Shire of Serpentine Jarrahdale

Mosquito Management Plan 2024–2029

Contents

President's Foreword

I am pleased to present the Shire's Mosquito Management Plan 2024–2029, which is integral to Council achieving our vision for a thriving, liveable and connected community.

This Strategy identifies the need for effective mosquito management in protecting our community and outlines the actions that will be undertaken to implement this.

As one of the fastest growing local governments in Western Australia (WA), this document will be critical in guiding the Shire to strategically plan for and action mosquito management. It will facilitate partnerships with the community and other stakeholders, in effectively addressing the hazard which mosquitos pose.

The Plan has been developed in consultation with key health agencies and provides best practice, holistic approach to mosquito management in the Shire. Forming part of delivering our Council Plan 2023–2033, the Plan ensures alignment with our strategic direction.

The Shire recognises the importance of mosquito management in our growing community, and looks forward to delivering the outcomes of the Plan in partnership with our community and stakeholders.

Rob Coales
Shire President

2.0 Introduction

The Shire of Serpentine Jarrahdale (the Shire) is situated between south-east of the Perth CBD, at the end of the southeast growth corridor (Figure 1). The Shire covers an area of approximately 905 km², and lies on the eastern edge of the Swan Coastal Plain and the western edge of the Darling Range. To the north of the Shire is the City of Armadale, to the east the Shire of Wandering, to the south the Shire of Murray and to the west the Cities of Kwinana and Rockingham.

The Shire forms the northern portion of the Peel Region which is regarded as the fastest growing region outside of Perth (Forecast id, December 2023). In 2023, the estimated residential population for the Shire was 38, 389 with a density of 0.368 persons per hectare. It is now forecast that by 2046 the Shire's population will be 95,275, an increase of 65,920 persons (185.64% growth) and average annual growth of between 4.5% and 5.5% (Forecast id, 2023). The majority of the rapid residential growth is in Byford and Mundijong, which is increasing human exposure to mosquito-borne diseases and nuisance levels of mosquitoes.

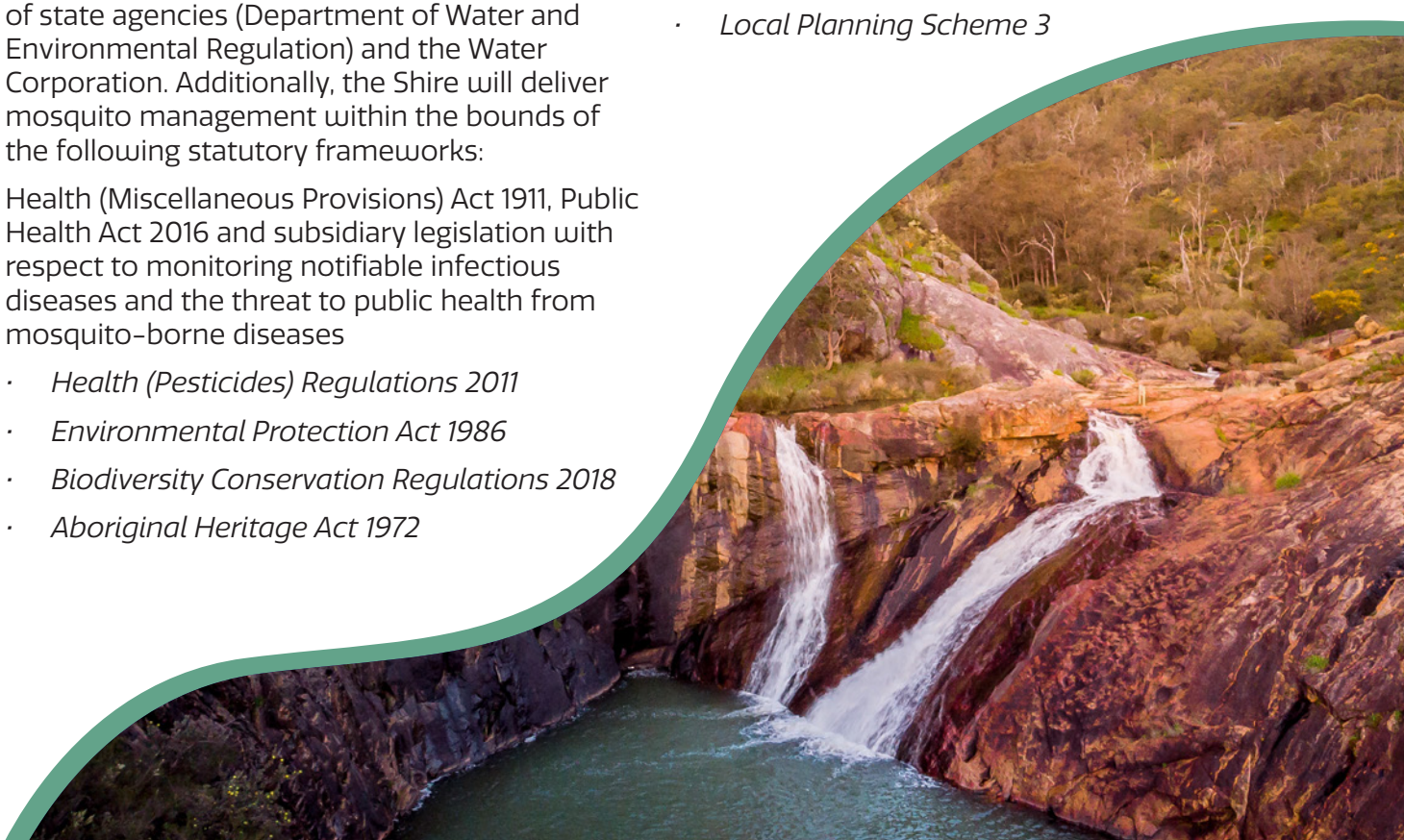
Mosquitoes can significantly restrict the enjoyment of outdoor activities causing considerable nuisance. Some species are known to present serious health risks to humans by acting as transmitters or vectors of pathogenic arbovirus such as Ross River Virus (RRV) and Barmah Forest Virus1 (BFV) (Department of Health, 2011).

The Shire's 2024-2029 Mosquito Management Plan builds upon and replaces the Shire's Mosquito Management Plan 2018. This Plan incorporates a balance of direct and indirect control methodologies that are environmentally compatible and economically feasible and are aimed at reducing mosquito populations to desired levels. The direct (reactive) control methodologies include chemical control, biological control, habitat modification and source reduction, while the indirect (proactive) methodologies include public education and awareness, and land-use planning.

The statutory controls that relate to mosquito management in the Shire primarily relate to the protection of Ramsar wetlands and waterways connecting to the Peel-Harvey Estuary catchment under the responsibility of state agencies (Department of Water and Environmental Regulation) and the Water Corporation. Additionally, the Shire will deliver mosquito management within the bounds of the following statutory frameworks:

Health (Miscellaneous Provisions) Act 1911, Public Health Act 2016 and subsidiary legislation with respect to monitoring notifiable infectious diseases and the threat to public health from mosquito-borne diseases

- *Health (Pesticides) Regulations 2011*
- *Environmental Protection Act 1986*
- *Biodiversity Conservation Regulations 2018*
- *Aboriginal Heritage Act 1972*
- *Planning and Development Act 2005* with respect to the responsibility to assess development applications that may potentially increase mosquito breeding areas or placing residents in close proximity to known mosquito breeding areas thus increasing the risk of mosquito-borne disease
- *Environmental Protection (Swan Coastal Plain Lakes) Policy 1992*
- *Wetlands Conservation Policy for Western Australia 1997*
- *Wetlands Policy of the Commonwealth Government of Australia 1997*
- *Local Planning Scheme 3*



3.0 Plan Objectives

The aim of this Plan is to protect the health, welfare and amenity of Shire residents from vector and nuisance mosquitoes. The principal objective is to reduce the risk of mosquito borne disease to the population by:

- *Identifying breeding and potential mosquito breeding areas in the Shire, particularly within high-risk urban residential growth areas.*
- *Undertaking an appropriate monitoring program – pre & post treatment data.*
- *Delivering a responsible chemical control program that considers environmental impacts the risk of chemical resistance.*
- *Disseminating public health information through integrated education programs through Department of Health – Fight the Bite campaign, CLAG regional campaigns – media ads, onsite warning signs etc.*
- *Establishing a unified community and stakeholder approach to mosquito management*

3.1 Key Factors

In considering the Plan Objectives, the key factors include:

- *Interpretation of the seasonal weather predictions such as the El Nino, La Nina and Southern Oscillation Index.*
- *Understanding the unique features of each site including application of physical reduction controls such as runnelling or filling/excluding a site.*
- *Surveillance of larvae sites – pre/post treatment, effective application of larvicide including chemical rotation to reduce resistance.*
- *Monitoring adult mosquito populations by officers and through the DOH trapping program.*
- *Monitoring the RRV/BFV isolates through the DOH virus detection data.*
- *Review the Mosquito Management Plan annually as new data is collected and before Council every 5 years.*
- *Strategically review the mosquito management budget prior to each financial year.*
- *Becoming part of the South Metropolitan Contiguous Local Authorities Group (CLAG).*

4.0 Budget and Resource Requirements

The integration of the Shire into the South Metro CLAG allows access to State funding, with 50% subsidies available for chemical treatments. This is formalised through a Memorandum of Understanding (MoU), and it is acknowledged that the CLAG funding is critical for the delivery of an effective mosquito control program.

The MoU should be directly referenced to gain an understanding of the funding commitments and process for the CLAG to set an appropriate annual member budget contribution.

The Shire provides funds separate to the CLAG for purposes outside of the auspices of the MoU such as;

- *mosquito awareness/health education,*
- *maintenance of equipment, including replacement of signage, etc.*
- *purchases of new equipment, e.g., adulticide hot/cold spray equipment, vehicles, quad bike,*
- *adulticides,*
- *general contingency fund, referenced as, "mosquito control".*

A key action forming part of this Plan, is joining the South East Metro CLAG.

An annual operational budget of $7,500, captures materials and equipment used in the management of mosquitos. This will vary, as needed, to respond to any hotspots or issues that emerge.

5.0 Stakeholders

Effective mosquito management requires consultation and collaboration with a range of internal and external stakeholders.

It is anticipated that when approving development applications and managing infrastructure, all parties involved will consider the potential for mosquito management implications. In some circumstances, mosquito control may not be recognised as a high priority due to conflict between mosquito control and the interests of internal and external stakeholders. This leaves most of the responsibility to the Environmental Health Officers (EHOs) to ensure that the MMP can be executed effectively.

The CLAG may be considered as an internal and external stakeholder as we share common boundaries, as well as a common mosquito risk problem. Pursuant to the CLAG MoU each member is reliant on the other to work in partnership to manage mosquitoes.

5.1 Internal stakeholders

In establishing a working relationship with the Environmental Health Section, the following parties can be considered as Internal stakeholders:

- Finance Department,
- Human Resources,
- Planning (land use development),
- Engineering Technical Services,
- Parks and Gardens.

5.2 External stakeholders

External stakeholders considered in establishing a working relationship with the Environmental Health Section in matters involving approvals/permission required to undertake certain mosquito control work, or for budgetary approval, include;

- DOH, (facilitate CLAG MoU, technical advice, training, mosquito-borne disease notification Disease Database (WANIDD).
- Mosquito Control Advisory Committee (MCAC), (CLAG budget and project approvals),
- Neighbouring Peel CLAG, (regional co-operation & initiatives).
- Department of Biodiversity Conservation Attractions, (DBCA), (Regional Open Space Management),
- Department of Planning, Lands and Heritage, (DPLH) (land use planning policy).

6.0 Planning for Development

New developments can significantly impact a MMP specifically within existing wetlands/ streams disturbed by new developments and new wetlands created during developments.

Notwithstanding the above, consideration should be given to all proposed developments, to address these impacts. Planning and Environmental Health teams discuss strategic and statutory planning applications, including subdivisions and development applications, and consider the mosquito management implications prior to the approval process being finalised.

New developments may require consideration if residents will be located within close proximity (3km) to a natural mosquito breeding habitat. A 1km critical distance separation will be a cause of concern in relation to a high risk of mosquito disease prevalence. Where this trigger for mosquito management is identified, subdivision and development approvals are required to prepare a localised Mosquito Management Plan as a condition of approval prior to the commencement of subdivisional works. The developer would be required to advise prospective lot purchasers that a Notification in the form of a section 70A notification, pursuant to the Act, has been placed on the Certificate of Title warning of the risk of mosquitoes and mosquito-borne disease. Developers should design and critically evaluate impacts of water management on mosquito control within a proposal.

Developments can create mosquito problems through the introduction of constructed water bodies, other water holding infrastructure such as nutrient stripping with planted vegetation. Developments generating large amounts of storm water from roofed areas and then having ponding/detention for more than 96 hours, also poses a hazard. Both can significantly impact on the mosquito management budget and required resourcing. To reduce these impacts the following is considered and addressed:

- Design,
- Maintenance/management,
- Water quality,
- Response and control actions.

Mosquito management is also addressed through Urban Water Management Plans (UWMPs) at the subdivision stage and potentially also Local Water Management Strategies (LWMS) at the structure plan stage, where applicable. This can ensure that as part of the subdivision design, water management, associated drainage and public open space is designed so as to avoid the creation of mosquito breeding habitats.

Reference should be made to Chironomid midge and mosquito risk assessment guide for constructed water bodies, Department of Health 2007. Storm water management, vegetated swales, living streams, effluent re-use are not addressed within this document and therefore should be read in conjunction with the;

- Department of Water's, Stormwater Management Manual for Western Australia and,
- Department of Water's, Decision Process for Stormwater Management in Western Australia

To assist with the identification and reduction of potential mosquito impacts any recommendations and/or requirements as part of the development approval process will be primarily communicated through the Shire's Environmental Health Team.

Apart from preliminary designs and assessments the Shire should look into long term management controls to avoid absorbing post development management costs within existing Shire budgets.

If mosquito management will not be effective or feasible, then a development may need to be reconsidered altogether, remembering that a refusal may result in a State Administration Tribunal appeal.

Reference can be made to the Environmental Protection Authority, Guidance for Planning and Development, Guidance Statement No 33, regarding land uses in areas of high conservation value.

7.0 Mosquito biology and ecology

To understand the transmission of disease and the prevalence of nuisance mosquitoes, the life cycle and habitat preferences of mosquitoes needs to be discussed.

The mosquito life cycle consists of four distinct stages: egg, larvae, pupa and adult.

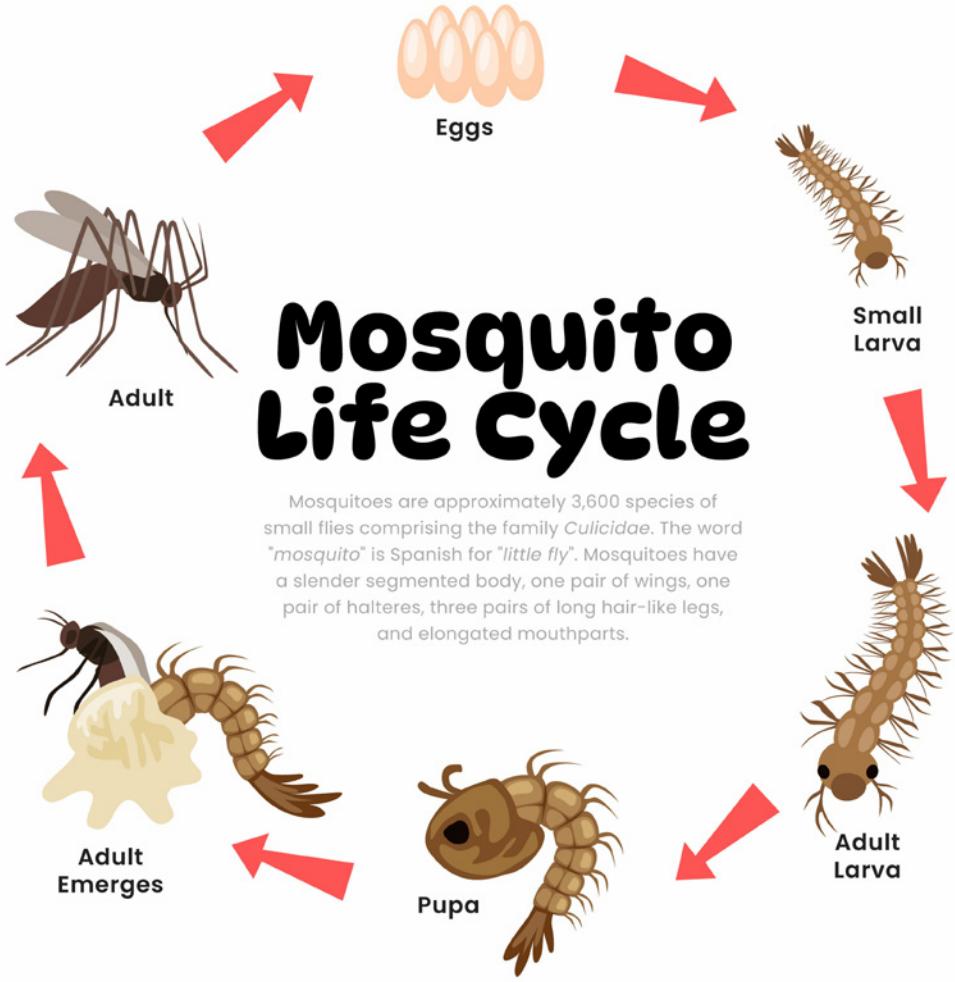
Interestingly the female mosquito is the only one that will bite, as they require a blood meal to obtain the necessary protein to produce around 100 to 500 eggs (Pacific Biologics, 2015). The eggs are laid on water bodies and depending on the species may require water for their complete development. Anopheles and Culex species of mosquitoes rely on permanent or semi-permanent water bodies as they will die if the water body dries out. While the Aedes species eggs are laid on the damp edges of waterbody and can remain viable for a considerable time until they are inundated with rainfall or tidal action.

The egg will hatch into a larvae that is entirely aquatic and will go through four stages, known as instars. After the fourth instar stage, around five to seven days after hatching, the larvae will moult and develop into a pupa which will complete its development in water or moist environment.

The larval and pupal stages of the mosquito life cycle are aquatic, feeding on microscopic organisms, decaying vegetation or bottom detritus. The larvae can be found in stagnant water such as swamps, puddles, dams as well as in animal water troughs, bowls and buckets. If no management is taken the larvae will become an adult mosquito in 4–10 days depending on the species and environmental conditions.

Following the pupa stage, the mosquito will develop into an adult mosquito and live for an average of 6 or 7 days for males and around 6 weeks for females. Anopheles and Culex species of mosquitoes may fully develop from an egg to an adult in 7–10 days while the Aedes species may take only 4–5 days.

The adult mosquito will usually remain in their larval habitat as long as there is a blood source and may only travel 50 to 100 metres. However other species may travel 1 to 5 kilometres and the Aedes vigilax may travel around 100 kilometres.



A summary of major species of mosquitos that have been identified in the Shire and the associated species characteristics are shown in Table 1.

Major Species

Mosquito Species	Distribution	Habitat & breeding preference	Dispersal capability from the breeding site	Biting habit & biting period	Active season	Human disease
Aedes notoscriptus	Throughout the Shire but most often associated with urban areas and localised complaints.	Clean water within the domestic environment; artificial containers such as: Discarded tyres & buckets, water ponds, bird baths, pet water bowls, gutters, pot plant drip, trays, self-watering pot plants, leaf axils, e.g. Bromeliads.	About 0.4 km Prefer to stay around houses. Generally, males are found within 20m of the larvae site.	Vicious; active dawn and dusk; sometimes at night and daytime; prefers shade and moist humid areas.	Most often in the warm months when domestic reticulation commences.	RRv and BFv.
Aedes camptorhynchus	Most parts of the Shire	Some opportunistic, freshwater wetlands, brackish swamps & saline affected inland regional waters	Up to 3-5 km, however, could be up to 8km.	Vicious; all times, particularly dusk & dawn.	Winter, spring and early summer.	RRv and BFv.
Aedes vigilax	Most areas in the Shire	Brackish wetlands/ streams	Generally, 5-8km; but up to 100 km.	Extremely vicious; all times. Especially during the heat of the day	Mid to late summer when air & water temps are high	RRv and BFv.

Table 1. Mosquito species identified in the Shire and associated species characteristics

Lesser Species

Mosquito Species	Distribution	Habitat & breeding preference	Dispersal capability from the breeding site	Biting habit & biting period	Active season	Human disease
Coquillettidia nr linealis	Most areas of the Shire	Permanent fresh water with Typha plant species.	1-3km based on anecdotal evidence	Vicious biters day & night.	October to January based upon complaints.	None known.
Anopheles annulipes	Some areas of the Shire	Permanent and semi-permanent freshwater bodies	Unknown	Nighttime; occasionally in day times	All year, peak in summer/ wet season	None known.
Culex annulirostris	Throughout the Shire	Permanent and semi-permanent fresh water to mildly brackish water. Prefers heavily vegetated sites	Up to 10 km.	Active in dawn, dusk and night.	Mid to late summer when water temps exceed18oC.	RRv and BFv
Culex quinquefasciatus	Some areas of the Shire	Clean or polluted water. Home environment e.g., unsealed septic tanks. Artificial containers, Urban environments in street drains around shopping centres & school car parks where reticulation run off occurs	Limited, no exact data.	Active in dawn, dusk and night.	Throughout the year.	Poor disease vector.

8.0 Environment

In Western Australia, mosquito species can be divided according to their breeding habitat such as wetlands, swamps, emergent vegetation, containers and temporary ground pools. Therefore, residents living in close proximity to mosquito natural habitats are more at risk of being impacted by nuisance levels of mosquitoes and diseases. Research shows that people who live three kilometres from salt marshes, brackish wetlands and freshwater wetlands are at greater risk of contracting Ross River Virus and Barmah Forest Virus (Department of Health, 2016). Environmental factors such as length of time standing water is available, sunlight or shade, emergent vegetation, predators and winds are important determinants for mosquito breeding habitats.

Mosquitoes are an important part of an ecosystem as they provide food for birds, bats, amphibians, fish and insects. Therefore, management of mosquitoes require a balance to minimise the impact to the environment and reduce the risk of mosquito-borne disease and nuisance levels to the community.

Most of the Shire is within the Peel Harvey catchment. The largest sub-catchment is the Upper Serpentine River, which flows east to west through the Shire passing near Serpentine. The Serpentine River is the most significant waterway in the Shire, hosting two drinking water dams. Several brooks run south and north of the river, many of which are no longer perennial (disconnected from groundwater) and respond only to direct rainfall.

As development proceeds through the southern area of the Shire and the population increases, it is likely that there will be an increased number of cases of mosquito-borne disease being driven by saltmarsh mosquito breeding especially along upper tidal reaches of the Serpentine River. A collaborative approach with the relevant CLAG is required to control the extent of breeding and control of saltmarsh mosquitoes, likely to disperse well beyond the border of Serpentine-Jarrahdale under favourable environmental conditions.

The Shire experiences a Mediterranean climate, meaning that we have cool wet winters and warm dry summers. The climate can have an impact on the availability of mosquito breeding sites and so mosquito species may fluctuate according to seasonal abundance and environmental conditions.

Extreme temperatures are detrimental in reducing the numbers of nuisance mosquitoes while milder temperatures help with their survival and dispersal (Whelan, 2017). During the warmer months, a mosquito may develop from an egg to an adult in around 4-5 days while the same species in winter may go through a period of 'larval hibernation' (Lindsay, 2011).

Rainfall also helps to provide a suitable habitat for mosquitoes as most species rely on water for the survival of larvae. If there is limited or no rainfall water bodies may dry up reducing mosquito breeding locations.

Wind plays a vital role in reducing the likelihood of mosquitoes in certain locations as the wind causes a wave action on the water surface which disrupts the larvae and pupae and impacts mosquito breeding (Midge Research Group of Western Australia, 2007). The wind can also prevent the growth of algae and aquatic weeds which provide a food source and protection for larvae.

During the Adult mosquito surveillance of 2022/2023 and 2023/2024, locations for trapping were chosen due to their proximity to streams, lakes or drains in residential areas, also equine and rural locations. A focus was made on water bodies close to residential areas to assess the impact mosquitoes have to Shire residents. Other locations were chosen to discover potential breeding sites throughout the Shire.

Common routine trapping location that are known by the Shire for risk of mosquito breeding or harbourage are below and displayed on the maps in Figure 1 and Figure 2.

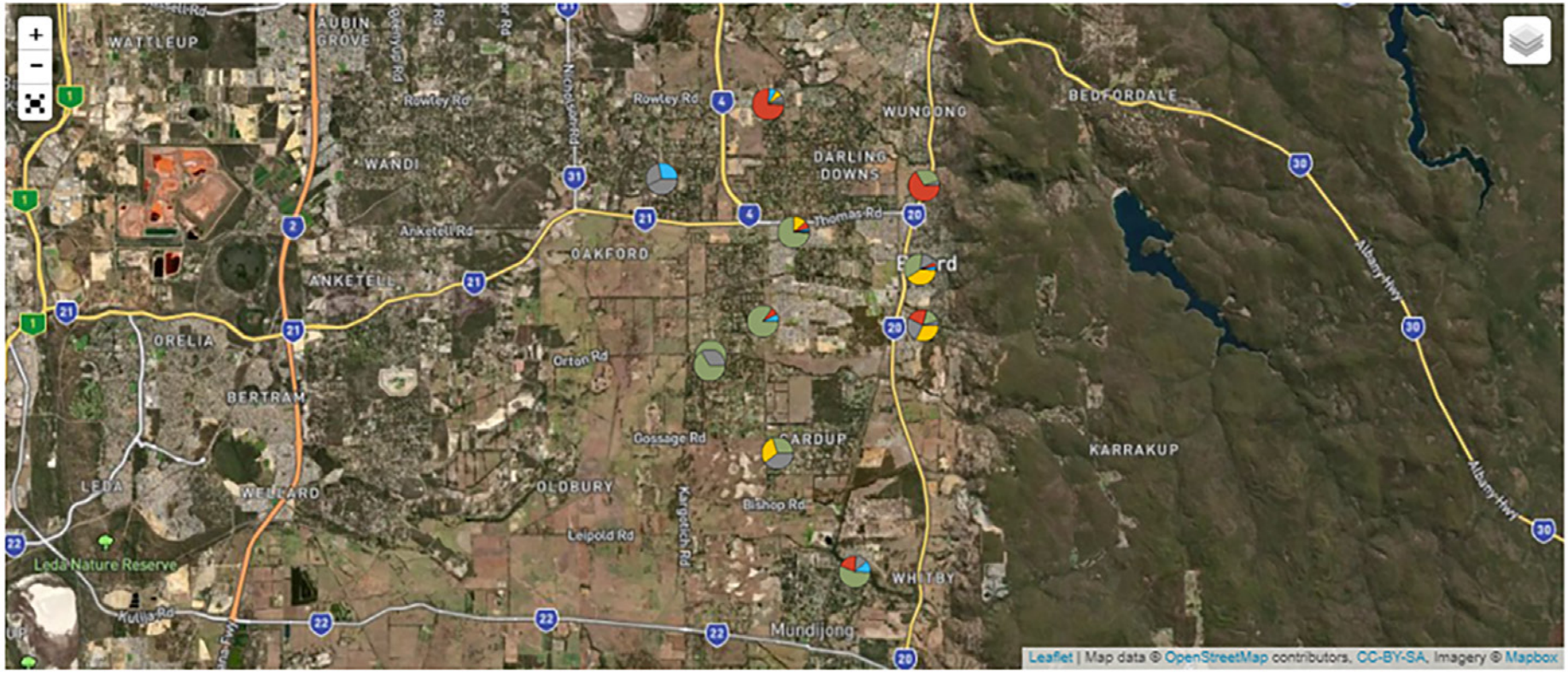
- Kandimak Boulevard, Byford
- Andalusion Avenue, Darling Downs
- Hopkinson Road, Cardup
- South Western Highway, Darling Downs
- Keirnan Street, Whitby
- Park Road, Byford
- Field view Chase, Oakford
- Orton Road, Oakford
- Gallant Turn, Byford
- Bouwman Park, Serpentine
- Jackson Road, Oldbury

The site data can include:

- Site name,
- Locations (GPS),
- Approximate inundation area,
- Vegetation types,
- Water characteristics including wind conditions which influence egg hatching,
- Site access,
- Prominent mosquito species,
- Virus isolation,
- Risk,
- Trap site present,
- Control methods

Abundance Map

Figure 1. Abundance of mosquitoes by location 22/23



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The size of the Pie Chart is is based upon the average number of mosquitoes trapped at each site.

- *Aedes camptorhynchus*
- *Aedes notoscriptus*
- *Culex quinquefasciatus*
- *Anopheles annulipes s.l.*
- *Culex molestus*
- *Tripteroides punctolateralis*
- *Aedes vigilax*
- *Culex annulirostris*
- *Anopheles atratipes*

All mosquito species coloured grey are currently not known to transmit disease to humans.

9.0 Data

Within the Shire of Serpentine Jarrahdale mosquito management is necessary for four reasons:

1. Virus Detection Data (RRV & BFV)

It has been well documented that known vectors of mosquito-borne diseases, such as Ross River virus (RRV), Barmah Forest virus (BFV) and West Nile virus (Kunjin subtype) (WNVKUN), are present within the Shire. This has been confirmed through adult mosquito trapping carried out by the Shire and the WA Department of Health (the Department) mosquito surveillance. The Shire and Department of Health conducted a virus detection program on 16 January 2024 which came back as negative for Ross River Virus, Barmah Forest virus and Japanese encephalitis virus.

2. Notified (locally acquired) mosquito-borne disease case data

Ross River Virus and Barmah Forest Virus are the most notified viruses sent to the Shire. Since the Public Health Units & Communicable Disease Control Directorate have been recording Ross River Virus and Barmah Forest Virus. From 2019 to 2020 there has been 29 cases of Ross River virus found in Shire residents and one case of Barmah Forest virus. This is enhanced surveillance data which represents cases actually obtained within SJ.

3. 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. The Aedes vigilax is one species in particular that is a ferocious bite and will attack at any time, day or night, and can travels tens of kilometres from their breeding sites.

The quantities of mosquitoes within a particular area also attribute to nuisance mosquitoes. The Shire monitors natural breeding sites and adult mosquito populations to control the number of mosquitoes found in these areas. Concerns and complaints from the community and residents can help identify problematic areas and nuisance mosquitoes. Although the Shire may not receive any or a few direct complaints per season, there is a community expectation for the Shire to manage mosquitoes at an acceptable level to reduce their impact.

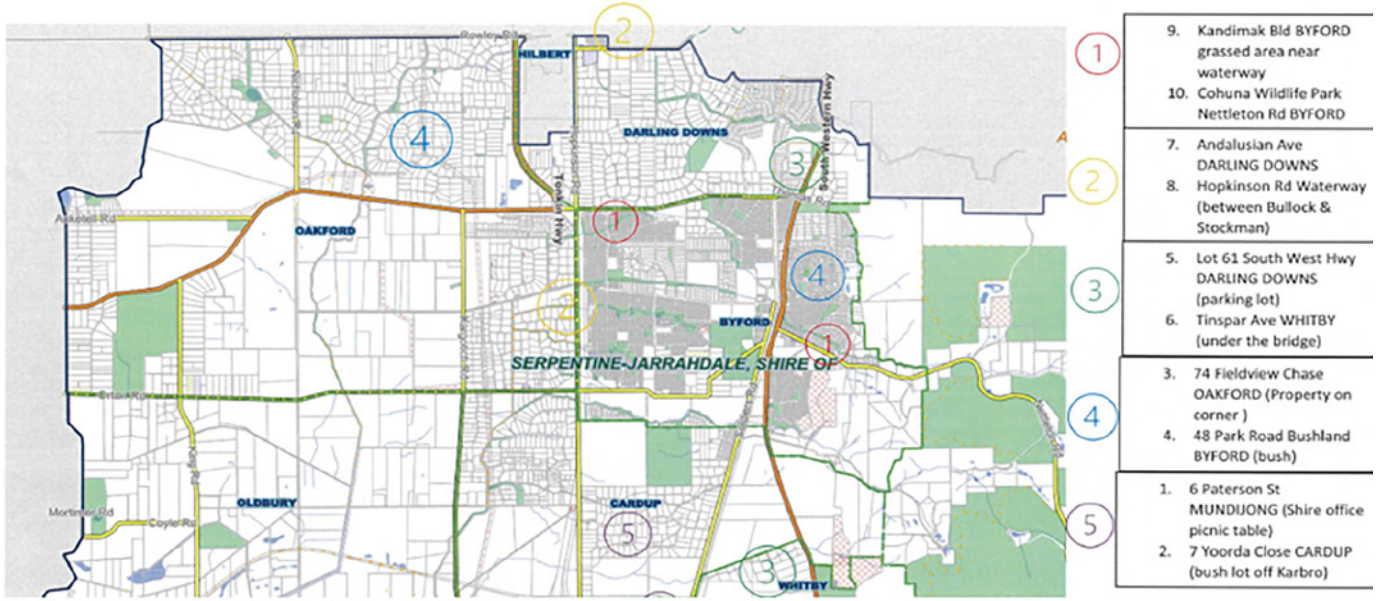


Figure 2. Locations for trapping 22/23

4. Adult trap results:

Throughout the Shire's adult mosquito surveillance, the numbers of mosquitoes depend on the rainfall, tide and temperature. At the start of the trapping season mosquito numbers are more numerous due to the presence of water, however during the warmer months majority of the water bodies dry up resulting in a reduced number of mosquitoes. The numbers of adult mosquitoes also reduce if a site is treated with larvicide which prevent the mosquito larvae from developing into an adult mosquito.

The numbers of adult mosquitoes vary from one year to the next due to variations in weather patterns and the presence of water. The 2022/23 trapping season caught a total of

331 mosquitoes across ten trap locations while the 2023/24 trapping season caught a total of 359 mosquitoes across 16 trap locations. Looking at the averages of both trapping seasons the 2022/23 season caught an average of 27.6 mosquitoes per trap while the 2023/24 trapping season caught an average of 23.8 mosquitoes per trap. The greatest number of mosquitoes trapped from both seasons was at Kandimak Boulevard, which has a small stream and trees amongst dense residential areas. The water in this location dries up by mid-November which reduces the numbers of mosquitoes. In 2022/23 season a total of 146 mosquitoes were caught at Kandimak Boulevard and the 2023/24 season caught 87 mosquitoes.

All adult mosquitoes trapped within the Shire have been female because they are attracted to the Carbon Dioxide within the traps mimicking a host as only females feed on blood for the development of their eggs, male mosquitoes feed only on plant juices such as nectar, to get the sugar they need for energy and survival.

Identification of adult mosquitoes shows that the Shire has more dominant species than others, however, may vary from one season to the next. The most common type of mosquito found within the Shire is the Aedes Notoscriptus as noted during the 2022/23 and 2023/24 trapping season. This type of mosquito is consistent with urban environments breeding in water holding containers and has been associated with the localised/urban transmission of RRV outbreaks. Aedes vigilax and Aedes campthorhyncus are vectors of both RRV and Barma Forest virus and have been trapped around the Shire.

Total Abundance of Adult Mosquitoes

Aedes

2020	
2021	
2022	304
2023	158
2024	17

Camptorhynchus

Notoscriptus

Vigilax

Culex

2020	
2021	
2022	27
2023	126
2024	48

Annulirostris

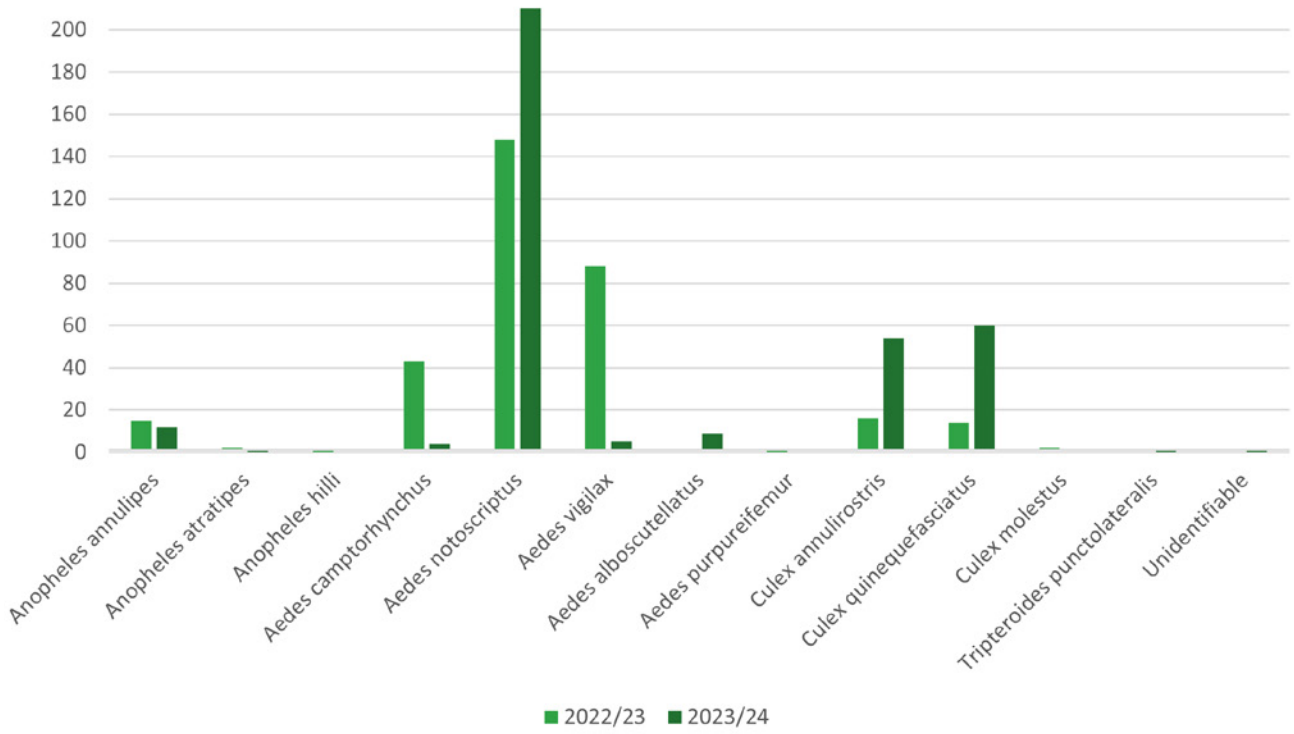
Quinqufasciatus

Anopheles

2020	
2021	
2022	12
2023	4
2024	6

Annulipes

Adult Mosquito Identification 2022/23 and 2023/24



Adult Mosquitoes Identified	2022/23	2023/24
Anophele annulipes	15	13
Anopheles atratipes	2	0
Aedes camptorhynchus	43	4
Aedes notoscriptus	149	242
Aedes vigilax	88	5
Aedes purpureifemur	0	1
Culex annulirostris	16	54
Culex quinequefasciatus	14	60
Culex molestus	2	1
Tripteroides atripes	1	0
Unidentifiable	1	0
Total	331	380

10.0 Monitoring

Monitoring is necessary to determine mosquito population dynamics and to identify mosquito breeding sites. The monitoring will provide a risk-based assessment to determine how mosquitoes within a certain area are to be managed to meet the desired level of mosquito control. The monitoring provides sufficient data of disease vector and nuisance mosquitoes to ensure the health, welfare and amenity of residents without any adverse environmental impact.

During the mosquito management season, (usually September to April) the Shire will complete weekly larval monitoring in areas where water is present and develop a threshold for treatment based on the impacted area. The dipper will be used to sample an area and is examined for mosquito larvae. If mosquito larvae is present, they will be extracted from the sample using a pipette and put in 60 ml of the sampled water and taken to the office for rearing and identification. Other data will be recorded during larvae monitoring such as the depth/extent of water, a description of the area, other animals or birds in the area, larval density and any other general information.
The larval density will be recorded using the following formula:

N *– number of larvae in sample*

S *– surface area of scoop cm2 (pie x radius 2)*

$$\textit{Number of larvae per m2} = \frac{1000}{S} \times N$$

Adult mosquitoes will be monitored using CO2 baited traps, otherwise known as light traps. Trapping will occur at least once per week during the mosquito monitoring season, from September to April for the purpose of informing and evaluating treatments. The traps are set up in the late afternoon, around 4:30/5pm and are collected the following morning around 8:30am. The trapped mosquitoes are taken back to the office and put in the freezer to be identified later. Identification will usually take place the day the mosquito was trapped or the following day. The number of mosquitoes are recorded as well as the species referencing the Atlas of Environmental Health. Recorded information will also include the locality, collectors name, sex of the mosquitoes and environmental conditions.

11.0 Chemical Control

Mosquito larvae is controlled with the use of larvicide when larvae are discovered at locations. There are current two types of larvicide used by the Shire; S-Methoprene and Bacillus thuringiensis subsp. Israelensis (Bti) or a combination of both. As S-methoprene is an insect growth regulator that interferes with the larvae normal development, which prevents the larvae from growing into an adult mosquito, Bti on the other hand kills the actively feeding larvae. Larvicide is target specific if applied at the label rate, requires no specialist equipment in treating small areas.

Larvicide group	Active constituent	Control period	Mode of action	Application timing
Bacterial toxin	Bacillus thuringiensis subsp. Israelensis (Bti)	One larval generation	Damages gut lining and prevents nutrient absorption, after ingestion. Death occurs within 24 hours.	Apply during feeding stages. Late 1st to early 4th instar
	Bacillus sphaericus (Bs)	Up to 3 weeks	As above. Replicates in water, producing spores that kill mosquito larvae, after ingestion. Product of choice for polluted environments eg. sewage lagoons.	Apply during feeding stages. Late 1st to early 4th instar (residual effect provides coverage for 3 weeks)
Insect growth regulator (IGR)	(S) - methoprene	Liquid: one generation Granule: one generation Pellets: 30 days Briquets: <150 days	Absorbed through outer cuticle, disrupts larval development. Death is more protracted. Mosquitoes fail to emerge as adults and usually die at pupal stage.	Timing is important. Apply 2nd to early 4th instar

12.0 Actions

Strategy	No.	Management Action
Collaboration	A1	Recognise that the mosquito problem does not respect municipal boundaries by entering into the South Metro Continuous Local Authorities Group (CLAG) partnership agreement.
	A2	Actively work with other South Metro CLAG member local governments on mosquito management in areas of concern across shared borders.
	A3	Actively work with other CLAG's on mosquito management in areas of concern across shared borders.
	B1	A Notification pursuant to section 165 of the Planning and Development Act 2005 will be recorded against the Certificate of Title of each new development lot located within a defined buffer of known vector breeding sites. The notification is to state as follows: *"This lot is in close proximity to known mosquito breeding areas. The predominant mosquito species is known to carry viruses and other diseases." (Western Australian Planning Commission).*
	B2	A Memorial will be placed on the Certificate of Title of each new development lot located within a defined buffer of known vector breeding sites.
	B3	During the development of a Structure Plan or subdivision, where the land is located within a defined buffer of known vector breeding sites, includes wetlands, or where a constructed wetland/detention basin is proposed, the landowner will prepare and implement a mosquito management plan (MMP) to the Shire's satisfaction. The MMP will be styled on the Department of Health 2014 document.
	B4	All Shire-approved MMPs that are prepared for residential development sites that contain a constructed wetland will be required to include a risk assessment matrix for the Shire's review to enable modifications to be implemented prior to construction commencing.
	B5	Stormwater storage will be designed to ensure that all stormwater is fully infiltrated within 96 hours to prevent the establishment of breeding habitat (WAPC, 2008).
Monitoring	C1	A monitoring programme will be implemented by the Shire at monitoring sites that are to be determined annually by the Coordinator Environmental Health based on suspected risk areas and areas identified through community complaints.
	C2	To facilitate mosquito management documentation, a series of standard operating procedures will be developed by the Shire. These may include: pre- treatment larval data sheet, field treatment data sheet, post-treatment larval data sheet, adult monitoring data sheet.
	C3	Shire adult and larval mosquito monitoring will be carried out on a fortnightly basis from September-April and once per month during May-August using the relevant standard operating procedures. The data obtained from each monitoring session will be added to the electronic management programme database and included in the annual report.

Strategy	No.	Management Action
Documentation	D1	Recognise that the mosquito problem does not respect municipal boundaries by entering into the South Metro Continuous Local Authorities Group (CLAG) partnership agreement.
	D2	Actively work with other South Metro CLAG member local governments on mosquito management in areas of concern across shared borders.
	D3	Actively work with other CLAG's on mosquito management in areas of concern across shared borders.
	D4	A database system that includes all information relating to mosquito management measures implemented within the Shire during will be maintained and updated regularly. Regular review of the information will be undertaken to ensure that the monitoring and control strategies are being implemented effectively.
Physical Control	E1	A drainage maintenance prioritisation tool will be developed to help inform the drainage maintenance program based on public health risks associated with mosquito borne disease.
	E2	Turf within Shire managed POS areas will be maintained with clippings removed from the road surface to reduce nutrient and debris input into drainage infrastructure.
	E3	Fertiliser use on turf within Shire managed POS areas will be minimised to prevent an increase in nutrient levels above acceptable levels within the stormwater system. Soil testing is undertaken to fertilise as required on specific reserves.
	E4	A programme will be developed to identify all Shire gross pollutant traps for inspection, to prevent blockages and retention of stagnant polluted water.
	E5	Based on priority, a maintenance programme for wetlands, constructed lakes, drainage basins and drainage swales will be implemented in Shire managed POS areas. Weeds identified will be controlled by either manual removal or spot herbicide application.
	E6	Street sweeping will be implemented on a regular basis to reduce nutrient input to the stormwater system.
	E7	Monitoring of soak wells and bubble-up pits in POS areas will be conducted regularly and larviciding treatments implemented as required.
	E8	Larviciding of standing water within POS areas will be undertaken during peak mosquito breeding times when larval monitoring indicates 'nuisance' populations of major pest and vector species.
	E9	Larvicides will be applied in accordance with the manufacturer's recommended application rates identified in the MSDS for each larvicide using calibrated equipment that are operated by operators who are qualified to undertake such work, are licenced by the DoH to perform these activities and are experienced in mosquito control.
	E10	Stormwater storage will be designed to ensure that all stormwater is fully infiltrated within 96 hours to prevent the establishment of breeding habitat (WAPC, 2008).

Strategy	No.	Management Action
Chemical Control	F1	Adulticiding (fogging) for mosquito species will only be carried out when the DoH advises that there is a public health imperative for it to be conducted and when environmental conditions are determined to be suitable
	F2	Larviciding of standing water within POS areas will be undertaken during peak mosquito breeding times when larval monitoring indicates 'nuisance' populations of major pest and vector species.
	F3	Larvicides will be applied in accordance with the manufacturer's recommended application rates identified in the MSDS for each larvicide using calibrated equipment that are operated by operators who are qualified to undertake such work, are licenced by the DoH to perform these activities and are experienced in mosquito control.
	F4	Standard Operating Procedures will be followed during the implementation of chemical control actions and Data Sheets will be used to record all data gathered prior to all information being entered onto the electronic database.
Biological Control	G1	Healthy ecosystems will be promoted through maintaining the abundance and diversity of predator species within the drainage basins and swales in all Shire vested POS areas.
Cultural Control	H1	Carry out annual community education by promoting the DoH "fight the bite" campaign and providing educational material in multiple formats
	H2	Conduct adult and larval mosquito surveys in alignment with individual MMPs and include results in the CLAG's annual report.
	H3	The Shire's website will include up to date information on monitoring results, current DoH warnings, vector-borne disease information and how to reduce mosquito breeding around the home.
	H4	Where proposed residential developments include, or are adjacent to natural wetlands, open drains or when constructed wetlands are proposed for construction, community education will be included as part of any Shire approved mosquito management plan.
Implementation	I1	Should proposed control measures not be effective in reducing mosquito numbers, the Shire will investigate alternative measures in consultation with the DoH.

Strategy	No.	Management Action
Training/Staff Develop	J1	All Environmental Health Officers should be conversant with this Plan, including the location of the monitoring sites, basic monitoring procedures and any occupational health and safety issues arising from their participation in its implementation.
	J2	All Shire Staff involved in the application of larvicides or adulticides must be suitably trained
	J3	All Shire Staff involved in the planning/development process and whose decision-making may have an impact on the implementation of the Mosquito Management Plan should be briefed on its objectives and implementation.
Funding	K1	An operational annual budget of approximately $7,500 is required for mosquito management activities,
Reporting	K2	Prepare evidence-based business cases to seek external funding for mosquito management activity such as drainage surveying, maintenance works or other projects requiring a capital expenditure
	K3	in the CLAG's annual report, include results of adult and larval mosquito surveys conducted in alignment with individual MMPs
	K4	in the CLAG's annual report, include information of all chemical treatments (date, product used and size of treatment)
	K5	Provide a summary of mosquito management activity to Council as part of the quarterly public health performance planning updates

Strategy	No.	Management Action
Training/Staff Develop	J1	All Environmental Health Officers should be conversant with this Plan, including the location of the monitoring sites, basic monitoring procedures and any occupational health and safety issues arising from their participation in its implementation.
	J2	All Shire Staff involved in the application of larvicides or adulticides must be suitably trained.
	J3	All Shire Staff involved in the planning/development process and whose decision-making may have an impact on the implementation of the Mosquito Management Plan should be briefed on its objectives and implementation.
Funding	K1	An operational annual budget of approximately $7,500 is required for mosquito management activities.
Reporting	K2	Prepare evidence-based business cases to seek external funding for mosquito management activity such as drainage surveying, maintenance works or other projects requiring a capital expenditure.
	K3	in the CLAG's annual report, include results of adult and larval mosquito surveys conducted in alignment with individual MMPs.
	K4	in the CLAG's annual report, include information of all chemical treatments (date, product used and size of treatment).
	K5	Provide a summary of mosquito management activity to Council as part of the quarterly public health performance planning updates.

13.0 Strategic Context

This Mosquito Management Plan 2024–2029 is an informing strategy integrated into future plans process required under the Local Government Act 1995. The development of a Mosquito Management Plan is a mandatory requirement for the Shire in forming part of the South Metro Contiguous Local Authorities Group (CLAG) that enables access to financial assistance from the Department of Health towards mosquito management.

Within the Shire's Integrated Planning and Reporting Framework is the Shire's Council Plan 2023 – 2033 which is a 10-year strategy shaped by the community. This Mosquito Management Plan aligns with the Council Plan pillar of 'Thriving' for its proposed partnership through a CLAG and the pillar of 'Liveable' by protecting and enhancing a safe environment for the community.

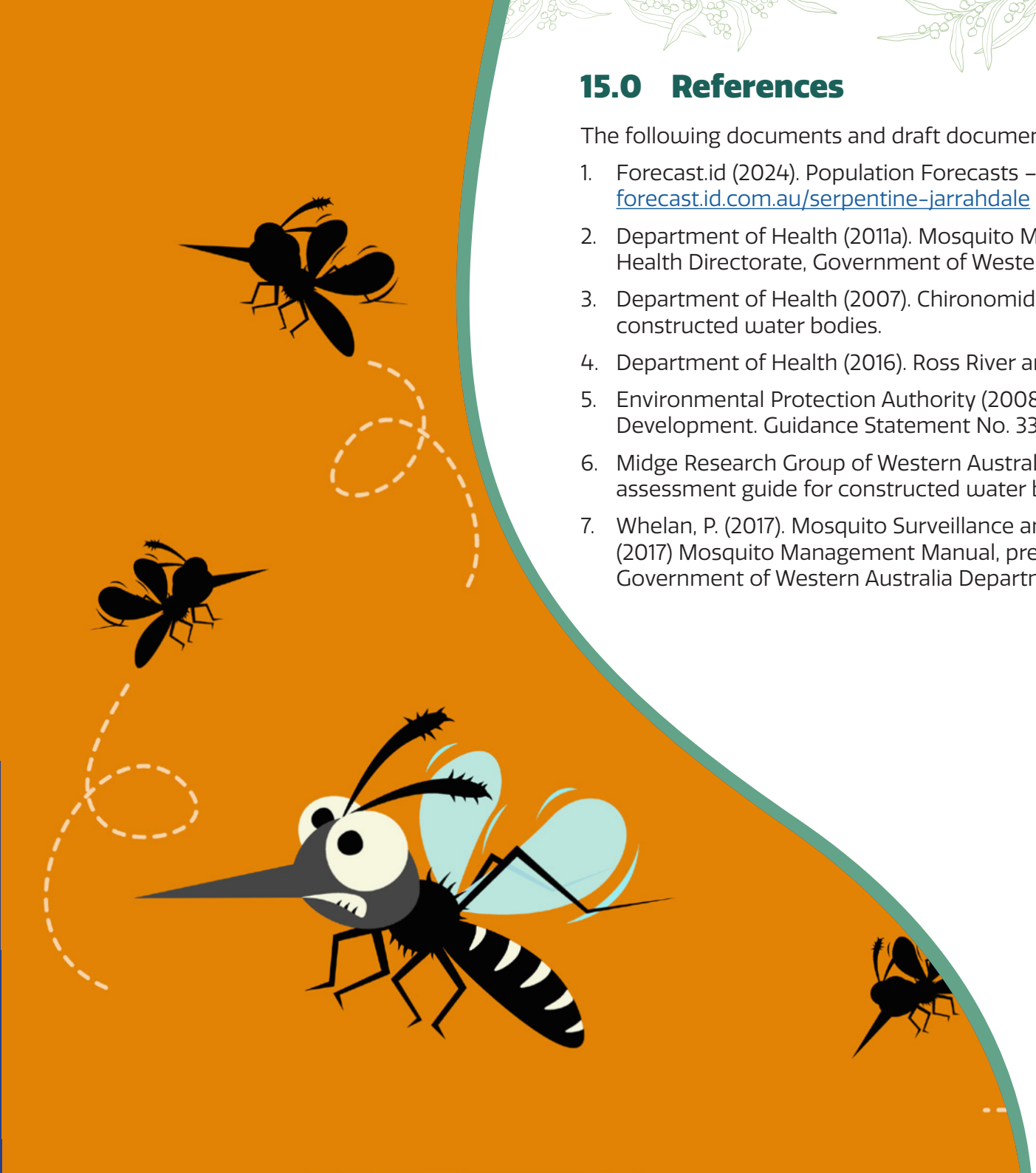
Through careful operational planning and prioritisation, the outcomes and objectives become deliverable actions in the four-year Corporate Business Plan 2023–2027, which is delivered through the adoption of an Annual Budget.

14.0 Acknowledgements

The Shire would like to acknowledge the contribution of the WA Department of Health Medical Entomology team, Shire service teams who provided feedback on the services they provide which contribute to the mosquito management and members of the community who provided valuable feedback to shape what we deliver in this Strategy.

The following documents were also used to complement this strategy:

1. Shire of Serpentine Jarrahdale Council Plan 2023–2033
2. Shire of Serpentine Jarrahdale Corporate Business Plan 2023–2027
3. Shire of Serpentine Jarrahdale SJ2050
4. Shire of Serpentine Jarrahdale Health and Wellbeing Strategy 2020 –2024
5. Shire of Serpentine Jarrahdale Mosquito Management Plan 2018
6. A Guide to developing a Mosquito Management Plan for Local Government



15.0 References

The following documents and draft documents were also used to complement this strategy:

1. Forecast.id (2024). Population Forecasts – Shire of Serpentine Jarrahdale,[Online] from: https://forecast.id.com.au/serpentine-jarrahdale
2. Department of Health (2011a). Mosquito Management Manual. Prepared by the Environmental Health Directorate, Government of Western Australia Department of Health.
3. Department of Health (2007). Chironomid midge and mosquito risk assessment guide for constructed water bodies.
4. Department of Health (2016). Ross River and Barmah Forest Virus.
5. Environmental Protection Authority (2008). Environmental Guidance for Planning and Development. Guidance Statement No. 33. Perth, Western Australia. May 2008.
6. Midge Research Group of Western Australia (2007). Chironomid midge and mosquito risk assessment guide for constructed water bodies. Midge Research Group of Western Australia.
7. Whelan, P. (2017). Mosquito Surveillance and Monitoring Techniques. In: Department of Health (2017) Mosquito Management Manual, prepared by the Environmental Health Directorate, Government of Western Australia Department of Health

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