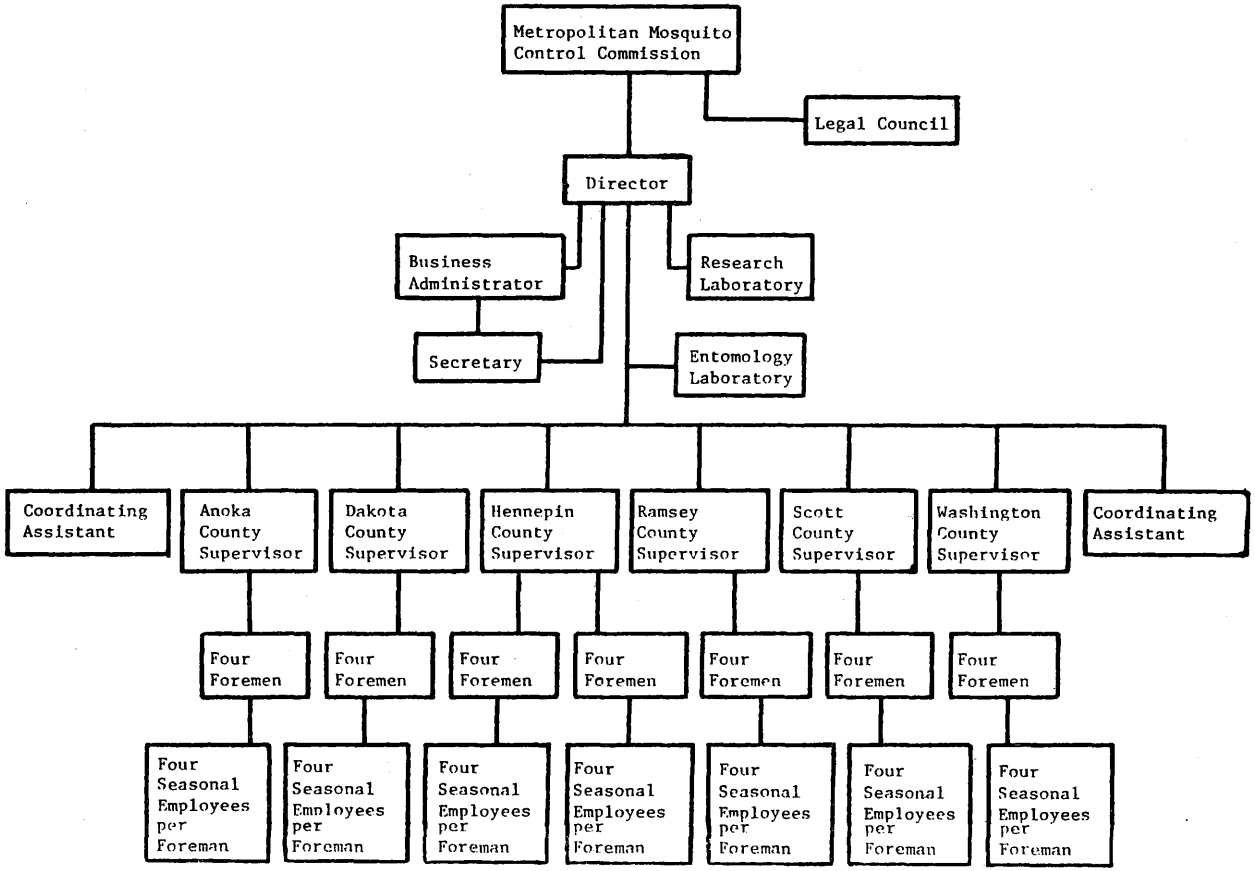
Spring (woodland) Aedes and Aedes vexans are involved in the transmission of dog heartworm. Their annual prevalence and the extensive flight range of the latter makes control of this species the most intensified and most expensive.

M.M.C.D. FIELD OPERATIONS

Staff

The Metropolitan Mosquito Control District operates a seasonal program. A director and 40 professional staff are employed on a full-time basis. An additional 120 persons are employed on a seasonal basis during the spring and summer months. A diagram showing the hierarchy of responsibilities within the District is shown in Table 26. Qualifications and responsibilities of field personnel are included in Appendix PD (exhibit D).

Table 26


Metropolitan Mosquito Control Commission
Legal Council
Director
Business Administrator
Research Laboratory
Secretary
Entomology Laboratory
Coordinating Assistant
Anoka County Supervisor
Dakota County Supervisor
Hennepin County Supervisor
Ramsey County Supervisor
Scott County Supervisor
Washington County Supervisor
Coordinating Assistant
Four Foremen
Four Foremen
Four Foremen
Four Foremen
Four Foremen
Four Foremen
Four Foremen
Four Seasonal Employees per Foreman
Four Seasonal Employees per Foreman
Four Seasonal Employees per Foreman
Four Seasonal Employees per Foreman
Four Seasonal Employees per Foreman
Four Seasonal Employees per Foreman
Four Seasonal Employees per Foreman

The mosquito season and field operations begin approximately March 15 when Aedes mosquito species begin hatching, and continue to approximately September 15 when Aedes vexans enter diapause. During the months of June through August two employee shifts work between 6 A.M. and 10:30 P.M.

Plant Facilities

The MMCD leases eight buildings in the Metropolitan Area. Seven are field offices located in each of the District's six counties. Each includes roughly 4,000 square feet of space. These facilities are used as regional administrative offices and for the storage of materials and equipment. The M.M.C.D. headquarters is located at 1802 Como Avenue in St. Paul. Administrative and laboratory facilities are located at this address.

Equipment

Equipment used by the MMCD for application of individual chemical control materials is detailed in Appendix PD (exhibit D).

In general, application equipment includes aerial and ground systems. Helicopters contracted for aerial larval control (2) are equipped with three application systems: a Simplex System Granule Spreader and two Ultra Low Volume (ULV 6-10 fl. oz. per acre) spray systems

Ground equipment include hand pressure sprayers (117); hand seeders (209); International Harvester Scouts equipped with granule guns (2); Hudson Back Packs (116) and cold foggers (56).

Support equipment are primarily limited to pickup trucks, oil tank trucks, jeeps and station wagons. The total number of vehicles owned or rented by the District for regular or seasonal use was 90 in 1974; 81 in 1975 and 75 in 1976. The reduction is due to the introduction of a double work shift in 1975, increasing the number of evening staff and reducing the number of vehicles needed during the day. A detailed inventory of vehicles is included in Appendix PD (exhibit D).

A system of 35 rain gauges are monitored during the mosquito season to determine when larval inspections should be initiated after a storm.

Eighteen light traps are operated daily in the central core area and periphery of the District. These fixtures operate automatically for a 13 hour period between sundown and sunrise and are used to monitor adult mosquito populations. Average weekly catches recorded at eight selected light traps during the 1975 and 1976 season are shown in accompaning Figure XIII.

Equipment Calibration

Hand carried Hudson liquid sprayers are used to apply fuel oil to pastures as a pupacide. The containers have capacities of two and four gallons.

Depending upon the density of foliage, one to three gallons of oil are applied per acre. The sprayers cannot be calibrated, the proper dosage is achieved by varying the walking speed and to a lesser extent the nozzle setting. Clean water surfaces require less oil, scum covered surfaced and dense vegetation require higher rates. A $\pm$ 10% error factor can be expected (field reports).

Hand seeders used for the application of chlorpyrifos and temephos dry granules are of two types. One is a canvas bag attached to a wood plate. The other is a plastic hopper. The capacity of the bag is approximately 8 lbs. of celatom or 28 lbs. of sand granules. The hopper capacity is 9.5 lbs. celatom or 20.5 lbs of sand.
In the field, a foreman issues the seeder to the applicator. The site is paced and the acreage determined. Each seeder is equipped with a gate to regulate rate of granule discharge. The gate is set according to the required dosage, swath and the walking gait of the applicator. Each employee retains use of his own adjusted seeder. Error in subsequent use is influenced by factors hindering maintenance of normal gait such as terrain, vegetation density, muck bottoms of ponds, etc. Under extremely difficult walking conditions the error factor of inexperienced employees could be as high as 25%. Under normal conditions, experienced employees would average $\pm$10% error.

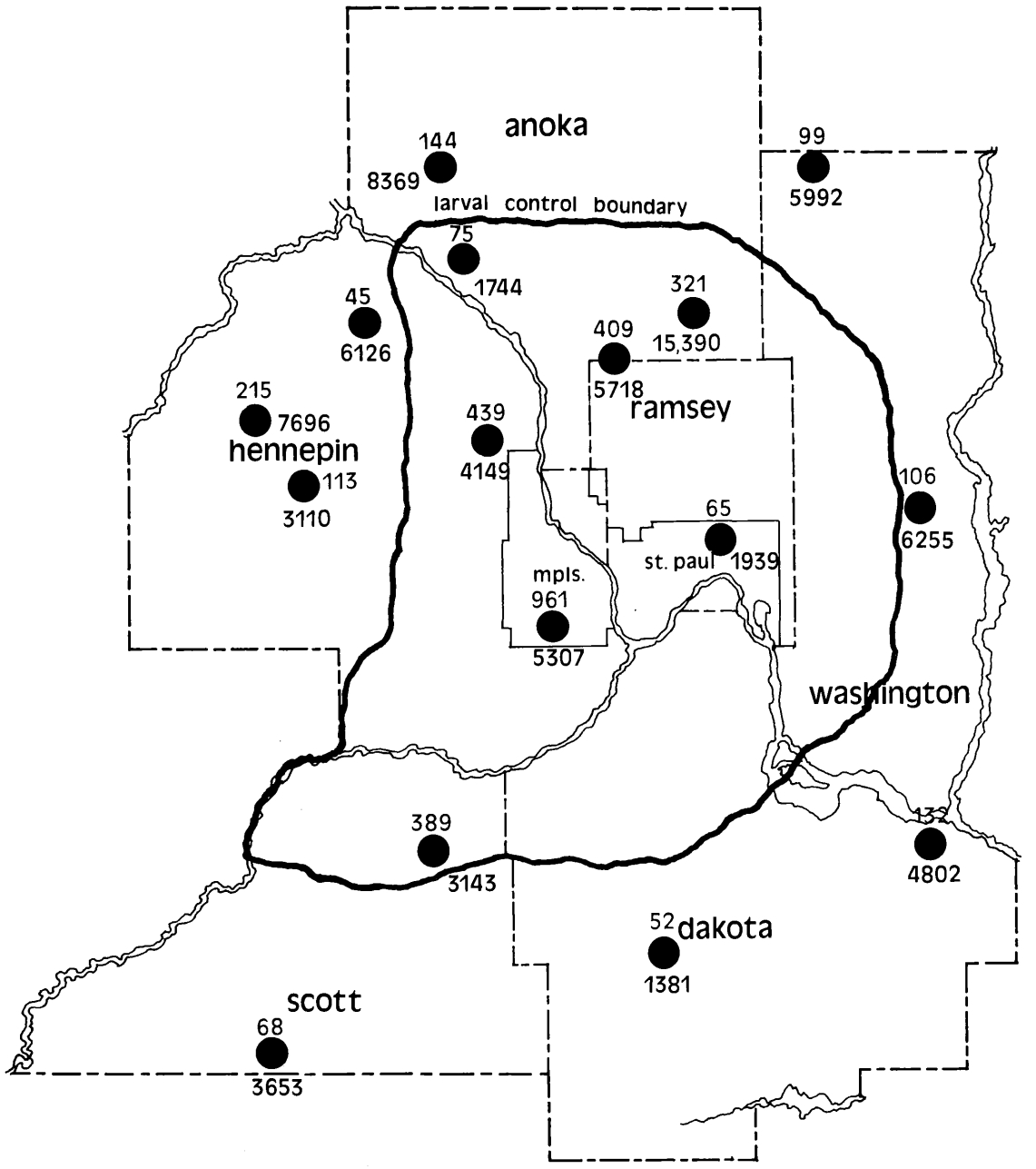


figure XIII.

light traps

monitored by MMCD

1976 : seasonal catch of Aedes vexans

● location of light traps

1975 : seasonal catch of Aedes vexans

miles 0 5 10 15 20 n

john and michele genereux

Cold foggers are used for the application of resmethrin and pyrethrum. The machines are calibrated to release material in ounces per minute. Each machine is equipped with a five gallon fluid reservoir. Proper application is achieved according to the following formula:

1.5 oz. per acre = 9 oz. dispensed per minute when truck speed is 10 m.p.h.

When calibrating, one gallon of material is put into the reservoir and the fluid level recorded. The machine is allowed to run for ten minutes. The amount of fluid required to bring the fluid level back to its original level is measured and divided by the number of minutes operated to determine the flow rate per minute.

To achieve the correct particle size the machine must operate under four pounds of pressure. Pressure levels are checked weekly with air pressure guages.

The cold fogger applies material in 300-500 foot wide swaths. The width of the swath is determined by the terrain and road intervals in the area to be treated. The need for treatment is determined through adult mosquito biting counts. Bite collections and spraying activities are conducted at temperatures above 60°F when winds are between 3-8 m.p.h. as measured by a hand held wind meter.

The Hudson Back Pack is also used to apply adult control liquids in areas not accessible to cold fog trucks. The prescribed dosage is 8.4 oz. per acre of resmethrin and 8.1 oz per acre of malathion.

The calibration procedure for the Back Pack is similar to that used for the granule seeder. The material discharge rate is based on the swath and rate of movement of the person making the treatment which combine to deliver the correct dosage rate.

For malathion, 0.34 lb AI/acre = 1.7 oz. per minute
and
8.4 oz. per acre = 5 minutes required to treat one acre.

For resmethrin, .007 pounds of insecticide = 4.3 oz. per gallon of finished spray = 1.6 oz. dispensed per minute = 8.1 oz. per acre = 5 minutes treatment per acre.

The average swath covered by the Hudson Back Pack is 23 to 30 feet. Calibration checks are conducted three times a year for granule seeders and back pack units.

Helicopters are used to apply liquid and dry granular materials. The equipment used to apply dry material is calibrated to deliver the required application rate. The helicopter is equipped with a fiberglass hopper which is baffled and fitted with a double latch cover and a metal metering gate. Mirrors are attached to landing skids to enable pilots to observe proper delivery and shut off.

The helicopter flies at an altitude of 50 feet at a speed of 55 miles per hour. Ground crews and airport flight service monitor wind speeds. No applications of dry materials are made at wind speeds in excess of 10 m.p.h. Most flights are made when wind speeds are less than 6 m.p.h. as there are no gusts at wind speeds of 1-4 m.p.h. (Lakeline Helicopter Co., 1977). The operational swath width is 85 feet.

The granule application equipment is calibrated at the beginning of each season and thereafter as needed. Multiple passes are made to measure the deposit obtained on each pass across the swath. When the desired discharge is achieved as measured by quantity of granules collected in one foot square pans placed at ten foot intervals across the swath, the gate opening is recorded. It is checked weekly during the season.

Any deviation in the correct application rate is obvious in two areas. The employee responsible for the aerial operation will notice that either more material is needed to treat a site or material is remaining in the system after treatment of the site. The bookkeeping system utilized by the District requires that each site application be recorded individually by number of acres treated and amount of material used. Any deviation from the prescribed application rate is noted at the weekly tabulation and investigated.

Liquid applications are made by helicopter at wind speeds of less than 5 m.p.h. Liquid spray is dispensed for larviciding at 6 and 13 fl. oz. and for adulticiding at 10 fl. oz. per acre rates. The swath widths are 120 and 320 feet respectively when flying at a 90° angle to the wind.

Each helicopter is equipped with a boom mounted with ten nozzles. The mass median droplet (MMD) diameter of the larviciding spray is 250 microns. The adulticiding nozzles produce a MMD of 35 microns.

Helicopter calibration is done on the ground. Based on the known effective swath width and the speed of flight the number of acres treated per minute is known. For example 55 mph x 88 feet traveled/mph x 120' swath ÷ 43560 sq. ft/acre = 13.3 acres treated/minute. Thus for a 6 oz/acre finished spray volume the flow of all nozzles combined must equal 80 fl. oz/minute.

Washing and Disposal of Equipment and Containers

All equipment is washed with soap (except hand seeders) twice a week. Vehicles are washed out of doors in areas where waste water does not run into depressions, ditches or sewage systems. In Scott County vehicles and equipment are washed indoors. Waste water runs into a trap then into a septic system. In Hennepin County, the vehicles are washed in a drive-through automated car wash. The waste water runs through a trap then into a sanitary sewer.

Between 45-50 gallons of water are used to wash each vehicle each week when hand washing. The car wash system uses approximately 100 gallons of water in the combined wash and rinse cycle. Soap is used in a concentration of one-half cup per 50 gallons of liquid.

Cans and containers are decontaminated as per instructions in the manual shown on appendix page Pd-41. Five gallon tins are punctured and disposed of in county land fills. Thirty gallon drums are stockpiled.

With the exception of some crystallized malathion and old test materials, current inventory rotation has prevented the need for disposal of deteriorated materials. Eighty-five gallons of malathion have been disposed of since 1975 through shipment to a class I disposal area in Illinois.

The District discarded 35 empty, decontaminated five gallon insecticide containers in 1976. No 35 or 55 gallon containers have been discarded since 1975.

Employees wear OSHA approved chemical resistant gloves and rubber boots when cleaning District equipment.

FUEL CONSUMPTION AND NOISE GENERATION OF MMCD OPERATIONS.

Energy use by the MMCD is generally vehicle related. Prior to 1973, a substantial amount of fuel oil (30,000 gallons) was used each season as a larvicide and insecticide carrier.

Current uses (1975) are in Table 27.

Noise

Noise generation in MMCD operations occurs mostly in early evening or early morning hours. This is due to the low wind conditions necessary for application procedures (larviciding and adulticiding) and to the flight activity of adult mosquitos during these hours (adulticiding). Sound readings for MMCD equipment are included in Table 28.

SAFETY

Operations of the Metropolitan Mosquito Control District are subject to federal and state safety regulations. Handling of equipment and insecticide materials are taught to field employees in thirty-day training programs. Employees are provided with approved respirators, goggles, aprons, gloves and boots which, if used properly, will prevent them from exposure to insecticide materials used by the District. The proper use of these items is detailed in the MMCD Field Manual, as well as emergency precautions (spills) and methods for cleaning or disposal of insecticide equipment or containers.

TABLE 27

ENERGY USE IN MMCD FIELD OPRATIONS

I.	Gasoline (vehicle Use)	
	1. Truck larviciding operations	25,100 gal.
	2. Truck field reconnaisance operations	15,800 gal.
	3. Truck and back pack adulticiding operations.	12,600
	4. Helicopter operations	9,000
	5. General administration	3,600
		66,100
II.	Insecticide Use	
	1. Fuel Oil	5,750 gal.
	2. Klearol and mineral oil (adulticiding)	4,000 gal.
III.	Other (motor oil and solvents)	600 gal.

SOURCE: MMCD Records, 1975.

TABLE 28

SOUND READINGS (DBA) FOR MMCD FIELD EQUIPMENT

Reading Location	Cold Fog Machines 8 HP	10 HP	LECO	BACK PAK
40 ft. behind	76	79	82	81
40 ft. to side	75	78	80	77
100 ft. 45° to back	72	73	76	72
4 ft. behind	97	101	102	105
Inside truck, window up	71	72	76	
Inside Truck, window down	75	75	83	
At operators ear level				102
At front of operator				97

Helicopter: Bell 47

Lift off from 50 ft. to one side:	101 dba
100 ft. to one side:	97 dba
180° turn 50 ft. overhead at 60 mph:	99 dba
Pass 50 ft. overhead at 60 mph:	101 dba
Pass 100 feet to side, 50 ft. altitude, 60 mph:	92 dba

Noise Measurement
Equipment Used: B & K 2205
Windspeed: 9 MPH

Ambient Noise: 50 dba
Measured by: Sergeant Samuel Boe of Minnesota State Patrol. (Aug. 3, 1976)

Wastes which cannot be recycled are transported to a hazardous waste (non-nuclear) disposal site in Illinois.

Before any seasonal District operations begin, each employee is required to have a blood sample taken at the Metropolitan Health Center. The process is repeated during the season, should toxicity be suspected. The protocol followed in this monitoring process is explained in Appendix PD (exhibit E). During an average season roughly 2 of 128 employees complain of skin irritation which may suggest solvent or insecticide allergy. Medical records show that symptoms can usually be avoided with a barrier creme and by wearing long sleeved clothing. No serious developments have been reported.

INSECTICIDE TOXICITY

According to Hayes (1973), "toxicologists view a poison as simply too much of anything." Hazard, on the other hand, "...is the risk that injury will occur inadvertently; it can be expressed only descriptively and only in terms of the conditions of use." Hayes goes on to point out that "the hazard that a man will be injured even slightly by using a pesticide according to directions is almost nil."

Hayes offers the following list of materials and their toxicity(Table 29). It is noted that the acute toxicity of malathion is equivalent to that of aspirin and that of temephos (Abate^{R}) is less acute than table salt.

The District use of insecticides is governed by human and animal safety margins implied in the granting of EPA registration. Beyond that however, the District has reduced the maximum allowable concentration as appropriate for effective mosquito control under local environmental conditions. By avoiding control for 100% satisfaction the District has not needed to increase dosage or change formulations in a response to insect resistance since its inception in 1958. (Cutkomp, 1961-1977).

Maximum dosage is seldom used for any insecticide formulation and materials have been selected which have been proven to create minimal hazard to non-target organisms while highly effective in their

TABLE 29

TOXICITY OF ONE DOSE OF SELECTED MATERIALS. (PESTICIDES ARE UNDERLINED)

Material	Species	Sex	Route	Dosage (mg/kg)	Effect	Reference
Botulinus toxin A						
a-fraction	mouse	-	Intravenous	0.000,000,27	LD50	Dasupta et al., 1966
unfractionated	mouse	-	intraperitoneal	0.000,001,4	LD50	Lamanna & Carr, 1967
unfractionated	mouse	-	Oral	0.001,4	LD50	Lamanna & Carr, 1967
Temik	rat	M	Oral	0.8	LD50	Gaines, 1969
Tetraethylpyrophosphate	rat	M	Oral	0.8	LD50	Gaines, 1969
Parathion	rat	M	Oral	13.	LD50	Gaines, 1960
Endrin	rat	M	Oral	17.8	LD50	Gaines, 1960
Arsenic trioxide	rat	M	Oral	72.	LD50	Gaines, per. comm.
Chlorpyrifos	rat	F	Oral	82.	LD50	Gaines, 1960
Nicotine sulfate	rat	F	Oral	83.	LD50	Gaines, 1960
DDT	rat	M	Oral	113.	LD50	Gaines, 1960
Pyrethrum	rat	M	Oral	470.	LD50	Gaines, per. comm.
Acetylsalicytic acid - aspirin	rat	M	Oral	1360.	LD50	Eagle & Carlson, 1950
Malathion	rat	M	Oral	1375.	LD50	Gaines, 1960
Sodium chloride - table salt	rat	M	Oral	3550.	LD50	Gaines, per comm.
Temephos	rat	M	Oral	8600.	LD50	Gaines, et al. 1967

LD50 A special instance of LD50 in which the specified effect is death (Lethal Dose).
mg/kg - milligrams of dosage material per kilograms of body weight of organism receiving dose.
1 milligram is one-millionth part of a kilogram. One kilogram is approximately equal to 35½ ounces.

SOURCE: Adapted from Hayes, 1973.

action against mosquitos. Chlorpyrifos is an exception. While its use is not preferred, it is the only mosquito control material with pre-hatch capability. The difference between dose and lethal concentration of a toxic material may be interpreted as a safe-use margin. This difference is an estimate of the factor by which the MMCD dosage rate must be multiplied to achieve a concentration that is acutely lethal to 50% of the population of a given species.

For aquatic organisms, this factor is derived by dividing the acute LC_{50} values (24, 48 or 96 hours depending on reference used) by the maximum concentration of insecticide used by the District. This concentration is roughly twice that used in practice and is rarely applied.

The safe-use margin in aquatic environments then is equal to the formula

$$\frac{LC_{50} \text{ (ppm or mg/l)*}}{\text{maximum concentration (ppm)}}$$

The maximum concentrations of insecticides used by the District are shown in the following table.

Insecticide	Applied Form	Max. Concentration
Temephos (Abate^R)	1% granule	.075 ppm
Chlorpyrifos (Dursban^R)	2.5 - 10.0 lb/acre	.075 ppm
Malathion	43% concentrate	.375 ppm

The safe-use margin for terrestrial fauna is the number of liters of water that must be ingested per mg/kg of body weight to reach the lethal LD_{50} level. This margin is then equal to:

$$\frac{LD_{50} \text{ mg/kg of body weight}}{\text{Maximum concentration mg/l}}$$

*1ppm = 1 mg/l

Note: 1 kg = 2.2 lbs
1 = .264 gal.
LD_{50} levels are calculated on feeding tests of more than one day duration.

Based upon these formulae the safe-use margins of insecticides have been determined for members of four vertebrate groups. Figures are shown in Table 30.

POLICY TOWARDS TREATMENT OF GOVERNMENT PROPERTY AND SENSITIVE AREAS

Although the Metropolitan Mosquito Control District is enabled with the powers of eminent domain, it maintains a policy not to exercise this privilege. At the request of County, State and private agencies, mosquito control measures are not conducted on lands within their jurisdiction. Such non-treatment areas include the Carlos Avery Wildlife Refuge in Anoka County and most properties within the Hennepin County Park Reserve District.

The District proposes a public re-evaluation of this policy as a result of preparing this document in order to determine the benefit-risk ratio to public health of maintaining uncontrolled breeding sites within the Metropolitan area.

Sensitive areas, as defined by the MMCD, refer to those which a. may be harmed by the use of certain cehmicals; b. may be harmed by the use of certain equipment; c. are owned by persons who request that no applications be made.

Areas within the first category include breeding sites which drain into fish-bearing lakes. Roadside ditches are an example. One percent of the total linear distance of all roadside ditches in the area requires control for mosquito breeding due to retention of rainfall or improper installation of culverts. Ditches are normally controlled by pre-hatch treatment with chlorpyrifos granules. Sensitive areas are treated with temephos.

The second category includes turkey farms and mink ranches and game preserves where animals are highly sensitive to the noise generated by aircraft application and other field equipment.

TABLE 30

TOXICITY OF SELECTED INSECTICIDES TO MEMBERS OF FOUR VERTEBRATE GROUPS AT DOSAGE RATES APPLIED BY THE MMCD

ORGANISM	TEMEPHOS		CHLORPYRIFOS		MALATHION	
	Safety Margin*	Reference	Safety Margin	Reference	Safety Margin	Reference
AMPHIBIA						
Bullfrog	> 26667	2	>5333	2		
FISH						
Bluegill	720	4	.03;04	4, 6	0.3	4
Green Sunfish	> 333	4			0.3	4
Fathead Minnow	> 133	4	<13.3	6		
Largemouth Bass	> 2667	4			0.8	4
Mosquito Fish	> 2667	4	3.07	6		
Perch					0.7	4
Rainbow Trout	2.1	4	0.15	4	0.5	4
Striped Bass	13.3	5	0.008	5		
BIRDS						
Bluejay	< 400	1				
Bobwhite	1227;20533	8;1			9325	8
Canada Goose			>1067	2		
Cardinal	1013	1				
Chukar	3600	2	809	2		
Common Grackle			173	3		
Coturnix	1121;3467	2;8	212	2	7899	8
Crow			>427	3		
House Sparrow	627	1	133-280	2		
Leghorn Chick			301;1067	9;3		
Lesser Sandhill Crane			333-667	2		
Mallard	1067;11920	2;8	1008	2	13333	8
Pheasant	420;2160	2;8	112	2	7037	8
Pigeon	668	2	359	2		
Red Winged Blackbird			173	3		
Starling			1000	3		
MAMMALS						
Rat (Oral)	114667	7	2067	7		
Rat (Dermal)	> 53333	7	2693	7		
Rat (Oral)	173333	7	1093	7		
Rat (Dermal)	> 53333	7				

*Safe Use Margin = $\frac{LD_{50}}{\text{Max. Con.}}$ for all organisms except fish where S-U-M = $\frac{LC_{50}}{\text{Max. Con.}}$

Sources:

1. Hill, 1971
2. Tucker and Crabtree, 1970
3. Kenaga, 1970
4. United States Environmental Protection Agency, 1972b.
5. Korn and Earnest, 1974
6. Dow, 1977
7. Gaines, 1969
8. Hill, et al. 1975
9. Stephens, 1966

A third category is private property whose owners have formally requested that treatment be avoided. The contribution of these areas to mosquito production is discussed in the following subsection. A fourth category is property on which bee hives and minnow ponds are located.

Lakes are not considered as sensitive areas because they are not treated. Label restrictions prohibit and there is no need to use insecticides in open bodies of water, especially fish bearing lakes. The margins of these lakes however may be treated for purposes of mosquito control. Lakes over 10 acres in size treated by the District are listed in Table 31.

TECHNICAL AND OTHER LIMITATIONS TO MOSQUITO CONTROL IN THE TWIN CITIES.

One hundred percent mosquito control is not possible in the Twin Cities under any one or combination of control program alternatives. To borrow the economic analogy, "4% unemployment = full employment," 99% mosquito control = total control in some regions of the U.S. in an "all other things being equal" situation. In the Twin Cities area 95-97% control is a more realistic goal. According to records maintained by the District annual control in St. Paul, at the center of the District is approximately 68% effective.

Physical and ecological conditions, budget restrictions, insufficient research, human error and the privileges of private property owners limit the success of any control program--chemical, biological or physical. Program goals also determine level of effectiveness.

In agricultural insect control, for example, level of control is determined by an economic threshold measured as the highest pest population which a crop can sustain without reducing the yield. In many instances, a 50-75% reduction in the pest population is sufficient to prevent losses. Often it is the highest level of control which can reasonably be achieved as well.

TABLE 31

METROPOLITAN LAKES OF MORE THAN TEN ACRES CHEMICALLY TREATED FOR MOSQUITO CONTROL

County	Township	Twp. No.	Range No.	Sec.	Number Breeding Sites Treated	Name	Total Acres	Average times treated per yr.	Average Acres Treated	Material Used
Anoka	Coon Rapids	31N	24W	1	2	McKay Lake	22	1	0.2	Abate
Anoka	Andover	32N	24W	36	1	Bunker Lake	70	1	0.7	Abate
Anoka	Columbia Heights	30N	24W	25	1	Highland Lake	10	1	3.0	Abate
Anoka	Columbia Heights	30N	24W	26	1	Sullivan Lake	10	1	3.0	Abate
Anoka	Fridley	30N	24W	24	1	Moore Lake	134	4	67.0	Abate
Anoka	Spring Lake Park	30N	24W	1	1	Spring Lake	60	2	12.0	Abate
Anoka	Spring Lake Park	30N	24W	1	1	Laddie Lake	82	1	32.4	Abate
Anoka	Lino Lakes	31N	22W	36	1	Otter Lake	328	1	3.2	Abate
Anoka	Lino Lakes	31N	22W	30	1	Baldwin Lake	239	2	23.9	Abate
Anoka	Lino Lakes	31N	22W	29	2	Rice Lake	408	1	114.2	Abate
Anoka	Lino Lakes	31N	22W	35	1	Amelia Lake	217	2	80.3	Abate
Anoka	Lino Lakes	31N	22W	27	1	Wards Lake	39	1	19.5	Abate
Anoka	Lino Lakes	31N	22W	27	1	Sherman Lake	17	1	8.5	Abate
Anoka	Lino Lakes	31N	22W	21	1	Rice Creek and George Watch Lake	509	1	422.5	Abate
Anoka	Lino Lakes	31N	22W	20	1	Marshan Lake	231	1	115.5	Abate
				Total	17		2376	1.4	905.9	

Table 31, Continued

County	Township	Twp. No.	Range No.	Sec.	Number Breeding Sites Treated	Name	Total Acres	Average times treated per yr.	Average Acres Treated	Material Used
Dakota	Eureka	113N	20W	33	3	Chub Lake	274	2	82.2	Abate
Dakota	Eureka	113N	20W	7	2	Rice Lake	79	2	19.8	Abate
Dakota	Farmington	114N	20W	25	2		40	2	32.0	Abate
Dakota	Eagan	27N	23W	5	3	Gun Club Lake	519	2	51.9	Abate
Dakota	Hastings	115N	17W	21	1	Lake Rebecca	40	1	20.0	Abate
Dakota	Hastings	115N	17W	27	1	Lake Isabell	112	1	33.6	Abate
Dakota	Burnsville	27N	24W	23N	4	Black Dog Lake	726	1	72.6	Abate
				Total			1790	1.3	312.1	
Hennepin	Plymouth	118	22	23	7	Medicine Lake	924	1	92.4	Abate
Hennepin	Plymouth	118	22	32	2	Gleason Lake	167	1	83.5	Abate
Hennepin	Plymouth	118	22	31	2	Hadley Lake	39	1	29.3	Abate
Hennepin	Brooklyn Park	119	21	26	2	Palmer Lake	325	2	195.0	Abate
Hennepin	Maple Grove	119	22	15	2	Rice Lake	306	2	30.6	Abate
Hennepin	Crystal	118	21	3	3	Upper Twin Lake	100	3	10.0	Abate
Hennepin	Crystal	119	21	10	2	Lower Twin Lake	101	3	5.1	Abate
Hennepin	Crystal	119	21	28	9	Fish Lake	221	3	110.5	Abate

Table 31, Continued

County	Township	Twp. No.	Range No.	Sec.	Number Breeding Sites Treated	Name	Total Acres	Average times treated per yr.	Average Acres Treated	Material Used
Hennepin	Maple Grove	119	22	21	2	Rice Lake	301	2	15.1	Abate
Hennepin	Maple Grove	119	22	25	8	Eagle Lake	470	4	47.0	Abate
Hennepin	Excelsior	117	23	36	1	Silver Lake	42	1	4.2	Abate
Hennepin	Richfield	28	24	25	2	Mothers Lake	310	2	232.5	Dursban
Hennepin	Richfield	28	24	25	1	Duck Lake	44	3	4.4	Abate
Hennepin	Richfield	28	24	26	1	Legion Lake	122	2	112.0	Dursban
Hennepin	Richfield	28	24	28	1	Richfield Lake	155	2	77.5	Dursban
Hennepin	Richfield	28	24	28	2	Wood Lake	165	3	16.5	Abate
Hennepin	Minneapolis	28	24	9	1	Bird Sanctuary Pd.	17	4	5.1	Abate
Hennepin	Edina	28	24	31	4	Mud Lake	102	2	81.6	Dursban
Hennepin	Minnetrista	117	24	9	1	Little Long Lake	104	1	5.2	Abate
Hennepin	Edina	28	24	19	1	Pamela Lake	10	1	8.0	Abate
Hennepin	St. Louis Park	28	24	6	1	Bass Lake Bed	175	5	157.5	Abate
Hennepin	St. Louis Park	117	21	20	2	Meadow Brook Lake	22	3	1.1	Abate
Hennepin	Minnetonka	117	22	35	1	Lone Lake	22	2	0.5	Abate
Hennepin	Minnetonka	117	22	34	1	Glen Lake	180	2	3.6	Abate

Table 31, Continued

County	Township	Twp. No.	Range No.	Sec.	Number Breeding Sites Treated	Name	Total Acres	Average times treated per yr.	Average Acres Treated	Material Used
Hennepin	Minnetonka	117	22	33	1	Wing Lake	11	2	0.6	Abate
Hennepin	Minnetonka	117	22	33	1	Rose Lake	17	2	0.3	Abate
Hennepin	Long Lake	117	23	9	1	Maxwell Bay	250	2	2.5	Abate
Hennepin	Minnetonka	117	22	27	1	Train Lake	15	3	0.8	Abate
Hennepin	Long Lake	118	23	32	1	Lake Classen	78	2	3.9	Abate
Hennepin	Long Lake	117	23	10	1	French Lake	322	2	48.3	Abate
Hennepin	Long Lake	117	23	5	6	Stubbs Bay	220	2	2.2	Abate
Hennepin	Woodland	117	22	18	1	Shover Lake	11	1	0.6	Abate
Hennepin	Deephaven	117	23	18	1	Lake Louise	10	1	0.5	Abate
Hennepin	St. Louis Park	29	24	31	1	Twin Lakes	3	1	0.3	Abate
Hennepin	St. Louis Park	117	21	6	1	Twin Lakes	50	1	50.0	Dursban
Hennepin	Bloomington	27	24	17	1	Comma Lake	10	3	1.0	Abate
Hennepin	Bloomington	27	24	8	1	Marsh Lake	300	3	270.0	Abate
Hennepin	Bloomington	27	24	5	1	Lake Girard	20	3	0.6	Abate
				Total			5741	2.2	1709.8	

Table 31, Continued

County	Township	Twp. No.	Range No.	Sec.	Number Breeding Sites Treated	Name	Total Acres	Average times treated per yr.	Average Acres Treated	Material Used
Ramsey	Maplewood	29	22	4	2	Kohlman Lake	234	1	117.0	Abate
Ramsey	Maplewood	29	22	9	1	Keller Lake	72	1	18.0	Abate
Ramsey	Maplewood	29	22	15	3	Wakefield Lake	23	1	1.2	Abate
Ramsey	Maplewood	29	22	16	1	Round Lake	122	1	24.4	Abate
Ramsey	Shoreview	30	23	1	1	Poplar Lake	19	1	1.9	Abate
Ramsey	Shoreview	30	23	35	1	Grass Lake	146	1	29.2	Abate
Ramsey	New Brighton	30	23	32	1	Jones Lake	28	2	8.4	Abate
Ramsey	Little Canada	29	22	7	1	Savage Lake	46	2	43.7	Dursban
Ramsey	Maplewood	29	22	10	1		15	2	15.0	Dursban
Ramsey	North St. Paul	29	22	2	1	Casey Lake	14	1	3.5	Abate
Ramsey	Maplewood	29	22	36	1		25	4	12.5	Dursban
Ramsey	Maplewood	29	22	25	1		50	3	5.0	Dursban
Ramsey	Arden Hills	30	23	34	1		10	1	3.0	Abate
Ramsey	Arden Hills	30	23	28	1		50	1	25.0	Abate
Ramsey	Maplewood	29	22	25	1	Beaver Lake	65	1	32.5	Abate
Ramsey	Roseville	29	23	2	3	Lake Owasso	360	1	18.0	Abate

Table 31, Continued

County	Tonwship	Twp. No.	Range No.	Sec.	Number Breeding Sites Treated	Name	Total Acres	Average times treated per yr.	Average Acres Treated	Material Used
Ramsey	Roseville	29	23	2	1	Reiling Lake	17	1	4.3	Abate
Ramsey	St. Paul	28	23	22	1	Crosby Lake	46	1	6.9	Abate
Ramsey	White Bear	30	22	3	1	Otter Lake	165	3	49.5	Abate
Ramsey	White Bear	30	22	2	2	Bald Eagle Lake	849	2	8.5	Abate
Ramsey	White Bear	30	22	9	1	Tamarac Lake	69	2	69.0	Abate
Ramsey	North Oaks	30	22	5	2	Deep Lake	65	3	9.8	Dursban Abate
Ramsey	North Oaks	30	22	7	1	Pleasant Lake	585	2	29.3	Abate
Ramsey	North Oaks	30	22	12	1	Charlie Lake	31	2	6.2	Abate
Ramsey	North Oaks	30	22	4	1	Wilkinson Lake	275	3	275.0	Abate
Ramsey	North Oaks	30	22	8	1	Black Lake	120	1	120.0	Abate
Ramsey	Vadnais Hgts.	30	22	19	1	Sucker Lake	59	4	5.9	Abate
Ramsey	Vadnais Hgts.	30	22	33	1	Willow Lake	75	2	67.5	Abate
Ramsey	Vadnais Hgts	30	22	19	1		10	1	10.0	Abate
Ramsey	White Bear	30	22	35	1		10	5	7.5	Abate
Ramsey	White Bear	30	22	22	1		20	2	2.0	Dursban

Table 31, Continued

County	Township	Twp. No.	Range No.	Sec.	Number Breeding Sites Treated	Name	Total Acres	Average times treated per yr.	Average Acres Treated	Material Used
Ramsey	North Oaks	30	22	5	1		15	2	4.5	Abate
Ramsey	St. Paul	29	23	35	1		10	1	2.5	Dursban
Ramsey	Roseville	29	23	1	1		10	1	5.0	Dursban
Ramsey	Roseville	29	23	5	1		10	1	2.5	Dursban
Ramsey	Roseville	29	23	12	1		35	2	17.5	Dursban
Ramsey	Roseville	29	23	13	1		15	2	7.5	Dursban
Ramsey	Roseville	29	23	14	1		15	2	7.5	Dursban
				Total			3785	1.9	1076.7	
Scott	Jackson	115	23	3	3	Strunks Lake	103	1	51.5	Malathion
Scott	Louisville	115	23	24	5	Gifford Lake	98	1	49.0	Abate/Mala.
Scott	Sand Creek	114	23	14	2	Gies Lake	185	2	46.3	Malathion
Scott	Sand Creek	114	23	24	5	Suttons Lake	463	1	185.2	Malathion
Scott	St. Lawrence	114	24	24	1	Browns Lake	25	1	2.5	Abate
Scott	Helena	113	24	1	1		25	2	17.5	Abate
Scott	Helena	113	24	8	2		15	1	10.5	Abate
Scott	Eagle Creek	115	22	2	2	Fisher Lake	262	1	26.2	Abate

Table 31, Continued

County	Township	Twp. No.	Range No.	Sec.	Number Breeding Sites Treated	Name	Total Acres	Average times treated per yr.	Average Acres Treated	Material Used
Scott	Eagle Creek	115	22	3	2	Blue Lake	200	1	30.0	Abate
Scott	Eagle Creek	115	22	10	1	Deans Lake	128	1	25.6	Abate
Scott	Spring Lake	114	22	10	2	Rice Lake	195	1	78.0	Malathion
Scott	Spring Lake	114	22	10	2	Crystal	33	1	3.3	Abate
Scott	Eagle Creek	115	22	26	1		12	1	6.0	Malathion
Scott	Eagle Creek	115	22	27	1		27	1	13.5	Abate
Scott	Eagle Creek	115	22	29	1		70	1	35.0	Abate
Scott	Spring Lake	114	22	4	1		22	1	11.0	Abate
Scott	Spring Lake	114	22	12	1		115	1	57.5	Malathion
Scott	Spring Lake	114	22	16	1	Buck Lake	81	1	48.6	Malathion
Scott	Spring Lake	114	22	23	1		38	1	19.0	Malathion
Scott	Glendale	115	23	6	2	Rice Lake	85	2	17.0	Abate
Scott	Glendale	115	23	29	1		11	2	4.4	Abate
Scott	Glendale	115	23	34	2	Hanrahen's Lake	67	1	6.7	Abate
Scott	Credit River	114	24	16	1		12	1	6.0	Abate

Table 31, Continued

County	Township	Twp. No.	Range No.	Sec.	Number Breeding Sites Treated	Name	Total Acres	Average times treated per yr.	Average Acres Treated	Material Used
Scott	Credit River	114	24	18	1		13	1	13.0	Fuel Oil
				Total			2285	1.1	763.3	
Washington	Woodbury	28	21	3	2		18	2	10.8	Abate
Washington	Woodbury	28	21	8	1		140	2	7.0	Abate
Washington	Woodbury	28	21	16	2		12	2	0.6	Abate
Washington	Woodbury	28	21	17	1		15	1	1.5	Abate
Washington	Cottage Grove	27	21	7	1		20	1	1.0	Dursban
Washington	Cottage Grove	27	21	17	1		13	2	0.7	Dursban
					Total		218	1.6	21.6	

In mosquito control, however, "man's tolerance for arthropods attacking his person is often so low that the best natural enemies cannot reduce populations of these pests to his satisfaction. For instance, no matter what the mosquito breeding potential of a given area is, with or without natural controls, one mosquito bite per person per night would often be regarded as unacceptable. This is particularly true if the mosquito happens to be a disease vector " (Bay, Berg, Chapman and Legner, 1976).

Level of control varies with habitat. In the Twin Cities area erratic weather restricts flight time. Dense vegetation canopies hinder aerial location of breeding sites, and restrict penetration of spray materials.

Budget factors restrict 'blue sky' programs in two ways. Budgets do not always permit variations in program techniques. Program differentials are supported by different requirements in personnel and field work. More money spent on breeding site inspections and multiple treatments of individual locations means fewer sites treated. On the other end, as a chemical control budget increases to meet the requirements of a job well done, the larval density at which control measures are implemented is necessarily reduced. In this instance a budget which cannot finance 99% control at every site in a 'do it right' program, pays the greatest price for near-perfect control.

In the instance of the Twin Cities MMCD, even an A+ control effort within the current boundaries of larval control would reap imperfect benefits. Because of their extensive flight range, Aedes vexans and other pest species bred at sites along the peripheries in no-control areas would continue to penetrate the interior of the District and create varying levels of background nuisance.

In addition to peripheral uncontrolled breeding sites there are also currently 4,865 uncontrolled areas within the District (26,162 acres). The District does not exercise its privileges of eminent domain, thus employees are denied access to some privately owned sources of mosquito populations. It is estimated that 4% of the adult female mosquitos

produced in the Metropolitan area originate in these locations. See Table 32 for distribution.

The number of refused entry sites increased annually between 1958-1964. There were 955 sites that year totalling 3,432 acres. Comparable figures for 1971 were 1,510 and 4,735.

In areas of otherwise high levels of control, the joint incidence of C. perturbans (which are not susceptible to chemical larval control) and the Aedes species bred in refused entry locations could easily comprise 50% of the mosquito problem.

In Vadnais Heights, for example, 16% of breeding locations are refused entry areas as are 5% of those in neighboring White Bear Lake. These areas may be partially responsible for the high levels of annoyance in and around these communities.

The ratio of male to female mosquitos is 1:1. Every acre of breeding sites sustains approximately 1.1 million female mosquitos each capable of laying 150-200 eggs (Breeland and Pickard, 1963). Within the District's core area there are 25,167 acres of breeding sites of which 3,891 are refused entry. Approximately 104,683 million female mosquitos can potentially occur in one hatch within the core area serviced by the District (116M per square mile).

Outside the core area are an additional 1,733 square miles including 127,543 acres of breeding sites with a total production capability of 140,287M female mosquitos (80M per square mile). In this region, 19,417 acres of sites are refused entry having a production capability of 21,359M female mosquitos.

The above figures assume one rainfall which totally floods breeding sites throughout the District. Even with this qualification, however, one notes that some 15% of the breeding acreage outside the core area are uncontrolled sites. Since mosquito dispersal is random, one can anticipate that a good proportion of the mosquitos bred in these sites enter the core area and take up residency there.

The Control District, by statute, operates in cooperation with the State Department of Agriculture,

TABLE 32

UNCONTROLLED PRIVATE PROPERTY WITHIN MMCD

Composite: Core Area*

	Breeding Sites		Refused Entry			
	Total No.	No. Acres	Breeding Sites	No. Acres	% of all Breeding Sites	% of Total Acres
Anoka	2,631	19,082.5	141	955.5	5	5
Dakota	4,602	10,167.0	256	293.2	6	3
Hennepin	8,246	28,270.0	127	142.5	2	1
Ramsey	5,196	13,425.0	115	299.9	2	2
Scott	1,974	9,130.0	89	444.0	4	4
Washington	5,028	15,093.5	499	1,755.9	9	11
Totals	27,677	95,167.8	1,227	3,891.0	4	4

Composite: Outside Core Area**

Anoka	6,059	61,945.7	549	8,942.5	9	14
Dakota	3,102	15,438.0	52	1,035.4	2	7
Hennepin	8,467	28,734.0	645	1,536.7	8	5
Ramsey***						
Scott	6,285	23,047.0	333	1,007.3	5	4
Washington	3,804	17,115.4	2,059	9,748.8	54	56
Totals	27,717	146,280.1	3,638	22,270.7	13	15

Summary: The Core Area includes:
- 49% of MMCD breeding sites
- 39% of breeding sites (acres)
- 34% of the entire District

The Outside Area includes:
- 51% of the MMCD breeding sites
- 61% of breeding acres
- 66% of the entire District

*Core Area = 900 square miles serviced by MMCD.

**Outside Core = Area within MMCD boundaries not normally controlled except for larviciding of spring Aedes, or adult control for outdoor events.

***Totally included in core area.

Note: The actual number of landowners in the Refused Entry Category in 1977 is 177. The distribution is as follows: Anoka (32); Dakota (42); Hennepin (26); Ramsey (44); Scott (22); Washington (11).

SOURCE: Metropolitan Mosquito Control District, 1976.

Health, Natural Resources, Highways, the University of Minnesota and the State Agricultural Experimental Station and the Federal Departments of Agriculture and Public Health. The District also maintains informal ties with bee keepers, and local industry in mutual efforts to avoid sensitive areas while spraying and avert possible creation of breeding areas through improper construction and draining.

The inadvertent creation of mosquito breeding sources could be avoided generally, if the District were consulted prior to initiation of major industrial, residential or recreational developments.

A word about human error. Nearly 75% of the summer staff is temporary. Although each field employee spends thirty days as an apprentice before assuming normal staff responsibilities, differences in individual perceptions may affect determination of breeding sites, accurate evaluation of need for treatment and uniform administration of treatment. A number of controls have been incorporated into program operations to limit the impacts of human error. Permanent MMCD staff are career professionals. Contact between field and office is maintained through a radio repeater system. Each field foreman has responsibility for no more than five subordinates and spends 25 - 50% of his time conducting quality control inspections. Each field applicator is equipped with detailed application manuals and reporting forms. Excerpts from these materials are included in Appendix PD (exhibit F).

The record keeping, inspection and application forms maintained by the District were reviewed for adequacy by the State Department of Agriculture in June, 1977. In his review J. R. Sandve, Assistant Director, Division of Plant Industry noted in part, "The system is so designed that quality checks of insecticide application rates are readily performed to insure uniformity throughout the control district. We are satisfied this record keeping system is an excellent system and fully meets the needs of the District in carrying out its program."

FUTURE ORIENTATIONS

For reasons noted early in this chapter, little money or technology has been invested in mosquito

control research. Control techniques to date have been a spin-off of agricultural pesticide development and evaluation. Consequently, mosquito control has almost consistently been equated with chemical control. In recent years, research into non-chemical control of agricultural pests has had a similar spin-off affect in the critique of mosquito control techniques, with agricultural research continuing to receive the lion's share of research monies.

Prior to 1974 research was not considered to be within the purview of MMCD responsibilities. Since that time, program priorities have been revised to include research and experimentation into non-chemical alternatives to traditional mosquito control techniques. Within the limits of a restricted budget (1.8% of 1977 allocations or $27,000) priorities have been determined and preliminary studies initiated. Findings to date have been encouraging and suggest some of the program alternatives discussed in the following chapter.

Briefly, research goals and expectations may be summarized as follows. A fuller discussion is included in Appendix PD (exhibit B) which accompanies this report.

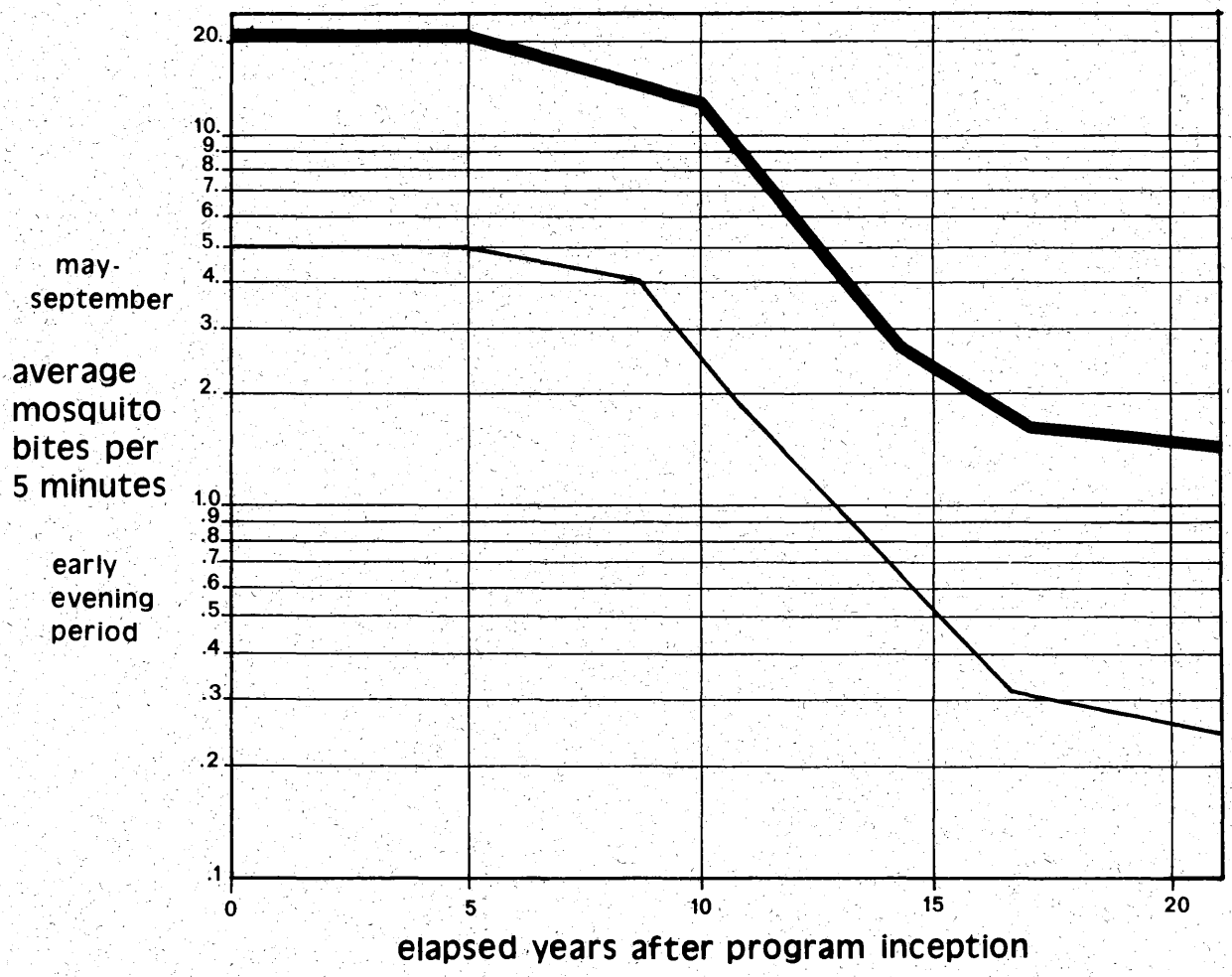
1. Development of an economical, biodegradable, encapsulated, slow release formulation to improve control in upland Type I non-draining sites. Goals are improved MMCD performance and the freeing of funds for more permanent physical or biological site modifications. A potential treatment area of 30% overlaps with limestone treatment areas described below. Cost/effectiveness compared to current program (20 year span) is 1.2-2.0. Earliest operational season: 1980.

2. Conduct of local experiments to assess the effectiveness of limestone treatments in reducing the length of time upland sites hold water. Using this method, localized percolation may be restored via an ion exchange process between monovalent hydrogen, sodium, potassium and ammonium ions and bivalent calcium ions. Potential

treatment area: 40% of current breeding sites. Earliest operational season: 1977. Cost/effectiveness compared to current program (20 year span): 7.2-9.0.

3. Development of biological control for Type III semi-permanent water sites. Phase one, the identificatiion of natural insect enemy complexes in these sites, is scheduled for completion in 1977. Phase two, evaluation, and Phase three, field tests, could begin in 1977-1978. Operational requirements include the establishment of breeding laboratories for selected species and their introduction into natural habitats on an annual basis. Biological control increases if semi-permanent water sites are made permanent. Potential treatment area is: 34% of MMCD acreage. The earliest operational program date is 1981. The cost effectiveness compared to current program (20 year span) is estimated to be 3.2.

4. Reduction of Coquillettidia perturbans in marsh breeding sites. This research is still in the conceptual stage and would require funding to begin local research. Research patterns would likely follow that used in biological control research as outlined above. Potential treatment area is about 5% of total MMCD acreage. Earliest operational date: 1983. Cost/effectiveness compared to current program: unknown.



program alternatives

PROGRAM ALTERNATIVES

INTRODUCTORY COMMENT

In addition to the current MMCD program of chemical mosquito control the District proposes five program alternatives considered ultimately to be technically feasible to effect varying levels of mosquito abatement in the Metropolitan Area of the Twin Cities.

The Metropolitan Mosquito Control District respects the need for research programs designed to support alternatives to dependency on chemical control methods. To date, however, District-sponsored or cooperative research has not been given high priority in District operations. Alternatives to use of chemical control measures are presented here with the intention of initiating cooperative agency interest in pursuing studies which will eventually determine the appropriateness of alternate methods in the Twin Cities environment.

It should not be inferred that the District is not confident of the program in current operation or is doubtful of the environmental soundness of its field methods. The following discussion of alternatives is offered as a response to the requirements of the MEQB Environmental Impact Statement process. The District is not advocating a program change in the immediate future, but would welcome the opportunity to combine research efforts in this area with State agencies to improve mutual understanding of alternate methods of mosquito abatement.

Aside from a no-control option, no one alternative discussed below could be effectively implemented by the MMCD as presently organized. Be it assured, however, that the technical staff of the MMCD are confident that each program alternative is a possible mosquito control technique.

Quantitative statistics incorporated into the body of this discussion are not fast and true. While confidence is assured in figures used to describe current operations, those used in describing alternatives are approximations based on the best information available to the District. Program costs are based upon 1976 figures and may deviate with site-by-site analysis.

PROGRAM ALTERNATIVE: NO CONTROL

Factors contributing to mosquito production and development are constant variables in mosquito control--topography, rainfall, temperature. In a no-control program, current chemical treatments would be suspended. Buildings and equipment currently under lease would be vacated upon termination of rental agreements. Forty full time professional and administrative staff positions and 120 seasonal field positions would be eliminated.

In the absence of a chemical control program, mosquito abatement would rest solely upon natural predator control, incidental control through use of agricultural pesticides, and homeowner control through use of domestic sprays, thermal and non-thermal fogs and yard and garden chemicals. Under provisions of Minnesota law community or county-financed mosquito abatement programs could be implemented in lieu of the present six-county mosquito control District. A copy of this enabling legislation is included in Appendix PD (exhibit A).

PROGRAM ALTERNATIVE: BIOLOGICAL CONTROL

Based upon evidence available to the MMCD at present, the District does not advocate adoption of a mosquito abatement program at this time which would rely entirely upon manipulated natural control agents. Control of mosquitos through natural enemy complexes is effective under specific conditions not common in the Twin City area (MMCD records). Reliance on this form of control, however, would not achieve the level of control acceptable to urban residents. At least five years of extensive research, properly financed is needed to develop the necessary technology to initiate effective use of biological control. In the opinion of a University of Minnesota entomologist (Cutkomp, 1977) five years may be an overly optimistic estimate.

This opinion is substantiated by Bay et al. (1976) who state, "Eventually, if organisms are to be released on a large scale against any mosquito, relatively economical methods of mass in vitro culturing and dispersal must be available. We are only fooling ourselves if we believe that this can be brought to fruition by the monies and research personnel presently available for biological studies of mosquitos."

Chapman (1976) reports that only a dozen full-time scientists were actively studying pathogens and parasites of mosquitos in the U. S. and Canada as of 1968. Research has been expanded somewhat in recent years and includes experimentation with fishes, notonectids, hydra, planaria and predacious mosquitos. The effectiveness of fungi, protozoa, and bacteria as control agents is also being investigated. Of these, the author notes that fishes are the only operational agents today.

Many natural control agents of mosquitos have been reported in the literature. Generally they have been divided into three basic groups: predators, pathogens and parasites. Five hundred and forty eight predators, 212 pathogens and 20 parasites are known for mosquitos (Jenkins, 1964). Potentially effective control agents exist in each of these groups. However, biological control agents characteristically exhibit rather narrow habitat requirements with

pathogens and parasites having the most limited host acceptance. Since predators physically capture and consume mosquito larvae, sites capable of supporting diverse predator populations usually produce few adult mosquitos.

Diversity of field habitats, differential life cycles and host susceptibility and insufficient field data have hindered the operational use of pathogens and other organisms.

Bay et al. (1976) describe these operational difficulties as follows:

> "An especially important consideration in the biological control of mosquitos is the diversity of habitats in which they breed. Mosquito breeding sites run the gamut of rain puddles, salt and freshwater marshes, tree holes, rock pools, wheel ruts, hoof prints, cisterns, tin cans and tires, snowmelt pools, leaf axils, rat-gnawed coconuts, crab holes, snail shells, flood plains, sewage oxidation lagoons, privys, and even the hollow interiors of some carnivorous plants that have evolved to lure and destroy other insects. Clearly, no single parasite or predator could be expected to find application against a group of insects with such an array of breeding sources and protection. To complicate matters, some mosquito larvae inhabit a variety of breeding sites at a common location, so that an effective predator in one of these might not have a noticeable effect on the adult mosquito population as a whole.
>
> Other problems include the relatively short life cycle of most mosquitos. This may be as brief as 3½ to 4 days for Psorophora confinnis (Lynch Arribalzaga) in the Coachella Valley of California, and for certain species of floodwater Aedes. Most established predators have little chance to discover and to respond to such "instantaneous" mosquito breeding. Man has even less time to mobilize for mass release with those parasites or predators that he may be successful in rearing. Furthermore, mosquito predators of which we are aware are not dependent on mosquito larvae, and are seldom if ever reciprocally regulating in the sense we commonly think

of as biological control. Some of these predators, particularly fish, however, are often destructive to mosquito larvae and can totally suppress larval populations to which they have access in permanent standing water. Unfortunately, as suggested earlier, "permanent" water constitutes only a fraction of the available mosquito breeding sites in many localities. Even in permanently marshy areas much exposed water is actually temporary or intermittent, dependent upon seasonal drought and flooding. In those areas where water is relatively permanent, many mosquito larvae are protected amid grass hummocks and in breeding pockets among debris-congested shallows.

Given the circumstances described, it is understandable that insecticides have been so heavily relied upon for mosquito control in recent years. Their advantages of economy, ready availability, storage, and applicability over discontinuous and obstructed larval habitats present formidable competition to known measures of biological control. Microbial pathogens, nematodes, and hydra are among the few organisms that conceivably could be produced stored, and applied in the manner of insecticides. For this reason, except for refinements in use of fish, the biological control research that has involved mosquitoes has been mostly with pathogens, including certain nematodes".

Promising field evaluations have been conducted with the biological control agents listed above. Predators are considered by the MMCD to have the greatest potential for effective use to control mosquitos in diverse aquatic habitats. They exhibit a remote possibility of causing human or animal disease in contrast to mosquito pathogens or parasites which require extensive EPA clearance, a research investment few Districts can afford. Recent mass culture developments with hydra and planaria (Yu and Legner, 1976; Tsai and Legner, 1977) show promise for seasonal innoculation into mosquito breeding habitats.

Genetic control of insects which has received popular attention, entails mass rearing, sterilization and release of insect populations to mate with wild populations leading to reduction in fertility and perhaps population elimination. Genetic control

methods have the advantage of being species specific and non-polluting and have been used to suppress some insect populations. Extensive research has been conducted in this field and the control of isolated populations has been demonstrated. The use of this control approach requires that the mosquito species to be controlled must be mass reared to be genetically manipulated, a factor which prevents the use of this approach to control the most important mosquito species found in the MMCD. Studies on colonization of Aedes vexans and related species indicate mating will not occur in cages. Time consuming, low yield hand mating of mosquito pairs has been demonstrated for some Aedes species, but the technique is not feasible for a genetic control program.

The Metropolitan Mosquito Control District conducted field tests using fathead minnows until 1974 and has been studying the role of invertebrate biological control agents since 1974. Hydra, notonectids, dytiscid larvae, bacteria and planaria have been tested under laboratory conditions. The potential for achieving good biological control is proportionate to the duration of water retention in a breeding site. Semi-permanent water sites would require physical modification to improve water retention and provide for ecological stability.

Effective biological control alternatives hold promise for improved use of natural enemies of mosquitos in permanent water sites (i.e., augmentation of food chain relationships, mass culture and distribution). No biological control alternatives with sufficient strength upon which to base an entire program currently exist, as mass culture and storage technology require further development.

Of the temporary water sites which lend themselves to predator control in the six county District approximately 25% (14,935 acres) are considered suitable for biological control as they exist. The balance (75%) (44,805 acres) would not work well in this program unless they were physically modified. Permanent water sites produce fewer mosquitos than do intermittent water sites where Aedes species originate. Nine hundred acres of permanent water sites are currently being controlled 85% by naturally occurring organisms in an experimental program.

Pathogens have been studied more for the biological control of mosquitos than any other group. Historically fish have been used in operational programs as mosquito predators more than any other natural control agent. In recent years aquatic insects, fresh water polyps (hydra) and flatworms (planaria) are beginning to receive closer attention as their role as predators of mosquitos becomes clearer.

Much has been written on the utility of biological control organisms. Recent revisions include the following:

Biological Control of medically important arthropods:
Legner et al., 1974; Biever et al., 1975; Chapman, 1974.

Notonectidae:
Hazelrigg, 1973; Ellis and Borden, 1970; Sjogren et al., 1977; Sjogren and Legner, 1974.

Hydra:
Yu, 1976; Yu et al., 1974; Yu and Legner, 1976

Planaria:
Tsai and Legner, 1977; Legner et al., 1977; Yu and Legner, 1976; Legner et al., 1975; Legner and Medved, 1974; McDaniel, 1974.

Nematodes:
Petersen and Willis, 1972; Petersen and Willis, 1976; Ignoffo et al., 1973.

PROGRAM ALTERNATIVE: PHYSICAL CONTROL

As noted earlier in this text, mosquito larvae breed most successfully in water depths of up to six inches. Intermittent shallow water is a feature of all Type I and Type II sites and the margins of Type III sites. The intended purpose of a program of physical site control is modification of these breeding areas in order to reduce mosquito productivity by altering water depth or increasing water retention and stability.

Physical site modification is acknowledged by the District as a possible means of reducing mosquito development in the Twin Cities area. This alternative control method would be applicable to many Type I pothole depressions and Type II woodland pools which are poorly drained, have little open water and support a narrow spectrum of plant and animal life.

No site research has been conducted locally to support the immediate adoption of many of the modification techniques discussed in the next few pages. Nor is there locally evidence that any suggested physical site alternations warrant elimination from consideration as future substitutes for or supplements to chemical mosquito abatement.

Physical modification techniques include:

a) limestone treatment of upland Aedes breeding sites;
b) ditching upland sites to prevent retention of runoff;
c) draining upland sites into a common location;
d) creation of island-moats in shallow breeding sites;
e) modification of shoreline slopes;
f) removal of organic debris from shorelines;
g) filling upland Aedes sites.

The District offers these options as technically feasible alternatives for further consideration. Some are being field tested currently. None has been nor is recommended for immediate adoption.

Limestone Treatment of Type I *Aedes* Breeding Sites

According to 1976 field reports, there are approximately 14,000 upland sites of 43,571 Type 1 sites in the District. Experimental evidence to date indicates that mosquito production in these sites could be reduced or eliminated through limestone treatments. In the process, mosquito annoyance levels could be reduced by 40% in 10 years.

The use of limestone to increase infiltration through the lens layers of pothole depressions is not an overnight operation. At least five years can be expected to elapse before positive results are seen. Then an increased rate of infiltration of rain water may result in the site becoming 100% non-productive for mosquitos. Current estimates are that one treatment of correct dosage will last 15-20 years.

In 1974, 30 temporary water sites and adjacent control sites were selected for experimental limestone treatment areas. Soil samples and laboratory percolation tests were performed in 1976. Variability in annual rainfall precludes accurate measurement of pre and post treatment effects. Results of water infiltration tests on soils collected from treated and control sites have confirmed the effectiveness of limestone treatments. Laboratory tests under artificial conditions have been inconclusive. Studies to determine the response of vegetation in depressions and invertebrate fauna to limestone treatments have not been conducted. Information on the effects of limestone is available in the agricultural literature.

Generally, field experimental treatments increase the rate of water infiltration by 3.3 times. Two experimental limestone treatment areas have already been eliminated as mosquito producing sites. Other limestone treatments have been limited to areas in county road ditches where water does not flow, but forms standing pools. Initiation of an operational treatment program is awaiting approval of the Minnesota Department of Natural Resources. Such a program (material and application) would cost an average of $28 per .5 acre. The 1977 MMCD

budget provides for funding of 1,400 site treatments.

More than two million tons of limestone is quarried in the Metropolitan area annually (MMCD survey of local quarries, 1976). The bulk (80%) is used for construction. The balance is produced for agriculture or shipped out-state. Roughly 60,000 tons of limestone are used in water and sewage treatment each year. The chemical composition of the waste lime applied to field sites is shown in Table 33.

Aside from limestone treatments, other more expensive physical mosquito control methods involve earth moving for site modification and maintenance. At least six alternatives are known. Some alternatives correspond to several site modifications generally referred to as "ponds" in technical specifications of the U. S. Department of Agriculture, Soil Conservation Service, Minnesota. Specifications employed by the Department vary from time to time. Any reference to USDA-SCS figures in this text are based upon 1975 publications which may be subject to change.

Excavation of ditches around upland Aedes breeding sites to prevent runoff water from reaching the lense area lining the bottom of pothole depressions. Approximately 3,000 breeding sites (Type I) are conducive to this ditching operation. Equipment costs approximate $50 per site. One hundred percent (100%) control has been achieved in experimental sites for an undetermined duration which could reduce overall mosquito production by 5-8%.

Drainage of a number of adjacent upland depressions into a common, single location by means of surface ditches with side slopes of 8 to 1 or flatter or tile lines. Equipment costs average about $50.00 per depression. Some 500 known sites (Type I and II) could be treated in this manner with 100% effective control in sites eliminated. Treatment of all possible sites would reduce total mosquito populations by roughly 1%. Type III sites would not be treated.

TABLE 33

ANALYSIS OF WASTE LIME

FROM THE CRYSTAL SUGAR COMPANY CHASKA FACTORY

Moisture		5.15%
Organic Matter		8.05
Silica and Insoluble in Hydrochloric Acid		.80
Iron and Alumina	$Fe_2O_3+Al_2O_3$	3.10
Calcium	CaO	43.65
Magnesium	MgO	2.24
Sodium and Potassium	Na_2+K_2O(as Na_2O)	.35
Sulfate	SO_3	.85
Phosphate	P_2O_5	.78
Carbonate	CO_2	35.75
		100.72%
Total Nitrogen		.20%

Combined:

Moisture		5.15%
Organic Matter		8.05
Silica and Insoluble in Acid		.80
Iron and Aluminum Oxides	$Fe_2O_3+Al_2O_3$	3.10
Calcium Carbonate	$CaCO_3$	75.19
Calcium Sulfate	$CaSO_4$	1.45
Calcium Phosphate	$Ca_3(PO_4)2$	1.70
Magnesium Carbonate	$MgCO_3$	4.68
Sodium Carbonate	Na_2CO_3	.60
	total	100.72%

SOURCE: Weitz, F. W. Contracted Analysis prepared for Chaska Sugar Company (1941)

The following modifications are alternatives to treatment of mosquito breeding areas in lowland-high water table zones.

Excavation of shallow marsh areas (Type I and III sites) to create duck nesting island habitats surrounded by permanent water moats. Holding of permanent water preserves a habitat for natural mosquito enemies as well. This method is applicable to small sites only (1-4 acres) of which there are an estimated 5,000 in the District. The method is 80% effective where used in controlling mosquitos. This treatment, used in all possible locations, would reduce overall mosquito populations by 15%. Costs average $1,200 per acre.

The island-moat concept is similar to that of dugouts and pits with which the USDA-SCS is associated. Dugouts are recommended by this agency for purposes of "keeping, making or improving habitat for waterfowl, furbearers or other wildlife " (USDA-SCS-Mn. 1975). According to USDA-SCS criteria, these modifications are suitable for USFWS Type I, II and VI wetlands, as well as Type III wetlands overgrown with cattails which have little open water and can retain wetland characteristics while supporting a pit or dugout (USDA-SCS, 1975). Dugouts are not recommended in areas of less than 1/2 acre as areas of this size are "used sparingly by waterfowl broods for courting and breeding " (USDA-SCS,Mn.1975)

Dugouts or island moat modifications proposed by the MMCD would have a total radius of 70-150 ft. The moat would have a diameter of 10-20 ft. The outer perimeter of the site would have a slope of 2:1. The island slope would be 5:1. Each site would include an escape ramp with a slope of 5:1 to 7:1. Water depth at the center would be at least 3 feet. Ten feet from the outer edge of the site a spoil bank would be deposited according to recommendations of the U.S. Fish and Wildlife Service.

SCS specifications (1975) call for a spoil bank of less than 2 feet. A recent study on the effects of stream channelization in Wisconsin (Prellwitz,1976)

includes a recommendation that dredge spoil should be "spread on adjacent land to eliminate waterfowl nest concentrations on steep soil banks which serve as travel lanes for predators."

C. Warren Curtis, Minnesota State Resource Conservationist (1977) notes that most "ponds" have a design life of 25-50 years, depending on purpose and installation costs. He notes as well that, "aquatic vegetation at the end of the design life would take on characteristics of natural wetlands similar to that of natural ponds or wetlands with corresponding water conditions with emergent vegetation occurring at depths of 3 feet and submergent vegetation at depths of 3 feet or less."

Increasing the slope of marsh shorelines to reduce flooding limits the breeding areas subject to flooding after rainfalls, thus limiting the number of eggs hatched. Slope modification could be applied to 7,000 to 10,000 Type III marsh breeding sites in the District which average in size from 3 to 20 acres. The effectiveness of this method in controlling mosquitos under Metropolitan conditions has not been determined. Based upon results elsewhere, slope modification can be projected to reduce mosquito production by 80%. Increased slope also concentrates larvae, increasing predation. Cost of slope modification of this kind is estimated at $300 per 1,000 linear feet.

Removal of organic debris from shorelines is a treatment applicable to both high and low water table areas. If organic matter is removed down to the mineral soil, mosquito egg laying is discouraged and thus mosquitos are reduced. This treament would remain effective until redeposition of the organic substrate. Where used as a measure, control is roughly 95% effective. Approximately 2,000 Metropolitan breeding sites (of 0.5 acres) could be controlled in this manner, resulting in a 2% reduction of total mosquito population. Treatment costs per site are estimated at $75. Combined factors of cost, energy expended and potential short-life of the measure make this an undesirable method for large scale control operations.

Filling upland Type I *Aedes* breeding depressions with dirt is a control method appropriate to sites of less than 0.1 acres in size. Cost is estimated at $100 per site. Application to 2,000 sites would reduce overall mosquito populations by 5%.

Due to the large number of mosquito breeding locations and the time required to institute corrective measures, it is estimated that it would require 10-15 years to change the base mosquito population level using a physical control program alone. The resultant shifts in mosquito populations would remain dependent on weather and be influenced by infiltration of adult mosquitos into the District core area from uncontrolled peripheral areas. An estimated maximum 60% reduction in adult mosquito populations would occur in a minimum of 20-25 years after program inception at a 10 mile radius from downtown St. Paul.

CONTROL OF *COQUILLETTIDIA PERTURBANS* BY LOWERING WATER LEVELS

Lowering of the water level below the roots of host plants for several weeks during the summer or fall can effectively prevent development of *C. perturbans* (Darsie and Springer, 1957). Cattails, one of the principle plants utilized by *Coquillettidia* are considered by some waterfowl management people to be undesirable under certain conditions. In these instances the control of these plants may permit replacement by species more desirable to waterfowl and may eliminate this source of *Coquillettidia* breeding.

PROGRAM ALTERNATIVE: CONTROLLED RELEASE PESTICIDE

The pre-hatch and larvicide materials presently used by the District require an average of six treatments per site per season with temephos, and three treatments per site per season with chlorpyrifos. If one treatment could be made to each site, which would remain effective the entire mosquito breeding season, more sites could be reached with the available manpower, equipment and energy.

At present the District is evaluating the possible use of a chlorpyrifos controlled release formulation in its program. The product is "DURSBAN^{R} 10 CR Insecticide," manufactured by The Dow Chemical Company, and is registered with the EPA for ground application. Approval for aerial application is expected in about one year. This formulation would provide control with one application per year in sites where chlorpyrifos can be used.

The material is a small polyethylene pellet (1 mm x 3 mm) in which the active ingredient is embedded. DURSBAN 10 CR can be used as a pre-hatch or larvicide. When the pellets are immersed in water the insecticide is slowly released. The release of insecticide stops when the water recedes and the pellet is left uncovered. The release continues when reflooded; this process continues until all the active ingredient is released.

The polyethylene carrier is totally inert and essentially non-degradable with no measurable decomposition products. The addition of 10 lb/acre of these pellets to the soil would be equivalent to 10 ppm in the top 6 acre inches of the soil. DURSBAN 10 CR, if used by the District would be dispensed at 19 lb. per acre.

If used by the District, DURSBAN 10 CR would replace the presently used chlorpyrifos 1% granules and would allow more sites to be controlled with the same man hour output. Temephos larviciding applications, adulticiding with resmethrin, biological and physical control experimentation would continue as a large part of the program.

A formulation similar to the DURSBAN 10 CR using temephos as the active ingredient, which could replace the presently used temephos 1% granules may be commercially available within several years. Chlorpyrifos is used by the District because pre-hatch treatments can be made in advance of a rain and longer periods of control can be expected for the same cost. If a controlled release temephos formulation were used, chlorpyrifos could be eliminated from the program.

Using chlorpyrifos 1% granules, 18 to 22 thousand acres are now treated two and some times three times per season. With the use of a controlled release formulation pre-hatch treatments could be made at any time prior to the mosquito season when snow does not restrict access. Temephos site treatments would be made in sensitive sites. It is expected that 50 to 65 thousand acres could be pre-hatched with a controlled release formulation each season. During the summer months the normal control activities would continue. During dry periods when the second or third pre-hatch would otherwise be taking place, implementation of biological or physical control operations would be the priority.

Before a controlled release formulation would be put into operational use by the District, the impact of such a formulation on insecticide resistance and field evaluations would have to reveal the appropriateness of this method to the control program. Manpower needs, duration of the treatment (1 season or more) and cost would be factors in determining acceptability.

The presence of limited amounts of non-degradable plastic in the soil maybe a cause for concern by some if the polyethylene formulation were to be used. Its projected use would be less than 10 years. Within 3 to 5 years a degradable silicate (sand) capsule, under joint development by the District and Washington University, St. Louis, Missouri is expected to be available. The silicate formulation would act like time capsules, breaking apart at various times depending on the type of capsule formulation. As each capsule breaks open it releases into the water the amount of insecticide needed at that time.

These are small capsules about the size of the presently used Celatom granule. It is expected that these capsules could be produced by District staff during winter months and would be inexpensive enough to warrant use in the MMCD program.

The silicate formulation is under study in small scale experimental tests by the MMCD. Results to date have been promising and have produced between 60% and 100% control with slow release formulations in Aedes test sites upon repeated wetting.

The concentration of insecticide in the water with DURSBAN 10 CR is approximately 20 fold less than with conventional granule formulations. With the DURSBAN 10 CR the concentration in the water ranges between 0.6 and 2.2 ppb. With granules applied at 0.05 lb. AI/acre the concentration is 18.4 to 36.8 ppb (Nelson and Evans, 1975).

The cost of DURSBAN 10 CR is $3.30 per pound. A silcate capsule formula would cost about $0.26 - $0.30 per pound plus the cost of the active ingredient, manufactured by MMCD staff. Initial start-up costs are projected at $12,000.00

Figures in Table 34 compare the costs of alternate materials. High and low ULV and granule figures are calculated for temephos and chlorpyrifos, respectively. High and low estimates for controlled release polyethylene and silicate capsules are for levels expected to control and the lowest rate likely to attain control.

TABLE 34

AVERAGE ANNUAL COSTS PER ACRE OF ALTERNATE TREATMENT MATERIALS

		Materials							
	Total Acres	ULV Treatment Low	ULV Treatment High	Granules Low	Granules High	Polyethylene Controlled Release Low	Polyethylene Controlled Release High	Silicate Capsules Low	Silicate Capsules High
Helicopter									
3 or more acres	176,775	$4.50	9.00	9.24	23.68	28.50*	59.00*	11.28	21.50
1 to 3 acres	47.705	6.75	13.50	10.65	26.40	29.00*	59.50*	11.60	21.90
Ground									
3 or more acres	176,775	9.00	18.00	12.90	26.10	29.75	59.75	12.83	21.65
1-3 acres	47.705	8.25	16.50	12.15	24.60	29.50	59.50	12.58	21.40
Less than 1 acre	16,970	6.93	13.86	10.83	21.96	29.06	59.06	12.14	20.96

*Estimated

SOURCE: MMCD, 1976

PROGRAM ALTERNATIVES: OPTIMUM CONTROL

The following information is presented assuming an understanding of current real and technical limitations influencing the level of mosquito control obtainable in the Minneapolis-St. Paul Metropolitan area as previously described.

To enable the minimum annoyance goal of 1 mosquito per 5 minute period to be achieved within the Metropolitan area now served by the larval control program, an additional 10 miles peripheral buffer zone would be needed. This area would include eastern Carver County which is particularly important due to prevailing southwest breezes which carry adult mosquitos into the southern Metropolitan area.

In such a larval control program emphasis would be placed on permanent and long term corrective measures to reduce the labor, material and energy costs now necessitated by the need to revisit the breeding areas for inspection and control following each rainfall resulting in a mosquito hatch. This approach would require a considerably increased budget requirement for an estimated 15 year period at which time the investment in long term control would result in reduced mosquito population, reduced budgetary requirements and reduced use of insecticides.

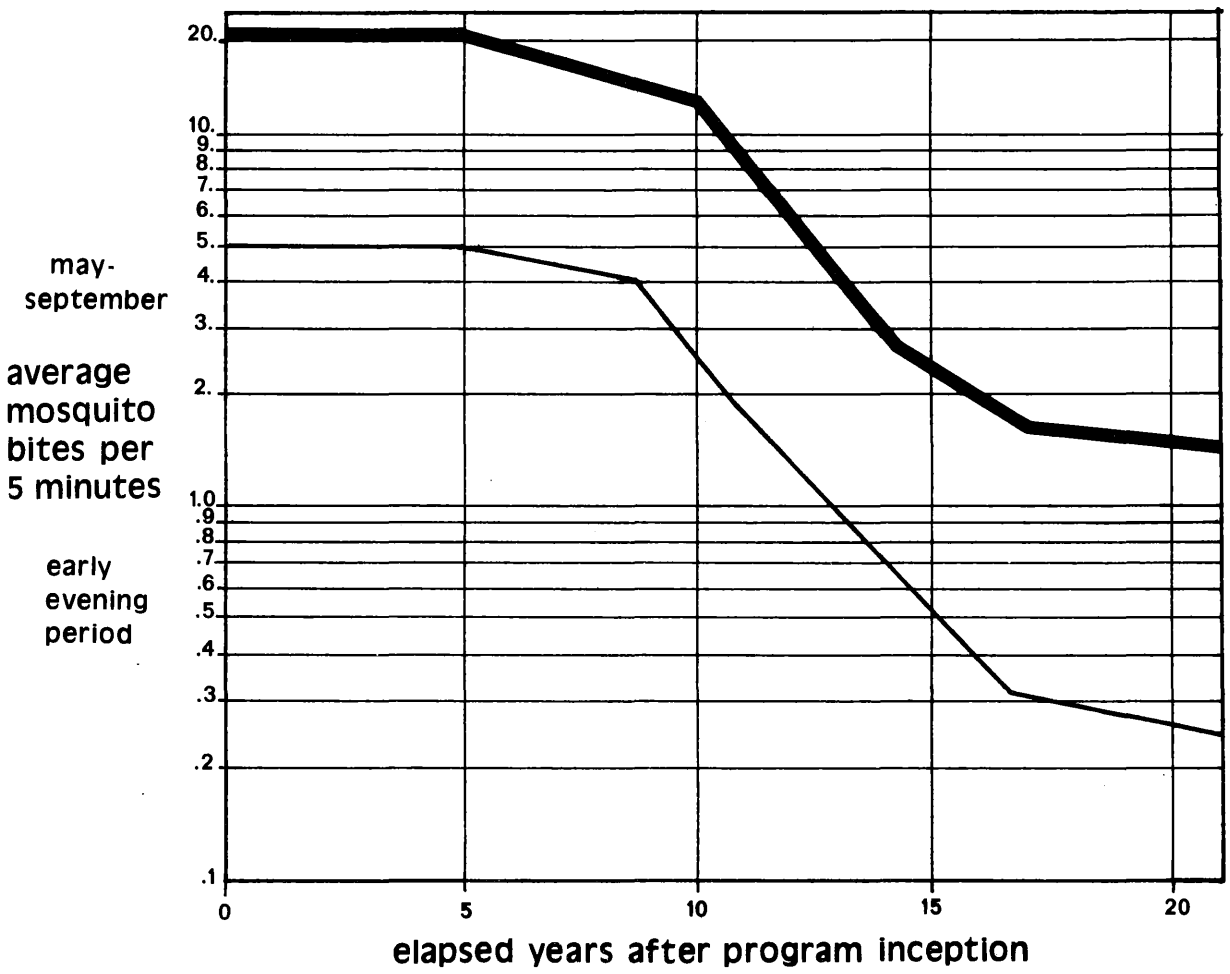
Annual funding for such a program is projected at 3 times the 1976 budget or $4,500,000. Of that amount 50% of the budget would be spent on permanent corrective measures, 47% or $2,115,000 on physical control modifications and 3% or $135,000 to fund needed physical and biological control program development studies on a university grant or in-house basis.

The remaining half of the budget would consist of the 1976 budget plus an increase of 17% or $750,000 to augment the current chemical control program to provide an increased immediate level of control during the 10 year lag period until the results of the permanent corrective measures take effect.

At that time the chemical control program could be reduced 1/2 and five years later to 1/4 of its original level.

Maintenance of a combined mass culture biological and chemical control program capable of controlling broods of mosquitos developing both in permanent water and locations not suitable to physical modification would be required at a level approximating 25% of the initial chemical control program or $550,000 per year (equivalent to 1/6 of the current program based on an equivalent area). Adult control measures would remain a low emphasis support to reduce adult populations in the event of local outbreaks. The maintenance cost for the physical modification program would be projected to reduce 1/2 in twenty years, yielding an estimated annual budget requirement of $2,575,000 (1976 dollars).

The entire program is based on the assumption that the Department of Natural Resources would grant approval for necessary slope modification of marsh shorelines and excavation of intermittent water marsh habitats to create permanent water basin or moat areas in the center. Without this approval, the physical modification program would be limited to upland Aedes sites. A projected 20 year mosquito biting curve (exclusive of Coquillettidia perturbans) at a point 10 miles from the center of the District for a normal eighteen inch precipitation per year is estimated in Figure XIV.



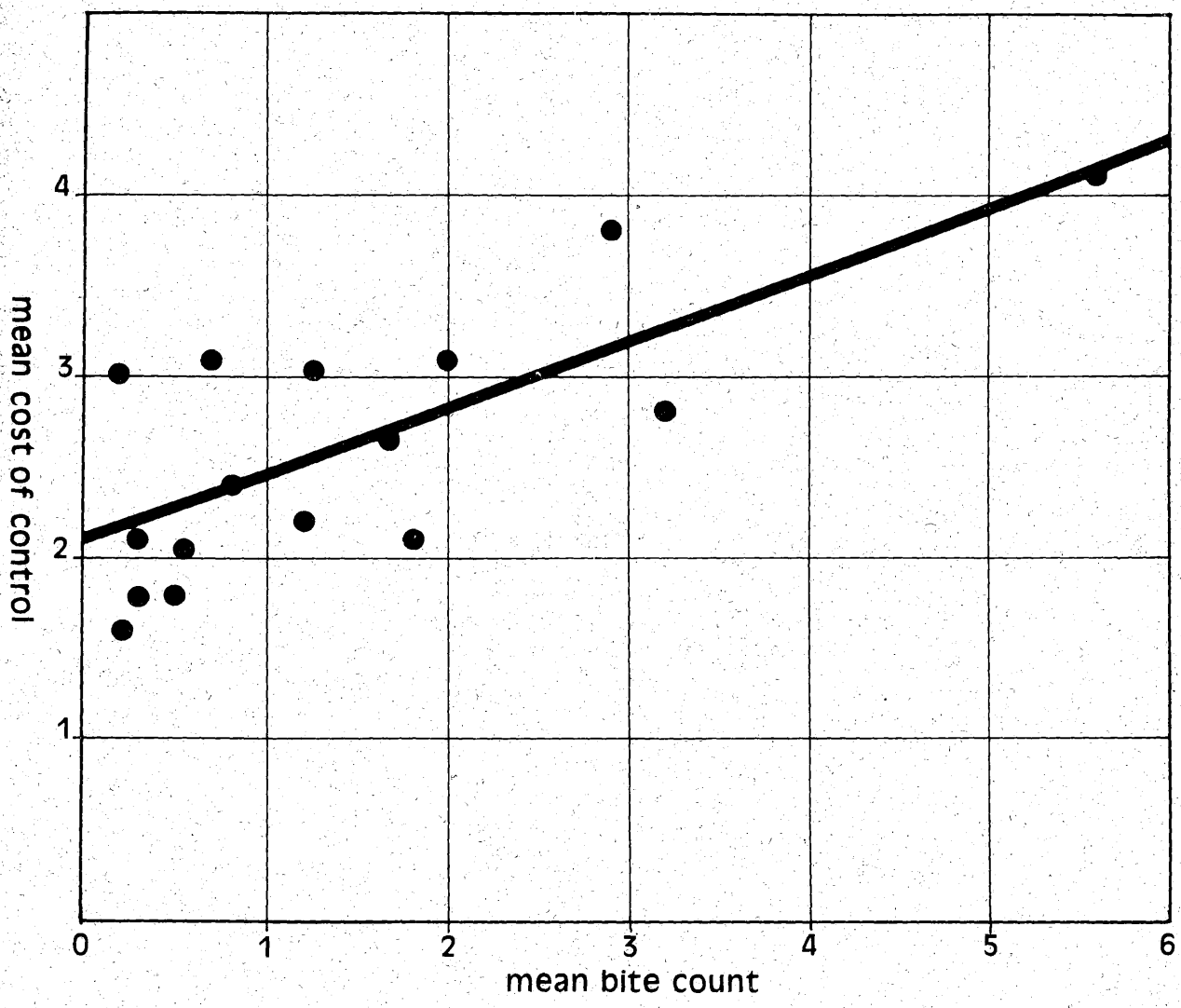
mosquito production
as a result of permanent site corrections

resultant population
with combination physical and chemical control

figure XIV.

projected mosquito bite counts curve

under optimum 22 year program, 10 miles from the center of the current district


mean cost of control
4
3
2
1
0
1
2
3
4
5
6
mean bite count

ENVIRONMENTAL IMPACTS

INTRODUCTORY COMMENTS

To supplement its own conclusions in an objective and scientifically sound manner, the Metropolitan Mosquito Control District distributed concerns brought to its attention by the Minnesota Environmental Control Citizens Association, (initiators of the action) and state agency personnel as well as descriptions of its current program and alternatives (discussed in "Alternative Programs") to 12 scientific specialists. These scientists were asked to assess the potential impacts of current and alternate control techniques upon features of the physical and natural environment as permitted by their academic qualifications and professional expertise. These experts are regarded by their peers as being among the top 5 in their fields.

The questions forwarded to these gentlemen are included in Appendix EI (exhibit A) which accompanies this text. Correspondence between the MMCD and each commentator is filed at the MMCD Offices at 1802 Como Avenue and may be reviewed there.

Portions of the comments offered the MMCD have been reproduced in the following discussion and credited as appropriate. Where credit is not assigned to a single individual, it may be assumed that the finding represents a composite of several responses, or reflects the judgment of the project proponent.

Prior to reading this chapter, it is suggested that the reader review the following matrix. The discussion of program impacts which follows is designed to expand upon judgments presented in this summary matrix. Numerical values appearing in the matrix are included in the subsequent discussion.

environmental impacts of alternate mosquito control programs

degree of impact at stages of program development

subject of impact	current MMCD program			no control option			biological control option			physical control option			controlled release chemical[a]			optimum mosquito control		
	5 years	15 years	25 years	5 years	15 years	25 years	5 years	15 years	25 years	5 years	15 years	25 years	5 years	15 years	25 years	5 years	15 years	25 years
freedom from mosquito annoyance	5	5	5	■	■	■	■	■	■	■	1	4	6	7	7	6	7	7
public health	3	3	3	■	■	■	■	2	3	■	2	3	5	5	5	5	5	5
animal health	3	3	3	■	■	■	■	■	1	■	1	3	5	6	6	5	6	6
non-target organisms																		
aquatic micro-organisms	1	1	1	■	■	■	■	■	■	2	2	2	1	1	1	1	1	1
crustaceans	3[c]	3[c]	3[c]	■	■	■	■	■	■	■	■	■	4	4	4	4	2	1
aquatic insects	1	1	1	■	■	■	■	■	■	■	■	■	2	2	2	2	1	■
terrestrial insects	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
pollinating insects	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
terrestrial flora	■	■	■	■	■	■	■	■	■	■	1	1	■	■	■	■	1	1
aquatic flora	■	■	■	■	■	■	■	■	■	3	3	3	■	■	■	3	3	3
birds	■	■	■	■	■	■	■	■	■	2	2	2	■	■	■	2	2	2
waterfowl	1	1	1	■	■	■	■	■	■	1-2[b]	1-2[b]	1-2[b]	2	2	2	1-2[b]	1-2[b]	1-2[b]
fish	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
amphibians & reptiles	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
aquatic mammals	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
terrestrial mammals	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
humans	■[d]	■[d]	■[d]	■	■	■	■	■	■	■	■	■	■[d]	■[d]	■[d]	■[d]	■[d]	■[d]
physical environment																		
hydrologic cycle	■	■	■	■	■	■	■	■	■	1	1	1	■	■	■	1	1	1
surface water quality	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
ground water quality	■	■	■	■	■	■	■	■	■	1[e]	1[e]	1[e]	■	■	■	■	■	■
solid waste	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
air quality	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
noise	2	2	2	■	■	■	■	3	3	3	3	3	1	1	1	3	3	3
wetlands (MMCD)																		
type I	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
type II	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■

type III	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
topography	■	■	■	■	■	■	■	■	■	■	1	1	■	■	■	■	1	1
insecticide residue																		
bio-magnification	1	1	1	■	■	■	■	■	■	■	■	■	1	1	1	1	1	1
degradation products	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
synergism & potentiation	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
re-synthesis	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
soil residue	1	1	1	■	■	■	■	■	■	■	■	■	1	1	1	1	1	1
resistance																		
mosquito	■	■	■	■	■	■	■	■	■	■	■	■	■	1	3	■	■	■
other pest arthropods	■	■	■	■	■	■	■	■	■	■	■	■	■	■	1	■	■	■
non-pest arthropods	■	■	■	■	■	■	■	■	■	■	■	■	■	■	1	■	■	■
energy use	1	1	1	■	■	■	■	■	■	1	1	1	2	1	1	2	2	1
cost-benefits																		
per capita cost																		
public ($)	.80	.80	.80	3.11	3.11	3.11	.20	.40	.40	.80	.80	.80	3.20	1.80	1.80	2.40	2.40	1.30
private ($) ⓕ	1.10	1.10	1.10	1.33	1.33	1.33	3.11	2.97	2.97	3.11	2.55	1.42	.44	.44	.44	.86	.58	.44
% MMCD acres controlled	35%	35%	35%	0	0	0	0	5%	5%	11%	33%	55%	95%	95%	95%	87%	94%	100%
% mosquito reduction 10 mile radius from core	65%	65%	65%	0	0	0	0	5%	5%	0	20%	60%	95%	95%	95%	80%	90%	95%
added adult residential hours of outdoor evening recreation/ total dollars spent ⓕ	7.4	7.4	7.4	—	—	—	—	.3	.3	1.2	1.2	5.7	5.5	9.0	9.0	5.2	6.4	11.5

key:

■	insignificant
1	minor
3	significant
5	major
7	extreme

qualifying notes:

ⓐ it is understood that formulation changes may be necessary to compensate for mosquito resistance.

ⓑ accurate estimation of impacts requires a site-by-site study. generally impacts are both positive (increased habitat) and negative (possible loss of food supply).

ⓒ impact is greatest in temporary water sites (I, II).

ⓓ impacts are limited to allergies in hypersensitive persons.

ⓔ limestone treatments are proposed for type I upland sites. testing will precede any use in sites where ground water tables lie near the surface.

TABLE B

KEY TO INTERPRETATION OF VALUES RECORDED
IN MATRIX:EXECUTIVE SUMMARY

ENVIRONMENTAL PARAMETER	VALUE	DEFINITION
Freedom from mosquito annoyance	■	Residents cannot use most parks in the day without annoyance (July).
	1	Parks can be used in the daytime with minimum mosquito annoyance.
	3	Parks can be used at night with minimum annoyance.
	5	70 of 90 summer nights with mosquito bite counts of 1 or less per five minutes at the District's center.
	7	70 of 90 summer nights with mosquito bite counts of 1 or less per five minutes in all areas of the District.
Public Health		
	1	Fewer than 25 cases confirmed per annum.
	3	Fewer than 10 cases confirmed per annum.
	5	Cases are sporadic, confined to the outer fringes of the District and number fewer than 5 per year.
	7	Diseases not reported.

ENVIRONMENTAL PARAMETER	VALUE	DEFINITION
Animal Health	■	Incidence of heartworm and equine encephalitis equal with the current norm in areas beyond the controlled boundary of the District.
	1	The incidence of mosquito-borne animal disease = 25% less than the current norm outside the controlled area of the District.
	3	Disease cases occur at the periphery of the District and = 50% of the current norm beyond the controlled area of the District.
	5	Disease cases occur entirely at the periphery and = 75% fewer than the current norm in uncontrolled areas beyond the District boundaries.
	7	Diseases in domestic animals is uncommon in the District.
NON TARGET ORGANISMS Aquatic Micro-organisms	■	No change.
	1	Temporary suppression of some populations of aquatic micro-organisms.
	3	Temporary wholesale suppression of all populations of aquatic and soil micro-organisms during the period of mosquito control.

ENVIRONMENTAL PARAMETER	VALUE	DEFINITION
	5	Temporary elimination of aquatic and soil micro-organisms in the area of treatment (ie. for up to 1 year following treatment).
	7	Permanent elimination of aquatic and soil micro-organisms in the area of treatment (ie. 10 years or longer following treatment).
Crustaceans Aquatic insects Terrestrial insects Pollinating insects	■	Populations reduced by 1% or less within a median square mile without elimination of the species; populations reduced 5% or less in any given square mile.
	1	Populations reduced 5% or less within a median square mile and 50% or less in any given square mile.
	3	Populations reduced 25% or less within a median square mile without elimination of the species and 75% or less in any given square mile.
	5	Populations reduced by 50% or less within a median square mile; elimination of populations in several square mile areas.
	7	Populations eliminated within a median square mile.

ENVIRONMENTAL PARAMETER	VALUE	DEFINITION
Aquatic flora Terrestrial flora	■	No change.
	1	One-time disruption of 25% - 50% of the vegetation in the area of treatment.
	3	One-time disruption of 50% or more of the vegetation in the area of treatment.
	5	Killing of an individual of a rare species or elimination of vertebrate habitat in the treatment area.
	7	Elimination of a rare species.
Birds Waterfowl Fish	■	Elimination of food, shelter, nesting and loafing space for 1% or less of the population in a median square mile.
	1	Elimination of food, shelter nesting and loafing space for 5% of the population in a median square mile.
	3	Elimination of food, shelter nesting or loafing space for 20% of the population in a township.
	5	Direct toxicity to 50% or elimination of habitat for 50% of the population within a township.
	7	Elimination of a species within a township by direct toxicity or alteration of habitat.

ENVIRONMENTAL PARAMETER	VALUE	DEFINITION
Aquatic mammals Terrestrial mammals	■	No change of habitat.
	1	1% reduction of populations within a square mile.
	3	5% reduction of populations within a square mile.
	5	30% reduction of populations within a square mile.
	7	Elimination of a species within a square mile by direct toxicity or alteration of habitat.
Humans	■	Fewer than 5 cases of reported skin irritation each year.
	1	Five or more reported cases of skin irritation each year.
	3	Medically certified illness (including laboratory confirmation) in employees or general public as a result of the program.
	5	Accidental death due to physical causes.
	7	Medically certified death due to toxicological effects.
PHYSICAL ENVIRONMENT		
Hydrologic Cycle	■	No change

ENVIRONMENTAL PARAMETER	VALUE	DEFINITION
	1	Water retention time reduced in median MMCD Type I site treated with limestone to five days.
	3	Elimination of all but semi-permanent and permanent water sites.
	5	Elimination of all but permanent water sites.
	7	Localized lowering of surface water levels below depth required for terrestrial plant growth.
Surface Water Quality	■	No change.
	1	Annual phosphate loading in a permanent body of water increased by 5% or less.
	3	Phytoplankton blooms make water unfit for vertebrate populations.
	5	Water is unfit for human recreation.
	7	Water is toxic to humans.
Groundwater Quality	■	No change.
	1	Percolation of pre-existing pollutants into groundwater.
	3	Introduction of non-toxic pollutants into aquifer headwaters.
	5	Introduction of toxic materials into groundwater supply.

ENVIRONMENTAL PARAMETER	VALUE	DEFINITION
	7	Introduction of toxic materials into groundwater used for drinking.
Solid Waste	■	No change.
	1	Accumulation of insecticide carrier residues to one part in one thousand in the top 6" of soil in the treated area.
	3	Accumulation of insecticide carrier residue to one part in ten in the top 6" of soil at the treatment site.
	5	Solid waste is visible at the treatment site or is equal to 1% or more of the solid waste in the Twin Cities.
	7	Solid waste is unavoidably visible.
Air Quality	■	No change.
	1	Visibility is limited in the median recreation areas being treated for 5 minutes or more.
	3	Materials are emitted into the air which could combine with other pollutants to form sub-lethal toxic substances.
	5	Fog conditions result creating the probability of automobile accidents.
	7	Materials are emitted into the air at levels toxic to mammals.

ENVIRONMENTAL PARAMETER	VALUE	DEFINITION
Noise	■	No change in ambient noise levels.
	1	Noise causes momentary surprise and diverts attention. Wildlife leave the area and return when noise subsides.
	3	Noise causes momentary disorientation, or noise is continuous at 80 dBA or more in several locations.
	5	Noise at or in excess of pain threshold.
	7	Noise results in permanent hearing damage.
Wetlands MMCD I,II,III	■	No change.
	1	Change does not alter wetland classifications as stated in the U. S. Fish and Wildlife Service Circular 39 or ongoing revisions to that classification system.
	3	Wetlands (MMCD classification)are reduced by 1% to 20%.
	5	Wetlands (MMCD classification) are reduced by 20% or more.
	7	Wetland breeding sites are eliminated in a township.

ENVIRONMENTAL PARAMETER	VALUE	DEFINITION
Topography	■	No change.
	1	Change in topography from one acceptable appearance to another, equally acceptable appearance.
	3	Erosion is caused by physical changes which results in site-restricted hill and gully topography.
	5	Construction leaves open cuts in the earth or flattens rolling terrain.
	7	Physical changes destroy an area considered to be uniquely beautiful.
INSECTICIDE RESIDUE		
Bio-magnification	■	No change in normal processes
	1	Organism absorbs insecticide or its degradation products, stores materials without adverse effects, and excretes non-toxic metabolites
	3	Insecticide is held in the food chain for an extended period of time with no adverse effects.
	5	Insecticide accumulation shortens the normal life-span of any vertebrate species.

ENVIRONMENTAL PARAMETER	VALUE	DEFINITION
	7	Insecticide products accumulate in the food chain interfering with reproduction or causing mortality in any vertebrate species.
Degradation Products	■	No change.
	1	Insecticide degrades quickly into non-toxic, non-persistent by-products.
	3	Degradation products are 50% less toxic than the parent compound.
	5	Parent and degradation products have equivalent toxicity.
	7	Degradation products are more persistent and more toxic than parent compound.
Synergism and Potentiation	■	Insecticide interacts with a material in the pre-existing environment. The interaction increases the toxicity of dosage now in use by 1% or less.
	1	Interaction between an insecticide and a pre-existing condition increases toxicity of a current dosage by 1 to 5%.
	3	Insecticides are shown to reduce safe-use margins by 15% or more when combined with other substances.

ENVIRONMENTAL PARAMETER	VALUE	DEFINITION
	5	Insecticides combine with other materials to result in chronic toxicity which shorten human life spans by 2 years or more.
	7	Insecticides are shown to combine with other materials in the environment to produce mortality in animals or man.
Re-synthesis	■	No change.
	1	Degradation products re-combine at non-toxic trace levels.
	3	Degradation products re-combine at levels 80% less toxic than parent compounds.
	5	Degradation products re-combine at levels 40% less toxic than the parent compound and have a duration of 1 year.
	7	Degradation products readily re-combine in the original parent materials with equal toxic strength.
Soil Residue	■	Residues are not measurable in ppb 60 days or more after application.
	1	Trace levels are measurable 60 days or more after treatment but in levels insufficient to cause mortality in any organism.
	3	Residues are present 60 days after release equal to 50% of the original application.

ENVIRONMENTAL PARAMETER	VALUE	DEFINITION
	5	Residues present 60 days after application are equal to 100% of the original application.
	7	An insecticide - soil relationship evolves whereby the insecticide does not degrade. Release after multiple treatments can occur at a concentration twice that achieved by a single application.
RESISTANCE by Mosquitos and Pest Arthropods	■	No resistance.
	(*+) 1	The probability exists that resistance will develop as a response to a larval control material in the area most intensely treated.
	(*+) 3	Resistance is expected to develop as a response to larval control materials in use.
	(*+) 5	Resistance occurs in response to all but the most expensive larval control materials.
	(*+) 7	Resistance occurs as a response to all insecticides approved for the larval control of mosquitos.

*+before the numerical value indicates non-pest arthropods.

ENVIRONMENTAL PARAMETER	VALUE	DEFINITION
ENERGY CONSUMPTION	■	Energy consumption, measured in gasoline, is equivalent to .001% of total metropolitan consumption.
	1	Energy consumption, measured in gallons of gasoline, is equivalent to .01% of total metropolitan consumption.
	3	Energy use, measured in gallons of gasoline, is equivalent to .1% of total metropolitan consumption.
	5	Energy use, measured in gallons of gasoline, is equivalent to 1% of total metropolitan consumption.
	7	Energy use, measured in gallons of gasoline, is equivalent to 10% of total metropolitan consumption.

COST BENEFITS

Cost benefits analysis are based on current figures. Current public expenditures are $.81 per capita. Current private expenditures ($1.10 per capita) are based upon responses of 1920 households in a survey conducted by the District in 1976. Hours spent outdoors per dollar spent are based upon historical mosquito light trap and bite count recordings and responses by adults to survey questions in 1976.

CURRENT CHEMICAL CONTROL PROGRAM

INTRODUCTORY COMMENT

To summarize briefly from information presented in earlier sections of this report, the current MMCD program is one of chemical control. Some 26,450 mosquito breeding sites are treated from one to six times each year with the following EPA approved insecticides: chlorpyrifos, temephos, malathion and fuel oil.

Applications are made aerially (64%) and by ground. Insecticides are applied in liquid and granular form. Sites treated chemically are of three types: Upland intermittent water depressions (I); woodland depressions which hold water once annually during the period of snow melt (II); and marsh sites associated with more permanent water (III). A discussion of the environmental impacts of this program follows.

MOSQUITO ANNOYANCE

5 Yrs.	15 Yrs.	25 Yrs.
5	5	5

The MMCD philosphy is to provide the highest level of control for the greatest number of people. In other parts of the country, it is frequently possible to acheive 95 to 98 percent control, as mosquito production is far less severe than in the Twin Cities area.

The MMCD encompasses 2,633 square miles of which 900 are treated with both larval and adult control measures. This area coincides with the residential density of three fourths of the metropolitan population.

Maximum reduction of mosquito annoyance occurs in central St. Paul and Minneapolis where effective control is estimated at 87%. Eight miles from St. Paul (in any direction) mosquito control is 65%.

Mosquito annoyance is most severe in the north and western portions of the District and occasionally in the Minnesota and Mississippi River flood plains in time of summer flooding. Mosquito density is normally three times greater in outlying areas than at the center of the District (Genereux, 1976).

Reduction of mosquito populations in the MMCD has been calculated using standardized light trap populations compared to mosquito breeding intensity.

Mosquito breeding intensity was assumed to function as a result of a combination of acreages and numbers of sites near light traps. These traps were standardized by comparing them to each other in terms of their ability to represent mosquito biting activity in typical residential locations. See Appendix EI, (exhibit B), for a more detailed description of methods and results.

The difference in relative change in mosquito counts is a direct function of the M M C D larval and adult control program.

Where the MMCD intensively controls mosquito populations, changes in household behavior are evident. A detailed summary for Metropolitan areas is included in Appendix EI, (exhibit B). To empirically identify the program's impacts on outdoor behavior, a survey of households was conducted during the summer of 1976. To those accustomed to sharply higher mosquito counts, as recorded in Figure XIII, there seemed evident, in many of the interviews, a metro-wide inclination not to notice the mosquito population of 1976.

This limitation not withstanding, the Metropolitan Mosquito Control District has been shown to have at least four important positive socio-economic effects as a result of its current control program

1. As a direct result of the program, adult residents of the core area of the District (rings one and two) are able to spend more time outdoors than would otherwise be possible. This is largely due to the fact that the central-city mosquito collection

zones are within the District's control area (see Figure XV).

Approximately 27,526,000 additional residential evening hours are available to adults in this area in an average 92 day summer season (June-September 1) or 22.5 hours per adult, per summer. Historical frequency of low-annoyance evenings in the Twin Cites is shown in Figure XVI. It should be noted that these evening figures are more significant than the evening hours of the summer of 1976 for two reasons:

a) Calibration from a low activity season is likely to underestimate activity;
b) Bite counts of less than 1 per five minutes did not appear to significantly deter outdoor activity.

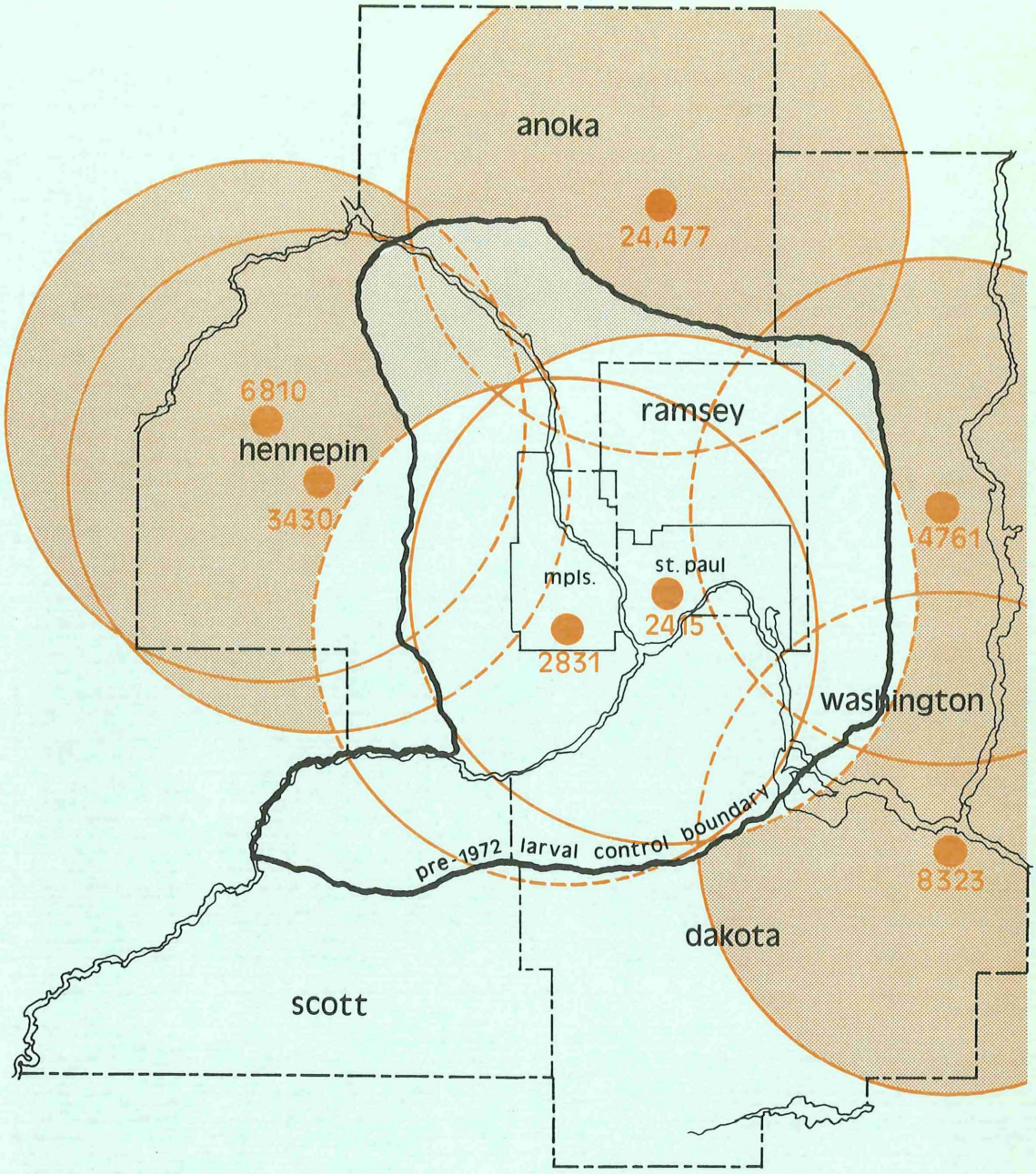
Principle program beneficiaries are residents in the:

a) Central cities of Minneapolis/St. Paul;
b) Older suburbs, especially those in northern Ramsey and southern Anoka Counties.

2. Public mosquito control results in considerable savings in household expenditures for bug sprays and mosquito repellents. Approximately $1,242,000 is saved in the six-county District in an average summer with control.

   Higher savings are experienced in those areas noted in item (1) above. Control is more important in the northern sector due to the higher natural incidence of mosquitos (see Table 35).

3. The worth of control is related to activities rather than location. Respondents were asked to specify activities that had been interrupted by mosquitos, and then place a value on mosquito elimination from the most favorite activity. The median value for those responding was $10.00 (per household). By averaging the cost of repellents into the calculation for non-respondents, per capita



collection zones

location of light traps

1000 average female mosquito population, for 5 typical years: 1960, 1961, 1964, 1970, and 1971.

source: MMCD records.

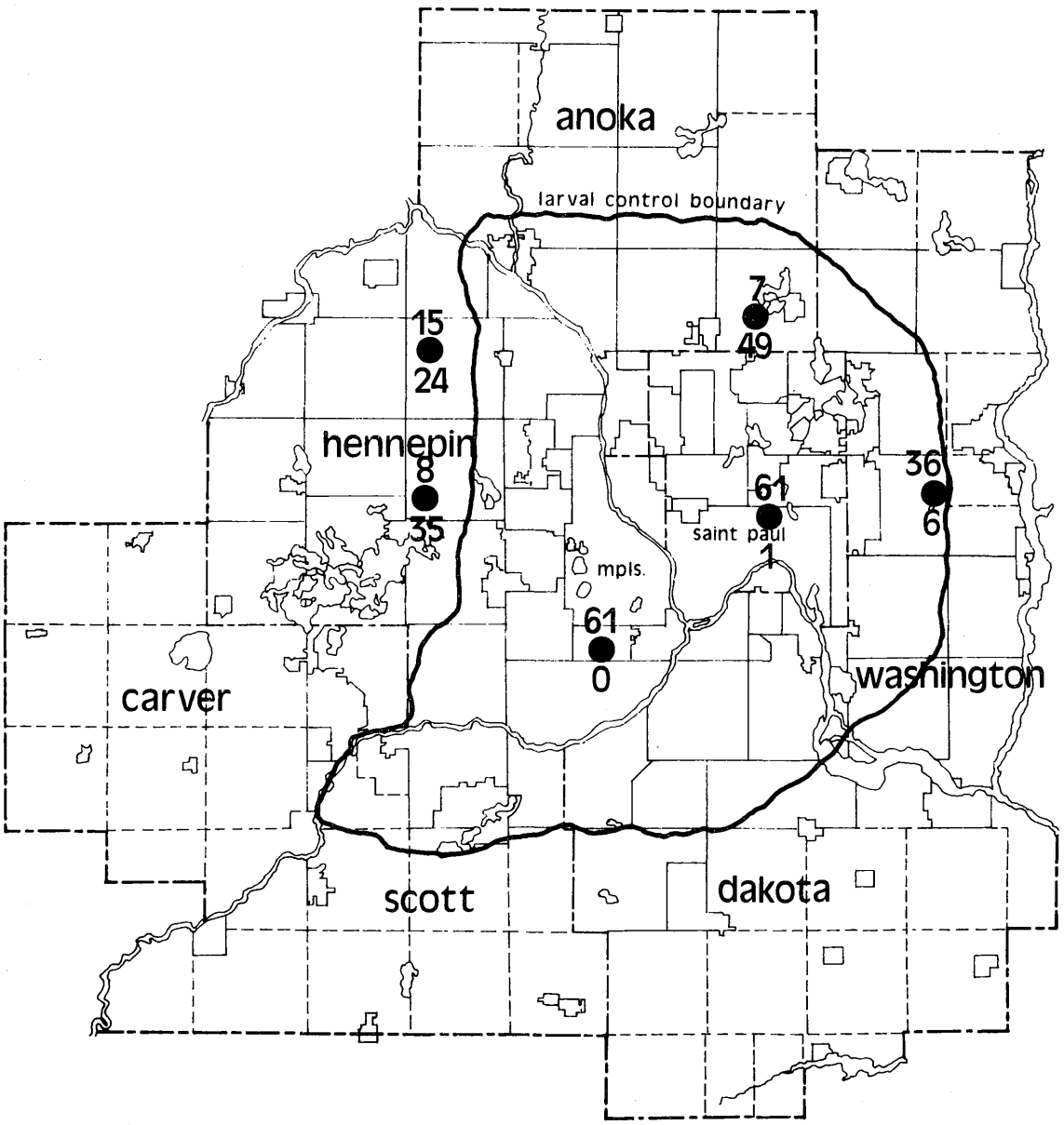
figure XV.

mosquito counts and collection zones

at seven selected light traps

miles 0 5 10 15 20 n

john and michele genereux



00 number of low days
● location of trap
00 number of high days

low annoyance = 1 mosquito bite or less per 5 minute bite count

high annoyance = 10 mosquito bites or more per 5 minute bite count

source: female mosquito counts, MMCD, 1959-1976

figure XVI.

mean number of summer days with low and high mosquito density

miles 0 5 10 15 20 n

john and michele genereux

TABLE 35

AVERAGE EVENING BITING COUNTS OF MOSQUITOS IN AREAS NEAR STANDARDIZED TRAPS

	Average Night Counts of Female Mosquitos		
	Overall	Worst Month	Other Summer Months
St. Paul	24	42	16
Richfield	17	29	12
Plymouth	301	531	186
Maple Grove	214	414	117
Lake Elmo	96	213	43
Centerville	1050	1928	612

value of mosquito control is found to be $1.95 or $1.15 above current funding levels.

The above, of course is only an estimate of value and probably a quite low one, since:

a) Only one activity of one member of a household was recorded, not all the activities of all members;

b) Only 45% responded to the open-ended question;

c) 1976 was a year of low mosquito production.

4. Persons who manage public recreation areas consider MMCD adulticiding operations both beneficial and necessary (MMCD survey 1976). While coordination could be improved, there is no doubt about real value of the program in these areas in the opinion of respondents. Approximately 5,000,000 user evenings receive some benefits from MMCD activities.

Overall, including calculations on public recreation areas, the program provides some 29,000,000 mosquito-free evening hours per summer, and reduces expenditures by over $1,300,000.

According to residents surveyed, the District should have more money alloted to it if improved control were assured. This support was widespred and appeared to result from a long term perspective.

Respondents do perceive that an environmental cost is being paid for their benefits. Approximately 24% of those who were interviewed agreed or strongly agreed that the District's spraying caused serious damage to the natural environment.

This perception appears to carry over into private insecticide use. Those who thought the District program dangerous spent an average of $1.72 last year on insecticides; those who didn't think so spent $3.68.

Other attitudes were less evidently connected. The perception of damage appeared to have little effect on other responses. A statistical tool called Cramers ϕ was used to assess the degree of connection between reponses on environmental damage and these items:

1. "Public control is adequate in this neighborhood" (Cramers ϕ =.086)

2. "More should be done to control mosquitos in this neighborhood." (Cramer ϕ =.158)

3. "If a higher level of control could be guaranteed, more public funds should be directed toward mosquito control." (Cramers ϕ =.136)

Nonetheless, this apprehension is an important negative effect of the current program.

Problems in the analysis include the low mosquito counts noted above. More important, perhaps, is the reduction in annoyance even in those hours which

are not denied. In addition, there are undoubtedly many activities, also valued by respondents, which are not recorded here. Finally, secondary impacts, such as energy used traveling to and from recreation in mosquito-free areas or the economic value of fee-based recreation, were not evaluated.

These finer distinctions are difficult to achieve in a phone survey. The results that are suggested above are therefore quite conservative. For this reason, they may be all the more useful for policy planning.

One would expect that research done in a heavy mosquito year would show threshold levels beyond which restriction of outdoor evening time would become substantial. It is clear that such thresholds are probably not below five bites in a five minute bite count.

PUBLIC HEALTH			Few diseases are normally transmitted by mosquitos
5 Yrs.	15 Yrs.	25 Yrs.	to humans in the Twin
3	3	3	Cities Area.
ANIMAL HEALTH			Disease carriers do breed
3	3	3	in the area and are generally controlled under

the routine operations of the MMCD.

Heartworm in dogs does occur in severe proportions in parts of the District. Given the current level of overall mosquito control, this disease can not be effectively checked without the cooperation of dog owners and local veterinarians.

The District is not currently equipped to adequately respond to emergency outbreaks of disease without temporarily suspending normal operations.

Knowing that outbreaks of Western Equine Encephalitis can occur in the District (i.e.1975), the District monitors Culex tarsalis larval and adult mosquito populations and treats these breeding areas with particular attention when populations of this species rise above normal.

The impact of insecticides on humans may be analyzed from at least three perspectives: insecticides as allergens, insecticides as oral and dermal poisons and insecticides as carcinogens.

According to Dr. Lowell Henderson of the Mayo Clinic (1977a), roughly 10% of the general population suffer from respiratory allergies. Dr. Henderson states as well that, "persons with rhinitis (hay fever-like symptoms) and asthma may have their symptoms aggravated by breathing in almost any kind of odors, fumes, dusts, smoke, etc. This usually has nothing to do with a true allergic mechanism, but rather the direct irritating effect of those items. Generally, the effect of these exposures are transient so that within a few hours the symtoms subside with or without treatment.

Henderson concludes (1977a) that it is his "clinical impression that respiratory problems deriving from mosquito control are not very prominent or significant". noting that an occasional asthmatic patient coughs or sneezes transiently when fogging devices are in operation.

Henderson also notes (1977b) that "the position that many nondescript symptoms and complaints may be due to adverse effects of items in our environment.... is an assumption...and since many of the symptoms are of a type that all of us have from time to time or that many emotionally disturbed persons have, the thesis is quite tenuous. Henderson (1977b) does not recommend that the idiosyncratic reaction "stand in the way of good public health measures including a mosquito control project with materials that have been adequately tested for levels of toxicity".

Indications of dermal or respiratory insecticide poisoning could be expected to occur in persons having the most prolonged contact with the formulations (Durham, 1965), thus most studies relating to pesticide impacts on man have been conducted under conditions simulating factory, laboratory and field experiences. Studies have shown that some people may be hypersusceptible to organophosphates; dermal absorption is more probable than respiratory absorption.

dermal poisoning is more likely to occur under conditions of abnormally high temperatures in agricultural areas (Durham, 1965; Hayes, 1975).

In a study conducted and reported by Zucker (1965), 106 persons with positive reactions to ragweed or unrefined pyrethrum were given skin tests with pyrethrum extract. Fourteen persons with a history of reactions to household insecticides were further exposed. No definite allergic reactions were noted. Zucker concludes that a positive reaction to pyrethrum does not indicate allergy to insecticide containing refined pyrethrums.

Pyrethrums have a low mammalian toxicity (Camougis, 1971) oral LD_{50} =1000 mg/kg. Camougis (1971) estimates that two gallons of a normal household spray containing 1% pryethrums would have to be ingested to effect a 50% chance of pyrethrum poisoning.

Hayes (1967) reports that insecticide poisoning is most common in this country in southwestern states where cotton is the primary crop, temperatures are seasonably high and field workers are often poorly educated in the uses of pesticides or are unable to read instructions because of a lack of fluency in English.

Twenty-six pesticide-induced deaths were reported in California in 1966 (West, 1969). Eighteen of these were confirmed suicides. Eight were accidents (5 children; 3 workers). Cases of dermatitis and conjunctivitis were noted in 1000 cases; many go unreported (West). West attributes the majority of cases of this type to ignorance and anxiety about getting the job done economically.

Pesticides may be contacted through the skin, inhaled as dust or ingested on food or in water.

Dust inhalation was the subject of a 1974 study in Weld County, Colorado (Starr et al., 1974). Dust samples were collected from 28 households and 55 adults occupationally associated with pesticides for one year. Control participants had no occupational exposure to pesticides. Data showed no relationship between pesticide levels in dust and pesticide levels in blood.

Field studies with chlorpyrifos (Dursban^{R}) in 1967-1968 are reported by Eliason et al.(1969). When used under field conditions as an aerosol, the material caused depression of plasma cholinesterase in spraymen. Tests concluded that, "Dursban^{R} emulsion or suspension formulations are not acceptable for use as a premises larvicide (i.e. house insecticide) treatment.

Ludwig et al., (1970) reported that cholinesterase depression does not occur using chlorpyrifos (Dowco^{R}-179) in aerosol form until the dose is increased 100 fold over effective use rates.

Hayes (1975) notes that "sufficient inhalation of the propellants released from a discharge of otherwise harmless insecticide aerosols can cause death, even though there is no intentional misuse and no attempts to seek a thrill". Hayes attributes this phenomenon to characteristics of the solvent used in commerical formulations, and recommends mayonnaise-type concentrates or avoidance of the need for a solvent by reliance on granules, powders or dust formulations. Hayes notes that granules, as used by the MMCD are preferable as they afford greater control, are less susceptible to drift and reduce respiratory exposure. "Some pelletized granules are virtually dust-free" (Hayes, 1975).

Laws et al.(1968) report findings of a test conducted in Puerto Rico which involved the addition of temephos (Abate^{R}) to the drinking water storage vessels in a community of 2,000 to control Aedes aegypti. Once added to water, Abate mobilizes and hydrolyses slowly. In the study, the highest concentration reached after a single application of 1ppm was 0.5 ppm. Maximum dosage received by each person(assuming a daily water intake of 2 liters) was 1 mg/man/day. No side effects or changes in plasma or red cell cholinesterase was found.

Another health concern associated with the use of insecticides focuses upon their synergistic potential in combination with other drugs and their carcinogenic properties.

National health statistics, as reported by National Academy of Sciences (1976), reflect decreases in heart and vascular diseases, strokes and diabetes since 1970 with increasing deaths associated with cancer (lung, pancreas, leukemia). The National Academy of Sciences goes on to note that this trend dates from 1946 and is not related to rising uses of pesticides accounting for delays in reporting procedures and retarded confirmation of cause and symptoms.

Roughly a dozen agents are recognized as human carcinogens (Train 1976). Only a few pesticides subjected to tests on laboratory animals have been found positive - 11 out of 120 tested in 1969 (Train 1969). None of the materials used by the District was included in this list of suspected materials.

Zapp (in Chichester, C.O., 1965) quotes a British governmental study stating,"any substance may accumulate in the body if the daily dose is great enough. Before accumulation can occur, the daily dose of the chemical must be greater than the amount of the chemical which the body can eliminate by excretion or metabolism, in the course of twenty-four hours... if a pesticide residue occurs in a foodstuff in a normal amount following the approved use of the pesticide, there is every reason to expect that the body will be able to deal with it."

Studies with pyrethrums (Camougis 1971) in combination with other drugs have been conducted. Where chronic daily doses equalled one-fourth the LD_{50} higher mortality was found when pyrethrums were combined with alcohol and caffeine. Pathological changes were noted when pyrethrums were combined with aspirin, caffeine and nicotine. Camougis (1971) concluded that the findings have significance to man "only if combinations of massive doses were taken daily over long periods of time."

Hayes (1975) notes that workers employed for over 25 years in the formulation of DDT have absorbed dosages equivalent to 35 mg/man/day while remaining well. Hayes quotes findings of Warnick and Carter (1972) which show that examinations of workers exposed

to DDT and other pesticides for several years reveal no clinically significant effects.

District employees have been required to have cholinesterase blood tests as a matter of routine. Nothing of clinical significance has been detected as a result of these tests (MMCD records). Skin irritations have been reported by field workers (MMCD reports). Medical follow-up procedures have not substantiated a causal relationship between these symptoms and formulations used by the District in its program. Complaints have been registered with the District by residents who claim insecticide cold fogging aggravates allergies and epilepsy. No medical confirmation of this possibility has been received by the District though requests have been made. As a matter of practice, the District avoids aerial applications on breeding sites within one quarter mile of residents who have registered medical complaints.

The MMCD program has not eliminated mosquito borne disease in domestic animals. Cases of heartworm and encephalitis in the larval control area are estimated to be 50% of those reported in uncontrolled areas of the District.

NON-TARGET ORGANISMS — The current program has no significant effects upon algae, aquatic insects, birds, waterfowl, fish, aquatic mammals, terrestrial mammals amphibians or reptiles.

At most, insecticides used by the MMCD may negatively affect pollinating insects and crustaceans. The impact in minor.

Twenty-four per cent of the household populations surveyed by the District in 1976 perceive the use of insecticides in adulticiding operations to be hazardous to the environment.

Since many persons may be surprised at the insignificant environmental affects of the insecticides on logcal ecology, an extensive discussion of pertinent toxicological theory and empirical investigations follow.

AQUATIC MICROORGANISMS:
ALGAE, BACTERIA, PHYTOPLANKTON

5 Yrs. 15 Yrs. 25 Yrs.
1 1 1

Aquatic microorganisms are defined by Ware and Roan (1970) to include "microflora and microfauna commonly found in fresh water, brackish and marine environments." Unicellular organisms (algae, protozoa, fungi and slime molds) and lower protists (blue-green algae, myxo-bacteria, spirochetts and eubacteria) are cited by the authors. Plankton are defined as organisms which drift in the water. Phytoplankton as algae (diatoms); zooplankton as small protozoa, arthropoda, profiera, cnidaria, platyhelminthes, aschelminthes and annelidia as well as larval stages of other organisms and relocated microflora and fauna (Ware and Roan, 1970). Fresh surface waters are usually not identified with any characteristic bacterial flora (Frobisher, 1949) though higher forms of bacteria are found in lakes (Ware and Roan). Ware and Roan (1970) note that "rainfall increases the number of soil bacteria in waters which collect runoff."

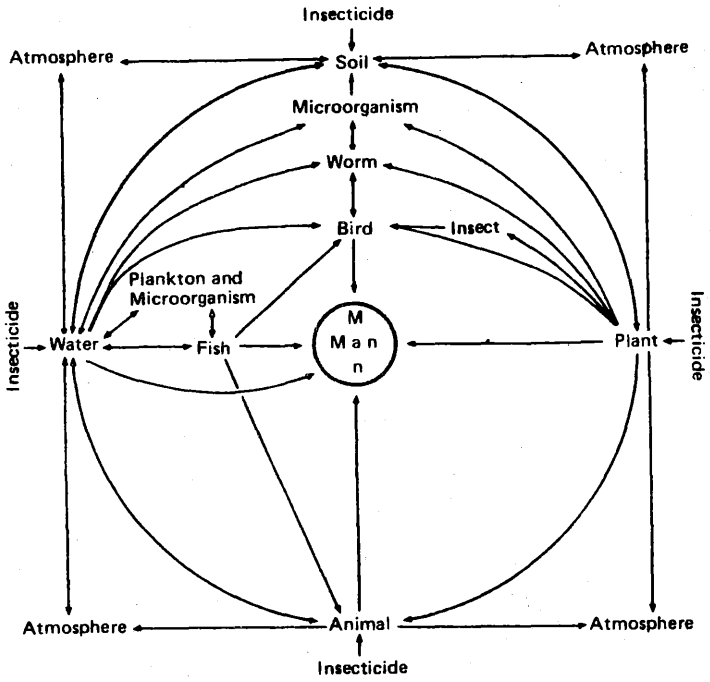
The authors conclude that "a detailed recitation of the pesticides detected in the aquatic environment at various places and times would include all pesticides that have been or are in current use...the diversity of species, (however) is even greater than the diversity of chemicals added to the environment (with the consequence) ...that the public tends to extrapolate from the adverse effects of certain chemicals...on a few organisms to include an entire ecosystem."

The effects of insecticides on microorganisms will vary depending on the chemical dosage, soil properties and various environmental factors (Bollen 1961; Domsch, 1963 in Tu and Miles, 1976).

According to Ware and Roan (1970) "Aquatic microorganisms absorb and concentrate pesticides from water apparently inversely related to water solubility of the compound...it appears that any of the small forms will metabolize any of the pesticides to some extent... phosphate insecticides are readily metabolized by all bacteria, actinomycitis, fungi and algae."

The authors explain that rapid and thorough absorbtion of of pesticides by microorganisms is a function of their high surface-to-mass ratio.

Tu and Miles describe the normal insecticidal path as that shown in the following diagram:



SOURCE: Adapted from Tu and Miles, 1976.

The water solubility of most pesticides, especially organic pesticides is low varying from 1 ppb to complete miscibility in waters (Ware and Roan, 1970). The solubility of malathion (ppm) chlorpyrifos at 21°C is 140; at 20°C is 2; Abate at 21°C is 0.025 and that of DDT is 0.0012 (Harris, 1970).

Insecticides applied to soil are generally considered to have minor deleterious effects on soil micro-organisms (Bollen, 1961 in Tu and Miles, 1976). Persistence depends on the depth of soils into which material are mixed with residues most noticeable in the upper six inches (Chisholm et al, 1950; Lichtenstein et al, 1962)

Bartha et al. (1967) conclude that pesticide concentrations "greatly in excess of those recommended for agricultural and home use are required to produce effects, and that supplementary organic matter

reduces pesticide toxicity and increases microbial degredation of the pesticides in soil."

Tests conducted with organophosphates used by the MMCD have demonstrated that long-term negative impacts upon microorganisms are not probable.

Chlorpyrifos, temephos and malathion have been among materials whose effects are reported most frequently.

Tests reported by Shin-Chiang Lin et al., (1972) measuring the effects of six organophosphates (including chlorpyrifos) showed "no inhibition of nitrification at normal field rates of 5 ppm and some inhibition at rates of 50 ppm and 500 ppm. Chlorpyrifos was found to have no effect upon the growth of four species of Rhizobia. Chlorpyrifos (Dursban^{R}) was the most toxic organophosphate tested against alfalfa and sweet clover. The authors report that, "at 500 ppm levels plant weights were well below that of the non-inoculated controls; 50 ppm applications resulted in growth closely comparable to the non-inoculated controls."

Chlorpyrifos was found to depress bacterial mold and fungi populations during the first of an eight week test reported by Tu (1970). No effects were detected in subsequent weeks. Application of the material increased ammonia production at rates of 10mg/g. It was supposed that the formulation transformed and detoxified in the soil or that nitrifiers adapted to insecticides. The formulation was oxidized by microorganisms and had no negative effect upon phosphorous mineralization.

It has been found that insecticides applied prior to plant emergence have minimal effects on microbial activities influencing soil fertility (Tu and Miles, 1976).

Hurlbert (1975) has determined acute toxicity (LC_{50}) of several organophosphate and organochlorine insecticides on a number of aquatic organisms. Adaptations from Hurlbert are shown in Table 36 for three compounds used by the District and DDT. Chlorpyrifos (Dursban^{R}) is used as a spring pre-hatch,

TABLE 36

ACUTE TOXICITY OF FOUR INSECTICIDES TO FIVE AQUATIC ORGANISMS

Insecticide PPM	Estuarine Phytoplankton (Photosynthesis reduction, %) 4-hr at 1000 ppb	Daphnia (48-hr EC_{50})	Three Marine decapods (96-hr.LC_{50})	Mosquito larvae (24-hr LC_{50}) *	Mosquito larvae (24-hr LC_{50}) **	Stonefly naiad (96-hr LC_{50})	Fresh Water amphipod (96-hr LC_{50})
DDT	77	0.36	0.6-6	70	10	7.0	1.0
Tempehos (Abate^{R})	-	-	-	1.6	5	10	82
Chlorpyrifos (Dursban^{R})	-	-	-	2.8	6.3	10	0.11
Malathion	7	1.8	33-83	80	320	10	1.8

* Culex fatigans
** Anopheles albimanus
SOURCE: Hurlbert, S.H. 1975

temephos (Abate^{R}) to treat sensitive areas and malathion to treat pastures. Malathion is used for larval control in pastures. It has been phased out of the adult mosquito control program.

Bacterial mortality in a waste disposal lagoon 24 hours after treatment with selected insecticides is reported by Steelman et al., (1966) as shown in Tables 37 and 38.

Concentrations at dosage applied by the District is .075 ppm (0.1 lb. in 6 inches of water). Bacterial mortality 48 hours after treatment with 0.0001% (1ppm) chlorpyrifos was 2.7% (Table 38). This rate is thirteen times greater than that used in the District program.

Earlier studies by Hurlbert et al. (1970) measured pesticide concentrations in mud, water and vegetation at post-treatment intervals. Chlorpyrifos concentrations were measured in the upper five cm. of mud taken from a pond treated at 1.1 kg/ha with the following results:

	Concentrations (ppb)		
Interval	Water	Mud	Vegetation
4 hours	223	10	-
1 day	97	115	-
14 days	<4	195	-

Derby and Ruber (1971) tested organophosphates to measure oxygen depression in algae cultures. They concluded that photosynthesis of four estuarine phytoplanktons was inhibited by all test materials. Temephos (Abate^{R}) was determined the least toxic following Baytex^{R}, propoxur (Baygon^{R}) and DDT. Temephos lowered oxygen production of algae cultures at concentrations of 1.0 and 0.1 ppm with results, "not significantly different from the controls, hence all changes refer only to ... net primary production."

Temephos is used by the District at a rate of.075 lb AI/acre (0.056 ppm).

Table 37

Bacterial Mortality in Waste Disposal Lagoon Water 24 Hours After Treatment With Three Insecticides Used In the MMCD Program

Insecticide	Mortality after 24 Hours at ppm Shown					
	1,000	5,000	10,000	50,000	LD_{50}	LD_{90}
Temephos (Abate^{R})	17.7(22)*	38.2(22)	18.9(22)	87.1(22)	0.900	5.10
Chlorpyrifos (Dursban^{R})	67.0(32)	99.9(32)	99.9(32)	99.9(32)	.028	0.16
Malathion	16.5(36)	32.9(36)	39.4(36)	81.2(36)	.400	2.35

*No. in millions of bacteria per ml. of untreated lagoon water.

SOURCE: Steelman et al., 1966

Table 38

Bacterial Mortality In Waste Disposal Lagoon Water After Treatment With Temephos, Chlorpyrifos And Malathion at 0.0001% (1ppm)

Insecticide	% Mortality	
	24 hours	48 hours
Temephos (Abate^{R})	0.00 (24)	1.37 (29)
Chlorpyrifos (Dursban^{R})	.00 (24)	2.75 (29)
Malathion	.83 (24)	.00 (29)

No. in millions of bacteria per ml. of untreated lagoon water

SOURCE: Steelman et al. 1966

Nelson and Evans (1975) found that chlorpyrifos seriously affected Daphnia though the organism was not completely eliminated at highest treatment levels. Particular sensitivity was noted at 24 hour. LD_{95} - 0.025 ppm. Cyclops were affected in woodland pools, but increased in rice culture habitat to be more toxic to cladocerans and copepods than to rotifers. In the Nelson-Evans study, copepod nauplii were not affected one way or another. In woodland pools the material had the net effect of decreasing zooplankter populations with the consequential increases in populations of small phytoplankters.

Chlorpyrifos (Nelson and Evans, 1975) was found to depress diatoms at all treatment levels with findings apparent six weeks after treatment. With the exception of one species each of ephemeroptera, odonata, coleoptera, no extensive benthic mortalities were recorded. Sixty-eight genera of plankton were encountered by the authors in test sites. Greatest diversity (49 genera) and numbers found in sites treated with 1000ppb chlorpyrifos. Forty genera were recorded in control pool sites.
Negatively impacted phytoplankton were limited to Mougeotia, Spirogyra and Zygnema. Negatively impacted zooplankton genera were Eudorina, Pleodorina, Daphnia and Macrothrix.

Harris (1972) states that as a group, "Organophosphorous compounds are not as insecticidally active in soil as the organochlorines. The final residuals of these products depend upon the various structures of the chemicals within the group. Residues are derived by the process of hyrolysis (Spencer, 1971) with soil microflora active in affecting the rate of degradation (Tu and Miles,1976)

Hurlbert (1975) lists many secondary aquatic ecosystem effects stimulated by the introduction of pesticides to the environment to regulate the growth, survivial or reproduction of specific species:

1. blooms of phytoplankton after treatment as a result of mortality of zooplankton or decomposition of herbicide-killed macrophytes;

2. increases in macroscopic filamentous algae following insecticide mortality of herbivorous insects;

3. reduction of invertebrate populations dependent on vegetation as substrate or refuge;

4. increases in populations of benthic detritus-feeders and filamentous algae following destruction of aquatic vascular plants with herbicides;

5. increases in populations of some invertebrates following reduction of competitor populations;

6. increases in invertebrate predators that feed on the replacing species;

7. increases in growth rates of surviving individuals in a food-limited population whose densities are lowered by pesticide-causing mortality;

8. declines in populations of species which cannot compete with species whose numbers increased as a result of pesticide-depression of their predators;

9. changes in oxygen, carbon dioxide, bicarbonate ion, calcium and other chemical parameters as a result of changes in phytoplankton and macrophyte populations;

10. reduction in turbidity following removal of carp populations with pesticides.

Tu and Miles (1976) concur with these findings adding that all organisms specifically aquatic microorganisms absorb and concentrate insecticides, even the most stable and persistent. They conclude, however, that "no one has yet demonstrated that these compounds serve as nutritional or energy sources for organisms leading to elimination of the compounds from the environment."

CRUSTACEA		
5 Yrs	15 Yrs	25 Yrs
3	3	3

Recent species identification studies conducted by the MMCD (1976,1977) confirm the assumption that crustacean populations occur in MMCD. Types I, II and III breeding sites and are the dominant feature of intermittent water sites. They are permanent residents of these sites due to their immobility and the drought-resistant characteristic of their eggs.

As noted in the previous subsection, chlorpyrifos (Dursban^{R}) kills crustacea. Populations re-establish themselves. Fifty-one percent of 20 wet MMCD Type 1 sites had crustacea in them two weeks after treatment with chlorpyrifos in a survey conducted by the MMCD 1977. Eighty-percent of the control sites were populated with crustacea; seventy-one percent of the sites treated with temephos (Abate^{R}).

In Illinois, temephos used against the same mosquito pest found in this District applied at 0.05 to 0.1 AI lbs./acre, killed chironomid midges and cladocerans but had no effect on copepods, ostracods, snails and diving beetles (Didia et al., 1975). This work was done on species brought in from woodland pools for laboratory testing.

Tests in the field where the species naturally occured (Liem and LaSalle, 1976) showed like results: cladoceran populations were reduced 40%, copepods and ostracods 10%, and mayflies not at all. All these populations returned to normal densities in 48 hours. As used by the MMCD, therefore, temephos larvicide is unlikely to seriously affect game, fish or other aquatic nontarget organisms (Provost, 1976).

According to Muirhead-Thompson (1971) the micro-crustacea most frequently used when measuring the effects of industrial effluents and metallic poisons is the water flea, Daphnia. Daphnia is recongnized as a particularly good indicator species for laboratory tests (Muirhead-Thompson 1971).

As mentioned in a previous section (Environmental Setting) Daphnia emerge early in the year in MMCD Type I and II breeding sites and complete a generation in 6 days. Cladocera respond variously to organophosphates (Muirhead-Thompson, 1971).

Forty-eight hours EC_{50} (ppb) of cladocera at 21° C to malathion was 2 (Daphnia) and 3 (Simocephalus) (Cope, 1966). Testing copepods, Ruber and Baskar (1968) found that the organisms were least affected by temephos (Abate^R) whereas chlorpyrifos (Dursban^R) was as toxic to them as DDT.

Toxic impact is a function of dosage (Muirhead-Thompson, 1971; Hayes 1975). Temephos (Abate^R) applied at 0.025 lb/acre caused no noticeable mortality in odonata, copepods, ostracods and ferry shrimp (von Windeguth and Patterson, 1966). At 0.03 lb/acre in temporary pools in Wisconsin along Lake Michigan, temephos eradicated cladocera while amphipods, isopods, ostracods and copepods remained unaffected.

It is generally reported that non-target invertebrates are either unaffected or only temporarily reduced in numbers when treated with organophosphates (Warnick et al., 1966).

AQUATIC INSECTS

5 Yrs	15 Yrs	25 Yrs
1	1	1

The most varied and prolific aquatic life in District breeding sites is found in MMCD Type III sites. The impacts of insecticides on aquatic insects is a function of materials used, specificity of formulations, dosage, frequency of application and biological characteristics of the insect.

Generally, undesirable effects of insecticides on aquatic organisms are minimal to species with short life cycles and high reproductive capacity (Mulla 1976). A recent EPA report (1972) includes the opinion that "most organisms in the wild have short life spans, and the turn-over rates of the population are very high...because most species have high reproductive rates, most individuals in a population are biologically excess to the continued existence

of the population and unless the fraction of the population killed is high, the level of the population will be only temporarily suppressed...individuals rendered unfit (from genetic changes induced) will be eliminated without detriment to the continuation of the the population.

The relative effects of each insecticide used by the MMCD on aquatic insects has been determined by Mulla, (1976) and is summarized as follows:

> Petroleum Oils: Breathing insects such as Hemiptera and coleoptera (immature and adult) are killed by oil. Others, especially those having gills (mayfly, dragonfly) are not affected (Arevad, 1961). Those populations which are effected generally re-establish within three weeks (Mulla et al., 1970). Generally, the highly refined mosquito larvacide oils have had less effect on non-target organisms, than less expensive diesel oils used by the MMCD.

The District's use of petroleum oils is confined to hand treatment of sites smaller than three acres which are usually of the intermittent water type. The applications are normally made during warm summer months. Sunlight degrades No.2 fuel oil as it is applied. The oil is normally reduced from a film into small lenses on the surface of the water within several hours after application. Films of oil less than 10^{-4} cm thick do not ffect the rate of solution of oxygen (Downing and Truesdale, 1955). All films of this nature are reported not to prevent the growth of fresh water plants (Roberts, 1930). A detailed discussion of the impact of petroleum oils on the environment is included in McKee and Wolf (1963).

Temephos is the safest insecticide used in mosquito larval control (Mulla, 1976; Ruber and Baskar, 1968). At 0.025 AI lb/acre, temephos may be toxic to cladocerans and odonate naiads (Porter and Gojomerac, 1969). At 0.05 AI lb/acre and 0.1 AI lb/acre, temephos is toxic to larvae of mosquitos, midges and cladocerans,but has little toxic effect on copepods, ostracods and diving beetles. Temephos is not toxic to dragonflies, mollusks or shrimp.

When tested at highest approved dosage rates, temephos caused mortality in highly sensitive organisms for a period of seven days after application (Didia et al., 1975). In tests conducted in 1968 against eighth generation copepods, temephos proved the least toxic of eight mosquito toxicants (Ruber and Baskar, 1968). In the same test, ostracods (Cypronotus incongruens) were found to be "remarkably insensitive to Abate." Results were reported at 24 and 48 hour intervals.

Results (Fales et al. 1968) of a sampling of organisms in a lake after treatment with temephos (Abate^{R}) at .03 ppm are shown in Table 39.

Cooney and Pickard (1974) concluded that temephos (Abate^{R}) had no detectable effect on any non-target organisms observed by them in the Tennessee Valley Region. At 0.10 lb AI/acre, the effects of temephos 24 hours after treatment was as follows for four organisms (measured in no. of organisms per dip).

	Treated		Control	
	Pre Treatment	Post Treatment	Pre Treatment	Post Treatment
Isopoda	0.00	0.13	0.30	0.50
Ostracoda	0.93	1.20	0.20	1.90
Salientia	0.00	0.00	0.00	0.00
Tricladida	0.00	3.73	0.20	1.10

Chlorpyrifos

Chlorpyrifos has the highest toxicity of all materials used by the MMCD with the possible exception of malathion. The general effect of chlorpyrifos is the alteration of the balance between arthropod populations for a period of two to six weeks. Herbivorous zooplankton usually decrease in number while the predacious populations increase (Mulla,1976).

In applications at 0.025 lb/acre and 0.25 lb/acre, chlorpyrifos greatly reduced the total insect and crustacean populations (Hurlbert, 1969).

TABLE 39

IMPACTS OF TEMEPHOS ON AQUATIC ORGANISMS 24 AND 48 HOURS AFTER TREATMENT AT 0.03PPM.

ORGANISM		Living Pre-treatment	After Treatment 24 hours Alive	24 hours Dead	48 hours Alive	48 hours Dead
	INSECTA					
COLEOPTERA						
Dytiscidae	Coptotomus interrogatus (Fabricius)	0	1	0	0[1]	0
	Graphoderus liberus (Say)	10	1	1	0[1]	1
	Hydroporus carolinus Fall	0	0[1]	0	0[1]	1
	H. tenebrosus Le Conte	0	0	0	0	1
	Hydrovatus pustulatus (Melsheimer)	0	0	0	0[1]	1
	Laccophilus fasciatus Aube	0	0[1]	1	0	0
	L. maculosus (Germar)	0	0[1]	8	0[1]	13
Gyrinidae	Dineutus assimilis (Kirby)	0	0[1]	1	0[1]	6
	D. nigrior Roberts	0	0[1]	0	0	6
Haliplidae	Haliplus fasciatus Aube	0	1	6	0	23
	H. triopsis Say	0	1	9	0[1]	44
	Peltodytes muticus (LeConte)	0	0	0	0[1]	2
	P. sexmaculatus Roberts	0	0	0	0	3
Hydrophilidae	Berosus peregrinus Herbst	0	0	0	0	1
	B. striatus Say	0	0[1]	2	5	5
	Enochrus nebulosus (Say)	0	0	0	0	1
	Hydrochus scabratus Mulsant	0	0[1]	1	0[1]	2
	Hydrochus sp.	1	0	0	0	4
	Tropisternus blatchleyi orchymont	0	0[1]	3	0	3
	T. natator Orchymont	2	0[1]	0	0[1]	0
Noteridae	Hydrocanthusiri color Say	0	0	1	0	0
DIPTERA						
Chaoboridae	Chaoborus albatus Johnson and Chaoborus spp.	1	2	2	0	3
HEMIPTERA						
Belostomatidae	Belostoma flumineum Say	0	1	0	0[1]	0
Corixidae	Hesperocorixa interrupta Say	0	1	20	0[1]	307
	H. obliqua (Hungerford)	0	1	11	0	320
	H. vulgaris (Hungerford)	0	0	7	0	13
	Sigara sp.	0	0	67	0	67
Gerridae	Rheumatobates rileyi Bergroth	0	0	0	0	2
	Trepobates pictus Herrick-Schaeffer	1	4	19	0	37
Mesoveliidae	Mesovelia mulsanti White	0	0	0	0	1
Nepidae	Ranatra americana Montandon	1	0[1]	0	0	0
Notonectidae	Buenoa margaritacea Torre-Bueno	32	0	61	0	17
	Notonecta irrorata Uhler	1	2	0	0	9
	N. undulata Say	49	0	109	0	83
ODONATA						
Aeschnidae	Anax junius (Drury)	0	0[1]	0	0	1
Libellulidae	Plathemis lydia Drury	0	0[1]	3	0[1]	17
	ARACHNOIDEA					
ACARINA						
Hydrachnidae	Hydrachna spp.	1	29	0	11	0
	MOLLUSCA					
GASTROPODA						
Physidae	Physa gyrina Say	0	0	3	0	7
Planorbidae	Helisoma anceps Menke	0	0	12	0	12

[1]Not found alive in quantitative sampling, however, this species was found alive in the qualitative sampling.

[2]Estimated millions dead and moribund

[3]Estimated millions dead

SOURCE: Fales, et al., 1968

Tests conducted by Cooney and Pickard (1974) with chlorpyrifos (Dursban^{R}) in Tennessee flood waters found granular applications at 0.10 lb AI/acre to be effective against Aedes species for 25 days. At rates of 0.05 lb AI/acre, the material was effective for 2 days. Chlorpyrifos exhibited no effect on ostracod, salientia or tridadida but slightly depressed isopoda populations at 0.10 lb AI/acre.

Chlorpyrifos (Dursban EC) 40% formulation used to treat Culex tarsalis had the following impacts on non-target organisms at various doses (Mulla et al., 1966):

TABLE 40

IMPACT OF CHLORPYRIFOS ON SELECTED NON-TARGET ORGANISMS

lb/Acre	Average no. larvae per dip Culex tarsalis pre-treat.	post-treat.	%control	Non-Target Impact
0.001	16.9	6.8	60	C,DBL,MF,P(alive)
0.002	13.8	2.4	83	C,DBA,DBL,P(alive)
0.005	7.2	0.0	100	C,DBA,DBL,P(alive)
0.10	6.6	0.0	100	DBA,DBL,(alive) C,DBH,MF(dead)

C-corixids, DBA-diving beetle larvae, DBA-diving beetle adult, MF-mayfly naiad, P-mosquito pupae

SOURCE: Mulla et al., 1966

Sanders and Cope (1968) conducted static bioassays to determine relative toxicities of insecticides to naiads of three species of stonefly. Chlorpyrifos was most toxic to Pteronarcella badia and Claassenia sabulosa.

The effects of tests conducted by Moore and Breeland (1967) with aerial applications of

chlorpyrifos are reported in Muirhead-Thompson (1971). At dosages between 0.001-0.005 lb/acre, no effects on non-targets were noted. At rates of 0.01 - 0.02 lb/acre die-off of all arthropods was detected.

Campbell and Denno (1976) studied the effects of chlorpyrifos and temephos on aquatic insects in a New Jersey salt marsh. They concluded that there were no acute toxic impacts after one treatment, nor indications of accumulating effects after multiple treatments. The materials were not found to alter the diversity, richness or densities of insect communities.

Lusk et al., (1976) report that nonthermal aerosol applications of chlorpyrifos resulted in some mortality to non-target arthropods. They determined the impacts to be minor as the post treatment populations of at least 50% of the collections were higher than those of pre-treatment counts. Results of this study are shown in Table 41.

Malathion has a greater negative impact on non-target organisms than either temephos or chlorpyrifos, chiefly because a higher dosage rate is required for effective control of mosquito larvae (Mulla, 1976).

Generally, granular formulations and time-release formulations have less effect on non-target insects than emulsified concentrates. The maximum concentration achieved by the insecticide is lower in the former (Mulla and Chadhury, 1968).

TERRESTRIAL INSECTS

5 Yrs	15 Yrs	25 Yrs
■	■	■

Under natural conditions, one percent of all insect eggs that hatch survive to reproduce. Yet population dynamics operate such that insects migrate to fill voids and maintain a stable density under favorable environmental conditions.

Aerial application of ULV (6-10 fluid ounces) insecticide are made in the spring in rural areas over roughly 10% of the total District mosquito breeding

TABLE 41

EFFECTS OF NON-THERMAL TREATMENT WITH CHLORPYRIFOS ON NON-TARGET ARTHROPODS (COLUSA, CALIFORNIA) IN COLLECTIONS MADE WITH DEZULUETA NET TRAPS ON 3 CONSECUTIVE DAYS IN AUGUST 1975.

		PLOT								
		I			II			III		
		Individuals Captured								
Order	Number of Families	Pre-Treatment	Post Treatment	Post Treatment	Pre-Treatment	Post Treatment	Post Treatment	Pre-Treatment	Post Treatment	Post Treatment
Ephemeroptera	1	1	-	1		2	1	1		
Odonata	1	1		1	1	2	1			
Hemiptera	2		1		1		2			1
Homoptera	1	1			6	5	3			
Lepidoptera	4		1	1	2	5	1		3	2
Diptera	12	14	3	13	6	1	4		1	1
Hymenoptera	7	2	1	1	8	6	2			
Araneida	1					1				
Total	29	19	6	17	24	22	14	1	4	4

Source: Lusk, et al., 1976

acreage.

During these flights, insect populations contacting spray material may be suppressed by 50% up to a distance of 100 yards downwind. Two hundred yards downwind 25% may be affected. These populations generally begin re-establishing 96 hours after being exposed to chlorpyrifos.

Aerial applications of granules have less affect on terrestrial insects (5% at 100 yards and 1.3% at 200 yards (Hayes, 1975). Granule particles are between 200-2000 microns in size and are resistant to drift (Middleton, 1965). The MMCD applies chlorpyrifos pre-hatch formulations in granular form.

Distribution of insecticides by air is a function of dosage compound stability, volatility and winds (Hayes, 1975). Hayes notes that a compound must be applied in tremendous amounts to be recognizable in the air of a distant place. Furthermore the compound must resist oxidation, hydrolysis in the presence of oxygen, water vapor and sunlight long enough to be dispersed intact.

Organophosphates, when displaced from soil to air by water, are more affected by hydrolysis than evaporation (Lichtenstein, 1966) and their oxidative and hydrolytic by-products are of minimal toxicity (Hayes, 1975). Hartley (1969) concludes that, destructive reactions in the upper atmosphere are of great importance in the detoxification not only of synthetic compounds, but of ordinary biological waste products."

Ground applications have little affect on terrestrial insects as only the water area is treated, and insecticide released upon granule contact with water. Cold fogging with resmethrin is conducted at night and leaves no spray deposits detectable by gas chromatography (DeVries, 1977). Insects affected would be those resting in foliage or in flight. Resmethrin would kill an estimated 5% of all the terrestrial insects in a treated area, or those smaller than mosquitos with equivalent or higher rates of metabolism.

Generally 80% of the insect population is believed to rest in vegetation near the ground which is not penetrated by cold fog. The residual half life of resmethrin is four hours.

POLLINATING INSECTS

5 Yrs	15 Yrs	25 Yrs
■	■	■

Agricultural crop protection accounts for 30% of the pesticides applied in the Metropolitan area; of this a minimum of 85% are highly toxic to bees and other beneficial insects. They are almost always applied during daylight hours when bees and other beneficial insects are active and therefore they are hazardous (Atkins 1976).

The M.M.C.D. program utilizes less than 2% of the pesticides applied in the region. Of this fraction, 48% are applied in granular formulations which are almost always nontoxic to honey bees, other pollinators and beneficial insects. The other 52% are applied mostly as adulticiding sprays during darkness or at dusk or dawn (Atkins, 1976).

Pesticide toxicity to honey bees from pesticides used by homesteads, agriculture and the MMCD in the Minneapolis-St. Paul metropolitan area are shown in Table 42.

Less than a 2% kill of honey bees and other pollinating insects overall is predicted as a result of the adulticiding program using resmethrin ULV and chlorpyrifos ULV applicators (Atkins, 1976). Chlorpyrifos at 0.025 lb AI/acre is highly toxic to honey bees and will kill every bee contacted at time of application (Atkins, 1972). Chlorpyrifos is used as a ULV application mainly when bees are not actively foraging and is not used in areas where hives are registered or have been mapped by the MMCD

Sandve (1977b) comments on the difficulty in locating apiaries in the Metropolitan area stating that:

1. bee colonies are not always located at the owner's home address;

TABLE 42

PESTICIDE TOXICITY TO HONEY BEES

Pesticide Name		LD_{50}	Slope,	Toxicity of Residue to Honey Bees:
Common	Trade	µg/bee	Probits	No. Days
Carbaryl	Sevin	1.34	2.45	3-8.5
Carbofuran	Furadan	0.160	4.31	3-6
Chlordane		8.80	2.34	Unknown
Chlorpyrifos	Dursban	0.114	7.80	1
Diazinon	Diazinon Spectacice	0.372	8.97	1-2
Dieldrin		0.139	4.65	1.5-5
Dimethoate	Cygon, De-Fend	0.188	5.94	1-3.5
Fensulfothion	Dasanit	0.350	5.46	Unknown
Fonofos	Dyfonate	8.67	4.87	NIL
Malathion	Cythion	0.709	8.04	2-4
Metalkamate	Bux	1.66	5.12	Unknown
Methoxychlor		.38	1.37	NIL
Pyrethrins		NT	-	NIL
Resmethrin	SBP-1382, Synthrin	0.063	4.67	NIL
Temephos	Abate	1.55	2.85	1-215

NT = relatively nontoxic to honey bees at dosages used.

SOURCE: Atkins, 1976

2. the exact colony location is not always correctly described by the beekeeper;

3. some beekeepers fail to register all colony locations;

4. some beekeepers fail to register any of their bees.

Sandve notes that the MMCD field staff "seems to be doing a good job adding new apiary locations to the maps as soon as they are found and... are making an honest effort to locate all bee colonies, explain control procedures to beekeepers and...avoid application of toxic materials during daylight hours when bees are in flight." The District's location maps compare favorably with those of the Minnesota Department of Agriculture.

Bee foraging does not occur at night; however, bees may cluster on the outside of their hives if the temperature is above 70°F. Treatments of chlorpyrifos, malathion or other pesticides used at bee-toxic dosages or formulations applied over bee colonies in hot weather, when bees are clustering on the outside of the hives, may cause severe losses. Some bees may be foraging during the morning application period, if the temperature is above 60°F (Atkins, 1976).

Less than a 2% kill of honey bees and other pollinating insects is also predictable for the larviciding program. Chlorpyrifos and temephos applied in granular formulations should have little or no impact at the dosages used (Atkins, 1976).

No food chains are known where magnification effects on reproductive capability would occur. We are not cognizant of any impact of the carriers of these pesticides on bees and other pollinating insects (Atkins, 1976).

Mosquitos themselves are rarely required as obligative plant pollinators though they do frequently satisfy a biological need for carbohydrates by taking nectar meals from several species of Minnesota plants.

Pollination may incidentally occur during feeding (Cook, 1977; Price, 1977).

TERRESTRIAL & AQUATIC FLORA			
5 Yrs	15 Yrs	25 Yrs	
■	■	■	T
■	■	■	A

Physiologically, plants do not posses the acetylcholinesterase enzyme system responsible for organophosphate poisoning responses in animals.

Eto (1974) states that, "organphosphorous pesticides are generally short-lived in the environment and biological systems; they are commonly degraded through hydrolysis and other reactions into nontoxic and water soluble compounds which are rapidly excreted from animal bodies...the animal excretes the greater part of an applied phosphoric ester, in changed or unchanged form within a few hours or days, whereas the plant tends to store chemicals."

Pesticides which are not sloughed off plants remain as an effective deposit...the physical properties of the plant surface determine absorption. The thickness of the wax layer in the subsurface influences absorption and transfer of organophosphates (Eto 1974).

Organophosphorous compounds have a short life in water and do not persist or build-up in freshwater plants (Muirhead-Thompson, 1971).

Hurlbert et al., (1970) report finding residues of chlorpyrifos on pond vegetation. Residues following treatments at 1.0 lb/acre after treatment.

Gleason (1977) offers the opinion that inhibiting cholinesterase would have very little effect on higher aquatic plants.

Repeated treatments of agricultural crops and ornamental plants with dosage rates of chlorpyrifos and temephos exceeding those used by the District by 32 to 65 times, have resulted in no adverse physiological effect (Kenaga, 1976).

The half life of chlorpyrifos in grass is reported to be one to two days (Kenaga, 1973). Uptake of the chemical or its degradation products into plants did not occur in studies conducted by Kenaga (1974).

Phytotoxic effects observed on rare occasions have been to sites on foliage contacted by spray causing 'necrosis' or burning (often resulting from the solvent carrier). None have been reported for chlorpyrifos or temephos ULV applications (Kenaga, 1976). They have on occasion been observed on sensitive plants when malathion liquid has been applied at close range with Hudson Back Packs in private yards.

Resmethrin and granular applications do not affect plants as they leave no spray deposits.

Harris et al.(1968) studied DDT and chlorpyrifos as soil insecticides to control cutworms. A result of the study was the determination that chlorpyrifos (Dursban^{R}) disappeared rapidly in soil and left no residues in tobacco plants.

Smith et al., (1967b)found that chlorpyrifos, while it accumulates on the surface of the plant roots, is not absorbed into the plant. The formulation enters the plant where "it metabolizes to form primary hydrolysis products where the phosphorus is still attached to the 3,5,6-trichloro-2-pyridinal." The absorption of chlorpyrifos by plants throught roots and leaves is insignificant (Eto, 1974).

Chlorpyrifos and temephos were tested by O'Neal et al., (1975) on nursery stock. Both materials were found to control pest larvae without phytotoxic symptoms. At 4 lb AI/acre, temephos was considered unsafe for use on Pinus clausa Vasey and Ulmus pumila Linn.

Soil characteristics affect the absorption of insecticides by plants (Getzin and Chapman, 1959); greater absorption occurs in sandy soil than in loam, clays and muck soil (David and Gardiner, 1951).

SHOREBIRDS

5 Yrs	15 Yrs	25 Yrs
■	■	■

Seven years of widescale commercial usage of chlorpyrifos at the rate of one lb./A for pest control on lawns and sod and at 0.025-0.05 lb./A in water for mosquito control have resulted in no known reports of bird kills on treated areas " (Kenaga, 1973).

Hill (1971), however, reports that temephos proved highly toxic to passerines and killed all blue jays tested at 30ppm. Mammalian and avian toxicity for some pesticides are not comparable; rats, for instance are very tolerent of temephos.

Studies conducted by Travis (1968), Tucker and Crabtree (1970), Moody and Lester (1968), Stickel (1976), Travis et al., (1968), U.S. Public Health Service (1966) and Peterson (1966) have established LC_{50} values for Abate on sparrow, pheasants, pigeons, quail chukars, mallards and ducklings. Stickel (1976) concluded that temephos (Abate^R) is harmless to nearly all forms of life when applied for mosquito control.

Relative to dieldrin, temephos (Abate^R), chlorpyrifos (Dursban^R) and malathion rated 12th, 18th and 51st - 53rd in tests rating the impacts of 85 pesticides on bobwhites, Japanese quail, pheasants and mallards (Heath et al., 1972).

WATERFOWL

5 Yrs	15 Yrs	25 Yrs
1	1	1

Kenaga notes that the estimated lethal concentration of chlorpyrifos for new-born mallards is 30 ppm. (30-300 ppm for most birds). At dosage rates applied by the MMCD, a residue of between 0.15 ppm and 0.68ppm is left immediately following application.

Under laboratory conditions involving turkeys and chickens maintained on chlorpyrifos treated soil, it has been found that minimal residues of chlorpyrifos are retained in fat or skin tissues of birds, and then only for a short time (Kenaga, 1973).

In studies conducted using the insecticide resmethrin (cold-fog)--no detectable effects were noted in 32 species of native bird populations when fields were treated with 0.15 lbs. AI/acre (S.B. Penick and Co., 1975).

Kenaga notes that "no-effect levels in dietary food and drinking water are nearly identical...test doses of 80 ppm of chlorpyrifos are not available to birds in lakes, ponds or streams even temporarily... there would appear to be a very wide margin of safety to birds from the use of concentrations of chlorpyrifos in waters treated for mosquito control (Kenaga, 1973). "... after many years of field usage throughout the United States at the recommended rates, no determined effects have been reported on birds. In five day feeding studies with temephos insecticide, LC_{50} data on game birds from the U.S. Fish and Wildlife Service were as follow: mallard ducklings 1500ppm; Corturnix quail chicks 240ppm; pheasant chicks 163ppm, and Bobwhite quail chicks 96 ppm (American Cyanimid Comapny, 1975).

Small amounts of petroleum oils have been found to reduce hatching of eggs and cause embryonic mortality (Albers, 1976). Fuel oil in the amount of 20-40 µl or more per egg produced 100% mortality under test conditions.

As used by the District, the active fraction in the oil normally breaks down in sunlight in the first hour after application.

FISH

5 Yrs	15 Yrs	25 Yrs
■	■	■

"In general, most pesticides bioconcentrate in the environment to some degree. However, bioconcentration depends upon the species, the concentration of pesticides and the structure of the pesticide including polarity. It has been noted that chlorpyrifos may bio-accumulate up to 320 times in fish " (Haque,1976).

Kenaga adds that although a"... temporary build-up of residues of chlorpyrifos occurs in fish, as explained by Smith et al., (1966), fish are able

The following table is based on data generated by the U. S. Fish and Wildlife Service.

TABLE 43

RELATIVE TOXICITY OF EPA REGISTERED INSECTICIDES FOR MOSQUITO LARVAL CONTROL TO MALLARD DUCKS

Compound	Sex	Age	LD_{50} mg/kg (95% confidence limit)
Temephos	Male		80 - 100
	Female		80 - 100
Fenthion	Female	4 months	5.94 (4.28-8.23)
Chlorpyrifos	Male		70 - 80
	Female		75.6 (35.4 - 161)
	Ducklings	17 days	167 (78.3-357)
Parathion	Male	3-4 months	2.13 (1.54-2.96)
	Female	2-3 months	1.90 (1.37-2.64)
Malathion	Female	3-4 months	1485 (1020-2150)
Petroleum Oils	Male/ Female	>12 months	>20 ml/kg

SOURCE: Tucker and Crabtree, 1970

to readily metabolize these residues to non-toxic materials (principally the pyridinol moiety) and in a few days metabolize chlorpyrifos to readily excretable metabolizes with essentially no bio-concentration "Kenaga, 1976).

Smith, et al., (1966) state that fish absorb chlorpyrifos slowly but rapidly metabolize the compound and eliminate detoxified products into the water. They go on to state that normally the compound is absorbed by plants and soil restricting the uptake by fish.

MMCD restricts the use of chlorpyrifos to land-locked depressions. Thus fish are not exposed to this material.

No known accumulation of temephos occurs in water, mid samples, or biological organisms. Under exaggerated rates of 1 lb. AI/acre residue could not be detected four hours after treatment of streams and only traces were evident in ponds (Byrne, 1976; Bowman, 1966). These rates are twenty times in excess of those used by the MMCD Laboratory tests conducted by the U. S. Fish and Wildlife Service conclude that temephos is relatively non-toxic to fish (American Cyanamid Company, 1975).

Resmethrin is used as a cold-fog and does not bio-accumulate. It is subject to rapid photo-decomposition (92% in 24 hours). When tested by S. B. Penick and Company at rates of 0.10 lb. AI/acre at two week intervals, no mortaility occurred in killifish. At 0.15 lb. AI/acre, resmethrin had no affect on trout (S.B. Penick, 1975).

Malathion accumulates to a lesser degree than chlorpyrifos.

Howard Krosch, Co-ordinator, Monitoring and Control Unit of the State Department of Natural Resources (1977) reports that "we know of no fish or wildlife kills related to MMCD activities" since suspension by the District of DDT.

TABLE 44

ACUTE TOXICITY OF THREE ORGANOPHOSPHORUS INSECTICIDES TO FISH

Pesticide	Organism	Acute Toxicity LC-50		Sub-Acute Effects	No Effect
		ug/liter	hours	ug/liter	ug/liter
Chlorpyrifos	Lepomis macrochirus	2.6	96		
	Salmo gairdneri	11	98		
Temephos	Salmo gairdneri	158	96		
Malathion	Pimephales promelas	9000	96	580(spinal deformity, 10-month)	200 (10-month exposure)
	Lepomis macrochirus	110	96	7.4(Spinal deformity, several months)	3.6 (11-month)
	Lepomis cyanellus	120	96		
	Lepomis microlophus	170	96		
	Micropterus salmoides	285	96		
	Salmo gairdneri	170	96		
	Salmo trutts	200	96		
	Oncothynchus hisutch	101	96		
	Perca flavescans	263	96		
	Ictalurus punctatus	8070	96		

SOURCE: United States Governmental Protection Agency, 1972b.

On a toxicity scale for fish of low to very highly, temephos falls into the first category and chlorpyrifos and malathion into the latter (Travis et al., 1968). In tests conducted by Mulla (1966) temephos was toxic to carp only at rates much higher than used for mosquito control. The study also concluded that organophosphate insecticides are unstable in water and do not accumlate in non-target organisms.

Temephos, chlorpyrifos and malthion LC_{50} values for some fishes are as follows: (FPRL, Mountand Stephan, 1967; Eaton, 1971; Macek and McAllister 1970; Pickering 1962, as reported in U. S. EPA 1972b)

At .01 lb/acre, chlorpyrifos (Dursban^R) caused 3% mortality to bluegills and 10% mortality to largemouth bass 63 days after application (Macek et al., 1972). At .05 lb/acre the effective mortality to these fish was 55% and 46% during the same time period.

Preliminary bioassay results for chlorpyrifos (Dursban^R) submitted to the U.S. Bureau of Sport Fisheries and Wildlife by the Dow Chemcial Company (1966) are reported in Table 45.

Korn and Earnest(1974) found temephos to be the least toxic insecticide studied against striped bass in saline water, with TL_{50} values over 1,000 mg/l while chlorpyrifos had TL_{50} value of less than 1 mg/l.

Pyrethroids are highly toxic to fish (Mauck et al., 1976) and are not used by the District for larval or pupal control in fish-bearing waters or runoff areas.

AMPHIBIANS AND REPTILES

5 Yrs	15 Yrs	25 Yrs
■	■	■

Amphibian habitats are treated with temephos or chlorpyrifos (Type III and I sites). These insecticides do not negatively affect the life or development of bull frogs(Table 30).

TABLE 45

EFFECTS OF CHLORPYRIFOS ON TEN SPECIES OF FISH
SUMMARY RESULTS OF PRELIMINARY BIOASSAYS

Species	Temp. . C.	Concentrations in p.p.m. at 3 hours			24 hours			96 hours		
		0.1	1.0	10.0	0.1	1.0	10.0	0.1	1.0	10.0
Rainbow trout	12	0	0	0	0	10	10	10	10	10
Goldfish	17	0	0	0	0	9	10	0	10	10
Carp	17	0	0	0	0	6	10	2	10	10
White sucker	12	0	0	0	0	10	10	10	10	10
Black bullhead	12	0	0	0	0	7	10	0	8	10
Green sunfish	17	0	9	10	10	10	10	10	10	10
Bluegill	12	0	1	10	10	10	10	10	10	10
Yellow perch	12	0	3	10	8	10	10	10	10	10

Source: U. S. Bureau of Sport Fisheries and Wildlife, 1966.

A locally recognized decline in the frog population is not associated with mosquito control. Declines in populations do not correlate geographically with sites treated for mosquitos. According to the Minnesota DNR, the suppression of regional frog populations is a result of a redleg disease enzootic (Krosch, 1977).

AQUATIC MAMMALS

5 Yrs	15 Yrs	25 Yrs
■	■	■

Standard toxicological tests are conducted on terrestrial mammals thus no references were found on aquatic mammals. The following is offered to place the potential for concern in perspective.

At dosage rates currently used by the M.M.C.D., all the resmethrin discharged over 25 acres would not quite be a lethal oral dosage for one rat (Provost, 1976). Assuming that resmethrin is equally toxic to other mammals and to the rat, which is not necessarily so, the following comparisons can be made. If all 814 pounds (AI) of resmethrin used by the M.M.C.D. in one year were consumed by the District's cottontail rabbits the population would be reduced 0.13%, if by squirrels that population would be reduced by 0.09%, and if by deer that population would be reduced 0.04%. Since insecticidal fogs are known to dissipate and deposit little if any toxic residues, it is clear that the M.M.C.D.'s adulticiding program poses no measurable hazard to the area's vertebrate wildlife. (Provost, 1976).

Temephos is approved by the U. S. Public Health Service for use in bird baths and animal watering devices at rates up to 10-15 ppm (CDC, 1967 in Muirhead - Thompson, 1971), rates much higher than those used by the MMCD (0.075 ppm) in sensitive areas.

TERRESTRIAL MAMMALS

5 Yrs	15 Yrs	25 Yrs
■	■	■

Temephos, as used by the M.M.C.D. and anywhere else in the world, has the best safety record of any modern insecticide used in mosquito control. The M.M.C.D.'s dosage are 0.025 to 0.075

in ground and air treatments (Provost, 1976).

Very early samples of malathion were only 65 to 70% pure, and they were more toxic than commerical samples made since about 1952. The toxicity of any particular sample is increased by solution, especially solution in vegetable oil (Hazleton and Holland, 1953). However, in spite of these variables, malathion has a low acute toxicity when administered by any natural route.

In 2 year feeding studies it was learned that even a dietary concentration of 5,000 ppm does not increase mortality of rats, although food intake is reduced (so that the dosage is somewhat less than the predicted 250 mg/kg) and weight gain is subnormal. The rats remain asymptomatic even though plasma cholinesterase activity is reduced to 5 to 40% of normal, red cell enzyme activity to approximately zero, and brain acetylcholinesterase to 5 to 40% of normal (Hazleton and Holland, 1953).

A dietary concentration of 1,000 ppm (50 mg/kg) for 2 years is accepted by rats. It produces no inhibition of growth but does reduce plasma cholinesterase activity to about 64%, red cell enzyme activity to 5 to 40% and brain enzyme activity to about 64% of normal (Hazleton and Holland, 1953).

A dietary level of 100 ppm for 2 years (about 5 mg/kg/day) produces little or no inhibition of cholinesterase and no other detectable effect in rats (Hazleton and Holland, 1953). Results in short-term feeding studies are consistent. In fact, rats tolerate dietary levels of highly purified malathion as high as 500 ppm without inhibition of blood cholinesterase.

Absorption, Distribution, Metabolism and Excretion. The most striking difference in the metabolism of malathion and that of the majority of organic phosphorus compounds used as insecticides is the presence of two carboxy groups in malathion. The compound is subject to the various kinds of metabolism that other organic phosphorus insecticides undergo. In addition, the splitting of either

carboxy ester linkage renders the compound non-toxic. Details of the metabolism have been reported by O'Brien (1960) and by Health (1961).

The excretion of absorbed malathion is prompt. When 25 mg of ^{14}C - malathion was administered to each of six male rats, activity appeared in the urine within 2 hours, and 91.72% was eliminated within 24 hours while an additional 7.75% remained in the gastro intestinal contents. Excretion was mainly via the urine(83.44%) and partly by the feces (5.51%), but 2.77% was exhaled as carbon dioxide. No unmetabolized malathion could be detected 8 hours or longer after dosing (Bourke et al., 1968; Hayes, 1976).

Chlorpyrifos Toxicity to Laboratory Animals. When given in sufficient dosage, chlorpyrifos produces signs indistinguishable from those of other organic phosphorus compounds, and its speed of action is approximately the same as that of other =S, diethoxy compounds. The acute toxicity is of moderate degree. The compound is only slightly less toxic to rats when applied to the skin than when administered orally (Gaines, 1969). There is considerable variation in the susceptibility of different species.

In hens protected from death by atropine, subcutaneous dosage of 200 mg/kg produced ataxia which lasted only 10 to 20 days but, unlike that caused by malathion, was delayed 3 to 18 days in onset. Recovery was complete. A subcutaneous dosage of 100 mg/kg did not cause neurotoxicity (Gaines, 1969). Earlier studies using oral dosage up to 150 mg/kg also failed to produce neurotoxicity (Stevenson, 1966). In two year dietary feeding studies in rats, dosages of 1 and 3 mg/kg/day produced moderate depression of plasma and red blood cell cholinesterase, and brain cholinesterase was depressed by 3 mg/kg/day. In two year feeding studies in dogs, the results were identical except that there was some inhibition of plasma, but not red cell cholinesterase by a dosage of 0.1 mg/kg/day. All cholinesterase levels recovered promptly when dosing was stopped. In both species even the highest dosage studied (3 mg/kg/day) produced no clincially important effects as judged by survival, growth, relative and absolute organ weights, blood, urine, and clinical chemical

findings and gross and microscopic pathology, including tumors. The no-effect levels are 0.10 and 0.03 mg/kg/day in rats and dogs, respectively (McCollister et al., 1974).

Absorption, Distribution, Metabolism, and Storage. A single dose of ^{36}Cl-chlorpyrifos administered to rats led to rapid absorption and excretion in the urine (90%) and feces (10%). The products excreted were ^{36}Cl-3,5,6-trichloro-2-pyridyl phosphate (75-80%), 3,5,6-trichloro-2-pyridinol, and a trace of the unmetabolized material. In the initial distribution within the tissues, some of the ^{36}Cl chlorpyrifos was trapped in the fat and was mobilized and excreted slowly with a half life of about 62 hours hours (Smith et al., 1967a)

Slight storage of unmetabolized chlorpyrifos was found in the fat of cattle dipped repeatedly in 0.025% emulsion. No oxygen analog was detected (Ivey et al., 1972). In a similar way, the insecticide was excreted in the milk of cows that had been spray-dipped with a 0.15% emulsion. The maximal concentration in milk was 0.304 ppm, and detectable excretion continued through the fourth day. Pasteurization caused a 26 to 47% decrease in concentration (Leshev et al., 1972; Hayes, 1976).

The agricultural crops within the metropolitan counties involve insecticide treatment of 102,004 acres (v 301,900 by the MMCD) with 98,566 AI pounds of toxicant (v 6,253 by the MMCD), or 0.97 pounds AI per acre (v 0.02 by the MMCD). This gross difference is meaningful only in that it typifies the enormously greater insecticide dosage used against crop insects as compared to mosquitos, which is the case everywhere. The difference is especially notable with mosquito adulticiding. The MMCD, for instance, averages only 0.0036 pounds AI per acre for that procedure, or 1/267 the average dosage on farm crops of the District. The insecticides used on farm crops in the District, although applied to less acreage, pose a greater threat to wildlife than the insecticiding procedures of the MMCD (Provost, 1976).

Two groups of toxicants are used in agriculture. The most used are carbamate insecticides applied as

systemics, i.e., they are absorbed by the plants and kill insect pests feeding on root, stem or foliage. The other group of compounds is the organophosphate class, three of which, diazinon, Dyfonate and Dasanit, account for 28% of all insecticide application to crops. Dyfonate and Dasanit are applied as systemics, so that, all in all, farm pests in the District are treated overwhelmingly (71%) with systemic formulations (Provost, 1976).

Six payments have been made in the metropolitan area by the U. S. Department of Agriculture since 1971 (Steppel, 1977) to compensate for bee kills. "None of the losses paid were due to pesticides used for mosquito control" (Frost, 1977, Krosch, 1977).

Of pesticides used by homeowners (60%) and agriculture (38%) in the Twin Cities area, possibilities of drift or water transport probably make agricultural usage of Diazinon a greater threat to wildlife than any of the mosquito-control procedures of the MMCD (Provost, 1976).

The use of systemic pesticides in agriculture (e.g., Dasanit, Dyfonate) could pose a threat to deer and other grazing animals feeding on or near treated cropland. Hazards through homeowners uses of pesticides is a possibility, although suspension of the popular commercial organochlorine compound Chlordane, in 1976 greatly reduces the threat (Provost, 1976).

HUMANS

5 Yrs 15 Yrs 25 Yrs

■ ■ ■

Generally insecticides have the same affect upon humans as upon other mammals (Eto, 1974).

There is not expected to be any negative impact on human beings from the use of temephos, chlorpyrifos, malathion, or resmethrin used by the District at the dosage rates registered for mosquito control or at double those rates. The impact, consisting entirely of relief from the annoyance and health hazard of mosquitos, should be entirely positive. The safety for people applies to any distance from the point of discharge of insecticide; and the degree of exposure of 3 persons in the area will be considerably

briefer and inversely proportional to the square of the distance from the point of application (Hayes, 1976).

There are no expected long-term human consequences of continuing to apply insecticide formulations even ten times per season (Hayes, 1976).

The only dispersal agents requiring consideration from the standpoint of human health are solvents. The use of granules, emulsions, and ultra low volume formulations greatly reduces the amount of solvents used. The solvents that are used either as such or as larvicides without any other active ingredient are mainly mineral and fuel oils. These materials are dangerous if swallowed because they are very likely to be aspirated and to cause pneumonitis. However, once dispersed, they are harmless. The quantity of these oils used for mosquito control is probably considerably less than the amount of fuel oil and closely related materials, mainly gasoline, lost to the atmosphere by evaporation from storage and spillage in the metropolitan area (Hayes, 1976).

Synergism or potentiation, like antagonism, is a rare phenomenon although malathion is a compound that is synergized by a number of other organic phosphorus compounds, including some pesticides and some non-pesticides. Compounds that synergize one another must be administered at about the same time and at dosages that approach the toxic (or therapeutic) level of each of them in order to exhibit synergism. No example is known of a worker absorbing enough malathion to constitute a problem in connection with synergism. In fact, no case of human poisoning by any pesticide has been reported in which synergism played a necessary part. This is true whether one considers interaction between pesticides and other pesticides or between pesticides and medications or other non-pesticides (Hayes, 1976).

The effects on humans are the same whether one considers the use of liquid larvicides applied six times per year or temephos or chlorpyrifos controlled release pellets applied once a year (Hayes, 1976).

Emphasis has been placed on dosage-response relationships in experimental animals and especially in man.

It must be expected that a sufficient excess of any compound, including those necessary to life, will be harmful or even fatal. The compounds being used are highly dangerous if accidentally swallowed by a child or if ingested with suicidal intent. However, the compounds are safe for workers who use them with reasonable care and safe for the general population whose exposure is far less than that of applicators (Hayes, 1976).

Potentiation of the toxicity of one organic phosphorus compound by another was discovered in connection with malathion and EPN (Use of which has been susperceded by more effective materials) by Frawley et al. (1957a and 1957b). The degrees of potentiation is usually only a few fold, although as shown by Murphy et al. (1959), triarthocresylphosphate (TOCP) (not a pesticide) may increase the toxicity of malathion by a factor as great as 100. In many instances, potentiation among organic phosphorus compounds involves inhibition of carboxylase by one of them, permitting the other (often malathion) to avoid destructive metabolism and thus exhibit its inherent toxicity (Cohen and Murphy, 1971a). However, carboxylesterase inhibition alone is not adequate to predict the relative capacities of various compounds to potentiate the toxicity of malathion (Cohen and Murphy, 1971b). Dosages of TOCP greater than that necessary to produce maximum inhibition of carboxylase produce a dosage-related inhibition of maloxon binding in the liver, thus freeing the active agent for inhibition of cholinesterase (Cohen et al., 1972).

An even more important point is that both potentiating compounds must be present simultaneously or almost simultaneously and at toxic or near toxic levels. It was pointed out by DuBois (1961) that there is no danger from residues of potentiating compounds in food provided the individual tolerance levels are not exceeded. No potentiation occurs when the compounds are present in dosages that ordinarily are encountered even by workers. There is no evidence that potentiation has been of any clinical importance in people exposed to pesticides (Hayes, 1976).

The MMCD requires blood tests of its employees prior to assigning them to work involving exposure to insecticides. The District also supplies each

employee with federally approved protective clothing to reduce exposure. Allergenic responses to the use of insecticides or residential exposure is rare and not well understood. It is believed that such responses occur in persons with a hypersensitivity to certain solvents or protein-base products. Resmethrin, most generally encountered in cold-fogging, is not among these (Hayes, 1976).

PHYSICAL ENVIRONMENT

HYDROLOGIC CYCLE

5 Yrs.	15 Yrs.	25 Yrs.
■	■	■

The current program operations do not affect the hydrologic cycle of the Twin Cities Basin, nor does the current program have any impact upon topography, or surface and ground water quality (Pfannkuch, 1976).

Organophosphorus insecticides do not leach (Eto, 1974; Weber, 1972). Concerning the insecticide with the longest residual life (chlorpyrifos), 80% attaches to soil and organic matter within 8 hours of application (Smith et al., 1966).

Temephos is used in areas where surface drainage occurs, especially in areas where run-off enters permanent bodies of water (e.g., Type III sites). The duration of larval control of temephos at rates used by the MMCD is 12 hours.

The degradation products of both insecticides are biologically inactive. Many organophosphates are considered as rapidly decomposing (including chlorpyrifos and malathion), losing their insecticidal activity in 2-4 weeks (Eto, 1974). "With only a very few exceptions, all organophosphorus pesticides are neutral phosphoryl or thiophosphoryl compounds... fully esterfied phosphorus acids are susceptible to hydrolysis...in acqueous solutions, many organophosphorus pesticides are most stable between pH 1 and 5 and are much more unstable under alkaline conditions" (Eto, 1974). Most soils in the District are acidic.

Generally, organophosphate insecticides do not have great mobility in soils. Their absorption by soil reduces their loss by volatilization and reduces their insecticidal activity (Weber, 1972).

SOLID WASTE

5 Yrs.	15 Yrs	25 Yrs.
■	■	■

Insecticide granules used by the District are normally packaged in heavy paper sacks which are disposed of as municipal garbage amounting to about 6500 lbs/yr. Metal containers are decontaminated. Those over 5 gallons in volume are recycled. Usually 70 containers of 5 gallons or less are disposed of each year. Inactive insecticide materials are disposed in a Class I chemical disposal site in Illinois along with other similar waste materials. These are stored at the Hennepin County Hopkins Public Works facility prior to transfer to Illinois.

Insecticide granule carriers of sand and diatomaceous earth are screened particles of natural earth. Polyethylene and rubber, the carriers used for presently available controlled release materials, would amount to less than 20 ppm in the top six inches of soil, at prescribed use rates (Dow Chemical Company, 1977).

AIR QUALITY

5 Yrs.	15 Yrs.	25 Yrs.
■	■	■

During the course of an average mosquito season 234,000 acres are treated for adult control with resmethrin at the rate of 1½ fluid ounces as a cold fog. The carrying agent which constitutes 91% of the spray is a food-grade mineral oil (Klearol). Approximately 2,700 gallons are used per season.

Approximately 825 gallons of diesel oil is applied as aerial ULV to 24,000 acres annually.

Granule and liquid aerial larviciding is done. During 1975 and 1976 44,873 acres were treated annually as a prehatch with an average of 5 lbs of chlorpyrifos granules/acre. ULV aerial larviciding with chlorpyrifos and temephos is performed principally during years of above normal rainfall (1975 - 21,456 acres; 1976 - 240 acres; 1977 - 380 acres) over large sites.

Aerial applications are normally conducted between dawn and 11:00 A.M., and cold fogging by truck after sundown when wind speeds are 2 - 8 mph. Spraying is

not done during high wind or under calm conditions.

Thus, of the total acres larviciding by air in an average mosquito season, 75.3% is prehatch work using granules and 24.7% is ULV spraying. ULV aerial applications are not made over heavily populated areas, but are confined to rural areas during the months of April and May after periods of heavy rainfall.

Aerial larviciding with granules is advantageous in one important aspect. Granules penetrate the plant canopy, delivering the total dose to the mosquito breeding water and leaving negligible residues on plants. Thus, the chances of killing terrestrial non-targets is reduced (Mulla and Axelrod, 1962).

During prehatch spraying using the Simplex granular spreader, the granules are unavoidably beaten by the impeller creating some dust which is discharged with the granules.

Because of the smaller droplet sizes and volumes, ULV spraying presents some problems which must be carefully considered. Presently there is no way to completely eliminate unwanted drift. There are three factors of primary importance in relation to drift and the MMCD program:

a) height of application -- the greater the distance between the point of release and target, the greater the chance that small droplets will respond to turbulence. The District aircraft fly at 50 feet. While lower altitudes would increase accuracy they are impractical due to numerous trees which usually surround the breeding site.

b) meteorological conditions, especially wind velocity -- winds over 6-8 mph make spraying hazardous (Potter, 1976). On the other hand, light winds (1-5 mph) increase canopy penetration by droplets (Akesson, 1973).

   During light wind conditions, downwind drift can be calculated and corrections can be made without reducing accuracy. As wind speeds increase beyond 5 mph, accuracy is lessened. The effect of wind speed on water droplets is shown in Table 46.

TABLE 46

EFFECT OF WIND SPEEDS ON WATER DROPLETS

Wind velocity (in mph)	Distance travelled by 100 micron droplets while falling 10 feet. (in yards)
0.5	3.0
1.0	5.8
2.0	11.7
4.0	23.2
5.0	27.0
10.0	51.0

Source: Southwell and Cooper, 1973.

Extrapolation of the above data to account for the 50 feet flying altitude would be misleading since wind speeds decrease closer to the vegetation canopy. A ULV adulticiding study conducted by Rathburn et al. (1969) showed wind velocities in mph averaged 1.3, 2.5, 3.4, 4.1 and 5.0 at 1,5,10, 20 and 40 feet above ground, respectively.

c) droplet size -- droplets less than 50 micron in diameter (1 micron = 1/25,000 inch) constitute the principal droplets which drift beyond the target (Akesson et al., 1972). Presently there is no mechanical improvement of nozzles which would help eliminate this problem. Evaporation of larger particles as they drop through the air (resulting in smaller droplets) has been lessened by the District's use of high boiling range oils as carriers. These oils have lower volatilities than water (Akesson and Yates, 1970). Droplets emitted through nozzles used in ULV larviciding are between 35-300 microns in diameter (average 200 microns). The District ULV aircraft adulticiding droplet range is 30 - 100 microns (average 50 microns) (Mulla et al., 1973).

Besides careful consideration of the three items above, mechanical advances also contribute to aerial application safety. Spray units are equipped with pressure shut-offs on the nozzle to prevent loss of spray liquid while the aircraft is turning.

Other air pollutants include vehicle exhaust and fumes emitted from building furnaces.

NOISE

5 Yrs.	15 Yrs.	25 Yrs.
2	2	2

According to Al Perez of the Minnesota PCA, noise impacts are experienced in environments where noise levels are currently very high or very low. Noise intrusions in areas of quiet are considered a considerable disturbance. Noise intrusion in areas where ambient noise levels are constant (in the range of 40-60 dBA) is less problematic. No instances of MMCD generated noise causing an intrusion approaching a pain threshold are to be expected with the current program.

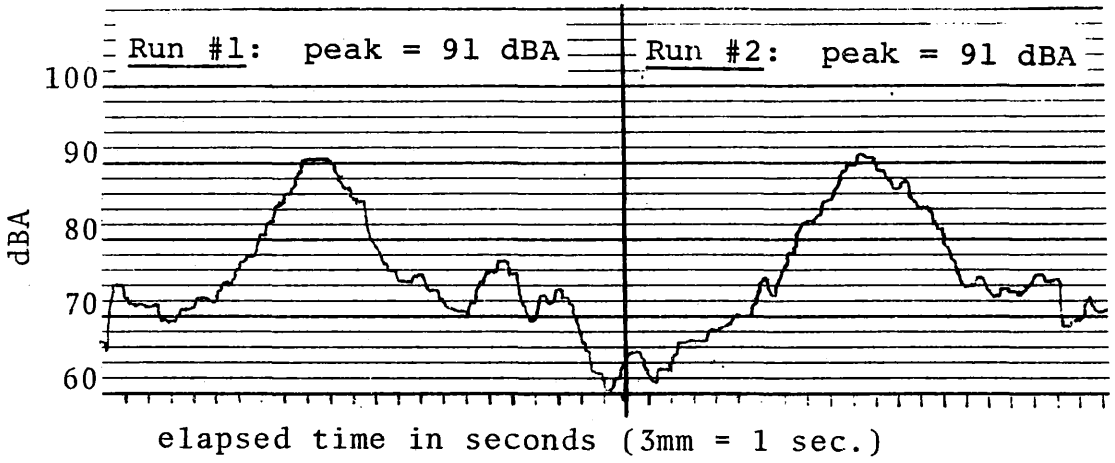
Noise caused by MMCD equipment does not violate state or Federal noise standards, and is not considered hazardous based on present knowledge, but does violate ambient quiet. This is especially true during aerial and cold fog spraying operations which normally occur at dawn and after sundown in rural and residential areas.

Although some MMCD operations may momentarily startle humans and animals, there have been no reported cases of accidents, or harm as a result. Nor has there been any known displacement of animal species.

A histogram taken by the Noise Section of the MPCA in August 1977, show that the peak sound pressure levels generated by a helicopter used in M.M.C.D. operations has a duration of one second or less.

The worst case, a peak of 98 dBA was a pass-by directly overhead at a altitude of 50 ft at 60 mph. This is contrary to District policy. The more common highest exposure level is as follows:

Test Pass-by 100 ft. to the side at an altitude of approximately 50 ft. and a speed of approximately 60 mph.



WETLANDS

5 Yrs. 15 Yrs. 25 Yrs.

The current MMCD mosquito control program does not have any bearing upon the size, amount of duration of Twin Cities wetlands.

Approval of the proposed ordinances of the Metropolitan Council authorizing local units of government jurisdiction over alteration of wetlands may affect
To date, the
authority of eminent domain. Denied access to significant mosquito breeding areas may require review of this policy.

If the projected loss of 100,000 acres of wetlands (Upper Mississippi River Basin Commission, Level B Study, 1976) in the region is an accurate estimate, some 38% of the mosquito breeding within the MMCD will be out of production by the year 2000.

This anticipated reduction in acreage is not likely to affect overall MMCD operations because:

a) wetland breeding sites may be reduced in size but not totally eliminated as productive areas;

b) elimination of large wetland areas does not imply reduction in total mosquito production as more

mosquitos are bred in small sites than in large ones;

c) The District as now funded and equipped can only control 900 square miles in the center of the 2,633 square mile service area.

INSECTICIDE RESIDUE

BIOLOGICAL MAGNIFICATION

5 Yrs.	15 Yrs.	25 Yrs.
1	1	1

None of the insecticides used by the MMCD are capable of biological magnification, described by Hayes (1975), as "... the phenomenon by which the concentration of a chemical is increased in successive steps of a food chain, with the danger that some species, especially the ones highest in the series, will be injured by the compound." This has not been shown to occur in organophosphate compounds, including temephos, chlorpyrifos and malathion, nor in synthetic pyrethroids, including resmethrin. The phenomenon is also unknown in carbamates, so it cannot occur in the District from insecticidal programs of either mosquito control or agriculture (Provost, 1976).

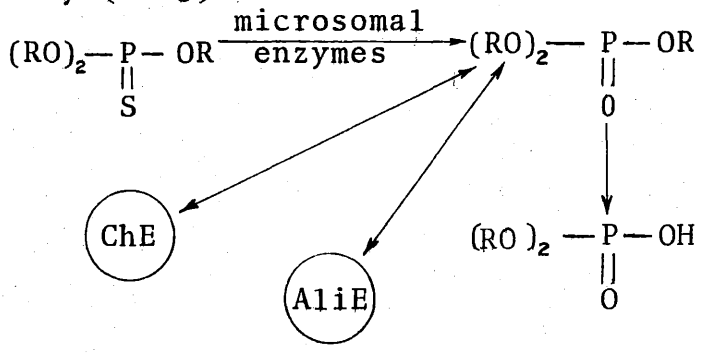
Hayes (1975) comments that biological magnification "may be little more than a rare curiosity requiring a whole series of species that are inefficient at degrading and excreting a given compound." Hayes continues to note that, "persistence in organisms is necessary for biomagnification to occur...most pesticides are degraded readily by living organisms." Metabolism is normally a two-phased process involving oxidation/hydrolysis and synthesis or conjugation (Williams,1959). "Synthesis includes the combination of a foreign compound with a normal metabolite of the body to form a more water soluble and readily excreted product" (Williams, 1959; Eto, 1974).

DEGRADATION PRODUCTS

5 Yrs	15 Yrs	25 Yrs
■	■	■

The degradation products of organophosphate insecticides used by the MMCD present no unusual hazard. If not bio-accumulated they are held in the soil, as discussed below. Degradation products of resmethrin, chlorpyrifos, temephos

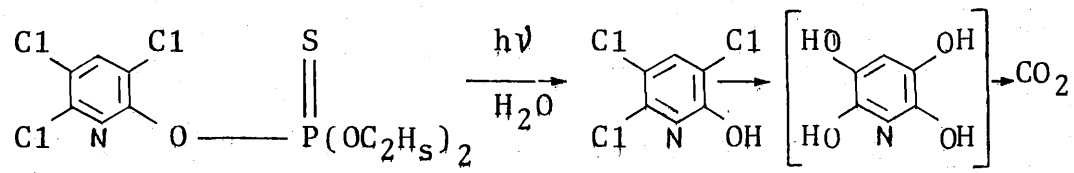
and Malathion are as follows. The normal metabolic pathy way of organophosphate insecticides is described by Frawley (1965) as



Resmethrin: Cleavage products--chrysanthemic acid, benzaldehyde, benzyl alcohol, and benzoic acid; oxidation products--various esters (small quantities) (Schumaker, 1976).

Chlorpyrifos: Cleavage product (hydrolysis) is 3,5,6-Trichloro-2-pyridinol (rest of breakdown products are not stable enough to be of consideration) (Kenaga, 1976).

If above pyridinol is exposed to UV light it will breakdown (half life of 80-100 days) to carbon dioxide, ammonium carbonate, sodium chloride and formic acid (Smith, 1966).

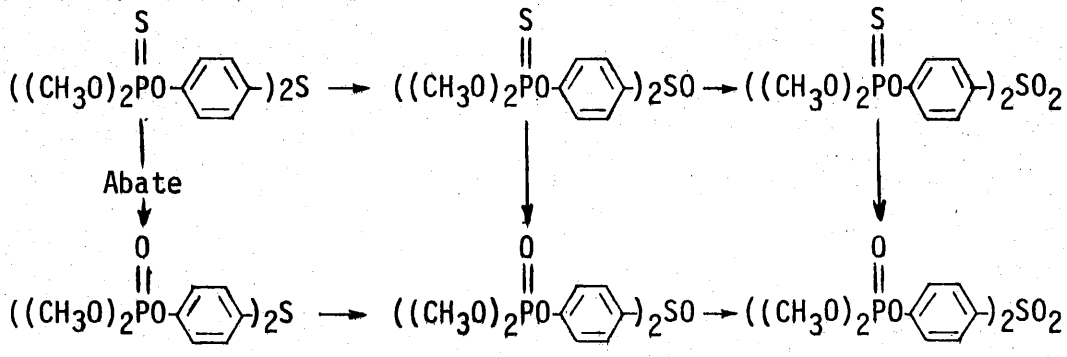


(Decomposition) (Eto, 1974)

Chlorpyrifos

Temephos: Metabolic products of insecticide on vegetation; sulfoxide derivative (major product), sulfone derivative, dioxone analog (minor products), unsymmetrical mono-oxono analog and symetrical dioxons analog (American Cyanamid Company, 1974).

Through oxidation of the thioether moiety, temephos is reduced wherein sulfide is converted into sulfoxide and then sulfone as shown in the following metabolic pathway (Eto, 1974).



k (M^{-1} min^{-1})

x 10^{-6} 0.37 1.10 1.56

(mosquito larvae ChE)

Malathion: Primary hydrolysis products--basic solution-diethyl dumarate and dimethyl phosphorodithioic acid.

Acid solution--dimethyl phosphorothionic acid and 2-mercaptodiethyl succinate. Note: rate of hydrolysis increases fourfold with 10°C increase in temperature. (Muhlmann and Schrader, 1957).

Ultraviolet light degrades the compound to less polar compounds but no products have been identified (Cook and Ottes, 1959; Mitchell, 1961).

Microbial degradation: Malathion monoacid (alpha isomer) Malathion dicarboxylic acid, Potassium dimethyl phosphorothioate, Potassium dimethyl phosphorodithioate (Walker and Stojanovic, 1971).

The residue life of a pesticide depends on soil type. In general, the half life increases with increasing organic content in the soil (Haque, 1976). Accumulation (residue)is a function of dosage.

Within the MMCD, organic content is highest in Type III breeding sites associated with permanent bodies of open water, then in Type II and finally Type I sites. The organic content of soils in each of these sites is higher than that of upland knolls. Depression soils are organic having between 5-10% carbon content (MMCD records, 1974).

Residues of malathion persist for about 1 week. The half life of temephos is about 12 hours with complete degradation in a matter of days. Chlorpyrifos remains biologically active for about three weeks with no residues present after the mosquito season. (Kenaga, 1976). Chlorpyrifos when applied to the upper 1 inch layer of loam was not moved from that layer when drenched with six inches of water (Gray, 1976).

The persistence of DDT, by comparison is anywhere from one to 30 years (95% breakdown). A breakdown of 75% normally occurs in 2-5 years.

Herbicides are generally active for between one and 18 months (Matsumura, 1972b).

SYNERGISM, POTENTIATION AND RE-SYNTHESIS

5 Yrs	15 Yrs	25 Yrs
■	■	■

Little is known about this topic as related to insecticides used by the MMCD beyond that reported previously. Generally, organophosphates are unstable and degraded through hydrolytic and oxidative processes. As regards the synergistic (one component is non-insecticidal) effects of insecticides with other pollutants, Dr. E. E. Kenaga notes that chlorpyrifos volatilizing from application sources is not known to be an air pollution problem except at the time of application. Thus no information on synergism with frequent air pollutants such as SO_2 and CO is known nor does it seem a significant question. Many chemicals used with phosphate insecticides such as chlorpyrifos are additive but not synergistic in their toxic effects.

We are unaware of examples of significant synergism with the use of chlorpyrifos with other insecticides (Kenaga, 1976). The District would suspend the use of any material found to synergize with other pollutants or other toxic materials.

Hayes (1975) concludes that, "for industrial chemicals as well as for pesticides, the most common joint action is a simple additive one. If the dosage of the two compounds is small, there is enough enzyme to detoxify both of them and the phenomenon of potentiation is not manifest."

For potentiation to occur two compounds capable of interacting positively must be absorbed at the same time and each at the same dosage which would be hazardous if only one were absorbed (Hayes, 1975). The chances of an animal or person encountering two such compounds simultaneously are not very great.

Laboratory tests conducted by Keplinger and Deickman, (1967) measured the combined interactions of chlorinated hydrocarbon, organic phosphorus and carbamate insecticides in rats and mice. The largest quotient found between expected and resultant LD_{50} rates was 2.26 effected with chlordance and methoxychlor in mice.

Feeding tests with a combination of six pesticides and and eight food additives detected no differences in toxicity resulting from single or combined compounds(Fitzhugh, 1966). Malathion was one of the pesticides tested.

Frawley (1965) summarizes synergism and antagonism as "biological effects which are greater than or less than expected." Frawley notes two such proven effects inhibition of aliesterase by organic phosphates and stimulation of liver microsomal enzymes by chlorinated hydrocarbons. The author concludes that either effect would be rare at a chronic or subacute level at usual environmental exposures below the 'no-effect' levels of formulations "cannot synergize or antagonize the toxicity of other chemicals handled by the same biological systems."

The effect of toxicants on enzymes is primarily a function of dose. Rate of absorption, protein binding, ph effects on penetration and cross-membrane transfer, and membrane permeability also retard or enhance the availability of toxic substances to the reaction site (Hayes 1975). These conditions can be regulated. Rate of absorption, for example can be conditioned by formulation. Chlorpyrifos absorption is retarded in a granular form as used by the District in its operations.

RESISTANCE

MOSQUITO AND NON-TARGET ARTHROPOD RESISTANCE TO INSECTICIDES

Some two dozen factors affect the degree to which mosquitos and non-target arthropods develop resistance to insecticides in the Twin Cities area:

5 Yrs	15 Yrs	25 Yrs
■	■	■

a) genetic frequency of resistant alleles:

b) the number of resistant alleles:

c) dominance of resistant alleles:

d) interaction of resistant alleles:

e) past selection by other chemicals;

f) generation turn-over time;

g) offspring per generation;

h) monogamy/polygamy

i) isolation;

j) mobility;

k) migration;

l) monophagy/polyphagy;

m) refugia (adult harborage);

n) chemical nature of (MMCD) insecticide;

o) relation to previously used insecticides;

p) persistence of residue;

q) formulation;

r) application (larval treatment density)threshold;

s) selection threshold;

t) life stages subject to spray;

u) mode of application;

v) space--limited selection

(Georghiou, 1977).

Genetic, biological and behavioral factors associated with resistance cannot be controlled; however, those relating to insecticide selection and application practices can.

Georghiou and Taylor (1977) determined through simulated testing that, "slowest resistant responses occurred when (1) the population was diluted by immigrants, (2) population density was drastically suppressed by severe selection, and (3) susceptible individuals have a reproductive advantage over their resistant counterparts."

Predictions of tolerance and developing resistance can be measured through testing procedures conducted on mosquito larvae (Womeldorf, et al., 1966).

A testing program of this kind has been conducted by the District in co-operation with the University of Minnesota annually since 1961. No mosquito resistance has been detected in response to insecticides used by the District since its inception. Temephos has been used intensively for ten years (Cutkomp 1977).

Cutkomp (1977) states that resistance to temephos by Aedes species is unlikely due to the insecticide's lack of persistence. "A treated population of Aedes may be killed and the insecticide will have dissipated before a new population hatches. To a lesser extent this may be true with chlorpyrifos whose toxicity is greatly reduced by organic particles in the breeding pools"(Cutkomp, 1977).

Of the 22 factors cited by Georghiou (1977) the lack of resistance by mosquitos to District-used insecticides may be attributed in large part to three factors:

a) restriction of the larval control program to an area of 900 square miles at the center of the District thus resulting in minimal pressure on the regional mosquito population;

b) the extensive flight range of Aedes vexans (15 miles from breeding sites) which allows for migration of untreated mosquitos from outlying areas and 'refused entry' breeding sites into the core area where population mixing allows for dilution of genentic pools (Georghiou, 1976; Cutkomp 1977);

c) Fewer generations per year than normal for areas in which resistance has been a problem, resulting in less selection pressure.

In years of normal rainfall and normal mosquito production Culex tarsalis breed most commonly in MMCD Type IA and III sites associated with semi-permanent and permanent water. These sites make up about 10% of all breeding sites and receive less chemical treatment than MMCD Type I habitats of Aedes vexans.

Resistant strains of Culex tarsalis might develop if this species were severely pressured. However, Culex tarsalis represent less than 1% of the mosquito population and are not treated specifically except in years of heavy rainfall when an incrased incidence of encephalitis cases occur as in 1975 and 1977.

Should resistance develop in future years, cross-resistance may be conferred to other insecticides (Georghiou, 1972; Busvine, 1971). Development of cross resistance has been related to frequent exposure to a wide variety of agricultural sprays (Georghiou, 1972) or past history of intensive treatment with related materials (Georghiou, 1969). Resistance has been the greatest problem in agriculture intense areas with long growing seasons. Such areas provide maximum opportunity for selection of resistant genes via the greater number of mosquito generations per year and exposure to both agricultural and mosquito control materials.

COST/BENEFITS

5 Yrs	15 Yrs	25 Yrs
■	■	■

The current MMCD program is financed through public monies at a rate of 80 cents per capita. At this level of financing, 35% of the total acreage within the six county district can be controlled. Maximum control is achieved in the central city of St. Paul (87%). Control at a 10 mile radius from this site is approximately 65%.

Private costs for supplemental control by individual households is $1.10 per capita.

Current levels of control provide for 7,000,000 hours of outdoor leisure time which would be denied without a control program.

ENERGY CONSUMPTION

5 Yrs	15 Yrs	25 Yrs
1	1	1

Gasoline consumed in the operation of MMCD vehicles (81) and in 225 hours of helicopter flight time in 1975 (a peak year) represented 0.007% of gasoline used in the seven-county Metropolitan area that year.

Fuel oil was used as a carrying agent in thermal foggers until 1972. Total consumption that year was 30,220 gallons. In subsequent years, Klearol (a food grade mineral oil) has replaced fuel oil as an adulticide carrying agent. Due to current use of superior application equipment only 4,000 gallons of Klearol are used annually.

PROGRAM ALTERNATIVE: NO CONTROL

INTRODUCTORY COMMENT

Suspension of the current program implies both the suspension of the current MMCD larval and adult-iciding program and termination of public efforts to maximize the uses of non-chemical substitutes to control mosquito populations. The environmental effects of a no control alternative are discussed below.

MOSQUITO ANNOYANCE

5 Yrs.	15 Yrs.	25 Yrs.
■	■	■

Within two years after suspension of any public mosquito control efforts, mosquito populations would increase to natural limits. Subject to radical changes in annual rainfall, population dynamics would act to maintain total mosquito density at a stable level in the foreseeable future (2000).

Localized reductions in mosquito populations may be achieved temporarily through the use of pesticides by homeowners. It is estimated that per capita expenses for such materials would increase by 61% over 1976 figures to $1.77.

Mosquito density at the core of the Twin Cities Area (Central Cities) averages 32 mosquitos per light trap night. Under natural conditions this figure would be about 210 (13 hours) mosquitos for the same period.

PUBLIC HEALTH

5 Yrs	15 Yrs	25 Yrs
■	■	■

The mosquito poses a public health hazard both as a pest and in the transmission of disease. Under conditions of normal temperatures and rainfall, outbreaks of Encephalitis can be expected in exceptional years. The outbreak is usually associated with flooding and is usually suppressed with emergency measures. In the absence of a regional mosquito district the direction of these emergency efforts would not exist locally.

Mosquitos which transmit Western Equine and St. Louis Encephalitis in wet years inhabit Types IA and III breeding sites. The larvae of California Encephalitis develop in basal holes of hardwood trees and artificial containers. These vectors are common to the Twin Cities area; densities are dependent on precipitation and temperature cycles.

As population growth forces urbanization of wooded areas, the chances of youngsters encountering infected Aedes triseriatus mosquitos increases. Under conditions of natural mosquito development, these areas would not be controlled.

ANIMAL HEALTH

5 Yrs	15 Yrs	25 Yrs
■	■	■

Control of mosquito - borne animal diseases is currently dependent upon a four-way effort between the District, veterinarians, State authorities and animal owners. The vectors of Western Equine Encephalitis, and dog heartowrm develop in Types I,II,III and flood plain sites.

The number of dogs and horses owned in the metropolitan area is steadily increasing (veterinarian contact 1976; Cutkomp, 1977). While encephalitis infection in horses is closely monitored by the State Livestock Sanitary Board, heartworm in dogs is not. Although preventative measures against heartworm are easily available, their use is not widespread (personal communication with area veterinarians 1976). Heartworm continues to be a severe problem in parts of the Twin Cities region despite the positive effects mosquito control has had on reducing the number of vectors capable of transmitting the disease. Reports confirm that heartworm in humans is becoming more noticeable as well. Forty cases were confirmed in the U.S. between 1965 - 1975 (Dayal and Neafie, 1975).

In the absence of a centralized mosquito abatement program, heartworm and encephalitis in domestic animls would be proportionate to the effective prevention of the diseases by animal owners, public health authorities and veterinarians.

NON-TARGET ORGANISMS

5 Yrs.	15 Yrs	25 Yrs
■	■	■

In the absence of public mosquito abatement, it can be expected that the ecology in which non-target organisms breed and spend the duration of their life cycle will remain unaffected.

Crustacea populations would increase in Type I sites treated with chlorpyrifos to reach pre-treatment levels. phytoplankton populations would decrease due to increased crustacean filter feeding.

Private mosquito control measures, however, would no doubt be conducted to cope with increasing mosquito populations, which might affect non-target organism population densities where used.

POLLINATING INSECTS

5 Yrs.	15 Yrs	25 Yrs.
■	■	■

"Homestead pest control accounts for 68% of the pesticides applied in the area; of this total one-half are highly toxic to bees and other beneficial insects. These pesticides are most likely to be applied only during the daylight hours when honey bees and other beneficial insects are active. Homesteaders tend to over dose when they apply pesticides, increasing the toxicity problem" (Atkins, 1976).

An analysis of the impact domestic and agricultural pesticides would have on other features of a wetland ecology when applied in an uncontrolled manner is beyond the scope of this EIS. It may be assumed, however, that abuses such as those mentioned above are a real probability.

PHYSICAL ENVIRONMENT

5 Yrs.	15 Yrs	25 Yrs.
■	■	■

Adoption of a No Control Alternative would be with the understanding that the physical environment would not thereby be affected.

Adverse effects to water quality in wetland areas may result depending upon the types of materials and methods of application used by individual landowners

to control mosquitos and other pests. Topography and ground and surface water are not impacted by chemicals as currently applied by the District (Pfannkuch, 1976).

INSECTICIDE RESIDUE

5 Yrs. 15 Yrs 25 Yrs.

■ ■ ■

In the absence of insecticide use, residue would not be an impact.

RESISTANCE TO INSECTICIDES

5 Yrs. 15 Yrs 25 Yrs.

■ ■ ■

Under this program alternative, neither mosquitos nor other organisms would be subject to direct population pressures conditioned by insecticides. The expected high agricultural and homeowner use would not exert an important impact on development of resistance.

COST/BENEFITS

In the absence of a public mosquito control program, per capita expenditures for individual methods of mosquito abatement (i.e. spray and repellent) are calculated to be $1.77 (1976 dollars).

This figure is derived from the formula:

mean cost/per capita = .115 bite count

and the estimate that six mosquitos would be added to the number recorded in a five minute bite count during an average season with mosquito control.

ENERGY USE

Does not apply

PROGRAM ALTERNATIVE: BIOLOGICAL CONTROL

INTRODUCTORY COMMENT

Biological control is mosquito control through the manipulation of natural enemies. Twenty-five percent (83,466 acres)or 35% of the 54,000 breeding sites within the six-county Metropolitan Mosquito Control District have physical and ecological characteristics which would support this program alternative (13,500 sites). About 3,400 of 23,725 acres or 9.8% of these breeding sites retain water permanently and thus are readily adaptable to be ultimately controlled by natural enemies under a biological control program. The remaining 59,741 acres or 25% (10,125 sites) require physcial modification in order to support predator life. Only Type III (permanent water) sites are amendable to dependable, self maintaining biological control at the present time.

The following discussion only applies to those 3,400 sites which are amendable to biological mosquito control without physical modification. It is understood that 75-90% effective mosquito control in these sites would become established only several years after program initiation.

MOSQUITO ANNOYANCE

5 Yrs.	15 Yrs.	25 Yrs.
■	■	■

In the absence of any chemical control, a mosquito control program based solely upon the use of biological predators would be essentially the same as a No Control Alternative. Mosquito annoyance would be equally severe in either case. This judgement is based upon published conclusions regarding the ineffectiveness of natural/biological control in satisfying low human tolerance for mosquitos (findings quoted earlier in this text, ALTERNATIVE PROGRAMS: Biological Control).

PUBLIC HEALTH

5 Yrs.	15 Yrs.	25 Yrs.
■	2	3

Biological control of mosquitos would have no effect on the reduction of disease carrying mosquitos during the first five years of the program. Thereafter,

minimal control would be evident. Vectors native to semi-permanent water would be affected (50% impact on Culex in 25 years).

ANIMAL HEALTH

5 Yrs. 15 Yrs. 25 Yrs.

■ ■

Minimal vector control by extension implies minimal control (through mosquito abatement) of related animal disease (viz. heartworm and encephalitis). Although some control would eventually occur, control in the short term would be insignificant and any retarding of disease would depend solely upon preventative medical measures.

Twenty-five years after program inception, minor control would be achieved through biological control of Culex tarsalis (encephalitis). Biological control of Aedes vexans (Heartworm) vectors would be insignificant.

NON-TARGET ORGANISMS

5 Yrs. 15 Yrs. 25 Yrs

GENERAL

■ ■ ■

POLLINATING INSECTS

■ ■ ■

WATERFOWL

■ ■ ■

Biological Control would affect the ecology of breeding sites and their environs in much the same manner as a No Control Alternative. The introduction of native mosquito predators would not alter the natural habitat.

Increases in mosquito populatons in non-biologically controlled areas would probably stimulate local pest control by individual landowners. This practice may disrupt localized ecological balances.

A minor positive affect of biological control would be resultant increases in waterfowl food sources.

PHYSICAL ENVIRONMENT

5 Yrs. 15 Yrs. 25 Yrs.

■ ■ ■

A strictly biological control program alternative would not affect the physical environment in or near breeding sites in any significant manner.

INSECTICIDE RESIDUE	Does not apply.
RESISTANCE	Does not apply.
COST/BENEFITS	Many years are required to develop a mosquito pest management program using only natural enemies in the 3,400 breeding sites.

During those years mosquito control in the Twin Cities Area would be insignificant.

It is estimated that during this period, per capita expenditures for personal mosquito control would average $1.77 (1976 dollars) and public control would cost 20 cents per capita, using 1976 population figures.

Fifteen years after program inception, it is estimated that 9.8% of the total acreage within the current MMCD would be controlled for mosquitos. This area produces about 3% of the overall mosquito population. These figures are not anticipated to change by the year 2000.

Program costs, however, will increase. If a biological control alternative were adopted in 1978, for instance, per capita costs in 1993 would equal 40 cents. No change in cost is anticipated after 1993.

Using the same examples, private expenditures for personal mosquito avoidance (sprays, repellents) would be $1.74 in 1993 and 2000. Total per capita costs would be $2.14.

ENERGY USE			
5 Yrs.	15 Yrs.	25 Yrs.	Energy consumption would be limited to gasoline used to mass culture and transport biological organisms to field sites, and hydrocarbons used in heating and cooling laboratory and administrative offices.
■	■	■	

PROGRAM ALTERNATIVE: PHYSICAL CONTROL

INTRODUCTORY COMMENT

This program alternative includes eight major operations which are designed to reduce larval production in breeding habitats. Site modification either changes the moisture conditions necessary for mosquito development or creates an environment which will support natural mosquito predators. Mosquito production in over one half of the Metropolitan mosquito breeding sites could be affected through physical control efforts. The environmental effects of this alternative are discussed below.

MOSQUITO ANNOYANCE

5 Yr.	15 Yrs.	25 Yrs.
■	1	4

A physical control program (only in selected MMCD Type I and III breeding sites) would have little effect on the reduction of mosquito annoyance for at least 5 and probably 10 years after program inception.

Type II breeding sites (frozen depressions in wooded areas) cannot be controlled by physcial modification short of radically altering natural topography. The cost effectivness of this action is currently considered quite low. Some Type II sites could be controlled through removal of organic debris.

Twenty-five years after the introduction of a physical control program in areas which can be treated in this manner, mosquito production in the Metropolitan area would be reduced by 50%.

Mosquito annoyance would not be reduced proportionately. Physical control would treat sites dispersed throughout the area with little regard for residential population density. Thus, a minority of the population would experience some relief while a majority of the population would experience more annoyance than they do today.

PUBLIC HEALTH

5 Yrs.	15 Yrs.	25 Yrs.
■	2	3

A physical control alternative would reduce the risk of mosquitosto public health in much the same manner as a Biological Control program.

Risks would be higher during the first decade of program development and be reduced minimally as the program matures.

The capacity to effect emergency control would be substantially reduced under this alternative.

ANIMAL HEALTH

5 Yrs.	15 Yrs.	25 Yrs.
■	1	3

Following the physical changes in breeding sites during the early years natural control agents are expected to be able to dependably control some populations of mosquitos. However the mosquito-borne disease control will be insignificant. Under these conditions, it is expected that the incidence of dog heartworm and equine encephalitis within the District would approximate that currently reported in the uncontrolled, outlying areas of the District.

In later years, natural control or reduction of breeding sites effected through physical modifications would reduce incidence of mosquito-borne animal disease in the District to 25% and 50% of current levels outside the District boundaries.

NON-TARGET ORGANISMS

5 Yrs.	15 Yrs.	25 yrs
AQUATIC MICRO-ORGANISMS		
2	2	2
BIRDS		
2	2	2
WATERFOWL		
1-2	1-2	1-2

The affects of a physical control program on habitat ecology are closely associated with the control method and breeding site characteristics. Physical modification is specific and proposed as follows:

Type I 14,000 sites - limestone treatment

3,000 sites - ditching to divert rainfall from pot hole depressions.

500 sites - drainage to create permanent water sites

Type I site modifications would have minor affects on aquatic and terrestrial flora. Application of limestone to small upland depressions (.4 acre sites) would raise the soil pH and increase moisture in surface soil. Resultant changes in plant associations would be minor. Normally, pot hole areas have little aquatic vegetation due to their intermittant nature. Upon drying, terrestrial vegetation types invade the center. Insect populations normally found in Type I sites are limited to mosquitos, midges, water boatmen and some diving beetles. A number of crustaceans also occur. Population density depends on fluctuations in standing water.

Limestone treatments are designed to limit the duration of water retention in these temporary water sites. Thus aquatic vegetation would not be favored and terrestrial flora found in adjacent areas would become more established towards the center of the depression.

Ditching and drainage operations would eliminate any intermittent aquatic life from treated sites, in favor of permanent aquatic life in fewer sites.

Generally speaking, tree nesting and ground nesting song birds, rodents and terrestrial mammals would be favored by ditching and drainage operations. Aquatic species (amphibians, insects and waterfowl) would suffer habitat reduction. The extent to which resultant deeper water habitats would offset these loses is not well understood (Huff, 1976b).

The effect of limestone treatments on waterfowl is not well known. According to specifications of the SCS governing development of waterfowl 'ponds', (USDA-SCS-Minnesota, 1977), waterfowl do not use wetland sites of less than one half acre for courting or nesting. An estimated 40% of the MMCD Type I sites designated as suitable for limestone treatments are less than one-half acre in size. The effects of limestoning to increase infiltration in these sites will probably not affect waterfowl.

It is generally presumed (Huff, 1977 ; Gleason, 1977; Henderson, 1977 ; Swanson, 1976) that migrating and nesting waterfowl frequent MMCD Type I sites in the early spring. Later in the season these sites are normally dry. MMCD Type I sites are among the first

to thaw and crustacean populations develop quickly in mild temperature (especially Daphnia). The extent to which waterfowl, especially ducks, are dependent upon these sites as normal nesting, feeding and loafing grounds is not known. Site monitoring would be required before any final judgements are made. The frequency and length of dry periods during which time insect and crustacean populations are absent from these sites, may reduce their usefulness as permanent sources of protein required in the nesting ducks diet and by growing ducklings.

The application of limestone to small MMCD Type I depressions does not imply elimination of the site. The rate of infiltration is increased by three times; but intermittent periods of wet and dry conditions are not reversed. It is known that hens retrieve a percentage of their protein from seeds (Swanson et al., 1974; Huff 1977). Increased production of terrestrial flora around and within these sites as a result of limestone may be beneficial food sources. The topic requires further study. The short elapsed time since beginning the experimental limestone applications, now being monitored by the District, has not thus far permitted an adequate evaluation to be made.

If duck populations are indeed dependent upon the continued maintenance of MMCD Type I sites for survival at current population levels, it is projected that limestone applications to 14,000 sites would possibly reduce food and shelter habitat for 5% to 10% of the duck population in the median square mile in the District during the first 25 years of the program.

Proposed physical modification of Type III sites is limited to island and moat construction and shoreline slope modification (5,000 and 10,000 sites respectively). Another alternative is the removal of organic debris from these sites. Removal of debris is technically feasible in any site but is considered environmentally unsound as a general practice as it would inhibit biological productivity for a number of years. Island/moat construction and slope modification will suppress flora and fauna populations during construction. It is expected that these populations will re-establish readily (Huff, 1976). It is possible that affected

populations may include known rare and endangered species. Maple/basswood forest vegetation would be favored over swamp forest and brush associations.

According to Curtis (1977) the average life of a created 'pond' is 25 years. Natural wetland characteristics (wildlife, vegetation) are evident as the pond approaches maturity. Department of Agriculture specifications note that planting around ponds is not necessary as natural vegetation re-emerges soon after construction.

The creation of new habitats in the form of islands is likely to be beneficial to waterfowl, muskrat, beaver and mink populations. Their predators (weasels and foxes) may be adversely affected.

Slope modification will affect waterfowl if improperly managed, through the elimination of warm water feeding areas essential to nesting ducks and their young (e.g. for mallards 18" and for teal 9" are maximum depths). This action would also reduce the natural habitat of shrews, and amphibians.

Slope modification would tend to reduce habitats common to aquatic plant communities, sedge meadows and alder/willow swamps (see Appendix EI (exhibit C) for details).

PHYSICAL ENVIRONMENT

HYDROLOGIC CYCLE

5 Yrs	15 Yrs	25 Yrs
1	1	1

Very minor modifications in the hydrologic cycle would result from limestone treatments. The total amount of water likely to be infiltrated from a rainfall of 1.5" in an average watershed of 3.13 acres would be .09 acre feet (Pfannkuch 1976). In 14,000 upland sites, this would amount to 1260 acre feet of water dispersed throughout the metropolitan area. This is equal to .6 of one percent of the total run-off generated in the Twin Cities Basin by this type of rainfall (Pfannkuch, 1976).

The net change in water infiltration caused by limestone treatments to all sites is equal to 1070 acre feet per rainfall event (1.5") since some infiltration occurs naturally in intermittent water sites

(Pfannkuch, 1976). Under ideal conditions, water retention in the average site treated would be limited to five days or less (MMCD, 1976).

The hydrologic cycle for the Twin Cities Basin is shown in Figure XVII.

The points where physical modification of breeding sites could have the greatest impact is in the change of evaporatranspiration characteristics of the land surface, secondly in changing the proportion of surface runoff and subsurface runoff volume, and in changing infiltration characteristics near the surface.

The period of water retention in the depression is estimated to be in the order of 10-12 days, well over the 7-days gestation period of a mosquito brood. Water inflow into the depression consists of direct precipitation on the site and runoff from the adjacent watershed area. The outgoing volumes are by evapotranspiration and infiltration.

Shjeflo (1968) has determined that infiltration rates for prairie potholes range from 0.006 to 0.002 feet per day. Since the breeding sites discussed here are smaller than those in his study, and local study sites have more fine inwash (that is not moved or shifted as it would be by currents in a larger water body) the smaller figure is used in the calculations.

In an untreated breeding site about 8% of the standing water would infiltrate during the quoted reference period. The total amount collected in an average site (0.5 acres with 2.5 acres watershed area) would be 0.125 acre feet right after the rainfall.

Treatment with limestone would increase infiltration rates by a factor of about 3.3. They would reach a value of 0.0066 ft/day after successful application. In 10 days 26% of the collected water would infiltrate. Of this only a fraction can be expected to reach and recharge the groundwater reservoir. The exact figure will depend on depth to water and antecedent moisture conditions. Correlation of shallow well water readings with hydrographs in the Anoka sandplain area have shown that only about 25% of precipitation events seem to be reflected in the well hydrographs (Winter and Pfannkuch 1976).

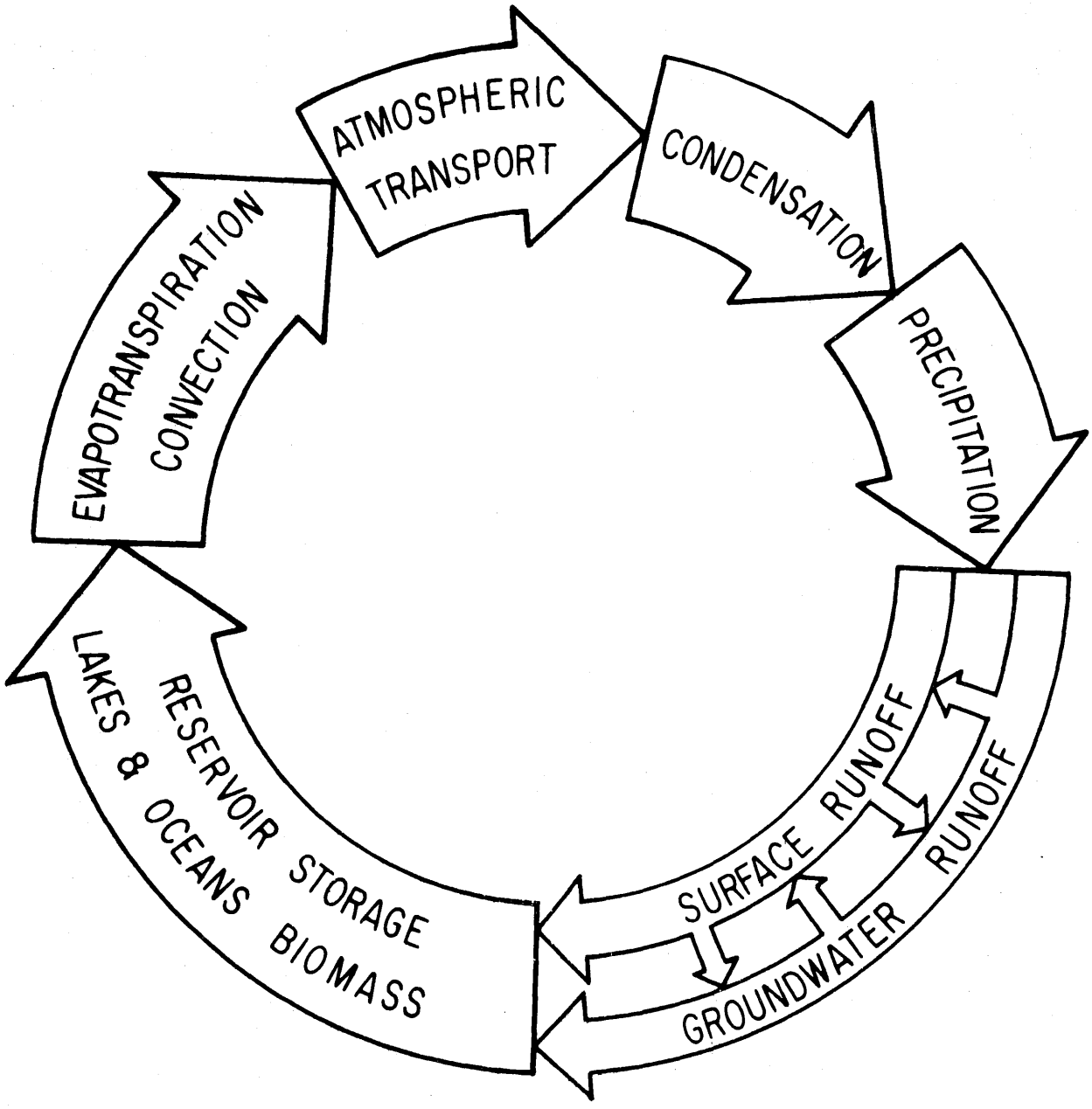


figure XVII.

hydrologic cycle

twin cities basin

source: Olaf Pfannkuch, 1976

john and michele genereux

The goal projected by the District for selection of a limestone alternative is reduction of water retention in MMCD Type I sites from the 10-12 day norm to five days or less. It is not expected that this goal will be reached in every site. Field tests on experimental sites show that this goal is realistic, however. Further, it has been found that the theorem, "The smaller the site and the smaller the adjacent runoff area, the shallower the lense covering at the bottom of the site and the more rapid the infiltration once treated" applies to many sites within the District. Thus the infiltration rate of 0.002 feet/day cited above may be low in many instances. By extrapolation, the number of days water is retained in the sites under normal and post-treatment conditions may be less than stated above.

In the course of its experiments with limestone treatments the District has effectively eliminated mosquito breeding in two MMCD Type I sites.

Pfannkuch (1976) concludes that limestone applications to MMCD Type I sites has no deleterious impact on topography, ground water or surface water quality. In his report to the District, Pfannkuch (1976) makes four judgements:

1. With consideration to the amount of limestone applied to each site, the contact time between infiltrated water and the affected soil zone is well below the time required to achieve equilibrium concentrations of calcium in the water.

   Using the equation $CaCO_3+H^+=Ca^{+2}+HCO_3$ one would expect limestone to dissolve with the net effect of increasing calcium, bicarbonate and carbonate in water. The impact would be seen in increased total dissolved solids, hardness ($CaCO_3$) and alkalinity ($CaCO_3$).

   In the absence of site specific data, Pfannkuch (1976) estimates concentration at saturation and projects possibilities of achieving equilibrium in light of the effects normally caused by natural soil materials.

Solubility of calcite under the conditions (1 atmosphere, 25°C) is approximately 20 mg/1. Super saturation and increased carbon dioxide pressure in the soil may cause increased solubility to a rate of several hundred miligrams per litre (Pfannkuch, 1976). Results of recent studies (Hera, 1970; Back and Hanshaw, 1971) suggest that infiltrated rainwater reaches equilibrium with surrounding limestone in approximately 4000 years.

2. The amount of limestone applied to a breeding site is negligible when compared to the natural limestone and dolomite content of Des Moines drift material. This material comprises the subsurface zone between the infiltration site and the water table. The eastern portion of the Twin Cities corresponding to the St. Croix Moraine is the only area in the District not underlaine with materials derived from the Des Moines lobe.

   Schneider (1961), Arneman and Wright (1959) and Wright (1962) have determined that the limestone content of Des Moines drift material ranges between 26% and 52%. The calcium carbonate content is higher in smaller grain size fractions.

   Pfannkuch (1976) estimates that a limestone content of 40% in Des Moines drift material would be conservative. He notes that a 10 foot column at one site (0.5 acres = 21,780 ft^2) contains 163,350 cu. ft. of rock (assuming 25% porosity) of which 65,340 cu. ft. are limestone or dolomite.

   By comparison a limestone application of 4 cu ft would be equivalent to 0.6% of the volume contained ten feet below the surface.

3. It is not expected that even full saturation of calcium infiltrated water would negatively impact groundwater in the limestone-free St. Croix moraine due to a dilution factor of 100 to 200.

4. No negative effects are expected from treated surface water as the proposed sites are isolated

depressions, unconnected to the regional drainage network.

The concentration of runoff into a more permanent water site (ditching) would "change the surface/volume relationship and leave a relatively smaller system across which evaporation could take place." (Pfannkuch, 1976).

Shoreline slope modification, island/moat construction and removal of organic debris would not affect the hydrologic cycle of the Basin.

TOPOGRAPHY

5 Yrs.	15 Yrs.	25 Yrs.
■	1	1

Of the proposed physical modification techniques, only island/moat construction would noticeably affect current topographic features. The impact would be positive from an aesthetic appreciation in the conversion of pothole terrain to acres of open water.

WATER QUALITY

5 Yrs.	15 Yrs.	25 Yrs.
Surface		
■	■	■
ground		
1	1	1

None of the proposed techniques will affect surficial or groundwater quality. While limestone treatments would improve soil permeability, it is not expected that more than a fraction of infiltrated surface water will reach the groundwater table in upland areas (see hydrologic cycle above).

Most groundwater in the Twin Cities Basin is in constant contact with varying degrees of limestone and dolomites. The eastern part of the region (corresponding to the St. Croix Moraine) is a sole exception. The amount of limestone applied per breeding site would be negligible in comparison to natural conditions, except in this eastern area.

Calcium solubility of water infiltrated through limestone in a treated site would approximate that of rainwater or runoff normally infiltrated through dolomite or limestone layers underlying most Metropolitan topography. (Pfannkuch, 1976)

WETLAND MODIFICATION

	5 Yrs.	15 Yrs.	25 Yrs.
I	■	■	■
II	■	■	■
III	■	■	■

Physical changes in area wetlands would occur under this alternative to a substantial degree. Ditching and drainage operations would have the greatest effect on the size and occurrence of wetlands. Moat construction would alter rather than eliminate current wetland areas, by preventing seasonally dry periods in some 5000 marshes.

NOISE

5 Yrs.	15 Yrs.	25 Yrs
3	3	3

Equipment noise generated in the process of altering breeding sites would be of significant, short duration. The noise would be comparable to tractor noise in rural areas and will displace wildlife for a short time. (Huff, 1976b).

INSECTICIDE RESIDUE

Does not apply.

RESISTANCE

Does not apply.

COST/BENEFITS

Per capita public costs of a 25 year physical control program are expected to reflect the cost of current mosquito control within the District.

Private expenditures for personal mosquito abatement would increase over 1976 levels by 67 cents per capita per year due to ineffective mosquito reduction at program inception.

By the fifth year of program operation, 11% of the acreage within the current M.M.C.D. boundaries would be under control. This figure would increase to 33% in year 15 and 60% in year 25.

Mosquito reduction at a radius ten miles from the center of the District would be 0% (5th year), 20% (15th year) and 60% (25th year).

It should be noted that 60% control in 25 years would not necessarily mean controlled areas coincide with population centers.

ENERGY USE

5 Yrs.	15 Yrs.	25 Yrs.
1	1	1

Levels of energy consumption during all phases of a physical control program are expected to be 50% greater than 1976 use rates. While the number of vehicles in use would decrease the nature of vehicles in use (heavy equipment) for construction would more than offset the savings.

Assuming that these operations were to take place in a 12 week summer and fall season, during normally dry periods, and that 30 machines equivalent to a D-6 caterpiller were used for a 50 hour week, energy consumption would approximate 135,000 gallons per season.

Limestoning is a relatively energy-cheap method of site treatment. Assuming a five year treatment period, gasoline consumption should be at a maximum of 8,000 gallons per year.

Total energy use would be roughly 148,000 gallons per year or .01% of the average annual metropolitan consumption.

PROGRAM ALTERNATIVE: CONTROLLED RELEASE INSECTICIDE CAPSULES

INTRODUCTORY COMMENT

A controlled release chemical mosquito control program is currently being investigated by the MMCD as an alternative to larviciding operations in Type I (intermittent water) breeding sites.

Controlled release DURSBAN 10/CR insecticide was approved in 1976 by the EPA for use in mosquito control. Controlled release, as used here refers to that product. The MMCD itself, in cooperation with scientists at Washington University, St. Louis, Missouri is in the latter stages of developing a bio-degradable controlled release product which if approved, would substitute for DURSBAN 10CR by 1982. This product is currently being tested by the District under an EPA-approved experimental use permit.

In any form, controlled-release materials need only be applied once during a mosquito season and thereby allow for control of more breeding sites. In their performance, controlled release formulations restore the effectiveness of DDT without its widely recognized environmental side effects. Environmental impacts of this alternative are discussed below.

MOSQUITO ANNOYANCE

5 Yrs.	15 Yrs.	25 Yrs.
6	7	7

Assuming that a controlled-release program could be fully funded, mosquito annoyance would be reduced to insignificant levels during the first year of operation. The controlled-release formulation is effective in the control of any mosquito species bred in the Twin Cities area.

In the initial years of this program, it is estimated that a mosquito bite count of .5 per 5 minutes will be achieved in the present core area of the District. In later years this count per 5 minutes will be achieved at a distance of 10 miles from the outer boundaries of the District as a result of extended control effectiveness.

PUBLIC HEALTH

5 Yrs	15 Yrs	25 Yrs.
5	5	5

As mosquito annoyance is reduced, public health risks caused by mosquitos are proportionately reduced. A modified program would be capable of preventing arbovirus epidemics which can potentially occur during years of high rainfall. The pellets would be of no value in the control of adult mosquitos in an emergency.

In the event of an emergency, however, MMCD equipment would be free to initiate immediate relief.

ANIMAL HEALTH

5 Yrs	15 Yrs	25 Yrs
5	6	6

The extensive mosquito control provided through the use of a controlled release formulation would reduce disease carrying mosquitos to a point at which encephalitis in animals would become uncommon and heartworm of dogs limited to rural foci. In initial years, it is expected that the number of reported cases of these diseases

in domestic animals would be confined to outlying areas and their incidence would be 75% below current norms.

NON-TARGET ORGANISMS

	5 Yrs	15 Yrs	25 Yrs.
GENERALLY	■	■	■
AQUATIC INSECTS	2	2	2
CRUSTACEA	4	4	4
WATERFOWL	2	2	2

The effects of the use of a controlled-release formulation would be insignificant to flora, terrestrial insects, pollinating insects, birds, terrestrial mammals, amphibians and humans.

Notable negative effects would occur among aquatic communities (viz. insects, crustaceans and waterfowl, the latter via food reduction).

The C-R formulation is basically chlorpyrifos which, as discussed under impacts of the current MMCD program, kills crustacea. Presence of the chemical in a MMCD Type I site for an entire season would mean that these organisms would be exposed during the typically short wet periods and their populations suppressed. Although exposure to C-R chemicals during flooded periods is constant, the strength of the chemical released is less forceful at any one time than in other formulations (liquid or granules). Thus, it is not expected that crustaceans will be permanently eliminated from a treated site. A 50% reduction in populations per median square mile is projected, however with possible elimination from some areas.

A C-R formulation would have similar impacts on insect populations customarily found in MMCD I sites. The net effects would be less deleterious, however as aquatic insects, unlike crustaceans are mobile. The impact on insects is expected to be a 15% - 20% reduction in populations in a median square mile, without elimination of any species.

It is projected that a C-R formula would effect more than 5% but less than 20% of the waterfowl in a median square mile surrounding a treated MMCD Type I site. This impact would be similar in MMCD.

Type III sites (authorized by the EPA for treatment with DURSBAN 10 C-R)· Land treated along the fluctuating water margin maybe affected with a resulting suppression of waterfowl food sources.

Studies conducted by Nelson and Evans (1975) using DURSBAN 10-CR at rates of 250, 500, 1000 and 2000 ppb showed adverse effects on Daphnia, no adverse effects to benthic organisms and no adverse effects to wildlife. Mosquito larvae was effectively controlled at rates of 1000 and 2000 ppb.

PHYSICAL ENVIRONMENT

5 Yrs	15 Yrs	25 Yrs.
■	■	■

A controlled-release insecticide program alternative would negatively affect surface water quality in the event that the materials were used in relatively permanent water sites. The effects would be limited to the presence of the material in surface water for short durations. In the view of the MMCD, it is preferable to use this material in Type I, intermittent water sites where surface water does not drain into the regional water system.

In studies with DURSBAN 10-CR conducted by Nelson and Evans (1975) statistical analysis showed no variance in alkalinity or total hardness at various treatment levels. Differences noted in dissolved oxygen were attributed to the rice culture environment in which tests were conducted. Significant differences in hydrogen-ion concentration, turbidity, BOD and water temperatures were not observed in relation to chemical applications.

Use of the currently registered C-R formulation would involve a solid waste residue in the form of polyethylene plastic pellets in which the material is encased. This material is inert and not bio-degradable.

Pending registration of a bio-degradable silicate capsule, there is not an alternative currently available to this polyethylene pellet.

Noise generated by current mosquito control operations would be greatly reduced under a C-R insecticide alternative. This method of control would eliminate the

need for aerial ULV and granular spraying and greatly reduce the need for ground cold fogging treatments. A one-time application would eliminate 3 to 6 trips to each treated site currently made for larval control.

WETLANDS

5 Yrs. 15 Yrs. 25 Yrs

■ ■ ■

A controlled-release insecticide program would not affect the size, amount or duration of Twin Cities wetlands.

INSECTICIDE RESIDUE

5 Yrs. 15 Yrs. 25 Yrs.

BIO-MAGNIFICATION

1 1 1

DEGRADATION PRODUCTS

■ ■ ■

SYNERGISM

■ ■ ■

RE-SYNTHESIS

■ ■ ■

SOIL RESIDUE

1 1 1

The properties of chlorpyrifos in a timed-release form are identical to those of this material in a liquid or granular form. This organophosphate is decomposed through a process of hydrolysis and temperature. Once applied, a trace amount of the insecticide sufficient to control mosquitos is released for at least 60 days when the pellets is immersed in water.

A more complete discussion of the residual impacts of this material is presented earlier in this chapter (Environmental Impacts of the Current Program).

RESISTANCE

5 Yrs 15 Yrs 25 Yrs

■ 1 3

Mosquito resistance is dependent upon many biological and physical factors as well as the history and frequency of insecticide application in an area.

Mosquito resistance is not known in the MMCD today.

Resistance development may be a significant impact of a timed-release capsule program, however. Application of a C-R capsule once at each site would replace a current program of multiple applications per season with temephos and chlorpyrifos.

A continuing release of insecticide would pressure more populations as more sites would be treated with currently available manpower.

If resistance developed, it would be expected to develop first at the center of the District in both Aedes vexans and species with shorter flight ranges (especially Culex tarsalis) as their gene pools would not be diluted by non-pressured populations flying into the controlled zone from outlying areas of the Twin Cities region.

It is not expected that chlorpyrifos will be a major insecticide in mosquito control for the time required to establish resistance. Should temephos be registered for use in a C-R formula, it would be favored to chlorpyrifos.

NON-TARGET ARTHROPOD RESISTANCE

5 Yrs.	15 Yrs.	25 Yrs.
■	■	1

Resistance to a controlled release capsule formulation may develop among non-target aquatic organisms as well, though at a much slower rate. Although a C-R release process would pressure non-target organisms on a continual basis for the life of the formula, the insecticide concentration would be less than that of a single application of liquid or granular formulations.

Crustacean populations as discussed above would be most affected in Type I breeding sites (the principal non-mosquito population inhabiting these areas). A variety of aquatic organisms would be affected in Type III sites, many of which are natural enemy complexes of mosquito larvae and adults. Cutkomp (1977) notes that non-targets with the exception of Cladocerans, are less susceptible than A. vexans to insecticides.

COST/BENEFITS

The current MMCD program is publicly financed at a rate of 80 cents per capita. This money finances chemical control of 900 square miles of the District (34% of the area) with maximum control of 87% at the center of St. Paul. Control is about 60% at a distance of 10 miles from this site. (Roseville). In 1976, area households spent an average of $3.14 to supplement public control.

A controlled release program, if used exclusively and indiscriminately in all breeding sites would provide

95% control at a 10 mile radius from the center of the District. Roughly 95% of the acreage within the District would be controlled.

The costs of this program are dictated by manufacturing costs of producing the C-R formulation. The currently approved polyethylene pellet is costly as well as non-bio-degradable.

Used at the rate required to provide effective control, material costs would average $3.20 per capita during the first five years.

The bio-degradable silicate capsule (yet to be approved) is cheaper by comparison by roughly 33%. Public costs of this program would average $1.80 (1976 dollars).

Private costs of supplemental control (sprays, repellents, etc.) would not be expected to be necessary in the District under this program alternative.

ENERGY USE

5 Yrs	15 Yrs.	25 Yrs
2	1	1

Energy consumed in this program would vary with the composition of the capsule. A polyethylene material is far more energy-intensive than a silicate. Should this alternative be adopted before registration of a silicate product, energy consumption would be an associated factor during the first five years.

Energy consumed in manufacturing the quantity of polyethylene pellet carriers required by this program is estimated to be equivalent to at least 350,000 gallons of gasoline annually. The current feed stock for this process is natural gas.

Use of a C-R option would reduce energy otherwise consumed in current MMCD operations. Helicopters would be used more intensively in lieu of ground equipment. A single application would suffice per season at each treated site. Reconnaissance work would be sharply curtailed. Expected energy consumption in field operations would be as follows:

1. helicopter related - 25,000 gallons of gasoline

2. ground applications - 10,000 gallons

3. administrative - 2,000 gallons

Total 37,000 gallons

PROGRAM ALTERNATIVE: OPTIMUM, UNRESTRICTED 25 YEAR PROGRAM OF MOSQUITO CONTROL

INTRODUCTORY COMMENT

The program alternative referred to in this text as Optimum Control can generally be considered as a technically feasible, blue-sky mosquito control project for the Twin Cities area. The program combines stages of chemical, physical and biological techniques discussed elsewhere in this report with a projected goal of 95% effective mosquito control within twenty-five years of program inception. The blue-sky element of this program alternative is cost, which would be significantly greater than in others discussed, and carte blanche approval by state agencies particularly PCA and DNR.

The environmental impacts of this alternative are similar to those of a Physical Control Program. A detailed assessment of the program affect on the natural, physical and human environment of the Twin Cities follows.

MOSQUITO ANNOYANCE		
5 Yrs.	15 Yrs.	25 Yrs.
6	7	7

A mosquito control program of this nature is designed to proceed in three overlapping phases. The level of mosquito annoyance experienced by area residents would be reduced incrementally as each phase matures.

During the first five years, the chemically controlled boundary of the District would be extended ten miles beyond its current limit. Controlled release formulations would be the dominant form of chemical control. If a C-R formulation were used to control Type III sites, larval control of the most annoying pest species, Coquillettidia perturbans would be effected for the first time.

At the same time, limestone treatments would be applied to all appropriate breeding sites. The only possible exceptions are sites where groundwater tables lie very near the surface.

The combined effectiveness of these activities should reduce mosquito annoyance to an insignificant level (90% control) at the center of the District by the end of Phase One.

In outlying areas, annoyance would be considerably reduced and would resemble the current situation the suburbs of the District (estimated 65% control).

Further annoyance reduction would occur at the end of the fifteenth year of program operation. This reduction would result from physical site modification and ensuing dependence upon biological mosquito control.

By the year 2000, chemical control would be the least important element of larval control. Type I sites treated with limestone would require re-treatment but would no longer produce mosquitos. Type III sites would roughly be 85% controlled by natural predator complexes. Type II sites would continue to produce spring Aedes and require an annual chemical control treatment. Throughout the populated areas of the District mosquito annoyance would be insignificant.

PUBLIC HEALTH

5 Yrs.	15 Yrs.	25 Yrs.
5	5	5

Control of disease vectors under an optimum program alternative would be highly successful ten years after program inception and near perfect by the year 2000.

Response to emergencies would increase in effectiveness without jeopardizing normal seasonal responsibilities. Insecticide or other project-related fatality would be acciental.

ANIMAL HEALTH

5 Yrs.	15 Yrs.	25 Yrs.
5	6	6

Improved control of mosquito vectors in all parts of the District would reduce associated diseases in domestic animals to manageable levels.

Cases of reported disease would be reduced throughout the District to a level equivalent to 75% less than is currently expected in outlying areas. By the time the program is fully developed, disease will occur only rarely anywhere in the District.

NON-TARGET ORGANISMS

AQUATIC INSECTS

5 Yrs.	15 Yrs.	25 Yrs.
2	1	■

During initial years, aquatic insects would continue to be temporarily suppressed by chemical insecticides as discussed under impacts of the current control program. Suppression of some aquatic organisms is a particularly noticeable side-affect of a controlled-release capsule formulation. Since this material once applied remains active, when sites are wet, for the duration of the season, these non-target organisms will be under constant pressure. The affect will be most severe in Type III sites and reduce natural control effectiveness.

As sites are identified as capable of supporting natural enemy complexes, controlled release will be suspended as a control agent. At the same time, the physical control elements of the program will proceed to convert Type III sites to permanent water sites. This expansion of the bio-mass will encourage development of other organisms higher in the food chain.

TERRESTRIAL INSECTS

5 Yrs.	15 Yrs.	25 Yrs.
■	■	■

The absence of aerial spraying in the optimum program will eliminate any incidental suppression of terrestrial insects associated with the current program. Slight suppression of insects smaller than mosquitos will continue as a result of cold fogging. A slow-release formulation, however would not affect non-target organisms in this category. Field tests demonstrate that non-target organisms are more adversely affected by emulsified concentrations than by controlled-release or granule formulations (Mulla, 1976; Hayes, 1975).

POLLINATING INSECTS

5 Yrs.	15 Yrs.	25 Yrs.
■	■	■

The impact on bees and other beneficial pollinating insects would be the same as under the current MMCD chemical control program during the first 5 years of the optimum control alternative (maximum 2% kill ratio in areas treated).

As controlled-release formulations are introduced and adulticiding operations (cold-fogging) curtailed, the insects' encounter with insecticides would be greatly reduced. Biological and physical control methods would have no affect on bees or other beneficials. These insects would continue to be threatened, however, by other non-mosquito control related pesticides used by homeowners and agriculturalists.

AQUATIC AND TERRESTRIAL FLORA

5 Yrs.	15 Yrs.	25 Yrs.
Aquatic		
3	3	3
Terrestrial		
■	1	1

The greatest impact of an optimum control program alternative on aquatic and terrestrial flora will be that associated with limestone treatments in Type I breeding sites.

The restoration of soil permeability in these sites will shorten the aquatic life span of these sites and encourage the encroachment of terrestrial flora from the surrounding habitat upon the center of the depression.

Construction and excavation associated with physical control alternatives would be associated with the destruction of individual plants. Protected species are likely to be encountered (Huff, 1976).

BIRDS AND WATERFOWL

5 Yrs.	15 Yrs.	25 Yrs.
range for the period		
(1-2)		

The effects of this program on birds and waterfowl have been discussed above as impacts to physical control and controlled release capsule alternatives to the current program.

FISH

5 Yrs. 15 Yrs. 25 Yrs.

■ ■ ■

ULV or granular formulations of Malathion and chlorpyrifos insecticides used by the MMCD are not registered for use in streams or ponds or any area which drains into permanent or flowing bodies of water.

Chlorpyrifos, considered to be the more toxic of the two if used improperly, has been registered for use along the shores of these areas in a controlled-release formulation.

Although it has been noted that chlorpyrifos accumulates in fish (Haque, 1976), it is also known that fish metabolize these residues to readily excretable metabolites (Kenaga, 1976).

Marganian and Wall (1972) report that chlorpyrifos applied to intertidal plots in granular form at the rate of 0.05 lb/acre had no noticeable harmful effect on fiddler crabs or other organisms. They found the material persisted in various soils as follows:

Substrate	Number of Days	
	Aug.	Max.
Intertitdal sand	2	4
Salt marsh sod	5	12
Salt marsh mud	15	22
Sea water	-	0

According to Schmidt (1973), "fish absorb chlorpyrifos slowly, but metabolites, it rapidly. The metabalites then enter the water and are absorbed by plants and further metabolized...with the exception of the diethyl (3,5,6-trichloropyridyl -2) phosphate, none of the excreted products is a significant ChE inhibitor. Since, however, virtually no cholinestrase inhibition could be determined in fish, this compound can be excluded as a metabolite."

It should be restated that controlled-release chlorpyrifos releases at a rate well below the toxicity threshold of fish (Kenaga, 1976). This material degrades at a rate close to that of release. A C-R formulation would not be used in open bodies of permanent water. The formulation may be used along shorelines to control Coquillettida perturbans.

Later uses of a C-R formulation, physical and biological control would not adversely affect fish. Some proposed site modification would not adversely effect fish. Some proposed site modification would benefit fish by increasing habitat and food supply.

CRUSTACEANS

5 Yrs.	15 Yrs.	25 Yrs.
4	2	1

During the initial chemical control phase of this program alternative, crustaceans will be eliminated upon contact from Type I sites and severely, through temporarily suppressed in other sites where bio-mass is greater but other more diverse forms of life are present, thus reducing contact potential.

In any site, crustaceans recover rapidly from pressures of insecticides as their life cycles are short and their reproductive capacity great.

During the post-chemical control phases of the program, crustaceans will not be affected. Populations will develop to the capacity of their habitat. Water fluctuations in Type I sites, despite limestone treatments, will temporarily suppress their development.

AQUATIC MAMMALS

5 Yrs.	15 Yrs.	25 Yrs.
■	■	■

The impacts of an Optimum Control program upon aquatic mammals would be identical to those incurred under the program alternative: Physical Control. Please refer to the discussion earlier in this chapter.

TERRESTRIAL MAMMALS

5 Yrs.	15 Yrs.	25 Yrs
■	■	■

Please refer to earlier discussions of a Physical Control Alternatives for a discussion of these impacts.

REPTILES AND AMPHIBIANS

5 Yrs.	15 Yrs.	25 Yrs.
■	■	■

Amphibian populations would generally benefit from physical changes in Type III breeding sites which will provide for year-round permanent bodies of water in

areas which currently dry out in the fall. Primary benefits would include more stable food supplies and increased opportunity for over-wintering in mud bottoms. Island moat construction would benefit reptiles, but cause slight decrease in amphibian number (Huff, 1976).

A balancing negative impact of slope modification would be a reduction in shallow water habaitat necessary to reptile reproduction and a consequent reduction in habitat carrying capacity.

According to Huff (1976) amphibians and reptiles will be among those species most apt to be killed during physical site construction. Negative impacts to reptiles caused by runoff diversion and pond consolidation may be reduced through species changes (Huff, 1976).

HUMANS

5 Yrs.	15 Yrs	25 Yrs.
■	■	■

Compounds used by the MMCD currently are considered safe for workers and for the general population whose exposure is far less than that of applicators (Hayes, 1976). A one-time application of a C-R capsule formulation would reduce the amount of exposure applicators would have to liquid solvents which are often the cause of allergic response in hypersensitive persons. Use of a C-R formulation for a short time during the life of the proposed program alternative would eliminate the need for chemical spraying in residential areas.

As the program progressed, chemicals would be eliminated entirely as adulticides. Contact with chemical materials would be insignificant.

PHYSICAL ENVIRONMENT

HYDROLOGIC CYCLE

5 Yrs	15 Yrs	25 Yrs
1	1	1

TOPOGRAPHY

5 Yrs	15 Yrs	25 Yrs
■	1	1

Please refer to discussion of these impacts earlier in in this chapter (Environmental Impacts of a Physical Control Alternative). Generally, impacts would be limited to the reduction of water retention in Type I sites as a result of limestone treatments. Topographic changes would exchange one asthetically acceptable land form for another equally acceptable land form.

SURFACE WATER QUALITY

5 Yrs. 15 Yrs 25 Yrs
■ ■ ■

While C-R formulations are in use (approximately 20 years in Type III sites) insecticides will continue to be a parameter, (though not toxic to non-target organisms other than some crustaceans and insect larvae) of surface water quality.

Upon activation of biological control, dependence on C-R capsule and adulticides will be phased out.

GROUNDWATER QUALITY

5 Yrs. 15 Yrs. 25 Yrs.
■ ■ ■

Groundwater quality is not expected to be negatively affected either by use of C-R formulations or non-chemical treatments of breeding sites. Rationale for this conclusion has been expressed in a discussion of the impacts of other proposed program alternatives presented earlier in this chapter.

SOLID WASTE

5 Yrs. 15 Yrs. 25 Yrs.
■ ■ ■

The controlled-release insecticide formulation currently registered by the EPA is encapsulated in polyethylene plastic. Inthe anticipation that a bio-degradable silicate substitute will be available by 1982, the MMCD proposes to delay the introduction of a C-R formulation into its optimum program alternative until the fifth year of program development.

Under the proposed alternate program using a silicate capsule there would be no solid waste consideration due to the use of sand.

AIR QUALITY

5 Yrs. 15 Yrs. 25 Yrs.
■ ■ ■

During the first five years, ground adulticiding will be maintained at current levels using resmethrin cold fog.

Related impacts are limited to the presence of occasional standing fogs of insecticide and vehicle emissions which contribute to reduce visibility (by about 5%) in localized areas on occasions.

Adulticiding should become less necessary as other elements of larval control improve, thus reducing the negative effects of this impact to insignificant levels.

NOISE

5 Yrs.	15 Yrs.	25 Yrs.
3	3	3

Noise generation currently associated with aerial ULV and granular spraying would be eliminated in this program alternative. Noise associated with ground spraying during early morning and evening hours would taper off as the program developed and the need for adulticiding using this method was phased out. Adulticiding by this method would be reserved for use in emergency situations.

Temporary, localized noise during the balance of the program would result from using heavy equipment in the physical construction and maintenance of breeding sites.

WETLANDS

5 Yrs.	15 Yrs.	25 Yrs.
■	■	■

Please refer to impacts of a physical control alternative in this chapter for a discussion of the effects of an optimum control program on Twin Cities wetlands.

INSECTICIDE RESIDUE

BIO-ACCUMULATION
DEGRADATION PRODUCTS
SYNERGISM
RE-SYNTHESIS

5 Yrs.	15 Yrs.	25 Yrs.
■	■	■

BIO-MAGNIFICATION

1	1	1

SOIL RESIDUE

1	1	1

As noted elsewhere in this text (viz. in the discussion of environmental impacts of the current program), organophosphates used in mosquito control do not persist as toxic, biologically active degradation products. Nor do these materials synergize with other pesticides or pollutants.

Materials proposed for temporary use during an optimum program alternative are principally chlorpyrifos (chlorpyrifos C-R formulation) and resmethrin (ground cold-fog adulticide). Resmethrin leaves very little residue (Provost, 1976; S. P. Penick & Co. 1975; see Pg. 124).

Chlorpyrifos does remain held on soil and organic plant matter (roughly 80% of an application initially, declining over a several week period) (Smith et al., 1966). In a C-R formulation, no accumulation would occur due to its degradation at a rate close to that of release. If adsorbed by organic matter, the material does not move. Decompostion is a function of hydrolysis and temperature, not bacteria.

RESISTANCE

5 Yrs. ■ 15 Yrs. ■ 25 Yrs. ■

To date, mosquitos and non-target organisms have not developed a resistance to any materials which have been used for mosquito control in the Twin Cities area. A limited larval control zone and continuous dilution of the Aedes vexans gene pool by dispersing adults from untreated breeding sites have contributed to this phenomenon (Georghiou, 1977; Cutkomp, 1977).

Under an optimum control program, the larval control zone would initially be extended ten miles beyond current limits. Formerly untreated sites would be controlled, thereby increasing the mosquito population pressured by insecticides.

A C-R chemical formulation of long, active duration would replace the current three to six one-shot treatments in A. vexans breeding sites. Thus, more Larvae would be subject to control pressures for longer periods of time.

As a result, it is expected that resistance may develop rapidly among controlled mosquito species-- minimally every five years--beginning in the core area and moving out. Should this occur, a change of toxicant within the C-R formulation would be required at each interval to counteract this response.

If resistance developed it could first develop locally among mosquito species having short flight ranges particularly the disease vector Culex tarsalis.

Introduction of a C-R formulation, suspension of adulticiding and activation of limestone treated sites after 15 years would increase controlled acreage to 94% of the MMCD. Mosquito control would achieve a level of 68% at a 10 mile radius from the core area.

An abatement program dependent solely on physical and biological control (25 years) would cost $1.30 per capita to maintain. One hundred percent of the MMCD area would be controlled and mosquito control 10 miles from downtown St. Paul would be 95% effective during the entire mosquito season.

It is not expected that private households will need to expend any personal funds during the program to supplement public mosquito control at home or in recreation areas.

ENERGY USE

5 Yrs.	15 Yrs.	25 Yrs.
2	1	1

As the program moves away from a dependence on chemical control, fuel consumption will drop. During initial phases of the program, construction activities of site modification will increase energy use significantly over the current program, principally in fuel consumption by heavy equipment.

During the first five years, it is expected that 209,000 gallons of motor vehicle fuels would be expended in the program. This assumes:

1. The current chemical program will continue (65,000 gallons);

2. 4,000 Type I sites would be limestoned each season (8,000 gallons);

3. 30 machines equivalent to a D-6 caterpillar would be used full-time during a 10 week construction season (135,000 gallons);

4. biological control would be limited to research (1,000 gallons).

By the end of the fifteenth year, current energy use in the present MMCD chemical program would be sharply reduced (by 25,000 gallons) upon adoption of a C-R formula; biological control and limestoning. Total energy use fifteen years into the program would approximate 174,000 gallons:

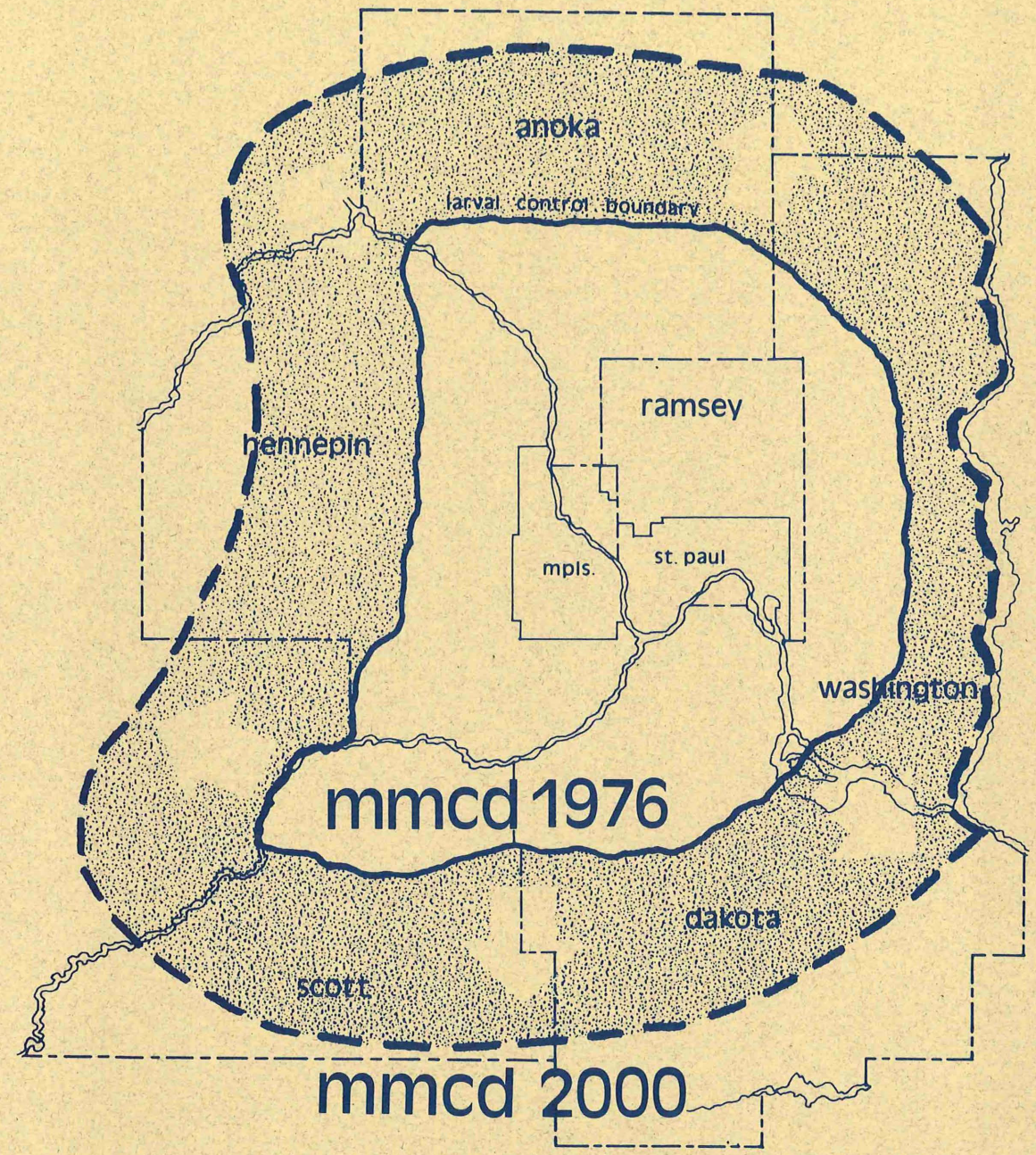
1. Chemical control 25,000 gallons
2. Physical control 135,000 gallons
3. Biological control 14,000 gallons

At program maturity (25 years) total energy use is projected to equial 49,500 gallons assuming:

1. C-R chemical control (22,000 gallons);

2. Physical maintenance using 3 heavy machines during a 10-week summer period (13,500 gallons);

3. Operational biological control (14,000 gallons).



mitigation and amelioration

IMPACT AMELIORATION

INTRODUCTORY COMMENT

The negative environmental impacts expected to result from continuation of the current mosquito control program or implementation of the five alternatives discussed in the previous chapter are relatively similar and relatively minor. Generally these negative impacts are conducive to mitigation, although implementation of these measures would either increase costs or reduce effective mosquito control.

Negative environmental impacts, (minor and significant), of each program alternative and corrective measures are as follows:

CURRENT M.M.C.D. CHEMICAL CONTROL PROGRAM

SUPPRESSION OF AQUATIC INSECTS AND CRUSTACEANS

Ninety-five percent of aquatic organisms affected by chemical insecticides used by the MMCD are found in Type III breeding sites associated with open water. Temephos is used to treat these sites at a dosage rate of 0.025 lbs. AI/acre.

At this rate, temephos kills roughly 20% of the immature aquatic insects it contacts. Adult stages are not affected. Reproductive capacity is rapid and impacted insect populations reestablish within five days of contact with the insecticide.

The most effective corrective measure to avoid this impact is suspension of chemical treatment in Type III breeding sites. There are approximately 25,000 acres of these breeding sites located within the six-county metropolitan area of the District. If not treated, the mosquito populations bred in these sites would increase by 20%.

Crustaceans are near the bottom of the food chain and are the single most populous aquatic life form in Type I and Type III mosquito breeding sites. Insecticide contact depresses crustacean populations in Type I and Type III sites. In both instances the depression is temporary. Crustacea would be expected to be present in 58% of Type I sites after treatment with chlorpyrifos (see p.e.i.-46). In contrast, 88% of untreated sites may be expected to be normally populated with crustaceans. Application of limestone to Type I sites where feasible would encourage development of crustaceans when the site was wet. Crustaceans do not survive the intermittent dry spells in pothole depressions, but their eggs are drought resistant and their gestation period is short.

Site modification to adaptable Type III sites would create permanent water sites in areas which normally dry in the fall. Drainage and island/moat construction would increase habitat and expand habitat carrying capacity for these and other aquatic organisms.

Insecticide would not be necessary to control mosquito larvae. Mosquito annoyance would be severe for several years while limestone treatments took effect and enemy complexes developed.

As a result of this program evaluation, the District reviewed its site identification program in 1977 and subcategorized 10% of Type I breeding sites as Type IA. These sites normally hold water until approximately July 1. Type IA sites are now treated with temephos until July 1 and with chlorpyrifos for the remainder of the season. This date coincides with the normal close of the duck breeding season.

AIR QUALITY	Vehicle exhaust fumes, occasional standing ULV fogs and drift are minor negative effects of the current program.

These temporary, localized impacts could be avoided by reducing the need for aerial and ground larval and adult mosquito control through implementation

of physical control or use of a controlled release formulation which need only be applied once per season. These measures would increase short-term operation costs by approximately 100%.

In terms of the District program, ULV larval spraying is cost effective even though its use is restricted to rural areas during spring months. Elimination of ULV operations is possible. Added treatment costs in years of high rainfall would increase three-fold with the substitution of granules for liquid formulas.

NOISE

Although equipment used in current MMCD operations (helicopters, back-pack and cold-foggers) do not exceed state or federal noise standards, noise generation is a significant annoyance. Early morning and late evening applications effect high levels of mosquito control but intrude upon the relative quiet of rural and residential areas.

Sixty percent of helicopter noise is caused by the rotor; 40% is engine noise. Noise can be reduced through FAA approved muffler system at a cost of $1,800.00. Differentials in dBA levels for muffled and non-muffled Bell 47 helicopters are as follows:

Reading	dBA Muffler	dBA no Muffler
Lift off from 50' to side	97	101
Lift off from 100' to side	92	97
180' turn straight on at 50' altitude directly overhead from 60 mph to turn speed then flying directly away	92	99
Overhead pass at 50' at speed of 60 mph	91	101
Pass 100' to side at 50' altitude at 60 mph	89	92

Prepared by: Sergeant Samuel Boe, Minnesota State Patrol

Muffling the engine exhaust system results in a considerable loss of horsepower and would necessitate more spraying trips to accommodate the need to reduce insecticide payloads by 15%.

Noise created by back-packs and cold-foggers approximates that of a riding lawn mower and cannot be mitigated.

ENERGY CONSUMPTION

Successful energy conservation is a function of efficient equipment efficiently used. The most energy efficient MMCD insecticide applicator is the helicopter which can provide treatment of more acres per gallon of gasoline than conventional ground equipment. Using a helicopter, one can treat 200 acres per hour using 25 gallons of fuel (8 acres per gallon). Using ground equipment 24,000 gallons of fuel are needed to treat 22,450 acres (1 acre per gallon).

Perhaps the chief energy use savings could occur as a result of changes in vehicle choice. In the past, the MMCD found that six cylinder engines lacked the power necessary to adequately handle low range work loads. Also, vehicles with standard transmissions were difficult to rent for a season. At the same time, lack of familiarity of seasonal personnel with standard transmissions resulted in repairs which proved costly in terms of operational effectiveness and repair bills.

Recently, some one-half ton pickup manufacturers have developed larger six-cylinder engines with standard transmissions which have low-range power equivalent to larger V-8 engines with automatic transmissions.

Based on EPA ratings, the V-8 engines use about 35% more gasoline than the six-cylinder engine. Assuming that these savings could apply to 75% of vehicle miles, approximately 25% of total ground vehicle energy use, or about 15,000 gallons per year, could be saved.

This option would require personnel competently trained in the operation of standard transmissions. It is anticipated that either

a) Seasonal personnel could be required to have this competence before being hired or,

b) Seasonal personnel could be trained as part of their overall training program.

Aside from fuel used in larviciding, the MMCD consumes 15,000 gallons of gasoline in site surveillance operations and 12,000 gallons in cold fog adulticiding.

As long as these operations are important elements of the MMCD program, these energy uses cannot be foregone. Introduction of a controlled-release insecticide would cut fuel use considerably. A two-year C-R formulation applied to Type II sites would reduce energy use by 4,000 gallons per year.

In the long-run, energy conservation could best be effected through physical site modification of Type I and III breeding areas. Physical control would reduce the number of trips required to effectively treat sites chemically.

Limestone treatments to 14,000 applicable breeding sites would reduce current levels of gasoline consumption by 15,000 gallons annually.

Another mitigating option would be administrative. Improved use of the MMCD record keeping system along with improved satellite imagery data could effectively reduce reconnaissance missions If readings could be made available within twenty-four hours after major rainfalls, it is suggested that the mitigative measures would benefit both current operations as well as proposed program alternatives.

PROGRAM ALTERNATIVE: NO CONTROL

MOSQUITO ANNOYANCE AND PUBLIC HEALTH — The greatest negative impact of a no-control alternative is severe increases in mosquito annoyance and consequent health hazards.

Mitigation of these impacts would involve periodic chemical control. In the absence of a larval control program, adulticiding with resmethrum or pyrethrum which are harmless (i.e. non-toxic) to organisms larger than mosquitos, is considered the preferred alternative. Mosquito control would be equivalent if not better than current control.

Multi-engine aircraft (Twin Beechcraft, DC-3 or equivalent) flying at elevations of 150 to 300 feet, would be used to apply 1 to 3 fluid ounces of material per acre in 1,000 foot swaths. Five to fifteen applications would be required per year (May through September) depending on rainfall patterns. Precipitation of 1½ inches or more throughout the District occurs 3-5 times per season, on each occasion applications would be made over approximately 900 square miles. Localized rainfall would require aerial treatment over those portions of the District receiving enough precipitation to produce a substantial brood of adult mosquitos.

The cost of such a program would be:

Labor, administration	$200,000
Material and application cost (assuming treatment of 6,300 square miles per season)	$2,216,000
	$2,416,000

The costs quoted above are 57% greater than the current MMCD budget. Labor and administration costs are lower as a program of this type would require no more than 10 qualified staff persons.

In the absence of any mosquito control program, emergency disease control would necessitate the participation of staff from the Federal Communicable Disease Center in Atlanta, Georgia and commerical aerial spray contractors (to supervise and conduct the aerial adulticiding as described above).

Increased mosquito annoyance implies a loss of leisure time spent outdoors, increased costs for

household mosquito control (45 cents per capita) and improper use of pesticides by individual landowners which may be hazardous to beneficial insects (especially bees) and other flora and fauna.

PROGRAM ALTERNATIVE: BIOLOGICAL CONTROL

MOSQUITO ANNOYANCE
POLLINATING INSECTS
LEISURE TIME
PERSONAL CONTROL

The effects of a biological control program on these aspects of the local environment would approximate the negative impacts of a no-control alternative discussed above.

PROGRAM ALTERNATIVE: PHYSICAL CONTROL

MOSQUITO ANNOYANCE

Mosquito annoyance would be a significant unavoidable impact of a physical control program. This impact could be mitigated with occasional District-wide adulticiding measures using resmethrin.

POLLINATING INSECTS

An indirect impact of this alternative would be unintentional killing of beneficials by homeowners. Beneficials are most active during daylight hours. Bees often forage as far as five miles from the hive for food. Domestic pesticides are usually applied during the day and in overly high dosage rates (Atkins, 1976).

WATERFOWL

Slope modification of shallow marshes and island/moat contruction are proposed in a physical control alternative. Limestone application to Type I sites is another major program element.

Radical slope modification may reduce nesting duck habitat and feeding areas of hens and ducklings.

This impact can be avoided, subject to site-by-site verification, by moderate slope modification.

If ducks nest near Type I sites as a matter of course or during periods of over population, limestone treatments could reduce food supplies. A firm determination of the effects of limestone treatments on ducks requires specific study.

WETLANDS — Physical site modification could be considered a negative impact if water retention in upland depressions is considered a positive feature of area topography.

In that event, the impact could be mitigated and mosquito control effected through maintenance of the current chemical control program in these areas.

PROGRAM ALTERNATIVE: CONTROLLED RELEASE CAPSULES

AQUATIC INSECTS — The shock of controlled release formulations is less intense than that of insecticides in liquid or granule formulations but of longer duration and greater magnitude.

At least 70% of immature insect species would be continually suppressed by use of C-R chemicals in shallow waters around Type III sites.

A mitigative measure could involve the design of a C-R formula that would become inactive after the mosquito season (normally August 15). Temephos could be used in granular form to control any broods appearing after that time.

The overall benefit of this corrective measure is dubious, however, as most aquatic populations peak in July and would be in a relative decline by fall.

WATERFOWL — Application of a C-R chlorpyrifos formulation in shallow margins of Type III sites may reduce insect larvae food sources of ducklings.

Three mitigative measures are proposed: 1) use of temephos granules in lieu of a C-R insecticide; 2) use of temephos in the spring and early summer and C-R formulations later in the season; 3) avoidance of a need for chemicals through physical site modifications taking precautions to provide shallow feeding areas for ducklings.

SURFACE WATER QUALITY — Though very little C-R toxicant would be released into the water at any one time, insecticides would be occasional surface water parameters. No mitigative measure is known.

NOISE — Noise generation would result from use of helicopters. Mitigation via use of engine mufflers is discussed earlier in this chapter as mitigation of present program impacts.

MOSQUITO RESISTANCE — Due to severe population pressure, selection for resistance is possible for species (principally Aedes vexans) receiving intense treatment.

Mitigative measures include:

1) maintaining the current MMCD boundaries of 900 square miles;

2) changing material formulations (of C-R) as needed;

3) treating mosquito larvae with materials other than those used for adulticiding (resmethrin);

4) changing adulticide materials and larval materials as needed;

5) maintaining current program techniques using a variety of insecticides.

ENERGY CONSUMPTION AND SOLID WASTE	The currently approved C-R formulation is encapsulated in an energy intensive, non-degradable polyethylene material.

These impacts could be avoided by eliminating the use of C-R formulations until a bio-degradable non-distillate-based silicate material is registered.

The 15 mile dispersal range of Aedes vexans would lengthen the time required to develop resistance in this species.

Since chemical control is not the main objective in the proposed alternative, resistance would be a temporary concern. Resistance would not prevent long-term control of disease vectors should their numbers cause health risks, due to continued effectiveness of unrelated adulticiding materials.

RESISTANCE IN NON-TARGET ARTHROPODS	Selection for resistance among non-target organisms would occur slowly and be most noticeable in Type III breeding sites where C-R formulations would be temporarily used

in mosquito larval control. The result would be less suppression of aquatic organisms.

Resistance would play an insignificant part in non-target population development as the program emphasis shifted-away from chemcials towards biological control.

PROGRAM COST/ BENEFIT RATIOS	An effective, multi-facet Optimum Control Program depends heavily upon increased public financial support.

The current program is financed at a rate of 80 cents per capita for maximum control of 87% at the center of a 900 square mile (35% of the MMCD) larval control zone.

An optimum program would cost $2.40 per capita during the first fifteen years of "gearing-up" phases in physical and chemical control. During the first five years chemical larval control, adulticiding and limestone treatments would provide 60% control at a radius 10 miles beyond the center of the District in 87% of the District acreage.

PROGRAM ALTERNATIVE: OPTIMUM 25 YEAR CONTROL PROGRAM

AQUATIC ORGANISMS — During the first five years of an optimum program alternative chemical operations similar to those currently in effect would be used.

Subsequently, and for approximately 15 years a C-R formulation would be applied to Type I sites. Crustacean populations would be suppressed by this insecticide. The impact would be reduced when C-R formulations were phased out and limestone treatments become effective, 25 years after program initiation.

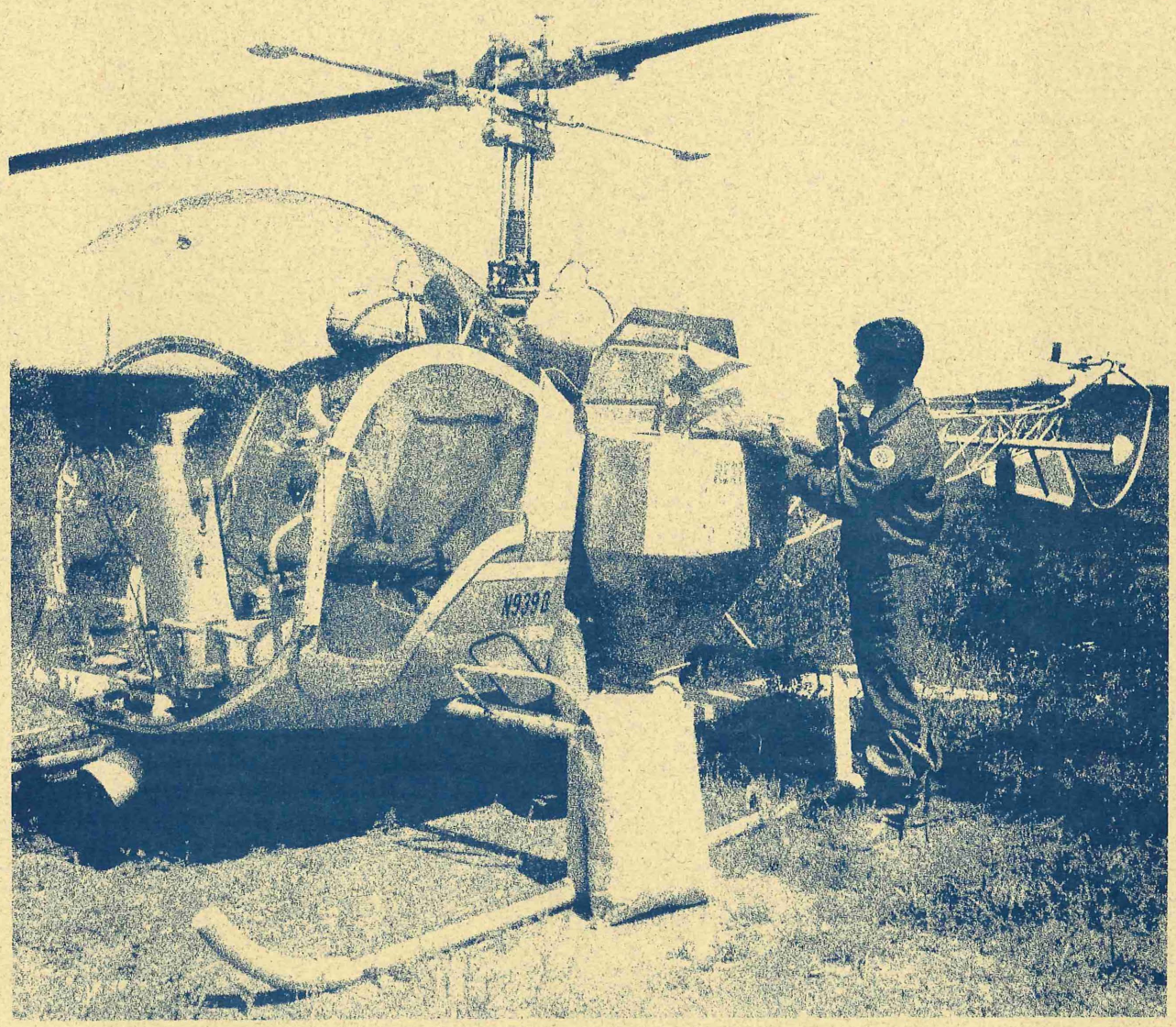
No mitigation is proposed short of no control in these sites and resultant increased mosquito production, or restricted use of C-R materials allowing for mosquito control in some sites.

WATERFOWL — The impacts of this program require site specific verification to determine degree of effects discussed earlier in this chapter.

NOISE — Noise generation would be minor and localized occuring in association with physical site modification during middle and late phases of the program. Noise is not expected to be severe or of long duration (approximately 2 days at each site).

No mitigation is proposed.

WETLANDS	Please refer to "Program Alternative: Physical Control" earlier in this chapter.
ENERGY CONSUMPTION	Energy Consumption would increase markedly over current practices during the first five years of program operation. By the fifteenth year, levels would fall to within 70% of current use rates.



unavoidable negative impacts

UNAVOIDABLE NEGATIVE IMPACTS OF ALTERNATIVE MOSQUITO CONTROL PROGRAMS

INTRODUCTORY COMMENT

Unavoidable negative impacts of alternative mosquito control programs are few and nearly identical, differing in degrees of magnitude and duration. These impacts and their degree of significance are shown in Table 47. Unavoidable negative impacts are a cost of effective mosquito control within each alternative program.

Accurate interpretation of the following table depends upon an assumption that funding levels will remain at the current rate of 80 cents per capita except in the case of the optimum program. Costs of this program have been calculated to reflect actual financial requirements of an ideal control program.

The maximum level of mosquito control under the remaining programs is premised on an appreciation of financial limitations. Under this premise, it should be noted that mosquito control would be less than effective under a program of strictly physical or strictly biological control and, of course, no control. If the proposed chemical mitigation were not acceptable or affordable, mosquito annoyance would be a major unavoidable impact of the no control and biological control alternatives and a significant unavoidable negative impact of the physical control alternative.

TABLE 47

SIGNIFICANCE OF UNAVOIDABLE NEGATIVE IMPACTS EXPECTED THROUGH ABATEMENT ALTERNATIVES AT TIME OF MAXIMUM PROGRAM BENEFIT

IMPACT	MOSQUITO CONTROL PROGRAM ALTERNATIVES					
	Current Program	No Control	Biological Control	Physical Control	Controlled Release	Optimum Program
Maximum Benefit	1977	-	1992	1990	1980	2000
Aquatic Insects	1	■	■	■	2	■
Crustaceans	3	■	■	■	5	1
Waterfowl	1	■	■	1-2	2	1-2
Noise	2	■	3	3	1	3
Energy Use	1	■ *	■ *	1*	2	1

*Assumes mitigative measures to control mosquito annoyance.

Key
- ■ Insignificant
- 1 Minor
- 3 Significant
- 5 Major
- 7 Extreme

effects on governmental responsibilities

EFFECTS ON GOVERNMENTAL RESPONSIBILITIES

The federal actions which are pending regarding the ongoing program include:

1. Review and redraft of occupational safety regulations for pesticide users.

2. Continuing research by the Department of the Army on silicate time released mosquito insecticide formulations in which the District has an interest and participation.

3. The growth of a Toxic Substances Division of the Environmental Protection Agency, which will conduct evaluations of many materials, including those used in the program. The future of carcinogenic pesticides is currently receiving a great deal of attention.

4. Determination by the Upper Mississippi Basin Commission that wetlands preservation is the principle natural environmental question in the Metropolitan area.

None of the above will in turn cause state agency involvement in regard to any particular option or alternative stated herein. However, agencies will be asked to cooperate and comment on future plans and plan evaluations in conjunction with Federal interests, chiefly the U.S. Fish and Wildlife Service. This is expected to be a general cooperative effort. If state manpower or funds are used to cooperate in this effort, they will not be used in response to federal regulation, but rather internal concerns of the metropolitan region and the State of Minnesota.

MULTI-STATE RESPONSIBILITIES ASSOCIATED WITH THE PROPOSED ACTION

No multi-state responsibilities or impacts are associated with this program.

STATE GOVERNMENT

State government laws, rules, and regulations which may effect the MMCD or which may in turn be triggered by it include at least the following:

1) Department of Agriculture (MDA). Review of pesticide application training, and recording procedures under Section 18.041-18.161.
Data on mosquito populations is sent to the MDA on a weekly basis for use in their department's Pest Report.

2) Department of Health (MDH). Through its Epidemiology unit, the Department coordinates with the District on disease vector control. Alternatives which call for elimination of the disease vector control capability (i.e. no control program) would necessitate a dependence on private contractors or the Federal Center for Disease Control.

3) Department of Natural Resources (MDNR). The Department is involved in two principle ways in the various alternatives:

   a) through its role as protector of wildlife, DNR will probably be involved with both the direct and indirect effects of alternate control methods on wildlife, with emphasis on higher forms such as shorebirds and waterfowl. Involvement will probably be limited to management questions as a result of cooperative research, although
   b) through its powers by regulating public waters, the DNR would be involved in any physical changes to Type III Sites (permanent wetlands). In the language of the Commission of the Department of Natural Resources (NR-200), public waters are water basins or water courses. "Water basins" are "enclosed basins normally filled or partly filled with water." Under this definition, sites which normally dry up-such as MMCD Type I, Type IA and Type II sites would not be considered "public waters".

Designations of public waters in the six-county area have not been as yet accomplished. These will be mapped by the DNR "using an analysis of the data on file and a review and analysis of aerial photos..." Local governments may add other water basins for consideration, followed by county review and field investigations to resolve differences. Depending on how local governments desire to designate basins, some Type I and IA sites may come under DNR protection.

The Metropolitan Mosquito Control District will be cooperating with the DNR to ascertain the extent to which any future desired shoreline modifications to Type III sites fall under DNR jurisdiction. Generally it is expected that permits will be required for any such modifications.

From a management assistance perspective, DNR personnel will have an important near future involvement via discussions of limestone impacts on wildlife in experimental upland locations.

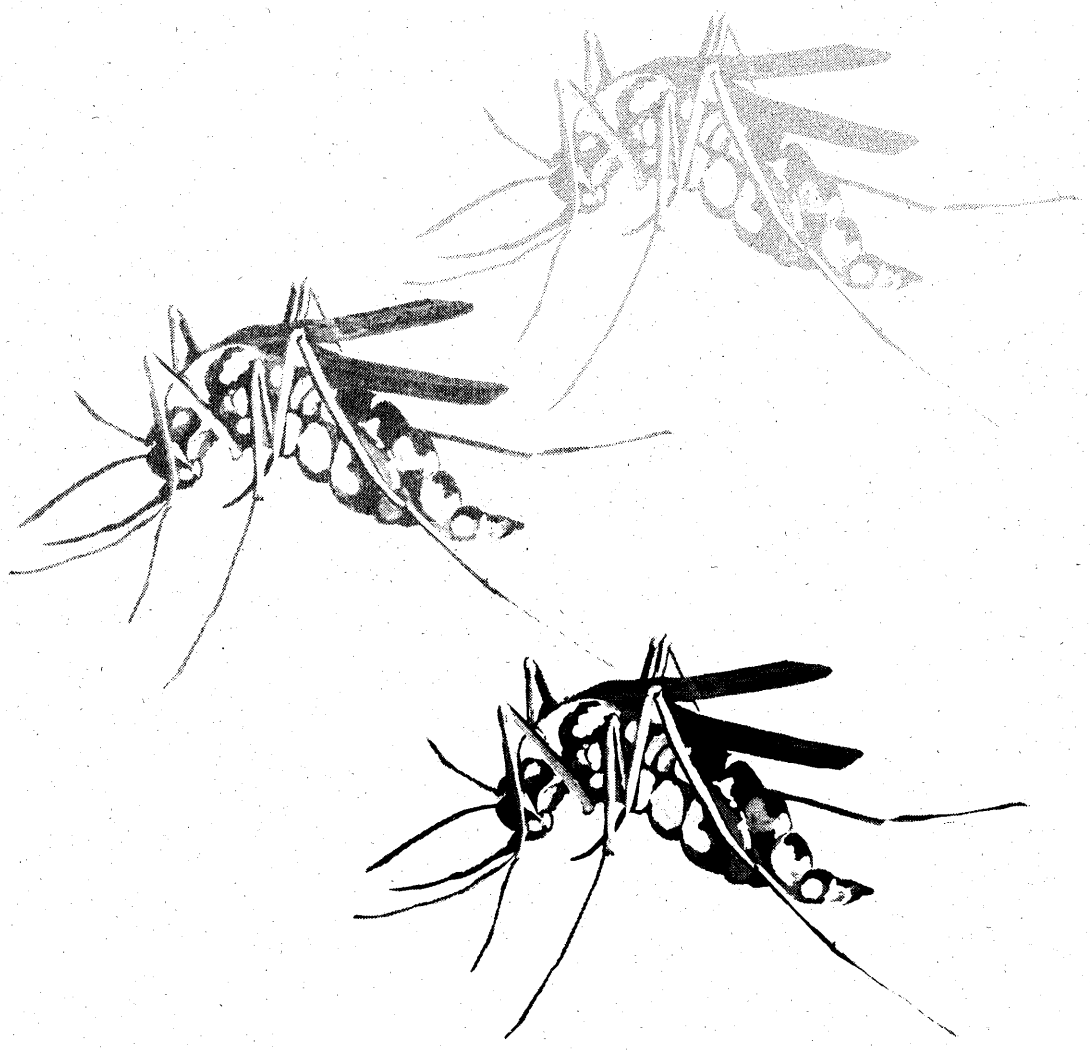
As these are not done on sites which "normally" hold water, there will probably be no legal permit requirements for either alternate insecticide applications or limestone applications.

4. The Pollution Control Agency (PCA) has responsibility over pollution of the air and water resources of the state. Generally, the PCA's involvement in the future of the District appears quite limited in a regulatory capacity except in the case of ditching. From a management perspective, the PCA will likely be involved in advising the MMCD where a combination of toxic surface deposits and water table depth make limestone treatments unwise. In addition, the District may need to consult with the PCA to prevent the creation of breeding sites in the event that dispersed storm runoff holding areas are constructed.

5. Metropolitan Council While the Metropolitan Council has no power to regulate MMCD activities, it has general responsibility to identify and advise on overall growth patterns, especially those which respond to a given public service expansion. Unless it were given regulatory authority over the District, no exercise in the powers of the Council vis-a-vis the District is contemplated under any alternative.

   From a planning and management perspective, the District has directed its efforts in remarkable accord with overall development framework guidelines. The one exception may be the level of control achieved in free-standing growth centers. Adult control in these areas has not yet received a priority equivalent to the larval control in the central cities and mature suburbs.

6. Individual Community Governments Depending on individual incorporated community shoreline ordinance decisions, the District may need permits for certain shoreline modifications should they be desired. Generally, the upland sites designated for limestone treatments will not fall under local government permit requirements, unless the DNR public waters definition is changed.



short term use vs.
long term productivity

SHORT-TERM USES AND LONG-TERM PRODUCTIVITY

INTRODUCTORY COMMENT

The Metropolitan Mosquito Control District program and alternatives to current program practices can be assessed in two essential perspectives as regards short-term uses and long-term environmental productivity:

1. Long-term biological productivity of wetland areas under MMCD jurisdiction.

2. Short-term enjoyment by citizens of the natural environment, facilitated seasonally through mosquito control. It is understood that this short-term benefit should serve the greatest number of citizens in the most economical manner possible.

The current MMCD program and program alternatives, have each been designed to enhance rather than threaten long-term environmental productivity. Each has been designed with an appreciation of the limitations of public funding with the objective of minimizing mosquito nuisance to the lowest feasible level.

The cost-effectiveness of mosquito control is the continuing responsibility of the Board of County Commissioners which formulates District policy and determines program funding. Cost-effectiveness is an over-riding concern to the Commission in its choice of program alternatives.

Guaranteeing the long-term biological productivity of wetlands, however, is the responsibility of the State Environmental Quality Board with the cooperation of its member agencies, metropolitan, regional and federal offices.

This is not to imply that the District does not share this environmental concern nor that it has shirked its responsibilities to safeguard environmental productivity in its program practices.

An adequate, final environmental impact statement is required to include a recommendation, by the

project proponent, for a preferred choice among project alternatives.

The MMCD staff is confident that each of the program alternatives presented in this document is technically reasonable and operationally feasible. This is not to imply that implementation of any one alternative as an addition to or in the current program is either immediately possible or recommended. Deviation from the current program would require an alternative level of funding; a re-ordering of funding priorities; a re-assessment of staff qualifications, and a re-directed research program to assure the compatibility of alternate practices with individual site control.

The MMCD has attempted to document the environmental impacts of its current program and anticipate those of alternate control techniques. The District wishes to thank those agencies, associations and individuals who reviewed the MMCD Draft EIS and shared and shared their appraisals with the authors.

These appraisals seem to suggest that the reviewing community is essentially (1) unopposed to the current MMCD program (2) supportive of increased efforts by the District to develop and experiment with non-chemical mosquito abatement techniques (3) reluctant to recommend adoption of abatement techniques requiring physical alteration of breeding sites (4) uncomfortable with the MMCD statements that the majority of mosquito breeding sites are not marshes (5) questions the need to control mosquitos when the primary purpose is to reduce mosquito annoyance (6) recommends further site-by-site analysis prior to acceptance of any alternative to current program operations.

ANALYSIS

Table 48 below summarizes the comparative cost-benefits (short term gains) vs. environmental production and protection (long term productivity) of alternate programs. Limestone application is listed separately from other physical control options.

TABLE 48

SHORT-TERM GAINS AND LONG-TERM PRODUCTIVITY OF ALTERNATE MOSQUITO ABATEMENT PROGRAMS

Alternative	Short Term Gains Long range per acre cost (compared to current program)	Long Term Productivity Environmental Problems
Current program	$1.00	1. Limited control for suburban areas. 2. Crustacean reduction 3. Helicopter noise. 4. Temporary and transitory fog.
Controlled Release	.91	1. Potential for resistance development in mosquitos. 2. Solid waste problem in early years. 3. Substantial crustacean reduction.
Limestone Applications	.14	1. Reduction of length of time intermittent sites remain wet following rainstorms. 2. Delay between application time and control time. 3. Possibly incomplete effect after very large rains.
Other Physical Changes	.83	1. Topography changes. 2. Limited time sites are sufficiently dry to work on.

Table 48 (Continued)

Other physical changes (continued)

		3. Reduction of food web following construction. 4. Only limited number of sites treatable.
Natural enemy complexes	.28	1. Production of natural enemies still difficult technically. 2. Many sites require physical modification. 3. Site-by-site analyses need to be done. 4. Only very limited number of sites are available.

The substantial benefit-to-cost advantages appear to exist for both limestone applications and natural enemy complexes. The draw back to the latter is the low state of technology and the very limited number of sites which can be controlled effectively without expensive earth moving procedures. Where heavy equipment must be used, the short-term gains will cost 1.11 times the current program, with no guarantee, as yet, of increases in long term environmental productivity.

The recommendation of the District, therefore is that the limestone application program go ahead at a level sufficient for thorough testing.

LIMESTONE TREATMENTS

Protection of long-term productivity is guaranteed by a gradual approach to the limestone operation. A first step is to select a significant number of locations, - e.g. approximately 45 per county of each of the following categories of Type I sites:

1. Less than 1/2 acre

2. 1/2 acre to three acres

3. Greater than three acres

Sites will also be cross-selected for variance in depth, soil type, and for land use categories of agriculture, residential and public use areas. Sites will be screened in cooperation with the MPCA and the MDNR, with technical oversight as necessary from the USFWS. This will allow different groupings for other impact questions.

Testing of sites will be done for both effectiveness as a treatment measure and environmental safety from the viewpoint of wildlife nesting habitats. These tests will be done under the supervision of Dr. Olaf Pfannkuch (geology), Dr. Dan E. Huff (terrestrial biology), Mr. Anthony Frank (wildlife population statistics) and Dr. Robert Sjogren (mosquito control and aquatic biology).

Of special importance will be the observations of behavior of property owners towards the reduction of water retention in these sites. Recommendations as to easement agreements (i.e., guaranteed mosquito elimination in exchange for no wetland alterations may be necessary and possible in some cases.

As research and analysis demonstrate the effectiveness of this operation and its environmental consequences - if any - the progress should be able to move ahead more rapidly. Generally, it is expected that the smallest sites will receive the earliest general application treatments.

CONTROLLED RELEASE

At present, the cost of applying controlled release formulations appears prohibitive. This is largely a manufacturing cost problem however. It is likely that specifically designed machines (helicopters; four-wheel trucks) operating under dependably dry working conditions (late summer and fall) would substantially reduce the present application cost figures. If this option becomes available, especially via wide use of temephos, it is likely to be used in as much as 90% of current applications. The slow release of bonded materials should effectively

eliminate any chronicity problems, since the insecticide will be present in the aquatic environment only during periodic flooding. This preserves long-range environmental safety while insuring effective treatment. At the same time, the applications will be much less frequent, resulting in less energy use and less intrusion on private lands.

Normal MMCD resistance tests as currently designed and operated will notify the District of any emerging resistance and enable it to shift materials or other applications to prevent its spread.

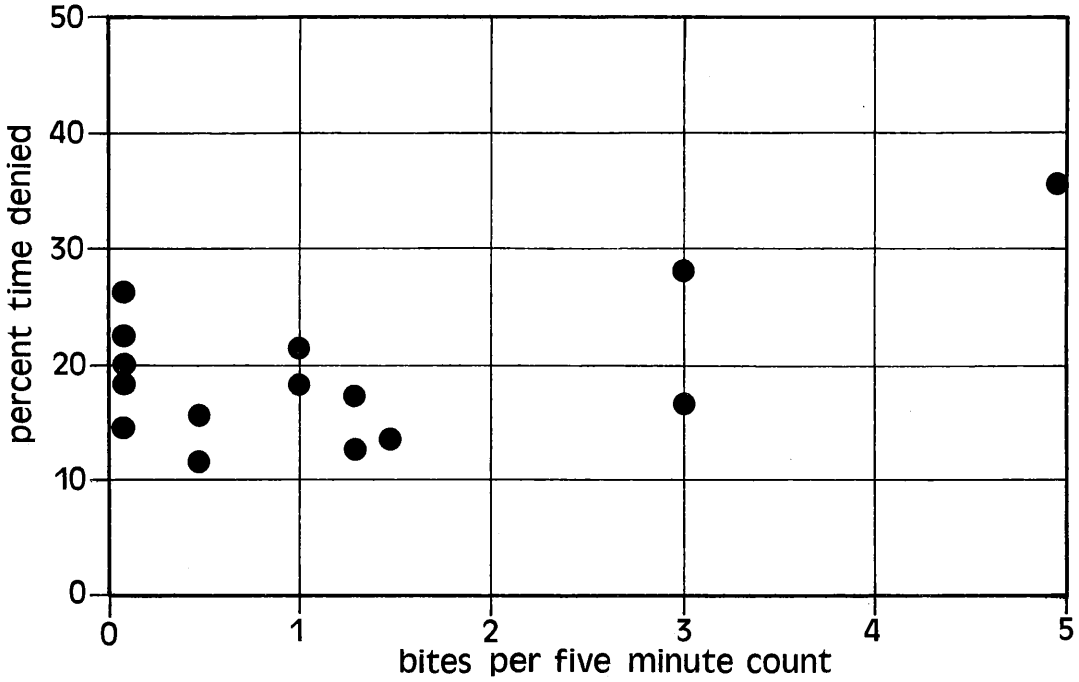
From a short-term environmental standpoint, the controlled release method will eliminate the application time peaks of insecticide presence that are most responsible for the suppression of non-target organisms.

It is recognized that sound technology does not always create optimum policies. The management functions of planning, manpower allocation, and verification are needed in order to be ready to maximize benefits and minimize costs from new programs. Fortunately, 36 District staff persons involved with field operations (central office, supervisors and foremen) have a strong field understanding about the intermittent and permanent wetlands they work in. In addition, several have had undergraduate or higher education in biology. It is recommended that permanent staff and seasonal employees be screened this year for interest and ability to work with limestoning and controlled release methods, and that appropriate further academic instruction be provided to permanent staff during the off season as appropriate.

Finally, the goals of the District need to be redefined especially in light of probable changes in the District's technology. The MMCD (1967) stated the goal of the District as providing the maximum possible benefit to the largest possible population. This conditional goal was necessary since the effectiveness of the District was (and is) dependent on the amount and spacing of rainfall in the District. Director Buzicky also stated that, as an operational goal, most people would not be severely annoyed by one mosquito approaching to bite every five minutes. This is in line with findings from the survey of 1976. The chart below shows the relationship between mean percent time denied and five-minute biting counts recorded.

FIGURE XVIII

SCATTERPLOT OF BITE COUNTS AND MEAN DENIED TIME OUTDOORS



A reasonable goal would be to limit bite counts, as Director Buzicky said several years ago, to 1 bite per five minute bite count.

Of equal importance to the program's long term goals is consistency and predictability. It is suggested that many summers would have benefited from a once-through adulticiding of the entire larval control area to eliminate the buildup of peak mosquito populations and make the subsequent larval control more effective. The benefits would be especially felt in older suburbs and the developing ring of suburbs.

Detailed costs and benefits of this kind of budget alteration should prove its worth in terms of such trade-offs as slightly reduced larval control.

Adoption of goals in terms of performance (so many mosquitos is a standard measurement) and a more detailed map of primary treatment locations instead of a general maximization goal would perhaps help focus day-to-day operations and seasonal planning efforts. This is especially true as the tools of control grow in number. More light traps at interior locations will be required to more immediately monitor changes.

In general, the District is free to choose between the following options and will cause little or no problem with long term productivity:

1. Granule applications of chlorpyrifos to Type I and II sites; temephos to Type III sites.

2. C-R formulations using silicate carriers.

3. Limestoning applications to Type I sites of less than 1/2 acre.

4. Adulticiding using resmethrin treatments.

Mosquito control required a scientific understanding of mosquitos and a sophisticated daily attention to and respect for their environments.

This Final Environmental Impact Statement has attempted to measure the extent to which the District understands mosquitos, their habitat and acts on that understanding to protect co-inhabitants while reducing the mosquito pest. In the last analysis, that understanding remains the prima facie requirement for assuring that damage to long-term environmental productivity will not occur.

comments on draft eis

REVIEW OF THE MMCD DRAFT ENVIRONMENTAL IMPACT STATEMENT

INTRODUCTORY COMMENT

In March, 1977 a Draft Environmental Impact Statement was submitted to the Minnesota Environmental Quality Board by the Metropolitan Mosquito Control District.

The District acknowledges receipt of written comments reviewing this DRAFT EIS which are reproduced in the following pages. Many of the criticisms and suggestions made therein have been incorporated into the revised discussions elsewhere in this report.

The District is particularly grateful for the contributions to this FINAL EIS made by the following reviewers. It is felt that the document has benefited from their interest and the District looks forward to participating in an ongoing dialogue with interested parties to further explore areas of mutual concern.

The District has attempted to respond to each significant point raised by reviewers in their comments. Where appropriate, the response has been incorporated directly into the text. Where response does not require major revision within the document, a brief clarification has been written and appears in this section of the report.

Reviewers comments are reproduced in the following pages. Reference to location of the response elsewhere in the text or clarifying statements are included in the body of the reviewers text in bold type.

Reviewers comments are listed in the order in which they were received by the District:

Dr. Richard O. Hayes
formerly associated with the
U. S. Public Health Service
Communicable Disease Center
Water Resources Branch
Ft. Collins, Colorado

Dr. Lowell Henderson, M.D.
Allergic Diseases
and Internal Medicine
Mayo Clinic
Rochester, Minnesota

Richard T. Huber
Acting Assistant Regional Director
U.S. Department of the Interior
Fish and Wildlife Service
St. Paul, Minnesota

Curtis J. Sparks
Water Quality Co-ordinator
Office of Environmental Analysis
Minnesota Pollution Control Agency

Charles F. Settle
MEQB Technical Representative
Minnesota Department of Health

Randall D. Young
Planning and Development Division
Minnesota Department of Agriculture

Carrol L. Henderson
Non-game Supervisor
Section of Wildlife
Minnesota Department of Natural Resources

L. K. Cutkomp
Insect Toxicologist
Department of Entomology, Fisheries and Wildlife
University of Minnesota

Partrick Lee Reagan and David Rivard
Consultants to the
Minnesota Environmental Control Citizens Association

Vonny Hagen
MEQB Technical Representative
Minnesota Department of Natural Resources
on behalf of
Carroll Henderson, Non-game Species Specialist,
Wildlife Section.
Charlotte Cohen, Hydrologist, Division of Waters
Robert Glazer, Lab Manager, DNR Chemistry Lab.

E. Laurence Atkins
Specialist in Entomology and Apiology
University of California, Riverside

Thomas D. Mulhern
Executive Director
American Mosquito Control Association, Inc.

Dr. Olaf Pfannkuch
Associate Professor
Department of Geology and Geo-physics
University of Minnesota

Metropolitan Council

J. R. Sandve
Assistant Director
Division of Plant Industry
Minnesota Department of Agriculture

Dr. Basil Furgala
Department of Entomology
Fisheries and Wildlife
University of Minnesota

Dr. Frederick Preiss
Manager Technical Services
McLaughlin Gormley King Company
Minneapolis, Minnesota

1.)
College of Veterinary Medicine
and Biomedical Sciences
Institute of Rural Environmental Health
Colorado Epidemiologic Pesticide Studies Center
Spruce Hall

Colorado State University
Fort Collins, Colorado
80523

April 4, 1977

Dr. Robert D. Sjogren, Director
Metropolitan Mosquito Control District
1802 Como Avenue
St. Paul, Minnesota 55108

Dear Dr. Sjogren:

Last month I received your Draft Environmental Impact Statement (E.I.S.) and the Draft Appendix. They were reviewed with special interest. You, the staff, the consultants, and the technical advisors are to be commended on the accurate and thorough job that was done. I certainly believe that you have documented your environmentally-concerned approach to mosquito control in the Metropolitan Mosquito Control District. Perhaps a study of the E.I.S. by the 2.4 percent of the area residents surveyed who were "actually bothered" by the control activities would bring about a change in their attitudes. The report should serve as a model for other districts that will be required to prepare an E.I.S. Now that you have the draft completed, I hope that the comprehensive review and tabulations will provide dividends toward your program planning, operations, and financial support. In the long-run, your district will be in a better position to discuss and support its control program than it would be had your request for a negative declaration been approved.

Thanking you for sending the E.I.S. draft material.

Sincerely yours,
Richard O. Hayes, Ph.D.
Visiting Professor

2.)

Mayo Clinic

Rochester, Minnesota 55901
Telephone 507 282-2511

Lowell L. Henderson, M.D.
Allergic Diseases
Internal Medicine

May 11, 1977

Robert D. Sjogren, Ph.D.
1802 Como Avenue
St. Paul, MN 55108

Dear Doctor Sjogren:

Thank you for sending me the material on mosquito control. I found it most interesting. I can, however, give you only some general answers to the questions that you posed about insecticide allergy.

Persons with rhinitis (hay fever-like symptoms) and asthma may have their symptoms aggravated by breathing in almost any kind of odors, fumes, dusts, smoke, etc. This usually has nothing to do with a true allergic mechanism, but rather the direct irritating effect of those items. Simple examples would include the smell of perfumes, cooking odors, and fresh cut grass, as well as the more pungent odors coming from hog lots and various industrial plants. Generally, the effect of these exposures are transient so that within a few hours the symptoms subside with or without treatment.

On the basis of the above, I would say that this type of person might have symptoms on exposure to any fogging type material or to any strong odors emitted by materials that are lying on the ground.

It has been estimated that about 10% of the population has some degree of oversensitivity of the respiratory membranes.

It is my clinical impression that respiratory problems deriving from mosquito control are not very prominent or significant. I have an occasional asthmatic person who mentions that he coughed or wheezed transiently at an outdoor theater when the mosquito fogging device was in operation.

I would not be able to give you an opinion about contact dermatitis from insecticides in a person's environment, since the consultants in the Clinic's Department of Dermatology handle skin problems. If you should wish to pursue that aspect you could contact Dr. Harold Perry, Chairman of our Department of Dermatology.

Again, many thanks for giving me the opportunity to comment on your questions.

Yours sincerely,

Lowell Henderson, M.D.

LLH:rs

DR. HENDERSON'S COMMENTS HAVE BEEN INCORPORATED INTO THE FINAL EIS IN A DISCUSSION OF THE IMPACTS OF INSECTICIDES ON PUBLIC HEALTH . SEE PAGE 206 THROUGH 211.

3.)

Mayo Clinic

Rochester, Minnesota 55901
Telephone 507 282-2511

Lowell L. Henderson, M.D.
Mayo Division
of Preventive Medicine

May 23, 1977

Robert D. Sjogren, Ph.D.
1802 Como Avenue
St. Paul, MN 55108

Dear Doctor Sjogren:

This is in reply to your request to evaluate Doctor Enkema's answer to your letter and the reprint of Theron Randolph's article.

Doctor Randolph has maintained a zealous interest for many years in a very gray zone of medicine. He takes the position that many nondescript symptoms and complaints may be due to adverse effects of items in our environment and diet.

As Doctor Randolph well knows, I do not fault him at all for making such assumptions and working with these often miserable people in trying to find and eliminate the cause of their trouble.

However, the situation remains an assumption, except in those cases where an individual is reasonably relieved of his symptoms after removal of certain items, only to have the symptoms recur if the contact is restored. Unfortunately, many of these studies cannot be done in a double-blind manner, and since many of the symptoms are of a type that all of us have from time to time or that many emotionally disturbed persons have, the thesis is quite tenuous.

There is undoubtedly the occasional person who may have an idiosyncratic reaction to almost any substance, and indeed, Randolph has removed some people from almost all worldly contacts. However, I am not convinced that his success is by any more than random chance. I would not let this type of possibility stand in the way of good public health measures including a mosquito control project with materials that have been adequately tested for levels of toxicity.

Yours sincerely,

Lowell Henderson, M.D.

LLH:rs

4.)

McLAUGHLIN GORMLEY KING COMPANY
8810 TENTH AVENUE N. • MINNEAPOLIS, MINNESOTA 55427, U.S.A.
TELEPHONE (612) 544-0341 • TELEX: 290 544 MACK GOVY • CABLE "MACK" MINNEAPOLIS

25 May 77

Dr. Robert Sjogren
METROPOLITAN MOSQUITO CONTROL DISTRICT
1802 Como Avenue
St. Paul MN 55108

Dear Bob:

In response to your request for literature pertaining to allergic reaction from contact with pyrethrins, I am herewith enclosing the following:

An Evaluation of Potential Risks Resulting
from the Use of Pyrethrins as Insecticides

Pyrethrum Dermatitis
II. The Allergenicity of Pyrethrum Oleoresin
and its Cross-reactions with the Saline
Extract of Pyrethrum Flowers
by F. E. Rickett and K. Tyszkiewicz

Investigation of Purified Pyrethrum Extracts
by Albert Zucker

I believe for your purposes you'll find the paper by Zucker to be the most beneficial in that he did expose humans who were sensitive to ragweed to pyrethrin aerosols in an attempt to illicit allergic reactions. He concludes that of the fourteen patients who had given a history of adverse reactions to insecticide sprays, none showed definite allergic reactions to pyrethrins.

I'll look forward to meeting with you some time in the near future to discuss the aerial spray work with synergized pyrethrins.

Sincerely,

MC LAUGHLIN GORMLEY KING COMPANY

Frederick J. Preiss, Ph.D.
Manager, Technical Services

sro

THE EFFECTS OF PYRETHRINS ON HUMANS IS DISCUSSED ON FEIS, PAGES 208 AND 210.

5.)

STATE OF
MINNESOTA
DEPARTMENT OF NATURAL RESOURCES
390 CENTENNIAL OFFICE BUILDING · ST. PAUL, MINNESOTA · 55155

DNR INFORMATION
(612) 296-6157

June 3, 1977

Robert D. Sjogren, Ph.D.
Director
Metropolitan Mosquito Control District
1802 Como Avenue
St. Paul, Mn. 55108

Dear Dr. Sjogren:

This letter is our comments on your draft E.I.S. Many of our concerns have previously been discussed at meetings between DNR personnel and you and members of your staff. We believe these meetings were very informative, and have gone a long way toward giving us better understanding of your operation and, we hope, perhaps given the MMCD a better understanding of some of our concerns.

In order to have our concerns on record, we are including here a number of items that have been thoroughly discussed and presumably resolved at those meetings.

In general, although we continue to have concerns about possible effects of chemical treatment we are more concerned about the much greater effects that physical alterations would have on wildlife populations and habitat. The effects of such habitat alterations are essentially permanent whereas effects of chemical treatments will cease if the application of chemicals stops. The chemicals you are using appear to pose only minimal hazards to wildlife when used according to label instructions.

Attached are specific comments made by Robert Glazer, Lab Manager, DNR Chemistry Lab; Carrol Henderson, Non-game Species Specialist, Wildlife Section; and Charlotte Cohen, Hydrologist, Division of Waters. These comments are to be considered part of this letter.

Sincerely,

Vonny Hagen
EQC Technical Representative

VH:HFK:lls

AN EQUAL OPPORTUNITY EMPLOYER

CHARLOTTE COHEN'S COMMENTS ON THE MMCD DRAFT E.I.S.

6.)
The physical control alternative poses greater concerns for waters than do the other alternatives or continuation of the current program.

The document states that "very minor modifications in the hydrologic cycle would result from limestone treatments."

a) First of all, the term "hydrologic cycle" should be clarified as to which processes it refers to--infiltration, total evapotranspiration from its sites, rainfall, runoff relations etc.

b) The extent of "minor modifications" should be described and quantified.

c) Since the limestone treatments will cause an increase in infiltration, the exact change in the size, duration and amount of the wetlands should be quantified (Particularly in light of the Metropolitan Council's projected annual and total wetland loss.)

d) The use of specific terminology should be used to accurately describe particular impacts on specific processes.

A) PLEASE REFER TO PAGES 274 THROUGH 279.

B) CHANGES ARE LIMITED TO APPLICATION OF APPROXIMATELY 3MM OF LIMESTONE PER ACRE WITH THE NET EFFECT OF REDUCING WATER RETENTION BY ONE THIRD (SEE PAGE 170 AND PAGES CITED ABOVE).

C) SIZE OF THE SITE (MEDIAN 1/2 ACRE, AVERAGE 0.6 ACRES, MAXIMUM 2 ACRES) WOULD NOT BE EFFECTED BY LIMESTONE.

DURATION OF WATER RETENTION: (SEE (B) ABOVE AND REFERENCED PAGES). REDUCTION OF WETLANDS USING LIMESTONE ON SITES OF LESS THAN 2 ACRES COULD RESULT IN THE REDUCTION OF MOSQUITO ANNOYANCE BY 40%. THE ACREAGE OF WETLANDS WITH THE MMCD WOULD BE REDUCED BY A MAXIMUM OF 4% (IF WATER RETENTION IS ELIMINATED ENTIRELY FROM 14,000 SITES). A MORE REALISTIC FIGURE WOULD

BE 1.3% ASSUMING WATER RETENTION AT A RATE OF 2/3 NATURAL CONDITIONS, AND EVAPOTRANSPIRATION OF 1050 ACRE FEET, 490 ACRE FEET BELOW PRESENT CONDITIONS (PFANNKUCH, 1976).

7)
The extent that island/moat construction would "noticably affect currently topographic features" should be quantified and described.

FLAT DEPRESSION AREAS TYPICAL OF BROAD MARSHES WOULD BE ALTERED BY THE APPEARANCE OF A MOUND ON THE ISLAND. SEE PAGE 88 IN THE DRAFT E.I.S. (DEIS) AND AN EXPANDED DISCUSSION ON PAGE 173 OF THE FEIS.

8)
The quantitative evidence that suggests that "none of the proposed techniques will affect surficial or ground water quality" should be described.

AVAILABLE INFORMATION IS CONTAINED IN RESPONSES TO QUESTIONS 6 AND 7.

9)
The "fraction of infiltrated surface water" expected to reach the ground water table should be quantified for each wetland type and proposed treatment.

LIMESTONE SEE PAGES 274 THROUGH 277.

COLLECTION OF WATER INTO A SINGLE SITE: UNDER THIS PLAN, THE INFILTRATION REGIME WOULD NOT BE ALTERED (PFANNKUCH, 1976). INCREASING WATER DEPTH IN A SINGLE COLLECTION SITE WOULD CHANGE THE SURFACE-VOLUME RELATIONSHIP LEAVING A SMALLER SURFACE ACROSS WHICH EVAPORATION COULD TAKE PLACE (PFANNKUCH, 1976).

ISLAND MOAT CONSTRUCTION: THIS MODIFICATION WOULD CAUSE NO CHANGE IN INFILTRATION CHARACTERISTICS (PFANNKUCH, 1976). IN THE CASE OF THESE LOWLAND SITES THE RATES OF WATER EVAPORATED OR TRANSPIRED ARE ESSENTIALLY THE SAME WHETHER EVAPORATION TAKES PLACE FROM THE FREE SURFACE OR BY WAY OF PLANTS. NO IMPACT IS EXPECTED ON THE HYDROLOGIC CYCLE (PFANNKUCH, 1976).

SHORELINE SLOPE MODIFICATION: ANY CHANGE IN THE HYDROLOGIC CYCLE WOULD BE LIMITED TO SLIGHTLY REDUCED OVERALL EVAPORATION BY REDUCTION IN FREE WATER SURFACE (PFANNKUCH, 1976).

REMOVAL OF ORGANIC DEBRIS: IN AREAS WITH PERIODICALLY FLUCTUATING WATER LEVELS, THIS OPERATION COULD POSSIBLY MAKE THE SURFACE NEAR THE SHORE MORE PERMEABLE. IN LOWLAND AREAS CLOSE TO THE GROUNDWATER TABLE, A RISE IN WATER LEVELS IS ESSENTIALLY IN PHASE WITH A RISE IN GROUNDWATER LEVELS. THUS, "NO ADDITIONAL STEEPENING OR GRADIENTS NEAR SHORE WOULD TAKE PLACE AND THE ORIGINAL INFLOW OR OUTFLOW RELATIONSHIPS WOULD NOT BE MATERIALLY ALTERED" (PFANNKUCH, 1976).

FILLING IN LOWLAND SITES: WOULD RESULT IN LESS CONCENTRATION AND MORE DIFFUSE INFILTRATION. WATER RETENTION WOULD CONTINUE AS FILLING DOES NOT CHANGE BOTTOM PERMEABILITY. EVAPORATION WOULD NOT BE A FACTOR, BUT INCREASED VEGETATION WOULD RESULT IN A DEGREE OF TRANSPIRATION CLOSELY ASSOCIATED WITH THE PREVIOUS EFFECTS OF EVAPORATION (PFANNKUCH, 1976)

PFANNKUCH (1976) CONCLUDES THAT "ALL OF THE METHODS FOR SITE MODIFICATION BASED ON PURELY MECHANICAL AND PHYSICAL CHANGES WILL NEITHER AFFECT THE TOTAL VOLUME OF WATER IN THE LOCAL HYDROLOGIC CYCLE NOR ITS RELATIVE DISTRIBUTION IN TIME. ENVIRONMENTAL IMPACTS WILL BE NON-EXISTANT OR NEGLIGIBLE".

10)
"Physical changes in area wetlands would occur under this alternative to a substantial degree. The term "to a substantial degree" is a subjective evaluation and needs quantification.

a) The physical changes in area wetlands should be described and quantified.

b) The exact size and occurrence of the wetlands affected by drainage and ditching should be described.

c) How much area and volume of water would moat construction alter?

A) SEE PHYSICAL ALTERNATIVES PAGES 169 AND 270.

B) SOME 3000 TYPE I SITES COULD BE TREATED BY DITCHING. THE AVERAGE SIZE OF TYPE I SITES IS 4 ACRES. THESE SITES ARE DISTRIBUTED AS SHOWN IN FIGURE IV ON PAGE 35 . FIVE HUNDRED SITES (TYPES I AND II)

ARE ADAPTABLE VIA DRAINING INTO COMMON SITES. TYPES I AND II SITES COVER 14.5% OF THE SIX-COUNTY AREA WITHIN THE MMCD (SEE FIGURES V-VIII AND TABLE 4 ON PAGES 35 THROUGH 39).

C) MOAT CONSTRUCTION IS APPROPRIATE FOR SITES LESS THAN 4 ACRES IN SIZE (OF WHICH THERE ARE ABOUT 5000). WATER DEPTH WOULD BE INCREASED FROM ROUGHLY 6 INCHES TO ABOUT 3 FEET (SEE PAGE 173).

11)
Since these physical control techniques obviously affect the topography, water quality and wetlands in one way or another, then the statement "shoreline slope modification, island moat construction and removal of organic debris would not affect the hydrologic cycle of the basin", should be quantified in order to be meaningful.

SEE RESPONSE TO COMMENT 9 ABOVE.

12)
What will be the effect on groundwater recharge and adjacent larger wetlands due to shoreline modification, island/moat construction, and removal of organic debris?

ACCORDING TO PFANNKUCH (1976), "INCREASED RECHARGE TO THE GROUNDWATER RESERVOIRS AND REPLENISHMENT OF SOIL MOISTURE DEFICIT IS TO BE CONSIDERED A POSITIVE HYDROLOGICAL IMPACT" OF LIMESTONE TREATMENTS.

APPROXIMATELY 3000 SITES ARE SUITABLE FOR MANIPULATION THROUGH DITCHING. THE AVERAGE AREA OF 40 SITES STUDIED BY PFANNKUCH (1976) IS 0.63 ACRES. DRAINAGE AREAS OF THESE SITES ARE APPROXIMATELY 3.13 ACRES IN SIZE. THE RATIO OF WATERSHED AREA TO DEPRESSION AREA IS 4.98.

UNDER CONDITIONS OF A 1.5" RAINFALL, PRECIPITATION IN AN AREA OF 3.13 ACRES WOULD APPROXIMATE 0.39 ACRE FEET 23% OF WHICH WOULD BE TRANSFORMED INTO RUNOFF (PFANNKUCH, 1976). INFILTRATION PER SITE IS 0.09 ACRE FEET PER EVENT OR 0.35 INCHES. INFILTRATION IN THE 5000 PROPOSED SITES WOULD EQUAL 450 ACRE FEET OR 0.22% OF TOTAL RUNOFF GENERATED IN THE TWIN CITIES BASIN FOLLOWING EACH RAINFALL OF 1.5" (PFANNKUCH, 1976).

13)
So that we would make a determination on the amount of public waters which would be affected by these alternatives and the sites for which permits would be required;

a) What is the exact (mapped) distribution of breeding sites, particularly in terms of USFWS Types III, IV, and V wetlands where these alternatives would be implemented.

b) What is the distribution of sites (mapped) where each of the physical control (limestoning and modification) techniques will be used?

c) "The negligible" amount of limestone used per breeding site should be described and quantified since the size of each treatment and the size of the individual site could constitute fill.

d) What is the distribution (mapped) of sites where each of the alternatives under the ultimate program would be implemented?

A,B,D).
AS THE MMCD DOES NOT INTEND TO IMPLEMENT ANY OF THESE PRACTICES IN THE IMMEDIATE FUTURE, MAPS OF SPECIFIC TREATMENT SITES HAVE NOT BEEN PREPARED. MANY SITES COULD BE TREATED IN ANY OR ALL OF THE MANNERS DESCRIBED UNDER PROGRAM ALTERNATIVE: PHYSICAL CONTROL (PAGE 169). THE LOCATION OF BREEDING SITES IS SHOWN IN FIGURES V-VIII. THE MAPPING OF 54,000 SITES IS INAPPROPRIATE TO REPRODUCE FOR A STUDY NOT BASED ON A SITE BY SITE ANALYSIS.

C. PLEASE REFER TO THE RESPONSE TO COMMENT 6B.

14)
There should be a more comprehensive discussion of how the identified impacts of the physical and ultimate control options on waters and wetlands will be mitigated. For example, loss and/or reduction of wetlands due to physical modification and limestoning; changes in topography; impacts of excavation and drainage; etc.

PHYSICAL CONTROL PROGRAMS AND ASPECTS OF AN OPTIMUM CONTROL PROGRAM DO NOT EFFECT WATER NEGATIVELY. LIMESTONE APPLICATION TO TYPE I UPLAND SITES WOULD HAVE A NET EFFECT OF IMPROVING WATER QUALITY FOR THE AQUATIC

FOOD CHAIN BY INCREASING THE ACIDITY OF THE WATER AND REDUCING THE SOIL ACIDITY. PLEASE SEE PAGES 178 AND 284 OF THE TEXT FOR A DISCUSSION OF C-R PESTICIDES AND CHLORPYRIFOS ON WATER.

LOSS OR REDUCTION OF WETLANDS IS A MOOT QUESTION AT THIS TIME AS THE DISTRICT IS NOT ADVOCATING IMMEDIATE ADOPTION OF ALTERNATIVE CONTROL PROGRAMS. WHAT STARTED AS A THEORETICAL INVESTIGATION FOR PURPOSES OF PREPARING THE DEIS, HAS ADVANCED TO A POINT OF REAL POTENTIAL FEASIBILITY. THE LOW RATIO OF BENEFITS TO COST FOR PHYSICAL CONTROL OPTIONS (ASIDE FROM LIMESTONING) PROMPT A DESIRE BY THE MMCD TO STUDY THE EFFECTS OF EXISTING EXAMPLES ELSEWHERE IN THE REGION BEFORE ENTERTAINING THE POSSIBILITY OF MOVING FORWARD WITH ANY EXTENSIVE EXPERIMENTS, MUCH LESS PROGRAM MODIFICATION. SEE DISCUSSION UNDER MITIGATION AND SHORT TERM GAINS VS LONG TERM PRODUCTIVITY, PAGE 300 AND 318. ONE SHOULD BE REMINDED THAT THE 100,000 ACRES REFERENCED EARLIER IN THIS TEXT AS EXPECTED LOSS OF WETLANDS IS NOT THE MMCD'S FIGURE BUT THAT OF THE UPPER MISSISSIPPI RIVER BASIN COMMISSION (1976). THE VALIDITY OF THIS FIGURE HAS NOT BEEN STUDIED BY THE MMCD.

15. The discussion of the unavoidable negative impacts under the alternatives should be expanded upon and described to include specific discussion of negative impacts of each program alternative, loss of wetlands, impacts of drainage and ditching, and impacts on wildlife habitat.

SEE ANSWER TO COMMENT 10 ABOVE.

BOB GLAZER'S COMMENTS ON THE MMCD E.I.S.

16)
First of all, I would like to say that the MMCD has done an outstanding job in preparing their E.I.S. It is obvious that they have tried to touch base with all concerned parties and tried to discuss the ramifications of their control program. Never-the-less I am confident that many people may, as I do, have reservations about the ultimate effect of their proposed programs.

I think that the alternative of physical control, which of course includes limestone treatment of temporary water sites should concern us the most. While insecticides may disrupt predator populations and possibly reduce wildlife, physical modification proposals

threaten to eliminate entire small ecosystems. Therefore, I have opted to confine my input to the effects of physical control modification proposals.

Contrary to the discussion in the E.I.S., pages 140-142, which suggests that Type I site modifications would have minor effects on aquatic and terrestrial flora and that Type I sites are not good feeding areas for ducks, and that song birds and mammals would be favored by ditching and draining operations, I suggest that the contrary is true. With your indulgence, I would like to present the findings of some literature I just consulted to substantiate this allegation.

Target areas for mosquito control in the district include upland depressions intermittently containing water in response to precipitation and runoff, upland depressions, the hydrology of which is dependent on ground frost conditions which impermeabilize the bottom of the depression, active once annually in response to spring melt and runoff and wetlands directly connected with permanent bodies of more or less open water.

I believe that these correspond or overlap with what is classified as Type I, II, and III wetlands by the Department of Interior (Wetlands of the United States, U.S. Department of Interior Circular 39, U. S. G.P.O. 1956).

The E.I.S. states that of the 240,000 acres of surface water in the region, 200,000 are breeding grounds of the Aedes mosquitos. Again quoting a reference cited in the E.I.S., "by year 2000 the Metropolitan area will lose 100,000 acres of wetlands". According to the District's figures, approximately 74,000 acres of these wetlands to be lost will be similar to those in the I and II classification. I believe that this is a pretty good indication that wetlands are already in a great deal of jeopardy and it portends a tremendous loss of wildlife habitat which can only be made worse by the MMCD's physical modification plans.

I submit that the areas the MMCD has proposed as target areas for mosquito control by physical modification and/or insecticide application are unique ecosystems in nature and are absolutely essential for the survival of a host of wildlife forms that are prized very highly. Although the E.I.S. has given a perfunctory account of the families and classes of animals and the species of

plants that would be impacted by their proposed operations, I think it would be profitable to consider some of them in more detail.

Mammals that use habitat around temporary ponds in the Metropolitan area (personal communication, Donna Baird, 1977) include:

Sorex cinereus	Masked Shrew
Sorex palustris	Water Shrew
Sorex articus	Arctic Shrew
Blarina brevicauda	Short-tailed Shrew
Condylura crostata	Star nosed Mole
Peromyscus maniculatus	Deer Mouse
Clethrionomys gapperi	Southern Red-backed Vole
Microtus pennsylvanicus	Zapus Hudsonius
Mustela erminea	Ermine or short tailed weasel

The water shrew and star nosed mole probably require habitat with some access to permanent water. The short tailed mole is a faculative herbivore, but it probably doesn't breed without insects.

SEE FEIS DISCUSSION PAGES 70 THROUGH 83.

17)

Mosquito predatory insects that are found in temporary waters of vernal ponds include:

Mesoveliidae	Marsh Treaders
Notonectidae	Backswimmers
Corixidae	Waterboatmen
Odonata	Dragon Flies
Hydracarina	Water Mites
Dytiscidae	Diving Beetles

This listing is at variance with the E.I.S. in that backswimmers, dragon flies and diving beetles are given as inhabitants of temporary ponds. In almost all cases these insects overwinter as adults in moist areas even if only mud is present and lay their eggs in the spring when they emerge. Their development then corresponds with their prey species. I believe this is another example of adaptive selection.

NO REFERENCE IS CITED TO HELP DEFINE "TEMPORARY". IT IS AGREED THAT THE GROUPS LISTED ARE FOUND IN PONDS HOLDING WATER LONGER THAN THREE WEEKS IN MID-SUMMER. HOWEVER, SUCH SITES ARE NOT MMCD TYPE I SITES. IT HAS NOT BEEN OUR EXPERIENCE THAT AQUATIC INSECTS OVER-WINTER IN OTHER THAN BODIES OF WATER THAT DO NOT EXPERIENCE COMPLETE FREEZE OUT.

18)
Water mites were not cited in the E.I.S. but these have been shown to be important since they are parasitic to mosquitos (Uchida and Miyazaki Life History of a water-mite parasitic on Anopheles, Proc. Imper. Acad. (Japan) 11, 73-76, 1936).

MITE SIGNIFICANCE IS UNRESOLVED, SEE MULLEN, 1976.

19)
There are far too many insects which are part of the life support chain for birds, amphibian and mammals and which are specifically identified with the sites of the temporary water that the MMCD suggests be adulterated or eliminated to enumerate in this paper. Therefore, I will simply endeavor to document the quantitative relationships that exist between certain birds, insects, and marsh plants that are germane to the E.I.S.

According to Krull, J.W.M.A. 34, 707, 1970 small life associated with plants, free swimming life on or in the hydrosol, all serving as potentially important food for ducks, has been, until recently, almost completely disregarded. Beard (1953:424) states "that ducklings of all species rely almost entirely upon animal foods (insects, crustacea etc.) during the first two or three weeks of their existence. Bartonek and Hicky, Auk 86, 443-457, 1969 demonstrated that the food consumed by juvenile canvasbacks and redheads, 96 and 43% respectively, consisted of animal material.

Before and during the nesting period protein demands of the hen are especially high. They continue to be high for ducklings and for molting adults. It is suggested that these demands cannot be easily met from plant life alone and are best satisfied from feeding in areas where insect densities are high enough for efficient feeding. Holm and Scott 1954: 171, New York Fish and Game 1 (2), 171-187, 1957 reported that wild young ducklings of several species developed satisfactorily on 19% total protein or 8% animal protein. Breeding and egg laying mallards exhibited satisfactory egg production and hatchability of fertile eggs when a diet containing 19.6% protein was fed, but unsatisfactory results were obtained with a 17% protein diet. Moyle (1961:3) reported that the protein content of leaves and stems is between 1 and 2% by weight,

rhizomes and tubets average about 2% and seeds and fruits may average 19%. Aquatic invertebrates on the other hand, usually are between 10% and 25% protein. Accordingly, it is sufficiently evident that egg laying hens, ducklings and molting adults cannot obtain their necessary protein (and specific amino acid) requirement entirely from aquatic plants.

AGREED. SEE TEXT PAGE 78 FOR DISCUSSION

20)
A clear general relationship exists between the abundance of aquatic invertebrates and the presence of hydrolphytess. In a study done by J. Krull, 1970, "Aquatic Plant-Macroinvertebrate Associations and Waterfowl", J.W.M.A. 34 707-718, 12 aquatic plants were associated with macro-invertebrates. Their study showed that one gram of animal material is generally associated with 100 grams of aquatic plant material. If these plants were in waters supporting fish I doubt that such insect densities would prevail. In all probability, according to Krull, prairie pot holes and marshes and many other shallow water units produce animal material equal to or in excess of the above figure.

IT IS IMPORTANT TO DISTINGUISH BETWEEN THE PRODUCTIVITY OF MMCD TYPE I, IA AND III SITES. SEE DISCUSSION ON PAGES 41 AND 70.

21)
The insect need by passerine birds is even more critical. The birds' digestion of food proceeds rapidly and in the case of insect food this is a very large amount of waste; thus requiring a great quantity of them to provide sufficient nutriment. Birds with crops fill both crop and stomach with food about twice a day, while insectivorous birds probably fill their stomachs on the average of 5 to 6 times daily. Hence the food found in a bird's stomach and crop represents in one case about half and in the other case about 1/5 to 1/6 of its food for the day (Henderson, The Practical Value of Birds, 1935). Close observation disclosed a brood of martins was visited with food 312 times a day, a brood of grossbeaks were visited 426 times a day and wrens about 600 times a day. Considering the above it is not difficult to extrapolate what the impact of the disappearance of insect-rich wet spots in the spring would mean to an insectivorous song bird's reproduction and survival.

WE DISAGREE SINCE AS DISCUSSED IN COMMENT 6C WETLANDS WOULD BE REDUCED BY ONLY 4%, AND TYPE I SITES WOULD STILL BE DAMP FOLLOWING RAINFALL.

22)
The Physical Control Program Alternative Section of the E.I.S. includes proposals to ditch, drain and modify shoreline slopes of marshes to consolidate ponds and to create more stable bodies of water. . According to Weller and Fredrickson, Avian Ecology of a Managed Glacial Marsh, Living Bird 12, 1973, "Laymen confuse stability with continued productivity in most semi-permanent glacial marshes, however, stability of water levels means a lake-type ecosystem which may be productive to fish but not conducive to marsh birds and muskrats. The usual product of stability is a centrally open marsh with a perimeter of dense cattail or other robust vegetation that is generally low in productivity of invertebrates and vertebrate life. We have come to speak of these marshes, ornithologically, as dead. They lack the lushness and diversity normally associated with temperate semi-permanent glacial marshes. The author continued later that "as a result of marsh successional patterns, a static marsh cannot be considered either a logical or desirable goal when managing for diversity or productivity. Moreover, managing for species d versity and using indicator species like the yellow headed blackbird, produces the greater abundance of all species concurrently. Monocultures are impractical and undesirable".

SEE FEIS PAGES 70 TO 83 AND RESPONSE TO COMMENT 10.

23)
It should be abundantly clear that we cannot have things all ways. The entire gamut of physical control alternatives, beginning with limestone treatment of MMCD Type I sites to draining and filling of large marshes would undoubtably get rid of mosquitos in those areas and would most assuredly be an absolute disaster for wildlife there too.

The interspersion of tiny vernal ponds up to large marshes throughout the Metropolitan area is one of our priceless treasures. There are very few cities indeed where one can watch a pair of ducks setting their wings to land in the middle of town, or see pheasants strolling along from our car windows or enjoy the noisy spring

that only an abundance of song birds, frogs and mammals chattering can give us. The luxury of a mosquito bite free evening may mean the loss of all of this. It may be, that as said in the E.I.S., "in mosquito control, however, human tolerance is so low that the level of control must be nearly absolute to meet demand satisfaction and that, as mosquito density falls off, tolerance is reduced accordingly". This is undoubtably true, but it must be pointed out that it is a choice of one port systems of the marshes, no matter how small or urbanized they may be, they are all important.

WE SHARE MR. GLAZER'S ENVIROMENTAL PHILOSPHY AND APPRECIATION OF METROPOLITAN WILDLIFE AESTHETICS WE DISAGREE WITH HIS "EITHER OR" PROPOSITION. IF CONTINUED RESEARCH INDEED SHOWS SIGNIFICANT WILDLIFE IMPACTS (SEE KEY TO IMPACT TABLE FOR DEFIN TION OF TERM SIGNIFICANCE) THE DISTRICT WILL NOT ENGAGE IN THESE CONTROL OPTIONS.

CARROL HENDERSON 'S COMMENTS ON THE MMCD E.I.S.

24)
The predicted impact of physical control measures on aquatic insects, crustaceans, and waterfowl is "insignificant". We feel that the impact of such measures would be substantial.

Type 1 marshes are an important component of wetland ecosystems. They are a very important source of food for migratory shorebirds which are not even considered by the E.I.S. Species using these ephemeral ponds include the greater yellowlegs, lesser yellowlegs, Wilson's phalarope, pectoral sandpiper, white-rumped sandpiper, Baird's sandpiper, least sandpiper, semipalmated sandpiper, dunlin, solitary sandpiper, sanderling, common snipe and the resident spotted sandpiper. The presence of these shorebirds within the metropolitan area is a recreational resource of considerable value because shorebirds are excellent subjects for birdwatchers. Shorebirds are typically abundant, conspicuous, fearless of man, and exhibit fascinating behavior which is enjoyable to observe.

Diving ducks like lesser scaup, redheads, canvasbacks, and ringnecks readily use type 1 marshes in the spring for feeding and resting during migration. The EIS does not comment on the differing types of ducks-divers

and puddle ducks -- nor does it even comment on any species. The lumping of "ducks" into a catch-all category for EIS analysis is a serious oversight. Even whistling swans have been seen occasionally feeding and resting in type 1 wetlands. Black bellied and golden plovers also find food in these shallow water areas.

WE DISAGREE THAT A TYPE I SITE SHOULD BE TERMED A MARSH, DUE TO ITS INTERMITTENT WATER CHARACTER. SECOND, WE FAIL TO UNDERSTAND HOW INCREASED INFILTRATION RATE IN AND OF ITSELF COULD CREATE THE KIND OF IMPACTS DESCRIBED ABOVE, ALTHOUGH SUCH UNECONOMICAL PHYSICAL CHANGES AS DITCHING COULD HAVE LARGER IMPACTS. SHOREBIRD ABUNDANCE TYPICALLY OCCURS IN WAVE WASHED SHORELINE AREAS OF LAKES AND MMCD TYPE III SITES, NOT MMCD TYPE I SITES WHICH ARE TYPICALLY CHOKED WITH EMERGENT VEGETATION AFTER MAY. SEE TEXT, PAGES 41 AND 78.

25)
Type I wetlands are also very important to transient and resident puddle ducks -- mallards, pintails, and blue-winged teal. Among the invertebrates of these areas are copepods and cladocerans which are critical sources of protein for hens. The protein diet is necessary prior to the onset of egg-laying (Krapu, 1974, Swanson, 1974). These marshes are particularly important for the early nesting species like the mallard and pintail because when they arrive in the spring there is little other aquatic habitat open for use.

There is a statement on page 141 that "ducks normally feed on larvae and snails. Type I sites are not ideal feeding areas since organisms inhabiting them are limited to a few varieties of crustaceans and mosquitoes." This statement is misleading.

For example, the report states that cladocerans, copepods, ostracods, and diptera larvae and pupae are found in type 1 sites on page 106. Sugden (1973) shows that cladocerans comprised 4 percent by dry weight of the diet of young pintails and diptera larvae and pupae comprised 18 percent by dry weight of the young pintail's diet. On a 9 point preference scale, dipterans rated 7.4 as preferred food of young pintails.

SEE TEXT PAGES 78 TO 82.

26)
Hen pintails need a high percentage of animal matter in their diets during the follicle development, laying, and post-laying periods of the nesting season (Krapu 1974). Cladocerans comprised 14 per cent by occurence and Diptera larvae and pupae comprised 33 percent by occurence of their diet during follicle development. These percentages changed to 3 per cent and 52 per cent, respectively during the egg laying period, and to 0 per cent and 50 per cent during the post laying period.

Similarly the esophageal contents of breeding hen pintails contained 5 per cent by occurence of cladocerans on shallow non-tilled wetlands (Krapu 1974 B). The esophageal contents also included 64 per cent Diptera larvae and pupae, by occurrence, on shallow untilled wetlands and 43 per cent Dipera on shallow tilled wetlands. The researcher commented that aquatic Dipterans (primarily larval forms), snails, fairy shrimp, and earthworms accounted for 71 percent of the female diet. Midge larvae alone comprised 16 per cent of the diet.

The discussion in this paper accurately assesses the high value of type 1 wetlands.

"Data indicating consumption of invertebrates is highest during egg formation and occurs principally on non-tilled shallow wetland basins have important implications concerning pintail productivity in the prairie pothole region if current land use trends continue...Many of the remaining wetlands in the prairie pothole region are being used as depositories for water previously held in surrounding wetlands of varying depths. Food habits information indicates pintails feed primarily on organisms characteristic of those wetlands which undergo frequent drying. Loss of part of the wetland complex and increased depth and permanency of the remaining basins reduces availability of pintail foods. Hydrological changes lead to the disappearance of certain preferred foods and increased depth prevents the birds from obtaining other foods still existing on or near the bottom of ponds."

"Pintails are attracted to recently flooded shallow wetlands habitat and will breed at high densities when such habitat is abundant during the nesting period..."

In conclusion, Krapu wrote "The need of this species for animal foods during egg formation underscores the importance of maintaining non-tilled shallow wetlands as an integral component of wetland complexes in the prairie pothole region.

The feeding ecology of blue-winged teal was reported by Swanson et al. (1974). The results also underscore the value of Type 1 marshes to hen blue-wings in the breeding season. The percent occurrence for cladocerans, copepods, ostracods, and dipterans was 33, 10, 31, and 87, respectively, and contradicts the statement on page 141 that "Type 1 sites are not ideal feeding areas since organisms inhabiting them are limited to a few crustaceans and mosquitoes."

MMCD TYPE 1 SITES HOLD WATER FOR SHORTER PERIODS THAN THOSE DESCRIBED BY SWANSON. THE FOOD VALUE OF THE INVERTEBRATES IS RECOGNIZED IN THE FINAL E.I.S. (FEIS). THE DENSITIES OF THESE ORGANISMS IN MMCD TYPE 1 SITES AND THUS THEIR RELATIVE VALUE IN CONTRAST TO MMCD TYPE III SITES HELD TO REPRESENT MORE CLOSELY SWANSON'S STUDY AREAS, WILL BE ESTABLISHED IN A JOINT DNR, USFWS AND MMCD STUDY PLANNED FOR 1978. SEE EXPANDED DISCUSSION IN FEIS PAGES 71 THROUGH 83.

27)
Swanson et al. wrote that "Seasonal wetlands provide ideal feeding sites in terms of abundance and availability of high protein foods throughout the spring and early summer".

On page 141 is also the statement "When duck populations are abnormally large, Type 1 sites may be used as overflow feeding and nesting areas." The previous data discredits the overflow feeding concept. According to Eberhardt (pers. comm.) waterfowl use on ephemeral marshes has nothing to do with the population level of ducks. They are consistently used.

The project proposes that 14,000 Type 1 sites would be eliminated, but on page 144 a minus one value has been given to the impact on type 1 sites. We certainly feel the impact should be much greater.

Page 7. The predicted impact on aquatic insects, crustaceans, and waterfowl by physical control is "insignificant". Assuming only minor impacts for the controlled release and ultimate programs is also questionable.

Pages 85 and 139 Physical control alternatives propose that 14,000 Type 1 sites will receive limestone treatment, 3000 will be ditched to divert rainfall from pothole depressions, and 500 Type I and II sites will be drained into common single locations by surface ditches or tile lines. Therefore, about 17,250 type I sites are scheduled for destruction. However, on page 85 it says that there are only 14,000 sites in the 6-county metro area. The reasons for this discrepancy are unclear.

THESE FIGURES ARE ESTIMATES OF POTENTIAL APPLICATION, WITH OVERLAP OF 3,250 SITES WHICH COULD BE MODIFIED IN MORE THAN ONE MANNER. SITE BY SITE STUDY WOULD BE NEEDED TO DETERMINE THE MOST SUITABLE MODIFICATION.

28)
Type III Wetland Considerations. A prime consideration in the quality of wildlife habitat is the amount of edge, or ecotone, between different cover types. The edge of Type 3 marshes is of importance to many aquatic and terrestrial vertebrates. Often the edge is vegetated by cattails or other emergent plants. This cover is used by red-winged blackbirds, yellow-headed blackbirds, marsh wrens, sora rails, and several species of ducks for nesting sites. Furbearers used the heavy cover for den sites and for seeking food. The cover is also important for brood-rearing sites for ducks.

Several of the physical mosquito control proposals exhibit shallow logic which does not recognize the complex ecological value and functioning of wetland ecosystems.

Steepening the shorelines of Type III sites would destroy the edge which is such an integral component of a diverse marsh community. This edge is also important as winter cover for pheasants.

On page 142 is the prediction that island/moat construction and slope modification will suppress flora and fauna populations during construction. It is expected that these populations will reestablish readily...Slope modification will affect waterfowl if improperly managed."

The fact is that slope modification (destruction) is improper management and that it will seriously affect many living components of wetlands, including waterfowl.

The shallow water of the marsh edge is necessary for the occurrence of some emergent vegetation and the invertebrate fauna which occurs in such vegetation communities. The deeper water favored by the MMCD is biologically less diverse and less desirable. It is the floral and faunal richness of these edges which make them important to wildlife. A "clean shoreline" is also a relatively sterile shoreline.

NO DATA IS REFERENCED TO SUPPORT THE STATEMENT THAT "DEEPER WATER...IS BIOLOGICALLY LESS DIVERSE..." MMCD EXPERIENCE STUDYING METRO AREA AQUATIC INSECT FAUNA INDICATES THE CONTRARY. JOINT DNR, USFWS AND MMCD STUDIES PLANNED FOR 1978 WILL RESOLVE THIS MATTER. SEE DISCUSSION PAGES 70 THROUGH 75.

29)
The island/moat proposal is also a questionalbe idea. The construction of islands and moats may constitute the "creation of new habitat" where no wetland habitat existed previously. However, the destructive modification of Type I, II, and III natural wetlands into islands and moats does not constitute the creation of "new habitat". The sites created would not support the diverse fauna and flora of the natural wetlands, and any benefit to waterfowl, muskrats, beaver, and mink would possibly be less than the benefits existing before existing before modification. The value of the islands to nesting ducks is questionable because raccoons regularly visit such islands and readily destroy any nests encountered. Raccoons were not mentioned in the discussion on page 142 of the EIS.

There is essentially no mitigation proposed for the destruction of wetlands which is proposed. The cost of adequate wetland mitigration would undoubtedly exceed the value of any mosquito control achieved.

SEE FEIS DISCUSSION ON PAGES 173 AND 271 FOR PREDATOR IMPACT. NO MITIGATION IS PROPOSED PENDING NEEDED STUDIES AS WAS INDICATED IN THE DEIS. ADDITIONAL UNDERSTANDING WILL PROVIDE THE BASIS FROM WHICH TO PROPOSE MITIGATING MEASURES.

A JOINT DNR, USFWS, AND MMCD FIELD REVIEW OF PHYSICAL MODIFICATION TO MOSQUITO BREEDING SITES MADE IN THE PAST BY PROPERTY OWNERS IS PROPOSED. THE POSITIVE AND NEGATIVE IMPACTS ON WILDLIFE OF EACH CHANGE WILL BE ASSESSED AND COMPARED TO THOSE PROJECTED IN THIS FEIS.

FIELD DATA ON THE DIRECT EFFECTS OF LIMESTONE APPLICATIONS DO NOT INDICATE SIGNIFICANT NEGATIVE IMPACTS. SEE PAGE 277.

WE AGREE THAT PRIVATE OR PUBLIC OWNERS OF INTERMITTENT TYPE 1 WETLANDS MAY BE ENCOURAGED TO PERMANENTLY ALTER THESE LOCATIONS ONCE INFILTRATION RATES HAVE BEEN INCREASED. IT REMAINS PROBLEMATICAL AS TO WHETHER IT SHOULD BE THE RESPONSIBILITY OF THE MMCD TO REGULATE THIS. DIRECT REGULATION BY INCORPORATED COMMUNITIES MAY BE A MUCH MORE EFFECTIVE MEANS OF MAINTAINING INTERMITTENTLY WET AREAS. WHETHER OR NOT BEHAVIOR CHANGES OCCUR SIMPLY BECAUSE OF LIMESTONE TREATMENT MUST, HOWEVER, BE TESTED.

IT SHOULD BE NOTED THAT PUBLIC WATERS AS DEFINED BY THE MDNR DO NOT INCLUDE INTERMITTENT SURFACE RUNOFF AREAS. IT SHOULD ALSO BE EMPHASIZED THAT UNDER LIMESTONE TREATMENTS, WATER WILL CONTINUE TO RUN INTO TREATED SITES AND WILL CONTINUE TO BE PRESENT FOR A TIME.

30)
University of California, Riverside
Riverside, California 92521

Dr. Robert D. Sjogren
Director
Metropolitan Mosquito Control District
1802 Como Avenue
St. Paul, Minnesota 55108

Dear Bob:

I have noted the following errors, etc. in reading the draft of the report:

p. 66 - What is mssing in the heading in this Table 18? It does not make sense to me.

p. 111, Table 27 - LD_{50}, ug/bee not u/bee

p. 117, line 26 - Haxleton should be Hazleton

p. 123, line 16 - maloxon should be malaoxon

p. 130, "h"; "l" monogamy/polygamy -- these are the same in both subdivisions?

Other than the errors noted above, I have one suggestion. I find it very difficult of find any one specific problem and its answer or parameter. It would seem desirable to have an index in addition to the Table of Contents. Notwithstanding, I find the EIS a through and comprehensive undertaking; I congratulate you for it. If I can be of further help to you, please contact me.

Very truly yours,
E. Laurence Atkins
Specialist in Entomology & Apiology

TIME AND FUNDS DID NOT PERMIT COMPLETION OF AN INDEX, HOWEVER, THE TABLE OF CONTENTS HAS BEEN GREATLY EXPANDED.

31)
Dr. Olaf Pfannkuch
Department of Geology and Geophysics
University of Minnesota

Dr. Robert Sjogren
Metropolitan Mosquito Cotrol District
1802 Como Avenue
St. Paul, Minnesota

Dear Dr. Sjogren:

The following corrections on the EIS draft are submitted in response to your request for comments.

Page	Line	Is	Should be
140	2	affects	effects
143	1	The hydrologic cycle.....	A generalized hydrologic cycle....
es-3	21	fluvialate	fluviatile
es-7	24	Larson-Hidgeon	Larson-Higdem
es-15	10	rainfull	rainfall
b-1	27	Strube	Strub
b-4	24	Wright, H. E.	Wright, Jr., H.E.
b-4	28	Wright, H. E.	Wright, Jr., H. E.

Sincerely yours,
Olaf Pfannkuch

AMERICAN MOSQUITO CONTROL ASSOCIATION, INC.

"Mosquito News, Journal of the American Mosquito Control Association"
"Mosquito Systematics" "AMCA News Letter"

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PLEASE ADDRESS REPLY TO:

5545 East Shields Avenue
Fresno, CA 93727

June 14, 1977

Dr. Robert D. Sjogren, Director
Metropolitan Mosquito Control District
1802 Como Avenue
St. Paul, Minnesota 55108

Dear Bob:

Probably you do not know that shortly after returning from the AMCA meeting in New Orleans, I left USA on April 18, for 6 weeks in El Salvador, under auspices of USAID, to help the Government of El Salvador (GOES) redevelop its plan for malaria control (83,000 cases in 1976) into a comprehensive vector mosquito control program, scheduled to begin functioning in July.

Because of the aftermath workload generated by the New Orleans meeting, and the pressures of preparing for the El Salvador mission, it simply was not possible for me to spend sufficient time to adequately review and appraise the impressive EIR you prepared for your program. However, leafing through it appeared to indicate that it is a most complete statement--obviously requiring a tremendous effort and cost to develop and assemble--which also, obviously, must be paid for by your local taxpayers.

This leads me to one general comment: regularly organized scientific mosquito control agencies such as yours have been, from the start, dedicated to improving for man and other animals one extremely important segment of the environment. Such agencies have been composed of "practical working environmentalists and ecologists", predating by many years the current crop of "regulatory environmentalists", and in fact, the standards of performance now demanded by the regulatory agencies are based mainly upon the standards that had been evolved earlier by state and local governmental agencies engaged in mosquito control!

The purpose for which the environmental regulatory agencies was created is fully appreciated by governmental mosquito control agencies, and they have been cooperating and will continue to cooperate within reason for a better environment. However, it is clearly unreasonable that they be required to squander funds on such arduous and costly detailed reports, which only increase the costs of their programs. This is particularly so because the dynamic change which constantly occurs in mosquito problems

and corresponding control programs, will quickly outdate any EIR developed now. One is impressed with the evident lack of respect for scientific programs exhibited by the bureaucratic regulatory agencies. This generates concern that the idealistic purposes for which they were formed, and what is worth while in the "environment protection" programs, may be lost as taxpayers come to appreciate the extraordinary inflationary and energy wasting impact of the unreasonable regulatory requirements. When this occurs, it is quite probable that the people may demand relief from the direct and indirect costs of the "environment" programs.

I'm sure you are aware that AMCA by unanimous vote of its members at the 1976 annual meeting passed a resolution offering full cooperation to the various regulatory agencies--but although a copy was sent to the administrator of the U.S. environmental protection agency, no acknowledgement was ever received!

Nevertheless AMCA still stands ready to cooperate with USEPA. The best form which such cooperation could take is the development of standards and procedures for local mosquito control by AMCA, with financial support by EPA through grants, to develop a suitable document which would be followed by all local mosquito control agencies, thereby obviating the need for countless wasteful local EIRs!

Sincerely yours,

Thomas D. Mulhern
Executive Director

TDM:lc
Encl

AMERICAN MOSQUITO CONTROL ASSOCIATION, INC.
Office of the Executive Director
5545 East Shields Avenue, Fresno, California 93727

RESOLUTION

WHEREAS: Local mosquito and vector control agencies are established to insure a healthy and satisfactory environment for man, free from degradation by mosquitoes and other vectors,

AND WHEREAS: The constituent members of AMCA have reported that federal, state, and regulatory agencies, by sometimes arbitrary and capricious action, are hampering the function of these mosquito and vector control agencies,

AND WHEREAS: The membership of AMCA includes the outstanding authorities in this field throughout the United States and over 100 other countries, and shares concern of these local agencies,

NOW THEREFORE BE IT RESOLVED: That the AMCA stands ready to provide information and assistance to the Congress and all regulatory agencies in order to achieve cooperation and understanding and to avoid conflict and confrontation between local mosquito and vector control programs and the various regulatory agencies.

ADOPTED WITHOUT DISSENTING VOTE, BUSINESS MEETING OF AMCA

APRIL 22, 1976

BOSTON, MASSACHUSETTS

33)

STATE OF MINNESOTA

DEPARTMENT OF AGRICULTURE
STATE OFFICE BUILDING
SAINT PAUL, MINN. 55155

LAND OF QUALITY FOODS

June 24, 1977

Mr. Ed C Bowler
Coordinating Assistant
Metropolitan Mosquito Control District
1802 Como Avenue
St. Paul MN 55108

Dear Mr. Bowler:

This letter is in response to your request to review the field operations records keeping system of Metropolitan Mosquito Control District.

We have examined in considerable detail the field operations records keeping system and found it to be very complete and thorough in all areas of field information. The records are summarized into a concise form yet individual inspection and application records are readily available for examination. Information on any inspection and application is easily retrievable.

The system is so designed that quality checks of insecticide application rates are readily performed to insure uniformity throughout the control district.

We are satisfied this record keeping system is an excellent system and fully meets the needs of the district in carrying out its program.

Sincerely,

J. R. Sandve

J.R. Sandve, Assistant Director
Division of Plant Industry

JRS/mab

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EQUAL OPPORTUNITY EMPLOYER

34)

STATE OF MINNESOTA

DEPARTMENT OF AGRICULTURE
STATE OFFICE BUILDING
SAINT PAUL, MINN. 55155
TELEPHONE: (612) 296-3347

LAND OF QUALITY FOODS

June 28, 1977

Mr. Ed C. Bowler
Coordinating Assistant
Metropolitan Mosquito Control District
1802 Como Avenue
St. Paul, MN 55108

Dear Mr. Bowler:

We have been asked to review the procedures used by the Metropolitan Mosquito Control District to avoid damage to bees caused by the application of insecticides. Your field records and apiary location maps are kept in an up-to-date manner comparing favorably with those used by the Department of Agriculture. We realize it is difficult to locate and map each apiary location in the metropolitan area. Some of the reasons are as follows:

1. Bee colonies are not always located at the residence home address

2. The exact colony location is not always correctly described by the beekeeper

3. Some beekeepers fail to register all colony locations

4. Some beekeepers fail to register any of their bees

There has been a dramatic increase in the number of new beekeepers in the six county metropolitan area in the past few years, especially hobby beekeepers. Your field staff seems to be doing a good job in adding new apiary locations to the maps as soon as they are found.

Our conclusion is that MMCD field personnel are making an honest effort to locate all bee colonies and are willing to explain mosquito control procedures to beekeepers. We also commend you for your policy that toxic materials are not

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applied during daylight hours when bees are in flight. We recommend that public relation efforts between the MMCD, the Minnesota Department of Agriculture and various beekeeper organizations be continued.

Sincerely,

J.R. Sandve, Assistant Director
Division of Plant Industry

JRS:ds

35)

UNIVERSITY OF MINNESOTA
TWIN CITIES

Department of Entomology,
Fisheries and Wildlife
219 Hodson Hall
1980 Folwell Avenue
St. Paul, Minnesota 55108

June 27, 1977

To Whom It May Concern:

Mr. E. Laurence Atkins, specialist in Entomology and Apiology, University of California, Riverside is, in my opinion, the most experienced if not the most knowledgeable authority on "injury to honey bees by pesticide poisoning."

I would certainly respect his opinion on matters regarding honey bees and pesticides. Anyone who has investigated the effect of pesticides on honey bees over 20 years in the State of California must be respected for his evaluation of honey bee - pesticide interactions.

Sincerely,

Basil Furgala
Professor

BF/skg

36)
United States Department of the Interior
Fish and Wildlife Service
Federal Building, Fort Snelling
Twin Cities, Minnesota 55111

Dr. Robert D. Sjogren, Director
Metropolitan Mosquito Control District
1802 Como Avenue
St. Paul, Minnesota 55108

Dear Dr. Sjogren:

Per your letters of March 19, 1977 and March 23, 1977, following are our comments on the Metropolitan Mosquito Control District draft Environmental Impact Statement (EIS).

Generally, the draft EIS appears to be a comprehensive document covering all facets of MMCD operations. Aside from some minor editorial deficiencies, we found only two substantive items that we feel are in need of further clarification.

Editorial. Whoever wrote the text of the draft EIS should be made aware that effect and affect are not synonyms. Throughout, but especially beginning with the chapter on Environmental Impacts, affect is used mistakenly in place of effect. Page 107, for example contains six such errors.

Page 11, last paragraph. The correct designation is U. S. Fish and Wildlife Service, not National.

Page 121, Section on Reptiles. Frogs properly are classified as amphibians, not reptiles.

WE TRUST THAT CORRECTIONS TO AFFECTED PASSAGES HAVE BEEN PROPERLY EFFECTED.

PLEASE ACCEPT OUR APOLOGIES FOR THE OVERSIGHT MADE IN INCORRECTLY IDENTIFYING THIS AGENCY.

THE TERM AMPHIBIANS HAS BEEN INSERTED INTO THE TEXT WHERE APPROPRIATE.

37)
Wetland Modification. Our principal distress with the draft EIS stems from the attitude of the writers that Type I wetland sites are of value only for the enhancement of mosquito populations. This being the case, in the District's view, they are fair game for elimination in the name of mosquito control.

We submit that the MMCD Type I wetlands (i.e. U. S. Fish and Wildlife Service Types I, II and III), far from being "overflow" feeding areas during periods of abnormally large duck populations, whenever that might be, actually are important seasonal habitat every year. These temporary water areas are among the first open water sites to appear in the spring. They are used heavily by migrating waterfowl. Investigators at our Northern Prairie Wildlife Research Center have information that indicates that the invertebrate fauna found in the Types I, II, and III (FWS) wetlands is an important source of protein for the migrating birds just prior to egg laying.

If it is the judgement of the MMCD that the adverse mosquito producing role of Type I, II and III (FWS) wetlands outweighs their value as wildlife habitat, then so be it. But the elimination of the wetlands via limestone treatments or ditching should not be premised in part on a supposed absence of benefit to waterfowl, as described on page 141. To the extent that the draft EIS fails to recognize the importance of wetland Type I, II and III (FWS) as spring waterfowl habitat, the draft is inadequate.

A) PLEASE REFER TO PAGE 70 OF THE TEXT, WETLAND FOOD CHAIN WHEREIN THE DESCRIPTION OF MMCD TYPES I, II, III SITES HAS BEEN SUBSTANTIALLY EXPANDED.

B) THE DISTRICT APPRECIATES THE DIFFICULTY IN TRANSLATING CLASSIFICATIONS OF WETLANDS AS DESIGNATED BY VARIOUS SOURCES INTO A COMMONLY UNDERSTOOD SET OF TERMINOLOGY. AN EFFORT HAS BEEN MADE TO DO SO IN THIS FEIS. NONETHELESS ONE AREA OF INTERPRETATION IS WORTH REPEATING.

IN THE DEIS AND FEIS, MMCD TYPE I BREEDING SITES ARE DEFINED AS POTHOLE DEPRESSIONS AVERAGING ABOUT 4 ACRES IN SIZE BUT VARYING FROM .06 TO OVER 100 ACRES IN SIZE. THESE SITES HAVE BEEN DEFINED AS SIMILAR

TO FWS TYPES I,II AND III.

MMCD TYPE I SITES ACTUALLY APPROXIMATE FWS TYPE III MOST CLOSELY. THE SIMILARITY HOWEVER IS PRIMARILY IN VEGETATION. IN ITS CIRCULAR NO. 39 (REVISED 1971) THE FWS DESCRIBES TYPE III INLAND SHALLOW FRESH MARSHES AS HAVING "SOIL WHICH IS USUALLY WATERLOGGED DURING THE GROWING SEASON; OFTEN COVERED WITH AS MUCH AS 6 INCHES OR MORE OF WATER." LATER IN THE DISCUSSION, THESE SITES ARE REFERRED TO AS "MARSHES USED EXTENSIVELY AS NESTING AND FEEDING HABITAT IN THE POTHOLE COUNTRY OF THE NORTH CENTRAL STATES AND ELSEWHERE."

MMCD TYPE I SITES ARE NOT WATERLOGGED DURING THE GROWING SEASON. THEY ARE NOT NORMALLY COVERED WITH MORE THAN SIX INCHES OF WATER. THEY ARE NOT MARSHES. TYPE I (FWS) SITES IN NORTH CENTRAL STATES (MINNESOTA IS NOT IN THIS GROUP) ARE, AS DNR PERSONNEL ARE FOND OF SAYING, SURFACE EXPRESSIONS OF GROUNDWATER.

MMCD TYPE I SITES ARE LENSE TRAPPED WATER SITES WHICH HOLD WATER INTERMITTENTLY BECAUSE OF POOR INFILTRATION AND LACK OF CONNECTION TO DRAINAGE SYSTEMS. UNDER CONDITIONS OF NORMAL PRECIPITATION IN THE TWIN CITIES (ROUGHLY 18" PER YEAR), THE AVERAGE MMCD TYPE I SITE WOULD BE WET INTERMITTENTLY APPROXIMATELY 125 DAYS BETWEEN MARCH 15 AND SEPTEMBER 15 (180 DAYS) NORMALLY DRYING UP BY JUNE, HOLDING WATER FOR ONLY 10 - 14 DAYS AT A TIME THEREAFTER. TEN PER CENT OF THESE MMCD TYPE IA MOSQUITO BREEDING SITES ARE WET THROUGH JULY 1. WATER DEPTH IS BETWEEN FOUR AND EIGHT INCHES IN THESE SITES.

IN THE ABSENCE OF A RELIABLE INVENTORY OF WATERFOWL FEEDING, NESTING AND LOAFING AREAS IN THE TWIN CITIES, MOST RESEARCHERS DEPEND UPON THE FINDINGS OF SWANSON (USFWS NORTHERN PRAIRIE WILDLIFE RESEARCH CENTER, JAMESTOWN, NORTH DAKOTA) FOR INFORMATION AND AUTHORITY IN THIS AREA. SWANSON, HIMSELF, ADVISED THE MMCD (PERSONAL COMMUNICATION FEBRUARY 1977) THAT MMCD TYPE I SITES ARE USEFUL TO WATERFOWL PRIMARILY AS SUPPLENTAL, OVERFLOW FEEDING GROUNDS.

DR. LEWIS COWARDIN OF THE NORTHERN PRAIRIE WILDLIFE RESEARCH CENTER WHO IS CURRENTLY IN THE PROCESS OF REVISING FWS WETLAND CLASSIFICATIONS, AND A FORMER RESIDENT OF MINNESOTA STATES (PERSONAL COMMUNICATION, JULY 1977) THAT FWS WETLAND CLASSIFICATIONS DO NOT APPLY ACCURATELY TO MINNESOTA WETLAND TYPES.

TWO-THIRDS OF THE MMCD SUPERVISORY STAFF HAVE BEEN IN THE FIELD FOR OVER TEN YEARS. SUPERVISORS WERE SURVEYED IN 1976 BY THE DISTRICT AND ASKED TO NAME DUCKS SEEN IN THE MMCD SERVICE AREA, ARRIVAL DATES OF MIGRATORY WATERFOWL, NESTING HABITS, AND EGG HATCHING DATES.

SUPERVISORS RESPONDED THAT DUCK POPULATIONS SEEK OUT OPEN WATER, GENERALLY MMCD TYPE III SITES, AND MOVE INTO MMCD TYPE I AREAS WHEN DUCK POPULATIONS OVER CROWD MMCD TYPE III SITES. SUPERVISORS NOTE THAT WOOD DUCKS, TEAL AND MALLARDS COMPLETE HATCHING BY JUNE 1 WHEN MMCD TYPE II SITES ARE DRY AND MMCD TYPE I SITES ARE BECOMING DRY. IT HAS BEEN OBSERVED THAT NESTS LOCATED NEAR MMCD TYPE I SITES FREQUENTLY DO NOT PRODUCE BROODS AS WATER IS NOT AVAILABLE TO WET THE EGGS.

WOOD DUCKS AND MALLARDS HAVE BEEN SIGHTED DURING THE SECOND WEEK IN MAY. BLUE BILLS, RED HEADS AND CANVAS BACKS HAVE BEEN SIGHTED BUT HAVE NOT BEEN KNOWN TO TO NEST IN THIS AREA.

C) LIMESTONE TREATMENTS TO 14,000 MMCD TYPE I BREEDING SITES OF A MAXIMUM SIZE OF 2 ACRES AND AN AVERAGE SIZE OF 1/2 ACRE WOULD ELIMINATE APPROXIMATELY 1.3% OF TOTAL WETLAND AREAS IN THE DISTRICT AS DEFINED IN WATER RETENTION TIME. THIS IS NOT TO SAY THAT 1.3% OF THE WETLANDS IN THE DISTRICT WILL DISAPPEAR BUT THAT WET PERIODS WILL BE REDUCED BY 1.3%.

WITH LIMESTONE TREATMENTS, THE DYNAMICS OF THE AQUATIC ECO-SYSTEM WILL APPROXIMATE THAT FOUND PRESENTLY WHEN PRECIPITATION LEVELS ARE LESS THAN 1½". IN NORMAL YEARS, RAINFALLS OF 1½" OR MORE OCCUR ROUGHLY SIX TIMES A SEASON.

38)
Chemical Program. From the time the District repented and gave up its reliance on organochlorine insecticides, we have had no cause to be alarmed at any aspect of your chemical programs. Until recently, that is. The growing extent of your dependence on Dursban (chlorpyrifos) as outlined in the draft EIS, comes as something of a surprise This organophosphate is among the most toxic of those registered for mosquito control. Even in the hands of professionals Dursban offers a small margin of safety for many non-target

organisms. The published studies on Dursban toxicity - some cited in the draft, some not - clearly indicate that the use of Dursban in mosquito control is a chancy choice. We agree that Dursban probably is safe in terrestrial situations. In aquatic sites, on the other hand, the outlook is less encouraging. Considering that Dursban is lethal to many invertebrates in concentrations of but a few ppb, we feel that the draft EIS should have presented more field data on effects on non-target invertebrate populations from use in MMCD operations. The same point applies to the other chemicals used in larvicid-ing operations. The invertebrate populations of the Type I, II and III (FWS) wetlands are an important constituent of habitat quality. It may be necessary to alter or destroy these populations to effect mosquito control objectives. If so, these effects properly should be assessed against the total cost of mosquito population reduction. The draft EIS is vague on this aspect of MMCD Chemical programs.

Thank you for the opportunity to review the MMCD draft EIS.

Sincerely yours,
Richard T. Huber

cc Minnesota DNR, St. Paul

SUBSEQUENT DISCUSSION WITH FISH AND WILDLIFE SERVICE STAFF REGARDING THE CHEMICAL PROGRAM COMMENT INDICATE THE STATEMENT "THE USE OF DURSBAN IN MOSQUITO CONTROL IS A CHANCY CHOICE" WAS BASED PRIMARILY ON ITS DIRECT TOXICITY TO FISH AND SECONDARILY ON INVERTEBRATE NON-TARGET ORGANISM SUPPRESSION.

AS PRESENTED IN THE DRAFT EIS, CHLORPYRIFOS IS NOT USED IN FISH BEARING WATERS OR LOCATIONS WHERE SURFACE RUNOFF COULD CARRY IT INTO SUCH WATERS. THE IMPACT OF CHLORPYRIFOS AND TEMEPHOS ON INVERTEBRATE POPULATIONS HAS BEEN EXPANDED UPON IN THE FEIS. THE INVERTEBRATE POPULATION LEVELS EXISTING IN SITES WHERE CHLORPYRIFOS IS USED, AND THUS THE SIGNIFICANCE OF ITS SECONDARY IMPACT ON WILDLIFE CONSTITUTES A DIFFERENCE OF OPINION BETWEEN THE USFWS AND MMCD STAFF. A JOINT USFWS, DNR, AND MMCD STUDY TO RESOLVE THIS MATTER IS PLANNED FOR 1978. FOR EFFECTS OF CHLORPYRIFOS AND TEMEPHOS ON BIRDS AND MAMMALS SEE TABLE 16.

39)
Minnesota Pollution Control Agency

Dr. Robert Sjogren, Director
Metropolitan Mosquito Control District
1802 Como Avenue
St. Paul, Minnesota 55108

Dear Dr. Sjogren:

The staff of the Minnesota Pollution Control Agency (MPCA) has reviewed the Metropolitan Mosquito Control District (MMCD) Environmental Impact Statement (EIS) and would like to offer the following comments.

The EIS gives the impression that there have never been problems related to the use of chemical insecticides in the Metropolitan Area. The EIS goes further and dismisses concerns by stating, on page 104 that persons believing that chemical control may cause environmental damage to birds and domestic animals is in direct contradiction to virtually all research on the toxicity of adulticiding materials. It is assumed that those answering the questionnaire are referring to adulticiding agents rather than larval control agents. This may be due to the fact that many persons do not know the difference between the two methods of control. We are concerned that a false impression is being portrayed by an editorial approach to the EIS. We intend to provide specific cases where problems have occurred so that the MMCD can evaluate their use of chemical control methods

DOCUMENTATION IN EVIDENCE OF THE ABOVE ALLEGATION WAS REQUESTED OF THE MPCA BY THE DISTRICT MAY 25, 1977. NO RESPONSE HAS BEEN OFFERED TO DATE (SEE MPCA COMMENT 165 THROUGH 167).

THE FOREGOING COMMENT REQUIRED A POINT BY POINT RESPONSE.

(A.) THE MMCD DOES NOT JUDGE ITSELF COMPETENT TO EVALUATE THE EFFECTS OF INSECTICIDE CHEMICALS AS USED IN THE TWIN CITIES FOR ANY PURPOSE OTHER THAN PUBLIC MOSQUITO CONTROL, AND HAS MADE NO ATTEMPT TO DO SO. COMPENSATION HAS BEEN MADE

BY THE USDA TO BEEKEEPERS FOR HONEYBEE KILLS. ATKINS (1976) QUOTED IN THIS FEIS (PAGE 265) NOTES THAT HOMEOWNERS FREQUENTLY OVERDOSE WHEN USING COMMERICAL PRODUCTS.

ONE KILL OF FORAGING BEES WAS REPORTED IN ASSOCIATION WITH ULV MALATHION TREATMENT AS FORMERLY APPLIED BY THE MMCD. NO WILDLIFE KILLS HAVE BEEN REPORTED RELATED TO MMCD OPERATIONS. SEE COMMENT 171.

ANY IMPRESSION LEFT BY THE DEIS THAT THERE HAVE NEVER BEEN ANY PROBLEMS ASSOCIATED WITH THE USE OF ANY INSECTICIDE IN THE METROPOLITAN AREAS WAS UNINTENTIONAL ANY IMPRESSION LEFT WITH THE READER THAT THE MMCD HAS HAD NO SIGNIFICANT ENVIRONMENTAL OR HEALTH-RELATED PROBLEMS AS A RESULT OF USING THE MATERIALS DISCUSSED IN THIS TEXT IS INTENTIONAL.

(B.) THE FACT THAT 24% OF THE PERSONS SURVEYED BY THE MMCD IN 1976 CONSIDER ADULTICIDING HAZARDOUS TO THE ENVIRONMENT DOES NOT MEAN THEY ARE CORRECT. REFERENCING DOCUMENTED EVIDENCE TO THE CONTRARY IS NOT A WAY OF "DISMISSING CONCERNS".

THE DISTRICT VIEWED THESE RESPONSES AS REAL OPINIONS AND DID NOT FORGO ITS ANALYSIS OF PROGRAM IMPACTS ON THE ENVIRONMENT SIMPLY BECAUSE 41% OF THE RESPONDENTS FEEL THERE IS NO ASSOCIATED PROBLEM.

THE DISTRICT HAS CONCLUDED ON THE BASIS OF ITS OWN EXPERTISE AND EXPERIENCE, THE FINDINGS OF REPUTABLE SCIENTISTS AND THE DATA GENERATED TO REGISTER INSECTICIDES THAT THE MATERIALS USED IN ITS FIELD OPERATIONS ARE NOT HAZARDOUS TO THE ENVIRONMENT WHEN APPLIED ACCORDING TO LABEL INSTRUCTIONS BY COMPETENT APPLICATORS EXCEPT AS STATED ELSEWHERE IN THIS TEXT.

THE REPORTING OF THESE CONCLUSIONS IS NOT MADE SELECTIVELY NOR WITH THE INTENT OF CREATING FALSE IMPRESSIONS. IT IS IMPORTANT TO REMEMBER THAT THIS EIS IS NOT INTENDED AS A HANDBOOK ON INSECTICIDES BUT AS AN ENVIRONMENTAL ASSESSMENT OF FOUR ORGANOPHOSPHATES AND PETROLEUM OIL AS USED FOR MOSQUITO CONTROL BY A LOCAL AGENCY. THESE

MATERIALS ARE VIEWED IN THAT CONTEXT. ANY GENERALIZATION DERIVED THEREFROM ABOUT CHEMICALS IS NOT APPROPRIATE.

GENERAL UNFAMILIARITY WITH THE MMCD BY THE TWIN CITIES POPULATION WAS BORNE OUT BY THE SURVEY CONDUCTED IN 1976. THE DISTRICT IS APPRECIATIVE OF THE IMPLIED WEAKNESS IN ITS PUBLIC RELATIONS EFFORTS AND WOULD WELCOME RECOMMENDATIONS WHICH MIGHT IMPROVE THIS PROBLEM.

ONE POINT ABOUT THE 24% OF THE POPULATION CONCERNED ABOUT THE EFFECTS OF SPRAYED INSECTICIDES ON THE ENVIRONMENT. THE QUESTION TO WHICH THESE PERSONS RESPONDED IN THIS MANNER WAS ONE OF MANY INCLUDED IN THE SURVEY. THE ANSWERS OF THIS POPULATION (24%) TO OTHER QUESTIONS ARE NOTEWORTHY. THIS GROUP OF RESPONDENTS SPEND LESS MONEY ON REPELLENTS AND SPRAYS THAN OTHER RESPONDENTS. THE BREAKDOWN IS AS FOLLOWS:

A) SPRAYS ARE DANGEROUS: $1.72 PER HOUSEHOLD

B) DON'T KNOW: $2.89

C) SPRAYS ARE NOT DANGEROUS: $3.68

ON THE OTHER HAND, TWO-THIRDS OF THIS 24% AGREE THAT IF HIGHER LEVELS OF CONTROL COULD BE GUARANTEED, MORE MONEY SHOULD BE SPENT ON MOSQUITO CONTROL.

ASSESSEMENT OF PROGRAM ADEQUACY DIFFERED INSIGNIFICANTLY FROM THAT EXPRESSED BY RESPONDENTS WHO DO NOT OPPOSE THE USE OF SPRAYS IN THE ENVIRONMENT.

TWO PERCENT OF THE TOTAL SAMPLE POPULATION REPORTED THAT MMCD OPERATIONS HAVE INTERFERRED WITH THEIR DAILY ROUTINES. THE FIGURE WAS 5% AMONG RESPONDENTS WHO OPPOSE SPRAYING IN THE ENVIRONMENT.

(C) THE DISTRICT TAKES EXCEPTION TO THE ALLEGATION THAT AN 'EDITORIAL APPROACH' HAS BEEN USED WITH THE INTENT OF 'CREATING FALSE IMPRESSIONS'. THE PURPOSE OF AN EIS AS UNDERTSOOD BY THE AUTHORS IS TO EXPOSE PRACTICES AS EMPLOYED IN THEIR ENVIRONMENTAL SETTING WITH THE INTENTION OF DRAWING CONCLUSIONS AS TO THE SIGNIFICANT OUTCOMES OF SHORT-TERM AND LONG-TERM INTERACTIONS BETWEEN THEM.

TO APPROACH THE RESEARCH WITH A FEELING THAT ANY INVESTIGATION NECESSARILY LEADS TO AN EXPOSE OF SERIOUS NEGATIVE IMPACTS IS UNREALISTIC. WHAT'S WORSE, IT INHIBITS THE OBJECTIVE ANALYSIS OF POTENTIAL ALTERNATIVES.

THERE IS A FINE LINE BETWEEN EDITORIALIZING AND PLACING EFFECTS OF A PROGRAM IN AN IMPACT PERSPECTIVE. THE DISTRICT APPRECIATES THE FACT THAT CONCLUSIONS DRAWN IN THE DEIS WERE NOT SUFFICIENTLY DOCUMENTED. THE PROCESS OF DOCUMENTATION, HOWEVER, HAS NOT ALTERED THESE CONCLUSIONS AS RESTATED IN THE FEIS.

40)
On page 55, a discussion on the insecticide registration process is given. We wish to point out that at one time DDT was registered and there is no absolute assurance that chemicals used by the MMCD will not turn out to be as dangerous as previously registered insecticides.

SEE TEXT, PAGE 101 UNDER PROGRAM DESCRIPTION AND PAGE 112 IN ENVIRONMENTAL IMPACT SECTIONS FOR DESCRIPTIONS OF INDEPENDENT SCIENTIFIC EVALUATIONS OF REGISTERED MATERIALS.

41)
On Page 78, the DEIS states that informal ties are maintained with beekeepers. Is this only with those registered or with all beekeepers? It should be noted that registration is required only for keepers with more than ten hives. This would represent a minority of the overall beekeepers in the District.

42)
ACCORDING TO MINNESOTA LAW (PORTIONS OF WHICH ARE REPRINTED ON PAGE 84), ANY BEEKEEPER REGARDLESS OF THE NUMBER OF HIVES ONE OWNS, IS REQUIRED TO REGISTER BEES WITH THE MINNESOTA DEPARTMENT OF AGRICULTURE. THE MMCD HAS NOTED THESE APIARIES ON ITS FIELD MAPS AS WELL AS OTHERS FOUND IN THE COURSE OF FIELD OPERATIONS. THE LOCATION OF HIVES SO NOTED ARE REVISED FROM TIME TO TIME AND NO AERIAL APPLICATIONS ARE MADE WITHIN ONE QUARTER MILE OF THESE SITES.

METHODS USED BY THE MMCD IN THE LOCATION OF BEE COLONIES HAVE BEEN REVIEWED BY THE MINNESOTA DEPARTMENT OF AGRICULTURE. DEPARTMENT FINDINGS WERE CONVEYED TO THE DISTRICT IN THE FORM OF A LETTER REPRODUCED AS COMMENT 35.

42)
On page 121, a discussion on the impact to humans is provided. We believe this discussion should provide the worst case conditions, under abnormal operation and faulted or improper use to adequately determine the potential impacts of the use of insecticides. It is our understanding that many of these insecticides could be hazardous to the hyper-allergenic, infants, old aged, and heart patients. Particular concern should be expressed in the EIS for hyper-allergenic people regarding the use of pyrethrins.

A) A WORST CASE SITUATION WOULD INCLUDE, THE CRASHING OF A HELICOPTER WITH A PAYLOAD OF LIQUID CHLORPYRIFOS; THE SPILLING OF LIQUID INSECTICIDES ON ONE'S PERSON; THE INTENTIONAL INGESTION OF LIQUID INSECTICIDES FOR PURPOSES OF SELF-DESTRUCTION; THE 'DUMPING' OF MIXED INSECTICIDES BY A FIELD WORKER AT A SINGLE LOCATION; THE SPRAYING OF RESMETHRIN DIRECTLY INTO A BEE HIVE.

IF A HELICOPTER LOADED WITH PREPARED CHLORPYRIFOS LIQUID INSECTICIDE (2.6 LB AI) WERE TO CRASH NEAR A 10 ACRE LAKE USED AS A SOURCE OF DRINKING WATER THE EFFECT WOULD BE ELIMINATION OF ALL FISH AND OTHER AQUATIC ORGANISMS ABOVE THE LEVEL OF BACTERIA. IN THE EVENT OF SUCH AN OCCURENCE, THE MMCD WOULD REQUEST THAT THE HEALTH DEPARTMENT POST THE LAKE. WATER WOULD NOT BE TOXIC FOR DRINKING OR SWIMMING AFTER 24 HOURS.

SEVERE ACCIDENTAL DERMAL CONTACT WITH A DOSE OF CONCENTRATE WOULD RESULT IN A DEPRESSED CHOLINESTERASE LEVELS IF CONTACT WAS PROLONGED. IMMEDIATE WASHING WITH SOAP AND WATER WOULD NORMALLY AVERT ANY DANGER IN THE LONG TERM. THE MMCD FOLLOWS U.S. OSHA STANDARDS AS SHOWN IN APPENDIX PD EXHIBITS C AND D (PAGES PD 30 AND PD 53).

SEEDER CAPACITY IS MATERIAL REQUIRED TO TREAT 3 ACRES. "DUMPED" MATERIAL WOULD DISPERSE FROM THE DUMPING SITE IN THE PRESENCE OF WATER SLOWLY RELEASING FROM THE GRANULES. ONCE RELEASED, MATERIAL WOULD RUNOFF WITH SURFACE FLOW, AND PLATE OUT ON ORGANIC MATERIAL IN THE AREA OF FLOW.

SUICIDE BY INSECTICIDE WOULD BE EFFECTIVE.

B) ALLERGY IS A TOPIC DIFFICULT TO HANDLE IN GENERALITIES. SOME (RANDOLPH, 1966) WOULD SUBJECT ALL EMISSIONS INTO THE ENVIRONMENT TO THE TEST OF ALLERGY-PRODUCING AGENTS. HENDERSON (COMMENTS 2 AND 3) WOULD RESERVE JUDGEMENTS SUBJECT TO A CASE BY CASE ANALYSIS. HENDERSON DOES SUBMIT RELUCTANCE TO CONFIRM THAT INSECTICIDES USED BY THE MMCD ARE ALLERGENIC.

43)
On page 107, the discussion is made on the impacts of the use of petroleum oils. This discussion is limited to the aquatic insects and should be expanded to include water quality effects, such as oxygen demand and the effects on aquatic plants.

SEE FEIS PAGE 222.

44)
On page 112, the discussion of terrestrial and aquatic flora impacts does not include in the discussion anything with regard to the impact on aquatic flora.

SEE FEIS PAGES 216 AND 232.

45)
Nowhere in the EIS is there a discussion on impacts to water quality including nutrient enrichment, oxygen demand and concentration of residual or degradation products in water bodies.

SEE FEIS PAGES 248 AND 254.

46)
On page 136, a discussion on biological control is provided. There is some confusion in the statement on mosquito annoyance that states that biological control is essentially the same as no control. Since 9.8% of the breeding sites are effectively controlled to 70-90%, we do not understand the basis for this conclusion.

CONTROL OF ONLY 10% OF BREEDING SITES WOULD NOT LOWER MOSQUITO POPULATIONS SUFFICIENTLY TO PROVIDE NOTICEABLE RELIEF. IN COMBINATION WITH OTHER PROGRAMS THIS MAY BE VALUABLE.

47)
It is difficult to relate the names of insecticides to the common trade names. There should be a definition showing that Dursban is the same as chlorpyrifos and Abate is the same as temphos. It was not until Dursban and chlorpyrifos were interchanged on page 127 that it was evident that the common names that we are most familiar with were not being used.

EARLY IDENTIFICATION IS PROVIDED IN THE FEIS.

48)
There are two sections missing in the DEIS.

A. Impact on State Government of any Federal controls
B. Multi-State Responsibilities

THESE HAVE BEEN INCLUDED IN THE FEIS.

49)
On page 73, Table 22 should state in the table the units dBA.

THIS HAS BEEN CORRECTED IN THE FEIS.

50)
Page 104, paragraph 5, states, "There is no doubt about the real value of the program in these areas." This statement is not supported by the previous statement in paragraph 4 which indicates that 26% of those polled are concerned about environmental damage resulting from adulticiding operations.

THE VALUE OF THE PROGRAM IS NOT DEPENDENT ON PERCEPTIONS OF DAMAGE TO THE ENVIRONMENT. AS INTERPRETED BY THE GENERAL PUBLIC THIS PERCENTILE INIDICATES A NEED FOR MORE PUBLIC EDUCATION ON THE PROGRAM IMPACTS AS RELATED IN THE FEIS.

51)
On page 133, the definition of the density of number of mosquitos per 11 hour monitoring period is unclear.

AN ELEVEN HOUR PERIOD IS A LIGHT TRAP NIGHT.

52)
There should be a better description of the quantities, types, and disposal methods of insecticide materials. It should be noted that the Rosemount site is not a disposal site (page 124). Information obtained from the University of Minnesota indicates there are no insecticide waste materials from the MMCD stored at this location. Will this material be shipped directly to Illinois?

SEE FEIS DISCUSSION ON PAGES 137 AND 138. FUTURE WASTE MATERIALS WILL BE STORED AT THE PCA APPROVED HENNEPIN COUNTY PUBLIC WORKS FACILITY STORAGE AREA UNTIL SHIPPED TO ILLINOIS.

53)
We are concerned that wastewater from washing equipment is being improperly disposed of. There should be a discussion in the EIS on the disposal of wastewater.

SEE TEXT, PAGE 137.

54)
There is concern about the right of eminent domain granted to MMCD. We believe that persons who feel strongly about the use of chemicals in our society should have the ability to restrict the use of chemicals on the properties which they own. Our experience indicates that there is a significant concern regarding the spraying of private property without permission, and the EIS does not express that concern. We believe the MMCD should develop a method to handle the requests of the public to avoid sensitive areas and the MMCD be accountable for any damage to private property resulting mosquito control programs. There should be a description in the EIS of the MMCD procedures on following up complaints of the public.

WE ARE NOT AWARE THAT UNIVERSAL PROHIBITION OF CHEMICAL USE ON LAND OWNED BY THOSE NOT WISHING SUCH APPLICATION IS FORMAL MPCA POLICY.

THE RIGHTS OF PRIVATE PROPERTY INCLUDE THE RIGHT, NORMALLY, OF PREVENTING TRESPASS. THIS RIGHT IS LEGALLY ABRIDGED FOR SUCH OVERRIDING PUBLIC GOOD AS PREVENTION OF FATALITIES, FIREFIGHTING, AND POLICE ACTIVITIES.

THE MINNESOTA LEGISLATURE DEEMED IT NECESSARY TO GRANT THE RIGHT OF ENTRANCE AND TREATMENT ONTO PRIVATE PROPERTY TO THE MMCD FOR THE TREATMENT OF MOSQUITO PRODUCING AREAS. THE REASON IS THAT MOSQUITOS DO NOT REMAIN AT THE SITE WHERE THEY ARE PRODUCED, BUT INSTEAD DISPERSE THROUGHOUT A LARGE PORTION OF THE METROPOLITAN AREA.

A GROWING SENSE OF THE VALUE OF PRIVATE PROPERTY VS PUBLIC GOOD HAS BEEN EVIDENT IN SUCH CONSTRUCTION - ORIENTED ACTIVITIES AS ELECTRIC POWER TRANSMISSION SYSTEMS, PIPELINES, AND HIGHWAYS. ALL OF THESE ACTIVITIES IMPLY THE RIGHT AND USE OF EMINENT DOMAIN TO CHANGE SURFACE PROPERTY - AT LEAST TEMPORARILY - AND PAY THE DAMAGES FOR INJURY THAT LOCAL JURIES FIND REASONABLE.

INJURY AS WELL AS PRIVACY ARE ISSUES WHEN EMINENT DOMAIN IS ENFORCED. NO INJURY CAN NORMALLY BE SHOWN TO EXIST WITH THE MMCD OPERATIONS, NO LIABILITY CAN BE SHOWN FOR USE OF EMINENT DOMAIN BY THE DISTRICT. WITH THE EXCEPTION OF TIRE RUTS, NO REPORTS OF ACTUAL INJURY TO PROPERTY HAVE BEEN RECEIVED AND DOCUMENTED BY THE DISTRICT.

NO EXERCISE HAS BEEN MADE BY THE MMCD OF EMINENT DOMAIN. REQUESTS THAT THE DISTRICT REFRAIN FROM ENTERING ONE'S PROPERTY ARE HONORED. THIS INCLUDES INSPECTIONS, LARVICIDING, AND ADULTICIDING. THUS NO ISSUE CURRENTLY EXISTS. IF ONE WERE TO RANK THE IMPACT OF ENTERING PRIVATE PROPERTY (AS IN THE IMPACT TABLE ON PAGES 186 TO 198). THE FOLLOWING WOULD SEEM APPROPRIATE:

RATING PUBLIC USE OF PRIVATE PROPERTY

IMPACT	NO.	DESCRIPTION
INSIGNIFICANT	■	ENTRY ONTO PUBLIC PROPERTY ONLY.
MINOR	1	NO ENTRY ONTO PRIVATE PROPERTY WHOSE OWNER HAS SO REQUESTED.
SIGNIFICANT	3	ENTRANCE ONTO PRIVATE PROPERTY 10% OF WHOSE OWNERS HAVE REQUESTED NO ENTRY BE MADE.
MAJOR	5	ENTRANCE ONTO PRIVATE PROPERTY 25% OF WHOSE OWNER'S HAVE REQUESTED NO ENTRY BE MADE
EXTREME	7	ENTRANCE ONTO PRIVATE PROPERTY 50% OF WHOSE OWNERS HAVE REQUEST NO ENTRY BE MADE.

UNDER THESE DEFINITION, THE MMCD HAS A MINOR IMPACT ON PUBLIC USE OF PRIVATE PROPERTY.

THE ONLY CASE WHERE ENTRANCE WILL BE MADE AGAINST WILL OF THE OWNER IS FOR CONTROL OF DISEASE VECTORS IF THAT SHOULD BECOME NECESSARY. AS THE DISTIRCT CONTINUES ITS PROGRAM OF IMPROVING CONTROL, IT PLANS TO EVALUATE THE ANNOYANCE LEVELS THAT MAY BE ASSOCIATED WITH INDIVIDUAL CONTROL SITES, UNDER THE PREMISE THAT A PUBLIC PEST IS NOT BEING CONTROLLED BY THE PROPERTY OWNER. UNDER SUCH A PROCEDURE, IT IS NOT LIKELY THAT DIP COUNTS OF UNDER 2.5 MOSQUITOS (OR 1/4 MILLION MOSQUITOS PER ACRE) WOULD RESULT IN PUBLIC CONTROL AGAINST PRIVATE OWNER'S OWN DESIRES. THE DISTRICT TREATS AIR SITES CONTAINING 1 OR MORE MOSQUITOS PER DIP. IF THE PROPERTY OWNER UTILIZES A BIOLOGICAL, PHYSICAL, OR CHEMICAL CONTROL PROCEDURE THAT EFFECTIVELY REDUCED THE PEST, NO PUBLIC CONTROL PROCEDURES WOULD BE INITIATED. TECHNICAL ASSISTANCE WILL BE PROVIDED TO PROPERTY OWNERS WHO DESIRE TO USE ALTERNATIVE METHODS.

55)
We wish to again request that data collection programs be developed or that documentation be provided to answer the concerns previously expressed. (See Appendix ei, page ei, comments 1, 4 and 9.) As we discussed in our meeting on May 2, 1977, a better way of describing the effectiveness of aerial spraying of target areas would be to show the area impacted in a typical situation under varying wind speeds and application rates. In this and in other cases, the worst case situation should be defined along with the mitigation which is available to the MMCD.

SEE MITIGATION AND SHORT TERM USE LONG TERM PRODUCTIVITY SECTIONS OF FINAL. WORST CASE EXAMPLES HAVE BEEN INCLUDED ON PAGES 211 TO 245. SEE ALSO PAGES 249 TO 252.

56)
We appreciate the opportunity to comment on the MMCD DEIS. The Agency would like to emphasize the fact that we are in support of an integrated pest control program, when the benefits are shown to be effective and of significant benefit to the taxpayer, rather than relying heavily on the unilateral chemical approach.

Sincerely,
Curtis J. Sparks
Water Quality Coordinator
Office of Environmental Analysis

minnesota department of health
717 s.e. delaware st. minneapolis 55440

May 19, 1977

57)

Mr. William J. Caeser
Assistant to the Director
Metropolitan Mosquito Control District
1802 Como Avenue
St. Paul, Minnesota 55108

Dear Mr. Caeser:

Subject: Metropolitan Mosquito Control District Draft Environmental Impact Statement: Options for Control to the Year 2000, March 1977.

It is apparent in reviewing the MMCD Draft Environmental Impact Statement (EIS) that major time, effort, and resources have been expended on the project. The Minnesota Department of Health was involved in the discussions held while the plans for the EIS were formulated. The concerns of the Department were submitted by letter to the MMCD, and these appear on pages 4 and 5 of Appendix EI of the Draft EIS. These concerns are addressed in various areas within the Draft EIS and are covered to our satisfaction. In our review of the Draft EIS, however, there are three additional comments that we would like to bring to your attention:

1. (Pages 32-36) The data is accurate; however, it is important to understand that there is a difference in the breeding places and distance that various mosquitos travel. Aedes triseriatus breeds in wooded areas where it is difficult to put insecticide or larvacide. These mosquitos fly only very short distances, so that cases of encephalitis tend to occur in areas very close to where the mosquitos live and breed. It has also been shown that the LaCrosse virus over-winters in mosquito eggs and is how the virus is passed on from year to year.

Different mosquitos are susceptible to different types of control measures and an analysis needs to be done on the cost of controlling different types of mosquitos by species, and size and location of area to be covered.

2. (Appendix Pages ES26-ES35) We agree with this report. Only a percentage, (possibly as low as 10-20%) of the cases of encephalitis which occur in Minnesota are reported by physicians. It is difficult to know the exact number of cases that occur in any area of the State.

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3. The Draft EIS states that only insecticides registered by the U.S. Environmental Protection Agency are applied, and these only by trained applicators in compliance with Minnesota Department of Agriculture applicator certification regulations. EPA registrations consider effectiveness of the pesticide for its intended purpose, effects on non-target organisms, recommended dosages, application methods, and appropriate labeling. The pesticide is registered for a specific use only if it is "environmentally safe" (non-target organisms are protected from unreasonable adverse effects), and the health and safety of the individuals using the chemical material can be protected. Health is a central consideration in the EPA registration process and it is our opinion the Department is not in a position to refute EPA conclusions which are based on latest technical knowledge. If the Department develops a program in response to the Toxic Substances Control Act it may be in a better position to take issue with EPA decisions. The developing Minnesota applicator certification program will also be subject to EPA approval and should be adequate to assure training in the safe use of registered pesticides.

Yours very truly,

Charles F. Settle
MEQB Technical Representative
Minnesota Department of Health

cc: R. D. Sjogren, Director
Metropolitan Mosquito Control District
Don Skinner, President
Minnesota Environmental Control Citizens Assoc.

STATE OF MINNESOTA

DEPARTMENT OF AGRICULTURE
STATE OFFICE BUILDING
SAINT PAUL, MINN. 55155
TELEPHONE: (612) 296-7686

LAND OF QUALITY FOODS

May 25, 1977

58)

Dr. Robert Sjogren, Director
Metropolitan Mosquito Control District
1802 Como Avenue
St. Paul, Minnesota 55108

Dear Dr. Sjogren:

Various staff members of our Department have had an opportunity to review the draft Environmental Impact Statement prepared on the operations of your District. There are three areas which we would like to see expanded upon in the final document.

First, although the document does treat the means of monitoring the actual dosages of insecticides applied by the District, we also feel that it is important to know the means of assuring that equipment used in applying the insecticides is calibrated so as to insure proper application rates.

Second, a review of the means by which the District handles citizens' input and citizens' complaints will be helpful in completing this document. Would you please indicate the various approaches which citizens may take to provide input into your operations as well as your complaint mechanism?

Third, our Department would also like to see the Final EIS include a summary of the types of information which the District provides to those agencies which, under Minnesota Statutes 1976, Section 473.716, Subdivision 2, act in an advisory capacity to the District.

I hope that you will be able to incorporate these additional items in your Final Environmental Impact Statement. Our Department looks forward to reviewing that document upon its completion. Should you have any questions in the meantime, please feel free to contact me.

Sincerely,

Randall D. Young
Planning & Development Division

cc: Commissioner Wefald, Rollin Dennistoun, Joe Sandve, Charles Settle

ENJOY THE HIGH QUALITY AND INFINITE VARIETY OF MINNESOTA FOODS

EQUAL OPPORTUNITY EMPLOYER

AS INDICATED IN THE DEIS THE DESIRE FOR SOUND TECHNOLOGICAL ADVANCES IS SHARED. SEE SHORT TERM GAINS/LONG TERM PRODUCTIVITY SECTION.

1. MEANS OF MONITORING ARE INCLUDED IN THE FEIS, PAGES 133 TO 137.

2. REVIEW OF COMPLAINTS IS MORE COMPLETE IN THE FEIS AND IS INCLUDED ON P.144. PRINCIPALLY, COMPLAINTS ARE REQUESTS FOR NO ENTRY ONTO PROPERTY, FEAR OF HELICOPTER CRASHES, HELICOPTER NOISE, USUALLY FROM EARLY SATURDAY MORNING AERIAL TREATMENTS, AND, MOST COMMONLY, COMPLAINTS OF MOSQUITO ANNOYANCE.

   REQUESTS FOR NO ENTRY, ONCE DOCUMENTED, ARE HONORED. FEARS ARE CALMED BY THE RESPONSE THAT VERY FEW HELICOPTER CRASHES HAVE EVER OCCURRED. TEMPORARY NOISE IS AN UNAVOIDABLE NEGATIVE IMPACT OF THE PROGRAM. COMPLAINTS OF MOSQUITO ANNOYANCE (I.E. SERVICE REQUESTS) ARE RECORDED AND FORWARDED TO COUNTY SUPERVISORY STAFF WHO PRIORITIZE THE REQUESTS BY DATE RECEIVED AND WORKLOAD AND ASSIGN THEM TO THE FOREMEN ASSIGNED TO THE AREA IN WHICH THE COMPLAINT ORIGINATED. THE RESPECTIVE FOREMEN CONTACTS THE PARTY WHO CALLED, EVALUATES THE ANNOYANCE LEVEL AND SUPERVISES NEEDED CONTROL MEASURES.

3. THE METROPOLITAN COUNCIL HAS A NON-VOTING RERESENTATIVE WHO ATTENDS DISTRICT MEETINGS. THE DEPARTMENT OF AGRICULTURE RECEIVES PEST REPORTS FROM THE DISTRICT AND APPROVES APPLICATIOR TRAINING AND TECHNIQUES. THE HEALTH DEPARTMENT COORDINATES WITH THE DISTRICT IN IDENTIFYING DISEASE AND VECTOR POTENTIAL.

59)
Metropolitan Council
Suite 300 Metro Square Building
Saint Paul, Minnesota 55101

Memordandum

To: Physical Development Committee
FROM: Environmental Planning Division Staff (Jim Schoettler)

Subject: Metropolitan Mosquito Control District
- Draft EIS. Referral File Number 4355

I. DESCRIPTION

The Metropolitan Mosquito Control District has prepared a draft Environmental Impact Statement (EIS) which addresses the environmental impact of both the District's present mosquito control activities, and future alternatives for control to the year 2000. Preparation of the EIS was ordered by the Minnesota Environmental Quality Council.

II AUTHORITY AND TIMING

The draft EIS is submitted for review and comments. The review period will close May 23, 1977. In April, 1976, the Metropolitan Council adopted a policy to 'review only those EIS's for which one or more specific Council program or policy interests can be established" and to "review only for those interest." As noted below, staff has identified three matters which the Metropolitan Council is concerned with.

III BACKGROUND

The Metropolitan Mosquito Control District was formed in 1958 under the provisions of Minnesota Statutes section 18.022. Six of the seven metropolitan counties formed the district by special joint action. Carver County was not and is still not included. A member of the Metropolitan Council serves on the District's board, but without a vote.

The District is considered under the Metropolitan Council Act to be a "independent commission, board or agency." Review of Mosquito Control District plans would, therefore, follow the guidelines set forth at Minnesota Statutes 473.165 which provide that long-term comprehensive plans determined by the Council to have an areawide effect, multi-community effect, or substantial effect on metropolitan development must be submitted to the Council for review before the plan is placed into effect.

SINCE A GRADUAL DEPOPULATION TREND HAS OCCURRED IN THE CENTRAL CITIES SINCE THE START OF THE DISTRICT, AND SINCE THERE IS LITTLE TO INDICATE THAT SUCH GROWTH HAS BEEN TOWARDS AREAS OF LOW MOSQUITO BREEDING SITE DENSITY, THERE IS NO DIRECT EVIDENCE TO INDICATE

THAT MOSQUITO CONTROL HAS ANY SIGNIFICANT EFFECT ON RESIDENTIAL LOCATION DECISIONS. HENCE, ITS EFFECT ON METROPOLITAN DEVELOPMENT ARE, AT BEST, UNCERTAIN.

60)
Although the EIS is not a plan, it addresses alternative control activities for the District to the year 2000; this implies the existence of a plan. To date no plan has been submitted.

Staff has met with a representative of the District to discuss this memorandum. It was concluded that the several issues highlighted here can be adequately resolved by additional text and clarification in the final EIS.

IV. METROPOLITAN INTERESTS

The draft EIS is a very informative document about the District and its mosquito control activities. Most of the material is technical and not related to metropolitan planning. However, staff has identified the following three interests which should be considered by the District.

A. Development Framework
On page 92 of the EIS it is stated that:

"Due to the continued outward growth of the Metropolitan Area since the formation of the District and the resultant increased need for a substantial larval controlled, peripheral buffer zone to reduce the affect or influx by dispersing Aedes vexans (a mosquito species), the entire six county area, eastern Carver County and both sides of the Minnesota River bottom should be included in a larval control program."

It goes on to say that annual funding for such a program would be three times the 1976 budget. This is a clear example of the increasing cost of urban services due to urban sprawl.

The District should be aware that the Metropolitan Council has adopted a Development Framework Plan for the Metropolitan Area. This framework identifies the approximate areas which are to receive urban services; and also identifies

areas such as the commercial agriculture and general rural use regions which will not receive metropolitan urban service investments.

In its strategy to serve the largest number of people in the most efficient way, the District should utilize the Development Framework Plan as the long-term indicator of urban development location. The District should determine whether it is possible to conform its mosquito control activities to serve this area primarily.

The Metropolitan Council is aware that mosquito control is dependent on several factors, including breeding site distribution, prevailing winds, and the need for a "buffer" zone around the protected area. Therefore it is not expected that mosquito control efforts will occur in an area coincidental with the Metropolitan Urban Service Area (MUSA). Rather, the MUSA and the identified Freestanding Growth Centers and Rural Centers could serve as the focus of District control efforts.

IV. METROPOLITAN INTERESTS.

A. DEVELOPMENT FRAMEWORK

WE AGREE THAT THE GOAL OF THE METROPOLITAN COUNCIL IN PROTECTING THE METROPOLITAN URBAN SERVICE AREA (MUSA) HAS BEEN LARGELY IDENTICAL TO THE AREA ALREADY SERVED BY LARVAL CONTROL AND IS IN THE LINE WITH CONSISTENT MMCD POLICIES SINCE ITS INCEPTION. SERVICING OF FREE-STANDING GROWTH CENTERS AND RURAL CENTERS IS LIMITED TO ADULT CONTROL ACTIVITIES; THIS IS CARRIED OUT PERIODICALLY ON A WHOLE TOWN BASIS AS OFTEN AS TWICE A WEEK WHEN ANNOYANCE IS SEVERE. RURAL AREAS ARE NOT NORMALLY SERVICED EXCEPT FOR SPECIAL EVENT LOCATIONS OR TO CONTROL DISEASE VECTORS.

61)

B. Alteration of Wetlands and Water Features

The EIS identifies "physical control" as a general alternative to the use of chemicals for mosquito control. This alternative includes limestone treatment, excavation of ditches, drainage of a number of adjacent upland depressions, excavation of shallow marsh areas, slope alteration of marsh shorelands, removal of shoreland organic debris, and

filling of a certain type of wetland.

The Metropolitan Council has adopted a number of development guide policies which collectively support the protection of natural drainage features, and require that alternatives be non-detrimental to the hydrological or ecological systems. Thus wholesale alteration or elimination of these features would be contrary to present Metropolitan Council policies.

The EIS correctly notes that approval of the Department of Natural Resources would be needed for any wetland or drainage alteration. Also, approval of watershed districts, the individual local governments, and property owners would be required. The EIS should assess the effectiveness the alteration methods would have if only a limited number of sites to be altered received the necessary approvals.

Shoreland alteration, dredging, ditch excavation, and filling all imply extensive disturbance of the public waters, and potential erosion and sedimentation problems. Erosion and sedimentation are already severe problems in many parts of the Area. Recently, the Metropolitan Council approved a grant request of several million dollars for sediment removal in a metropolitan watershed. Erosion and sedimentaiton is a major concern in water quality management and is included in the 208 water quality management program being carried out by the Council. The District should consult with the U. S. Soil Conservation Service and the Country soil and water conservation districts to establish methods and procedures which would minimize erosion and sedimentation problems.

APPROVAL OF ONLY A LIMITED NUMBER OF SITE ALTERATIONS WOULD REQUIRE A RELATIVELY GREATER DEPENDENCE ON RECURRING CHEMICAL APPLICATIONS. THERE ARE STRONG RESERVATIONS ON THE PART OF THE DISTRICT REGARDING THE COST EFFECTIVENESS OF PHYSICAL CONTROLS (SEE PAGE 320).

WITH THE POSSIBLE EXCEPTION OF LIMESTONING, NO OPERATIONAL PROGRAM IS ANTICIPATED BEFORE 1985. LIMESTONING IS NOT

EXPECTED TO HAVE SERIOUS DETRIMENTAL EFFECTS TO HYDROLOGY OR ECOLOGICAL SYSTEMS SINCE IT INCREASES PERCOLATION WITHOUT ALTERING THE SITES HYDROLOGICAL FUNCTION. SEE PAGE 274.

62)

C. Long-Term Planning

> The EIS is evidently the first attempt by the District to consider future activities in a comprehensive fashion. This effort approximates long-term planning. The mosquito control district is urged to develop a long-term plan, based on the findings of the final EIS, and to update the plan on a regular basis. Since the activities of the District will have multi-community effect, and since general development of the Metropolitan Area should influence the location of mosquito control activities, we request that the District submit its long-term plan to the Metropolitan Council for review with metropolitan development policies and plans.

ANY CHANGES IN FUTURE ACTIVITES OF THE DISTRICT ARE DEPENDENT ON CHANGES IN THE MOSQUITO CONTROL TECHNOLOGY THAT CAN BE EFFECTIVELY AND SAFELY EMPLOYED. TO SOME EXTENT, PLANNING BENDS TO THESE CHANGES AND TO FUNDING LIMITS. THE RELATIONSHIP OF THE EIS FINDINGS TO FUTURE PLANS IS THUS A FUNCTION OF WHAT IS POSSIBLE (EFFECTIVE CONTROLS) COMPARED TO WHAT IS PERMISSABLE (RESPONSIBLE AGENCY APPROVALS). PLANNING CHANGES FUNCTION RATHER AUTOMATICALLY FROM TECHNOLOGICAL CHANGES; MANAGEMENT'S ROLE IS TO ENFORCE LONG TERM POLICIES AS POSSIBLE WITHIN LIMITS MENTIONED.

THE EIS HAS AFFORDED A COMPREHENSIVE INTERNAL AND EXTERNAL REVIEW OF DISTRICT OPERATIONS IN TERMS OF THEIR IMPACTS ON EFFECTIVENESS AND THE NATURAL ENVIRONMENT.

HOWEVER, WE DID NOT MEAN TO IMPLY THAT PREVIOUS TO THE DEIS, THE DISTRICT HAS HAD LITTLE OR NO IDEA OF WHERE IT WAS GOING. THE METROPOLITAN COUNCIL HAS THE OPPORTUNITY TO KEEP INFORMED OF MMCD ACTIVITIES THROUGH ITS REPRESENTATIVE ON THE COMMISSION. IF, IN THE DISCUSSION OF FUTURE OPTIONS AND CHOICES BETWEEN THESE OPTIONS THE COUNCIL HAS PERTINENT COMMENTS TO MAKE ON ALL OR PART OF THE DISTRICT'S PLANS, IT IS INVITED TO DO SO BY FORMAL CORRESPONDENCE OR LESS

FORMAL COMMENT THROUGH ITS REPRESENTATIVE.

63)
V. Conclusions:

A. The EIS observes that an expanding urban area requires a proportionately larger mosquito control area. The District should be aware that the Metropolitan Council had adopted a Development Framework Plan that can over the long-term assist the District in its effort to achieve the greatest beneficial effect for the metropolitan public in the most efficient way.

B. The District identifies wetland alterations as a means of mosquito control. Wholesale alteration or elimination of these features would be contrary to present Metropolitan Council policies.

C. The effectiveness of the "physical control" method may be impaired if only a limited number of sites receive the necessary approval.

D. Erosion and sedimentation problems may result from the "physical control" alternative.

E. The District should be commended for its examination of future control activities. The EIS could be a useful basis for a long-term plan for mosquito control, and such a plan would be subject to Metropolitan Council review.

VI. Recommendation

Staff recommends that the Physical Development Committee act on the following and submit the same to the Council for final action:

A. The District should utilize the Metropolitan Development Framework Plan as the long-term indicator of urban development locations, and should determine whether it is possible to focus its control efforts toward these areas.

B. The District should note in the EIS that wholesale alternation of natural drainage features is contrary to Metropolitan Council policies.

C. The District should review the effectiveness of its "physical control" program in the event that only a limited number of sites receive the necessary approval for alternation.

D. The District should establish methods and procedures in the physical control program to minimize erosion and sedimentation problems.

E. The District should prepare a long-term plan for mosquito control activities based on the final EIS and submit it to the Metropolitan Council for review against metropolitan development guide policies and plans.

STATE OF
MINNESOTA
DEPARTMENT OF NATURAL RESOURCES
CENTENNIAL OFFICE BUILDING · ST. PAUL, MINNESOTA · 55155

May 31, 1977

DNR INFORMATION
(612) 296-6157

64)

Dr. Robert D. Sjogren, Dir.
Metropolitan Mosquito Control Dist.
1802 Como Avenue
St. Paul, Minnesota 55108

Dear Bob:

I appreciated the opportunity to meet with you on Friday, May 27, to discuss the MMCD draft EIS. As you requested, I am submitting several ideas which were brought out at the meeting.

First, I believe the MMCD is to be commended for achieving the 68 per cent reduction in mosquitoes at the core of the metro area and a 45 per cent reduction at the 10-mile radius line. Considering that total eradication is impractical, these levels indicate a very high degree of success.

Second, there should be differential goals between the core area and the 10-mile periphery, because core area goals are probably not practical at the 10-mile perimeter of the control area. For example, the goals could be 75 per cent and 50 per cent, respectively.

My reason for suggesting these lower percentages than are mentioned in the EIS is that as your program approaches higher levels of effectiveness, the cost -- both economically and environmentally, would be prohibitive.

I suggest that the best approach for a comprehensive mosquito control program which has already achieved your relatively high level of control is one which combines the field control effort with a public information and education effort.

By using news releases in newspapers, radio, and television it would be possible to inform the public when major hatches are predicted and at what time of day the biting problems would be most severe. The reduction in annoyance achieved by effective use of the news media could be equal to or greater than additional field control efforts and the cost would probably be substantially less.

I am enclosing a reprint of a publication which was referred to at our meeting, and I hope it will be useful to you. As you can see from Figure 2, the highest level of flight activity for Aedes vexans was from 15 minutes after sunset until one hour after sunset, with a peak observed from 30 minutes until 45 minutes after sunset.

AN EQUAL OPPORTUNITY EMPLOYER

This is an example of one type of information which could be incorporated into news releases to help the public better cope with mosquito annoyance. This could be especially beneficial in peripheral areas where the level of mosquito control is lower.

I believe that such I and E is not a luxury, but a necessity. It would help the public deal more effectively with mosquito annoyance and it would give them a better understanding of the total program provided by the MMCD.

Sincerely,

CARROL L. HENDERSON
Non-Game Supervisor
Section of Wildlife

CLH:pmt
Enc.

THE DISTRICT AGREES WITH THE COMMENTS IN GENERAL, AND WOULD ADD ONLY THAT CONSISTENT LEVELS OF CONTROL MAY BE AS IMPORTANT AS PERCENT MOSQUITO REDUCTION. SEE THE REVISED APPENDIX EI ON MOSQUITO CONTROL EFFECTIVENESS. ALSO, THE PERCENT CONTROL MAY BE ABLE TO RISE AS HIGH AS 97% AT THE CORE AND 75% AT THE 10-MILE BAND BEFORE FURTHER INCREMENTAL IMPROVEMENT COSTS WOULD BE ECONOMICALLY AND ENVIRONMENTALLY PROHIBITIVE.

VARIOUS FORMS OF PUBLIC INFORMATION HAVE BEEN USED. THE GENERAL VOCAL RESPONSE TO WARNINGS ABOUT UPCOMING MOSQUITO INFLUXES HAS BEEN COMPLAINTS OF POOR PERFORMANCE. INFORMATION AND EDUCATION, USING DATA AND PRESENTATIONS FROM THE FEIS, MAY BE, AS MR. HENDERSON STATES, THE ONLY WAY TO GAIN A LONG RANGE UNDERSTANDING OF THE SITUATION.

65)
University of Minnesota
To: Robert Sjogren
From: L. K. Cutkomp

I have not made any specific comments or corrections from the Appendix. I believe that if changes which I have suggested in the main report would have any bearing on a few parts in the Appendix they could be taken into consideration.

Comments on MMCD E.I.S.

Table, P. 8-9 Exec. Summary
a. I don't know of evidence of needed formulation change every 5 years to avoid resistance. Since none has been found (all years of DDT use and since, it seems an unnecessary assumption).
b. also questionable.

Figure VIII 0-10 sites/mi^2 seems to be a broad category which leaves one wonderng whether there are any or not. Surely there must be at least 1 in every sq. mi. and a breakdown of 1-5 and 5-10 might be appropriate.

p.28 Losses of wetlands may be correct but I would like to see some reference to justify it.

p.43 Mid-page-damsel flies are Zygoptera, Dragon flies are Anisoptera; both belong to the Order Odonata.

p.45, Table 8 spelling of chlordane.

p. 46, Table 95. Dasanit not Dosanit. Information about Bux is not current. It has been little used for 2-3 year. A more recent issue would be appropriate.

p.62, Table 16 The 2nd part of the table should have a heading--Treated for Adult Control.

p.83, 1 & 5 Chapman is mispelled.

p. 84 last paragraph-- fathead, not flathead minnows; spelling of 'dytiscid' larvae.

p. 98-9, Table qualifying notes--see comments as given for Executive Summary (p. 8-9).

p. 105 line 4. impacts instead of inpacts.

p. 107 - middle - the word effect should be used instead of affect; also last line on page.

p. 108, 2 line Herbivorous is correct spelling.

p. 111, Table 27 spelling errors- Spectracide - Dyfonate - not Syfonate.

LD_{50} µg/bee not µ/bee

p. 120 3 paragrpah -- Provost statement--carbamate insecticides applied as systemics-- not true with Bux, and Furadan is a moderate systemic, certainly not killing all insects feeding on stem and foliage. It is not particularly effective as a systemic vs. aphids.

p. 129, 1.13 - Herbicide statment is too general and broad. Certain triazines (Atrazine) do have biological activity of 18 mo. but 2,4-D type herbicides are decomposed quite rapidly (days or a week or so).

p. 131 - top of page - the many factors listed on p. 130 are not adequately summarized for the public appreciation. Under b) at least it should be stated that because of the extensive flight range and mobility of A. vexans many chemically untreated mosquitoes may mix and breed with the numbers treated, thus reducing the possibility of resistance occuring.
In addition, the likelihood of resistance occurring with temophos is minimal because of its lack of persistence. A treated population of Aedes may be killed and the insecticide will have dissipated before a new population hatches. To a lesser extent this may be true with chlorpyrifos which is greatly reduced in toxic effects by organic particles in the breeding pools.

p. 133, 1.13--' encephalitis can be expected once in ten years' I think this statement is too definitive or dogmatic. In actuality I believe it

has been longer. I think it should be modified to state that in years of heavy rainfall which promote extensive mosquito breeding (especially of C. tarsalis) WEE and SLE outbreaks may occur. The increased population of horses might be mentioned.

p. 135-138 - Biological control - Depending upon manpower and finances, I question somewhat that an effective biological control program can be operating in 5 years. Perhaps if some specific information was included this could be documented a little better.

p. 149 and 150. last paragraph p. 140 - I don't know, but really don't believe that resistance would be a significant impact of a timed-release capsule program; there was no evidence with DDT which had a long-lasting effect; certainly many untreated mosquitoes will be mixing with the population- also evidence with A. vexans is very sparse. Likewise on p. 150-- non-target organism effect is a great assumption that such an effect will occur, particularly since most of them (exc. Cladocerans) are not as susceptible as A. vexans anyway. Although the resistance problem does occur in intensely treated area, considering the extensive breeding area in the 6 or 7 county area, I think the resistance potential is being unduly emphasized. Furthermore, chlorpyrifos may not be the prime insecticide in 10 years or so.

My comments have some bearing on the discussion on p. 161-2.

MINOR COMMENTS (I.E. SPELLING ERRORS AND USE OF CORRECT SPECIES NAMES) HAVE BEEN INCORPORATED INTO THE TEXT.

COMMENTS ON RESISTANCE HAVE BEEN INCLUDED ON PAGE OF THE TEXT. SEE PAGE 259.

MORE PRECISE BREAKDOWNS OF NUMBER OF SITES ARE INCLUDED IN APPENDIX TABLE ES- 5

WETLAND ACREAGES ARE BASED ON HISTORICAL EXPERIENCE IN THE METROPOLITAN AREA.

ADJUSTMENTS HAVE BEEN MADE IN THE DISCUSSION OF BUX AND FURADAN. SEE PAGE 101.

COMMENTS ON HERBICIDES HAVE BEEN APPROPRIATELY MODIFIED. SEE PAGE 99.

ENCEPHALITIS HAS BEEN SERIOUS ENOUGH TO BE TREATED DIRECTLY VIA SPECIAL CONTROL OF CULEX TARSALIS IN PAGES 89 AND 130.

THE FIVE YEAR FIGURE WAS INCLUDED AS A MINIMUM. SEE PAGE 164 FOR A DISCUSSION OF THIS TOPIC.

66)

Minnesota Environmental [illegible]
[illegible] 8
P.O.Box 80089
612 [illegible]
646-0559

June 2, 1977

Robert D. Sjogren, Ph.D.
Director
Metropolitan Mosquito Control District
1802 Como Ave.
St. Paul, Minn. 55108

Re: Comments on the Draft EIS of the MMCD

Dear Dr. Sjogren:

Enclosed are two copies of MECCA's comments on the draft EIS of the MMCD program. Gennerally, we found the EIS to be inadaquate and poorly done both structurely and substantively. The EIS should contain an index so that items may be quickly found. Presently, one has to jump all over the EIS in order to find all the data on a paticular topic. The bibliography is inadaquate. In addition, many times it is impossible to determine whether a statement made in the EIS was substaniated by a source. We recommend that you correct these structual problems in the final EIS.

Substantive problems exist throughout the report and are severe. This draft EIS does not meet the requirements of M.S. § 116D.04, Subdivision 1, Minn. Reg. MEQB 31. The draft EIS: 1.) failed to evaluate and describe the nature and effects of the pesticides being used; 2.) incompletely discusses the adverse environmental effects of the current program; 3.) inadaquately describes or reviews the adverse effects of the alternative programs; and, 4.) failed to adaquately address issues involving land use, committment of resources, and the impact of federal controls on state government.

In addition to the above, other problems exist with the MMCD attempts to justify its program. The techniques used by the district to determine the effectiveness of its mosquito abatement practices are inappropiate. We found the methods and techniques used to be biased, skewed, poorly done and totally unacceptable. Further, the surveys conducted by the district have the same flaws and are also unacceptable.

In sum, we recommend that the draft EIS be rewritten to address the inadaquacies and questions put to you in our comments. If you have any questions, we will be glad to address them.

On behalf of the Chemicals and Pesticides Task Force and MECCA,

Sincerely,

Patrick Lee Reagan
Patrick Lee Reagan
Consultant

David Rivard
Consultant

Encl:

COMMENTS CONTAINED IN THIS COVER LETTER ARE SUBSTANTIATED NEITHER BY SPECIFIC REFERENCE TO SUPPOSED DEFICIENCIES IN THE TEXT NOR TO DOCUMENTED PROBLEMS WHICH WOULD POINT UP SUCH DEFICIENCIES. AS SUCH, THE COMMENTS MAKE LIVELY READING AS A STRING OF DENIGRATING ADVERBS AND ADJECTIVES THAT REFLECT THE AUTHORS POWERS OF RHETORIC.

IN THE DOCUMENT SUPPLIED BY MECCA, A SECTION ENTITLED "OVERVIEW AND HISTORY" PRECEDES THE DISCUSSION OF ACTUAL COMMENTS ON THE DRAFT EIS. SINCE THE MATERIALS ARE LARGELY REDUNDANT TO OTHERS PRESENTED ELSEWHERE IN THE TEXT, THEY ARE OMITTED HERE.

67)
II. Comments on the Draft EIS of the M.M.C.D.

Minnesota Statutes, 116D.04, subdivision 1 provides that an environmental impact statement (EIS) shall contain information and discussion in seven areas involving the proposed action. Section 116D.04, Subdivision 1 specifically states:

> Subdivision 1. Where there is potential for significant environmental effects resulting from any major governmental action or from any private action of more than local significance, such action shall be preceded by a detailed statement prepared by the responsible agency or, where no governmental permit is required, by the responsible person, on:
>
> (a) The environmental impact of the proposed action, including any pollution, impairment, or destruction of the air, water, land, or other natural resources located within the state;
>
> (b) Any direct or indirect adverse environmental, economic, and employment effects that cannot be avoided should the proposal be implemented;
>
> (c) Alternatives to the proposed action;
>
> (d) The relationship between local short term uses of the environment and the maintenance and enhancement of long term productivity, including the environmental impact of predictable increased future development of an area because of the existence of a proposal, if approved;

(e) Any irreversible and irretrievable commitments of resources which would be involved in the proposed action should it be implemented;

(f) The impact on state government of any federal controls associated with proposed actions; and

(g) The multistate responsibilities associated with proposed actions.

The comments contained in this section of the report cover A through F of section 116D.04, Subdivision 1 and other comments pointing out inconsistencies and questions, errors, and recommendations for additions to the report. These sections are labeled G.H. and I respectively.

A. The Environmental Impact of the Proposed Action

As pointed out on page two (no. 11) of the EIS, the District's program "is based upon chemical control of mosquitos using five of the fifteen EPA registered materials: Chlorpyrifos, temephos, resmethrin, malathion, and fuel oil."[14] Therefore, in order to satisfy the requirements of the act in determining the environmental impact of the MMCD program, a complete review of the chemicals used in pest control by the District must be provided. This review must cover, as a minimum, the toxicity of the pesticides, both acutely and chronically; their degradation products; the method of metabolization in flora and fauna; potential for synergism; and, the ability of the pesticides to persist. In addition, the section also requires a review of the potential impacts on the workers who apply the pesticides, and on the non-occupationally exposed public. In addition, this section requires a review of other effects of the program, such as the noise problem.

The EIS provides little information on the toxicity of the presticides used by the MMCD. Page 47 provided the oral LD_{50} for rats and pages 57 through 61 provides some information on the active ingredients used in the pesticides.

THE COMMENTS ABOVE IGNORE COVERAGE OF THE SUBJECTS CITED ON PAGES 117 THROUGH 123 IN THE DEIS.

68)
Pesticides can have all kinds of effects, the importance of which cannot be understated. The Environmental Protection Agency described these effects in their report: Effects of Pesticides in Water, which stated:[15]

> Pesticides may be harmful because they eliminate or reduce populations of desirable organisms directly, or because they indirectly alter conditions required by these organisms. Direct effects include mortality, birth defects, induction of tumors and genetic changes, altered behavior patterns, or physiological changes including alterations in reproduction; the effects may take place during any stage of the organisms's life history. Indirect effects may include reduction of species used as food sources by other species; reduction in rates of photosynthesis, decomposition or mineralization, with attendant unsatisfactory conditions for certain species; and temporary increased BOD (biological oxygen demand) in a body of water resulting from decomposition following death of plankton or other organisms caused by a pesticide. Additionally, many species can accumulate pesticide residues directly from the water, or from sediments, and these residues may in turn be accumulated in organisms that feed on the lower forms of life. This latter phenomenon has resulted in pesticide residues entering human food supplies and in effects on other mammals and fish-eating birds.
>
> Except in the case of man and domestic animals, effects on individuals are less important than effects on populations, communities of organisms, and whole ecosystems. Most organisms in the wild have short life spans, and the turn-over rates of the populations are very high. Furthermore, because most species have high reproductive rates, most individuals in a population are biologically excess to the continued existance of the population and unless the fraction of the population killed is high, the level of the population will be only temporarily suppressed. Birth defects, tumors, and even genetic changes may be relatively unimportant to survival in wild populations with rapid turn-over rates because individuals rendered unfit will be eliminated without detriment to the continuation of the population; i.e., mortality is transferred to

the unfit. Where turn-over rates are low and life spans relatively long as in osprey, eagle, brown pelican and certain other species, birth defects, genetic changes, and tumors may be significant.

With continued and increasing pesticide use, unintentinal deleterious effects on the environment and on human health are becoming apparent or are being suspected. Among these, teratogenic, carcinogenic and mutagenic effects are currently receiving special attention. The concern for potential mutagenicity of organo-phosphates is evident.

WE FAIL TO UNDERSTAND WHAT IS MEANT BY "EVIDENT". THE ONLY REFERENCE CITED BY MECCA INCLUDES A LIST OF POTENTIALLY CARCINOGENIC MATERIALS, NONE OF WHICH HAVE EVER BEEN OR ARE IN USE BY THE MMCD. A WIDER REVIEW OF THIS SUBJECT HAS BEEN CONDUCTED FOR THE PURPOSES OF THIS FEIS, CONCLUSIONS HAVE NOT SUBSTANTIATED CAUSE AND EFFECT RELATIONSHIPS ASSOCIATED WITH MMCD MATERIALS. SEE ALSO PAGES 209 THROUGH 211.

69)
A summary of organophosphorus insecticides should include diverse recent publications, providing data on the mutagenic, teratogenic and carcinogenic capacities of these substances. Materials should also relate to other members of the biome. Therefore, this EIS must contain a review of both the acute and chronic effects of the pesticides used by the MMCD.

SEE RESPONSE TO IMMEDIATE PREVIOUS COMMENT.

70)
The EIS contains incomplete information on the degradation products of the pesticide (pg. 127-129). The EIS concludes that the degradation products are non-toxic. However, no information is provided on the acute and chronic toxicological nature of these degradation products or their effects on non-target species. This information must be provided for the EIS to be complete.

Along this same line, no information is provided on how the by-products are metabolized in species after exposure.

SEE PAGES 254 TO 257 IN THE FEIS.

71)
For example, the statement on the bottom of page 115: "Petroleum oils are absorbed by organic matter and metabolized by bacteria as a food source." This statement is insufficient. The ecochemistry of specific pesticide hydrolysis products should be discussed.

PETROLEUM OILS DO NOT READILY UNDERGO HYDROLYSIS. ORGANOPHOSPHATES DO HOWEVER UNDERGO HYDROLYSIS, AND THIS PHENOMENON IS DISCUSSED ON PAGE 254 IN THE TEXT. READERS INTERESTED IN THE INTER-ACTION BETWEEN PETROLEUM OILS AND BACTERIA SHOULD REFER TO THE FRESHWATER FOUNDATION ARTICLE ON CHARLES CLEVENGER'S STUDIES IN THE LAKE MINNETONKA AREA (FACETS OF FRESHWATER VOL. 2, NO. 2).

72)
Page 129 concludes that there is little information known about the nature of synergism between insecticides used by the MMCD. But a book published in 1965, Research in Pesticides, devoted a full chapter to the synergistic and potentiation products of pesticides, especially those involving Malathion - a pesticide used by the MMCD.[16]

SEE FEIS DISCUSSION PAGES 254 AND 257.

73)
The national Academy of Sciences in their report: Pest Control: An Assessment of Present and Alternative Technologies discussed a wide variety of synergistic and potentiation effects in pesticides.[17] In addition, much research is available about the interaction of pesticides and common drugs.[18] This information should be reviewed and summarized in the EIS with special consideration that these pesticides are sprayed in an urban area around numberous citizens who take a wide variety of drugs.

THE COMMENT IMPLIES A PROBLEM EXISTS FROM THE INTERACTION OF PESTICIDES AND COMMON DRUGS. THE REFERENCE CITED REPORTS THE CONTRARY: "...THE TOLERANCE LEVELS THAT HAVE BEEN ESTABLISHED ON THE BASIS OF CHOLINESTERASE INHIBITATION ARE SUFFICIENTLY LOW TO ENSURE THAT CHOLINESTERASE INHIBITION AND CONSEQUENT POTENTIATION OF THE TOXICITY OF OTHER PESTICIDES AND DRUGS WOULD NOT OCCUR." "FROM THE STANDPOINT OF THE COMBINED TOXICITY

OF ORGANIC PHOSPHATE INSECTICIDES AND DRUGS, THE DEMONSTRATION THAT EXPOSURE TO AN ENZYME INDUCING AGENT (IE. DURG) DOES NOT INCREASE THE TOXICITY OF THESE INSECTICIDES IS OF CONSIDERABLE IMPORTANCE."

MOREOVER, THE REFERENCE REPORTS THAT A STUDY WITH AN ENZYME INDUCING DRUG ADMINISTERED...."FOR A PERIOD LONG ENOUGH TO CAUSE MARKED INDUCTION OF HEPATIC MICROSOMAL ENZYME DECREASED...SUSCEPTABILITY TO THE ACUTE TOXICITY OF SEVERAL (10) OF THE COMMON ORGANIC PHOSPHATE INSECTICIDES".

74)
No discussion is provided on the persistence of these pesticides and their degradation products. Page 160 dismissed the subject by stating that the pesticides used by the District "do not persist as toxic, biologically active degradation products". No source for this statement is provided. It is important to remember some of the factors that influence the persistence of pesticides are common to both plants and soils. These are, firstly, the characteristics of the pesticide, including its over all stability either as parent compound or metabolites, its volatility, solubility, formulation, and the method and site of application. A second group includes the environmental factors, particularly temperature, precipitation (and humidity) and air movement (wind). The other factors depend upon the properties of the plant or soil.

Characteristics influencing the persistence of pesticides in plants include the plant species involved, the structure of the cuticle, the stage and rate of growth and the general condition of the plant. Corresponding soil characteristics are the soil type and structure, its organic matter content, clay content, acidity or alkalinity, mineral ion content and degree of aggregation and its microbial population.

THE QUOTE IS NOT A WAY OF DISMISSING THE TOPIC, RATHER IT IS A STATEMENT OF FACT. THE SOURCE OF THE STATEMENT IS INFORMATION PROVIDED BY DR. WAYLAND HAYES, TECHNICAL CONTRIBUTOR IN THE FIELD OF TOXICOLOGY. MORE INFORMATION CAN BE FOUND IN THE FEIS ON PAGES 232 AND 254.

75)
Pesticide residue analysis is needed for specific leaf litter and soil types. This residue data should

contain information about the assimilation of cleavage products into the environ, and also, how these products are metabolized by various fauna representatives.

SEE FEIS 211 TO 214; ESPECIALLY, ETO (1971).

76)
Since microarthropod, macroarthropods and microflora are know to be involved in the decomposition of foreign materials, some indication as to how these could be effected over a 25 year treatment period should be made.

SEE NEW DISCUSSION ON MICRO-ORGANISMS IN THE TEXT, PAGES 211 THROUGH 219.

77)
Nonvertebrate and vertebrate chemical absorption levels should also be indicated.

SEE TEXT PAGE 211 THROUGH 219.

78)
Capacity of pesticide residue storage in indigenous plant species must be determined. The main pesticide cumulator is soil from which chemicals transfer through the root systems into the plants.

SEE TEXT PAGE 232 AND 248.

79)
These products, and their breakdown substances, do migrate from the soil to underground water, surface water, and atmospheric air (pollutants have leached through protective lens coverings in permanent bodies of water in St. Louis Park). Secondary pollution risks are possible and should be studied carefully. Sites of Type areas should be regarded in an exclusive manner with these different factors presented. This type of information must be provided for each pesticide if the EIS is to be complete.

THE INSECTICIDES USED BY THE MMCD AND THEIR DEGRADATION PRODUCTS DO NOT LEACH OR ENTER THE AIR SIGNIFICANTLY AS DISCUSSED ON PAGES 248 AND 249.

80)
Page 160 of the EIS dismisses the subjects of bio-magnification, bio-accumulation, and resynthesis in one sentence. More information on these subjects as they relate to each pesticide and their degration products must be provided.

WE EXPANDED THE DISCUSSION IN THE FEIS ON PAGE 254. AND 257. THE CONCLUSIONS REMAIN BASICALLY THE SAME.

81
Pages 121-123 provide information on the effects of pesticides in humans. The statement concludes that there are no negative and only positive impacts from the application of pesticides. Over the years many known deaths and injuries have been shown from occupational exposure of pesticides, primarily from organophosphorous compounds.[19-24],

THIS IS A FALSE AND MISLEADING STATEMENT. MORTAILITY HAS ALMOST EXCLUSIVELY BEEN FROM SUICIDES, CHILD ACCIDENTS OR MISUSE. SEE FULL DISCUSSION OF SOURCES MENTIONED HERE ON PAGE 208 OF THE TEXT, WITH SPECIAL ATTENTION TO HIGH TEMPERATURES AND LINGUISTIC DIFFICULTIES.

82)
Recently, OSHA and the EPA have been involved in setting re-entry standards for fields sprayed with pesticides, including Malathion - a pesticide used by the MMCD. A review of these statutes and regulat-ions should be provided as well as a specific review of the medical literature on the toxicity and accumulation of pesticides in workers.

THERE HAS BEEN NO NEED TO ESTABLISH RE-ENTRY STANDARDS FOR MOSQUITO CONTROL MEASURES BECAUSE OF THE SUBSTANTIALLY LOWER DOSAGE RATES USED IN MOSQUITO CONTROL. SEE PAGE 245 IN THE TEXT RELATING TO THE LITERATURE REVIEW ON EFFECTS OF MMCD MATERIALS ON HUMANS.

83)
Pesticides can affect the non-occupationally exposed as well. Recent studies have shown that pesticides are part of the makeup of household dust.[25] Because the MMCD program is primarily urban in nature, and because of the known potentiation between pesticides and the common drugs used by urban dwellers, special

attention should be focused in the EIS on the MMCD contribution to this problem especially near homes where the MMCD sprays.

CONSIDERING THE RELATIVE DIFFERENCE IN QUANTITY OF PESTICIDES USED (HOMEOWNERS 99.6% VS MMCD .4%) AND THE FACT THAT MOST MMCD APPLICATIONS ARE MADE 200 FEET OR MORE FROM HOMES, THE POINT IS INSIGNIFICANT. SEE ALSO FEIS DISCUSSION ON PAGE 208.

84)
There has also been some work on the effects of pesticides on the chronically ill.[26] The EIS should address this problem. In addition, the EIS should address the issue of those who are allergic to various pesticides and how the MMCD reacts to those who request that they stop spraying in their neighborhood because of this problem.

SEE LETTERS, COMMENT 3 AND 165. DESPITE REQUESTS TO DR. RANDOLPH TO COMMENT ON THE SPECIFICS OF DOSAGE, MATERIALS, FORMULATION AND APPLICATION METHODS USED BY THE DISTRICT NO RESPONSE OR CAUSE AND EFFECT DATA WERE PROVIDED. REQUESTS FROM CITIZENS THAT NO MOSQUITO CONTROL MEASURES BE CONDUCTED IN THEIR NEIGHBORHOOD ARE RECORDED ON DISTRICT MAPS, AND THE REQUESTS HONORED. SEE DISCUSSION, PAGE 211.

85)
Another impact of the MMCD program is the noise problem. The EIS points out on page 73 that a helicopter (which is used in the MMCD program) provides between 92 and 101 dba in its operation, which is well within the pain and damage threshold. On page 126, the MMCD admits that its practices violate ambient quiet. Because of the hazardous noise levels at which the MMCD helicopter operates, a discussion of the effects of noise on humans and other non-target species must be provided.

NINETY-TWO OR 101 DBA DO NOT CONSITUTE EITHER PAIN OR DAMAGE THRESHOLDS. SEE TEXT, PAGE 252 AND THE SUMMARY IMPACT TABLE KEY, PAGE 184 FOR FURTHER DISCUSSION.

86)
B. Direct or Indirect Adverse Effects Due to the MMCD Program.

There are three basic areas that this section offers comments on in the MMCD program EIS. These include: resistance in the target species, effects on non-target organisms including a review of species considered, and the economic aspects of the program.

On page 131 of the EIS the MMCD claims that "mosquitos have shown no resistance to insecticides nor have non-target organisms built up a resistance to temporary population suppression." The study provides no citation in support of this statement.

SEE FEIS DISCUSSION PAGE 259.

87)
In fact, it is in contradiction to experience elsewhere. In California, for example, mosquitos have become resistant to many insecticides including Malathion and Abate and Dursban which are used by the MMCD.[27]

Richard Garcia summed up the situation in California,[28]

> The chemical approach to mosquito control and to vector control in general has had serous setbacks in many parts of the world. The main cause of these setbacks or failures, with some notable exceptions, has been the development of genetic resistance by the vector population to one and sometimes to several different chemical compounds. The general rule has been that when a population of arthropods (a class of invertebrates) develops resistance to one compound, a different one is substituted to achieve control. This sequence can lead to an intolerable situation with serious consequences, as exemplified by current conditions in certain parts of California.
>
> Following resistance to DDT, a series of different chemicals was applied for control. Malathion, ethyl parathion, and methyl parathion were used extensively during the 1950's, but complete resistance was developed to all these compounds by the early 1960's. Fenthion was then introduced and gave adequate control until its failure in 1968. Other chemicals, such as Dursban, were employed, but they too were effective for only a short period. The situation is truly in a crisis state as far as chemical control of these mosquitos is concerned. The remarks of one mosquito

> abatement manager at a recent mosquito control meeting summed the situation up: "In many counties of the State chemical sprays are no longer effective at safe, legal, economical rates. After 25 years of continuous spraying the mosquitos have become immune or multi-resistant to all common public health mosquitocides including malathion, parathion, E.P.N., fenthion, Abate, Vapona, Dibrom, Dursban, and others."
>
> The most serious result of extensive chemical control efforts against the pasture mosquito was the development of a high degree of resistance in Culex tarsalis populations. Since Culex tarsalis is the most important vector of Western Equine Encephalitis in California, the situation is indeed critical.

Moreover, insecticide resistance has developed in 225 species of insects, mites and ticks, 97 of which attack man and animals.[29]

FACTORS ASSOCIATED WITH RESISTANCE IN CALIFORNIA, DO NOT DIRECTLY BEAR ON MINNESOTA CONDITIONS FOR REASONS CITED IN THE TEXT ON PAGES 259 TO 262.

88)
On page 154 of the EIS, the MMCD states that the most severe "pressure" will be on organisms in Type III sites. Further, on page 131, the MMCD states: "resistance to insecticides by Culex tarsalis may locally occur faster than in Aedes vexans if larvae are 'pressured', as their flight ranges appear more restricted." On page 32, it states that Culex tarsalis normally breeds in Type III sites. This leads us to believe that the MMCD is in error when they state that no resistance is building up. In California, the most serious result of chemical control was the development of a high degree of resistance in Culex tarsalis.[30] The MMCD should re-evaluate its statement on resistance and further examine the issue in the EIS.

CULEX TARSALIS IS NOT NORMALLY PRESSURED IN THE MMCD PROGRAM. IN CALIFORNIA THE SPECIES RECEIVES CONTINUOUS CONTROL PRESSURE. SEE TEXT PAGE 261.

89)
The second effect of the program is on non-target species. On page 106 of the EIS it states that "the

current program has no significant effects upon aquatic insects, birds, waterfowl, fish aquatic mammals or reptiles". This statement leaves much to be desired. The increasing input of chemicals to the environment points to the need to control the input of pesticides. This requires a detailed analysis, not only of pesticide efficiency, but also of ecological response of the environment to the pesticide, before it is introduced for application. Such an analysis should cover: (1) a comprehensive spectrum of indigenous species, or if unobtainable, spectrum of indigenous orders for non-vertebrates and vertebrates. (2) spectrum of species sensitivity (3) results of regionally indigenous qualitative and quantitative bioassy analysis, (4) educational community response to pesticide usage, (5) neutralization, toleration and adaptation abilities of representative ecosystems, outlined exclusively for Type I, II and III sites, (6) share of individual pesticides in total toxicity caused by chemical contamination (7) ecological predictions of environmental effects upon a comprehensive list of sensitive species.

THE NORMAL EPA REGISTRATION PROTOCOL IS ESSENTIALLY THE SAME AS ABOVE. TEST DATA ON INDICATOR ORGANISMS GIVE RELIABLE INDICATIONS OF THE EXPECTED EFFECTS ON OTHER ORGANISMS OF SIMILAR TAXONOMIC STATUS. THE WHOLE CONCEPT OF INDICATOR SPECIES IN ANY FIELD OF SCIENCE OBVIATES THE NEED TO DUPLICATE THE TESTS IN DIFFERENT HABITATS. AQUATIC FOOD WEB RELATIONSHIPS ARE SIMILAR REGARDLESS OF GEOGRAPHICAL DIFFERENCES IN SITES. THE RESPONSE OF MEMBERS OF A TAXONOMIC GROUP TO A STANDARDIZED DOSE IN DIFFERENT HABITATS IS ESSENTIALLY THE SAME GIVEN EQUIVALENT CONDITIONS. REDUNDANT TESTS ARE USEFUL IN CONFIRMING INITIAL FINDINGS OR IN INDICATING SPECIAL CONDITIONS UNDER WHICH THESE FINDINGS VARY. HOWEVER, REPEATED CONFIRMATION OF INITIAL FINDINGS PUBLISHED IN THE TECHNICAL LITERATURE QUICKLY ACHIEVE A LEVEL OF DIMINISHING RETURNS. GENERALLY FOR WIDELY USED MATERIALS SCIENTIFIC INTEREST WILL BE QUICKLY AROUSED IF IMPORTANT VARIATIONS FROM INITIAL FINDINGS CAN BE CONFIRMED.

THE ORGANISMS WHICH ENCOUNTER THE MATERIALS USED BY THE MMCD HAVE BEEN STUDIED UNDER A VARIETY OF ENVIRONMENTAL CONDITIONS AND THE RANGES OF EXPECTED RESPONSES REPORTED. IT IS PRECISELY THIS INFORMATION UPON

WHICH THE DISTRICT BASES ITS SELECTION OF MATERIAL USED. ALL THINGS CONSIDERED, SITE BY SITE HABITAT TESTING IS A MOOT POINT FOR THE SIMPLE REASON THAT TOXICITY IS NOT A FUNCTION OF HABITAT. THE TWO MOST IMPORTANT FACTORS WHICH INFLUENCE TOXICITY WITHIN NORMAL LIMITS ARE TEMPERATURE AND NUTRITIONAL STATE OF THE ORGANISM, WITH THE OVER-RIDING FACTOR BEING DOSE.

90)
All these features of the individual pesticide can be expressed in numbers or by a graph with numerical axes. An application of multi assay bioindicatory analysis for the ecological evaluation of pesticides already used or being introduced for use should be included. A listing of experimental animals used in data should be included, denoting their use as bioindicators, and explaining the features these test animals exhibit which qualify them to adequately represent the habitat which is being assessed. These species should then be applied as field monitors. The basis for bioindication of chemicals in environments, and their characteristics in relation to the above seven points, can be accomplished with the help of bioassay and the application of models of aquatic and terrestrial ecosystems, treated sub-specifically, with a model selection which should be discussed before application. Familiar vertebrate wildlife comprise less than five percent of the animal kingdom. A major proportion of the other thousands or so non-insect species are aquatic and will be increasingly exposed to a continuing application of pesticides throughout this program. Organisms such as the Amphibia, which require the same habitat needs as the majority of mosquito species, and which depend upon the safer, predator-free intermittent bodies of water, must be particularly studied. Effective management of this toxicant wildlife complex demands general and simple means for the prediction and estimation of effects and hazards upon indigenous metropolitan area fauna. Direct non-food exposure to organophosphates is presently much more extensive than was believed four years ago, even though their bio-concentration rates are noticeably lower than the chlorinated hydrocarbons.

WHILE ALL SPECIES HAVE NOT BEEN IDENTIFIED AND TESTED INDICATOR SPECIES HAVE BEEN TESTED AND THE IMPACTS, IF ANY, OF THE DISTRICT PROGRAM ARE DISCUSSED UNDER THAT SECTION.

91)
In addition, this statement on page 106 is contradictory of statements made elsewhere in the report. On page 6 of the EIS (No. 26a) it states that there is an effect on crustaceans and on page 107 it states "Insecticides used by the MMCD kill crustaceans which are a food source for higher forms of insect life." Some of these crustaceans may be reduced as much as 40% for a short period of time (page 116). It seems clear that this could have a great potential effect on the ecosystems where spraying occurs. What is the predicted crustacean population over the next 25 years?

SEE DISCUSSION ON PAGES 218 AND 220. THE CRUSTACEAN POPULATION OVER THE NEXT 25 YEARS IS PREDICTED TO REMAIN THE SAME GIVEN CURRENT TREATMENT REGIMES DUE TO THE HIGH REPRODUCTIVE CAPACITY OF THIS GROUP TO PRESS THE LIMITS OF THE HABITAT.

92)
On page 110, the EIS states that the MMCD predicts less than a 2% loss to honeybees and other pollinating insects. This statement is based on a letter from Atkins who offered no statement as to how this prediction was derived.

THE STATEMENT WAS BASED UPON EXPERIENCE GAINED IN CONDUCTING EXTENSIVE TOXICOLOGICAL TESTING OF PESTICIDE IMPACT ON HONEYBEES. SEE TEXT PAGES 229 TO 230 . PARTICULAR REFERENCE IS MADE TO THE PEST MANAGEMENT TABLE INCLUDED IN ATKINS ET AL. 1973.

93)
Further, on page 134 it states that homestead pest control accounts for 68% of the pesticides applied in the area of which half (34%) affect bees and other beneficial insects. There are a number of questions we have about this statement.

1. What geographic area constitutes "this area"?

   THE SIX COUNTY AREA WITHIN THE MMCD.

2. This 68% figure was taken from Lansing, Michigan (p. 44 of EIS). How do you determine a 2% loss if 1/2 of 68% can affect pollinating insects with or without the MMCD program? Why should these figures relate to Minnesota?

   THE CONTEXT OF THE 2% LOSS STATEMENT RELATES ONLY TO THE IMPACT OF THE MMCD PROGRAM, INDEPENDENT OF OTHER PESTICIDE USE IN THE DISTRICT. THE ADDITIVE EFFECT OF OTHER PESTICIDE USE WOULD NOT BE A SIGNIFICANT FACTOR, AS THE FACTORS DISCUSSED UNDER SYNERGISM & POTENTIATION ON PAGES 257 AND 259 WOULD BE ESSENTIALLY THE SAME.

94)

How do pesticides affect the pollination of plants if pollinating insects are destroyed?

Pollination interrelationships constitute vital, and often very precise, links in environmental productivity. The co-dependence of much of the native fauna and flora in these terms is cause for grave concern in the light of continuing pesticide applications. In New Brunswick, as an established case history, applications of organophorus insecticides have severely damaged the populations of the native pollinator fauna of lowbush blueberries and have apparently disrupted bird populations so that they have become unprecedented agricultural pests. Unfortunately, little is known of the pollination interrelationships, in their exact extent per given micro-habitat, in natural or semi-natural environments. Very often, the reproductive biology of the plants is in-completely known, and the pollinating vectors they are involved with cannot be identified. Valuable alternative forage for pollinators, and forage for other beneficial insects, may contain lethal residues of these insecticides. Potential bio-control agents may be jeopardized.

It is clear that the disruption of pollination mechanisms, which possibly constitute a weak link in the web of eco-logical information flow, would have far-reaching conse-quences to whole ecosystems. The lack of pollination would result in the lack of seeds and fruits, which in turn would result in food scarcity for, and possible starvation or altered habitats of, seed and fruit eating animals and, of course, failure of plant reproduction. As the world loses more of its plant and animal diversity, the prodigious numbers of species of plants, pollinators, and flower visitors, which are in jeopardy, locally and over wide areas, as a result of an improperly monitored pesticide program is a matter of grave concern.

IF POLLINATING INSECTS ARE MORE THAN TEMPORARILY SUPPRESSED, IT COULD HAVE AN ADVERSE EFFECT ON PLANTS. HOWEVER, WITH THE ESTIMATED LOSS OF LESS THAN 2% OF HONEY BEES AND OTHER POLLINATING INSECTS AS REPORTED BY ATKINS, THE DISTRICT HAS LITTLE IMPACT POTENTIAL IN THIS AREA.

95)
There is need for greatly increased vigilance of these co-dependent interrelationships, and for initiation of inter-disciplinary research into understanding both botanical and zoological aspects of the ecological processes. Honey-bees constitute a minor portion of insect pollinator popu-lations.

WE AGREE THAT GREATER UNDERSTANDING IS NEEDED HOWEVER, WE FEEL THAT IT IS BEYOND THE SCOPE OF THE DISTRICT PROGRAM TO ESTABLISH THIS INFORMATION.

96)
A determination of other insect orders participating in this event is needed, with a portrayal of the relating toxicities of individual materials applied. Chart L.D. rates should be species specific.

THE CHART ON PESTICIDE TOXICITY TO HONEYBEES PERTAINS TO APIS MELLIFERA.

97)

On page 108 of the EIS, it states: "Malathion has a greater negative impact on non-target organisms than either temephos or chlorpyrifos, chiefly because a higher dosage rate is required for effective control of mosquito larvae." This statement should be supported by evidence and documented accordingly.

REFER TO MATERIAL LABELS FOR REQUIRED DOSAGE LEVELS AND ATKINS ET AL.,1973 FOR RELATIVE IMPACT AT THOSE DOSAGES.

98)

Page 44 discusses the usefulness of bats and other birds as mosquito predators. What is the effect of bio-accumulation of pesticides on these animals?

NONE OF THE DISTRICT USED INSECTICIDES BIOACCUMULATE IN BATS, OTHER MAMMALS OR BIRDS. EFFECTS OF BIO-ACCUMULATION OF PESTICIDES APPLIED BY OTHERS HAS NO RELATIONSHIP TO THE MMCD PROGRAM.

99)

Page 112 of the EIS discusses the effect of pesticides on terrestrial and aquatic flor. The EIA implies that pesticides are not a problem to plants. Gleason offered the following comments on this statement:31

> On page 112 it states, ". . . plants metabolize insecticides as do mammals and excrete by-products with little material translocation." Unfortunately the E.I.S. cites no reference to the scientific literature on this point. It may be true, but I know of very little work being done in this area. My own view is that I would expect the choline esterase inhibitor type of insecticide to have very little effect on the higher aquatic plants, but I would not be so certain about the various species of phyto-plankton. Even assuming the insecticides are not harmful to these organisms, nothing is known about their metabolism by algae. It is possible that the insecticides are concentrated by these organisms. Since they form an important part of the food chain, it would be a consideration in treating sites designated as Type III, permanent bogs and marshes, and also temporary sites which may occasionally support a duck population.

This statement should be expanded to cover her concerns.

SEE REFERENCES CITED IN THE FEIS ON PAGES 211 TO 218, AND EXPANDED DISCUSSION ON IMPACT OF MMCD MATERIALS ON PHYTO-PLANKTON.

100)

Gleason also offered comments on the EIS statement regarding bio-accumulation of chlopyrifos in fish:[32]

> Reference is made to the bio-accumulation of chlorpyrifos in fish on page 115, but this effect is not given further consideration. I think that past experience with accumulation of pesticides in the environment has shown us the possible hazards of ignoring this problem. I realize that the MMCD is responsible for the dissemination of relatively small amounts of insecticide. Reference is made to this on page 120 where the much greater use of insecticides by farmers is pointed out. But I hardly feel this is a valid comparison. Every person who takes an interest in national affairs knows of the current world food problems and even the strict environmentalists would make some concessions to increasing agricultural productivity. The MMCD, on the other hand, is only trying to save us from a relatively minor annoyance.

WE REFER THE AUTHORS AND THEIR REVIEWER TO THE DEIS PAGES 64 AND FEIS PAGE 124 WHERE THE DISCUSSION RELATES THAT THE MMCD DOES NOT USE CHLORPYRIFOS IN FISH BEARING WATERS OR SITES WHICH COULD DRAIN INTO THEM.

101)
In addition, Malathion has also been associated with many fish kills.[33]

ITS USE BY THE MMCD AS A LARVAL CONTROL MATERIAL IS CONFINED TO PASTURES WHICH DO NOT DRAIN INTO IMPORTANT FISH BEARING WATERS. THE READER IS REFERRED TO FEIS PAGE 235. WHICH DISCUSS THE KNOWN TOXICITY OF MALATHION TO FISH.

102)
On page 65 of the EIS it states: "Temephos is used in Type I and II sites which drain into lakes or streams after each rainstorm." Yet on page ES-74 it states: "This product is toxic to birds. Keep out of lakes, streams or ponds" etc. Does the MMCD read its own labels?

THE LABEL ALSO SAYS: FOR CONTROL OF MOSQUITO LARVAE IN STANDING WATER, SHALLOW PONDS, LAKES AND WOODLAND POOLS, TIDAL WATER, MARSHES, SWAMPS AND OTHER AREAS. THESE ADEQUATELY DESCRIBE ALL THE LOCATIONS IN WHICH THE DISTRICT USES TEMEPHOS IN TYPE I, II, AND III SITES. THE STATEMENT REFERENCED BY MECCA REFERS TO THE STANDARD CAUTION STATEMENT WHICH SHOULD BE RECOGNIZED FOR AWARENESS OF THE IMPACTS WHICH IMPROPER USE OF THE PRODUCT COULD HAVE ON THE ENVIRONMENT (I.E., RINSING OF EQUIPMENT IN LAKES, ETC.).

103)
The EIS should provide information in those sites where runoff is evident. It should describe rate and quantity of runoff water from separate rainfall events on a watershed and show the rate and quantity of sediment and pesticides transported.

RUNOFF, IN EFFECT, CREATES MOSQUITO BREEDING AREAS. THE RESULTANT COLLECTION OF WATER OR RISE IN ITS LEVEL CAUSES MOSQUITO EGGS TO HATCH. SITE BY SITE RECORDS ARE AVAILABLE TO INTERESTED INDIVIDUALS. PFANNKUCH 1976, HAS STUDIED THE PHYSICAL DYNAMICS OF THIS PROCESS AS IT APPLYS TO MMCD FIELD SITES. HIS CONCLUSIONS ARE DISCUSSED IN THE FIES. LITTLE MMCD APPLIED INSECTICIDE IS ASSOCIATED WITH RUNOFF AS APPLICATIONS ARE MADE TO POST RUNOFF WATER COLLECTION AREAS.

104)
The NAS report: Pest Control: An Assessment of Present and Alternative Technologies recommends:[34]

> The control of arthropod vectors of disease or other pests of public health should be attempted only with recognition, and insofar as possible an intimate knowledge, of the significance of the ecology and behavior of the target species and the epidemiology of the disease and with appreciation for environmental values that may be depreciated.

Pesticides are not specific in their action, and are bound to have both direct toxicological and indirect ecological effects on other organisms other than pests. Judgements of environmental consequences resulting from the use of toxic materials must be based in part on sound knowledge of amounts and natures of residues in environmental compartments which occur in Type I, II, and III sites.

WE AGREE, JUDGEMENT OF ENVIRONMENTAL CONSEQUENCES HAS BEEN A NORMAL COMPONENT OF THE MMCD PROGRAM AS DISCUSSED IN THE FEIS PAGES 116 THROUGH 123.

105)

The EIS should cover three related but quite separate activities. First, general surveillance of the environment in order to detect significant changes in populations of non-target organisms and micro-ecosystems. In some cases, circumstantial evidence about pesticide usage will also suggest that the observed changes in populations is the unforseen effect of a pesticide. This hypothesis must then be tested by a combination of residue studies, toxicology and field observations and experiments.

Second, regular measurements of pesticide residues undertaken to determine the effectiveness of the control measures. When the results are compared with a value determined to be excessive, control activities are adjusted accordingly. Measurements include those in water, soils, plants and animals, human food and human beings, and atmospheric and precipitate accumulation levels.

Third, regular measurements of populations or other parameters of wild organisms known to be valuable as indicators of pesticide effects. This type of information can act both as an early warning system and as a means of measuring the biological effectiveness of control measures. It shows where the reduction of pesticide residues, demonstrated by monitoring them, has been sufficient to cause a recovery in the species concerned.

THE REQUEST FOR GENERAL SURVEILLANCE OF THE ENVIRONMENT IN ORDER TO DETECT SIGNIFICANT CHANGES IN POPULATIONS OF NON-TARGET ORGANISMS IN MICRO-ECOSYSTEMS IS CREDIBLE. THE COST OF SUCH A MONITORING PROGRAM EITHER NOW OR IN THE FUTURE IS PROHIBITIVE AND IMPOSSIBLE TO DO IN EVERY REALM OF THE ENVIRONMENT. IF FUNDING FOR THIS TYPE OF WORK IS CONSIDERED MERITED THEN THE SUGGESTION IS THAT IT BE DONE UNDER A STATE AGENCY. IF SUCH MONITORING WERE IN FACT DEEMED NECESSARY IT WOULD HARDLY START WITH A MOSQUITO ABATEMENT PROGRAM CONSIDERING THE RELATIVELY MINUTE DOSAGES USED IN CONTRAST TO AGRICULTURAL AND FOREST PESTICIDE APPLICATIONS.

106)
Pesticide drift from the application of these pesticides is also a potential adverse effect of the program. Page 112 of the EIS briefly discusses drift as an issue. On page 2 (No. 12) the EIS implicitly dismisses drift as a problem. The EIS should provide information on the rates of pesticides in air which do not land on the target sites. Further, some discussion of the effects of pesticides on non-target species due to drift should be provided.

DISTRICT USE OF ULV LIQUID APPLICATIONS IS CONFINED TO THE SPRING WHEN WEATHER CONDITIONS ARE MORE STABLE THAN DURING THE SUMMER MONTHS WHEN LAPSE WEATHER CONDITIONS CONTRIBUTE SUBSTANTIALLY TO INCREASE THE POTENTIAL FOR DRIFT. THE DISTRICT USE OF GRANULE APPLICATIONS DURING THE SUMMER REDUCES THE DRIFT PROBLEM TO A SUBSTANTUALLY LOWER LEVEL THAN IF ALL AIRCRAFT APPLICATIONS WERE MADE WITH LIQUID. SEE FEIS PAGE 249 FOR A REVISED DISCUSSION OF THIS TOPIC.

107)

Atmospheric transport is of basic importance for the regional distribution of chemical substances implemented through an aerial spraying program. Studies have indicated that global variability of these constituents within the troposphere is strongly correlated to tropospheric resident time. If this resident time is longer than half a year, the constituent could show a fairly uniform distribution. This would indicate a uniform atmospheric pesticide level throughout the district area.

TROPOSPHERIC CONCENTRATION OF PESTICIDES CAN OCCUR UNDER HIGH DOSAGES OF EXTENSIVELY USED PERSISTENT PESTICIDES

APPLIED IN LIQUID FORM. THE MMCD'S PROGRAM USES NEITHER HIGH DOSAGE, EXTENSIVE LIQUID APPLICATIONS (RELATIVE TO REGIONAL AGRICULTURAL APPLICATION REFERENCED IN THE LITERATURE ON THIS SUBJECT) NOR PERSISTENT INSECTICIDES.

108)
In an aerial spray program, only a portion of the pesticide is placed on the target area. The rest of the aerosol is carried away by the wind over a distance to higher atmospheric levels, resulting in precipitations. The parameters which discuss the atmospheric resident time should be discussed, since the normal chemical and biological degradation agents would not be as effective under such conditions.

THE COMMENT THAT "ONLY A PORTION OF THE PESTICIDE PLACED IN THE TARGET AREA" APPLIES TO SPRAYS. THE DISTRICT EMPHASIS ON GRANULE USE MITIGATES AGAINST AERIAL DISPERSAL BEYOND TARGET AREAS. SEE COMMENT ABOVE.

109)
The economic aspects of the EIS should be elaborated upon. The California Mosquito Control Association states that: "In many counties of the state chemical sprays are no longer effective at safe, legal and economical rates."[35] Page 5 of the EIS (No. 23) shows that no control or biological control are cheaper methods for public expenditures. The EIS should elaborate on how these estimates were arrived at.

NO CONTROL IS CHEAPER FROM A PUBLIC EXPENDITURE PERSPECTIVE SINCE NO TAXES ARE LEVIED FOR THE PURPOSE. IF NO CONTROL WERE TO MEAN ONLY NO CONTROL OF LARVAE POPULATIONS, THE COSTS WOULD POSSIBLY BE GREATER FOR A PURELY ADULT CONTROL PROGRAM.

BIOLOGICAL CONTROL IS SO LIMITED IN ITS APPLICATION AREA THAT EXPENDITURES ARE EQUIVALENTLY LIMITED. .

IN CALIFORNIA, SOME AREAS HAVE EXPERIENCED A SUFFICIENT RESISTANCE PROBLEM TO MAKE A GIVEN INSECTICIDE IMPRACTICAL DUE TO HIGH APPLICATION RATE REQUIREMENTS. IN THESE CASES THERE HAS USUALLY BEEN A SWITCH TO A DIFFERENT MATERIAL. NO RESISTANCE HAS BEEN ENCOUNTERED BY THE DISTRICT TO EITHER LARVAL OR ADULT CONTROL MATERIALS USED IN FIELD OPERATIONS.

110)
C. Alternatives to the MMCD Program.

One of the essential parts of an environmental impact statement is to consider alternatives to the proposed action--in this case, the chemical spraying program of the MMCD. The EIS considered those alternatives "that they are comfortable with" (p. B2). What alternatives are they uncomfortable with?

GENERALLY, THOSE WHICH WOULD SPEND PUBLIC FUNDS WITH LITTLE OR NO DIRECT RETURN FOR WHAT IS SPENT. A GOOD EXAMPLE WOULD BE A PROGRAM OF RESEARCH ONLY. PROGRAMS THAT WOULD INVOLVE ONLY ADULT CONTROL (SEE PAGE 305, MITIGATION OF NO CONTROL) WOULD COST AS MUCH OR MORE, AND WOULD NOT PROVIDE AS CONSISTENT A CONTROL AT THE SAME COST AS THE CURRENT PROGRAM.

111)
The NAS report recommends with regard to alternatives to pest control:[36]

> We recommend that problems internal to chemical pest control technology warrant a high-priority effort on the part of concerned agencies to evaluate and then to further the development of alternative technologies.

The MMCD considered five alternatives to the chemical spraying program. These include: no control, biological control, physical control, controlled-release capsules of pesticide chemicals, and ultimate control, which is a combination of chemical, biological, physical, and controlled-release capsule use. Generally, these alternatives are not adequately addressed and seem to be biased in favor of the aspects that support the MMCD. The following are specific comments with regard to these alternatives.

The no control alternative is described on page 82 in one paragraph. Most of this paragraph is taken up with the negative aspects of this alternative on employment, etc. Some discussion of the positive benefits should be provided as well. Some of these include: absolutely no damage would be done to non-target species; mosquito predators would increase; people allergic to pesticides would have reduced exposure; no resistance would build-up in mosquitos; and economic savings are realized in terms of reduced cost for per capita expenditure of mosquito control and reduced property taxes.

Page 169 purports to describe the environmental impact of no control. This is more of a description of chemical control, since the MMCD alleges that chemical control would still be needed; consequently, it talks about chemical control rather than no control. We recommend that no control be discussed for both positive and negative effects, in this section.

SEE PAGE 263 OF THE FEIS. REDUCED COSTS ARE PROBABLY AN ILLUSION, SINCE HOUSEHOLDS WOULD SPEND MORE FOR SPRAYS AND REPELLANTS. SEE IMPACT SUMMARY TABLE, PAGE 185.

112)
The EIS does provide some information on the advantages of natural biological control as opposed to manipulative biological controls as the second alternative. These natural biological control mechanisms would increase as a result of the no control alternative.

REGARDING INCREASES IN NATURAL CONTROL MECHANISMS, ANY INCREASE IN NATURAL CONTROL MECHANISMS WOULD BE INSUFFICIENT TO PROVIDE A NOTICEABLE REDUCTION IN MOSQUITO POPULATIONS AS EVIDENCED BY THE MOSQUITO ANNOYANCE LEVELS IN UNCONTROLLED AREAS OF THE MMCD.

113)
With amphibian populations affected through a chemical control program, no control would facilitate a naturally-balanced bio-control system. An example of a comprehensive spectrum of indigenous species, using the class Amphibia as a case in point, to denote the complexity involved in inter-species predator-prey relationships and denoting the inadequacy of generalizing the spectrum of fauna sensibility into broad catalogues, Amphibia species which are represented in the MMCD area are listed. The amphibian larvae share the same habitat area as Aedes and Culex mosquito larvae. The adult amphibian species, denoted with an asterisk, are species which prey exclusively upon mosquitos and other similar-sized soft bodied insects. An example involving this class is in the Appendix.

NO DOCUMENTATION IS PRESENTED TO SUBSTANTIATE THE OPENING STATEMENT. AVAILABLE DATA (SEE FEIS PAGES 104 AND 239) INDICATE A WIDE MARGIN OF SAFETY EXISTS FOR DIRECT TOXICITY. AS DISCUSSED IN FEIS PAGES 72 AND 73 THE INTERMITTENT WATER NATURE OF TYPE I SITES RETARD THE DEVELOPMENT OF SUBSTANTIAL AQUATIC INSECT POPULATIONS TO SERVE AS FOOD, SIMILARILY DRY PERIODS IN SUCH SITES WOULD BE ADVERSE

FOR AMPHIBIAN FAUNA. PERMANENT WATER SITE AQUATIC INSECT FAUNA ARE NOT SIGNIFICANTLY REDUCED DUE TO THE SHORT PERIOD OF EFFECTIVENESS (12 HOURS) OF TEMEPHOS. AQUATIC MIDGES OF THE FAMILY CHIRONOMIDAE (COMMONLY CALLED FALSE MOSQUITOS) ARE PRODUCED IN FAR GREATER NUMBERS IN SEMI-PERMANENT AND PERMANENT WATER SITES THAN ARE MOSQUITOS AND PROVIDE AMPLE FOOD SUPPLY FOR AMPHIBIANS IN THE ABSENCE OF ADULT MOSQUITOS.

114)
The EIS points out that manipulative biological control is also a viable alternative. Page 43 of the EIS, points out that two-thirds of the marshes (Type III sites) are capable of supporting food chains which would act as predators to mosquitos. This is elaborated on page PD-28 of the appendix. Further, p. 80 of the EIS points out the manipulative biological control could potentially treat 34% of the district. This is the same as the acreage treated by the present chemical control method. Further, p. 84 points out that the field evaluations look good. These statements are inconsistent with their statement on page 83 that bio-control is not ready. The EIS should provide information on these field evaluations and explain why it would take five years to go to bio-control. It should be noted that the NAS report endorses biological control as a feasible alternative.[36]

THE NAS REPORT DOES ENDORSE BIOLOGICAL CONTROL AS A FEASIBLE ALTERNATIVE. HOWEVER, SUBSTANTIAL RESEARCH REMAINS TO BE DONE TO BRING THE ALTERNATIVE FROM A STATE OF FEASIBILITY TO OPERATIONAL PRACTICALITY, PARTICULARLY MASS CULTURE TECHNOLOGY. FURTHER THE 34% FIGURE QUOTED IS CONTINGENT ON PHYSICALLY CHANGING SEMI-PERMANENT INTO PERMANENT SITES. SEE PAGE 164 OF THE FEIS FOR MORE DETAILED DISCUSSION.

115)
Physical control was discussed as a third alternative. This method would place limestone in shallow depressions as a means of mosquito control. Little description was provided on how this mechanism works as a mosquito control option.

SEE FEIS, PAGE 170, APPENDIX, PAGE 24 AND RESPONSES TO COMMENTS BY MDNR AND USFWS.

116)
The EIS states that there is no environmental impact from the use of limestone because it would not be able to leach through the lens covering into the ground water (pages 3 (No. 3), 80 (No. 2)). Experience in St. Louis Park with the cresote plant which contaminated ground water 950 feet down shows that the lends coverings are permeable to chemicals and hence this is not a viable alternative.

WE ASSUME "CHEMICAL" REFERS TO DANGEROUS CHEMICALS. THE DISTRICT HAS HAD DISCUSSIONS WITH THE MPCA TO DEVELOP A LIMESTONE SITE DESELECTION PROCEDURE TO INSURE THAT NO LIMESTONE APPLICATIONS ARE MADE TO AREAS WHERE CONCENTRATIONS OF DANGEROUS CHEMICALS OCCUR (ESPECIALLY THOSE THAT ARE WATER SOLUBLE). OF SPECIAL CONCERN WILL BE SITES NEAR INDUSTRIAL LOCATIONS AND FARM YARDS. THE DISTRICT ASSUMES THAT THE EPA AND THE MPCA WOULD HAVE PRIMARY RESPONSIBILITY TO INSURE THAT NO PERSISTENT WATER SOLUBLE TOXIC MATERIALS ARE USED ANYWHERE IN THE DISTRICT.

117)
Another aspect of physical control includes modifying shoreland to eliminate reeds and other aquatic vegetation in Type III sites. Page 124 attempts to discuss this impact. The impact on waterfowl and natural predators as well as general modification of the aquatic environment are poorly considered, if at all. The EIS should delve into greater detail on these impacts. In summary, physical control is not a viable alternative. This is supported in a recommendation in the NAS report on Pest Control:[37]

> In the future, development and implementation of mosquito control through manipulation of the environment should incorporate appropriate safeguards to preserve the natural vegetation and fauna of aquatic habitats. To this end, more sophisticated forms of environmental manipulation than, for example, simple ditching, should be utilized.

REFERENCE IS MADE TO PROBABLE EFFECTS OF PHYSICAL CHANGES ON FLORA AND FAUNA IN DEIS APPENDIX PAGES EI 46 THROUGH 48. SEE EXPANDED DISCUSSION OF THIS TOPIC ON FEIS PAGES 271 THROUGH 274.

118)
In addition, the EIS should provide additional information on the laws and regulation of the DNR and MPCA as they relate to the physical control alternative.

SEE PAGE 315 OF THE FEIS.

119)
The fourth alternative discussed was the Controlled-Release Capsule (C-R Capsule). This alternative consists of placing controlled-release dursban, temephos, or chlorpyrifos capsules in Type I sites, which release the chemical whenever water is present. Information in the EIS was neither provided on the toxicity of dursban, whether acutely or chronically, nor on the other problems outlined previously in II.A.

TOXICITY OF DURSBAN (CHLORPYRIPHOS) WAS DISCUSSED IN THE DEIS, PAGE 118, AND HAS BEEN EXPANDED IN THE FEIS, PAGE 242 THROUGH 248.

120)
On page 148, the MMCD states that dursban will have no effect on the environment. On page 173, the MMCD points out that the C-E Formulation would build up resistance in Aedes vexans and Culex tarsalis within five years and resistance would be a significant aspect in the use of the C-R capsule. Further, on page 91, the MMCD states that field evaluations would need to prove the "rationality" of using the product. On this basis alone, the C-R Formulation is unacceptable.

C-R FORMULATIONS, OF A SINGLE INSECTICIDE, USED EXCLUSIVELY OVER THE ENTIRE DISTRICT WOULD PROBABLY INDUCE RESISTANCE. FIVE YEARS IS A WORST CASE ESTIMATE. C-R FORMULATION MANAGEMENT COULD READILY MITIGATE THE SPEED OF RESISTANCE BY MATERIAL SELECTION AND BLENDING OF OTHER CONTROL METHODS. SEE PAGE 285, FEIS.

121)
In addition to the above, the EIS provided little if any information on: the concentration levels as it leaks out of the C-R capsule; what the half-life of the chemical is; its potential for synergism and potentiation; the problem of bio-magnification, bio-accumulation, and persistence; concentration levels as the capsule releases and the water decreases; its effect on non-target organisms; metabolization products and effects.

SEE FEIS PAGES 281 TO 288. PARTICULAR REFERENCE IS MADE TO NELSON & EVANS, 1975 FOR THE DETAILED DATA DEVELOPED TO SUPPORT REGISTRATION OF DURSBAN® 10CR. RELEASE RATES DIFFER, OTHER FACTORS BEHAVE THE SAME AS DISCUSSED IN FEIS PAGES 176 TO 178..

122)
Why was no mention made of the fact that dursban would not be applied unless there was 1 1/2 inches of rain as was mentioned in the EA and before the MEQB Pesticide Task Force?

BECAUSE SUCH A STATEMENT IS NOT IN THE EA, WAS NOT MADE BEFORE THE MEQB PESTICIDE TASK FORCE, AND IS INCORRECT.

123)
What would be the impact on non-target organisms if they ingested the capsule?

AVAILABLE INFORMATION ON GRANULE AND CONTROLLED RELEASE PELLETS INDICATE RELEASE RATES ARE LESS THAN THE LEVEL WHICH PRODUCES MORTALITY IN WILDLIFE. NELSON AND EVANS, 1975 RELATE A 2.72 KG DUCK MUST INGEST 816 PELLETS TO PRODUCE DELETERIOUS EFFECTS.

124)
The NAS report recommendation is worth noting:[38]

> The study team recommends continuation of the current trend toward a balanced, integrated approach in pest control tactics taking into account the ecology and behavior of the pest species, the epidemiology, and environmental values. The implementation of multi-tactic control systems will increase research efforts; consequently, the study team recommends continued and expanded support of research on ecologically based control systems for mosquitoes and other arthropods of medical importance.

Further discussion is needed concerning use of the controlled release capsule. Concentration levels, given with receding water levels and reduced water volume, should be provided. There should also be comprehensive bio-impact data.

SEE NELSON AND EVANS, 1975.

125)
The fifth alternative is the ultimate program. This is based on a combination of biological, physical, C-R capsules and chemical control. For the reasons noted above this alternative is unacceptable since it includes physical and C-R capsule formulations.

THIS PROGRAM IS ESPECIALLY ACCEPTABLE BECAUSE IT ALLOWS FREEDOM TO CHOOSE BEST FEATURES FOR EACH ENVIRONMENTAL SITUATION TO MAXIMIZE EFFECTIVENESS AND MINIMIZE ADVERSE ENVIRONMENTAL IMPACTS.

126)
In summary, site by site analysis should be provided for chemical, biological, physical, C-R capsules and ultimate control programs. On page 162, it states that there are other chemical alternatives. Descriptions and data on these should be provided as well. Based on the above, the chart on page 8 and 9 is not an accurate reflection of the data.

THERE IS NO REFERENCE ON DEIS, PAGE 162, THAT STATES THERE ARE OTHER CHEMICAL ALTERNATIVES. THEY ARE, HOWEVER, PRESENTED IN DEIS ON PAGE 47, AND PAGES 66 AND 67.

127)
D. Short Term vs. Long Term Use of the Environment.

Page 11 indicates that there are 240,000 acres of surface water of which 200,000 acres are breeding sites for Aedes vexans. In addition, there are 265,000 acres of wetlands. On page 28, it indicates that 100,000 acres of mosquito breeding sites will be lost by the year 2000. Why isn't this 21.5% of the breeding acres reflected in the chart on pages 8 and 9 on "% MMCD acres controlled"? Page 126 indicates that 38% of MMCD service area will be out of production.

PAGE 11 IS IN ERROR. IT SHOULD STATE THAT 240,000 ACRES OF MOSQUITO BREEDING AREAS ARE PRESENT IN THE DISTRICT. THE PART ABOUT 200,000 ACRES OF BREEDING GROUNDS SHOULD BE OMITTED. MECCA'S COMMENT THAT THERE ARE 265,000 ACRES OF WETLANDS IS UNCLEAR AS THERE ARE NO FIGURES IN THE DEIS TO THAT EFFECT. FIGURES GIVEN ON PAGE 28 RELATE TO THE PROJECTIONS MADE IN THE LEVEL B STUDY. THE DISTRICT DID NOT BASE ITS PROJECTIONS ON THEM.

128)
On page 42, it states that over 60% of the recreational land in Anoka county is in the form of nature preserves (15,050.1 acres). Within the MMCD area, over 45% of the recreational land is in nature centers. Figure V shows that the northern areas are prime breeding grounds. On page 74, the EIS

states that the MMCD does not enter these areas. The EIS should contain information on how the MMCD program interferes with these preserves and a more detailed description of why the MMCD does not enter these areas.

THE DISTRICT CONTROL MEASURES WITHIN THE VARIOUS NATURE CENTERS DEPEND UPON THE RELATIONSHIP AND UNDERSTANDING PARTICULAR TO EACH AREA. FOR ADMINISTRATIONS WHICH APPROVE CONTROL MEASURES, THE DISTRICT PERFORMS CONTROL OPERATIONS. THE DISTRICT DOES NOT ENTER THOSE WHICH REQUEST THE DISTRICT NOT TO DO CONTROL WITHIN THEIR BOUNDARIES. MECCA'S REASONING THAT INFORMATION SHOULD BE PROVIDED ON HOW THE MMCD PROGRAM INTERFERS WITH THESE RESERVES SEEMS SUPERFLUOUS.

129)
The EIS indicates on page 92 that it wishes to expand its program due to continued urban growth. The EIS should evaluate its program in terms of its impact on land use. As pointed out in the Metropolitan Council comments on the EIS, the MMCD should evaluate its program on land use. Do mosquitos provide a dis-incentive to urban sprawl? If so, then the MMCD should not spray where urban sprawl is likely in order to help implement the Development Framework Plan for the metropolitan area.

THE EIS DISCUSSION OF OPTIMUM MOSQUITO CONTROL PROMPTED A REFERENCE BY THE MMCD OF EXPANDED BUFFER ZONES. ALTHOUGH URBAN DEVELOPMENT WAS MENTIONED AS A RATIONALE FOR MOSQUITO CONTROL BEYOND CURRENT MMCD LARVAL CONTROL BOUNDARIES (AS A HEALTH MEASURE AND AS A MEANS OF PROVIDING BENEFIT TO TAXPAYERS), EXTENDED CONTROL IS MORE ACCURATELY A RESPONSE TO FLIGHT BEHAVIOR OF AEDES VEXANS. THIS SPECIES HAS A DISPERSAL RANGE OF 15 MILES. MOSQUITOS HATCHED OUTSIDE THE CONTROLLED AREA CONTRIBUTE TO THE MOSQUITO PROBLEM WITHIN THE CORE OF THE DISTRICT. EXTENSION OF THE BUFFER ZONE WOULD EXTEND THE BOUNDARY OF EFFECTIVE CONTROL WITHIN THE DISTRICT WITH PRINCIPLE BENEFICIARIES CONTINUING TO BE RESIDENTS OF THE CENTRAL CITIES AND THEIR SUBURBS. THE MMCD REFERS TO THIS LARVAL CONTROL BOUNDARY EXTENSION AS A "BUFFER ZONE." A "BUFFER ZONE" WOULD EXTEND THE LARVAL CONTROL AREA APPROXIMATELY 10 MILES. THE OUTER BOUNDARY OF THE CURRENT MMCD WOULD REMAIN CONSTANT EXCEPT IN THE SOUTHERN AND EASTERN SECTORS. THEREFORE, THE OVERALL SUCCESS OF SUCH A PROGRAM WOULD DEPEND ON COOPERATIVE INVOLVEMENT OF CARVER COUNTY IN THE MMCD PROGRAM.

A LARVAL CONTROL BOUNDARY IS NOT SYNONYMOUS WITH A MOSQUITO CONTROL SERVICE AREA; THE BOUNDARY IS WIDER. CURRENTLY A LARVAL CONTROL AREA OF 900 SQUARE MILES PROVIDES 87% CONTROL AT THE CENTER, 65% CONTROL IN INNER SUBURBS AND 43% AT THE MARGIN. AN EXTENDED BUFFER ZONE WOULD INCREASE CONTROL AT THESE BANDS TO 96%, 87%, 65% AND 43% AT THE NEW MARGIN. IT IS NOT POSSIBLE TO ACHIEVE 100% CONTROL AT THE CENTER WHILE ACCESS TO PRIVATELY HELD BREEDING SITES IS DENIED.

IN A TECHNICAL VEIN, HOWEVER, EXPANSION OF THE BOUNDARY WHILE INCREASING EFFECTIVE MOSQUITO CONTROL, MAY STIMULATE SELECTIVITY FOR RESISTANCE IN SOME SPECIES IN THE LONG RUN.

130)
E. Irreversible Commitments of Resources.

Section II.B. of these comments pointed out that the MMCD is in error when they state that mosquitos are not becoming resistant to pesticides. They claim this is true because of the extensive flight of Aedes vexans and because they limit larvae control to the core area.

Assuming they are correct in their diagnosis for Aedes vexans, this would not be true for Culex tarsalis, which has a shorter flight range. This means that as Aedes vexans are killed off, Culex tarsalis will fill the void left by Aedes. This will happen because Culex does not have the flight range, and, hence, the gene pool dilution that the Aedes has. In summary, this means that the chemical spraying program may actually be encouraging disease vectors instead of eliminating them. Heartworm is a classic example. If the MMCD program was working, heartworm would be going down not up (see pages 34, 133).

However, the MMCD may be wrong of Aedes vexans as well. Page 150 of the EIS states that Aedes vexans (and Culex tarsalis) could become resistant to the Controlled-Release formulations. If they can become resistant (Aedes), why can't they become resistant to Malathion and temephos as they have in California?

In either case the public will lose out if the disease vectors (Culex tarsalis) become resistant to the chemicals used by the MMCD. A resistance will occur from the abatement of a nuisance (Aedes vexans). If this happens, the continuation of the MMCD program would be an irreversible commitment of our resources, which are needed for disease vector control, that are presently being wasted on an attempt at nuisance control.

THE MMCD IS NOT IN ERROR. RESISTANCE IS VERY READILY OBSERVABLE IN LABORATORY TESTS WELL IN ADVANCE OF SIGNIFICANT DEVELOPMENT. TESTS CONDUCTED BY ENTOMOLOGISTS AT THE UNIVERSITY OF MINNESOTA SINCE 1961 SUBSTANTIATE THE CLAIM THAT RESISTANCE IS NOT A FACTOR IN THE DISTRICTS' PROGRAM. THIS TOPIC IS DISCUSSED IN THE FEIS ON PAGES 259 TO 262 AND IN COMMENT 65.

THERE IS NO ECOLOGICAL CONCEPT SUCH AS THE "VOID" REFERRED TO IN THE FOREGOING COMMENT. AEDES VEXANS AND CULEX TARSALIS ARE DIFFERENT SPECIES. LARVAL DEVELOPMENT OF EACH IS A FUNCTION OF DIFFERENT ECOLOGICAL REQUIREMENTS. WHILE EGGS OF EACH SPECIES DEVELOP IN WATER, CULEX TARSALIS ONLY OCCUR IN SIGNIFICANT NUMBERS WHEN RAINFALL IS ABNORMAL.

THE CURRENT MMCD MOSQUITO CONTROL PROGRAM, THOUGH NOT SPECIES SPECIFIC, IS PRIMARILY AN AEDES CONTROL PROGRAM. CULEX TARSALIS ARE SPECIFICALLY CONTROLLED WHEN RAINFALL LEVELS STIMULATE THEIR RAPID PRODUCTION (1975, 1977 FOR EXAMPLE). AEDES VEXANS KILLED BY MEANS OF NORMAL CONTROL EFFORTS DO NOT LEAVE A VOID FILLED BY C. TARSALIS AS LIGHT TRAP AND BITE COUNT RECORDS FOR THE LAST TWENTY-FIVE YEARS WILL BEAR OUT.

A NUMBER OF AEDES SPECIES FIGURE PROMINENTLY IN THE HEARTWORM CYCLE OF THIS DISEASE; SPECIES CURRENTLY BEING CONTROLLED. DUE TO THE NUMBER OF VECTORS AND THE HIGH LEVEL OF CONTROL NEEDED TO SUPPRESS TRANSMISSION, THE DISTRICT ALONE CANNOT STOP HEARTWORM (SEE ES P. 34 FOR A DISCUSSION OF HEARTWORM).

DR. SCHLOTTHAUER (PERSONAL COMMUNICATION, 1976) RELATES THE INCREASE OF HEARTWORM MAY BE DUE TO INCREASES IN DOG SHOWS, INCREASED MOBILITY OF DOG OWNERS AND THE MOVEMENT OF DOGS ACROSS STATE LINES IN THE ABSENCE OF CENTRALIZED CONTROLS REGULATING MOVEMENT OF INFECTED ANIMALS. INCIDENCE OF HEARTWORM LOCALLY IS HIGHER WHERE LARVAL CONTROL MEASURES ARE ABSENT.

A COMPARISON OF MOSQUITO CONTROL IN CALIFORNIA WITH PRACTICES IN MINNESOTA IS NOT A VALID COMPARISON OF FACTS. ENVIRONMENTAL CONDITIONS DIFFER, SPECIES DIFFER, SPECIES CONTROLLED DIFFER, DEGREE OF CONTROL DIFFERS, AND HISTORY OF RESISTANCE DIFFERS.

THE POTENTIAL OF RESISTANCE TO AN INSECTICIDE DEVELOPING (IN ANY FORMULATION) EXISTS. THE PROBABILITY OF RESISTANCE OCCURRING IN THE TWIN CITIES IS REMOTE (SEE DISCUSSION IN TEXT ON PAGE 261 AND CUTKOMP'S LETTER COMMENT 65.

THE REVIEWER CLAIMS THAT 'THE PUBLIC WOULD LOSE OUT IF THE DISEASE VECTORS (C. TARSALIS) BECOME RESISTANT TO THE CHEMICALS USED BY THE DISTRICT; ADVOCATES SUSPENSION OF THE CURRENT PROGRAM TO AVERT AN UNLIKELY POSSIBILITY. IT IS DIFFICULT TO UNDERSTAND HOW THE PUBLIC WOULD BE SERVED BY SUSPENSION OF A PROGRAM WHICH CURRENTLY CONTROLS MOSQUITO POPULATIONS BETWEEN AN ESTIMATED 87% AND 43% AT CENTRAL AND OUTLYING PORTIONS OF THE CONTROL AREA. THIS LEVEL OF CONTROL WITH NO HISTORY OF RESISTANCE CAN HARDLY BE DISMISSED AS A "WASTEFUL ATTEMPT AT NUISANCE CONTROL."

131)

F. Impact on State Government of Federal Controls

There are two kinds of federal controls which have impact on the MMCD program. These are the laws and regulations governing the registration of pesticides that the MMCD uses, and the laws and regulations on worker safety and health. The EIS should review these laws and regulations in detail and take time to discuss whether the policies and procedures created by these laws have been fairly implemented. Such a discussion is important to assure the MMCD and the public that the pesticides are safe and that the workers are protected. Our analysis indicated that the EPA cannot and has not assured the safety of pesticides in general, and that OSHA is not adequately protecting workers exposed to hazardous substances including pesticides.

Perhaps the main reason that the MMCD failed in its duty in providing adequate information on the toxicology and adverse effects of their pesticides in the EIS is their belief that EPA would not let a pesticide on the market that would be harmful (page 46). This kind of blind trust can be fatal. The records over the years have shown that neither the EPA nor its predecessor protected the public and the consumer from defective and dangerous pesticides. The following is a summary of those reports.

In 1968 the General Accounting Office (GAO) issued a report criticizing the Agricultural Research Service (ARS) for failure to remove misbranded and adulterated pesticides from the market.[39] The situation continued to deteriorate. Congress reacted by transferring the pesticide authority to the newly created Environmental Protection Agency under Reorganization Act. No. 3. In 1972, the Federal Insecticide, Fungicide, and Rodenticide Act of 1947 was amended (see 7 U.S.C. § 135 et. seq.). In 1973, a second GAO report showed that the EPA was failing to remove hazardous pesticides

from the channels of trade to protect consumers from defective products. Some of the findings and conclusions of that report are as follows:[41]

1. The consumer has not been adequately protected from defective pesticides because of inadequate EPA efforts to determine whether registered pesticides were marketed in accordance with provisions of the Act.

2. EPA did not give its inspectors enough guidance for determining which registered pesticides to sample. As a result, inspectors repeatedly sampled some pesticides but never sampled others.

3. About 32,000 pesticides were registered as of June 30, 1972. Only 7,000 had been sampled during the preceding 4 1/2 years. GAO found that at least 3,300 samples of 253 pesticides had been taken during that period.

4. About 64 percent of the manufacturers in the three EPA regions included in GAO's review did not have any of their pesticides sampled by EPA during this period.

5. The effectiveness of EPA's surveillance over pesticide imports was reduced because the Bureau of Customs did not report the arrival of many pesticide shipments to EPA, and EPA did not adequately sample those that were reported.

6. Although the Secretary of the Treasury was required to prescribe regulations for implementing the import provisions of FEPCA by January 19, 1973, such regulations had not been promulgated as of March, 1974.

7. Because of the lack of space, personnel, and equipment, EPA's biological laboratories could not test most samples for safety and effectiveness.

8. During the 18-month period preceding June 30, 1972, EPA collected 9,344 samples but tested only 19 percent for safety. Of those tested, 16 percent were found to be defective.

9. Only 32 percent of the samples were tested for effectiveness. Of those tested, 28 percent were found to be defective. Thus the number of unsafe and ineffective pesticides being used by consumers could be significant.

10. Many pesticides are decomposable, but EPA did not conduct any studies to determine rates of decomposition or the period of time for which pesticides could be expected to be effective.

11. In registering new pesticides, EPA relied on manufacturers' test data on the pesticides' safety and effectiveness. Even for those pesticides such as disinfectants and rodenticides, with histories of violations, EPA made only limited tests before registration.

12. In a 1968 report to the Congress, GAO pointed out that the Federal Government was not prosecuting firms for serious and repeated violations - no manufacturers were referred to the Department of Justice for prosecution during fiscal years 1959-68.

13. Since then, EPA's prosecution activity has increased steadily; during fiscal year 1973 it referred over 250 cases to Justice for possible prosecution. EPA has not, however, effectively used the enforcement alternatives of canceling registrations and recalling products to prevent marketing of repeatedly ineffective pesticides.

14. During an 18-month period EPA laboratories found that 25 percent of the disinfectant and 32 percent of the rodenticide samples tested were ineffective. Although EPA repeatedly found some rodenticides and disinfectants ineffective, it did not, with few exceptions, cancel their registrations, or require that claims for effectiveness be deleted from the labels.

15. Also, EPA requested the recall of only 90 of the 559 disinfectant and rodenticide shipments from which it collected ineffective samples.

16. GAO reviewed records for 48 pesticides which EPA found to be defective as a result of safety and effectiveness tests from August 1972 through January 1973. In only 2 of the 48 cases were manufacturers notified of the defects. Other manufacturers were allowed to continue marketing defective pesticides because EPA did not act.

17. Although EPA's policy is to notify manufacturers when it discovers an ineffective or chemically deficient pesticide shipment, it did not normally notify the public.

18. Not only was the consumer exposed to pesticides which EPA found to be frequently ineffective or chemically deficient, but also other Federal agencies purchased quantities of these pesticides and in some cases, in effect, recommended their use to consumers.

19. Although all States required registration of pesticides sold within their borders and made some market surveillance, EPA made only limited use of the data obtained by the States to supplement its market surveillance programs.

In 1975, the GAO issued a fourth report pointing out that the EPA was failing to protect the public and the environment adequately from pesticides.[42] The complete list of problems is found in Appendix Two. In summary, the GAO found: 1.) adequate safety and efficiency data was not available at the EPA; 2.) many labels do not comply with EPA requirements; 3.) better assurances are needed that pesticide residues in food are safe; 4.) safety of interim tolerances were not established for registered pesticides; and 5.) statutory registration requirements were not carried out in a timely and adequate manner. The story doesn't end here, as bad as this seems.

In early 1976, three attorneys left the EPA because they felt that the EPA was refusing to take action on pesticides that were suspected of causing cancer, birth defects or mutations. They released a working document that contained over 100 chemicals used as pesticides.[43] No actions have been taken on these pesticides.

REGARDING A REVIEW OF THE LAWS AND REGULATIONS GOVERNING THE REGISTRATION OF PESTICIDES AND REGULATIONS ON WORKERS SAFETY AND HEALTH, THE DISTRICT COMPLIES WITH THESE REGULATIONS AND WILL COOPERATE WITH ANY STATE OR FEDERAL AGENCY WISHING TO REVIEW THEIR ADHERENCE BY THE DISTRICT.

THE DISTRICT DOES NOT HAVE STATUTORY AUTHORITY TO FUND A PROGRAM WHICH WOULD BE NECESSARY TO PROVE OR DISPROVE THE MERIT OF EPA DECISIONS REGARDING PESTICIDES. A DISCUSSION IS INCLUDED ON THE FACTORS INFLUENCING THE SELECTION OF PESTICIDES USED IN THE DISTRICT PROGRAM.

A COPY OF THE CITATION #43 IN MECCA REPORT WAS REQUEST FROM MECCA TO DETERMINE WHETHER ANY OF THE DISTRICT INSECTICIDES WERE INCLUDED. THIS DOCUMENT DID NOT LIST ANY MATERIALS USED IN THE DISTRICT PROGRAM. A PUBLICATION BY INNES ET AL., TITLED "BIOASSAY OF PESTICIDES IN INDUSTRIAL CHEMICALS FOR TUMORIGENICITY IN MICE: A PRELIMINARY NOTE" TESTED 120

SELECTED PESTICIDES AND INDUSTRIAL COMPOUNDS FOR TUMORIGENICITY IN MICE. SIMILARILY NONE OF THE DISTRICT MATERIALS WERE CONSIDERED SUFFICIENTLY HAZARDOUS TO INCLUDE IN THIS TEST GROUPING.

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In December 1976, Senator Kennedy's Subcommittee on Administrative Practice and Procedure of the Senate Committee on the Judiciary issued a report on the EPA and the regulation of pesticides. The report offered the following recommendations:[44]

1. Thorough and expert review of all safety testing data on pesticides should be done for each compound prior to registering, reregistering, or granting tolerances. This is a fairly self-evident recommendation but EPA has simply not performed the reviews. Two quite elementary steps must be taken immediately. First, EPA must organize its own data files and in some cases find missing data files. Second, it must require its reviewers to read the files, including the correspondence files that contain the comments of prior reviewers. The embarrassing fact is that EPA in many cases cannot even find the material it is charged with assessing, and it has systematically failed to even read relevant material it possessed.

2. In connection with the first recommendation, the safety testing data underlying previously granted residue tolerances should expeditiously be subject to the same thorough scientific review as the data used for reregistration. In addition, the EPA should immediately expedite the development and finalization of regulatory procedures for setting tolerances, and those procedures should fully reflect the findings of this report.

3. The data submitted by manufacturers should be made public as a matter of course. The material to be withheld from public scrutiny should be narrowly defined, consistent with statutory definitions of confidential material, and the burden of identifying with particularity material claimed to be confidential should be imposed on the manufacturers as a condition to EPA accepting data submissions. Timely public access to safety testing data has the potential for subjecting that data to additional scientific

scrutiny by public interest groups, other Government agencies, independent scientists with an academic or other interest in a particular compound, and perhaps on occasion by the scientific personnel of competing pesticide companies. In any case, scrutiny of the data over and above what EPA can provide will sharpen the analyses and improve the regulatory effort. It might also provide some incentive for the companies to develop more accurate data and the EPA to improve the quality of its own internal reviews.

4. In connection with ensuring that it will have a better data base, the EPA should expeditiously establish and implement an effective program to evaluate the testing procedures of and accuracy of data developed by laboratories utilized by pesticide manufacturers submitting data to EPA. There have been serious problems experienced by the FDA in this regard and, since pesticide companies use some of the same labs used by drug companies, there is every reason to urge EPA to investigate and closely monitor the labs that develop pesticide safety data.

   In this connection, EPA should start vigorously investigating whether the pesticide manufacturers are disclosing all relevant safety data to EPA in a timely fashion. The performance of the Velsicol Chemical Corporation in its production of Leptophos, to cite just one example, clearly indicates that the agency is not receiving critically important information on the health effects of some pesticides.

   The problem of the falsification and withholding of safety data is one that is best addressed (A) through continual and systematic monitoring of the pesticide companies and the laboratories, and (B) swift and effective sanctions for violations, including criminal prosecution for intentional violations in this area. Currently, EPA has neither committed the resources nor mustered the will to police these problems.

5. Scientific talent should be utilized in a more effective manner. EPA should consider the possibility of developing a health-risk office, peopled by the best available scientific talent, and independent of any particular regulatory program--whether it be pesticides, toxic substances or pure water. The

health-risk office would be charged with reviewing safety testing data developed from other sources, most notably pesticide manufacturers, and would have some capability to develop data on its own. Its mission would be to use its scientists to ferret out and assess health and environmental risks. They would not be required to assess benefits.

6. Qualified scientific and management personnel should occupy the appropriate positions in the pesticide program. This is, of course, easier said than done. Although the agency must share part of the blame for unqualified personnel, a large part of the problem is the inability to attract first-class scientists because of inadequate financial inducements, and civil service rules. The built-in impediments to such a recruiting program are not primarily the fault of EPA, but the EPA and other agencies facing similar problems should develop a plan to attract top-flight scientific talent and present that plan to the Congress for action. The Congress itself should be receptive to changes in civil service rules and Government pay ceilings that are carefully drawn to alleviate demonstrable shortcomings in the Government's ability to attract and keep the best scientists.

While we recognize that there is nothing that the MMCD can do about the problems in the EPA, it can review its practices and check the available data and present it in a readable form as it is required to do under the State Environmental Policy Act. Relying on the EPA for assurances that the pesticides used are safe is folly. The above records point that out. The MMCD must provide adequate information on the toxicity and adverse effects of their pesticides in the EIS in order to meet the requirements of MEPA.

THE DISTRICT DOES REVIEW THE EPA PRACTICES AND KEEPS CURRENT WITH THE TECHNICAL PUBLICATIONS ON MATERIALS APPROVED TO USE FOR MOSQUITO CONTROL. THE DISTRICT DOES NOT HAVE THE STATUTORY RESPONSIBILITY TO STAFF AT A LEVEL SUFFICIENT TO INDEPENDENTLY RUN THE ENTIRE SET OF INVESTIGATIONS SIMILAR TO THOSE REQUIRED FOR REGISTRATION TO VERIFY EPA'S JUDGEMENT.

THE INSECTICIDE REGISTRATION PROCESS AND THE RIGOROUS SELECTION PROCESS USED BY THE DISTRICT IS DISCUSSED ON PAGE 112 TO 115 OF THE TEXT. THE DISTRICT LEANS HEAVILY ON ITS REVIEW OF LITERATURE IN THE FIELD IN ADDITION TO EPA'S

EXTENSIVE REGISTRATION CRITERIA.

IT SHOULD BE NOTED MUCH OF THE INFORMATION SUBMITTED IN REGISTRATION OF AN INSECTICIDE IS UNPUBLISHED INFORMATION WHICH IS SUBMITTED ON A CONFIDENTIAL BASIS BY THE COMPANY MARKETING THE INSECTICIDE. SUCH INFORMATION HAS NOT BEEN AVAILABLE FOR INCLUSION IN THE FEIS. HOWEVER, ITS EXISTENCE IS A MATTER OF RECORD AND CONTAINED IN A COMPUTER PRINTOUT OF THE EPA DATA FILES ON EACH MATERIAL USED. THE PRINTOUT IS AVAILABLE FOR REVIEW AT THE DISTRICT OFFICE. HOWEVER, THE DISTRICT HAS INCLUDED AVAILABLE REFERENCES WHICH IT IS AWARE OF ON THE TOXICITY AND ADVERSE EFFECTS OF INSECTICIDES USED IN THE PROGRAM. IN OUR OPINON, THIS SATISFIES THE REQUIREMENTS OF MEQB. THE DISTRICT TRUSTS IT IS SUFFICIENTLY READABLE.

IT SHOULD BE RECOGNIZED THAT IN INITIATING THE EIS PROCESS MECCA CLAIMS OF HAZARD TO THE ENVIRONMENT HAVE BEEN UNSUBSTANTIATED BY DOCUMENTARY EVIDENCE. A REVIEW OF THE IMPACTS OF THE ON GOING PROGRAM BROUGHT TO LIGHT NO SIGNIFICANT SUBSTANTIATION OF THESE ALLEGATIONS. THE DIRECTOR DOES CONDUCT AS THOROUGH A REVIEW AS POSSIBLE OF ENVIRONMENTAL IMPACTS OF INSECTICIDES APPROVED FOR MOSQUITO CONTROL. THIS IS EVIDENCED BY THE INSECTICIDES AND FORMULATIONS USED IN THE PROGRAM. WITH THE EXCEPTION OF CHLOPYRIFOS, WHICH IS USED SELECTIVELY BY TYPE OF BREEDING SITE, DUE TO ITS PRE-HATCH CAPABILITY, TEMEPHOS, MALATHION AND RESMETHRIN ARE AMONG THE SAFEST OF ALL MATERIALS REGISTERED FOR MOSQUITO CONTROL (SEE TABLE 15).

133)
The same type of record exists for the Occupational Safety and Health Administration (OSHA) which is responsible for protecting workers. The EIS must provide adequate information to assure themselves, the workers, and the public that adequate safeguards exist to protect the workers from the dangers of pesticides. To that end, the EIS should review the legal authority of OSHA and EPA as they relate to worker protection. As a minimum, they must review 29 USC 651, 29 CFR, Part 1910.267a, 7 USC 135, and, 40 CFR Part 170. In addition, a review of information provided in the hearings on these regulations as they relate to pesticides used by the MMCD would be appropriate.

A DISCUSSION OF THE OCCUPATIONAL SAFETY STANDARDS EMPLOYED BY THE DISTRICT ARE INCLUDED IN THE FEIS APPENDIX PAGE PD 65 THROUGH 67. THE DISTRICT IS IN COMPLIANCE WITH THE

STANDARDS AND WILL COOPERATE WITH ANY INSPECTION OSHA AND EPA STAFF WISH TO MAKE TO CONFIRM COMPLIANCE. THE MMCD DOES NOT CONSIDER THE REVIEWERS CLOSING REQUIREMENT APPROPRIATE.

134)
G. Inconsistencies and Questions.

In reviewing this EIS, a number of inconsistencies were discovered, many of which have been mentioned previously in Section two of these comments. In addition, many questions have arisen. The following inconsistencies and questions should either be elaborated upon or corrected before the final EIS is written.

Page 102 states that there are five positive socio-economic effects of the current program. Page 104 provides the following as a "positive socio-economic effect":

> 4. In terms of perceived environmental costs, a surprising number of persons believe the program is environmentally damaging; 26%. Most of these reported they consider a danger exists for birds and domestic animals, such as horses and dogs. Most of these persons appeared to be commenting on adulticiding operations. These opinions are in direct contradiction to virtually all research on the toxicity of the adulticiding materials used by the MMCD.

How does this constitute a "positive socio-economic effect"?

APPROPRIATE REVISIONS HAVE BEEN MADE IN THE TEXT OF THE FEIS. NOTE OF THE INCONSISTENCY IS APPRECIATED. IT SHOULD BE NOTED THAT THE FIGURE CITED IN ITEM (4) ABOVE IS ACTUALLY 24%.

135)
If dursban is going to be applied at 19 lbs/acre (p. 90) and if the other pesticides are applied at a rate of .0035 lbs/acre to .5 lbs/acre for the various pesticides (p. 57-63), then how can dursban concentrate in the water at a 20-fold lower level than the conventional granule formulations: 0.6 to 2.2 ppb versus 18.4 to 36.8 ppb?

DURSBAN 10CR CONTAINS 10% CHLORPYRIFOS (1.19 LBS. OF ACTIVE INGREDIENT. THE CONTROLLED RELEASE FROMULATION IS UNDER EVALUATION IN ACCORDANCE WITH THE DISCUSSION ON PAGE 55 WHICH DISCUSSES FIELD TESTS TO EVALUATE CONTROL MATERIALS. A TWENTY FOLD LOWER LEVEL THAN CONVENTIONAL

GRANULE FORMULATION RESULTS FROM THE SLOW RELEASE CHARACTERISTICS OF THE CHLORPYRIFOS FORMULATION. THE RATE OF RELEASE IS SO SLOW THAT IT PERMITS CONTROL FOR A YEAR OR MORE.

136)
Pages 44-45 provide figures on pesticide use in Lansing, Michigan. Explain how these figures relate to Minnesota.

THIS COMMENT IS BASICALLY THE SAME AS COMMENT 93 PREVIOUSLY DISCUSSED. BRIEFLY, IT IS NOT IDEAL TO USE COMPARATIVE METHODS WHEREIN THE PROPERTIES OF "B" ARE USED TO DESCRIBE THE CHARACTER OF "A". NONETHELESS, IN THE ABSENCE OF DATA FOR "A" (TWIN CITIES) INFORMATION ABOUT LANSING, MICHIGAN HAS BEEN REPORTED. THIS SEEMS APPROPRIATE FOR PURPOSES OF AVOIDING VAGUENESS IN THE TEXT. FIGURES FOR LANSING WERE SELECTED BECAUSE OF GEOGRAPHICAL PROXIMITY AND BECAUSE THEY REPRESENTED THE NATIONAL NORM IN THE EPA STUDY.

137)
Page 91 states that dursban C-R formulation can be used on 50,000 to 60,000 acres. How can this statement be consistent with the previous information provided in II.C. of these comments? That section pointed out that mosquitos would become resistant to dursban within five years.

CHLORPYRIFOS (DURSBAN^{R}) HAS BEEN USED BY THE DISTRICT SINCE 1975. MOSQUITOS SHOW NO RESISTANCE TO THE MATERIAL (CUTKOMP, ANNUAL REPORTS). THE STATEMENT THAT MOSQUITOS WOULD BECOME RESISTANT TO THIS MATERIAL IN A C-R FORMULATION IN FIVE YEARS IS TOO ABSOLUTE. THE WORDING OF THE TEXT WAS STATED TO READ THAT RESISTANCE WAS POSSIBLE AND A MEANS TO AVERT THE POSSIBILITY WAS TO CHANGE FORMULATIONS AT FIVE YEAR INTERVALS. AS NOTED IN COMMENT 65 CUTKOMP FEELS 5 YEARS IS A PESSIMISTIC ESTIMATE.

138)
H. Errors.

On page 21 of the EIS, it states that the lens coverings over the shallow depressions are impermeable. Yet the situation in St. Louis Park shows that these coverings are permeable. For further information, contact the MPCA.

THE DISTRICT HAS NOT STUDIED THE ST. LOUIS PARK SOIL. UNDER THE LIMESTONE TREATMENT OPTION, PERMEABILITY WOULD BE INTENTIONALLY INCREASED. THE PROBLEM IS LOW PERMEABILTY, RATHER THAN NO PERMEABILITY.

139)
On page 43 it states that mosquito enemies rarely use temporary water sites. This is inconsistent with the information we have provided in Appendix one of our comments.

IN THE CONTEXT OF THE DISCUSSION ON DEIS PAGE 43 THE NATURAL ENEMIES REFERED TO WERE INVERTEBRATE FORMS SHOWN TO HOLD SIGNIFICANT POTENTIAL AS MOSQUITO CONTROL AGENTS DUE TO THE HIGH DENSITIES THEY CAN DEVELOP IN MOSQUITO BREEDING AREAS. WHILE WELL WRITTEN, THE SOURCE OF THE DISSERTATION ON AMPHIBIANS IS NOT REFERENCED, NOR DOES IT PROVIDE DATA TO SUPPORT CONJECTURE ON THE IMPACT OF THE MMCD PROGRAM ON AMPHIBIAN POPULATIONS. MORE PERTINENT TO THE DISCUSSION OF AMPHIBIANS AS NATURAL ENEMIES, THE DISTRICT IS NOT AWARE OF ANY DATA WHICH SHOW THAT AMPHIBIANS PLAY A SIGNIFICANT OR DEPENDABLE ROLE IN THE CONTROL OF MOSQUITOS. INCIDENTIAL MOSQUITO FEEDING AT ANY LEVEL IS HELPFUL BUT CAN NOT BE DEPENDED UPON IN A CONTROL PROGRAM.

140)
An ultimate control program as used in the EIS relies on pesticides in a C-R formulation. Page 4, No. 22 states this is not so. Explain.

THE STATEMENT ON PAGE 4, #22 IS CORRECT IN THAT WHILE CONTROLLED RELEASE INSECTICIDES WERE INCLUDED AS A PART OF THE ULTIMATE CONTROL PROGRAM PRESENTED, THE DISCUSSION ON THIS ALTERNATIVE ON DEIS PAGE 92 THRU 95 STATES THAT "IN SUCH A LARVAL CONTROL PROGRAM EMPHASIS WOULD BE PLACED ON PERMANENT AND LONG TERM CORRECTIVE MEASURES".

141)
I. Additions.
Additional information must be provided in the EIS in addition to the information requested earlier in these comments.

1.) An inventory of sites where spraying occurs, together with the natural predators that exist there, and other non-target organisms that literature shows may be affected.

DUE TO THE LARGE NUMBER OF SITES AS CITED IN THE DEIS APPENDIX PAGES 19 - 25, AND THE TIME REQUIRED TO ACCURATELY SAMPLE AND IDENTIFY NATURAL ENEMY COMPLEXES THAT EXIST IN FIELD SITES, BASED ON THE EXPERIENCE OF THE DISTRICT AS CITED IN THE APPENDIX PAGES PD 19 AND 20, THE MECCA

DEMAND THAT SUCH INFORMATION BE PROVICED IS UNREASONABLE. NOR IS IT NECESSARY, SEE PAGES 211 THROUGH 245. IMPACTS TO NON-TARGET SPECIES, ESPECIALLY INSECTS ARE ADEQUATELY DOCUMENTED.

2.) The percent of mosquitos that existed and are controlled, by sites.

THIS INFORMATION IS AVAILABLE AT MMCD COUNTY HEADQUARTERS FOR ALL FIELD SITES TREATED IN THE LARVAL CONTROL PROGRAM AND FOR EACH OCCASION TREATMENTS ARE MADE. SEE APPENDIX PD 93 THROUGH 124. ALL SITES ARE MAPPED.

142)
III. Additional Problems in the EIS
There are three other basic problems in this EIS. First, the chart on pages 8 and 9 of the Executive Summary (pages 98 and 99 of the text) is an inaccurate and misleading representation of the factual situation. Second, the figures used to indicate effectiveness are arbitrary, misleading, and inaccurate. Finally, the current program of the MMCD is ineffective.

RESPONSE PRESENTED IN FOLLOWING COMMENT DISCUSSION.

143)
A. Summary Chart.
The chart on pages 8 and 9 of the Executive Summary is an inaccurate and misleading representation of the factual situation. First, the chart contains a key from 3 to -3 showing the impacts of the current program and the alternatives. No criteria was provided for determining the real value of these figures. They seem to be more opinion than anything else.

DEFINITIONS FOR THE VARIOUS IMPACT CLASSIFICATIONS, FROM INSIGNIFICANT TO EXTREME, ARE DEFINED FOR EACH SET OF IMPACTS IN THE FEIS. SEE PAGES 13 TO 25.

144)
Second, the list of non-target organisms is not a complete list of all classes and orders. For example, if amphibians were included, there would be many negative impacts shown from the current, physical, C-R chemical and ultimate control alternatives.

AMPHIBIANS ARE INCLUDED IN THE REVISED SUMMARY TABLE, AS ARE MICRO-ORGANISMS. SEE PAGE 184, FEIS.

145)
In addition, a number of questions arise:
1. Why doesn't the percent of MMCD acres controlled reflect the 38% loss of wetlands due to urban sprawl? (p. 126).

THE DISTRICT IS HOPEFUL THAT EFFECTIVE REGULATION BY THE MDNR, METROPOLITAN COUNCIL, COUNTIES, AND COMMUNITIES WILL PREVENT THIS MAJOR LOSS OF WETLANDS. IT DOES NOT APPEAR APPROPRIATE TO BASE FUTURE PLANS ON WHAT IS PERCEIVED TO BE SUCH EXTENSIVE PRIVATE ENVIRONMENTAL ALTERATIONS. MOREOVER, MANY OF THESE WETLANDS MAY IN FACT BE REDUCED IN SIZE WITHOUT A CONSEQUENT ELIMINATION OF HABITAT FOR MOSQUITO BREEDING.

146)
2. Why isn't footnote E regarding allergies in hypersensitive persons indicated for 5 and 15 years of the current MMCD program, and 15 and 25 years of the C-R formulation control alternative? Chemicals are still being used. Therefore, aren't allergic reaction still going to be present?

C-R FORMULATIONS DO NOT USE THE MALATHION SOLVENT WHICH IS RESPONSIBLE FOR THE ONLY DOCUMENTED CASE OF ALLERGY TO MMCD MATERIALS. FOOTNOTE E DOES APPLY TO THE 5 AND 15 YEAR LEVELS OF THE PROGRAM.

147)
3. Shouldn't the biological control option show 34% control, since this method could treat 34% of the district (see II.C. of comments and p. 80 of EIS)?

CORRECT, THIS HAS BEEN ADJUSTED. IT SHOULD BE EMPHASIZED, HOWEVER, THAT THIS 34% IS DUE PRINCIPALLY TO PHYSICAL ALTERATIONS, NOT SIMPLY INTRODUCTION OF BIOLOGICAL CONTROL AGENTS.

148)
4. Shouldn't the percent of mosquito reduction be the same as the current program since the same acreage is treated?

NO, THE PERCENT OF MOSQUITO CONTROL IS MEASURED IN THE MOST POPULATED AREAS, WHERE LARVAL CONTROL IS CONCENTRATED. BIOLOGICAL CONTROL WOULD BE DISPERSED THROUGHOUT THE MMCD AND MORE FREQUENTLY IN RELATIVELY UNPOPULATED AREAS. SEE TABLE ES 5 FOR A DISCUSSION OF RELATIVE DENSITY OF SITES AND FIGURE VIII IN THE FEIS.

149)
The section of the chart should show negative impact on mosquitos in the current program, as argued in section II.E. of the comments.

BY "THE SECTION" IT IS ASSUMED "A SECTION' IS MEANT. THIS NEGATIVE IMPACT IS INCLUDED UNDER "% MOSQUITO REDUCTION 10 MILE RADIUS FROM CORE."

150)Statistics of Effectivenss in the EIS.
The first problem in the EIS with regard to effectiveness statistics is their inconsistency. Page 3 states that there is 68% control in the center and 10% ten miles out in any direction. Page 75 states that there is 65% control and 45% control. On page 100 the figures are 68% and 45%. Which are the correct figures?

THE CORRECT FIGURES, BASED ON ANALYSIS DONE IN THE DEIS, WERE 68% AT CENTER, 45% TEN MILES OUT, 34% AT THE PERIPHERY OF THE LARVAL CONTROL BOUNDARY.

THESE FIGURES HAVE ALL BEEN ADJUSTED BASED ON MORE RECENT ANALYSIS. THEY ARE 87% AT THE CENTER, 61% TEN MILES FROM THE CENTER AND 43% AT THE PERIPHERY OF THE LARVAL CONTROL BOUNDARY.

151)
The second problem with the figures is their method of calculation. On page EI-23 of the Appendix, it states that there are a large number of variables which affect the light count data. This can bias the estimates in terms of estimating the number of mosquitos in an area. In addition, the Appendix admits that direct comparison of trap counts is difficult and "the conclusions from such a comparison may be questionable."

SEE APPENDIX, EI 20 FOR A DISCUSSION OF NEW METHODS WHICH WERE EMPLOYED TO ELIMINATE THE BIAS, AND PERMIT DIRECT COMPARISONS BETWEEN LIGHT TRAPS.

152)
One light trap in downtown St. Paul and 16 traps throughout 900 square miles is insufficient for gathering accurate data. On page EI-23 of the Appendix, you assume that the light trap populations are representative of the changes over time of mosquitos bred in a given geographic area. In the last two years, the traps varied by tens of thousands of percent.

ASSUMPTIONS ABOUT REPRESENTATIVESNESS WERE TESTED FOR EIGHT TRAPS IN JULY, 1977. SEE EI 25. VARIANCE IN TRAP POPULATIONS ARE A FUNCTION OF OVERALL MOSQUITO POPULATIONS, WHICH VARY GREATLY.

153)
Third, you try to avoid inconsistencies by taking the log count of the light trap, which means you measure error in terms of orders of magnitude instead of measuring real error. I submit that this is not a effective measurement technique.

LOG COUNT MEASUREMENTS ARE AN ACCEPTED DATA TRANSFORMATION TECHNIQUE USED TO REDUCE CURVILINEAR RELATIONSHIPS INTO LINEAR EXPRESSIONS. ALSO THEY ARE USEFUL AS A GENERAL TENDENCY INDICATOR. THEY WERE USED IN THE DEIS AS AN INDICATOR ONLY.

SINCE SUFFICIENT NON-LOG COUNT MEASUREMENTS WERE DEVISED FOR THE FEIS, THE LOG COUNT ANALYSIS IS NOT REPEATED IN THE FINAL. SEE FEIS APPENDIX, EI 20. SEE RECOMMENDATIONS SECTION OF THE CHAPTER ON SHORT TERM GAINS VS LONG TERM PRODUCTIVITY ON THE NUMBER OF TRAPS WHICH CAN PROFITABLY BE EMPLOYED. CURRENT DATA DOES APPEAR ADEQUATE FOR OVERALL EFFECTIVENESS ANALYSIS, HOWEVER.

154)
Moreover, no base line data was provided to see if the MMCD program had any effect. What were the light trap counts before the MMCD existed?

THE LIGHT TRAPS OUTSIDE THE LARVAL CONTROL BOUNDARY ARE A CONTINUOUS BASE LINE DATA SYSTEM THAT IS FAR SUPERIOR TO ANY HISTORICAL BASE YEAR, GIVEN THE VARIETY OF RAINFALL CONDITIONS FROM YEAR TO YEAR. SEE APPENDIX, EI 24, FOR A DISCUSSION OF THE CALIBRATION OF THESE TRAPS FOR THIS PURPOSE.

155)
Therefore, I suggest that your effectiveness figures are a bunch of bunkum.

EFFECTIVENESS ANALYSIS IS A SOPHISTICATED PROCEDURE WHICH DEMANDS MORE THAN A CURSORY EXAMINATION. TO FACILITATE READING, THE ANALYSIS HAS BEEN REWRITTEN IN THE APPENDIX FOR THOSE WHO MAY HAVE HAD A DIFFICULT TIME APPROACHING THE SUBJECT MATTER.

156)
Many criticisms may be made of your survey techniques as well. In general, I found the survey poorly designed incomplete samples taken, and the survey areas skewed in the direction of satisfaction. Most people surveyed were in the core area where other factors besides the MMCD program could influence the number of mosquitos present (for example, auto exhaust).

THE SURVEY EMPLOYED A STRATIFIED SAMPLE DESIGN OF NEIGHBORHOODS (CENSUS TRACTS) BASED ON EQUIVALENT INCOMES AND DISPERSION THROUGHOUT THE DISTRICT. SAMPLES WERE BETWEEN 109 AND 131 IN EACH NEIGHBORHOOD, A REMARKABLE CONSISTENCY.

AREAS WERE NOT SKEWED IN THE DIRECTION OF SATISFACTION. AREAS SUCH AS EXCELSIOR, SHAKOPEE, FARMINGTON, MOUNDS VIEW, GEM LAKE AND BAYPORT LIE IN AREAS WHERE CONTROL IS NOT PARTICULARLY EFFECTIVE; ST. LOUIS PARK, ANOKA AND CRYSTAL SUFFER FROM PROXIMITY TO LARGE BREEDING AREAS. ONLY 5 OF 16 NEIGHBORHOODS WERE IN THE CORE AREAS: 2 EACH IN ST. PAUL AND MINNEAPOLIS; ONE IN COLUMBIA HEIGHTS.

AUTO EXHAUST IN THE AMOUNTS LIKELY TO BE PRESENT IN EITHER THESE COMMUNITIES HAS NEVER BEEN SHOWN TO HAVE AN EFFECT ON MOSQUITO POPULATIONS. THE NUMBER OF MOSQUITOS PRESENT CAN BE A FUNCTION OF CO_2, LIGHT, AND HEAT. ALL OF WHICH ARE FOUND IN RELATIVELY GREATER AMOUNTS IN THE INTERIOR.

157)
Ignoring this, the calculation of the number of mosquitos present meant that even in the dead of winter there would still be 14.64 denied time (page 37). Explain that.

THE 14.64 REPRESENTS THE CONSTANT, OR THE CROSSING OF THE X-AXIS BY THE REGRESSION LINE. IT MAY BE CONSIDERED THE MEASUREMENT OF THE EXPECTATION OF MOSQUITOS EVEN WHEN THEY ARE NOT MEASUREABLE IN FIVE MINUTE BITE COUNTS. THIS IS A RESULT OF ESTIMATING WHAT MIGHT BE A NON-LINEAR RELATIONSHIP WITH A LINEAR ONE.

158)
C. Ineffectiveness of the Program.
A program which spends over 1.5 million dollars of taxpayers' monies so that people can spend 15 minutes additional time outside each day is a waste.

PLEASE SEE "READING INTO THE ANALYSIS OF EFFECTIVENESS," APPENDIX EI,45.

159)
The EIS states that any program which cannot achieve 99% control at every site pays the biggest price for a near-perfect control (p.76).

TRUE. THE ONLY WAY "NEAR-PERFECT" CONTROL 98%+ CAN BE ACHIEVED UNDER THESE CIRCUMSTANCES IS BY AREA WIDE ADULT CONTROL OPERATIONS.

160)
In addition, the EIS states on page 75 that "human tolerance is so low that the level of control must be nearly absolute to meet demand satisfaction." It is clear, then, that the MMCD is not meeting demand satisfaction.

TRUE. STILL, ANNOYANCE MAY WELL BE TOLERABLE EVEN THOUGH DEMAND REMAINS UNSATISFIED. SEE APPENDIX, ES 62, AND PAGE 323 IN THE TEXT.

161)
Also, the MMCD lists five ways that its program is ineffective and inefficient. These are as follows: (pages 76 through 79).

1. Dense vegetation restricts penetration of spray materials.
2. Inadequate money for a "blue sky" program.
3. The MMCD is refused entry into 26,162 acres in the core area. The EIS states that the refused entry sites could easily comprise 50% of the mosquito problem.
4. The MMCD is unable to control 127,543 acres outside the core area.
5. Human error.

RESPONSES ARE AS FOLLOWS:

1. DENSE VEGETATION IS PENETRATED BY GRANULE APPLICATIONS.
2. "BLUE SKY" OR NOT, THE PROGRAM IS AN ESTIMATED 87% EFFECTIVE AT THE CORE.
3. REFUSED ENTRY MAY CONTRIBUTE AS MUCH AS 25% OF THE REMAINING 13% MOSQUITOS AT THE CORE, LESS ELSEWHERE.
4. THESE AREAS ARE NOT GENERALLY DENSELY INHABITED. IN CONCENTRATED POPULATION AREAS OUTSIDE THE LARVAL

CONTROL AREA, THE DISTRICT PROVIDES ADULT CONTROL PERIODICALLY.

5. HUMAN ERROR HAS NOT APPARENTLY RESULTED IN SERIOUS EFFICIENCY OR EFFECTIVENESS PROBLEMS. WE ASSUME THEREFORE IT HAS BEEN QUITE MINOR.

162)
In summary, the present MMCD program is ineffective and potentially dangerous. In addition, the physical, C-R formulation, and ultimate control options are unacceptable.

THESE COMMENTS HAVE ALREADY BEEN ADDRESSED ABOVE.

163)
Therefore, it is recommended that the MMCD be abolished.

THE DISTRICT WILL TAKE MECCA'S RECOMMENDATION UNDER ADVISEMENT.

FOOTNOTES

1. Chemical Spraying Program of the Metropolitan Mosquito Control District, Chemicals and Pesticides Task Force, MECCA, June 1972.

2. Pesticide Task Force Report to the Minnesota Environmental Quality Council, MEQB Pesticide Task Force, June 17, 1976.

3. Op. Cit. MECCA Report.

4. Op. Cit. MEQB Pesticide Task Force Report.

5. Minnesota Statutes, Chapter 116D.

6. Minnesota Statutes, Chapter 116C.

7. Minnesota Statutes, §116D.04, Subd. 2.

8. Minn. Reg. MEQB 31.

9. Environmental Assessment of the Metropolitan Mosquito Control District, MMCD, 1976.

10. Skinner, Don C., MECCA"s Review of the Environmental Assessment as Produced by the MMCD, 1976.

11. I.b.i.d.

12. I.b.i.b.

13. Minnesota Statutes § 116D.04, Subdivision 1.

14. MMCD E.I.S. Options for Control to the Year 2000, MMCD, 1977.

15. Effects of Pesticides in Water: A Report to the States, EPA-NTIS, 1972, p. 4.

16. Frawley, John P., "Synergism and Antagonism", Research in Pesticides, Academic Press, New York, 1965.

17. Contemporary Pest Control Practices and Prospects: Report of the Executive Committee, Vol. 1, Pest Control: An Assessment of Present and Alternative Technologies, NAS, 1976. (Hereinafter: NAS Report, Vol. 1).

18. Dubois, K.P., "Combined Effects of Pesticides", Canad. Med. Ass. J. Vol. 100, Jan. 25, 1969, P. 173.

19. West, I., "Detection and Control of Pesticide Poisoning: A Public Health Problem", Chemical Fallout, _____.

20. West, I., "Occupational Disease of Farmworkers", Archives of Environ. Health, Vol. 9, July 1964, p. 92-98.

21. Kazen, C., et. al., "Persistance of Pesticides on the Hands of Some Occupationally Exposed People", Arch. Environ. Health, Vol. 29, Dec. 1974, p. 315-318.

22. Mounce, L.M. and Savage, E.P., "The Epidemiology of Aerial Application Accidents in the High Plains 1966-1969", Agriculture Aviation, Vol. 15, No. 4, October 1973.

23. Wolfe, H.R., et. al., "Exposure of Spraymen to Pesticides", Arch. Environ. Health, Vol. 25, July 1972.

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31. Comments of Florence Gleason on the MMCD EIS.

32. I.b.i.b.

33. Garrission, A.W., et. al., "Confirmation of Pesticide Residues by Mass Spectrometry and NMR Techniques", Fate of Organic Pesticides in the Aquatic Environment, American Chemical Society, Vol. 111, 1972, p.38.

34. Op. Cit. NAS Report, Vol. 5.

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36. Op. Cit. NAS Report, Vol. 1.

37. I.b.i.d. Vol. 5.

38. I.b.i.b.

39. Need to Improve Regulatory Enforcement Procedures Involving Pesticides, B-133192, GAO, September 10, 1968.

40. Environmental Protection Agency Efforts to Remove Hazardous Pesticides from the Channels of Trade, B-133192, GAO, April 26, 1973.

41. Pesticides: Actions Needed to Protect the Consumer from Defective Products, B-133192, GAO, May 23, 1974.

42. Federal Pesticide Registration Program: Is It Protecting the Public and the Environment Adequately from Pesticide Hazards? RED-76-42, GAO, Dec. 4, 1976.

43. Personal correspondence between Russell Train and William Moorhead, Feb. 26, 1976.

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APPENDIX ONE

With amphibian populations affected through a chemical control program, no control would facilitate a naturally-balanced bio-control system. An example of a comprehensive spectrum of indigenous species, using the class Amphibia as a case in point, to denote the complexity involved in inter-species predator-prey relationships and denoting the inadequacy of generalizing the spectrum of fauna sensibility into broad catalogues, Amphibia species which are represented in the MMCD area are listed. These amphibian larvae share the same habitat area as Aedes and Culex mosquito larvae. The adult amphibian species, denoted with an asterisk, are species which prey exclusively upon mosquitos and other similar sized soft bodied insects.

1) Mudpuppy (Necturus maculosus) An aquatic salamander whose habitat includes lakes, ponds, rivers, streams and other permanent bodies of water. Almost any small aquatic animal may be taken as food - fishes, crayfish, aquatic insects, mollusks, etc.

*2) Jefferson salamander (Ambystoma jeffersonianum) A small salamander of slender build. An early spring breeder in intermittent ponds and other temporary bodies of water. Food consists exclusively of small, soft bodied insects.

*3) Blue-spotted salamander (Ambystoma laterale) Small, stocky salamander which breeds in spring in small ponds and ditches. Utilizing these species — specific predator for temporary bodies of water. Food: small insects.

4) Eastern Tiger salamander (Ambystoma tigrinium tigrim) A medium-sized salamander. The most common species sited in the Twin Cities area. A very early spring breeder, usually congregating in deeper water holes than do the previously mentioned salamanders. Unlike most salamander species, Ambystoma tigrinium may utilize more permanent breeding sites for its larvae development as they sometimes take up to two years to reach the terrestrial stage. Breeding areas of more permanently established areas.

*5) Red Spotted Newt (Diemectylus viridesces viridescers) As adults, these small salamanders are aquatic, inhabiting more permanent but small ponds or lakes. However, larvae mature in smaller water bodies, then mature into a terrestrial "eft" stage for two years, before again transforming into the more permanent aquatic newt phase. Adult diet consists of small-bodied invertebrates, primarily insects, while eft stage eats small soft-bodied insects. Two subspecies present in Twin Cities area.

*6) Red-backed salamander (Plethodon cinereus cinereus) A terrestrial salamander, hiding in all manner of objects, under rocks, stones, logs, bark or soil humus. Remarkable in that lungs are absent and respiration is accomplished through the skin and the lining of the mouth. May be particularly vulnerable to foreign chemical residue. Food consists exclusively of very small, soft bodied insects.

*7) American toad (Bufo americanas) The most widespread and abundant "hoptoad" of the northeast. Habitats are legion, spanning the gap from city backyards to mountain wilderness. Requisites are shallow bodies of water in which to breed (temporary pools or ditches or shallow portions of ponds, etc.). The larvae is very small, as are the metamorphosed young. Young toads (under 1/2" in length) feed exclusively upon mosquitos and other similar sized soft bodied insects.

*8) Dakota toad (Bufo hemiophrys) Habits similar to Bufo americanos.

*9) Fowlers toad (Bufo woodhousei fowleri) Habits similar to Bufo americanos.

*10) Great Plains toad (Bufo cognatus) Habits similar to Bufo americanos.

*11) Spring Peeper (Hyla crucifer) One of our smallest frogs (3/4 to 1-3/4 in.). A "tree-frog" especially inhabiting areas of brushy second growth or cutover woodlots if these are near small, temporary or semi-permanent ponds or swamps. In early spring, nearly every small pond has its quota of Spring Peepers whose descriptive mating call can be readily distinguished, a high, piping whistle, a single clear note, repeated at intervals of about a second. Due to their extremely small size, even as adults, this species diet consists entirely of mosquitos and other similar sized soft bodied insects.

*12) May treefrog (Hyla versicolor) A medium sized (1½ - 2 in.) treefrog, with variations in color which may run the gamut from gray, brown, or green to pearl-gray, or even almost white. Not often seen on the ground, except in breeding season. Usually forages after small bodied insects aloft, chiefly in small trees or shrubs that are near or actually standing in shallow bodies of water. Extremely well camouflaged when clinging to brown or gray bark of a tree, and often its presence is known solely from its vibrant, trilling mating call in the spring.

*13) Western Chorus frog (Pseudacries triseriata triseriata) To judge by the choruses heard during the spring, this small, ubiquitous frog (3/4 - 1½ in.) requires small, shallow bodies of water. But although these intermittent bodies of water are required for the development of tadpoles, this frog survives in a wide variety of habitats, some of them surprisingly greatly physically altered by man (roadside ditches, etc.). Due to its small size, food is similar to that of Hyla crucifer.

14) Bullfrog (Rana catesbeiana) Our largest frog, aquatic and preferring larger bodies of water than all other indigenous frogs. A resident of lakes, ponds, bogs, sluggish portions of streams, where its food is available. Feeds chiefly upon larger invertebrates. Larvae require two years to metamorphose.

15) Mink frog (Rana septentrionales) A medium sized frog, found along watercourses, but especially partial to borders of ponds and lakes of colder water. Look for it where water lilies are plentiful and where it can venture well out from shore to hop from pad to pad. Adults prey upon small soft bodied insects which inhabit these types of ponds.

16) Green frog (Rana clamitans) Similar to Rana septentrionales in habits and habitat.

17) Northern leopard frog (Rana pipiens pipiens) This is the "meadow frog" at least in summertime, when its wandering led it far away from water. A medium sized frog which preys upon small soft bodied insects. One of the most common amphibian species of recent years. However, the recent drastic decline in their populations throughout the Twin Cities has not been studied.

*18) Wood frog (Rana sylvatica) During spring breeding a hoarse clacking sound suggesting the quack of a duck denotes this species. An "explosive" breeder, the eggs are laid all in the course of a few days, and the adults then disappear from the ponds instead of lingering sometimes for weeks as do other frogs. Diet consists exclusively of small, soft bodied insects.

This is a comprehensive spectrum of the representative indigenous amphibian species of the Metropolitan district. In view of the fact that they represent a diversification and very old group of animals, it is rather unusual that all living members of the class of Amphibia are carnivorous as adults. Moreover, they usually feed only upon live animals, either actively seeking prey, or passively waiting for it to come close enough to be caught. Their restriction to live prey seems to reflect the great dependence of amphibians upon the sense of vision and their tendency to react only to moving objects.

Adult salamanders feeding on land will take prey of any appropriate size, including insects, arachnids, annelids and any other soft bodied small animal. The size of our indigenous species dictates that their diet includes primarily small insects. Small neotenic (aquatic) salamanders such as mudpuppys (Necturus maculosus) feed on aquatic insects, invertebrates of various kinds, and crustacea. Free-swimming larval salamanders will take arthropods and soft bodied invertebrates. As particulate feeders, they have not evolved the branchial filter found in Anuran (frog) tadpoles, but instead, have a well-developed buccal apparatus for ingesting and swallowing prey. The primary

factor affecting the selection of food by aquatic salamanders, just as with terrestrial species, is that the prey must be of the appropriate size. Smaller species of amphibians will ingest smaller prey (note species preying exclusively upon smaller insects, this is an indication of size). Many adult anuras (frogs), including bufomids (toads), and ranids (genus Rana) capture prey on land by a flicking contact with their tongues. Refer to Figure 10-5 and 10-6.

All amphibian species breed in spring, with the vast majority of indigenous species requiring smaller, intermittent bodies of water. In some species, the larval stage lasts through August, while in some, as with the American toad or the Chorus frog, it may be only several weeks before the breeding area dries up, and the larvae must mature. No one is sure of the exact mechanism which accelerates the larval maturity process, but maturity is usually accomplished before their breeding areas go dry. The utilization of temporary breeding sites insures that fewer predators will be available to prey upon the larvae and young. Thus, the larvae have evolved feeding characteristics which utilize the available food sources within these intermittent bodies of water. Anuran (frog) tadpoles, as a group, are omnivorous, and gain food in a variety of ways. However, the tadpole diet for any given species is more restricted and is dependent upon their ecological "position". Some species which live in the littoral zones of these breeding areas are herbivorous, using their horny teeth to graze, and ingest particles from soft plant tissues. Others are bottom or surface "filter feeders", concentrating bacteria, protozoas, small animals, and inorganic detrius by filtration of water that is being pumped through the mouth into the branchial apparatus and out the spiracle during respiration. Some tadpoles are pelagic planktonic feeders and consume minute plants and animals which aggregate at or near the surface of the water. They also gulp air at the water's surface. Applications of fuel oil to water surfaces would be particularly harmful here.

Cooperative feeding by toad tadpoles (Bufo) have been observed by Bragg (1946, 1965). These aggregations swim about in masses and create whirlpools through their movements; the whirlpools suck up and concentrate plankton and organic material which has settled on the bottom of the pool. The concentrated food is then "inhaled" in the respiratory current of water passing through the tadpole and filtered by the branchial apparatus. Pesticide concentration levels could reach toxic proportions in a short period of time with these types of feeding adaptations, despite the relatively short life span of the organophosphates. The more obvious toxicant feature, the elimination of these food sources, should also be noted.

Anuran egg masses laid in water (representative of all indigenous species) are characteristically shaped and positioned in adaptation to prevailing oxygen tensions. Certain species require more dissolved oxygen for embryonic respiration than others. With the effect of pesticides upon a host of aquatic organisms, oxygen content studies should elucidate this concern. Figure 11-2 sites three major anuran egg masses. The study of hormonal regulation of metamorphosis and how chemical metabolites of insecticides may alter this process deserves special attention.

The DNR and the Bell Museum of Natural History have noted the annual decline in amphibian populations within the Twin Cities metropolitan district. Whether or not this is due to a mosquito control program, simple habitat destruction, or the enzootic redleg disease is due for debate. Redleg disease afflicts only certain members of a representative amphibian complex where every member is becoming increasingly scarce. Ranids, particularly Rana pipiens, have been the only members of this diverse class reported as developing this anomaly. The ability and adaptation of the majority of amphibian species to utilize less permanent, smaller bodies of water for reproduction could indicate their ability to co-exist with an urbanization trend which would still leave these

opportune bodies of water available. The ability of Bufo americas to exist well within inter-city limits is a good case in point. With the knowledge now available regarding amphibian natural history, it is more probable, although inadequately studied, that indigenous amphibian populations are declining from the greater acceleration of a mosquito control program. This view should be regarded with the interdisciplinary approach of herpetological study, utilizing sources and personnel from the most logical informational source regarding this problem in the metropolitan area, the Bell Museum of Natural History.

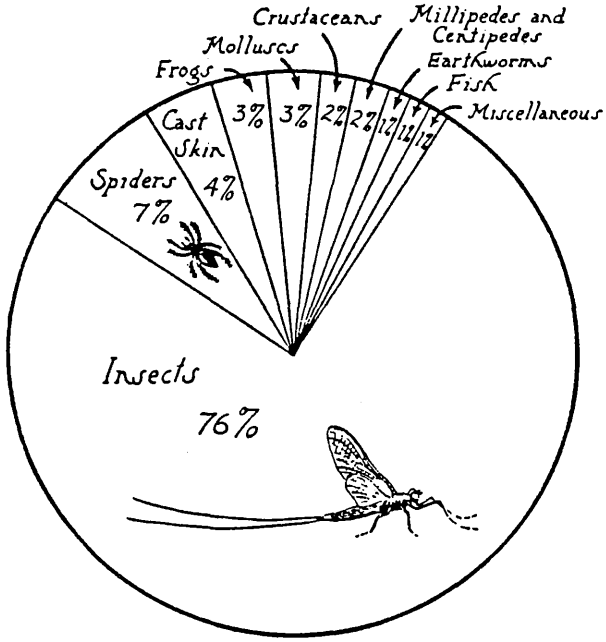

Figure 10–5 Food consumed by the green frog (*Rana clamitans*) expressed in volume of each kind of food. (From Oliver: *The Natural History of North American Amphibians and Reptiles.*)

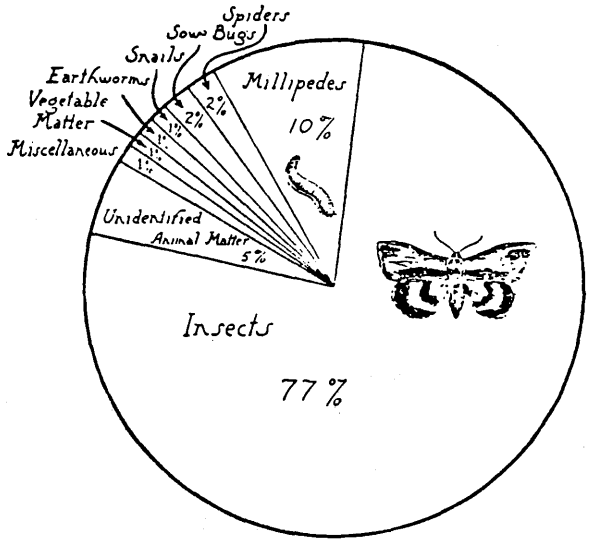

Figure 10–6 Food consumed by the American toad (*Bufo americanus*) expressed in volume of each kind of food. (From Oliver, *The Natural History of North American Amphibians and Reptiles*.)

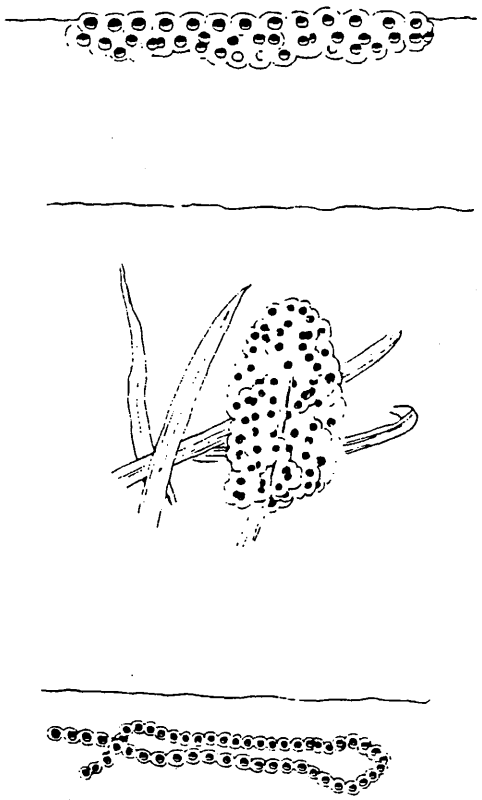

Figure 11-2 Three generalized kinds of anuran egg masses. *Top*, a flattened egg mass, characteristic of bullfrogs (*Rana catesbeiana*), deposited at the surface of the water. *Center*, a globular egg mass, such as formed by northern chorus frogs (*Pseudacris triseriata*), attached to vegetation beneath the surface of the water. *Bottom*, eggs, such as those of true toads (*Bufo*), deposited in elongated strings.

Supportive Material Included with MECCA's Comments:

G.A.O. 1976. Comptroller General's report to Congress. Federal Pesticide Registration Program: is it protecting the public and the environment adequately from pesticide hazards? RED-76-42, Appendix Two pp 52-56.

A summary of G.A.O. findings concerning the pesticide registration program conducted by the U.S. EPA and U.S.F.D.A.

The G.A.O. believes that "the American consumer has not been adequately protected from the potential hazards of pesticide use because of inadequate efforts to implement provisions of the Federal Laws regulating pesticides." The major reasons for this appears to be inadequate time, staffing and funding of the E.P.A. which necessitates less than complete testing and review of new and old pesticides.

Nisbet, I.C.T. 1972 Mosquitos and Man. Conservation Leader, July 1972. pp 57-60

The paper describes basic mosquito ecology, and defines the mosquito "problem". Next, control methods, as used in and around Lincoln, Massachusetts are described. Particular attention is given to chemical control and a number of insecticides used for mosquito control. Abate, fuel oil, dursban, malathion and pyrethrins are described in terms of usefulness, effectiveness and environmental impact. The author believes that while no control is the best option for a quality environment, a mosquito control district is better than small communities running their own programs since control districts are run be professionals. Regional control is "a remarkably inexpensive operation." In this context, there is an urgent need to develop integrated control systems to minimize environmental degradation.

164)
Minnesota Energy Agency
740 American Center Building
160 East Kellogg Boulevard
St. Paul, Minnesota 55101

June 3, 1977

Dr. Robert D. Sjogren, Director
Metropolitan Mosquito Control District
1802 Como Avenue
St. Paul, Minnesota

Dear Dr. Sjogren:

I appreciated the opportunity to discuss the EIS on the mosquito control program several weeks ago. The document is well written and very creative. Several questions emerged from our discussion:

1. Are petroleum or natural gas used as feedstocks in the manufacture of chlorpyrifos, temephos, resmethrin or malathion? How much energy is required for the manufacture of these materials?

PETROLEUM AND NATURAL GAS ARE BOTH USED AS FEEDSTOCKS IN THE MANUFACTURE OF MALATHION AND TEMEPHOS. NEITHER ARE USED AS FEEDSTOCKS FOR CHLORPYRIFOS OR RESMETHRIN. ENERGY (BTU/LB. OF TECHNICAL) REQUIREMENTS ARE: CYTHION (MALATHION) 8,900; TEMEPHOS 80,000 INFORMATION WAS NOT AVAILABLE FOR CHLORPYRIFOS AND RESMETHRIN.

165)
2. Fuel used for transportation appears to be the greatest energy requirement for the program. How does the District plan to reduce its gasoline comsumption?

SEE FEIS PAGES 287 AND 303.

166)
3. To what extent does mosquito control on the urban fringe encourage outward growth of the metropolitan area?

SEE RESPONSE TO COMMENT 59.

These issues merit fuller treatment in the final EIS. Thank you for your assistance,

Sincerely,

Karen Cole
Environmental Coordinator

167)
Minnesota Pollution Control Agency
1935 West County Road B2
Roseville, Minnesota 55113

June 14, 1977

Dr. Robert D. Sjogren, Director
Metropolitan Mosquito Control District
1802 Como Avenue
St. Paul, Minnesota 55108

Dear Dr. Sjogren:

This is in response to your request for clarification on the points raised regarding the Metropolitan Mosquito Control District (MMCD) Draft Environmental Impace Statement (EIS).

It was our intention to refer all future claims of problems to the MMCD for investigation. We will be interested in your procedures for investigating claims and what responsibility the MMCD would take in ensuring that claims are adequately investigated.

PROCEDURES FOR CLAIMS OF INJURY TO DOMESTIC ANIMALS OR WILDLIFE FROM THE USE OF INSECTICIDES ARE REFERRED TO MDNR FOR IMPARTIAL DETERMINATION OF CAUSE. PHYSICAL DAMAGE TO PROPERTY IS ADJUDICATED BY THE SUPERVISORY STAFF IN CONSULTATION WITH THE DIRECTOR. IMMEDIATE PRIORITY IS GIVEN TO THE ABOVE CLAIMS.

168)
Regarding worst cases to be included in the discussion of potential effects, please use the maximum concentration of materials received by the MMCD. As part of the discussion of this potential effect, please include possible impacts to hyper-allergenic persons, infants, old aged and heart patients.

A TWO FOLD INCREASE IN DOSAGE WOULD BE THE WORST CASE EXPECTED TO OCCUR UNDER OPERATIONAL CONDITIONS. THE TWO FOLD POTENTIAL IS BASED ON THE FACT THAT FIELD SEASONAL PERSONNEL ARE UNDER THE SUPERVISION OF TRAINED PROFESSIONAL STAFF AT A MAXIMUM RATIO OF 4 TO 1, AND A CLOSE INSECTICIDE INVENTORY CONTROL SYSTEM IS IN EFFECT AS DESCRIBED IN THE APPENDIX. ANY EMPLOYEE OVERAGES ARE APPARENT ON A WEEKLY COMPARISON OF ACREAGE TREATED AND INSECTICIDE QUANTITY USED. THE USE OF ONE PERCENT INSECTICIDE GRANULES BY GROUND REDUCES THE LIKELIHOOD OF OVER TREATMENT WHICH COULD BE ASSOCIATED WITH THE USE OF LIQUID CONCENTRATES. HELICOPTER APPLICATION EQUIPMENT AND HAND SEEDERS ARE CALIBRATED ANNUALLY, A DISCUSSION OF WHICH IS INCLUDED ON PAGE 133.

169)
In reference to nutrient loadings to lakes and reservoirs, we recognize that application rates, although low, do add to the total nutrient budget. For this reason, we request a listing of lakes and reservoirs which receive insecticides containing organophosphates and the loadings of nutrients applied. As to the effect on oxygen demand, the BOD_5 and volume of material in each application would be sufficient.

THE NUTRIENT LOAD CONTRIBUTED BY THE MOST FREQUENTLY USED ORGANOPHOSPHATE INSECTICIDES CHLORPYRIFOS (3 APPLICATIONS) AND TEMEPHOS (6 APPLICATIONS) IS 0.11 AND 0.04 LBS. PHOSPHORUS/ACRE/YEAR RESPECTIVELY.

SEE PAGES 30 AND 147 OF THE FEIS FOR THE LAKE LISTINGS.

I hope this will be of assistance to you in preparing the final EIS.

Sincerely,

Curtis J. Sparks
Water Quality Coordinator
Office of Environmental Analysis

UNITED STATES DEPARTMENT OF AGRICULTURE
AGRICULTURAL STABILIZATION AND CONSERVATION SERVICE
230 Federal Building & U.S.Courthouse
316 North Robert Street
Saint Paul, Minnesota 55101

June 8, 1977

170)

M.M.C.D.
ATTN: Ed Bowles
1802 Como Avenue
Saint Paul, Minnesota 55108

Dear Mr. Bowles:

Upon review of bee indemnity payments for 1976 for Anoka, Hennepin, Scott, Ramsey, Washington and Dakota, we find that no payments were made because of spraying by the MMCD.

This is in response to your telephone conversation of today.

Sincerely,

Leslie F. Steppel
Acting State Executive Director
Minnesota State ASCS Office

UNITED STATES DEPARTMENT OF AGRICULTURE
AGRICULTURAL STABILIZATION AND CONSERVATION SERVICE
230 Federal Building & U.S.Courthouse
316 North Robert Street
Saint Paul, Minnesota 55101

June 27, 1977

171)

Ed Bowler, Coordinating Assistant
Metropolitan Mosquito Control District
1802 Como Avenue
Saint Paul, Minnesota 55108

Dear Mr. Bowler:

The following information is furnished as requested in your letter dated June 23, 1977:

Anoka County	No payments made.
Dakota County	in 1976 one payment for $262.50.
Hennepin County	In 1976 one payment for $450.00.
Ramsey County	No payments made.
Scott County	In 1971 one payment for $260.00. In 1972 one payment for $655.00. In 1976 one payment for $105.00.
Washington County	In 1974 one payment for $1327.50.

Sincerely,

L. F. Steppel

L. F. Steppel
Acting State Executive Director
Minnesota State ASCS Office

ASCS
UNITED STATES DEPARTMENT OF AGRICULTURE
AGRICULTURAL STABILIZATION AND CONSERVATION SERVICE
230 Federal Building & U.S.Courthouse
316 North Robert Street
Saint Paul, Minnesota 55101

June 28, 1977

172)

Ed Bowler, Coordinating Assistant
Metropolitan Mosquito Control District
1802 Como Avenue
Saint Paul, Minnesota 55108

Dear Mr. Bowler:

In addition to the information furnished in our letter dated June 27, 1977, would like you to know that none of the losses paid were due to pesticides used for mosquito control.

Sincerely,

Maynard Y. Frost

M. Y. Frost, Acting State Executive Director
Minnesota State ASCS Office

STATE OF
MINNESOTA
DEPARTMENT OF NATURAL RESOURCES
390 CENTENNIAL OFFICE BUILDING · ST. PAUL, MINNESOTA · 55155

DNR INFORMATION
(612) 296-6157

173)

Metropolitan Mosquito Control District
1802 Como Ave.
St. Paul, Minn. 55108

ATTENTION: Ed Bowler

Dear Ed:

As we discussed over the phone the other day, I have checked with Jack Skrypek regarding any documented fish or wildlife kills related to MMCD mosquito control activities.

We both recall Dr. John Moyle, (former Techical Assistant to the Director) mentioning that in the early days of the District, when DDT was relied on heavily, several minor kills did occur. We know of no fish or wildlife kills related to MMCD activities that have occurred in recent years.

Yours truely,

Howard F. Krosch, Coordinator
Monitoring and Control Unit
Ecological Services Section

HFK:tjt

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Rochester, Minnesota 55901
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September 6, 1977

Harold O. Perry, M.D.
Dermatology

174)

R. D. Sjogren, Ph.D.
Director
Metropolitan Mosquito Control District
1802 Como Avenue
St. Paul, Mn 55108

Dear Doctor Sjogren:

Some months ago you sent me a communication in regard to insecticide respiratory allergy. I circulated the information you provided to members of our staff and it has finally made the circuit back to me. No one of my staff had any experience in this regard.

Dr. Howard Maibach of the University of California, San Francisco, has been very active in testing various insect repellents. He may be in a position to give you additional information about allergy in association with the use of various insecticides.

Most sincerely,

Harold O. Perry, M.D.

HOP:djs