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Source: *Journal (Water Pollution Control Federation)*, Vol. 35, No. 5 (May, 1963), pp. 663-668
Published by: Water Environment Federation
Stable URL: http://www.jstor.org/stable/25034842

MOSQUITO CONTROL IN AN INDUSTRIAL WASTE LAGOON

Roger P. Scovill

The objective of the studies conducted and sponsored by Oscar Mayer and Company at Madison, Wisconsin, for mosquito control in lagoons irrigated with treated wastewater is of a dual nature. The first is to enable disposal of wastewater in a manner devoid of nuisance conditions resulting from insect propagation or due to objectionable odors, and the second is to reduce the sewage service costs of the company by reduction of the volume of wastewater discharged to city sewers.

These studies were begun in 1959 with the cooperation of the staff of the City of Madison Health Department and the University of Wisconsin Entomology Department. Basic parameters set up (1) are extended in this paper with additional data on organic loading of the irrigated areas, as well as the data pertinent to mosquito control. The data presented in this paper does not repeat the earlier data. General information concerning the 1959–1962 irrigation seasons is shown in Table I. Table II shows lagoon influent characteristics for the same seasons.

Description of Facilities

A search of technical literature on mosquito control in irrigated areas was conducted to determine a procedure applicable to the irrigation facilities operated by the company. These facilities as shown in Figure 1 consist of two separate units, one area of which is six diked plots or lagoons, approximately 150 ft wide and 1,800 ft long, totaling 32.7 acres, which receive the water through gated culverts from a common filling lagoon. Effluent of the Burke Wastewater Treatment Plant is pumped to the filling lagoon, the pump capacity being approximately 1,700 gpm. The lagoons vary in area and are in peat-muck soil containing a dense, emergent vegetation of Reed Canary grass and some weed growth areas. A second area is an open field termed the south field, 58 acres in area, with a variable soil from miami-silt loam and clay to peat and muck, some areas of which contain lenses of sand at varying depths below the surface. The vegetation on this field is Reed Canary grass, Quack grass, and other weed growths. The south field is irrigated by means of portable piping placed to allow broad irrigation from crest points of the higher areas in the field. The elevation of the field varies by approximately five feet. The lagoons and south field can drain by percolation through the soil to Starkweather Creek.

Procedures Previously Reported

Distribution of insecticides for control of mosquito larvae as emulsions, sprays, dusts, solutions, pellets, and fogs to the lagoons or by direct addition to the force main is possible. Some of the previous material published in the literature is shown in Table III.

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TABLE I.—Total Irrigation and Rainfall—Comparative Years

Month	1959		1960		1961		1962	
	Irrigation (mil gal)	Rainfall (in.)	Irrigation (mil gal)	Rainfall (in.)	Irrigation (mil gal)	Rainfall (in.)	Irrigation (mil gal)	Rainfall (in.)
Nov.	12.7	2.29	—	—	—	—	8.1	3.94
Dec.	5.4	0.31	—	—	—	—	0.3	1.02
Jan.	—	—	—	—	—	—	—	—
Feb.	—	—	—	—	—	—	—	—
Mar.	—	—	—	—	—	—	—	—
Apr.	—	—	—	—	—	1.33	—	1.43
May	5.3	3.06	—	6.26	14.2	1.17	9.2	3.01
June	3.6	3.86	12.7	2.09	19.7	1.84	11.2	2.09
July	11.4	4.12	8.6	6.04	6.1	3.67	5.5	4.39
Aug.	14.6	5.68	10.4	6.18	4.5	1.78	13.3	2.04
Sept.	8.3	3.44	10.8	3.90	2.4	7.92	12.5	1.31
Oct.	10.0	5.55	8.0	3.32	1.6	3.75	20.1	1.68
Total	71.3	28.31	50.5	27.79	48.5	21.46	80.2	20.91
Irrigation Season (days)	224		184		178		220	
Mean Season Rate (mgd)	0.32		0.27		0.27		0.36	
Actual Operating Days	76		47		58		104	
Mean Operating Day Rate (mgd)	0.94		1.10		0.84		0.77	
Mean Season Rate (gpd/acre)	3,500		3,000		2,980		3,970	
Mean Rate Operating Days (gpd/acre)	10,300		12,100		9,200		8,490	
Total Irrigation (in.)	28.9		20.4		19.7		32.6	
Total Rainfall (in.)	28.31		27.8		21.5		20.9	
Total Water (in.)	57.2		48.2		41.2		53.5	

Phosdrin Used

Phosdrin was selected for study during the 1959 irrigation season because the method of application was simple and inexpensive when using the procedure described in (2). Phosdrin is completely miscible in water enabling thorough distribution when fed into the lagoon influent. This chemical is very highly toxic, however, and must be handled with extreme care to avoid ingestion, absorption, or inhalation, the LD concentration reported as being 50 ppm for any warm- or cold-blooded animal life. The material is not accumulatively toxic, having a half-life of approximately 48 hr. Control of

TABLE II.—Characteristics of Lagoon Influents—1959–62

Determination	1959	1960	1961	1962
BOD (mg/l)	193	122	203	323
SS (mg/l)	183	102	123	201
Chlorides (ppm)	1,793	1,926	1,704	1,782
Total N (ppm)	56	48	67	72
Insecticides Added (lb)	91.0*	116.0*	163.9†	30.0‡

* Phosdrin.
† 6 lb Phosdrin, 154.7 lb DDT, and 3.2 lb Baytex.
‡ Baytex plus 20 gal of 25-percent DDT solution.

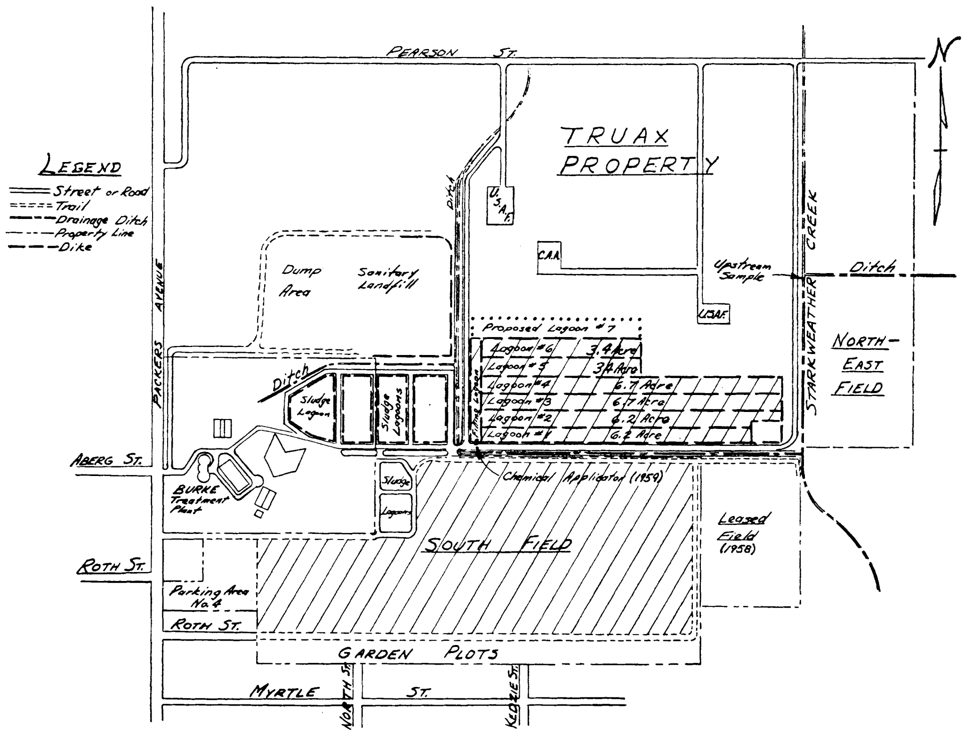

FIGURE 1.—Oscar Mayer and Company wastewater treatment facilities.

the concentration of chemical fed to the field was accurate, employees being supplied with a predetermined volume of chemical once each operating day, the 55-gal supply barrel being filled with chemical and water, and operated unattended at a constant rate for 24 hr. The irrigation pump was set to discharge the precise volume of water desired to result in the exact concentration of phosdrin treatment required.

The lagoon areas were irrigated with phosdrin-treated water at rates averaging 28,200 gpd/acre, and dipper counts of the areas irrigated were made. The result of these counts indicated that control was obtained in an area 1,900 ft from the point of distribution at concentrations of 0.25 ppm. Complete control over the entire area of each lagoon was obtained at concentrations of 0.49 ppm and 0.43 ppm. The duration of the control achieved was insufficient to prevent re-infestation if the lagoons would not be dry within seven days of treatment, or if a new charge of phosdrin could not be distributed over the entire lagoon prior to seven days after the initial treatment. Recharge was limited by weather conditions governing transpiration and evaporation rates and by the percolation rate. When the volume of water within a lagoon was sufficient to prevent thorough mixing by the recharge treatment, only partial control would be achieved, and areas would exist unaffected by the recharge. Operational control of mosquito larvae

TABLE III.—Summary of the Properties of Selected Insecticides

Chemical	Suggested Dosage (ppm)	Effective Area (acres)	Maximum Distance Traveled (miles)	Application Procedure
Parathion	0.05	10–30	0.25	Emulsion
Dipterex	0.50	20	1.80	In Solution
Phosdrin	0.25	5	0.50	In Solution
Chlorthion	0.025	31	—	Emulsion
Malathion	Up to 2.0	—	—	Spray
DDT	Up to 2.0	—	—	Spray

was accomplished at a concentration of 0.5 ppm phosdrin, with the lagoon area allowed to become completely dry every seven days. The mosquitoes which emerged from irrigated areas were identified as *Aedes dorsalis* emerging first, followed by *Aedes vexan* and *Culex pipien*. In small ponds and ditch sections emergence was controlled by hand distribution of five-percent DDT in Number 2 fuel oil.

Operational Experience with Baytex

Investigation of control of mosquito larvae using the Chemagro Corporation product Bayer 29493 tradenamed "Baytex" was begun in 1961. Basically these tests resolve into two procedures, (*a*) control of larvae existing in an area of standing water, and (*b*) prevention of development of larvae from a dry lagoon area when flooded with wastewater, and determination of the optimum period of residual effect.

Baytex is in the intermediate class of organic phosphate pesticides as far as mammalian toxicity is concerned.

Control of Existing Larvae

In conducting tests for determination of the extent of distribution which will result by addition of the insecticide at the point of entry to a lagoon, the following procedure was carried out. A uniform flow discharge insecticide applicator was developed, of five-gallon capacity, which would enable distribution of a known amount of chemical into the water passing through the culvert into a lagoon. A standard five-gallon can with an airtight filling cap is fitted with a breather pipe through the top and of sufficient length to terminate two inches from the bottom. A one-fourth inch diameter discharge tube is fitted to the side of the five-gallon can at the bottom and includes a one-eighth inch diameter draincock. In operation the rate of discharge is uniform and adjustable by manipulation of the draincock valve.

The volume of wastewater to be irrigated is determined in advance, and the insecticide concentration desired is determined and placed at the lagoon inlet. The system is then placed in operation, the pump being run at a specific discharge rate for a pre-determined period of time. Facilities for this control include a butterfly valve and orifice meter on the pump discharge piping. The discharge of the insecticide is regulated to run out within 15- to 30-min of the total irrigation period.

The test lagoon was flooded and mosquito larvae and pupae were allowed to develop in sufficient numbers (3 to 10 per one-half pint capacity dipper) widespread over the entire lagoon area, so that positive determination could be made as to the extent of the kill. Confirmation of the larvae population prior to distribution of the insecticide and following a test was made.

The test area was then treated with a dosage of 0.32 lb/acre (0.396 ppm) Baytex. After a period of 24 hr, live pupae of *C. pipien* were found 300 ft from the point of application. Dead larvae and live pupae were sampled in the same dip at a distance approximately 635 ft from the point of application. At greater distances than this, no effect was apparent; larvae and pupae were sampled (5 to 25 per dip) to the extreme end of the lagoon. A replicate of this test was conducted at a concentration of 0.32 lb/acre established at 0.644 ppm. After a period of 24 hr, live and dead larvae could be sampled up to 900 ft from the point of application of the insecticide. No effect was evident beyond this point.

Summary

As a result of these tests it was concluded that complete mixing would not take place under the existing field conditions without forced circulation of the water, and that effective control could not be obtained over the entire lagoon at insecticide concentrations less than 0.5 ppm when a mosquito larvae

infestation of standing water existed.

This conclusion was borne out by a further test in which a small volume of water remained in the extreme end of a ditch 1,700 ft from the point of application. A dose of 0.622 ppm was distributed into the lagoon. Although the water level was changed in the ditch section, no mixing took place, and the population of larvae was unaffected.

Prevention of Development of Larvae with Baytex

Experimentation was conducted at various concentrations of insecticide starting with a lagoon area completely dry and distributing wastewater volumes which could be completely evaporated and transpired within 12 to 14 days. These tests resulted in an operating procedure involving addition of Baytex at 0.2 ppm with the irrigated water and at this strength no emergence of mosquitoes took place in a period of 14 days. Larvae could be found in any shallow water that existed at that time and which would emerge within two to three days if the water had not evaporated.

Effect on Wild Life

Throughout the experimentation with both Phosdrin and Baytex the lagoons were heavily populated with ducks of several species and with pheasants. Numerous woodchucks and some muskrats and skunks lived in the lagoon embankments. Other small birds, mostly red-wing blackbirds and sandpipers were very numerous. The environment was ideal for propagation of wildlife and no deleterious effects were observed at any time.

Effect on Streams Receiving Percolating Water

Sampling stations previously established in investigations for irrigation of wastewater in the lagoons were upstream of the lagoon area in Starkweather Creek and approximately 1,500 ft downstream from the area. Samples of the creek water are collected weekly and analyzed for 5-day BOD, total nitrogen, and chlorides. Chlorides ordinarily increased approximately 114 ppm, increases in BOD and total nitrogen were small and within the range of normal sampling and analyses errors. Rough fish spawned in ditch areas upstream from the lagoons and numerous turtles were present in the creek.

Organic Loading of Irrigated Areas

Total nitrogen averaged 72 ppm in the wastewater irrigated, 16.4 tons being discharged to the lagoons and 5.7 tons to the south field during the 1962 irrigation season. BOD discharged averaged 2,045 lb/day. For the lagoons, 24,500 gpd/acre contained an average of 323.6 mg/l BOD or 65.9 lb/day/acre with no odor nuisance created. Irrigation of the south field was conducted at a rate which would allow all water to be disposed of within 7 to 11 days. Whenever small ponds of standing water existed, the water was treated with DDT and Malathion sprayed onto the surface.

Operational Costs

On the basis of the 1961 experience for costs, which were estimated to result in a savings of $51.87/mil gal of water irrigated due to the reduction in the sewer service charges, a total savings of $4,160 will result from the irrigation of 80.2 mil gal in fiscal year 1962.

Conclusions

For mosquito control in an industrial waste lagoon containing dense, emergent vegetation, and irrigated with water containing organic material, disolved and suspended solids, etc., the use of Baytex at 0.2 ppm, active ingredient basis, will prevent emergence of mosquitoes for up to 14 days over 6.7 acres of area with the insecticide added into the influent, total length of the lagoon being 1,800 ft.

Acknowledgment

The cooperation and assistance of the staff of the City of Madison Health Department in identification of species, trap counts, dipper counts, and containment of the emerged mosquito density to the areas under test is appreciatively acknowledged.

References

1. Johnson, A. S., "Effluent Disposal by Irrigation." Central States Sewage and Industrial Wastes Association, Minneapolis, Minn. (June 1958).
2. Gahan, J. B., "Applicator for Adding Chemicals at a Uniform Rate." *Mosquito News* 15-3, 143.
3. Gahan, J. B., "Further Studies With Water Soluble Insecticides for the Control of Mosquito Larvae in Irrigation Water." *Mosquito News* 17, 198 (Sept.).

MEETINGS OF INTEREST

May 13–17	**Water Resources Engineering Conference,** Hotel Schroeder, Milwaukee, Wis. ASCE, 345 East 47th Street, New York 17, N. Y.
May 19–24	**American Water Works Association,** Kansas City, Mo. Raymond J. Faust, AWWA, 2 Park Ave., New York 16, N. Y.
May 30–31	**Sanitary Engineering Conference,** Vanderbilt University, Nashville, Tenn. Dr. Peter A. Krenkel, School of Engineering, Vanderbilt University, Nashville, Tenn.
June 4–6	**First Water Conference,** TAPPI, Netherland-Hilton Hotel, Cincinnati, Ohio. TAPPI, 360 Lexington Ave., New York 17, N. Y.
June 5–7	**Rudolfs Research Conference,** Rutgers University, New Brunswick, N. J. H. Heukelekian, Dept. of Sanitation, Rutgers University.
June 6–8	**91st Annual Meeting of the Manufacturing Chemists Association,** The Greenbrier, White Sulphur Springs, W. Va.
June 12–14	**Stream and Estuary Analyses,** Civil Engineering Dept., Manhattan College, New York 71, N. Y.
June 17–21	**Biological Waste Treatment,** Manhattan College; see above.
June 17–21	**Gordon Research Conference on Air Pollution,** Tilton School, Tilton, N. H. Dr. George W. Parks, Director, Gordon Research Conferences, Univ. of Rhode Island, Kingston, R. I.
Sept. 4–6	**Symposium on Environmental Measurements,** Robert A. Taft Sanitary Engineering Center, 4676 Columbia Parkway, Cincinnati, Ohio.