Government of **Western Australia**
Department of **Health**

# A guide to developing a mosquito management plan for Local Government

## Part B – Case study examples

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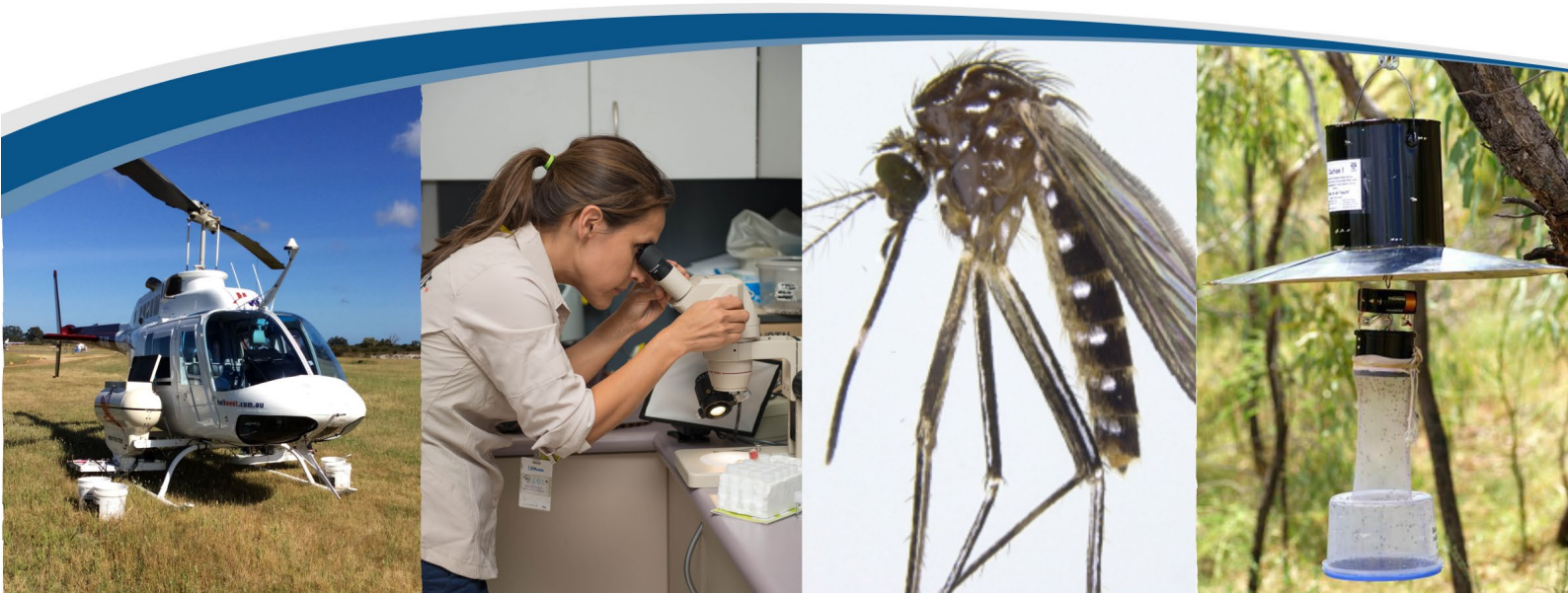
## Foreword

This document should be used in conjunction with Part A: Template and Guidance Notes. It details example used in previously developed Mosquito Management Plans (MMPs), which may be helpful to use as a guide when producing information for your own MMP.

The issue of mosquito management is complex. For more detailed information, refer to the WA Department of Health's (the Department) most current Mosquito Management Manual or mosquito management related content on the Department's website.

## Contents





# Template and guidance notes

## 1.0 Introduction/executive summary

**Example 1:**

The Shire of [xxx] covers a vast area of 50,000 square kilometres and is located more than 1,000 kilometres north of Perth. The Shire comprises several small communities with one major town site (xx). The Shire's neighbouring local governments include the City of [xxx] and the Shire of [xxx].

The town site of xx has a population of approximately 5,000 people according to the 2016 Census. The Shire is surrounded by vast expanses of flat inter-tidal salt marshes and native bush land. The Shire has experienced significant growth since 2010 due to the newly developed industrial area, bringing more workers and resulting in the construction of new housing estates at the southern end of the residential area. The new subdivisions are in close proximity to bushland (natural adult mosquito harbourage areas) and salt marshes (natural mosquito breeding habitat), increasing the likelihood of an impact from mosquitoes. Furthermore, these housing developments provide for high density living, placing a greater number of residents in close proximity to high mosquito nuisance areas.

The Shire experiences temperatures consistently high in the summer months along with a relatively high rainfall, mostly experienced from November to March. The mean annual rainfall for xx is 500mm. It is generally during these months, due to the favourable weather conditions and the significant amount of pooling water in surrounding natural breeding habitat, the Shire is subjected to an increase in adult mosquito populations.

The Shire also experiences extreme high tides, with peak tides reaching 8.5 metres. Mosquitoes breed naturally on the salt marsh habitat when the land becomes inundated with water, following a tidal event. Each high tide can trigger another breeding cycle of mosquitoes.

The varied natural environment in the xx region provides for a wide range of temporary, seasonal and permanent mosquito breeding sites. Some of the environmental variances that can greatly impact the mosquito numbers are:

- tidal variations
- rainfall and flood events during the wet season
- temperature
- humidity

All of these weather factors play an important role in mosquito management and need to be considered during the implementation of the program. Even with a MMP in place, there will be occasions when mosquito management is not effective due to factors such as unfavourable environmental conditions. Ineffective control, combined with the close proximity of the xx town site to these natural breeding areas mean, despite best efforts, there will be times when a significant mosquito nuisance will result.

**Example 2:**

The Shire of [xxx] is geographically part of the Swan Coastal Plain and incorporates the expanse of wetlands that run from xx to xx. The Shire is experiencing significant population growth and with this growth comes the pressures of expanding urbanisation. One of these pressures is the availability of land for development resulting in some development occurring within close proximity to known mosquito breeding areas. When this occurs, the risk of new residents becoming infected by a mosquito-borne disease increases.

Mosquitoes are a concern for the community not only due to their potential to transmit debilitating diseases but also due to their nuisance value which can impact on the ability of residents to enjoy the amenities and natural beauty of the area. In contradiction to this, while they may be pests, mosquitoes

are an important component of the local ecosystem, providing food for birds, bats, amphibians, fish and insects. The challenge is creating a balance between these factors and implementing a program that has little impact on the environment but reduces the risk of the community being exposed to mosquito borne diseases.

This challenge can be met through an integrated mosquito management program incorporating physical, chemical, cultural and biological control options. Such an approach needs to consider the statutory obligations, policies, guidelines, current practices, the community and the environment. By having such an approach to mosquito management, it creates an effective and environmentally sensitive solution that is sustainable. It also provides for avenues that are sometimes less allocated for, being health promotion and chemical resistance management.

**Example 3:**

Mosquitoes are a fact of life within many areas of the State and greater metropolitan area. Mosquitoes are one of the most significant groups of insects with the potential to cause nuisance and transmit diseases to humans.

The continued development of residential areas in close proximity to natural mosquito habitats promotes increased exposure between mosquitoes and the urban environment.

Residential backyard breeding in gutters, storm water systems, roadside drains and constructed wetlands can be attributed to urban development and infrastructure. Such development has allowed for the creation of more breeding habitats for different species of mosquitoes.

The City of xx has approximately xx kilometres of xx River foreshore situated between xx and xx. Much of this land is owned by the State of Western Australia and consists of wetlands and areas which are potential breeding sites for mosquitoes.

The incidence of Ross River virus and Barmah Forest virus throughout WA presents a serious risk to public health. Whilst not all mosquito species are vectors of disease, many are aggressive biters and can have a significant impact on quality of life.

Without the appropriate controls, precautions and treatment of mosquitoes, outdoor recreation areas, gardens, and other similar areas are rendered potentially useless. The nuisance and annoyance caused by mosquitoes is not easily translated into economic values.

The City of [xxx]'s mosquito management strategy is designed to reduce the impact of mosquitoes on both the residents and visitors to the City.

An effective MMP provides a clear definition of the mosquito problem, determination of practical objectives, the selection of appropriate control measures, procedures for measuring the effectiveness of the mosquito control operations and the establishment of a process for evaluating the management strategy.

It is not realistically possible or environmentally desirable to eradicate mosquitoes as they are an important part of the ecosystem. However, it is possible to achieve a reduction in mosquito populations, to minimise the risk of mosquito borne disease such as Ross River and Barmah Forest virus, with an effective integrated management plan.

## 2.0 Program objectives

**Example 1:**

The principles governing this MMP are:

- Mosquito management incorporates the health, environmental and socio-economic values across the Shire of [xxx].

- While disease control is the primary focus, reduction of nuisance mosquitoes is a legitimate aspect of improved community well being.
- Mosquitoes are an important part of the ecosystem and their treatment may have both positive and negative impacts on the environment. With this in mind, all efforts will be made to ensure management strategies minimise negative impacts on the environment.
- Effective mosquito management requires the cooperation and coordination of all stakeholders.
- Treatment of mosquito larvae and/or adults is an on-going activity that requires continual surveillance and review.

The objectives governing this MMP are:

- to identify breeding areas and potential breeding locations
- to provide an easy access document to convey information to future staff
- to inform, guide and assist developers, consultants, land owners, residents, council staff and the general public of Councils mosquito management actions and guidelines
- to work with other local governments in the region to ensure mosquito management is carried out in a cooperative manner and to ensure complimentary mosquito management across LG borders
- to strategically guide the financial direction of mosquito management.

## 3.0 Strategic implications

**Example 1:**

In accordance with the Shire's Strategic Plan, our Mission is to make the Shire of [xxx] the most attractive place to live, work and visit in Western Australia. The MMP strives to address the following strategic directions:

- Provide a safe place to live, work and play
- Prevent illness and harm through the provision of a safe environment

## 4.0 Statutory management and legislation

**Example 1:**

As the Town's lake systems are protected under the Environmental Protection Swan Coastal Plain Lakes Policy 1992 and the Ramsar Convention, approvals have been obtained, allowing the Town to carry out mosquito management in the Lakes according to the MMP. If, under review, changes are made to the MMP, new approvals will need to be obtained.

**Example 2:**

Under provisions within the WA Local Government Act 1995, the City has adopted measures specific to the prevention and control of mosquito-borne diseases which are contained in the City of [xxx] Health Local Laws 1997.

## 5.0 Mosquito biology and ecology

**Example 1:**

Mosquitoes go through four development stages - egg, larva, pupa and adult. This whole cycle from hatching egg to flying adult can take as little as 5-7 days in summer. During colder months the life cycle may take several weeks. Mosquitoes can breed in any type of standing water. Different species

of mosquitoes will breed in different environments, from natural and man-made water bodies to a variety of water-holding containers, and from fresh to brackish or even saltwater.

Some species of adult mosquitoes are known to travel 3km or more from a breeding site in search of a blood meal. As a result, residents living at a distance from the breeding sites (as well as those close by) may be affected.

There are approximately 100 species of mosquitoes in WA and many of them can be serious pests. In addition to being a nuisance, mosquitoes can also pass on viruses when they bite. The main viruses transmitted by mosquitoes in WA are:

- **Ross River virus (RRV)** - this is the most common virus transmitted by mosquitoes in WA. Symptoms of RRV disease include joint pain and swelling, sore muscles, rash, fever and fatigue. Symptoms may persist for several weeks to months.
- **Barmah Forest virus (BFV)** – BFV disease has similar symptoms to RRV disease but is not as common.
- **Murray Valley encephalitis (MVE) virus** – MVE is a rare but potentially fatal disease that occurs mainly in the northern two thirds of WA. Symptoms include fever, drowsiness, confusion, headaches and stiff neck, nausea and vomiting, muscle tremors and dizziness. In severe cases brain damage, paralysis or death may result.
- **West Nile virus (Kunjin subtype) ($WNV_{KUN}$)** – This has previously been known as Kunjin virus or KUNV. While the symptoms of this rare but serious disease can be similar to MVE, illness is generally milder and not life threatening.

There are no specific cures or registered vaccines for any of these diseases, so managing mosquitoes and human/mosquito interaction via an integrated mosquito management program is the only way to reduce the risk of mosquito-borne disease transmission.

## 6.0 Breeding sites

**Example 1:**

The [xxx] subdivision is currently under development. The responsibility for the maintenance and governance of the subdivision (including mosquito management) will remain with the proponent during the development phase of the subdivision. At the completion of the development stage (in five years time) the responsibility for the continued management of mosquitoes will fall to the Shire of [xxx].

**Example 2:**

Of the 600Ha of natural mosquito breeding habitat identified within this MMP, more than half of this land is located on private property, with the remainder being vested in the City of [xxx]. For this reason, the environmental health section has been involved in extensive community consultation with the above-mentioned land owners over the management strategies being proposed in this MMP. As a result of this consultation, the land owners have agreed to allow access to their land for the purpose of mosquito surveillance and for larvicides to be applied on their land via an aerial treatment program.

## 7.0 Nuisance/disease risk

**Example 1:**

Within the Shire of [xxx], mosquito management is necessary for two reasons:

1. Mosquito-borne disease risk (vectors, disease and human cases)

It has been well documented that known vectors of mosquito-borne diseases, such as Ross River virus (RRV), Barmah Forest virus (BFV), Murray Valley encephalitis virus (MVEV) and West Nile virus (Kunjin subtype) ($WNV_{KUN}$), are present within the Shire. This has been confirmed through adult mosquito trapping carried out by the Shire and through opportunistic mosquito surveillance carried out by the WA Department of Health (the Department). The Department's surveillance work has also detected mosquito-borne viruses in mosquitoes trapped within the Shire, indicating the viruses are active at various times.

The Shire also participates in the Department's sentinel chicken program (discussed further in Section xx). This program regularly detects annual wet season activity of MVEV and $WNV_{KUN}$ in the xx region.

During the last mosquito season, the xx region experienced a large RRV outbreak with 45 notifications, 15 of which were likely to have been acquired within the Shire. Based on the Shire's population size this is a significant number of cases within one season.

To further assess the risk of mosquito-borne disease in the State, the Department has analysed 10 years worth of human case data, which has ascertained the Shire's average attack rate (the number of cases per 100,000 population) for RRV is significantly higher than the average attack rate for the rest of the State. This data places the Shire at a ranking of xx out of 138 local governments in terms of risk rating for RRV (where one is the highest risk and 138 is the lowest risk).

These mosquito-borne diseases all have a significant impact on the health, social and financial well-being of residents and visitors to the region.

2. Nuisance mosquitoes

As well as being a disease risk, mosquitoes can also be a considerable nuisance. Some mosquito species in the Shire are known to be aggressive biters, causing discomfort and pain to affected residents and can impact significantly on lifestyle. One species in particular, *Aedes vigilax*, is not only a ferocious biter, but will attack at any time during the day or night and can travel tens of kilometres from their breeding sites. This can cause a significant nuisance to residents and visitors, severely impacting their outdoor amenity.

As well as monitoring natural breeding sites, the Shire monitors adult mosquito populations in response to local nuisance concerns throughout the residential and urban areas around the town. Although the Shire only receives an average of 6 direct complaints per season, there is a community expectation for the Shire to manage mosquitoes at an acceptable level to reduce their impact whilst recreating in public open spaces and/or their own properties.

## 8.0 Baseline survey/existing data

**Example 1:**

A baseline investigation has been carried out across the development site over the last 12 months. As part of this investigation, an adult trapping program has been established, with three EVS/$CO_2$ traps being set on a fortnightly basis through the spring, summer and early autumn months. Monthly trapping continued over the cooler months to develop knowledge of species composition changes in the mosquito fauna throughout the entire year. Environmental data, including rainfall, tide and temperature, was correlated with mosquito surveillance results to determine the natural triggers for breeding at various sites. Figure A shows the location of the three established EVS/$CO_2$ traps across the development site.

(Insert figure A here)

The initial results from the first 12 months of adult trapping can be seen in Figure B. Trap 1 collected the largest number of adult mosquitoes for most months of the year, being substantially higher than the other sampling locations. Trap 3 collected the lowest number of adult mosquitoes compared to the other sampling locations. All three traps consistently caught fewer mosquitoes in the winter months. Mosquito numbers increased in all traps from September before beginning to decline in February/March. The composition of all adult traps was similar with a dominance of *Aedes camptorhynchus* between September and December, after which, *Aedes vigilax* became the dominant species across the trapping sites until the end of March.

(Insert Figure B here)

Larval monitoring has also been carried out across the proposed development since January 2011 to gather baseline data on the density and species present. The frequency of larval monitoring has been based on weather conditions/breeding triggers, but generally occurred on a weekly to fortnightly basis throughout spring, summer and early autumn. Mosquito breeding only occurs at the site when the tide height of 1m is exceeded and the minimum daily temperature is > 20$^{o}$C, triggering the need for larval monitoring to begin. Larval monitoring was reduced to monthly sampling over late autumn and winter. Figure C shows the larval dipping sites that have been established across the development site.

(Insert Figure C here)

At each sampling location, several dips were taken and the number of mosquito larvae within each dip estimated. An average was calculated, based on the number of dips taken and then converted to obtain an overall estimate of the number of mosquito larvae at each site (larvae per $m^2$). These results from the first year are shown in Figure D. Larval specimens were also collected for identification to determine the mosquito genus at each site.

(Insert Figure D here)

Dip site 2 regularly collected more mosquito larvae than the other dip sites, possibly due to the shelter provided within Lake xx and the constant high tides leading to hatching of mosquito eggs on a regular basis. Monitoring sites further north had fewer mosquito larvae, possibly due to the tides having less impact and lower levels of flooding leading to a reduction in hatching of mosquito eggs. Dip site 3 had the lowest number of mosquito larvae, possibly due to the tidal action removing larvae from the site at low tides when the water is drawn to the ocean.

In summary, *Aedes vigilax* and *Aedes camptorhynchus* were the two most dominant species trapped throughout the site over the first 12 months of adult monitoring. Similarly, they were also the dominant species collected during larval monitoring. Significantly, both of these species are capable of transmitting Ross River and Barmah Forest viruses. Appendix xx shows a full list (in descending order of dominance) of adult mosquitoes collected across the site for the first year of the study and their associated disease risks.

## 9.0 Mosquito management strategies

**Example 1:**

There are four mosquito management strategies that should be considered in the development of an integrated mosquito management plan: physical, chemical, cultural and biological. Avoiding the reliance on a single strategy will help to prevent many of the problems inherent with long-term control, such as the development of chemical resistance.

The following mosquito management strategies are currently employed in the program:

**Physical Control –** Physical control methods are used to reduce the potential for mosquito breeding and harbourage by modifying the natural or built environment. Breeding sites are reduced by

decreasing the amount of vegetation within drains, marsh or other known breeding sites or by filling in low lying land to reduce the impact of flooding/tides.

**Chemical control (larvicides) –** It is more efficient to treat the mosquitoes as larvae, while they are contained within an aquatic environment, rather than as flying adults. Larvicides kill mosquito larvae and/or prevent the larvae developing into adult mosquitoes. They are also target-specific when applied at the label rate, reducing the impact on the environment.

The following larvicides are currently used as part of the Shire's mosquito management program –

S-methoprene is an insect growth regulator that is absorbed by the larvae and prevents the larvae from emerging from the pupal stage. The Shire applies this product in accordance with the required application rates throughout the mosquito season. This product is available in several different formulations, including slow-release briquets, which can provide ongoing control for up to 150 days under certain environmental conditions.

*Bacillus thuringensis israelensis* (Bti) contains spores and endotoxins of naturally occurring bacterium. These spores and endotoxins are ingested by mosquito larvae, resulting in death within 24 hours. Bti is toxic only to the larvae of certain dipteral (true flies). It does not harm other aquatic, marine or terrestrial fauna.

**Chemical control (adulticides) –** Adulticides used in fogging activities are designed to kill adult mosquitoes. However, they will kill other flying insects (eg. bees, dragon flies etc) and can be lethal to fish. For these reasons, fogging is only used by the Shire when there is an imminent public health risk associated with mosquito-borne disease transmission, often following above average rainfall or flooding. Fogging activities are planned appropriately to ensure wind conditions are optimal, there is no rain, and the product will not drift over wetlands or water bodies where fish may be present. It should be noted that the environmental impact, particularly on natural wetland/marsh areas can be significant and is undesirable. Fogging is short lived and will only knock down mosquitoes it comes in contact with at the time it is applied.

Residual surface treatment chemicals are occasionally used by the Shire. This involves the use of an adulticide, applied to internal and external surface areas at or around known breeding sites/harbourage areas, killing mosquitoes that land on the surface. These treatments can last up to six weeks, but like fogging, they will also have a significant impact on non-target organisms.

The following adulticides are currently used as part of the Shire's mosquito management program:

Pyrethroids – this chemical is used in the thermal fogger and is used as a spacespray for the control of adult mosquitoes and flies.

Bifenthrin – this is an insecticide that is used as a barrier treatment. The chemical is sprayed on surfaces such as dense vegetation and walls/fences to kill mosquitoes that land on the surface.

**Cultural control –** The public are a vital stakeholder for this MMP and have a responsibility in any integrated program to manage mosquitoes on their own properties. Due to the highly transient residential population in the region, it is important that educational programs are ongoing to ensure information is received by all residents and tourists. The Shire is actively involved in promoting the Department of Health's Fight the Bite campaign (see public education section below).

Research undertaken in the South West of WA (external) highlights the importance of imposing appropriate buffers between wetlands and residential/recreational land use to reduce the risk of mosquito-borne disease transmission. The Shire's environmental health team work with planning to ensure the implications of mosquito-borne disease risk are considered when assessing residential development applications. Where appropriate developers are required to submit their own MMP to ensure this has been considered. Man-made water bodies must also be designed and managed to discourage mosquito breeding.

## 10.0 Ongoing monitoring and surveillance

**Example 1:**

Mosquito monitoring commences, pending winter rainfall, from September through to late March. Mosquito population spikes can occur throughout the season, due to summer rainfall events, environmental conditions, nutrient availability and/or numbers of natural predators. It should also be noted that certain environmental conditions are more conducive to increased populations of specific species.

Adult (EVS/$CO_2$) trapping at historical sites is conducted fortnightly, with traps set late in the afternoon and retrieved early morning on the following day. Traps are generally in the field for between 14 and 16 hours. Where a localised complaint is received, an adult trap is set either at the resident's property or at a nearby protected area. In all cases, environmental conditions such as predicted wind speed/direction and rainfall should be considered prior to setting adult traps. Trapped adult mosquitoes are identified to species and counted, with all data being entered into a spreadsheet, which in turn produces a graphical presentation of the data.

Larval monitoring is conducted prior to any physical, biological or chemical control. Larval surveys have also proven important in identifying numbers and species in stormwater infrastructure and privately-owned properties. Species can be identified through the onsite collection of larval samples and the use of a microscope. Alternatively, pupal samples may be reared in a collection/rearing container and emergent adults can then be identified.

Ongoing monitoring and surveillance are vital to ensure the correct timing of chemical control and to assess the effectiveness of the control program.

## 11.0 Public Education

**Example 1:**

During the mosquito season, the following public education activities are undertaken:

- posters/display boxes with brochures placed at strategic locations throughout the Shire
- advertisements placed every fortnight in xxx newspaper
- radio advertisements used to inform general public of fogging activities
- social media is used to promote the campaign and inform the community about local government mosquito management activities
- xxx outdoor cinema provided with Fight the Bite resources and repellent for patrons to use
- active engagement with community at various events throughout mosquito season to promote Fight the Bite and awareness of health risk associated with mosquitoes.

Aboriginal environmental health practitioners visit the [xxx] community twice a season to promote practical mosquito prevention measures and to provide advice on how to use repellent effectively (repellent is provided at this time). Indigenous Fight the Bite posters are displayed at the community store.

## 12.0 Stakeholders

**Example 1 (internal stakeholders):**

As mosquitoes breeding on the xx flats are known to travel at least 3km from their breeding sites, the Shire's Planning Department will ensure all development proposals within this 3km flight range will be referred to Health for comment and assessment prior to any decision being made about the appropriateness of the proposed land use.

The Shire's engineering section has agreed to include regular monitoring for and maintenance of invasive vegetation at all compensation basins and storm water ponds within the Shire. In addition, there will be no newly created constructed water bodies without consultation with Health over appropriate design and ongoing maintenance of the water body.

**Example 2 (external stakeholders):**

Within the Shire, mosquito management is facilitated through monitoring and the treatment of breeding areas within the Shire's boundaries. Unfortunately, mosquitoes don't recognise these boundaries and coordinated efforts with neighbouring local government areas is needed to effectively manage mosquito-borne diseases.

Regional cooperation is supported and instigated by the Shire and has occurred through various avenues. The Shire has formally joined the City of [xxx] to form the [xxx] CLAG. This partnership entitles the two areas to financial support from the Department of Health for 50% of larvicide costs for hand treatments.

## 13.0 New developments

**Example 1:**

Ideally, residential developments should be located well away from mosquito breeding sites to minimise contact between mosquitoes and residents. However; this is not usually practical or achievable in the xx region due to the magnitude of the natural environment in comparison to the size of the town sites. To assist with informing residents of the potential risks of mosquito nuisance and mosquito-borne disease, any new developments will have a notification placed on the property title informing new residents of this risk.

**Example 2:**

With the City's growth expected to increase by an estimated 40,000 by 2031, land use, subdivisions and rezoning could play a role in increasing the risk presented to future residents/visitors. At a strategic level, allowing development of land in close proximity to known mosquito breeding habitat should be given due consideration. It has been demonstrated that an increase in risk of acquisition of RRV/BFV (where vector species are present) and/or nuisance can be directly correlated with proximity to breeding habitat.

The Western Australian Planning Commission (WAPC) Statement of Planning Policy No. 1: State Planning Framework provides a number of 'General Principles for Land Use Planning and Development'. Environmental principle IV states: 'The protection of environmental assets and the wise use and management of resources are essential to encourage more ecologically sustainable land use and development planning should contribute to a more sustainable future by adopting a risk-management approach which aims to avoid or minimise environmental degradation and hazards'. This principle is most relevant when considering appropriate planning for mosquito management.

The WAPC has the power to impose a memorial on land titles that are newly created through the process of subdivision and are potentially affected by a relatively permanent hazard. Similar to midge memorials, nuisance and disease risk associated with mosquitoes could be captured through use of a Section 12A (Town Planning Act and Development Act 1928) memorial notifying prospective purchasers of the hazard. This option will be considered by the City's Development Services Division.

The City has in place a policy which addresses development and associated midge nuisance around wetlands and lakes (APD6). Similar policy recognising mosquito risk could be adopted and

either amalgamated into APD6 or a new policy specific to mosquitoes developed and adopted. Buffer zones may be based on midge constraints or field work conducted to establish flight distance into sensitive land use areas. This option will be considered by the City's Development Services Division.

There is also an avenue for the WAPC to impose Conditions of approval on any subdivision proposal in high risk locations. Conditions dealing with risk associated with mosquitoes can be requirements such as the proponent being required to prepare a mosquito management plan and/or contribute to a local government mosquito management plan. Proposals may not be supported where it can be demonstrated that management of the risk cannot be achieved through environmentally sensitive methods. This option will be considered by the City's Development Services Division.

In cases where the development is proposed to be near existing natural wetlands or an artificial water body created, the proponent may be required to submit to the Environmental Protection Authority (EPA) for assessment. At the minimum, proponents should adopt the principles and standards within EPA Guidance Statement No. 40 – Guidance Statement for Management of Mosquitoes by Land Developers.

Increased stormwater catchment, treatment and final disposal/containment methods associated with development should be given due consideration by developers and the City. Implementing principles of water sensitive urban design with best practice/latest technologies may assist in reducing potential mosquito breeding sites and minimise the risk to the public.

## 14.0 Record keeping

**Example 1:**

It is critical that good record keeping practices are carried out. The following records (but not limited to) are kept on the Shire's system:

- annual complaint register
- RRV/BFV notifications and interview documentation
- adult and complaint-based trapping results
- larval sampling surveys
- chemical/bio-larvicide treatments
- reports
- product labelling/MSDS
- media releases

A centralised recording system should ensure current staff and any future employee/s involved with delivering the MMP have access to background knowledge.

An annual report will also be prepared in July each year to summarise the mosquito management actions that have taken place throughout the previous mosquito season.

## 15.0 Budget and resource requirements

**Example 1:**

Operating and implementing an effective mosquito management program is a costly exercise requiring large amounts of human and operational resources. The Department of Health may cover 50% of the larvicide used to reduce mosquito numbers, which goes some way to reduce the cost to local government. To ensure the continued improvement and implementation of the program, a source of sustainable financing needs to be secured. Without this, areas of the program will start to deteriorate and due to the nature of integrated mosquito management, once one component is lost, the program

starts to lose its effectiveness. Due to the nature of mosquito management and the large variations that can occur from one season to the next, there is also a need for funding to reflect this and be able to be adjusted accordingly. Currently the program requires a minimum of two officers at 0.6 FTE between September and January and one officer at 0.2 FTE during the remainder of the year. A dedicated 4WD vehicle is also required to be used for all mosquito management work.

## 16.0 Training and staff development

**Example 1:**

It is essential that personnel involved in the operational aspects of the MMP are suitably qualified, trained and/or supervised. Skills/knowledge required include:

- basic mosquito ecology
- principles of integrated mosquito management
- surveillance/monitoring techniques
- collection and recording of mosquito samples
- standard operating procedures for equipment
- safe storage, handling and application of chemicals/larvicides in accordance with product labelling and MSDS
- use of appropriate PPE in accordance with product labelling, MSDS and environmental conditions
- calibration techniques
- information technologies/geographical information systems
- budget management
- first aid.

The Department of Health offers an in-depth mosquito management course approximately every two years which teaches most skills and competencies required. All staff working in the area of mosquito management should undertake this training when available. The Department of Health is also available to offer advice and assistance regarding the MMP and its execution.

## 17.0 Procedure manual

**Example 1:**

A procedure manual has been produced which outlines the mosquito management actions to be completed at the various times of the mosquito season and throughout the year. It also contains site by site descriptions and assessments. Like this MMP, the procedure manual is a working document and will be reviewed and updated on a regular basis due to the constant changes in mosquito seasons and the associated environmental conditions. This document can be found in Appendix xx.

## 18.0 Review of mosquito management plan

**Example 1:**

Due to the nature of mosquito management, there will be an ongoing need to review and refine this document and the related procedure manual. This will allow both documents to accommodate new and/or changing mosquito breeding sites that may be identified from year to year depending on rainfall, tidal influence and human activity.

Furthermore, alternative approaches and new innovations to mosquito management may become available or desirable for the region. It is also necessary to periodically review achievements and results from consecutive seasons to identify emerging trends or risks.

## Contact us: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