Turlock Mosquito Abatement District
CEQA PRELIMINARY ASSESSMENT OF
INTEGRATED PEST MANAGEMENT PRACTICES USED TO
REDUCE THE RISK OF MOSQUITO-ASSOCIATED DISEASE AND ANNOYANCE

1. INTRODUCTION.

The purpose of this assessment is to evaluate whether the Turlock Mosquito Abatement District's ("District") mosquito control activities are exempt under the California Environmental Quality Act ("CEQA"). This assessment is prepared under CEQA Guidelines sections 15060 and 15061 to evaluate the application of CEQA and the CEQA categorical exemptions to the District's integrated mosquito management program.

The District was formed in 1946 in order to protect the public in the Southwest portion of Stanislaus County from disease-transmitting and annoying mosquitoes and other vectors. The District pursues this goal by a vector control program consisting of continual surveillance and monitoring of mosquitoes to ascertain the threat of disease transmission and annoyance levels, and the use and implementation of safe integrated vector management and control methods (discussed in more detail below) to maintain mosquitoes below those levels. This has been an ongoing and longstanding activity of the District, since at least 1965.

CEQA was adopted by the California Legislature in 1970. CEQA generally requires state and local agencies to prepare an environmental document (either an environmental impact report (EIR) or negative declaration) assessing the potential environmental impacts of discretionary projects that may effect the environment. CEQA exempts from this requirement certain projects and activities declared exempt by the Legislature ("statutory exemptions"; listed at CEQA Guidelines sections 15260-15282) and other classes of projects that the State Secretary for Resources has determined do not have a significant effect on the environment ("categorical exemptions"; listed at CEQA Guidelines sections 15301-15329). This preliminary analysis focuses on certain categorical exemptions as applied to the District's integrated pest management program.

The District previously concluded that its vector control activities were exempt from CEQA. (See District Board of Trustees minutes adopted on April 2, 1973, pages1482-1483.) With this CEQA preliminary assessment, the District re-evaluates the CEQA exempt status of its vector control program in light of current operations, activities and conditions.

In order to accomplish long-range, intelligent, and environmentally sound mosquito control, the management and manipulation of mosquitoes must be accomplished using not just one but all available pest control methods. This dynamic combination of methods into one thoughtful, ecologically sensitive program is referred to as Integrated Pest Management (IPM). The District's mosquito control program employs IPM principles by first determining the species list and abundance of mosquitoes through larval and adult surveys and then using the most efficient, effective and environmentally sensitive means of control. In some situations, water management or source reduction programs can be instituted to reduce breeding areas. The District also considers biological control such as the planting of mosquito fish. When these approaches are not practical or otherwise appropriate, then a pesticide program is used so that specific breeding areas and/or adult mosquitoes can be treated.

In the following sections, the District analyses the various IPM practices and considers the application of various CEQA exemptions.

2. MOSQUITO AND ARBOVIRUS SURVEILLANCE ACTIVITIES RELATED TO VECTOR CONTROL.

2.1 Introduction: The District is dedicated to protecting the public from both the discomfort of mosquito bites and potential mosquito-borne diseases. This responsibility involves monitoring (quantification) the abundance of adult and immature (larvae/pupae) mosquitoes, and mosquito-borne disease occurrence over time and space. The practice of monitoring both mosquito densities and the diseases they carry is termed surveillance. Applied properly, surveillance provides the District with valuable information on what mosquito species are present, when they occur, where they occur, how many there are, and if they are carrying disease that may affect humans. Equally important is the use of surveillance in evaluating the effectiveness of control actions in reducing mosquitoes and mosquito-borne human diseases.

2.2 Mosquito Surveillance Methodologies: Mosquitoes in nature are distributed within their environment in a pattern that maximizes their survival to guarantee reproductive success. Simply stated, this means that mosquitoes occur where they are likely to survive, mate, and produce young. One interesting aspect of mosquito biology is the fact that immature stages develop in water and later mature to a winged adult that is capable of both long and short range dispersal. This duality of their life history presents vector control agencies with unique circumstances that require separate surveillance strategies for the aquatic versus terrestrial life stages.

2.2.1 Immature stages: Mosquito immatures include four larval stages, the egg and a transitional pupal stage. Mosquito control agencies routinely target the larval and pupal stages to preclude an emergence of adults. Documenting the presence and abundance of the immature stages is usually limited to the larval and pupal stages. Operationally, the abundance of the immatures in any identifiable "breeding" source is measured as the number of immatures (can include numbers representing each individual instar-stage of larval development as well as pupae) per unit volume. This is referred to as a dipper count. The dipper count is an average of dips taken along a source to determine the density of mosquito larvae present.

2.2.2 Adult stage: Mosquito adults, primarily females, are sampled to determine the direct threat posed by their presence and abundance plus the fact that females of certain species are the carriers of mosquito-borne diseases (e.g., encephalitis or "sleeping sickness"). Various methodologies have been developed to both capture and quantify the relative abundance of mosquito species that affect human welfare. These methodologies consist of various types of traps that are mechanically configured to attract mosquitoes to the trap where they captured by suction and sequestered in an escape-proof net or glass enclosure.

2.2.2.1 Host-seeking traps: Host-seeking traps modified from the standard CDC-type portable light trap use the chemical carbon dioxide (dry ice) to attract female mosquitoes behaviorally cued to seek a host to blood feed. Essential trap components include a battery power source, low ampere motor with suction-type fan housed in a durable plastic cylinder, and collection bag for holding captured adults. The number of females collected during each night of trap operation is expressed numerically as the number of females per trap night.

2.2.2.2 Light traps: Light traps use a source of photo-attraction (incandescent light 25 watt lamp) to lure mosquitoes to the trap where they are pulled in by suction provided by an electric (110v AC) appliance motor/fan combination. Mosquitoes picked up by the suction are directed downward (via screened cone) inside the trap body to a glass collection jar where they are killed by an insecticide. The standard trap of this type used by most vector control agencies is the New Jersey Light Trap. This trap is considerably larger and less portable than the host-seeking trap and requires a source of 110v AC to operate. Like the host-seeking trap, the number of females collected during each night of trap operation is expressed as the number of females per trap night.

2.2.2.3 Artificial and natural shelter traps: Artificial shelters or artificial resting units (ARUs) consist of open ended cubical boxes of various standard sizes that are painted red on all surfaces. ARUs, more commonly referred to as red boxes, are placed in the environment in a way to attract females that are seeking a dark protected refuge in which to rest (hide) during the day. The number of mosquitoes removed from the box during the day by mechanical aspirator is expressed as the number per resting unit or ARU. Natural shelters consist of the variety of places where mosquitoes will hide during the day within their immediate environment. Most natural shelters consist of rodent burrows, caves, debris piles, and dense underbrush. Abundance expressed from natural shelter collections is often given as the number collected per unit of time from a particular shelter substrate.

2.3 Arbovirus Surveillance (Mosquito-borne Arboviruses): The District is very concerned with the likelihood of occurrence of mosquito-borne diseases. The viruses actively transmitted by mosquitoes to humans are diseases of wild birds, and humans only become exposed as a consequence of an accidental exposure to the bite of infective mosquito vectors. Two viruses of greatest public health concern in California are western equine encephalomyelitis virus (WEE) and St. Louis encephalitis virus (SLE). WEE affects predominately young children and SLE the elderly.

Detecting the presence of these mosquito-borne viruses in nature requires the application of a number of sophisticated methodologies. Two methods of encephalitis virus surveillance (EVS) commonly used by vector control agencies in California involve 1) capturing and testing female vector mosquitoes for the presence of mosquito-borne encephalitis viruses and 2) periodically testing for the presence of encephalitis virus specific antibodies in the blood serum of either sentinel chickens that are either intentionally or naturally exposed to infective mosquito bites.

2.3.1 Virus isolations from mosquito vectors: Female mosquitoes to be tested for the presence of encephalitis viruses are usually captured by either host-seeking traps or removed from natural and artificial shelters. Collections are sorted by species and pooled in lots of 50. Pools are later tested to determine if virus is present and to what extent virus is disseminated (minimum infection rate) throughout the vector mosquito population.

2.3.2 Antibody conversion rates in sentinel/wild birds: In addition to isolating viruses from mosquito vectors captured in the wild, the presence of virus in the environment also can be detected by exposing animals that are not affected by infection, but develop neutralizing antibodies to the specific viral pathogen. A number of sentinel systems have been developed, and among those evaluated are 1) domestic chickens in caged flocks consisting of 10-20 animals. Birds used as sentinels are treated humanely, and provided with ample, shelter, water and feed. The blood sample (serum) is subsequently tested for the presence of virus specific antibody.

2.4 Remote Sensing in Mosquito and Encephalitis Surveillance: Recent advances in spectral analysis via remote sensing (RS) by satellite/aircraft photography and video has provided a new technology for identifying potential risk areas of likely mosquito production and encephalitis virus transmission. Verification of risk sites identified by RS would be validated by ground surveys utilizing standard surveillance technologies. Once verified by ground-based surveillance, these new sites would then be considered for routine surveillance oversight.

2.5 Surveillance Activities and the Environment: The implementation of mosquito and encephalitis virus surveillance actions requires access for the placement of mosquito traps and sentinel birds in the field to physically collect adult mosquitoes and detect the presence mosquito-borne pathogens. Routine inspection of mosquito breeding sources also requires access to allow vector control personnel to obtain samples of larvae. Vector control personnel involved with surveillance activities also require unencumbered access (employee safety required of Title 8) to potential mosquito breeding and disease transmission sites to determine quantitatively the threat posed by existing conditions.

2.5.1 Surveillance Policy: The prevailing District policy is to perform essential surveillance activities with the least negative impact on the environment. Technical staff routinely use pre-existing accesses such as roadways, open areas, walkways, and trails. At times, vegetation management (e.g., pruning trees, clearing brush and weed removal) may become necessary where overgrowth impedes freedom of vehicle travel and technician movement on foot. All of these actions only result in a temporary/localized physical change to the environment with regeneration/regrowth occurring within a span of one or two years.

Vector control staff involved with performing surveillance duties are aware of the consequences of their actions in the field. Staff are instructed to be respectful of the environment and associated wildlife and are to proceed with an attitude to limit their impact to only what is necessary to perform their assigned tasks. Wanton disregard for environmental respect and attendant abuses are not tolerated in the District's vector control surveillance operations.

In our vector control work, the District uses whenever possible existing roads, driveways and trails. The District strives to minimize any off-road travel. When off-road travel is necessary, District staff is instructed to avoid threatened and endangered plants and sensitive habitat areas and to minimize any environmental damage caused by off-road travel.

2.5.2 Non-invasive Sampling: Non-invasive sampling is considered a type of sampling that does not impact the environment directly. Low impact methods include the placement of host-seeking traps, light traps, and artificial resting units (ARUs). In this situation, existing roads, trails, and clearings can be utilized if acceptable for accommodating sufficient surveillance access.

2.5.3 Invasive Sampling: Invasive sampling is considered a type of sampling that may impact the environment directly. Where roads, trails, and clearings have to be created to gain access to facilitate surveillance, the consequences may require removal of vegetation and grading to establish roads, trails, and minimal clearings. These actions are necessary to establish sites where routine surveillance actions are necessary based upon established environment risk factors associated with mosquito breeding and previous history of disease transmission. In any clearing or grading work, the District avoids threatened and endangered plants and habitats areas and minimizes the scope of the work to the smallest area feasible.

Obtaining samples of immature mosquitoes involves removal of some negligible quantities of water. This water may also include non-target organisms associated with the mosquito immatures. Technicians either will make a count of the immatures present or remove a small number for identification at the agency office laboratory, but then return to contents of the dipper back into the source. Taking dipper samples also requires the technician to wade into the source and repetitively sample/dip along transacts to assess the extent and magnitude of immature mosquito populations. Trampling of some vegetation can occur, but most sampling actions involve either walking the shore line or wading through open water gaps that border emergent vegetation (grasses, tules, cattails, etc.) where mosquito immatures are most likely to be sampled.

2.5.4 Transportation and Access Requirements: Normal surveillance necessitates the use of access roads, trails, and clearings to facilitate sampling. Roads allow vehicles to transport needed staff and equipment to specific sites deemed critical. As indicated above, this action may necessitate the periodic removal of some marginal vegetation and weed control on the median between the wheel ruts of established dirt/gravel roads. Access trails (2-3 feet in width) to the margins of wetlands, ponds, streams, and rivers are maintained by periodic vegetation removal via simple pruning, or mowing if necessary. Weeds/grasses choking trails also can be removed by spot application of herbicides.

2.5.5 All Terrain Vehicles (ATVs): The District sometimes relies upon the use of all terrain vehicles to facilitate access into areas that are not otherwise accessible by conventional transportation means or by foot. Some situations where flooding and wetlands preclude access by 4-wheel drive or reasonable walking distance in waders/boots do require the use of an approved ATV. Access is necessary for vector control staff to determine adequately 1) the presence and abundance of mosquitoes, either immature (larvae) or adult stages, and 2) the success of control operations in reducing the threat posed by documented and established mosquito breeding.

Overall, ATVs are used as an access means of last resort. Surveillance staff do not attempt to use these types of vehicles where environmental conditions (e.g., impenetrable vegetation/terrain, endangered/threatened plants, sensitive habitat) can result in causing an accident, personal injury or significant environmental damage. District policy also limits operation of ATVs to situations where 1) existing passages are available, 2) vegetation does not impede mobility, and 3) open water situations present the best course in which to proceed.

2.6 Special Use of Birds to Support EVS Activities: Placement of sentinel chickens constitutes a necessary component of encephalitis virus surveillance (EVS). Therefore, their physical presence is required at sites where virus activity is to be monitored on a routine basis. Sentinel chickens are sequestered in a coop structure (usually 4'x4'x6' or larger) covered with 1" welded wire to exclude access by resident wildlife with perhaps the exception of mice and other small rodents. Feed and water is housed within the coop enclosure. A wire skirting is placed around the base of the coop to prevent wildlife from foraging on the residual feed (various commercially available chicken feeds).

2.7 Analysis of CEQA Exemptions: CEQA categorical exemption classes 6 and 9 (CEQA Guidelines sections 15306 & 15309) exempt "basic data collection, research, experimental management, and resource evaluation activities which do not result in a serious or major disturbance to an environmental resource," and "activities limited entirely to inspections, to check for performance of an operation, or quality, health, or safety of a project."

The District's mosquito surveillance and monitoring activities described above constitute the types of inspection and data and information collection activities listed in these exemptions. The District monitors mosquito levels in order to determine and track the quantity, location and spread of mosquitoes, to provide the necessary data to make decisions on control measures, and to assess the effectiveness of its control methods.

Section 2.5 of this assessment demonstrates that the District's surveillance and monitoring activities minimally affect the land and water resources where the data collection occurs, and that the District staff that perform surveillance and monitoring conduct their activities in such a manner as to avoid any significant environmental impacts.

3. BIOLOGICAL CONTROL OF MOSQUITOES.

3.1 Introduction: Biological control of mosquitoes is the intentional use of mosquito pathogens, parasites or predators to reduce the size of target mosquito populations. It is one of the principal components of a rational and integrated mosquito control program. As resistance to pesticides and environmental concerns become more prevalent, biological control will be used more often as a method of protecting the public from mosquitoes and the diseases they transmit.

Biological control of mosquitoes is a relatively recent development and can be traced to observations and ecological studies in the 1940s and 1950s. Early investigations studied the potential effects of predators on mosquitoes. Results of such studies have been adopted in developing strategies to use mosquito predators in providing economical and sustained levels of control.

3.2 Biological Control Agents: Biological control agents of mosquitoes include a wide variety of pathogens, parasites and predators. As a rule, mosquito pathogens and parasites are usually highly specific to their mosquito host, whereas predators are more general in their feeding habits and opportunistically feed on mosquitoes.

3.2.1 Mosquito Pathogens: Mosquito pathogens include an assortment of viruses and bacteria. They are highly host-specific and usually infect mosquito larvae when they are ingested. Upon entering the host, these pathogens multiply rapidly, destroying internal organs and consuming nutrients. The pathogen can be spread to other mosquito larvae in some cases when larval tissue disintegrates and the pathogens are released into the water to be ingested by uninfected larvae.

Examples of viruses that can infect mosquitoes are mosquito iridoviruses, densonucleosis virus, nuclear polyhedrosis viruses, cytoplasmic polyhedrosis viruses and entomopoxviruses. Examples of bacteria pathogenic to mosquitoes are *Bacillus sphaericus* and several strains of *Bacillus thuringiensis israelensis*. The two bacteria produce proteins that are toxic to mosquito larvae. Both are produced commercially as mosquito larvicides.

3.2.2 Mosquito Parasites: The life cycles of mosquito parasites are biologically more complex than those of mosquito pathogens and involve intermediate hosts, organisms other than mosquitoes. Mosquito parasites are ingested by the feeding larva or actively penetrate the larval cuticle to gain access to the host interior. Once inside the host, parasites consume the internal organs and food reserves until the parasite's developmental process is complete. The host is killed when the parasite reaches maturity and leaves the host (*Romanomermis culicivorax)* or reproduces (*Lagenidium giganteum).* Once free of the host, the parasite can remain dormant in the environment until it can begin its developmental cycle in another host.

Examples of mosquito parasites are the fungi Coelomomyces spp., Lagenidium giganteum, Culicinomyces clavosporus and Metarhizium anisopliae; the protozoa Nosema algerae, Hazardia milleri, Vavraia culicis, Helicosporidium spp. Amblyospora californica, Lambornella clarki and Tetrahymena spp., and the nematode Romanomermis culicivorax.

3.2.3 Mosquito Predators: Mosquito predators are represented by highly complex organisms, such as insects, fish, birds and bats, that consume larval or adult mosquitoes as prey. Predators are opportunistic in their feeding habits and typically forage on a variety of prey types. This allows the predators to build and maintain populations at levels sufficient to control mosquitoes, even when mosquitoes are scarce.

Examples of mosquito predators include representatives from a wide variety of taxa: coelenterates, *Hydra* spp.; platyhelminths, *Dugesia dorotocephala, Mesostoma lingua*, and *Planaria* spp.; insects, Anisoptera, Zygoptera, Belostomidae, Geridae, Notonectidae, Veliidae, Dytiscidae and Hydrophilidae; arachnids, *Pardosa* spp.; fish, *Gambusia affinis, Gasterosteus aculeatus, Poecillia reticula*; bats; and birds, anseriformes, apodiformes, charadriiformes and passeriformes.

3.2.4 Environmental Relationships in Biological Control: The effectiveness of a mosquito biological control agent lies in its ability to reduce mosquito numbers as quickly as possible. An ideal biological agent 1) feeds preferentially on mosquitoes, 2) exhibits an extremely efficient hunting or parasitizing strategy, and 3) reproduces quickly. These traits determine suitability for practical application.

New mosquito sources initially have few predators and other competing aquatic organisms. Vector control personnel use this knowledge to develop a control strategy that involves integrated pest management techniques.

Since mosquitoes are capable of colonizing sources within days of flooding, initial control efforts attempt to suppress the first generations of mosquitoes until natural predators or competitors can control them. Initial treatment includes the selective use of pesticides and appropriate environmental manipulation, such as vegetation and water quality management. Once biological control is established in a "managed" source, periodic inspections at timely intervals are adequate to monitor changes in larval abundance. Periodically, the source may require treatments with pesticides when 1) predators are not effective, 2) aquatic and shoreline vegetation provides too much shelter, 3) the water level changes, or 4) water quality does not support predators.

3.2.5 Conservation and Application of Predators: The ability of predators to control mosquitoes, is related to four factors: 1) whether mosquitoes are preferred prey, 2) whether the hunting strategy of the predator maximizes contact with mosquitoes, 3) whether the predator consumes large numbers of mosquitoes, and 4) whether the predator is present in sufficient numbers to control mosquitoes. Predator effectiveness is enhanced when proper conditions are present.

Within a typical aquatic environment that produces mosquitoes, predators are distributed among different substrates. For example the surface of the pond supports water striders, planaria and spiders. Below the water surface, backswimmers, predaceous diving beetles and water scavenger beetles live and feed. If the pond contains vegetation, then the plant surfaces (periphyton) will support *Hydra*, damselfly and dragonfly nymphs, and giant water bug nymphs and adults. The benthos supports dragonfly and damselfly nymphs that feed on organisms associated with silts and organic detritus. Together, the different predators form a spatial network that accounts for predation throughout the pond. Ideally an adequate variety of vegetation should be present to maintain sufficient levels of predator diversity. Greater potential for an acceptable level of mosquito control exists when more predators are present. Care should be taken so that mosquitoes do not have an advantage when too much or too little vegetation is removed.

Most of the currently registered mosquito larvicides minimally impact predators. Making applications at the lower end of the label rate can further minimize any undesirable impacts from these larvicides. The overall objective of using predators is to reduce the use and frequency of pesticide applications. This minimizes environmental impact and delays the development of mosquito resistance to pesticides.

Predation on mosquitoes is a natural process that will occur without human intervention. However, the level of mosquito control by natural predators can be increased by the conservation of predators in the environment and by augmentation of the predator population through stocking and habitat enhancement.

3.3 Practical Applications of Biological Control Agents: Relatively few biological control agents are currently being used in California, although a number have been studied and tested extensively in the laboratory and field. Many have shown potential, but have not been used for a variety of reasons, including 1) difficulties in mass production, 2) failure to produce a consistent level of control, 3) expense, and 4) restricted application because of environmental concerns. Most agents, particularly predators and parasites, are only effective in association with mosquitofish and larvicides. Currently, the only practical biological control agents available to vector control agencies in California are *Bacillus thuringiensis israelensis*, *Bacillus sphaericus, Lagenidium giganteum* and the mosquitofish *Gambusia affinis.*

3.3.1 Microbial Agents and Mosquito Control: Commercial formulations of *Bacillus sphaericus* and *Bacillus thuringiensis israelensis* are extensively used as mosquito larvicides. Both are highly selective for mosquitoes and are innocuous to associated non-target organisms and predators. *Bacillus thuringiensis israelensis* is also toxic to black flies, a pest and disease vector.

Bacillus thuringiensis israelensis and *Bacillus sphaericus* are often considered chemical control measures because they are available in commercial formulations that consist of granular, powdered or liquid concentrates. The use of these two microbials is also discussed under the chemical control section.

3.3.2 Lagenidium giganteum and Mosquito Control: *Lagenidium giganteum* is a fungal parasite of mosquito larvae. Motile zoospores enter mosquito larva either when ingested or by penetrating the cuticle. The fungus grows rapidly throughout the host body cavity and once the host dies, zoospores are released that can infect other larvae.

Lagenidium giganteum is a highly specific parasite of mosquito larvae. Other organisms are not susceptible and there is no mammalian toxicity. However, use of *L. giganteum* is limited because of environmental requirements for growth and development of the fungus.

Lagenidium giganteum is available commercially as an aqueous suspension. It contains 40% (wt./wt.) *L. giganteum* (California strain) mycelium (10^{10} CFU or Colony Forming Units, a concentration measure by cell counts per liter) and 60% inert ingredients. *Lagenidium giganteum* may be applied from ground or air. Label rates range from 9 to 180 fluid ounces per acre. Most treatments will require 20 to 80 fl. oz./acre, a common rate is 25 fl. oz./acre. Zoospores form within 16 hours after application and mortality occurs within 24 to 48 hours.

3.4 Mosquitofish and Mosquito Control: *Gambusia affinis* is the most commonly used biological control agent for mosquitoes in the world. Correct use of this fish can provide safe, effective, and persistent suppression of a variety of mosquito species in many types of mosquito sources.
As with all safe and effective control agents, the use of mosquitofish requires a good knowledge of operational techniques and ecological implications, careful evaluation of stocking sites, use of appropriate stocking methods, and regular monitoring of stocked fish.

3.4.1 Aquatic Habitats: Mosquitofish are used to control mosquitoes in a wide variety of mosquito sources. These sources include both artificial and natural water bodies: industrial and municipal wastewater ponds; flood control basins and underground storm drains; neglected swimming pools, ornamental ponds and water troughs; irrigation and roadside ditches; seasonally flooded agricultural lands, rice fields, duck clubs and wildlife refuges; and such wetlands areas as marshes, sloughs, swamps and river seepage.

A high density of mosquitofish is required to control mosquitoes. In general, suitable habitats promote reproduction and recruitment rather than just sustaining the stocked mosquitofish population. Sources where conditions do not favor population growth may not be suitable for mosquitofish use, or may require stocking at substantially higher rates.

The principal habitat characteristic that affects the successful use of mosquitofish is its relative stability. Mosquitofish usually are not effective in intermittently flooded areas unless a refuge impoundment is provided. Because of this, mosquitofish are more effective against mosquitoes breeding in permanent and semi-permanent water, such as *Culex* spp., *Anopheles* spp., and *Culiseta* spp., than against floodwater species, like *Aedes* spp. and *Psorophora* spp.

Mosquitofish are best suited for use in shallow, standing water and are particularly useful in large sources where the repeated use of chemical control is expensive, prohibited, or impractical.

Availability of food, other than mosquito larvae, and shelter are also important factors affecting the suitability of a site. Mosquitofish survival, growth, and reproduction are highly dependent on diet and feeding rates. Shelter to protect the young from cannibalistic adults is essential for population growth.

Vegetation, or other shelter, may also reduce predation on adult mosquitofish by birds, larger fishes, and other predators.

Habitats in which the water quality conditions, particularly temperature, dissolved oxygen, pH, and pollutants, exceed the tolerance limits of mosquitofish are not suitable sites for biocontrol. In sources with poor but sublethal water quality, feeding, reproductive activity and consequently mosquito control, may be adversely affected. Use of mosquitofish is sometimes possible in suboptimal environments that inhibit reproduction, but special stocking and monitoring methods may be required.

The presence of piscivorous fishes or other predators in the source habitat may rule out stocking with mosquitofish. High densities of invertebrate and vertebrate predators, such as notonectids and young game fish, which prey on both small mosquitofish and mosquito larvae, can prevent mosquitofish population growth.

3.4.2 Stocking Methods: Stocking methods can have significant effects on the degree of mosquito control achieved. In most cases, the objective is to release the minimum number of fish at the time when conditions within the source promote rapid population growth and at locations which facilitate dispersal throughout the source. The most appropriate methods depend on the type and location of the mosquito source, season, and the degree and duration of control desired.

3.4.3 Stocking Rate: Mosquitofish generally are released at densities lower than those necessary for mosquito control with the expectation that reproduction and recruitment will greatly increase the fish population within a few weeks. The best stocking rate depends primarily on the type of mosquito source, season, and mosquito control objective, for example immediate control vs. control later in the season. Understocking can result in inadequate mosquito control whereas overstocking may result in excellent control, but is wasteful of the usually limited fish supply.

Stocking rates are usually reported as fish per acre, or pounds of fish per acre. The number of mosquitofish per pound depends on the population structure of the sample (*e.g.*, a mixed population of adults and juveniles versus a sample containing only mature females), source (e.g., cultured vs wild-caught fish), and even season (early versus late in the breeding season). In general, for a mixed population, there are approximately 600-1,300 fish/lb.; the most common estimate is 1000 fish/lb.

In general, for early season stocking of mosquito sources that contain healthy populations of food organisms and adequate vegetation to provide shelter for the small mosquitofish, 0.2-0.5 lb./acre is appropriate. Higher stocking rates are necessary in a variety of circumstances, including:

- late season stocking and/or short flooded season, for example, wild rice fields or duck club ponds. In these situations, mosquitofish population growth is reduced as a result of a shorter breeding season and declining thermal and photoperiodic stimuli for breeding;
- poor quality environments which depress or inhibit reproduction and/or feeding, for example, habitats characterized by low temperature, low light, or high levels of chemical or organic pollution;
- sources in which immediate mosquito control is desired;
- sources which harbor high densities of mosquito larvae, for example, wild rice fields.

3.4.4 Stocking Date: Date of release of mosquitofish into a mosquito source affects biocontrol efficacy primarily through its influence on mosquitofish population growth. The age of the source affects its quality; both food and shelter may be sparse in new habitats. In mosquito sources stocked late in the season, population growth is reduced because of the shortened breeding season and declining reproductive stimuli. Stocking date necessarily varies with type of mosquito source but, in general, mosquitofish are released one to three weeks post-flooding. Mosquito sources that require late season stocking, such as duck club ponds are usually stocked with higher numbers of fish or treated with supplemental larvicides.

3.4.5 Stocking Location: A sufficient number of mosquitofish must be stocked where mosquito larvae are present. Although mosquitofish can swim through dense vegetation, dispersal throughout a large habitat takes time and is slowed by the presence of additional barriers such as dikes or complicated shorelines.

The size and complexity of a source are important considerations when determining the number and locations of release sites. In large, complicated habitats, such as rice fields or wetlands, mosquitofish are typically be released at several locations. For small area sources, all fish may be released at a single site.

Water flow may also be a consideration. In general, mosquitofish are stocked at the upstream end of the source since fish tend to move downstream from the release site.

3.4.6 Handling Release and Monitoring: Most mosquitofish are released by hand; however, mosquitofish can also be dropped from airplanes and helicopters, when stocking large area sources such as rice fields. Regardless of the release method, care should be taken to minimize stress. Abrupt changes in water temperature should be avoided. Fish should be transported in water at a temperature similar to that at the end source. Mosquitofish should not be stocked during extremely hot weather or when water temperature approaches the upper tolerance limits of the fish (>35°C or 95°F).

After stocking, mosquitofish populations are monitored regularly to assess fish density, population growth, and biocontrol efficacy. A low number of fish may necessitate restocking or alternative mosquito control efforts.

3.5 Environmental Considerations of Mosquitofish Use: Many species of larvivorous fish have been evaluated as agents to control mosquitoes, including various species of atherinids, centrarchids, cichlids, cyprinids, cyprinodontids, gasterosteids, and other poeciliids. However, mosquitofish are considered best suited from both biological and operational perspectives.

3.5.1 Advantages of Mosquitofish for Biological Control: Mosquitofish possess characteristics which make them efficient predators of mosquito larvae. They thrive in shallow, calm, vegetated waters, which is the same environment where many mosquitoes prefer to lay eggs. Mosquitofish tolerate wide ranges of water temperature and quality. Mosquitofish are surface-oriented predators where mosquito larvae are an accessible prey. The small size of the fish enable them to penetrate vegetated and shallow areas within the mosquito source. Mosquitofish are live-bearers that grow rapidly, mature at a young age, and reproduce quickly. This allows the fish to establish a high population in the source shortly after stocking. In many sources, seasonal peaks in mosquitofish activity and population growth coincide with mosquito reproduction times. Because of their omnivorous feeding habits, mosquitofish can thrive in habitats where mosquitoes occur intermittently.

Mosquitofish are hardy and easy to handle, transport, and stock. As a result of extensive research and practical experimentation in California, mosquitofish can be reliably cultured in large numbers. Problems still exist in some areas with winter survival rates and inadequate supplies of fish in the spring. Because the fish reproduce where they are stocked, long-term control can be achieved by stocking relatively few fish, often in a single application. Compared to pesticides, which require repeated applications, mosquitofish can provide inexpensive and safe long-term control, sometimes within days after application. Although not all introductions are successful, mosquitofish are an effective biological control agent alone and as a component of an integrated pest management program.

3.5.2 Limitations to Use of Mosquitofish for Biological Control: Not all types of mosquito sources are suitable for stocking with mosquitofish and mosquitofish are not effective in all situations. Since mosquitofish usually are not stocked in numbers sufficient to cause an immediate effect, they do not control mosquitoes as quickly as pesticides do. In some areas, federal, state, or local agency permission is required to stock mosquitofish.

3.5.3 Deciding Whether or Not to Use Mosquitofish: Mosquito control and public health professionals believe the effectiveness and safety of mosquitofish to be ecologically preferable to the application of pesticides or draining of the mosquito source. The use of mosquitofish as a component of an integrated pest management program, particularly in altered or artificial aquatic habitats, is increasingly more important with the limited availability of registered pesticides and as insect resistance to pesticides increases. As agents for biological control of mosquitoes, mosquitofish deserve consideration, and, in many specific situations, are the best choice

Though mosquitofish are not native to California, they are now ubiquitous throughout most of the state's waterways and tributaries. In much of the state's wetland areas, mosquitofish are now part of the natural ecosystem. Also, much of the aquatic habitat that is highly productive for mosquitoes is disrupted habitat, with flora and fauna that are predominately non-native species. In these areas, stocking of mosquitofish will have minimal impact on non-target species.

Many precautions are taken to minimize the environmental impact in habitats where mosquitofish are introduced. Mosquitofish are introduced into wetland communities that are biologically complex. The impact on habitats that contain native fishes are especially considered and weighed prior to introduction. Mosquitofish are stocked only in careful compliance with federal and state endangered species acts, so as to avoid the potential to harass and impact threatened and endangered fish, amphibians, insects and other wildlife. The considered use of mosquitofish by the Distict ensures the protection of the environment by augmenting the natural process of predation on mosquito larvae through the use of a natural predator, the mosquitofish.

3.6 Analysis of CEQA Exemptions: CEQA categorical exemption classes 7 and 8 (CEQA Guidelines sections 15307 & 15308) exempt actions taken by regulatory agencies as authorized by state law to assure the maintenance, restoration, enhancement or protection of a natural resource or the environment where the regulatory process involves procedures for the protection of the environment. In order for this exemption to apply, the following elements must be satisfied:

- The District must be a "regulatory agency" authorized by state law to assure the maintenance, restoration, enhancement or protection of a natural resource or the environment.
- The District's biological control activities as described above must assure the maintenance, restoration, enhancement or protection of a natural resource or the environment.
- The District's regulatory processes must involve procedures for the protection of the environment.

3.6.1The District is a "regulatory agency" authorized by state law to assure the maintenance restoration, enhancement or protection of a natural resource or the environment.

The District is a local government agency created pursuant to state statute, Health and Safety Code division 3, chapter 5 (commencing with section 2200). State law charges the District with the authority and responsibility to take all necessary or proper steps for the control of mosquitoes and other vectors in the District.

The District and its employees are regulated by the State Department of Health Services (DHS). Vector control activities are coordinated with DHS pursuant to an annual Cooperative Agreement, under which the District commits to comply with certain standards concerning mosquito control and pesticide use. State law and the Cooperative Agreement require District vector control employees to be certified by DHS as a vector control technician. This certification helps to ensure that the employees are adequately trained regarding safe and proper vector control techniques, including the handling and use of pesticides and compliance with laws and regulations relating to vector control and environmental protection. The District also works in close coordination with the county agricultural commissioner, including periodic reporting of its activities.

As explained below, the District is one of many local, state and federal agencies involved in managing and regulating the environment. Its activities are undertaken in coordination with other agencies and pursuant to a framework of federal and state regulation.

CEQA does not define “regulatory agency.” The CEQA Guidelines do define “public agency” to include the District. (CEQA Guidelines section 15379.) To “regulate” means to govern according to or subject to certain rules and restrictions. (New Webster Dictionary.)

The District, as authorized by state law, and through its Board of Trustees and staff, governs the control of mosquitoes and vectors in the environment within the District’s boundaries. This action is subject to and done in accordance with District criteria regarding vector control that guide when, where, whether and how to control vectors (using biological control and other integrated pest management techniques), and also various federal and state laws that regulate vector control and environmental protection. As such, the District qualifies as a regulatory agency.

3.6.2 The District’s Biological Control Activities as Described Above Assure the Maintenance and Protection of a Natural Resources and the Environment: Biological control, and principally the use of mosquito fish, controls the level of mosquito larvae in water sources. The mosquito fish effectively control the larvae in water sources that otherwise could produce substantial numbers of adult mosquitoes. Mosquito fish act as a natural predator of mosquitoes to better control their levels in the current District environment. This control method maintains water sources and protects the adjacent environment in a condition more safe, healthful and comfortable for humans.

The District contains many sources that act as mosquito and vector breeding areas near populated areas. Without ongoing and effective vector control, the human environment would be significantly and adversely effected by substantial mosquito and other vector activity. The District’s mosquito control program, including biological and chemical control, is essential to maintain the vectors in the environment at a tolerable level. The District’s program will never alleviate all mosquitoes. Rather, it is a resource maintenance program aimed at striking a balance to allow comfortable and healthful human existence within the natural environment, while protecting and maintaining the environment. /History has shown us that the control and abatement of vectors are necessary for our human environment to continue to be habitable.

3.6.3 The District’s Regulatory Process Involves Procedures for the Protection of the Environment: There are numerous measures and procedures inherent in the District’s integrated vector control management practices that protect and avoid impacts on the environment:

- As explained above, the integrated pest management principles followed by the District involve the careful design and selection of the appropriate mosquito control method in a particular circumstance in order to avoid environmental effects.
- The District coordinates with other resource agencies (e.g., California Department of Fish and Game, U.S. Fish and Wildlife Service, U.S. Army Corps of Engineers) regarding its vector control activities, especially in and around sensitive habitat areas.
- The District strictly complies with the state and federal Endangered Species Act so as to avoid any impacts to an endangered or threatened species or its habitat.
- The District is an active member of the Mosquito and Vector Control Association of California, a statewide association representing the interests of vector control districts throughout the state. The Association, and its member districts, participate in the U.S. Environmental Protection Agency’s Pesticide Environmental Stewardship Program, a program to encourage and further greater environmental stewardship by vector control districts.
- The District has adopted and enforces an employee injury and illness prevention plan, code of safe conduct, emergency response plan, and hazard communication program. Compliance with these plans better ensures safe and careful vector control activities, thereby helping to protect the environment from damage, e.g., by a pesticide spill.

4. PHYSICAL CONTROL AND SOURCE REDUCTION.

4.1 Description of activities: Physical control, also known as source reduction, environmental manipulation, or permanent control, is one part of the District's Integrated Pest Management (IPM) program. Physical control reduction is usually the most effective of the mosquito control techniques available and is accomplished by eliminating mosquito breeding sites. This can be as simple as properly discarding old containers that hold water capable of producing mosquitoes such as *Culex pipiens* or *Culiseta incidens* or as complex as implementing Rotational Impoundment Management (RIM). RIM is a source reduction strategy that controls salt marsh mosquitoes *(e.g., Ae. taeniorhynchus, Ae. squamiger)* at the same time as significant habitat restoration is occurring. Source reduction is important in that its use can virtually eliminate the need for pesticide use in and adjacent to the affected habitat. Source reduction is appropriately touted for its effectiveness and economic benefits.

4.2. Mosquito Producing Habitats to Consider for Source Reduction.

4.2.1 Freshwater Lakes, Ponds And Retention Areas: Description of sites. Typical sites in California include the margins of reservoirs with shallow water and emergent vegetation, artificial ponds for holding drinking water for livestock and retention ponds created for holding of rainwater. Some retention ponds have been constructed within freeway interchanges and others have been built in cities and towns to provide wildlife habitat and flood protection. Natural lakes are usually not a problem because most of the water is deep, and there may be little emergent vegetation. Seasonal ponds such as central valley vernal pools and Sierra Nevada snow pools may produce large numbers of mosquitoes during part of the year. Vernal pools may be important habitats for rare and endangered species.

Typical mosquito species. There are a number of species of mosquitoes that exploit this type of habitat. In lower elevations in California, *Culex* species such as *Cx. tarsalis* and *Cx. stigmatosoma* may be found. *Culiseta inornata* and *Cs. incidens* also will breed in small ponds. In the Sierra Nevada, about 10 species of *Aedes* breed in melted snow. *Ae. tahoensis* and *Ae. hexodontus* are the most common species in these environments. At lower elevations, *Ae*. *washino* is a persistent problem along large river valleys. Larvae of this species are found in borrow pits, flooded quarries, and other ponds of freshwater.

4.2.2 Freshwater swamps and marshes: Description of sites. - The vast freshwater swamps and marshes that formerly existed in the central valley of California have mostly been drained and converted to cultivated agricultural crops. Within federal and state property, a number of marshes have been created and operated to provide aquatic habitats for wildlife, especially water fowl. Some of these marshes are drained and re-filled periodically to enhance the primary productivity of the habitat, and under certain circumstances, this can result in large populations of mosquitoes.

Typical mosquito species. - *Culex tarsalis, Cx. Pipiens complex* and *Anopheles freeborni* are the most common species found in these habitats. Depending upon the management practices for the marsh or swamp, floodwater *Aedes* such as *Ae. vexans*, *Ae. Melanimon*, Ae. nigromaculis and *Ae. dorsalis* can become serious problems, especially in those cases where marshes are periodically drained and re-flooded.

4.2.3 Temporary standing water: Description of sites. There are several species of mosquitoes that can breed in water that stands only 1 to 2 weeks. Such habitats include irrigation tail water as well as standing water in irrigated pastures. Many mosquito species are found in these sources. Pastures and other agricultural lands are enormous mosquito producers, frequently generating huge broods of *Aedes* and *Culex* mosquitoes.

Typical mosquito species. - *Culex tarsalis, Cx. Pipiens complex, Cx. stigmatosoma, Aedes melanimon, Ae. Nigromaculis and Culiseta inornata* are just some of the species that may breed in temporary pools.

4.2.4 Wastewater treatment facilities: Description of sites. - Aquatic sites in this category include a wide variety of ponds, ditches and other structures designed to handle wastewater of some kind. Included are sewage treatment ponds, ponds managed for denitrification, dairy drains, dairy ponds, storm sewers and water that accumulates from log sprinkling systems (cold decks).

- Typical mosquito species.

  Culex. Mosquito species found in these types of sources are generally *Culex pipiens* Complex, *Culex stigmatosoma*, and to a lesser degree, *Culex tarsalis*. Human activities are responsible for establishing the vast majority of the aquatic habitats used by *Cx. Pipiens complex*, the so-called house mosquito. A much wider range of larval habitats, including both artificial and natural aquatic systems, is used by *Cx. tarsalis*. In large wastewater ponds, immature *Cx. Pipiens complex* are generally most abundant near the outflow area where the nutrient loads are normally the highest.

  Culex tarsalis, another common mosquito in wastewater, is like *Cx. stigmatosoma* in terms of its range of larval habitats, but its seasonal pattern of abundance is similar to that found in *Cx. Pipiens complex. Culex tarsalis* inhabit not only semipermanent ponds but also more ephemeral habitats, such as temporary pools in spray-irrigation fields. *Cx. tarsalis* is the species with the greatest impact because it is the dominant *Culex* in California during the summer and fall, occurs in wastewater systems that vary over a wide range of nutrient loads, and is the primary vector of St. Louis encephalitis (SLE) and western equine encephalomyelitis (WEE) viruses.

  Aedes. - Unlike *Culex,* whose eggs hatch within a few days after being laid in rafts on the water surface, *Aedes* lay their eggs individually on moist substrate with hatching occurring only after the eggs have been flooded. Consequently, *Aedes* are seldom found in wastewater systems where there is little or no variation in surface water levels. However, poorly designed, improperly operated, or inadequately maintained systems often lead to conditions that are ideal for an invasion by floodwater mosquitoes. Poorly drained spray-irrigation fields often become water logged, especially during the rainy season. Under these conditions, many broods of *Ae. vexans* can be produced in a single season. Land application of wastewater may increase the salt content of the soils. Under these conditions, inland sites may become suitable aquatic habitats for salt marsh mosquitoes.

4.2.5 Containers: Description of sites. - Containers such as flowerpots, cans, treeholes, fountains and tires are excellent habitats for several *Aedes* and *Culiseta* species. Abandoned or poorly maintained swimming pools also fall into this category. Typically problems with container breeders occurs during the wetter parts of the year.

Typical mosquito species. Container-inhabiting mosquitoes of particular concern in California are *Aedes* sierrensis and *Culiseta incidens*. Other mosquito species found in containers include *Culex pipiens, Culex stigmatosoma, Culex tarsalis* and *Culiseta inornata. Ae. sierrensis* is the most common treehole breeder in California, and is probably the primary vector of dog heartworm here.

4.3 Physical control methods.

4.3.1 Source Reduction in Freshwater Habitats: Source reduction for mosquito control in freshwater habitats typically involves constructing and maintaining channels (ditches) to reduce mosquito production in areas such as flood plains, swamps, and marshes. The principle that directs source reduction work entails manipulating water levels in low-lying areas to eliminate or reduce the need for spraying applications.

Two different mosquito control strategies or approaches are considered when performing freshwater source reduction. One strategy involves reducing the amount of standing water or reducing the length of time that water can stand in low areas following significant rainfall events. This type of strategy involves constructing channels or ditches with control elevations low enough to allow for a certain amount of water to leave an area before immature mosquitoes can complete their life cycle.

Another strategy involves constructing a main central ditch with smaller lateral ditches at the lowest elevations of intermittent wet areas to serve as a larvivorous fish reservoir. As rainfall increases, larvivorous fish move outward to adjacent areas to prey on immature mosquitoes, and as water levels decrease, larvivorous fish retreat to water in the ditches. Weirs are constructed in main ditches to decrease water flow, decrease emergent aquatic weeds, prevent depletion of the water table, and allow larvivorous fish year-round refuge.

At this time, the District is rarely involved in construction of new drainage projects. The District rarely performs maintenance on existing drainage systems. This maintenance includes cutting, mowing, clearing debris, herbiciding overgrown vegetation, and excavating built up spoil material.

Over the past several decades, urban development has occurred in areas where mosquito control drainage ditches have existed as the primary drainage systems. In many cases, maintenance responsibility for mosquito control projects has been taken over by city and county public works departments and integrated those projects into their comprehensive stormwater management programs. Also irrigation districts and reclamation districts have integrated into their comprehensive drainage management programs maintenance programs to control mosquito breeding associated with crop land irrigation.

4.3.2 Aquatic Plant Management And The Effects On Mosquito Populations: This section describes the practices used to control mosquitoes and aquatic plants associated with freshwater environments only.

Certain mosquito species use various aquatic plants as a primary habitat for egg deposition and larval development. Because aquatic plants can, at times, produce heavily vegetated stands, the use of conventional mosquito management techniques, such as biological and chemical control, may be ineffective. Therefore, removal of the habitat may be the only means of reducing these mosquito populations to a desired level.

Aquatic plant management can have a positive effect on the control of mosquito populations. A primary goal in reducing mosquitoes that use aquatic plants is to eradicate or, at the very least, manage the aquatic plant communities at the maintenance or lowest feasible level.

The several important aquatic plant species provide a habitat for mosquitoes. The most noticeable are smartweed, bulrush and cattails.

While it can be possible to fill small artificial ponds that produce mosquitoes, it is usually impossible to do so in natural areas (however small), large permanent water bodies, or in areas set aside for stormwater or wastewater retention. In such situations, other options that are effective in controlling mosquitoes include periodic drainage, providing deepwater sanctuary for larvivorous fish, minimizing emergent and standing vegetation, and maintaining steep banks. *Aedes*, *Culex*, Coquillettidia, Mansonia, and *Anopheles* mosquitoes are frequently produced in these habitats.

Eradication or maintenance level control of aquatic plants is the best method of mosquito control..

Physical control methods include the use of equipment or tools to physically remove aquatic vegetation. Examples would include aquatic harvesters, backhoes, bucket cranes, underwater weed trimmers, and machetes. Mechanical control is limited to areas that are easily accessible to the equipment. Also, mechanical control can be labor intensive and extremely expensive.

4.3.3 Freshwater Swamps and Marshes: Environmental laws greatly restrict habitat manipulations in these areas (which can produce *Aedes*, *Culex*, *Anopheles*, and *Culiseta* species), making permanent control there difficult. Consequently, the District does not usually undertake physical control projects in these areas. If it does so, the District would undertake separate CEQA assessment on a case by case basis.

4.3.4 Wastewater treatment facilities: In many parts of California, clean freshwater for domestic, agricultural, or industrial uses is becoming a critical resource. Wastewater recycling and reuse help to conserve and replenish freshwater supplies. California citizens daily produce approximately 100 gallons of wastewater per capita from domestic sources alone. Concern for water quality conditions in lakes, rivers, and marine areas has resulted in the enactment of new state laws that will greatly limit future disposal of wastewater into these aquatic systems. To adjust to these changing conditions, many communities must implement wastewater reuse and recycling programs. Mosquito problems are frequently associated with some of the conventional wastewater treatment operations, and the expanded use of wastewater recycling and reuse may inadvertently create even more mosquito habitats.

Pond management options which are effective in controlling mosquitoes include periodic draining, providing deep water sanctuary for larvivorous fish, minimizing emergent and standing vegetation, and maintaining steep banks. The District routinely advises property owners on the best management practices for ponds to reduce mosquito development. In addition, the District provides localized vegetation management on ponds that enter into a contract with the District to discourage mosquito oviposition sites.

4.3.5.1 Septic Systems: Many households in California, especially in rural areas, use on-site treatment systems, such as septic tanks and associated drain fields. With proper soil porosity, sufficient lateral fields, and low human congestion, these systems are safe and efficient. The wastewater in a properly located and maintained septic tank system will percolate into the subsoil without causing surface water accumulation that may induce mosquito production. Yet, when these systems are placed in locations with inappropriate soil conditions, wastewater will flow laterally, often into nearby swales and ditches. Physical control measures include repair and rebuilding of systems, and ditch maintenance in areas where lateral flow occurs.

4.3.5.2 Municipal Treatment Facilities: In California, municipal treatment facilities may be associated with mosquito problems. These can stem from operation of both small (package plants) and large facilities. Package plants may result in mosquito production in holding ponds because they are poorly maintained or operated beyond their capacity. Larger plants may use various methods to improve water quality conditions beyond the levels obtained in secondary treatment process. These methods include spray irrigation, rapid-dry ponds, aquatic plant/wastewater systems, and the use of natural or modified wetlands. Physical control methods include vegetation management, pond maintenance, structure repair, and improvement of pond substrates.

4.3.5.3 Hyper-Irrigation Systems: Secondarily treated wastewater is used to irrigate golf courses, road medians, pastures, sod fields, and other types of crops. The City of Modesto system is an example of the hyper-irrigation system used to eliminate treated waste water. During the summer, these irrigated fields may become waterlogged, particularly those in low-lying areas with high water tables or in poorly drained soils. Under these conditions, the continued application of wastewater will result in the accumulation of surface water, thus providing aquatic habitats for a variety of mosquito species. Physical control methods are employed by landowners, and include proper grading of irrigated lands, and better water management.

4.3.5.4 Wastewater/Aquatic Plant Systems: At some sewage treatment facilities in California, certain species of aquatic plants (e.g., water hyacinths) have been added to human-made ponds containing secondarily treated wastewater for nutrient removal and biomass production. Mosquito problems can be produced in this type of system if the inflow has received an inadequate secondary treatment. Effective nutrient removal requires periodic harvesting of a portion of the standing crop.

4.3.6.5 Stormwater and wastewater management: The management of stormwater and wastewater is very important, and when done without sound engineering, poor construction or improper maintenance, can result in considerable mosquito problems. Because of recent restrictions on the flow of stormwaters into natural waterways, the question of design of stormwater retention facilities has become a critical issue. Physical control measures may be required, but proper design of facilities will be the most important factor.
Currently there is a wide range of mosquitoes produced in these facilities including floodwater *Aedes* species in intermittently wet facilities and *Culex* and *Anopheles* species associated with permanent or semi-permanent wet facilities. The *Aedes* species are the most pestiferous. Cx. tarsalis is often found in the intermittently wet facilities and serves as the primary vector for WEE and SLE.

Mosquito production can be engineered out of stormwater and wastewater facilities but not always easily. Permanent water ponds can be kept clean of weeds with a water quality sufficient to support mosquito-eating fish. Dry facilities can be designed to dry down in three days to prevent floodwater mosquito production, but some standing water beyond the three-day period may occur due to intermittent rainfall common during the rainy season.

4.3.6.6 Agricultural and Industrial Wastewater: Many commercial operations have on-site treatment facilities for decreasing nutrient loads from their wastewater, and generally, they use techniques similar to those applied to domestic wastewater. The quantity of wastewater produced at some commercial locations, such as those processing certain crops, may be highly variable during the year. Therefore, the amount of surface water in the holding ponds or spray fields used in the wastewater treatment may fluctuate considerably, thereby contributing to the production of certain species of flood-water mosquitoes. Wastewater from feed lots and dairy barns is often placed in holding or settling ponds without any prior treatment. Several mosquito species of the genus *Culex* can become extremely abundant in these ponds, especially in the absence of aquatic plant control.

4.2.6.7 Agricultural croplands: The production of agricultural crops when performed improperly results in mosquito breeding located in the field or adjacent to the field. This is often the result of improper land preparation or improper water management. Two different mosquito control strategies or approaches are considered to eliminate mosquito breeding. The first is to prevent water from standing longer than 3 days. This can be accomplished by reducing the amount of water applied to the crop or re-leveling the land before planting the next crop, to insure the land is put to the property grade. The second approach is used when it is determined that regardless of the land preparation or reduction of irrigation time that water will stand. The second approach involves the establishment of ponds where mosquito fish are stocked to control mosquito breeding. These ponds or tailwater ditches are put to grade so that the water stands in only one area of the field. The District contacts the property owner and provides consultation and references to other agencies and consultants who can help the property owner develop a plan to eliminate mosquito breeding on his property. The District does not physically perform any work on agricultural croplands to eliminate mosquito breeding. The following is a listing of some of the crops where mosquito breeding is mainly found: corn fields, irrigated pasture, alfalfa, nut crops, grape vineyards. The primary species of mosquitoes found in and adjacent to these fields are: Aedes nigromaculis, Aedes melanimon, Aedes vexans, Cx. tarsalis, Cx. pipiens complex.

4.3.7 Container habitats.

4.3.7.1 Miscellaneous containers: An artificial container, such as flowerpots, cans, barrels, and tires. A container breeding mosquito problem can be solved by properly disposing of such materials, covering them or tipping them over to ensure that they do not collect water. A container-breeding mosquito problem can be solved by properly disposing of such materials, covering them, or tipping them over to ensure that they do not collect water. The District has an extensive program that addresses urban container breeding mosquito problems through house-to-house surveillance and formalized education programs.

4.3.7.2 Tires: Waste tires have been legally and illegally accumulating in California for the past several decades. The legal accumulations usually take the shape of a somewhat organized pile containing up to several million tires. Illegally dumped tires may be scattered about from singly up to piles containing 40 to 50 thousand carcasses. Unfortunately, most of the problem tires are not in large piles, but scattered about, making removal difficult and, at best, labor intensive.

The design of tires makes them ideal breeding sites for several species of mosquitoes, of which, some are very important vectors of disease. Until the mid-1980s, waste tires were considered more of a nuisance and environmental threat than the possible foci of mosquito-borne disease epidemics. This changed in 1985 when a substantial breeding population of *Ae. albopictus* was discovered in Houston, Texas. It is probable that this population arrived from Japan as eggs deposited inside used tires.

Thus far, *Ae. albopictus* has not become established in California, and the dry summers here are not favorable to their establishment. However, their introduction poses a serious threat, and California mosquitoes such as *Culiseta incidens* and Culex pipiens may breed here in tire carcasses.

For management of used tires, the California Integrated Waste Management Board oversees storage sites with more than 500 tires. That agency also has developed regulations regarding the storage of waste tires with regards to vector control. These regulations include the provision of the local vector control agency being involved with the permit process required to store used tires.

4.4 Analysis of CEQA Exemptions: CEQA categorical exemption classes 1 and 4 (CEQA Guidelines sections 15301 & 15304) provide exemptions for some, but not all, physical control and source reduction activities. Class 1 exempts the operation, maintenance and minor alteration of existing drainage or other facilities involving negligible or no expansion of use. Examples include the maintenance of stream channels and debris clearing to protect fish. Class 4 exempts the minor alteration of land, water and vegetation that do not involve the removal of mature, scenic trees. Examples include minor trenching where the surface is restored and maintenance dredging where the spoil is deposited in an authorized spoil area.

As applied to the District's physical control and source reduction activities described above, the following activities fit within these CEQA exemptions: maintenance of and clearing of debris from drainage channels and waterways; excavation of built up spoil material; removal of water from tires and other urban containers; cutting, trimming, mowing and harvesting of aquatic and riparian plants (but not including any mature trees, threatened or endangered plant species, or sensitive habitat areas); and minor trenching and ditching.

Consistent with the scope of the exemptions, and as applied to vector control activities, exempt minor trenching and ditching means the following: digging, excavating and expanding ditches, drains and trenches in situations where all of the following conditions are satisfied: the capacity of the new or expanded facility is only negligible or insignificant; the surface area is restored; the spoil, if any, is deposited in an authorized area; and the work does not impact any mature trees, threatened or endangered plant species, or sensitive habitat areas.

Rotational impoundment management, major trenching and ditching, and other land alteration/source reduction projects that do not fit the above list of exempt activities generally are not exempt from CEQA. These activities will need to be analyzed on a case-by-case basis with project-specific initial studies or other appropriate environment documents. Likewise, other physical control activities not described above are not exempt from CEQA under the class 1 or 4 exemptions and they too will need to be analyzed on a case-by-case basis.

Aquatic plant management through the use of herbicides is exempt from CEQA as discussed below in the discussion regarding chemical control, section 5.

5. CHEMICAL CONTROL: Mosquito control operations use a combination of two basic chemical control methods to control mosquitoes: adulticiding and larviciding. In addition to those chemical control agents used for controlling mosquitoes the District also uses chemical control agents to control plant growth that promotes mosquito breeding. Only those pesticides registered by the United States Environmental Protection Agency and California Environmental Protection Agency are used by the District for mosquito control. With the existing federal and state limitations and regulations, the pesticides available for mosquito control, when applied in accordance with legal requirements, are very environmentally sensitive and cause no or very minor and discrete ecological impact.

The Environmental Hazards section on labels of pesticides used for mosquito control instructs applicators about how to avoid and minimize environmental impacts. For example, adulticide labels instruct the applicator to avoid direct application over water or drift into sensitive areas (i.e., wetlands) due to a potentially high toxicity of these compounds to fish and invertebrates. Although there is some variation in the habitats to be avoided, they usually include lakes, streams and marshes. The District strictly follows label instructions and carefully monitors environmental and meteorological conditions to maximize effectiveness while avoiding and minimizing non-target exposure and environmental effects.

<u>5.11 Description of Adulticides & Adulticiding Activities:</u> Application of insecticides for control of adult mosquitoes (adulticiding) is probably the most visible practice exercised by mosquito control agencies. Insecticides are applied using aerial or ground application techniques. The most common form of adulticiding is the application of insecticide aerosols at very low dosages and using little or no diluent. This method is commonly called the ultra-low-volume (ULV) method. Ground adulticiding is almost exclusively conducted with specially designed ULV equipment. Most aerial applications of adulticides are made with the use of special systems designed specifically for the ULV method.

The efficiency of adulticiding is dependent upon a number of integrated factors. First, the mosquito species to be treated must be susceptible to the insecticide applied. Some California mosquitoes are resistant or more tolerant to some adulticides thus affecting the selection of chemical. Second, insecticide applications must be made during periods of adult mosquito activity. This factor is variable with species. Some species of mosquitoes are diurnal (daytime biting), while others are crepuscular. Adulticiding should be timed when the mosquitoes are flying and/or exposed to the aerosol mist.

The chemical application has its own set of conditions that determine success or failure. The application must be at a dosage rate that is lethal to the target insect and applied with the correct droplet size. It has been shown that droplets within the 10-25 micron range are most effective in controlling adult mosquitoes.

Whether the treatment is ground or aerially applied, sufficient insecticide must be distributed to cover the prescribed area with an effective dose. Ground applications with densely vegetated habitats may require a higher dosage rate than that of open areas. This is purely a function of wind movement and its ability to sufficiently carry droplets to penetrate foliage.

Environmental conditions may also affect the results of adulticiding. Wind determines how the ULV droplets will be moved from the output into the treatment area. Conditions of no wind will result in the material not moving from the application point. High wind, a condition that inhibits mosquito activity will quickly disperse the insecticide too widely to be effective. Light wind conditions (< 6 mph) are the most desirable, moving the material through the treatment area and are less inhibiting to mosquito activity. ULV applications are generally avoided during hot daylight hours. Thermal conditions will cause small droplets to rise, moving them away from mosquito habitats and flight zones. Generally, applications are made between sunset and sunrise, depending upon mosquito flight activity. This practice minimizes exposure of non-target species such as bees or butterflies. Some mosquitoes (*Aedes* species) are most active during the daytime. Applications for these species should be made during the period of highest activity provided that meteorological conditions are suitable for application and care is made to avoid non-target impacts.

5.2 Adulticides: Throughout the discussion of adulticide materials, signal words which may occur on the material's label are mentioned. Following is an explanation of these signal words:

CAUTION. This word signals that the product is slightly toxic. An ounce to more than a pint taken by mouth could kill the average adult. Any product which is slightly toxic orally, dermally, or through inhalation or causes slight eye and skin irritation will be labeled "CAUTION".

WARNING. This word signals that the product is moderately toxic. As little as a teaspoonful to a tablespoonful by mouth could kill the average sized adult. Any product which is moderately toxic orally, dermally, or through inhalation or causes moderate eye and skin irritation will be labeled "WARNING".

DANGER. This word signals that the pesticide is highly toxic. A taste to a teaspoonful taken by mouth could kill an average sized adult. Any product which is highly toxic orally, dermally, or through inhalation or causes severe eye and skin burning will be labeled "DANGER".

In its mosquito control work, the District regularly uses the following adulticides:

5.2.1 Pyrethrins and Pyrethroids - General Description: Natural pyrethrins (pyrethrum) are extracted from chrysanthemum flower heads grown commercially in parts of Africa and Asia. Synthetic analogues of the natural pyrethrins reached commercial success in the 1950s. Like the natural pyrethrins, 'first generation' synthetic pyrethroids such as phenothrin and tetramethrin, are relatively unstable to light. During the 1960s-1970s, great progress was made in synthetic light-stable pyrethroids. These photostable pyrethroids represent the 'second generation' of these compounds.

Pyrethroids exhibit rapid knockdown and kill of adult mosquitoes, characteristics that are considered a major benefit of their use. The mode of action of these compounds relates to their ability to affect sodium channel function in the neuronal membranes.

Synthetic pyrethroids are not cholinesterase inhibitors, are non-corrosive and will not damage painted surfaces. They are less irritating than other mosquito adulticides and have a less offensive odor. In comparison to other adulticides, pyrethroids may be effectively applied at much lower rates of active ingredient per acre. The synthetic pyrethroids are mimics of natural pyrethrum, a botanical insecticide. Natural pyrethrum is used in agricultural areas and has a significantly higher cost.

5.2.2.1 Natural Pyrethrins.

INTRODUCTION. Natural pyrethrins are compounds that are not photostable. ULV Fogging 7395, manufactured by MGK, is a labeled natural pyrethrin, whose label contains a CAUTION statement. It contains 12% pyrethrin with piperonyl butoxide. ULV Fogging 7395 concentrate is diluted by the District to make a 2.5% solution of pyrethrin using a food grade oil to dilute the concentrate. Other pyrethrin products are used that are ready to use out of the original container. These products are usually a 3% formulation of pyrethrin.

FORMULATIONS AND DOSAGES. is applied a ULV Fogging 7395 is a ULV spray with a dosage per acre of 0.0025 lbs of pyrethrins/acre (piperonyl butoxide at 0.0125 lbs/acre).

5.2.2.2 Resmethrin.

INTRODUCTION. Resmethrin is another of the 1st generation synthetic pyrethroids used in California. Resmethrin, like permethrin, is a photolabile pyrethroid compound produced by AgrEvo and formulated as the active ingredient in products such as Scourge. Resmethrin is similar to the other pyrethroids in providing rapid knockdown and quick kill of adult mosquitoes. Resmethrin exhibits very low mammalian toxicity, degrades very rapidly in sunlight and provides little or no residual activity.

FORMULATIONS AND DOSAGES. Resmethrin products are available in several concentrations that range from 1.5% to 40% and may or may not contain piperonyl butoxide. Scourge products, containing resmethrin and piperonyl butoxide (a synergist), have a maximum rate of application of 0.007 lbs per acre of the active ingredient. Currently Scourge is a restricted use insecticide with labels that contain the signal word “Caution”.

TARGET SPECIES. Resmethrin is used against all California mosquitoes.

5.3 Ground Adulticiding Techniques and Equipment. The District regularly applies the following ground application techiques and equipment:

5.3.1 Adulticide Application made from Truck-mounted Equipment (Ground adulticiding): Ground adulticiding is the most commonly used method of controlling adult mosquitoes in California and in some counties is often perceived by the general public as the only method used.

Ground adulticiding generally consists of barrier spraying, and Ultra Low Volume (ULV) aerosol applications. Barrier treatments for adult mosquitoes consist of an application using a material to the preferred foliage, buildings, or resting areas of the species in order to intercept adult mosquitoes hunting for blood meals.

This technique is often used as a barrier treatment and is based on the natural history of and behavioral characteristics of the mosquito species treated.

Cold aerosol generators, cold foggers, and Ultra Low Volume (ULV) aerosol machines were developed to eliminate the need for great quantities of petroleum oil diluents necessary for earlier fogging techniques. These units are based on a design patented by the U.S. Army and are constructed by mounting a vortical nozzle on the forced air blower of a fogger. Insecticide is applied as technical material or at moderately high concentrations (as is common with the pyrethroids) which translates to very small quantities per acre and is therefore referred to as ultra low volume (ULV). In agriculture, this rate is assumed to be less than 36 ozs./acre, but mosquito control ground adulticiding operations rarely exceed 1-8 oz./acre. The optimum sized droplet for mosquito control with cold aerosols applied at ground level has been determined to be in the range of 5- 20 microns.

The sprayers today use several techniques to meet these requirements. Air blast sprayers are almost universal. They use either high volume/low pressure vortical nozzles or high pressure air-shear nozzles to break the liquid into very small droplets. Rotary atomizers, ultrasonic and electrostatic nozzles are other forms of atomization equipment. Centrifugal energy nozzles (rotary atomizers) form droplets when the liquid is thrown from the surface of a high speed spinning porous sleeve or disc. Ultrasonic equipment vibrates and throws the droplets off. Electrostatic systems repel the droplets .

5.3.2 Equipment: Ground adulticiding equipment is normally mounted on some type of vehicle, but smaller units are available that can be carried by hand or on a person’s back. Pickup trucks are the most common motorized vehicle for conveyance. ATV’s are occasionally utilized for ground adulticiding with Beecomist Pro-Mist 25 HD and Pro-Mist 15MP.

Cold aerosol generators, ULV’s in common parlance, are available in a broad range of sizes and configurations. The District uses Beecomist, Microgen and home made units that are mounted to district vehicles. The Home made units and Microgen aersoal generators all utilize gasoline engines that drive a rotary lobed blower. The nozzles on these machines differ, but they all resemble the old Army patent vortical nozzle. The Beecomist Pro-Mist 25 HD and Pro-Mist 15MP are electric driven rotary atomizer operating off the vehicle’s electrical system or marine battery.

The insecticide metering equipment available on these machines ranges from a electric pump on fixed flow machines to computer controlled, speed correlated, event recording and programmable flow management systems. The fixed flow units are designed to be operated with the vehicle traveling at a constant speed. The Beecomist units use 12 volt laboratory type pumps which are quite accurate.

Every manufacturer now produces a mid-range machine in the 8-12 horsepower (or equivalent) class and a few even smaller <6 HP machines. These units are more compact, lighter and typically are more fuel efficient than their larger relatives. The atomization capabilities of the larger machines in this class are normally sufficient for many of the pesticides now being used, particularly at the 5 MPH rates. All of the flow systems available for the larger units may be fitted to this class machine as well.
There are several hand held, 2-cycle engine, ULV sprayers available that are useful for small area treatments. There are several units configured as backpacks, with the engine/blower mounted on a pack frame connected to a remote nozzle with a hose. These units utilize an orifice to control flow and either aspirating or gravity feed to supply the insecticide. The District uses the London Fog Colt Model hand held fogger and the LECO hand held fogger.

5.4 Aerial Applications. The District regularly applies the following aerial application techinques:

5.4.1 Techniques for Aerial Applications: Aerial applications may be the only reliable means of obtaining effective control in areas bordered by extensive mosquito production sites or have small, narrow, or inaccessible network of roads. Aerial adulticiding is often the only means available to cover a very large area quickly in case of severe mosquito outbreaks or vector borne disease epidemics.

The District contracts with flying services as necessary to control mosquitoes. The District uses low volume aerosols and ultra low volume aerosols. Low volume (.5 gallon/acre) sprays are commonly applied with the pesticide diluted in light food grade oil. The rates vary from .5 gallons of mix per acre to 1.0 gallon per acre. The amount of pyrethrin used is of 0.0025 lbs of pyrethrins/acre (piperonyl butoxide at 0.0125 lbs/acre.

Lighter aircraft, including helicopters, can be used because the insecticide load is a fraction of the other techniques. If the aircraft are capable of >120 knots fine droplets can be created by the high-speed airstream impacting the flow from hydraulic nozzles. Slower aircraft and most helicopters typically use some variety of rotary atomizer to create the required droplet spectrum. ULV applications can be difficult to accurately place with any regularity. Without the visual cues, drift and settling characteristics can be difficult to access.

The flight parameters differ by program and technique. Some operations fly during hours of daylight so their applications begin either at morning's first light or before sunset and work into twilight. At these times, the pilots should be able to see towers and other obstructions as well as keep track of the spray plume. The aircraft can be flown at less than 200 feet altitude, which may make it easier to hit the target area.

Swaths are flown as close to perpendicular with the wind as is possible, working into the wind and commonly forming a long, tight S pattern. A number of factors affect the spray drift offset and settling such as wind speed, droplet size, aircraft wake turbulence, altitude and even characteristics of the individual aircraft. Pilots rely to a degree on experience for determining this offset.

Aerial applications can be expensive, considering the pesticide costs per acre, the high cost of owning, maintaining or leasing aircraft with the inherent increased salary demands, or contractual services. However, due to the commitments for any spray mission, decisions are given much thought and are scheduled when adult population levels have peaked.

5.4.2 Aircraft Equipment: The aircraft utilized for aerial adulticiding are as varied as the programs where they are located. Both rotorcraft and fixed wing are have been used by the District. The type used depends upon the contracting agency used by the District.

5.4.2.1 Fixed Wing: Fixed wing, multi-engine aircraft account for most of the aerial acreage adulticided in California. Light general aviation twins (including Cessna 336's and Piper Aztec's, AgCats or Thrushes) are suitable for ULV spraying. They can be economical to operate, simple to maintain, nimble to fly and somewhat less conspicuous when spraying. The fuel consumption of a smaller light twin may only be 30 gal/hour, but it may be limited to a useful payload of about 1000 lbs.

5.4.2.2 Rotor Craft: Rotor craft are seeing wider use for adulticiding. Many programs which operate them for larviciding duties will change the spray equipment and also adulticide with them. Additionally, programs will use them for adulticiding smaller areas which have difficult obstructions or meandering shapes. They are capable of much quicker turns, are more maneuverable and can be serviced at field sites thus reducing ferry times. They may be safer but auto-rotations in case of an engine failure at low level and higher speeds may be beyond the recoverable parameters for such a maneuver. Air speeds are between 70 knots for piston-engine ships and 110 knots for the faster light turbines.

5.4.3 Training and Maintenance: Operators of adulticiding equipment must be trained not only in the proper use and maintenance of the equipment, but also in the proper application of the insecticide which they are using. The pesticide labels specify details of the application including acceptable droplet spectra, flow rates, application rates, areas to avoid and target insects. State Law requires that operators be licensed to apply pesticides through the California Department of Health Services or be directly supervised by a licensed person.

Pilots operating aircraft spraying for mosquitoes must hold an Aerial Applicators certification issued by the State of California, and must meet continuing education requirements. This functions to keep those involved with aerial operations abreast of the latest developments, demonstrate calibration procedures and bring experts from related fields to special work sessions.

5.4.4 Discussion of Available Approaches: Adulticiding is the only known effective measure of reducing an adult mosquito population in a timely manner. All mosquito adulticiding activities follow reasonable guidelines to avoid affecting non-target species. Timing of applications (when mosquitoes are most active), avoiding sensitive areas, working and coordinating efforts with Fish and Game or USFWS and following label instructions all result in good mosquito control practices. Ground adulticiding can be a very effective technique for controlling most mosquito species in areas economically and with negligible non-target effects. It is the methodology normally recommended for fundamental start-up programs. Initially an agency is not able, or prepared, to invest in a larviciding program where most of the mosquito production sites within flight range of the residents must be treated to produce a discernible improvement.

A benefit of ULV cold aerosols is that they do not require large amounts of diluents for application and are therefore much cheaper and generally environmentally safer. The spray plume is nearly invisible and is applied at very low dosage rates (less than 0.007 lbs. per acre). Applications are made at times when mosquitoes are most active and when other beneficial insects are not, so any impacts that occur are minimal and quickly reversed.

Machines are calibrated at least once a year. Measurements for output and droplet sizes of the pesticides being used are confirmed to maximize efficiency and minimize potential adverse impacts.

It should also be noted that this form of control has been conducted safely for over 40 years without any glaring adverse impacts attributed to it when performed properly.

An area of good mosquito control practices that needs to be discussed and distinguishes our industry from agricultural practices is the use of drift to control adult mosquitoes. All aerial (as well as ground) adulticiding, other than residual sprays, relies on a cloud of atomized insecticide particles drifting across the landscape. Mosquitoes, which are in flight and become enveloped in this cloud and are unfortunate enough to have sufficient toxicant impinged on them, die. Without drift, the system will not function. There is a rising concern among certain private landowners, particularly those with organic farming operations, about the uninvited mosquito insecticide drifting over, or depositing onto their lands.
The District takes measures to avoid impacts to these concerns. Organic farmland are located and plotted by the district. The District contacts organic growers before applying any adulticides to their crop. Under the California Health and Safety Code section 110825 the District is allowed to apply adulticides to organically grown crops as long as the residue level does not exceed 5% of the Environmental Protection Agencies established residue allowed for that crop. However, the United States Department of Agriculture is currently developing a national organic rule that will address adutlicide applications to organic crops, once the new rule is adopted, it will determine if any, the adulticides that can be applied to organically grown crops to control mosquitoes.

Chemical sensitivity can be a serious concern. This issue is addressed by District's conducting ULV operations in the early morning and late evenings, when people will not be exposed to the pesticide cloud.

The influence of meteorological conditions to spray drift cannot be understated. Air temperature at ground level relative to that above it dictates air stability and consequently, patterns of drift and deposition. Higher temperatures on the ground will cause the spray cloud to become entrained in rising thermal currents interfering with the intended horizontal drift pattern. Wind speed and directionality are important for obvious reasons.

Laboratory bioassays have yielded lethal concentrations ranging between 10 to 50% of the organisms exposed to help predict impacts in the field. Field studies, however, are more difficult to conduct and therefore greater data gaps exist there. Of field studies conducted, almost all have focused on aquatic habitats and little is known about impacts in terrestrial systems. The greatest data gap may be understanding population-level impacts to non-targets, considering migration/dispersal, re-colonization and confounding factors such as habitat destruction, other sources of environmental contamination, natural variation in populations, etc. Predicting impacts on temporary and semi-permanent communities have been extremely problematic due to the fact that these non-target populations are r-strategists, a natural boom-bust cycle, where they have become rapid colonizers with shorter life cycles and frequently undergo localized extinction. Overall, direct deleterious effects have not been documented for non-targets in aquatic habitats as a result of deposition of currently employed adulticides, probably due to a small mass depositing per unit area and dilution factors such as tidal flushing and water depth.

Occasionally, cottage industry operations such as beekeeping report losses associated with adulticide treatments. These operations are occasionally located in areas where routine adulticiding is conducted. Such operations are encouraged to notify mosquito control managers to avoid exposing their colonies either by actions taken by the resident/manager or by mosquito control applicators. Avoiding beehives has been a primary concern of District operations. The locations of hives are identified on maps and technicians are instructed to avoid applying pesticide in a manner that would drift over these areas. Associating bee kills with mosquito control applications may be misleading since bee colonies are susceptible to a variety of diseases and other causes for loss in colony strength and production.

All personnel who apply pesticides are trained at least once a year. This training consists of an annual review of the pesticides the applicator will be handling that calendar year. All applicators are certified by the Department of Health Services on the safe and proper use of pesticides. Applicators must undergo a minimum of 20 hours of continuing education every two years to maintain their certification.

5.5 Larvicides and Larviciding.

INTRODUCTION

Larviciding is a general term for the process of killing mosquitoes by applying natural agents or commercial products designed to control larvae and pupae (collectively called larvicides) to aquatic habitats. Larvicide treatments can be made from either the ground or air. Larviciding was implemented as a malaria control procedure in the early 1900's and over the years, has become prominent. Many Mosquito Control Districts in California have incorporated larviciding into their pest management practices.

There may be times when it makes no sense to attempt any larviciding at all. The size and location of the source area may make timely larviciding impossible. Effective larviciding results are not always easy to achieve. Accuracy of the larvicide application is extremely important. Congregated larvae may be easy targets, but missing a relatively small area containing them is also easy and leads to the emergence of many adults. Application timing is important because different materials have different requirements. As with adulticides, dosage rates must be both sufficiently high to kill targeted species and sufficiently low to minimize non-target effects.

A wide variety of aquatic habitats and communities, ranging from small domestic containers to larger agricultural and marshland areas, are treated with larvicides. Natural fauna inhabiting these sites may include amphibians, fish, vertebrates and invertebrates, particularly insects and crustaceans. Frequently, the aquatic habitats targeted for larviciding are temporary or semi-permanent. Permanent aquatic sources usually contain natural mosquito predators such as fish and do not require further treatment, unless vegetation is so dense that it prevents natural predation. Temporary sites such as marshes and flooded agricultural areas or woodland depressions produce prolific numbers of flood-water mosquitoes. These sites are generally very low in species diversity due to the time needed for most species to locate and colonize them. While flood water mosquitoes develop during the first week post-inundation, it may take two to three weeks for the first macro invertebrate predators to become established. Finally, many non-target species exploiting temporary aquatic habitats are capable of recovering from localized population declines via re-colonization from proximal areas.

5.5.1 Larvicides: Throughout the discussion of larvicide materials, signal words on the label are mentioned. Following is an explanation of these signal words:

- **CAUTION.** This word signals that the product is slightly toxic. An ounce to more than a pint taken by mouth could kill the average adult. Any product which is slightly toxic orally, dermally, or through inhalation or causes slight eye and skin irritation will be labeled "CAUTION".

- **WARNING.** This word signals that the product is moderately toxic. As little as a teaspoonful to a tablespoonful by mouth could kill the average sized adult. Any product which is moderately toxic orally, dermally,

- **DANGER**. This word signals that the pesticide is highly toxic. A taste to a teaspoonful taken by mouth could kill an average sized adult. Any product which is highly toxic orally, dermally, or through inhalation or causes severe eye and skin burning will be labeled "DANGER".

Commercially available and experimental larvicides plus natural control agents available in California are discussed below. Arbitrarily, they are loosely categorized by their modes of entry/action on target/non-target organisms: Contact Pesticides, Surface Active Agents, Stomach Toxins, and Chitin Inhibitors. Registered trade names and active ingredients of products are used in the discussions.

In its mosquito control work, the District regularly uses the following larvicides:

5.5.2 Contact Pesticides: As the name implies, this loosely defined group of compounds is effective when mosquito larvae or pupae come in contact with it. Chemicals are absorbed through the insects outer "skin" or cuticle, and may be incidentally ingested or enter the body through other routes. Contact agents can be further subdivided into two sub-groups: 1) toxins primarily affecting an insect's nervous system; and 2) toxins primarily affecting an insect's endocrine system. The District does not use any formulations of the organophosphate malathion and formulations of the botanical pyrethrum to control mosquito larval stages. However the District does use endocrine system agents used in this period include many s-methoprene formulations.

5.5.2.1 s-Methoprene.

INTRODUCTION. s-Methoprene does not produce non-discriminatory, rapid toxic effects that are associated with nervous system toxins. s-Methoprene is a true analogue and synthetic mimic of a naturally occurring insect hormone called Juvenile Hormone (JH). JH is found during aquatic life stages of the mosquito and in other insects, but is most prevalent during the early instars. As mosquito larva mature, the level of JH steadily declines until the 4th instar molt, when levels are very low. This is considered to be a sensitive period when all the physical features of the adult begin to develop. s-Methoprene in the aquatic habitat can be absorbed on contact and the insect's hormone system becomes unbalanced. When this happens during the sensitive period, the unbalance interferes with 4th instar larval development.

One effect is to prevent adults from emerging. Since pupae do not eat, they eventually deplete body stores of essential nutrients and then starve to death. For these and perhaps other reasons, s-Methoprene is considered an insect growth regulator (IGR).

There have been widely distributed reports regarding the effect methoprene may have on certain amphibians. Reports of frog abnormalities have been widely circulated, but these reports have not stood up to scientific scrutiny.

FORMULATIONS AND DOSAGES. Currently, five s-methoprene formulations are sold under the trade name of Altosid. These include Altosid Liquid Larvicide (A.L.L.) and Altosid Liquid Larvicide Concentrate, Altosid Briquets, Altosid XR Briquets, Altosid XR-G and Altosid Pellets. Altosid labels contain the signal word "CAUTION".

ALTOSID LIQUID LARVICIDE (A.L.L.) & A.L.L. CONCENTRATE. These two flowable formulations have identical components except for the difference in the concentration of active ingredients. A.L.L. contains 5% (wt./wt.) s-Methoprene while A.L.L. Concentrate contains 20% (wt./wt.) s-Methoprene. The balance consists of inert ingredients that encapsulate the s-Methoprene, causing its slow release and retarding its ultraviolet light degradation.

DOSAGES. Use rates are 3 to 4 ounces of A.L.L. 5% and ¾ to 1 ounce of A.L.L. Concentrate (both equivalent to 0.01008 to 0.01344 lb. AI) per acre, mixed in water as a carrier and dispensed by spraying with conventional ground and aerial equipment. Because the specific gravity of Altosid Liquid is about that of water, it tends to stay near the target surface. No rate adjustment is necessary for varying water depths when treating species that breathe air at the surface.

TARGET SPECIES. Liquid formulations are designed to control fresh and saline flood water mosquitoes with synchronous development patterns. Cold, cloudy weather and cool water slow the release and degradation of the active ingredient as well as the development of the mosquito larvae. Accordingly, formulation activity automatically tracks developing broods.

ALTOSID BRIQUETS. The Altosid Briquet was the first solid methoprene product marketed for mosquito control beginning in 1978. It is made of plaster (calcium sulfate), 3.85 % (wt./wt.) r-methoprene, 3.85% s-methoprene (.000458 lb. AI/briquet) and charcoal (to retard ultra violet light degradation). Altosid Briquets release methoprene for about 30 days under normal weather conditions.

DOSAGES. Application should be made at the beginning of the mosquito season, and under normal weather conditions, repeat treatments should be carried out at 30 day intervals. The recommended application rate is 1 Briquet per 100 sq. ft. in non-flowing or low-flowing water up to 2 feet deep.

TARGET SPECIES. Flood water *Aedes* and permanent water *Anopheles*, *Culex*, and *Culiseta* larvae are usual targets. Typical treatment sites include storm drains, catch basins, roadside ditches, ornamental ponds and fountains, cesspools and septic tanks, waste treatment and settlement ponds, flooded crypts, transformer vaults, abandoned swimming pools, construction and other man-made depressions.

ALTOSID XR BRIQUETS. It is made of hard dental plaster (calcium sulfate), 1.8% (wt./wt.) s-methoprene (.00145 lb. AI/briquet) and charcoal (to retard ultra violet light degradation). Despite containing only 3 times the AI as the “30-day briquet”, the comparatively harder plaster and larger size of the XR Briquet change the erosion rate allowing sustained s-methoprene release up to 150 days in normal weather.

DOSAGES. XR Briquets should be applied 1 to 2 per 200 sq. ft. in no-flow or low-flow water conditions, depending on the species.

TARGET SPECIES. Targets are the same as for the smaller briquets. Appropriate treatment sites for XR Briquets include storm drains, catch basins, roadside ditches, ornamental ponds and fountains, cesspools and septic tanks, waste treatment settlement ponds, flooded crypts, transformer vaults, abandoned swimming pools, construction and other man-made depressions, cattail swamps and marshes, water hyacinth beds, pastures, meadows, rice fields, freshwater swamps and marshes, woodland pools, flood plains and dredge spoil sites.

ALTOSID PELLETS. Altosid Pellets were approved for use in April 1990. They contain 4% (wt./wt.) s-methoprene (0.04 lb. AI/lb.), dental plaster (calcium sulfate), and charcoal. Like the Briquets discussed above, Pellets are designed to slowly release s-methoprene as they erode. Under normal weather conditions, control can be achieved for up to 30 days.

DOSAGES. Label application rates can range from 2.5 lbs. to 10.0 lbs. per acre (0.1 to 0.4 lb. AI/acre), depending on the target species and/or habitat.

TARGET SPECIES. The species are the same as listed for the briquet formulations. Listed target sites include pastures, meadows, rice fields, freshwater swamps and marshes, salt and tidal marshes, woodland pools, flood plains, tires and other artificial water holding containers, dredge spoil sites, waste treatment ponds, ditches, and other man-made depressions, ornamental pond and fountains, flooded crypts, transformer vaults, abandoned swimming pools, construction and other man-made depressions, tree holes, storm drains, catch basins, and waste water treatment settling ponds.

ALTOSID XR-G.   Altosid XR-G was approved for use in 1997. This product contains 1.5% (wt./wt.) s-methoprene. Granules are designed to slowly release s-methoprene as they erode. Under normal weather conditions, control can be achieved for up to 21 days.

DOSAGES. Label application rates range from 5 lbs. to 20.0 lbs. per acre, depending on the target species and/or habitat.

TARGET SPECIES AND APPLICATION SITES. The species are the same as listed for the briquet formulations. Listed target sites include snow pools, meadows, rice fields, freshwater swamps and marshes, salt and tidal marshes, woodland pools, tires and other artificial water holding containers, dredge spoil sites, waste treatment ponds, ditches, and other natural and man-made depressions.

5.5.3 Surface Active Agents.

INTRODUCTION. Larvicides in this category include Oils and ethoxylated Isostearyl Alcohols. Unfortunately, none of the currently supported larvicides previously discussed act as pupacides. Therefore, pupal control must be achieved through the use of these products.

Oils were first used as effective Anopheline larvicides for malaria control in California at the turn of the century. Commonly used larviciding oils kill larvae and pupae when inhaled into the tracheae along with air at the surface of the water. With low dosages below 3 gallons per acre adequate mosquito control is not achieved. Dosage rates ranging from 3 gallons to 5 gallons per acre provide adequate mosquito control.

The District generally uses surface oils in heavily polluted waters, where beneficial organisms are low or nonexistent, in areas with late (non-feeding) instar larvae or pupae, or in areas where other larvicides have failed.

MOSQUITO LARVICIDE GB-1111. This product is a petroleum based “napthenic oil.”
The “napthenic oil” designation characterizes petroleum oil refining processes. The GB stands for Golden Bear and the product is most often referred to as Golden Bear 1111 or simply GB-1111. The label for GB-1111 contains the signal word “CAUTION”.

DOSAGES. GB-1111 contains 99% (wt./wt.) oil and 1% (wt./wt.) inert ingredients including an emulsifier. The nominal dosage rate is 3 gallons per acre or less. Under special circumstances, such as when treating areas with high organic content, up to 5 gallons per acre may be used.

TARGET SPECIES. GB-1111 is effective on a wide range of mosquito species. Applied to breeding areas, GB-1111 is an effective material against any mosquito larvae and pupae obtaining atmospheric oxygen at the water surface. It can even be effective in treating adult mosquitoes as they emerge.

5.5.4 Stomach Toxins.

INTRODUCTION. Mosquito control makes use of two stomach toxins whose active ingredients are manufactured by bacteria. These control agents are often designated as Bacterial Larvicides. Their mode of action requires that they be ingested to be effective, which can make them more difficult to use than the contact toxins and surface active agents. Bacteria are single-celled parasitic or saprophytic micro-organisms that exhibit both plant and animal properties, and range from harmless and beneficial to intensely virulent and lethal. A beneficial form, Bacillus thuringiensis (Bt), is the most widely used (especially in agriculture) microbial pesticide in the world. It was originally isolated from natural Lepidopteran (butterflies and moths) die-offs in Germany and Japan. Various Bt products have been available since the 1950’s, and in 1976, Dr. Joel Margalit and Mr. Leonard Goldberg isolated from a stagnant riverbed pool in Israel, a subspecies of B. thuringiensis that had excellent mosquito larvicide activities. It was named B.t. variety israelensis (B.t.i.) and later designated Bacillus thuringiensis Serotype

H-14. Either of these two designations may be found on the labels of many bacterial mosquito larvicide formulations used today. Another species of bacteria, B. sphaericus, also exhibits mosquito larvicide properties.

5.5.4.1 BTI (Bacillus thuringiensis israelensis).

INTRODUCTION. Like a tiny chemical factory capable of only one production run, each B.t.i. organism may produce, if the environmental conditions around it are favorable, five different microscopic protein pro-toxins packaged inside one larger protein container or crystal. The crystal is commonly referred to as delta (d-) endotoxin. If the d-endotoxin is ingested, these five proteins are released in the alkaline environment of an insect larvae's gut. The five proteins are converted into five different toxins if specific enzymes also are present in the gut. Once converted, these toxins work alone or in combination to destroy the gut wall. This leads to paralysis and death of the larvae.

B.t.i. is grown commercially in large fermentation vats using sophisticated techniques to control environmental variables such as temperature, moisture, oxygen, pH and nutrients. The process is similar to the production of beer, except that B.t.i. bacteria are grown on high protein substrates such as fish meal or soy flour and the spore and delta endotoxin are the end products. At the end of the fermentation process, B.t.i. bacteria exhaust the nutrients in the fermentation machine, producing spores before they lyse and break apart. Coincidental with sporulation, the delta endotoxin is produced. The spores and delta endotoxins are then concentrated via centrifugation and microfiltration of the slurry. It can then be dried for processing and packaging as a solid formulation(s) or further processed as a liquid formulation(s). Since some fermentation medium (e.g. fish meal) is always present in liquid formulations, they generally smell somewhat like the medium.

FORMULATIONS AND DOSAGES. There are five basic B.t.i. formulations available for use: liquids, powders, granules, pellets, and briquets. Liquids, produced directly from a concentrated fermentation slurry, tend to have uniformly small (2-10 micron) particle sizes which are suitable for ingestion by mosquito larvae. Powders, in contrast to liquids, may not always have a uniformly small particle size. Clumping, resulting in larger sizes and heavier weights, can cause particles to settle out of the feeding zone of some target mosquito larvae, preventing their ingestion as a food item. Powders must be tank mixed before application to an inert carrier or to the larval habitat, and it may be necessary to mix them thoroughly to achieve a uniformly small consistency. B.t.i. granules, pellets, and briquets are formulated from B.t.i. primary powders and an inert carrier. B.t.i. labels contain the signal word "CAUTION". Since fourth instar mosquito larvae quit feeding prior to becoming pupae, it is necessary to apply B.t.i. prior to this point in their development. Although the details are poorly understood, evidence suggests that larvae also undergo a period of reduced feeding or inactivity prior to molting from 1^{ST} to 2^{ND}, 2^{ND} to 3^{RD}, and 3^{RD} to 4^{TH} instars. If we apply B.t.i at these points in their development, the toxic crystals may settle out before the larvae resume feeding, and with synchronous broods of mosquitoes, complete control failures may result. With asynchronous broods, efficacy may be reduced. Kills are usually observed within 24 hours of toxin ingestion. As a practical matter, apparent failures are usually followed with oil treatments.

The amount of toxins contained within B.t.i. products are reported indirectly as the result of at least two different bioassays and are difficult to equate to one another. Prepared volumes of toxins are applied to living mosquito larvae and the resulting mortality produces through formulae numerical measures known as International Toxic Units (ITU's) and *Aedes* aegypti International Toxic Units (AA-ITU's). These measures are only roughly related to observed efficacy in the field, and are therefore inappropriate to consolidate and report on like other toxicants.

BTI LIQUIDS. Currently, three commercial brands of B.t.i. liquids are available: Aquabac XT, Teknar HP-D, and Vectobac 12AS.

DOSAGES AND FORMULATIONS. Labels for all three products recommend using 4 to 16 liquid oz/acre in unpolluted, low organic water with low populations of early instar larvae (collectively referred to below as clean water situations). The Aquabac XT and Vectobac 12 AS (but not Teknar HP-D) labels also recommend increasing the range from 16 to 32 liquid oz/acre when late 3rd or early 4th instar larvae predominate, larval populations are high, water is heavily polluted, and/or algae are abundant. The recommendation to increase dosages in these instances (collectively referred to below as dirty water situations) also is seen in various combinations on the labels for all other B.t.i. formulations discussed below.

B.t.i. liquid may also be “Duplexed” with the Altosid Liquid Larvicide discussed above. Because B.t.i. is a stomach toxin and lethal dosages are somewhat proportional to a mosquito larvae’s body size, earlier instars need to eat fewer toxic crystals to be adversely affected. Combining B.t.i. with methoprene (which is most effective when larvae are the oldest and largest) allows a District to use less of each product than they normally would if they would use one or the other. Financially, most savings are realized for treatments of mosquitoes with long larval development periods, asynchronous broods or areas with multiple species of mosquitoes.

BTI POWDERS. Aquabac Primary Powder, Vectobac TP and Bactimos WP brands of B.t.i. powders are available. The Vectobac TP label recommends using a calculated 3.2 to 6.4 oz (by weight)/acre in clean water, and up to 12.8 oz/acre in dirty water situations. The Bactimos WP label correspondingly recommends using 2 to 6 oz/acre and up to 12 oz/acre. Aquabac Primary Powder currently is labeled for manufacturing use only. However, the label is currently being amended by the EPA to allow end user applications in quantities similar to those of the other powder formulations.

BTI SAND GRANULES. Until the latter part of 1996, commercial formulations of B.t.i. sand granules were not available. However, labeling was available for both Vectobac and Bactimos B.t.i. powders to guide end users in making their own “On Site Sand Granules”. Sand formulations require coating the particles with an oil, such as GB-1111, and then applying dry B.t.i. powder which will stick to the oil. In California, most target mosquito species graze the water surface or within the water column, and not the bottom. It is desirable to stick the powder to the sand in a way that B.t.i. is released upon contact with the water, and is thus available for the larvae.

BTI CORNCOB GRANULES. Granular formulations use a carrier that is dense enough to penetrate heavy vegetation. There are currently two popular corncob granule sizes used in commercial formulations. Aquabac 200G, Bactimos G, and Vectobac G are made with 5/8 grit crushed cob, while Aquabac 200 CG (Custom Granules) and Vectobac CG are made with 10/14 grit cob. Aquabac 200 CG is available by special request. The 5/8 grit is much larger and contains fewer granules per pound. The current labels of all B.t.i. granules recommend using 2.5 to 10 lb./acre in clean water and 10 to 20 lb./acre in dirty water situations.

TARGET SPECIES. B.t.i. adversely affects larval stages of insect species in the Order Diptera, Suborder Nematocera, Families Culicidae (Mosquitoes) and Simuliidae (Black Flies). B.t.i. has been shown to be effective for numerous mosquito species, including members of the mosquito genera *Aedes*, *Anopheles*, *Culex*, and *Culiseta*, commonly targeted in California.

Products containing B.t.i. are ideally suited for use in integrated pest management programs because the active ingredient does not interrupt activities of most beneficial insects and predators. Since B.t.i. has a highly specific mode of action, it is an insecticide of minimal environmental concern. B.t.i. controls all larval instars provided they have not quit feeding, and can be used in almost any aquatic habitat with no restrictions. It may be applied to irrigation water and any other water sites except treated finished drinking water. B.t.i. is fast acting and its efficacy can be evaluated almost immediately. It usually kills larvae within 1 hour after ingestion, and since each instar must eat in order for the larvae to grow, that means B.t.i. usually kills mosquito larvae within 24 hours of application. It leaves no residues, and it is quickly biodegraded. Resistance is unlikely to develop simultaneously to the five different toxins derived from the

B.t.i. delta-endotoxin since they have five different modes of action. This suggests that this mosquito larvicide will continue to be effective for many years.

B.t.i. labels carry the CAUTION signal word, suggesting the material may be harmful if inhaled or absorbed through the skin. However, the 4-hr Inhalation LC 50 in rats is calculated to be greater than 2.1 mg/liter (actual) of air, the maximum attainable concentration. The acute Dermal LD 50 in rabbits is greater than 2,000 mg/kg body weight and is considered to be non-irritating to the eye or skin. That is equivalent to a 220 lb. individual spilling more than a half gallon of B.t.i. liquid onto himself or into his eyes. Toxicology profiles also suggest that the inert ingredients (not the B.t.i.) in liquid formulations, may cause minor eye irritations in humans. The acute Oral LD 50 in rats is greater than 5,000 mg/kg body weight (similar to an individual drinking over 5 quarts) suggesting the material is practically non-toxic in single doses. Common table salt has an LD 50 of 4,000 mg/kg of body weight.

B.t.i. applied at label rates has virtually no adverse effects on applicators, livestock, or wildlife including beneficial insects, annelid worms, flatworms, crustaceans, mollusks, fish, amphibians, reptiles, birds or mammals. However, non-target activity on larvae of insect species normally associated with mosquito larvae in aquatic habitats has been observed. There have reported impacts in larvae in the Order Diptera, Suborder Nematocera, Families Chironomidae (midges), Ceratopogonidae (biting midges) and Dixidae (dixid midges). These non-target insect species, taxonomically closely related to mosquitoes and black flies, apparently contain the necessary gut pH and enzymes to activate delta-endotoxins. However, the concentration of B.t.i. required to cause these effects is 10 to 1,000 times higher than normal use rates. Further, studies report these impacts are short-lived, with the population of these species rebounding quickly.

Concerning the operational use of B.t.i., timing of application is extremely important. Optimal benefits are obtained when treating 2nd or 3rd instar larvae. Treatments at other development stages may provide less than desired results. Therefore a disadvantage of using B.t.i. is the limited treatment window available.

5.5.4.2 Bacillus sphaericus (Bs).

INTRODUCTION. *Bacillus sphaericus* is a commonly occurring spore-forming bacterium found throughout the world in soil and aquatic environments. Some strains produce a protein endotoxin at the time of sporulation. It is grown in fermentation vats and formulated for end use with processes similar to that of B.t.i. A standard bioassay similar to that used for B.t.i. has been developed to determine preparation potencies. The bioassay utilizes *Culex quinquefasciatus* 3rd-4th instar larvae. The endotoxin destroys the insect's gut in a way similar to B.t.i. and has been shown to have activity against larvae of many mosquito genera such as *Culex, Culiseta*, and *Anopheles*. The toxin is only active against the feeding larval stages and must be partially digested before it becomes activated. At present, the molecular action of *B. sphaericus* is unknown. Isolation and identification of the primary toxin responsible for larval activity has demonstrated that it is a protein with a molecular weight of 43 to 55 kD.

VECTOLEX CG. VectoLex-CG is the trade name for Abbott Laboratories' granular formulation of *B. sphaericus* (strain 2362). The product has a potency of 50 BSITU/mg (*Bacillus sphaericus* International Units/mg) and is formulated on a 10/14 mesh ground corn cob carrier. The VectoLex-CG label carries the "CAUTION" hazard classification.

DOSAGES. VectoLex-CG is intended for use in mosquito breading sites that are polluted or highly organic in nature, such as dairy waste lagoons, sewage lagoons, septic ditches, tires, and storm sewer catch basins. VectoLex-CG is designed to be applied by ground (by hand or truck-mounted blower) or aerially at rates of 5-10 lb./acre. Best results are obtained when applications are made to larvae in the 1st to 3rd instars. Use of the highest rate is recommended for dense larval populations. Larval mortality may be observed as soon as a few hours after ingestion but typically takes as long as 2-3 days, depending upon dosage and ambient temperature. VectoLex-G should be stored in a cool, dry place, in an intact product package. Once the VectoLex-G package is opened, moisture can be absorbed by the product leading to loss of activity over time. Refrigeration is not necessary.

TARGET SPECIES. *B. sphaericus* adversely affects larval stages of insect species in the Order Diptera, Suborder Nematocera, Family Culicidae (mosquitoes). *Culex* species are the most sensitive to *Bacillus sphaericus*, followed by *Anopheles* and some *Aedes* species. In California, *Culex* spp. and *Anopheles* spp. may be effectively controlled. Several species of *Aedes* have shown little or no susceptibility, and salt marsh *Aedes* species are not susceptible. *Bacillus sphaericus,* in contrast to B.t.i., is virtually non-toxic to Black Flies (Simulidae).

B. sphaericus has demonstrated the unique property of being able to control mosquito larvae in highly organic aquatic environments, including sewage waste lagoons, animal waste ponds, and septic ditches. After a single application at labeled rates, field evaluations have shown VectoLex-CG to persist for 2-4 weeks. Field evaluations with VectoLex-CG have shown that *Bacillus sphaericus* may undergo limited recycling in certain organically rich environments.

VectoLex-CG has been extensively tested and has had no adverse effects on mammals or non-target organisms. *B. sphaericus* technical material was not infective or pathogenic when administered as a single oral, intravenous or intratracheal installation in rats. No mortalities or treatment-related evidence of toxicological effects were observed. The acute oral and dermal LD 50 values are greater than 5000 mg/kg and greater than 2000 mg/kg, respectively. The technical material is moderately irritating to the skin and eye. Oral exposure of *B. sphaericus* is practically nontoxic to mallard ducks. No mortalities or signs of toxicity occurred following a 9000 mg/kg oral treatment. Birds fed diets containing 20% w/w of the technical material experienced no apparent pathogenic or toxic effects during a 30-day treatment period. Mallards given an intraperitoneal injection of *B. sphaericus* demonstrated toxicological effects including hypoactivity, tremors, ataxia and emaciation. The LD 50 value was greater than 1.5 mg/kg.

Acute aquatic fresh water fish toxicity tests were done on bluegill sunfish, rainbow trout and daphnids. The 96 hour LC 50 and NOEC value for bluegill sunfish and rainbow trout was greater than 15.5 mg/liter; the 48 hour EC 50 and NOEC value for daphnids was greater than 15.5 mg/liter. Acute aquatic saltwater fish toxicity tests were done on sheep head minnows, shrimp and oysters. The 96 hour LC 50 value for both sheep head minnows and shrimp was 71 mg/liter, while the NOEC (no observable effect concentration) value was 22 mg/liter for sheep head minnows and 50 mg/liter for shrimp. The 96-hour EC 50 value for oysters was 42 mg/liter with a NOEC of 15 mg/liter.

Invertebrate toxicity tests were done on mayfly larvae and honeybees. The LC 50 and NOEC value for mayfly larvae was 15.5 mg/liter. Honeybees exposed to l0E4-10E8 spores/ml for up to 28 days demonstrated no significant decrease in survival when compared to controls. Acute toxicity of *B. sphaericus* to non-target plants was evaluated in green algae. The 120-hour EC 50 and NOEC values were greater than 212 mg/liter.

Bacillus sphaericus will not regenerate in salt water, rendering its use impractical for control of salt water mosquitoes. Cycling is limited to permanent fresh water bodies, and if organics are very high, recycling may be minimal.

5.5.5 Chitin Inhibitors.

INTRODUCTION. Chitin inhibitors are insect growth regulators that inhibit chitin synthesis and cuticle deposition during metamorphosis of insects. They have been known to affect non-target organisms such as crab, shrimp and other aquatic invertebrates.

Chitin inhibitors are used to control mosquito breeding in catch basins, street gutter’s, roadside ditches, agricultural and waste water ponds and impoundment’s, irrigated pasture, tailwater drains. These sites generally do not support significant numbers of non-target organism that are adversely affected by chitin inhibitors.

DIMILIN 25W is a wettable powder. Dimilin 25W contains Difflubenzuron as the active ingredient and contains kaolin Clay as an inert. It is a restricted use pesticide and contains the signal word “Caution”. Labeling restrictions reduce the impact that Dimilin 25W may have on non-target organisms.

DOSAGES. Dimilin-25 W is generally applied at 3.25 oz. per acre. The amount of active ingredient applied per acre is 0.05 lbs. This product is usually diluted with 10 gallons of water for each acre. Ground equipment is used to disperse this product.

Target Species. Dimilin 25W is a chitin inhibitor that is used primarily for control of Culex pipiens and Culex tarsalis mosquitoes found in catch basins, storm basins, roadside ditches, waste water ponds, tailwater drains. Aedes genera are generally found mainly in the irrigated pasture or tailwater drains.

5.5.6 Larviciding Techniques and Equipment.

A variety of larviciding equipment is used for both aerial and ground applications, necessitated by the wide range of breeding habitats, target species, and budgetary constraints. There are advantages and disadvantages to each application system and to the aerial and ground treatments themselves.

The District regularly uses the following ground application equipment and techniques:

5.5.6.1 Ground Application Equipment.

The District uses 4-wheel drive pick-ups equipped with sprayer units primarily for larviciding. In most cases, the spray equipment is bolted to the bed of the tuck. Chemical container tank, high pressure pump (for spray volume), low volume electric, (for low volume spray of pesticides), 18 Hp gasoline driven Kolher engine (Blower) and spray wand mounted to the driver side of the vehicle, control panel to operate the equipment is located in the cab of the truck. The driver can operate the power spray equipment from inside the cab of the truck.

Specialized equipment, such as All Terrain Vehicle’s (ATV’s) and curb rigs, have a chemical container mounted on the vehicle, a 12 volt electric pump supplying high pressure low volume flow, and a hose and spray tip allowing for application while steering the vehicle. ATV’s are ideal for treating areas such as agricultural fields, pastures, and other off-road sites. Additional training in ATV safety and handling is provided to employees before operating these machines. The curb rigs are right hand drive vehicles designed to apply larvicides to catch basins.

Additional equipment used in ground applications includes hand held sprayers, broadcast spreaders and backpack blowers. Hand held sprayers (hand cans) are standard one or four gallon style pump-up sprayers used to treat small isolated areas. The broadcast spreaders are used to apply granules and pellets. Backpack sprayers are gas powered blowers with a chemical tank and calibrated proportioning slot. Generally a pellet or small granular material is applied with a backpack sprayer or “belly grinder” machine designed to distribute pellets or granules.

5.5.62 Aerial larviciding equipment.

Aerial larviciding is accomplished via fixed wing or rotary aircraft. Both types of aircraft are used depending upon the contractor that the District will use to apply solids and liquids. A variety of nozzles and metering systems are used by the contracting air service. The District generally uses aircraft to control flood water mosquitoes associated with spring snow melt and winter flood-up for waterfowl season. The district only uses aircraft when ground vehicles can not access the area to be sprayed and total acreage exceeds 200 acres. The District contracts with agricultural flying services to perform the actual application.

Dependent upon target conditions, liquid or granular applications are used. Granular applications can either be sand, a pellet or a corncob granule supplied by a manufacturer. In some instances, agencies can formulate their own granular materials (e.g., sand mixes). Most granular formulations are applied at 2.5 to 15 pounds per acre. While granules have less drift and can penetrate vegetative cover, they are generally bulky (e.g., corn cob), heavy (e.g., sand) and usually expensive, especially when purchasing pre-mixed material.

With liquid applications, there is still some debate over the ideal droplet size and carrier. Using small droplets or ULV will allow greater payloads and thus be more economical, but the amount of material actually reaching the target area is poorly understood. Wind, temperature, evaporation and droplet movements have a major impact on success or failure of a ULV application. Using large droplets eliminates some of the drift problems of ULV applications but greatly reduces the payload. In addition, it is still not known whether large or small droplets actually have the better penetrating characteristics. Since this is still be researched, there may be differences among districts and the technique used.

In treating the various species of mosquitoes in California, getting complete coverage of the breeding area is critical. Missing just a tiny fraction of the target area can still result in the emergence of huge numbers of biting adults. While many pilots claim they can fly accurate swaths based on their skill alone, experience has shown that this rarely happens. For that reason, some type of guidance system is necessary when performing aerial larviciding over large areas.

5.6.6 Discussion.

ADVANTAGES OF GROUND APPLICATION.   There are several advantages to using ground application equipment, both when on foot and when conveyed by vehicles. Ground larviciding allows applications while in close proximity to the actual treatment area, and consequently treatments to only those micro habitats where larvae are actually present. This also reduces both the unnecessary pesticide load on the environment and the financial cost of it. Both the initial and the maintenance costs of ground equipment is generally less than those for aerial equipment. Ground larviciding applications are less affected by weather conditions than are aerial applications.

DISADVANTAGES OF GROUND APPLICATION. Ground larviciding is impractical for large or densely wooded areas. There is also a greater risk of chemical exposure to applicators than there is during aerial larviciding operations. Damage may occur from the use of a ground vehicle in some areas. Ruts and vegetation damage may occur, although both these conditions are reversible and generally short-lived. Technicians are trained to recognize sensitive areas and to use good judgement to avoid significant impacts.

ADVANTAGES OF AERIAL APPLICATION. There are several advantages to using both fixed and rotary wing aerial larvicide application equipment. It is more economical for large application areas provided the entire site has breeding. It is easier to calibrate equipment and operators because the target area is generally mapped and the material is weighed or measured when loading. It is more practical for remote or inaccessible areas such as islands and marshes than is ground larviciding. Aircraft applications are less intrusive to vegetation and wildlife than ground applications.

DISADVANTAGES OF AERIAL APPLICATION. More pesticides are used because the applications are not as precise as ground applications. Application windows can be narrow due to weather conditions. Aerial applications require special FAA licenses, training of staff, and additional liability insurance.

CHOOSING WHEN TO LARVICIDE. The District's general view is that larviciding is typically not as effective or as economical as permanent source reduction or water management, and is usually more effective than adulticiding. When looking at breeding sites and their mosquito production on a case by case basis, this logic appears infallible. However, this view was derived long ago when wetlands were not considered to be as important as they are today, many of the compounds used were different, and costs were in terms of money, manpower, and equipment. It was easy to assume that it was "cheaper in the long run" to move dirt and change the hydrology of an area than it was to apply pesticides. Many districts are being forced to use chemical methods to control mosquitoes in areas where water management is not used or is prohibited.

An alternative view focuses on environmental costs, with the tenet that undisturbed wetlands should remain pristine, and that any disturbance will have long term effects on non-target species of plants and animals. The District avoids source reduction in these areas. The District carefully balances how to simultaneously manage the already altered wetlands for mosquitoes and at the same time maximize their value to the ecosystem.

MANAGING LARVICIDE RESISTANCE. Selecting the proper class of larvicide and the formulation are both important in pesticide resistance management.

One way to encourage resistance is to use sub-lethal dosages. Many feel that the USEPA erred when it began allowing the market (cost) to dictate what the low dosage would be, despite the recommendations on the product label. Insects with inherent tolerances for weakly applied pesticides may survive to produce tolerant offspring. Soon, an entire population of tolerant mosquitoes may arise, and then continued use of the very low dose that caused the problem will affect only non-targets. Another way to accomplish the same thing is to depend on slow-release formulations beyond their recommended use period. Release rate studies have shown that the active ingredient are not available "linearly", and that beyond the recommended time limits, they may be sublethal. Districts acknowledge these issues, and take measures to rotate pesticides used on larval sites to avoid this situation.

Currently used mosquito larvicides, when applied properly, are efficacious and environmentally safe. These agents have been successfully integrated into District programs. Compared to the adulticides, there is less concern for the drift of mosquito larvicides, primarily due to application techniques. Mosquito larvicides are usually applied directly into natural and man-made aquatic habitats as liquid or solid formulations, and aerial drift is negligible. Drift in water can result from flushing or rainwater runoff. Under these conditions, dilution greatly reduces the pesticide concentration and consequently reduces exposure to non-targets.

Application of larvicides to organic croplands is an issue that the District has worked with and continues to the present. Larvicide applications are often a result of natural conditions such as flood water or rainwater breeding mosquitoes on organic croplands. The District takes measures to avoid impacts to organic growers. Organic farmland is located and plotted by the district. The District contacts organic growers before applying any larvicides to their crop. Under the California Health and Safety Code section 110825 the District is allowed to apply adulticides to organically grown crops as long as the residue level does not exceed 5% of the Environmental Protection Agencies established residue allowed for that crop. However, the United States Department of Agriculture is currently developing a national organic rule that will address adutlicide applications to organic crops, once the new rule is adopted, it will determine if any, the adulticides that can be applied to organically grown crops to control mosquitoes.

5.7 Herbicides.

INTRODUCTION

Herbicides are used to control weed growth that promotes mosquito breeding by providing habitat that is beneficial for development of immature mosquito stages or provides protection from larvicides used to control immature mosquito stages. The selective use of herbicides in mosquito control reduces the frequency of chemical applications to control mosquito breeding. It also reduces the amount of chemical used to control mosquito breeding. Generally herbicides are used to control weed growth found along the roadway, inside edge and in wastewater ponds. On occasion agricultural drain ditches require emergency herbicide efforts to control an existing public nuisance caused by mosquito breeding. Herbicides are used to maintain pathways in natural drains on a limited basis.

Throughout the discussion of herbicide materials, signal words on the label are mentioned. Following is an explanation of these signal words:

- **CAUTION.** This word signals that the product is slightly toxic. An ounce to more than a pint taken by mouth could kill the average adult. Any product which is slightly toxic orally, dermally, or through inhalation or causes slight eye and skin irritation will be labeled "CAUTION".

- **WARNING.** This word signals that the product is moderately toxic. As little as a teaspoonful to a tablespoonful by mouth could kill the average sized adult. Any product which is moderately toxic orally, dermally,

- **DANGER**. This word signals that the pesticide is highly toxic. A taste to a teaspoonful taken by mouth could kill an average sized adult. Any product which is highly toxic orally, dermally, or through inhalation or causes severe eye and skin burning will be labeled "DANGER".

Commercially available herbicides that are used to control weed growth by the District are discussed below. Arbitrarily, they are loosely categorized by their modes of entry/action on target/non-target organisms: Soil Active and Foliar Pesticides. Registered trade names and active ingredients of products are used in the discussions.

In its mosquito control work, the District regularly uses the following herbicides:

5.7.1 Soil Active Pesticides: As the name implies, this group of herbicides are used to control unwanted plants before they emerge. These pesticides bind to the soil particles and move down within the top 2 – 6 inches of soil to control plants as the seedlings germinate.

Soil Active Pesticides are used only on the inside edge of roadways and inside edge of wastewater ponds. These ponds have high organic loads that cause the soil active pesticides to bond to the organic matter. These ponds have clay layers that prevent the offsite migration of soil active pesticides. Pest Management Zones, PMZ's, have been identified in areas where ground water has become contaminated with soil active pesticides. There are no identified PMZ where the District applies soil active pesticides. The use of soil active pesticides decreases the amount and frequency of foliar herbicide applications. Soil Active pesticides allow for weed control during times of the year when access is limited and weather conditions are not favorable to foliar herbicide treatments.

5.7.2 Diuron.

INTRODUCTION. Diuron is used by mosquito control agencies to control germinating seedlings. It is used exclusively for control of weed growth found on the roadway and inside edges of wastewater ponds. Diuron is applied to soil normally during the months of December through February. It is mixed with water and applied as a spray to the soil. It adheres to soil particles and remains active for several months in the soil.

TARGET SPECIES. Diuron controls the following plants: annual grasses, red sprangletop, fiddleneck, shepherdspurse, wild mustard, annual smartweed, seedling Joshsongrass.

FORMULATIONS AND DOSAGES. The District uses dry flowable formulations of Diuron. Dry flowable formulations encapsulate the Diuron. Generally the dry flowable formulations are easier to mix, reduce worker exposure and stay in suspension in tank mixes. Dosage rates depend upon the soil type and type of plant that needs to be controlled. Dosages vary from 4 lbs. of Diruon per acre to 32 lbs. per acre.

DIREX 4L and DIURON 4L. are dry flowable herbicides that contains 4 lbs. of Diuron pre gallon of formulation.

DOSAGES. Direx 4L and Diuron 4L are applied from a range of 4 lbs. per acre to 12 lbs. per acre. Spray mixture varies depending upon spray equipment.

TARGET SPECIES. Direx 4L and Diuron 4L are designed to control the following plants: annual grasses, red sprangletop, fiddleneck, shepherdspurse, wild mustard, annual smartweed, seedling Johnson grass.

5.7.3 Foliar Herbicides. Foliar herbicides are used to control plants once they have emerged and are generally in the third leaf stage or larger. These compounds are effective at controlling plants that have emerged and are at varying stages of development. Some of the foliar herbicides move through the leaves and translocate down into the root killing the entire plant. Other foliar herbicides kill the part of the plant that the herbicide has contacted. These foliar herbicides basically defoliate the plant and the plant starves.

Foliar herbicides are used to control plants in a wide variety of habitats. The District uses foliar herbicides in sites such as: agricultural drains, wastewater ponds and natural drains and wetlands,(trail maintenance only). Foliar herbicides are used to control plants in highly environmentally sensitive areas, in locations where soil active pesticides are not allowed and on plants that can not be controlled by using soil active pesticides.

TARGET SPECIES. Foliar herbicides control the following plant species: fiddleneck, lambsquarters, pigweed, shepherdspurse, sunflower, Russian thistle, bermudagrass, cattail, dallisgrass, swamp smartweed, johnsongrass, curly dock, tules, cheeseweed, barnyardgrass and burning nettle.

5.7.3.1 Glyphosate.

INTRODUCTION. Glyphosate moves through the plant from the point of foliage contact and into the root system. Visible effects on most annual weeds occur with 2 to 4 days but on most perennial brush species may not occur for 7 days or more. When glyphosate comes in contact with soil (on the soil surface or as suspended soil or sediment in water) it is bound to soil particles. Under recommended use situations, once this product is bound to soil particles, it is not available for plant uptake and will not harm off-site vegetation where roots grow into the treatment area or if the soil is transported off-site. The strong affinity of this product to soil particles prevents this product from leaching out of the soil profile and entering ground water. The affinity between this product and the soil particles remains until this product is degraded which is primarily a biological degradation process carried out under both and anaerobic conditions by soil microflora.

TARGET SPECIES. The following plants are controlled by the use of Glyphosate: less than six inches in height: fiddleneck, lambsquarters, pigweed, shepherdspurse, sunflower, russian thistle, bermudagrass, cattail, dallisgrass, swamp smartweed, curly dock, tules, cheeseweed, barnyardgrass and burning nettle; all stages but must be at right time of maturity: cattail, tules and Johnson grass.

FORMULATIONS AND DOSAGES. Currently, there are two primary formulations of glyphosate. One formulation can be used on water and controls plants below the high water mark in ponds. The formulation that is labeled for used on water trademarks name is Rodeo. The other formulations are labeled for use on plants where the spray will not contact water. The formulation that can be used for plants away from water has several trademark names they are Roundup Pro, Glyfos, Roundup and

Roundup Ultra. All applications are made to the point of run-off from the plant leaf surface. The dosages vary depending upon the type of plant, it's susceptibility to the herbicide, stage of development, weather conditions and environment. The dosage rate per acre will vary from .75% of spray solution to 8% in water. When allowed glyphosate and Oxyfluorfen on occasions are tank mixed to control a broader range of plant species. In this way only one application is necessary, rather than two separate applications. The District currently uses Rodeo at 3.4 lbs. Glyphosate per acre. Glyfos and Roundup Pro are currently applied at 3.4 lbs. Glyphosate per acre. Rodeo, Glyfos and Roundup Pro all contain the signal word "Caution".

5.7.3.2 Oxyfluorfen.

INTRODUCTION. Oxyfluorfen is a soil active herbicide as well as a foliar herbicide. In order for Oxyfluorfen to act as a soil active herbicide it needs to be applied at 2.0 lb. active ingredient per broadcast acre. To be used as a foliar herbicide it is applied at 0.5 lb. to 2.0 lb. per acre. It is labeled for use on non-crop areas only. It is highly toxic to aquatic invertebrates, aquatic plants, wildlife and fish. Labeling for Oxyfluorfen prohibits its application to aquatic environments. Oxyfluorfen has two modes of action depending upon the amount of active ingredient applied. When used as a soil active herbicide it controls seedlings that are germinating. When used as a foliar herbicide it acts as a desiccant by drying out the leaves.

TARGET SPECIES. The following plant species are controlled as a foliar active herbicide: Cheeseweed, fiddleneck, filaree, burning nettle, pigweed, sow thistle, Russian thistle, annual grasses. When applying as a soil active herbicide the following plant species are controlled: burclover, cheeseweed, fiddleneck, lambsquarter, pigweed, annual sowthistle.

FORMULATIONS AND DOSAGES. There are several different formulations of Oxyfluorfen. The District uses primarily two formulations with the following trademark names Goal T/O and Goal 2XL. Both contain the active ingredient Oxyfluorfen but each has different amounts of the active ingredient. They are applied at the same amount of active ingredient per acre. When using as a soil active herbicide this product is applied at 2.0 lbs. active per acre. When used as a foliar application the amount of active per acre varies from 0.5 lb. active to 2.0 lb. active per acre. The dosage for foliar applications is dependent upon the stage of the plant and the plants susceptibility to the pesticide. Generally with plants that are 4 inches in height or less 0.5 lb. active per acre provide satisfactory control. When plants are 12 inches or higher then the higher rate is recommended, 2.0 lb. active per acre. When used with other glyphosate formulations, Oxyfluorfen provides control to plants that can not be controlled with glyphosate alone. The dosage rates are the same as noted for Oxyfluorfen when used alone.

OXYFLUORFEN. Currently there are two formulations that are used by the District. They are Goal T/O and Goal 2XL.

DOSAGES AND FORMULATIONS. Label for both formulations recommends that soil active rates be 2.0 lbs. per broadcast acre and that foliar rates range from 0.5 lb. to 2.0 lb. active per acre. When used alone or in a tank mix with glyphosate the District currently applies Oxyfluorfen at 0.5 lbs. active per acre. Oxyfluorfen is used to control weed growth that can not be controlled using glyphosate alone, along the inside edge and roadways of agricultural and industrial wastewater ponds. The labeling for both Goal formulations contain the signal word "Warning".

5.7.3.3 DIQUAT DIBROMIDE.

INTRODUCTION. Diquat Dibromide is a foliar active herbicide that is used to control plants in aquatic and noncrop sites. It is a nonvolatile herbicidal chemical for use as a general herbicide to control weeds in noncrop and aquatic areas. Absorption and herbicidal action is usually quite rapid with effects visible in a few days. It controls plant growth by interfering with photosynthesis within green plant tissue. Labeling precautions direct the user of diquat dibromide that it is toxic to wildlife and cautions against applying directly to water with the exception that it is permissible provide the user follows the labeling. When controlling aquatic plants if applied to entire surface of pond decomposition of dead plants may cause the loss of oxygen in the water that may cause fish to suffocate. Specific instructions are given to the user to prevent depletion of oxygen in the water. Approval of California Department of Fish and Game is required before applying to public waters. This product can be used in swimming pools, drinking water, irrigation structures. There are time intervals that restrict use and/or contact with treated after treatment to allow time for diquat dibromide to breakdown.

TARGET SPECIES. Diquat Dibromide is a wide spectrum foliar herbicide that is designed to control a wide variety of plant species. It is used to generally control all undesirable plants. The following is a list of some of the plants it will control: annual bluegrass, bermudagrass, tules, cattails, water grass,

FORMULATIONS AND DOSAGES. Diquat Dibromide is applied at a dose of .25 lbs. active ingredient to .50 lbs. per acre. It can also be applied to ponds for control of aquatic plants at .01 ppm using cation for calculating the ppm.

Reward is the trademark name of the product that the District currently uses to control tules, cattails and water grass in industrial ponds such as storm basins and percolation beds. This product is used on a limited basis and is not applied where sensitive invertebrates or wildlife exists. The District applies diquat dibromide at .27 lbs per acre. The label for Reward contains the signal word “Warning”.

5.7.4 Herbiciding Techniques and Equipment.

The District uses ground equipment to conduct all herbiciding activities. Both pick-ups and All Terrain Vehicles, ATV’s are used to herbicide.

5.7.4.1 Ground Application Equipment.

The District use a 4-wheel drive pick-up primarily to herbicide. This vehicle has been modified for herbiciding. A chemical container tank, with a gasoline driven bean pump with spray boom and nozzles mounted on the front of the pick-up are used primarily to spray roadways and inside edges of ponds. The driver operates the spray boom from inside the cab. A spray hose with a spray gun runs off a bypass hose that is 300 feet in length. This hose has been designed to spray areas not accessible by the boom. On occasion the District uses an All Terrain Vehicle (ATV) to spray weed growth where the district’s 4-wheel drive pick-up can not reach. The ATV has a chemical tank mounted to a spray boom. It has a 12 volt electric pump supplying high pressure low volume flow, and a hose and spray tip allowing for application while steering the vehicle. Additional training in ATV safety and handling is provided to employees before operating these machines. Additional equipment used in ground applications is hand held sprayers (hand cans). These hand cans can hold up to 4 gallons of spray mix.

ADVANTAGES OF GROUND APPLICATION. There are several advantages of using ground application equipment, both when on foot and when conveyed by vehicles. Ground herbiciding allows applications while in close proximity to the actual treatment area, and consequently treatments to only those sites where weed growth is actually present. Also Drift is of major concern when using any herbicide. The District minimizes drift by adding drift control agents when wind speeds exceed 6 mph. Before any application is made wind speed is checked by the applicator. When wind speeds exceed 10 mph or drift is observed spray operations are discontinued until more suitable weather conditions exists This also reduces both the unnecessary pesticide load on the environment and the financial cost of it.

CHOOSING WHEN TO HERBICIDE. The District’s general view is that herbiciding industrial and waste water ponds, where high organic loads allow for large mosquito breeding populations. These sites do not have significant natural predators to control mosquito larvae as the high organic loads have a negative impact on predator populations. Given the sharp angle of the banks of the ponds physical removal of the plant growth is not economically feasible. Without an aggressive herbicide program plant growth would develop along the pond creating harborage and mosquito breeding habitat. This would ultimately result in larger amounts of pesticides being applied to ponds, as with more plant growth it would take more pesticides to penetrate the weed growth covering the water.

5.8 Analysis of CEQA Exemptions.

CEQA categorical exemption classes 7 and 8 (CEQA Guidelines sections 15307 & 15309) exempt actions taken by regulatory agencies as authorized by state law to assure the maintenance, restoration, enhancement or protection of a natural resource or the environment where the regulatory process involves procedures for the protection of the environment. As discussed in section 3 regarding biological control, the District qualifies as a “regulatory agency” under these exemptions. The remaining issues as applied to chemical control therefore are these:

- Whether the District’s chemical control activities as described above assure the maintenance, restoration, enhancement or protection of a natural resource or the environment.

- Whether the District’s regulatory processes involve procedures for the protection of the environment.

5.8.1 The District’s chemical control activities as described above assure the maintenance and protection of natural resources and the environment.

The use of pesticides is an effective means to control mosquito populations in the District. The use of larvicides maintains and limits the proliferation of mosquito larvae in water sources, while adulticiding maintains the air environment free of harmful levels of mosquitoes. This control method maintains and protects the environment in a condition more safe, healthful and comfortable for humans.

The District contains many sources that act as mosquito breeding areas near populated areas. Without ongoing and effective vector control, substantial mosquito activity would significantly and adversely effect the human environment. The District’s mosquito control program, including chemical control, is essential to maintain the vectors in the environment at a tolerable level. The District’s program will never alleviate all mosquitoes. Rather, it is a resource maintenance program aimed at striking a balance to allow comfortable and healthful human existence within the natural environment, while protecting and maintaining the environment. History has shown us that the control and abatement of vectors are necessary for our human environment to continue to be habitable.

5.8.2The District’s regulatory process involves procedures for the protection of the environment.

In addition to the environmental protection measures and procedures inherent in the District’s IPM program as discussed in section 3, there are other practices unique to the District’s chemical control program that protect the environment:

There are numerous federal and state laws and regulations that strictly control and regulate the storage, transport, handling, use and disposal of the pesticides in order to protect against surface and groundwater contamination and other impacts to the environment and public health. (E.g., Federal Insecticide, Fungicide and Rodenticide Act; Cal. Food & Agric. Code divisions 6 & 7; Cal. Code of Regs., title 3, division 6.) The District and its staff consistently comply with these laws and regulations.

The District uses only pesticides registered by the U.S. Environmental Protection Agency and California Department of Pesticide Regulation. The District then strictly complies with the pesticide label restrictions and requirements concerning the storage, transport, handling, use and disposal of the pesticides.

Consistent with the District’s integrated pest management principles, when using pesticides, the District selects the least hazardous material that will meet its goals and the District rarely uses restricted materials-type pesticides.

Pesticides are applied only by duly certified and trained vector control technicians or applied by seasonal personnel under the direct supervision of a certified employee. The training includes education on appropriate practices to avoid environmental impacts and assure compliance with regulatory requirements.

The District regularly calibrates its pesticide application equipment to ensure that it emits the proper quantities of material.

7. EXCEPTIONS TO CATEGORICAL EXEMPTIONS.

A project or activity that is otherwise categorically exempt from CEQA may not be exempt if one of three exceptions applies (CEQA Guidelines § 15300.2):

1. There is a reasonable possibility that the activity may have a significant effect on the environment due to unusual circumstances;

2. The cumulative impact of successive projects of the same type in the same place, over time is significant; or

3. For categorical exemption classes 3, 4, 5, 6 and 11 (i.e., applies only to physical control), the project may impact an environmental resource of hazardous or critical concern where designated, precisely mapped, and officially adopted by a federal, state or local agency.

The District has considered these exceptions as applied to its usual and ordinary mosquito surveillance and control practices, and, based on the District's information and evaluation, none of the exceptions applies to the usual mosquito control program. However, in the future the District could be involved in a particular mosquito control activity that triggers or implicates one of these exceptions. The Board of Trustees of the Turlock Mosquito Abatement District delegates to the Manager the responsibility to evaluate the particular activity on a case-by-case basis to determine whether the exception applies. Because it is impossible to determine what those future activities might me that would trigger an exception to the exemption, the District can only commit to evaluating the future activity. The methodology used to conduct the evaluation will be based upon the nature of the activity.

8. CONCLUSION.

Except for major land alteration/source reduction projects and activities that may fall within one of the exceptions to the CEQA categorical exemptions, the District's usual and ongoing integrated mosquito management program and activities as described in this assessment are categorically exempt from CEQA.

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