8 Impact Assessment of Integrated Pest Management Alternatives to the Long-Term Plan

8.1 Introduction

The previous section (Section 7) discussed the impacts of the draft Long-Term Plan. The overall analysis methodology was discussed there.

The Long-Term Plan constituted the preferred methodology of conducting IPM. However, IPM alternatives were evaluated, including the "no-action" alternative of continuing the current vector control program. This section discusses impacts associated with IPM alternatives.

The IPM alternatives considered here can be grouped into three categories. They are:

- The existing program

Some of the analysis of impacts associated with the existing program were presented in Section 7, and will only be summarized here.

- Pesticide application alternatives

Alternatives consist of different pesticides than those considered for the Long-Term Plan, and different application strategies. Different pesticides analyzed as part of the risk assessment conducted by Integral were:

  - Three larvicides
    - Ethoxylated fatty alcohols
    - Temphos
    - Golden Bear Oil
  - Four adulticides
    - Naled
    - Deltamethrin
    - Fenthion
    - Chloripyrifos

The risk assessment also analyzed three other compounds (DEET, octanol, and propane). DEET was discussed in Section 7. Octanol and propane will be discussed as part of the application strategy alternatives.

Application strategy alternatives included the following:

  - use Mosquito Magnets in place of adulticides at Davis Park
  - eliminate the use of all larvicides in fresh water environments, and no use of methoprene in salt water settings
  - adulticide only in cases of declared human health emergencies (eliminates all adulticide applications considered under the evaluation management plan except for the aerial applications)
  - adulticide only after human illness
  - eliminate all adulticiding

- Water management alternatives

Three water management options were also considered. One, however, is to have no water management program. That alternative was considered under Section 9, Impacts of No Vector Control. The second was to conduct water management as has been the case under the current program for most of the last few years, using selective ditch maintenance. That option therefore will not be considered as a separate IPM alternative. The third water management option was to maintain all ditches in the County's marshes. That alternative will be considered as a separate IPM alternative in this section.

As discussed in Section 7, IPM programs address mosquito problems through a hierarchical application of the following elements:

- Public education and outreach
- Scientific surveillance
- Source reduction/control (water management is a special subset of source control)
- Biocontrols (a special subset of larval and adult control)

- Larval control
- Adult control (but only if necessary)

The assessment of potential impacts associated with considered IPM alternatives will be reviewed in terms of this hierarchical approach, as had been the case in Section 7. Each alternative was considered in light of each part of the hierarchy discussed below, even if not explicitly recognized in each section below.

8.2 Impacts of IPM Alternatives: Part 1, Public Outreach and Education

This section discusses the impacts of public education and outreach. It begins by summarizing the findings of Section 7.3 regarding the potential impacts associated with current program and then describes the potential for any impacts associated with changes in pesticides applications or the water management approach as otherwise described in the Long-Term Plan.

8.2.1 Current IPM Program

Public education and outreach associated with current operations appears to reduce impacts associated with mosquito-borne disease, albeit in ways that cannot be quantified. It may reduce impacts from pesticides applications if various guidances are heeded, and does not address water management. Use of DEET was identified as potentially having some impacts, although most authorities find it to be safe when used according to label instructions.

8.2.2 Alternative IPM Considerations

Selecting one or more of the alternative larvicides or adulticides does not appear to have any potential education and outreach impacts or benefits.

The pesticide application alternatives are (with potential public outreach and education impacts associated with each):

- use Mosquito Magnets in place of adulticides at Davis Park

This proposal could allow for education opportunities on alternative means of mosquito control.

- eliminating the use of all larvicides in fresh water environments and also not using methoprene in salt water settings

This proposal does not appear to have a direct link to public education and outreach.

- adulticiding only in cases of declared human health emergencies

This proposal might eliminate some notification requirements that exist currently (as almost all Health Emergency applications are done by air), and might make the no-spray registry unnecessary (depending on SCDHS decisions when health emergencies are declared, as the Commissioner can determine the list is a deterrence to maintaining public health).

- adulticiding only after human illness

Similarly, this proposal might eliminate some notification requirements that exist currently, and might make the no-spray registry unnecessary (depending on SCDHS decisions when health emergencies are declared, as the Commissioner can determine that its provisions do not need to be met, if adhering to them might interfere with the necessary maintenance of public health).

- elimination of all adulticiding

This proposal would eliminate the need for adulticide notifications, and for the no-spray list.

It might be argued the last four options require vastly increased education efforts in order that human health not be negatively affected by their implementation, especially regarding personal responsibility for mosquito avoidance and bite deterrence. However, it is not clear that any of these options represent any difference from the Long-Term Plan in terms of potential benefits and impacts (from a public education and outreach perspective).

- do not implement any changes to the former means of applying adulticides

This proposal does not appear to have a direct link to public education and outreach.

One water management option was to be explicitly considered: maintaining all ditches as water management. This proposal does not appear to have a direct link to public education and outreach.

8.3 Impacts of IPM Alternatives: Part 2, Surveillance

This section discusses the impacts of conducting surveillance. It begins by summarizing the findings of Section 7.4 regarding the potential impacts associated with current program and then describes the potential for any impacts associated with changes in pesticides applications or the water management approach as otherwise described in the Long-Term Plan.

8.3.1 Current IPM Program

The current approach reduces impacts associated with mosquito-borne disease by allowing prophylactic measures to be taken prior to any disease incidence. It also reduces disease risk by limiting vector populations by determining where incipient mosquito problems may be occurring. Good surveillance reduces the use of adulticides by allowing problems to be addressed more appropriately and earlier. An argument could be presented that surveillance, by identifying problems, causes more pesticide use since otherwise the problem might never have been detected. However, mosquito problems are generally defined by the presence of people, and so that means that the problems identified by means of surveillance would most probably have come to light through reports by the affected population. Essentially, surveillance drives IPM, and the accepted principle of IPM is intervention should be appropriate and early, rather than late. The current approach also allows for appropriate ditch maintenance or culvert repairs (essentially the two forms of water management that are permitted under the existing program) to be conducted, by identifying areas where breeding is occurring. Supervisors can then determine if ditch maintenance can provide a treatment for an on-going problem.

If ditch maintenance is accepted as a means of water management where the benefits exceed the costs, then surveillance as practiced under the current program clearly has human health and environmental benefits. If ditch maintenance is not accepted as having minimal impacts, then the current surveillance program provides considerable human health benefits with some environmental trade-offs.

8.3.2 Alternative IPM Considerations

One of the alternatives to be assessed was the use of other larvicides or adulticides in place of the selected compounds. Using one or more of the alternative compounds does not appear to have any potential surveillance impacts or benefits, although sampling to measure efficacy may need adjustments if some options are implemented.

The only one of the six alternative IPM options that might result in changes in surveillance would be the elimination of adulticiding – if that policy were to be adhered to without exception. But even absent an adulticide program, the County would probably still need to determine if mosquito-borne disease represented an elevated threat level, in order to provide guidance so residents could reduce exposure to the disease(s). Some specific surveillance actions might be

altered if adulticiding was no longer an option. However, the impact assessment for surveillance activities associated with the Long-Term Plan would not be greatly different compared to one conducted for a no-adulticiding program.

It might be argued, if human illness levels were to increase with changes in the adulticiding triggers, that public approval of the program might decrease, if it were to be known that the County had evidence from its surveillance program of a disease risk, but took no action. In that case, some impacts of surveillance activities would be increased. It is only in that sense, however, that impacts from surveillance might increase under the alternatives.

Under the water management option (maintaining all ditches throughout the County), surveillance would not be as important for this aspect of the program. Surveillance data might help prioritize activities, but no longer would be used to determine where or when water management was to occur. Therefore, implementation of such an option would minimize the import of surveillance, and so make any impacts or benefits associated with surveillance less trenchant.

8.4 Impacts of IPM Alternatives: Part 3, Source Reduction

This section discusses the impacts of conducting source reduction. It begins by summarizing the findings of Section 7.5 regarding the potential impacts associated with current program and then describes the potential for any impacts associated with changes in pesticides applications or the water management approach as otherwise described in the Long-Term Plan.

8.4.1 Current IPM Program

Public education is an important part of source reduction efforts. The impacts associated with the current public education approach were discussed in Section 7.3. Benefits from source reduction efforts in water management structures are fairly clear, as *Cx. pipiens* is the primary zoonotic vector of WNV, and uses these habitats to breed in. Recharge basins also support other fresh water mosquitoes. Human discomfort, at a minimum, can be decreased by controlling mosquitoes in these habitats and if bridge vectors are produced, control efforts can reduce risks to human health.

Impacts associated with the use of larvicides in general, and methoprene in particular, were discussed below in Section 7.8. Impacts associated with the use of *Gambusia* were discussed in Section 7.7.

8.4.2 Alternative IPM Considerations

Selecting one or more of the alternative larvicides or adulticides does not appear to have any potential source reduction impacts or benefits.

None of the IPM alternatives or the water management option appear to have any source reduction implications, and so have no associated benefits or impacts.

8.5 Impacts of IPM Alternatives: Part 4, Water Management

This section discusses the impacts of conducting water management. It begins by discussing impacts associated with the current program (use of ditch maintenance as the sole means of water management), and then describes the potential for any impacts associated with changes in pesticides applications or the water management approach as otherwise described in the Long-Term Plan.

8.5.1 Current IPM Program

The potential impacts and benefits associated with maintaining ditches as the sole means of conducting water management can be extrapolated from the discussion in Section 7.6. There, the positive effects of ditch maintenance were reviewed in the context of conditions at Pickman-Remmer marsh, and potential negative (less favorable) results were reviewed in the context of conducting ditch maintenance at Namkee Creek. It should be assumed that some slight modifications to the current program, such as sensitivity to turtle habitats, and perhaps a greater focus on the creation of fish habitat, might necessarily enter into current practices as a result of research associated with the project, but primarily machine ditch maintenance would be conducted as it has for approximately the last ten years or so.

The impact of continuation of existing ditch maintenance practices would be to reduce mosquito populations, improve water quality in areas of the marsh, and maintain fish habitats – but also to perpetuate other impacts associated with ditches and ditch maintenance. It would also mean foregoing benefits associated with other means of conducting water management. Ditch maintenance has shown to have some effectiveness for mosquito control, but not to the extent

that has been reported for other more progressive means of water management. This means that this choice appears to be suboptimal in terms of mosquito management, and also in terms of potential environmental benefits. This is the reason for the current moratorium on machine ditch maintenance, and one of the strong precepts behind identifying reversion as the preferred interim action under the Long-Term Plan.

8.5.2 Alternative IPM Considerations

Selecting one or more of the alternative larvicides or adulticides does not appear to have any potential water management impacts or benefits.

None of the alternative IPM options appear to have any water management implications, and so have no associated benefits or impacts.

The water management alternative clearly must have water management implications. Choosing to maintain all ditches throughout the County would expand the scope of the existing ditch maintenance policy. This policy would be adopted if the mosquito ditches were to be considered as any other part of the County's infrastructure, where it is sound to keep the infrastructure in good working order.

The problem with this approach is that expanding ditch maintenance, even in comparison to current ditch maintenance policies, would appear to offer few to no benefits for mosquito management and may result in considerably greater environmental costs. Environmental benefits would appear to be few: improvements in water quality, potentially, for certain areas of some marshes, and potentially gains in fish habitat (both for mosquito consuming fish and for estuarine fish). The benefits seem vastly outweighed by the potential effects.

As an example, maintaining all ditches throughout West Meadow would alter the existing hydrology, wildlife habitats, and vegetation patterns that make this marsh healthy. Disturbance to every ditch in this marsh could lead to changes in vegetation and hydrology. Ditch maintenance is not needed at this marsh because mosquito numbers are low and breeding is not a concern.

Thus, this alternative would appear to be a lesser choice in terms of mosquito control benefits, and also in terms of potentially causing environmental impacts because of insensitive application

of a management technique where it is not needed, and where, if management is needed, better options may be available.

8.6 Impacts of IPM Alternatives: Part 5, Biocontrols

This section discusses the impacts of biocontrols. It begins by summarizing the findings of Section 7.7 regarding the potential impacts associated with current program and then describes the potential for any impacts associated with changes in pesticides applications or the water management approach as otherwise described in the Long-Term Plan.

8.6.1 Current IPM Program

Biocontrols are currently limited in their use in the SCVC program. Mosquito fish (*Gambusia spp.*), purchased from local supply houses, are the only biological control used. Mosquito fish can have considerable environmental impacts if they escape into natural systems, or if the anthropogenic setting they are introduced into has value as the equivalent of a natural vernal pool or coastal plain pond. They are easy to acquire, however.

8.6.2 Alternative IPM Considerations

Selecting one or more of the alternative larvicides or adulticides does not appear to have any potential biocontrol impacts or benefits.

None of the six alternative IPM options, or the water management alternative, appear to have any biocontrol implications, and so have no associated benefits or impacts.

8.7 Impacts of IPM Alternatives: Part 6, Larval Controls

This section discusses the impacts of the use of larval controls. It begins by summarizing the findings of Section 7.8 regarding the potential impacts associated with current program and then describes the potential for any impacts associated with changes in pesticides applications or the water management approach as otherwise described in the Long-Term Plan.

8.7.1 Current IPM Program

An important part of the impact assessment was a quantitative risk analysis of the impacts of applying Bti, Bs, and methoprene at the computed concentrations to the four risk assessment areas. The analysis showed that there did not seem to be elevated risks for any potential human health or ecological impacts from these compounds. Three Long-Term Plan field efforts found

no impacts from use of the compounds, either. Efficacy considerations showed that the larvicides can be very effective at reducing mosquito populations. Resistance considerations suggested that the County's current approach has little chance of inducing larvicide-resistant strains of mosquitoes.

The impact analysis conducted in Section 7.7 suggested that aerial applications of larvicide may have some impacts to marsh birds due to startling from low helicopter fly-overs. There has been no direct research on the topic however, and there appears to be little pertinent research. What research was found was ambivalent regarding the scope of any potential impact.

Therefore, the current approach to larval control appears to be sound. The County has selected low impact pesticides, uses industry-standard means for applications, and only makes applications on the basis of surveillance that indicates the potential that adult populations generated by the larvae may cause impacts to people.

It should be recognized that the continued use of ditch maintenance would appear to require the County to use more larvicide than would be the case if more progressive water management options are followed. Implementation of progressive water management is intended to reduce aerial larvicide application rates by 75 percent, with no associated reduction in protection from mosquitoes and their impacts.

8.7.2 Alternative IPM Considerations

Selecting one or more of the alternative adulticides identified for consideration does not appear to have any potential larvicide impacts or benefits. However, three alternative larvicides were analyzed:

- Ethoxylated fatty alcohols
- Temephos
- Golden Bear Oil

Temephos is an organophosphate pesticide registered by USEPA in 1965 to control mosquito larvae, and is the only organophosphate with larvicidal use. Temephos is used in areas of standing water, shallow ponds, swamps, marshes, and intertidal zones. Abate is the trade name of the temephos product used for mosquito control. Temephos is applied most commonly by

helicopter but can be applied by backpack sprayers, fixed-wing aircraft, and right-of-way sprayers in either liquid or granular form. Temephos breaks down within a few days in water, and post-application exposure is minimal (Cashin Associates, 2005a).

Although temephos, as with the target larvicides evaluated in Section 7 does not pose a risk to human health, USEPA (2002a) concluded that it is more toxic to aquatic invertebrates than alternative larvicides. For this reason, USEPA has limited temephos use to areas where less-hazardous alternatives would not be effective, specifying intervals between applications, and limiting the use of high application rates.

Based on this information, temephos is concluded to pose a greater risk of environmental impacts than the Bti, Bs, or methoprene.

Monomolecular films are low-toxicity pesticides that spread a thin film on the surface of the water that makes it difficult for mosquito larvae, pupae, and emerging adults to attach to the water surface, causing them to drown. Films may remain active typically for 10 to 14 days on standing water, and have been used in the US in floodwaters, brackish waters, and ponds. Two particular products are Arosurf MSF and Agnique MMF (Cashin Associates, 2005a).

USEPA (2002a) has concluded that monomolecular films, when used according to label directions for larva and pupa control, do not pose a risk to human health. In addition to low toxicity, there is little opportunity for human exposure, since the material is applied directly to ditches, ponds, marshes, or flooded areas that are not drinking water sources.

Additionally, USEPA (2002a) has concluded that monomolecular films, used according to label directions for larva and pupa control, pose minimal risks to the environment. They do not last very long in the environment, and are usually applied only to standing water, such as roadside ditches, woodland pools, or containers which contain few non-target organisms.

Overall, based on this information, monomolecular films are considered to not pose greater or lesser risks than Bti, Bs, or methoprene.

Oils, like films, are pesticides used to form a coating on top of water to drown larvae, pupae, and emerging adult mosquitoes. They are specially derived from petroleum distillates and have been used for many years in the US to kill aphids on crops and orchard trees, and to control

mosquitoes. Products sold for these purposes include Bonide, BVA2, and Golden Bear-1111, (GB-1111) (Cashin Associates, 2005a).

USEPA (2002a) has concluded that oils, used according to label directions for larva and pupa control, do not pose a risk to human health. In addition to low toxicity, there is little opportunity for human exposure, since the material is applied directly to ditches, ponds, marshes, or flooded areas that are not drinking water sources.

USEPA (2002a) also has found, however, that oils may be toxic to fish and other aquatic organisms if misapplied. For that reason, USEPA has established specific precautions on the label to reduce such risks.

Based on this information, Golden Bear Oil could pose a greater ecological risk than Bti, Bs, or methoprene. However, risks would be mitigated if label directions are followed.

The only one of the alternative IPM or water management options that appears to have any larval control implications is eliminating the use of all larvicides in fresh water environments and also not using methoprene in salt water settings. Having stated that, the water management option of expanding ditch maintenance to all ditched marshes in the County should, as with continuance of current ditch maintenance practices, require more use of larvicides than would be required with the use of more progressive water management techniques.

The risk assessment found there were no ecological impacts from the use of Bti, Bs, and methoprene. If that is the case, then eliminating the use of the larvicides in fresh water environments would decrease mosquito control efforts without generating any offsetting environmental or human health benefits. It has been discussed (Section 7.11, above) that mosquito control appears to reduce human health impacts from mosquitoes. Therefore, a decrease in mosquito control would likely increase impacts associated with mosquitoes and mosquito-borne disease – again, without any offsetting environmental benefits.

It might be that the same degree of control could be realized through greater use of adulticides to address the increased populations of adult mosquitoes resulting from a lack of larval control. This is suboptimal for a number of reasons:

1) the risk assessment found some potential short term impacts to flying insects associated with all of the proposed adulticides

2) the risk assessment found the possibility of aquatic invertebrate impacts associated with the use of permethrin and malathion

3) adulticide use is effective for immediate reductions of risks associated with mosquito-borne diseases; adulticides are not as effective for long-term risk reduction because their effect is immediate, and localized to the area treated. Larval control addresses the mosquitoes prior to them becoming disease vectors (for almost all mosquito-borne disease) and when eventual wide-ranging populations are concentrated. This means control can be much more effective.

4) adulticide treatments only address the mosquitoes in the air when the adulticide is applied, and at the location where the pesticide is applied. This limits effectiveness in time and space.

5) the principles of IPM suggest that it is more effective and appropriate to address larval as opposed to adult pests.

6) larval pesticides are more targeted treatments than are adulticides, and thus the theoretical potential for impacts should be greater with the use of adulticides. This includes impacts to humans as well as to the environment.

7) because there is a greater theoretical potential for human impacts, accidents that may result in worker exposure to these compounds, or unintentional misapplications exposing the public, are more serious for adulticide use.

8) the County Pesticide Phase-Out Law inherently rejects the use of more toxic alternatives when less toxic substitutes are available. Larvicides would seem to be less toxic alternatives to adulticides, suggesting a legal concern for touting adulticides to replace larvicides.

Concerns were raised regarding larvicide use primarily because of work done by Hershey et al. (1998) in Minnesota on impacts of Bti and methoprene to non-target aquatic organism. The following discussion may help address those specific concerns.

Bti is generally not considered a risk for non-target organisms at concentrations applied for mosquito control (USEPA, 1998). There is some evidence of Bti effects to non-target aquatic dipterans that include midges (Chironomidae), biting midges (Ceratopogodinae), and dixid

midges (Dixidae), which are commonly associated with mosquitoes within the aquatic environment. These organisms are taxonomically similar to mosquitoes and black flies and can possess the gut pHs and enzymes necessary to activate Bti delta-endotoxins. Adverse effects to these groups, however, have only been noted at dosages 10 to 1,000 times greater than the application rate specified for mosquito control (FCCMC, 1998).

Overall, USEPA (1998) has concluded that Bti does not pose significant adverse risks to non-target organisms or the environment, especially since rates higher than those used for vector control are needed to produce any adverse effects. Other findings also tend to confirm a limited overall toxicity to wildlife for Bti (Brown et al., 2002; Russell et al., 2003; Lacey and Merritt, 2003).

The methoprene USEPA RED Fact Sheet states:

> Acute, short-term and subchronic effects studies on non-target immature and adult arthropods [Crustacea and Insecta, including shrimp, damselfly, beetle, tadpole] demonstrates 24- and 48-hour LC_{50} values >900 ppb. … Sensitive life stages of non-target organisms, *i.e.*, nymph and larvae, and non-target aquatic organisms that are highly related to mosquitoes, *i.e.*, dragonfly, are not affected by methoprene up to 1000 ppb.

Concerns raised by USEPA in the earlier 1991 RED regarding estuarine invertebrate toxicity were alleviated by studies that were completed after 1991. Estuarine invertebrate life cycle toxicity research in 1996 with mysid shrimp demonstrated minimal chronic risk (USEPA, 2001).

Based on USEPA review of data submitted to the agency between 1993 and 1996, the "do not use in fish-bearing waters" label restriction was removed from all solid methoprene mosquito products (USEPA, 2001). However, New York continues to prohibit the use of sustained release methoprene formulations to fish-bearing waters due to concerns over the teratogenicity (related to or causing malformations of an embryo or larva) of its breakdown products.

When early life stages of the fathead minnow (*Pimephales promelas*) were subjected to various concentrations of methoprene (ranging from 13 to 160 µg/L), the only impacts were found at the highest concentrations (Ross et al., 1994a). Environmental concentrations associated with sustained released briquets tend to be in the single microgram per liter range (Ross et al., 1994b)

Methoprene degrades rapidly in sunlight, both in water and on inert surfaces. Within three days of application, 90 percent will degrade via photolysis and microbial metabolism; without microbial metabolism, photolysis will degrade 80 percent in 13 days (USEPA, 2001). Overall, methoprene has a half-life ranging from 30 hours to 14 days, depending on environmental conditions. Higher temperatures and salinity lead to higher degradation rates (Glare and O'Callaghan, 1999). The effects of methoprene last up to a week, but it reaches undetectable levels in ponds within 48 hours of application (Madder, 1980; Schaefer and Dupras, 1973). These findings were confirmed in the Caged Fish experiment (Cashin Associates, 2005b).

Hershey et al. (1998) reported on long-term exposure tests conducted in Minnesota wetlands over the time period 1989 to 1993. The study did find statistically significant differences between non-target invertebrate populations exposed to methoprene and Bti, as compared to populations that were not so exposed. Specifically, they found no impacts from the pesticides in 1989, when drought conditions limited invertebrate populations. It is known that drought is the most limiting condition for freshwater wetland invertebrates. After several years of non-drought conditions, control area invertebrate populations began to flourish. This caused significant differences from treatment populations, which did not recover as quickly. In addition, because invertebrate predators of insects assumed to be directly affected by the pesticides also had reduced populations at the treatment sites, and these predaceous invertebrates are duck diet mainstays, it was assumed that the effects of the non-target impacts were propagating throughout the food chain.

However, a similar study conducted in the same area of Minnesota (Balcer et al., 1999) under different climatic conditions (the study was conducted from 1997-1998) but otherwise duplicative of the earlier study, did not find any such impacts. In fact, the Balcer study sampled the same wetlands as the earlier study, and did not find any differences between treatment and control sites in any of the insect populations. The Balcer study recognized that its results were much different from the original study, and suggested that two factors primarily contributed to the differences:

1) Hershey et al. conducted their study following several years of drought, which may have resulted in pre-stressed populations that were extra-susceptible to the pesticides; and

2) climatic conditions in 1997 to 1998 resulted in thick vegetative growth in the wetlands, which may have limited exposure to the pesticides for the targeted invertebrates.

Lawler et al. (2000), in a study conducted in California salt marshes, found no impacts on either caged or free-swimming invertebrate populations from sustained release methoprene and a combination formula of methoprene and Bti, although the dosages were effective for mosquito control. This included Diptera, which had been found to be the order most affected by the pesticides in Minnesota.

A review of methoprene by Antunes-Kenyon and Kennedy (2001) found that it is generally toxic to insects in Diptera, especially midges and mosquitoes. They found no impacts to amphibians, believed the weight of evidence was unclear regarding impacts to Crustacea, and suggested that due to rapid degradation, liquid formulation methoprene was unlikely to have any adverse impacts. Sustained-release briquets, especially 150-day formulations, were thought to have the potential for some impacts, especially in poorly-flushed waters. Overall, they determined there was no permanent ecosystem disruption from methoprene.

Hershey et al. specified that the impacts propagated up the food chain. Several studies have sought such impacts. Hanonowski et al. (1997) thought that, although their data showed no impacts from methoprene or Bti on marsh-breeding bird populations, under some conditions it was possible that pesticides could have negative impacts – but impacts that would be less than those caused by weather or predation. A peer review of the original, 1989 to 1993 study in Minnesota (Anderson et al., 1996) thought that the data presented were not conclusive regarding ecological impacts to ducks and other wetland birds, especially as it is possible that the ducks may vary their diet depending on available prey, but did suggest that further research was needed.

It is possible that complex feedback mechanisms produced the differences between the Hershey et al. and Balcer et al. studies. If food chain impacts do propagate, then controls on the food chain base will be reduced over time in the treatment areas. This may allow the treatment area to rebound from its slower recovery from drought impacts, because the reduced number of predators necessarily results in lower predation rates. Another possibility is that another, hidden confounding factor was responsible for the original difference, as perhaps whatever made these

wetlands good for mosquito breeding also tended to inhibit other invertebrate population recoveries following a drought.

8.8 Impacts of IPM Alternatives: Part 7, Adult Controls

This section discusses the impacts of the use of adult controls. Section 7.9 only examined impacts associated with the Long-Term Plan. However, the adulticide used under the current program (resmethrin, sumithrin, and malathion) are a subset of the identified preferred pesticides analyzed as part of the Long-Term Plan. In addition, the application means proposed for the Long-Term Plan is used under the current program, and the scenarios analyzed under the risk assessment were those generated by the current program. There are some important differences; therefore, the analysis of current operations will focus on the differences between the proposed Long-Term Plan use of adulticides and the way the current program uses adulticides, and report on how that may or may not affect the reported impacts of the Long-Term Plan. This section will then describe the potential for any impacts associated with changes in pesticides applications or the water management approach as otherwise described in the Long-Term Plan.

8.8.1 Current IPM Program

Impacts Associated with Applications of the Selected Pesticides

The adulticides currently used are resmethrin, sumithrin, and malathion. Current application impacts associated with aerial, truck, and hand-held applications of these pesticides were determined through the quantitative risk assessment (Section 7.9). The modeling suggested that there are no increases in risks for human health impacts associated with any of these compounds, and potentially some limited ecological impacts. A recently released study of pesticide use for WNV control also found no human health impacts (Peterson et al., 2005). The risk assessment found the following potential ecological impacts:

- For all products, potential impacts to honey bees, and other sensitive insects such as adult threatened dragonfly species and adult and caterpillar stages of endangered or threatened butterfly species were identified based on very conservative considerations. These impacts were thought to be very unlikely for resmethrin, if the analysis were adjusted to account for certain modeling overestimates, and local measurements of resmethrin decay. Similar considerations also are likely to ameliorate sumithrin use.

- For malathion, the potential for impacts to aquatic invertebrates was noted; it is assumed that, analogous to permethrin, the impacts will be short-term (see Section 7.9).

Furthermore, a review of epidemiological research regarding the potential for these compounds to cause breast cancer suggests that they do not play a significant role in that disease. Epidemiological studies of children's health problems did not find a link between their use and subsequent impacts – although the potential for impact was identified (it is far from clear whether the concentrations that children are exposed to are great enough to cause any kind of effect).

The Caged Fish experiment found no conclusive link between resmethrin use and any impacts to shrimp or sheepshead minnows, and the fate and transport research strongly implied it would be impossible for applications to have effects on estuarine organisms. Confounding factors meant the benthic invertebrate analysis was not as compelling for resmethrin as it was for methoprene.

The pesticides have been demonstrated to be effective when applied as the County does, and there are no signs of resistance to them in Suffolk County.

Differences in Adulticide Use between the Current Program and the Long-Term Plan

Surveillance has been improved under the Long-Term Plan. That is generally understood to reduce the likelihood that an adulticide application will occur. CDC light trapping will be conducted the night before a proposed event. If trap numbers are not 100 or more for human biting species, then it is almost a certainty that the application will be cancelled as being unjustified. Although the existing program has been evolving towards more sharply defined criteria for adulticide use, the development of the Long-Term Plan has accelerated that process, and the conditions under which Vector Control adulticide applications can occur are more precisely defined than they were before. This means that any realized potential impacts are likely to be more under the current approach than under the Long-Term Plan. The difference, however, as these potential impacts are not expected to be significant, is relatively small.

Because there will be more extensive efficacy testing under the Long-Term Plan, it will be easier to justify the Long-Term Plan approach to the interested public than it is to justify current operations.

Expanding the list of compounds not only creates management flexibility and reduces potential problems if resistance appears, but it may also reduce overall risks associated with mosquito impacts. None of the compounds in the current program are approved for agricultural applications (as mosquito control products). Therefore, the selection of natural pyrethrum under the Long-Term Plan means that if adulticide use is recommended for an area with a large amount of agricultural land use, a product will be available for effective use. Under the current program, either the application would not be made, or the application would not cover a continuous area (because the applicator would need to avoid the farms), resulting in the potential for an ineffective use of the pesticide.

Therefore, the current program approach, while not generating any significantly different potential impacts than the proposed Long-Term Plan, has certain elements that make it a little less desirable than the Long-Term Plan approach.

8.8.2 Alternative IPM Considerations

Selecting one or more of the alternative larvicides does not appear to have any potential larvicide impacts or benefits. Four alternative adulticides were analyzed:

- Naled
- Deltamethrin
- Fenthion
- Chloripyrifos

Naled is an OP insecticide that is applied as an ULV spray. Naled starts to degrade immediately upon release of the spray droplets in the open air (FDACS, 2005). Once the spray droplets land on surfaces, naled degrades rapidly. Naled also rapidly degrades in water and in the presence of sunlight (Cashin Associates, 2005a).

USEPA conducted preliminary risk assessments for naled as part of its overall cumulative assessment for organophosphate pesticides (USEPA, 2002b). As part of this assessment, USEPA evaluated the relative potency of naled and other organophosphate pesticides, including malathion. The endpoint used to gauge relative potency of OP pesticides was cholinesterase

inhibition. The USEPA assessment found that naled is almost 300 times more toxic than malathion.

Given this, naled is assumed to potentially pose a greater risk to human health or the environment than malathion. However, Peterson et al. (2005) found no human health impacts associated with the use of naled for WNV control (see Section 7 for more details on this study).

Fenthion is another OP pesticide. It is classified by USEPA as a Restricted Use Pesticide (RUP) due to the special handling warranted by its toxicity. Fenthion is highly toxic to birds, estuarine/marine invertebrates, and non-target organisms. The mosquito adulticide use of fenthion has been implicated in several bird kill incidents (Extoxnet, 1996a). All mosquito control formulations, as well as nondomestic, nongranular formulations of 70 percent and greater are RUPs. RUPs may be purchased and used only by trained certified applicators. Fenthion may not be used on food crops (Cashin Associates, 2005a).

USEPA, in its overall cumulative assessment for organophosphate pesticides (USEPA, 2002b), found fenthion to be more than 1,000 times more toxic than malathion.

Based on these collective data, fenthion is assumed to pose a substantially greater risk to human health and the environment than malathion.

Chlorpyrifos is a broad-spectrum OP insecticide. Chlorpyrifos is moderately toxic to humans, and repeated or prolonged exposure to organophosphates may result in the same effects as acute exposure including the delayed symptoms (Extoxnet, 1996b). Chlorpyrifos is very highly toxic to fresh water fish, aquatic invertebrates, and estuarine and marine organisms, and moderately toxic to birds (Cashin Associates, 2005a).

USEPA, in its overall cumulative assessment for OP pesticides (USEPA, 2002b), found chlorpyrifos to be over 300 times more toxic than malathion.

Based on these collective data, chlorpyrifos is assumed to pose a greater risk to human health and the environment than malathion.

Deltamethrin is a pyrethroid insecticide that kills insects both on contact and through consumption and later digestion. As is common with many pyrethroids, deltamethrin has a high toxicity to fish under laboratory conditions. However, in the field under normal conditions of use, fish seem generally not to be harmed. Deltamethrin has, however, been reported to have an

impact on aquatic herbivorous insects, and has been demonstrated to be toxic to bees (Extoxnet, 1996c). Toxic potency, generally, is similar to that of other synthetic pyrethroids (Cashin Associates, 2005a).

Overall, deltamethrin is considered to pose risks similar to those posed by other synthetic pyrethroids.

There are six alternative IPM options considered in the Long-Term Plan. They are:

- use Mosquito Magnets in place of adulticides at Davis Park
- eliminating the use of all larvicides in fresh water environments and also not using methoprene in salt water settings
- adulticiding only in cases of declared human health emergencies
- adulticiding only after human illness
- elimination of all adulticiding
- do not implement any changes to the former means of applying adulticides

A water management option, maintaining all ditches throughout the County, was also considered.

Eliminating the use of larvicides (even with some of the considerations discussed in Section 8.7.2) and conducting ditch maintenance throughout all County marshes are unlikely to have any notable change in identified impacts or benefits associated with adult control. The other four options will have effects on the identification of these potential impacts and benefits.

Use Mosquito Magnets in place of adulticides at Davis Park

Special traps have been developed in the last few years that are designed to attract and catch large numbers of mosquitoes, thus removing them from a fairly wide radius around the trap. Brands include the Mosquito Magnet, Mosquito Megacatch, the Flowtron Power Trap, and the Dragonfly (CA-CE, 2005).

All of these traps utilize some form of attractant that lures the host-seeking female mosquitoes to a capture or killing device (AMCA, 2005). In some cases, mosquitoes are captured by an impellor fan that draws them into a net, where they desiccate. Other trapping systems use a

sticky surface to which the mosquitoes adhere when they land. Still others utilize an electric grid to electrocute mosquitoes drawn into contact (CA-CE, 2005).

Attractants used are generally variations on a common theme of mimicking mammalian exhalations, scents, and body heat to provide host cues to questing female mosquitoes. The vast majority of these traps use CO_2, produced either through the combustion of propane or via CO_2 cylinder and released at between 350m and 500 ml/min. The plume of CO_2 produced mimics human exhalation and makes these traps specific for capturing blood-feeding insects. Therefore, non-target insects such as moths and beetles will be largely unaffected. The CO_2 is often synergized with 1-Octen-3-ol (octenol) (a derivative of gasses produced in the rumen of cows) to increase attractiveness by several orders of magnitude. The octenol is slow-released into the air along with CO_2 (CA-CE, 2005)

An alternative management option being considered by the county is use of mosquito traps in Davis Park. If used, these mosquito traps could release CO_2 and octenol into the atmosphere. Although CO_2 is a simple asphyxiate and cerebral vasodilator (BOCG, 2005), it would not reach toxic levels when released the ambient the environment during trap operation.

Similarly, no toxic effects are likely from release of octenol. USEPA (2003) has concluded that octenol, when released into air, is not harmful to humans, to other non-target organisms, or to the environment. There is the potential for toxicity if ingested, but this exposure route is highly unlikely.

Overall, no adverse health or ecological impacts are likely to be associated with the use of mosquito traps in Davis Park. Potential aquatic life risks associated with the use of malathion were predicted for Davis Park. Therefore, when evaluated specifically from a chemical risk standpoint, use of the mosquito traps would likely be a lower risk alternative than the use of malathion. No risks were predicted for the other target pesticides proposed for use in Davis Park; therefore use of mosquito traps in lieu of these other target adulticides will not significantly lower risks.

The Early Action project demonstration with the propane-powered traps found that they were ineffective at preventing mosquitoes from accessing an area (CA-CE, 2005). This indicates that they would probably not perform satisfactorily at Davis Park. This means that this alternative is not acceptable because reductions in potential impacts to the environment would be minimal

(malathion is not likely to be used at Davis Park, especially on a regular basis), and no control of mosquitoes might result.

It should be noted that some studies have found these devices to work well (CA-CE, 2005). This suggests that, analogous to DEET alternatives, efficacy may result if particular, as yet unidentified factors collude with the product to cause some synergistic effects. Thus, it may happen that the considered array would be effective, due to some factors not included in the test at Sayville. Since there is no reason to assume that this will be the case, however, prudence dictates not adopting this strategy of mosquito control.

Adulticiding only in cases of declared human health emergencies

This essentially was the management option evaluated in the risk assessment for Dix Hills and Manorville, where one to two applications per year by helicopter were assessed. Therefore, for these locations, implementation of this management alternative would not be expected to result in different risks than those estimated in this human health and environmental risk assessment. Should a public health emergency or case of human illness not occur, no spraying would occur and therefore there would be no human or ecological risk from the use of adulticides.

A greater adulticide application frequency was evaluated for Davis Park, and for Mastic-Shirley. In Davis Park, application frequencies in the range of 11 to 14 applications per season were considered. Risks were predicted for non-target terrestrial insects (all adulticides) and for aquatic life (crustacean and insects – malathion only). However, predicted risks were generally the same order of magnitude in Davis Park as in the other study areas, suggesting that application frequency does not significantly influence risks for the target adulticides and receptors evaluated. This is not surprising, given that none of the target pesticides persists to any substantial degree in the environment. Therefore, multiple applications, even a once per week application, as evaluated under the Davis Park scenario, does not significantly increase risk potential. For Mastic-Shirley, impacts were predicted for non-target terrestrial insects (all adulticides) and for aquatic life (crustacean and insects – permethrin and malathion only). However, similar to the reasoning applied for Davis Park, the overall risk potential is not likely to be reduced much by decreasing the frequency of the applications.

Overall, adulticide use only during health emergencies or after public illness does not appear to significantly reduce health or environmental risks for those areas being treated compared to those

risks estimated in this risk assessment. However, if this option did not merely reduce the number of applications, but eliminated them altogether, then the potential impacts associated with adulticide usage will also be eliminated.

However, the Long-Term Plan has clearly outlined a need for the County to control mosquitoes in situations other than those identified as Public Health Emergencies. Although the County certainly is not relying on adulticiding to achieve its mosquito control ends, there will be certain situations where the use of adulticides, outside of a Health Emergency, is necessary. To not conduct control at such times will cause impacts to the quality of life of many County residents, and also will cause various kinds of non-clinical health impacts. The analysis conducted by the County also suggests that not reducing human-biting mosquito numbers when they are not controlled increases risks of disease transmission. This is clearest in the case of EEE and salt marsh mosquitoes, but also seems to be the case for other kinds of mosquitoes and other pathogens, as well. Therefore, restricting adulticide operations as outlined here would have the net effect of increasing public health impacts, as well as increasing effects on quality of life.

Adulticiding only after human illness

The findings from immediately above hold in this case and there are additional potential impacts. For one, it is clear that there will be health impacts associated with this choice, as action will not be taken until after someone is ill. In addition, by waiting to take action, the efficacy of the adulticide will be reduced. This is because there is a lag between the transmission of disease and its reporting to health authorities. With WNV, for instance, it can take several weeks for someone to become ill and be diagnosed. This means that any treatment in direct response to a case is addressing conditions that are several weeks old – and, given the swiftness that mosquito ecology evolves across a summer, is probably no longer relevant. This makes for a logical disconnect in the motivation for treatment. If the treatment is not being made in direct response to the case, then other criteria are being used. If so, then it would make sense to use these other criteria, absent the wait for the human case, to determine if treatment should be made or not. Otherwise, it is as if some degree of societal pain must be undergone prior to conducting adulticide operations. This seems to be technically unsound, and morally and ethically bankrupt.

If the disease did not threaten humans except until people were becoming ill because pathogen presence within a person was necessary for transmission to occur – as might be an interpretation

of malarial transmission – and if there were significant impacts associated with the proposed adulticide application, or on a scale where human lives might be at stake, then the evaluation of this option might be more lenient. With the analysis of impacts of adulticides as outlined in Section 7, transient potential impacts to aquatic invertebrates and flying insects would have to be perceived as more abhorrent than the risk of human disease, for treatment not to be undertaken prior to a human case.

Another perspective that might support this kind of decision-making would be if adulticide treatments were thought to be ineffective at preventing disease transmission. However, if that were understood to be true, there would be no point in treating after a human case had occurred, either.

Elimination of all adulticiding

The County also is considering eliminating adulticide use as a management option. In the risk assessment, adulticide use was shown to potentially be associated with some adverse ecological effects. In all but one case, ecological risks were principally due to potential malathion use. The pyrethroid compounds generally were not predicted to pose unacceptable ecological risks. Therefore, elimination of malathion as an adulticide could be associated with some potential risk reduction. In addition, all adulticides were predicted to be associated with a potentially increased risk to non-target terrestrial insects, and consequently, elimination of adulticide use in general would eliminate this potential impact.

The degree to which true impacts would be avoided by exclusion of adulticides is not completely known. As stated throughout, the risk assessment employed relatively conservative assumptions designed to overestimate rather than underestimate risks. Consequently, risks could be substantially lower than those estimated here, and the overall magnitude of risk reduction by elimination of adulticiding might be lower than suggested by the conservative risk numbers presented here.

As a general conceptual position, however, chemical risks will be lower if chemicals are not released to the environment. Therefore, complete elimination of adulticides will lower risks, though the magnitude of that risk reduction cannot be defined with great certainty.

The basis for adopting the stance that adulticides should not be used seems to be that adulticides are ineffective. In one sense, this is patently not true, as tests show adulticides are effective in eliminating mosquitoes. However, it is also true that mosquito populations often rebound following an adulticide application. If that were to be generally the case, then it might be argued that mosquito control using adulticides was largely ineffective.

Assume for a moment that mosquito populations generally rebound quickly. The effect sought by adulticide use may only be transient, therefore. That may be sufficient for disease risk reduction measures, especially if a brooded mosquito is the target of the treatment. The mosquitoes that were eliminated are probably the parous (older) mosquitoes that represented the disease threat, and the population rebound may be comprised of younger mosquitoes that do not cause as much concern. If the intent of the treatment was for Vector Control, then short-lived effectiveness of a treatment means that the goal is only achieved for a fleeting time period. However, as has been discussed extensively throughout this assessment, Vector Control treatments not only address quality of life issues, but also have some degree of disease risk reduction, as reducing populations of human-biting mosquitoes when all major species of human-biting mosquitoes are vectors clearly decreases risks faced by people.

Although data from Suffolk County are not organized to make a quantitative presentation, the County knows that these treatments are effective. The County does not use adulticide treatments on a regular basis, except in the Fire Island communities, where uncontrolled breeding in the near vicinity creates long-standing intolerable conditions for residents. Instead, the County uses adulticide to reduce peak populations or to prevent the imminent transmission of disease. Short-term reductions of peak populations are sufficient to ensure they are not immediately repeated. Elimination of the highest disease threats means that the risks of disease will be lower.

Elimination of adulticiding would reduce fleeting risks associated with pesticides use, but allow other problems and risks associated with mosquitoes to go unchecked.

Do not implement any changes to the former means of applying adulticides

The pesticide use scenarios used in the risk assessment were constructed largely based on past practices within the County, and were designed to reflect possible maximal potential application scenarios for the future. The principal change between historical practices and the application scenarios evaluated by the risk assessment was a modification to the flight procedures used for

aerial application techniques, to reduce the possibility of off-target drift. As part of the alternatives assessment, the County requested that the risks potentially associated with adulticide applications using historical application methods be assessed.

Based on the air modeling work of RTP, historical application techniques may have under certain conditions resulted in off-target drift. For example, RTP identified the possibility of historical off-target drift during modeling of aerial applications previously occurring in Mastic-Shirley. Under historical flight procedures and with a predominant wind from the southwest, off-target drift was modeled to have occurred from Mastic-Shirley towards Wertheim NWR. The air modeling results for maximum historical depositions in Wertheim are summarized in Table 8-1 along with the maximum average depositions used to evaluate potential ecological risks in Mastic-Shirley (as described in Section 7).

Table 8-1. RTP Air Modeling Results for Historical Maximum Depositions in Wertheim National Wildlife Refuge and for Maximum Average Deposition used in the ERA for Mastic-Shirley

Adulticide	Historical Spray Event Maximum Deposition in Wertheim NWR (g/m^2)	Maximum Average Deposition Used in Mastic Shirley Ecological Risk Assessment (g/m^2)
Resmethrin (18%, Scourge)	3.47E-04	3.87E-04
Permethrin (31%, Permanone)	3.01E-04	3.33E-04
Sumethrin (10%, Anvil)	1.94E-04	2.15E-04
Fyfanon (96.8% Malathion)	9.41E-03	1.16E-03
PBO (54%, Scourge)	1.05E-03	2.15E-04
PBO (10%, Anvil)	1.94E-04	1.04E-02
PBO (66%, Permanone)[2]	6.41E-04	7.09E-04

Habitats in Wertheim potentially impacted from historical off-target drift would predominantly include aquatic-based habitats, such as open waters and marshes. Terrestrial upland forests and grasslands could also have been impacted.

In the case of pyrethroids (i.e., permethrin, resmethrin, sumithrin), the air modeling indicated that historical maximum deposition rates potentially reaching Wertheim would be comparable (within a factor of 1.1) to the maximum average deposition rates evaluated in the ecological risk assessment for Mastic-Shirley. Therefore, the risks estimated for ecological receptors in aquatic habitats (e.g., open waters and marshes) and in terrestrial upland habitats in Mastic-Shirley are

considered equivalent to potential historical risks to ecological receptors in equivalent habitats of Wertheim.

In the case of attendant PBO risks, the air modeling indicated that historical maximum deposition rates potentially reaching Wertheim would also be similar (within a factor of five higher or lower) to the maximum average deposition rates evaluated in the ecological risk assessment for Mastic-Shirley. Because PBO is a low contributor to ecological risks relative to the pyrethroids it is formulated with, the overall risks predicted for Mastic-Shirley based on maximum averages are again considered equivalent to potential historical risks in Wertheim.

For malathion, the air modeling indicated that maximum deposition rates potentially reaching Wertheim could have been approximately eight times higher than the maximum average deposition rate evaluated for malathion in the ecological risk assessment for Mastic-Shirley. Risks estimated in aquatic and upland habitats for Mastic-Shirley would therefore be up to eight times lower than potential historical risks in comparable habitats of Wertheim. The ecological consequences of this are likely negligible. The historical maximum deposition in Wertheim is considered a single, worst-case occurrence at an individual location. Although predicted ecological risks could be up to eight times higher, such risks would most likely occur to relatively few individuals. Populations of individuals distributed over a greater geographical scale than the individual location of maximum deposition would be unlikely to experience any significant impact.

The change in application means will result in less off-target drift and better concentration of the pesticides used in the areas where they are intended and needed. Former application means resulted in drift to areas where the pesticides were not intended to go. This is anathema under the principles of IPM. However, the analysis of potential ecological impacts resulting from the drift indicated that it did not generate incrementally different impacts.

8.9 Impacts of IPM Alternatives: Part 8, Management Structure

The proposed management structure for the Long-Term Plan is similar to that currently used by the County. Some of the blurred distinctions between SCVC and the ABDL operations and staff have been made more distinct under the Long-Term Plan, and there are additional reporting responsibilities. However, while these changes are worthwhile and are expected to improve the overall program, they are not expected to result in any significant impacts.

None of the alternatives considered throughout this section would cause any impacts, either.

8.10 Impacts of IPM Alternatives: Part 9, Risks from Mosquito-borne Disease

The risks associated with the current program were discussed in Section 7-11. There it was found that the current program appears to reduce potential effects of mosquito-borne disease by a considerable amount. This section will focus on qualitatively determining the potential for relative increases or decreases in risks associated with the alternatives, compared to the Long-Term Plan (it was found that the Long-Term Plan was likely to relatively decrease the risks of mosquito-borne disease, as compared to the current program).

8.10.1 Larvicide Alternatives

The three larvicide alternatives have not been found to be as effective, in Suffolk County environments, as the selected larvicides (CA-CE, 2004). This means they are likely to increase disease risks if implemented in place of the selected larvicides.

8.10.2 Adulticide Alternatives

None of the four adulticide alternatives are registered for use in New York State, which makes the issue moot. They are not registered in the State because of the perceived potential for environmental impacts, mostly because they tend to be more persistent in the environment compared to the selected pyrethroids and malathion. That greater persistence is usually also translated in greater control of mosquitoes, although it is not necessarily clear that is the case. Generally, all of the labeled mosquito control adulticides have approved application rates that result in approximately the same amount of control for those mosquitoes airborne during an application (Mount, 1995). A more persistent adulticide may reduce the number of non-flying mosquitoes that can continue to cause problems, or address mosquitoes that migrate into the target zone close to when the adulticide was applied (at least during the time it was degrading). However, because mosquito populations tend to rebound quickly, it is not clear that any of these four compounds has much greater long-term efficacy that the compounds selected under the Long-Term Plan.

8.10.3 Application Alternatives

Use Mosquito Magnets in place of adulticides at Davis Park

Because the Mosquito Magnets were not found to be effective, they will not reduce risks associated with mosquito-borne illness as much as the adult control measures outlined in the Long-Term Plan.

Adulticiding only in cases of declared human health emergencies

The County has striven to be persuasive that vector control applications of adulticide reduce some incremental amount of disease risk. Therefore, the Long-Term Plan will be more effective than this alternative.

Adulticiding only after human illness

The intent of the Long-Term Plan approach is to avoid any human cases of mosquito-borne disease. This alternative clearly assumes that some disease is acceptable, and so would tolerate a higher degree of disease risks.

Elimination of all adulticiding

Some effort was expended immediately above to suggest that adulticide applications are effective in reducing the risk of mosquito-borne disease. Therefore, the Long-Term Plan will have a lower risk of mosquito-borne disease than this alternate.

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