Bellvista 2

Precinct 1 & 2 Caloundra South Urban Development Area

Biting Insect Investigation and Mitigation Report

For

Stockland Developments Pty Ltd (Sunshine Coast)

Prepared by

Darryl McGinn
Director and Principal Investigator

Version 6.0
22 November 2010

Mosquito Consulting Services Pty Ltd
ACN 095 739 067
PO Box 339 Mt Ommaney QLD 4074
Ph./Fax: (07) 33761856
Mobile: 0404043867
e-Mail: Darryl.McGinn@mcspty.com
ABN: 16 095 739 067

1.0 Background

In April 2009, Stockland Developments Pty Ltd engaged Mosquito Consulting Services Pty Ltd to conduct a Biting Insect Investigation for its proposed development of Bellvista Stage 2 at Caloundra. On 22 October 2010, the Urban Land Development Authority (ULDA) published the Caloundra South Urban Development Area: Interim Land Use Plan: Version 1 (ILUP). This report has been revised to address the ILUP.

Section 5.6 of the ILUP sets out the principles and requirements for achieving desirable Environmental and Sustainable Development outcomes. Within this section are stated requirements to mitigate impacts from biting insect breeding habitat and to also minimise adverse impacts on amenity during construction (and in this context –biting insects are presumed to be included).

Prior to the publishing of the Caloundra South ILUP, the reference document by which biting insect issues were addressed was the Sunshine Coast Regional Council (old Caloundra City Council) Biting Insect Code. While it is noted that Section 1.4 of the ILUP excludes other planning instrument provisions unless specifically called up within the ILUP, mitigation of biting insect impacts is included as a requirement however, the ILUP contains no reference or guidance as to how to assess this issues.

This report makes the assumption that the above mentioned Biting Insect Code is consistent with the objectives of the ILUP requirements to mitigate biting insect impacts and provides a useful precedent for assessing biting insect issues within the ILUP.

This report contains information to satisfy the Biting Insect Code and includes the entomological study component of the impact assessment. The study was conducted during seasonal conditions that have produced representative abundance of mosquitoes as required in the Code's Guidelines (11.6.5 – 2). Indeed the report is a composite of three separate biting insect surveys completed by the Author on this and adjacent sites between October 2004 and May 2009.

2.0 Scope and assumptions of this report

The development site lies within 15 Km of Pumicestone Passage. This (prior to the ILUP) trigged the application of Biting Insect Code in relation to this assessment. This report deals mostly with mosquitoes. The site is considered to be located beyond the generally accepted pest flight range of most marine biting midge species. Negligible numbers of biting midge (relevant to human biting) recovered in study light traps validated the above assumption.

This report deals with:

- The methodology of the Investigation and include:
  - Detail of the entomological survey that was undertaken for adult mosquito and their potential breeding sites,
  - Indicate the risk assessment that was used to characterise and prioritise the hazards for public health and amenity.
- Comments on the way the development will address the Biting Insect Code Specific Outcomes (7.4.3) including:
  - Design of the development to minimise risk (Outcome 1) – and consistent with the ILUP Section 5.6,
  - Mosquito control that may be required during construction and amelioration of existing mosquito breeding where appropriate (Outcome 2) – and consistent with the ILUP Section 5.6,
  - Provide recommendations for design of any storm water control devices to minimise risk of mosquito production (Outcome 3)
  - Recommendations for the development that will include passive control through urban design (Outcome 4).

3.0 Context of the Development Site and Future Land Use

Bellvista 2 will interface with relatively natural habitat that will remain on its western and southern boundary. The southern margin of the development is bounded by Lamerough Creek. To the south of Lamerough Creek that largely includes the balance of the Caloundra South Urban Development Area. Plate 2 shows the proposed development relative to the natural habitat of Lamerough Creek and the adjacent area of Caloundra South.

The Caloundra South UDA (along with most of the coastal environment of Australia) is generally regarded as having high seasonal exposure to biting insects including mosquitoes and biting midge. Biting insects have a complex interaction with humans. There are more than 275 described species of mosquitoes within Australia and for almost any given coastal location; it is common to record upward of 50 species. As a group with many species each with its specific biology and ecology, mosquitoes are very diverse in their selection of breeding habitat. Mosquito breeding is however always linked with availability of water. Habitats used by mosquitoes are diverse and include freshwater ground pools of transient or permanent nature, urban artefacts (man-made articles around domestic/industrial activity), saline wetland including intertidal estuarine habitat and salt-marsh. Biting midges that impact on humans are a far less diverse group with generally less than 6 species involved. Both mosquitoes and biting midge can impact on amenity through nuisance biting.

The potential impact of nuisance biting is highly contextual subject to the human activity involved and abundance of biting insects. Generally being bitten during casual recreational activity is not as seriously regarded as chronic exposure people may endure in the home. The degree of domestic

exposure to biting insects is highly variable subject to the proximity of urban development to biting insect breeding and harbourage habitat and the seasonal factors (temperature, rainfall, tidal activity) that drive biting insect production. In addition to the adverse impact on amenity that may be produced by biting insects, their role in transmission of disease and adverse public health outcomes is the principle reason for ensuring new urban development addresses this issue.

Many species of mosquito likely to be abundant within the coastal zones of Australia are considered important vectors of human disease. The most common diseases currently impacting on coastal communities include Ross River virus and Barmah Forest virus. More than 35 mosquito species are known to carry either or both of these viruses. Up to 10 mosquito species commonly present in coastal areas are considered very important vectors of human disease.

4.0 Bellvista 2 Entomological Study Methodology

4.1 Adult mosquitoes

Adult mosquito populations were characterised by collecting them in light traps baited with carbondioxide and the chemoattractant, Octenol. Adult mosquitoes were collected into 70% alcohol for preservation. They were later identified to species by microscopy. Data on species abundance was recorded for each trap location. Seasonal weather conditions were monitored over the collection period to assist data interpretation. Plate 1 shows the type of light trap that was used.

Plate 1. Light Trap With CO_2 & Octenol

4.2 Mosquito Breeding Sites

The development site was surveyed for the presence and extent of potential mosquito breeding habitat. A portion of the development master plan is overlayed onto the existing habitat (aerial photograph) site map (Plate 2) to show the natural habitat in context with the proposed form of the development.

Ground water was sampled for mosquito larvae. Where larvae samples were taken, they were returned for identification to species. Evidence of potential habitat was noted during the survey and included in this report as likely for production of specific species.

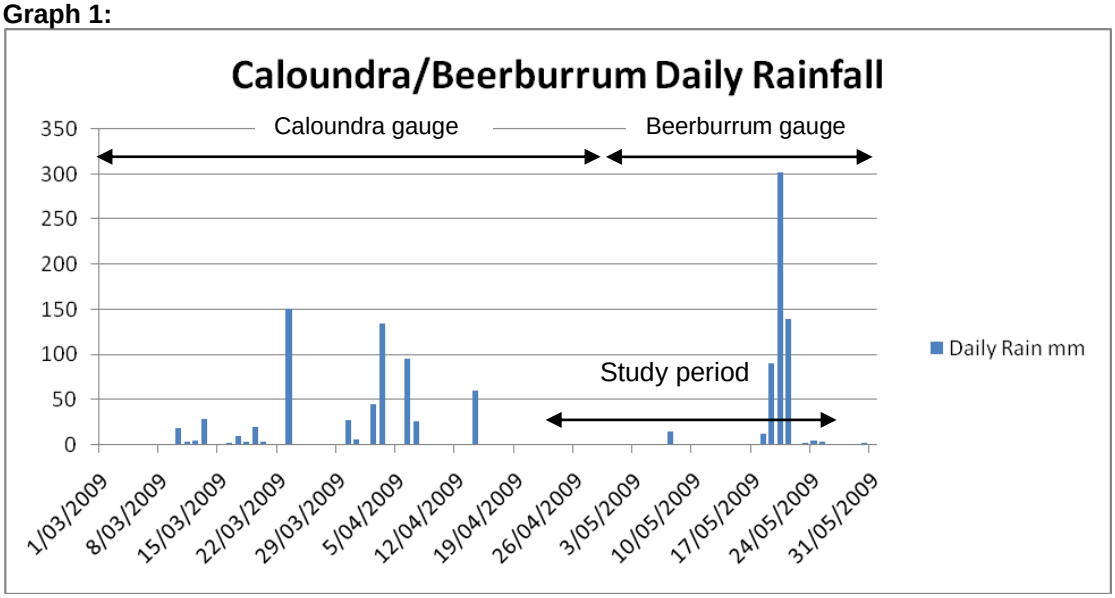
Plate2: Bellvista 2 Proposed Plan and Aerial Photo of Site and Historic Mosquito Trapping Locations (Oct 04 to May 09)

5.0 Survey Results

5.1 Weather Conditions

Weather conditions prior to the mosquito trapping for May 2009 were characterised by high rainfall that produced numerous ground pools suitable for mosquito breeding. Graph 1 shows daily rainfall for the Caloundra rain gauge (26.7850°S 153.1147°E) up to 1 May 09 and the Beerburrum gauge (26.9586°S 152.9619°E) to 31 May 09. The Beerburrum gauge returns are used for May due to an apparent failure in the Caloundra instrument during extreme weather events in mid May.

Graph 1:



The weather conditions were considered appropriate for representative mosquito sampling except that some site flooding likely suppressed *Culex annulirostris* breeding. This has been taken in to account when assessing the potential risk for this species.

5.2 Adult mosquitoes

The adult mosquito collection specifically on the Bellvista 2 site comprised 16 trap nights from 23 April to 14 May 2009. Twenty species of mosquitoes from 6 genera were represented within the light trap collections.

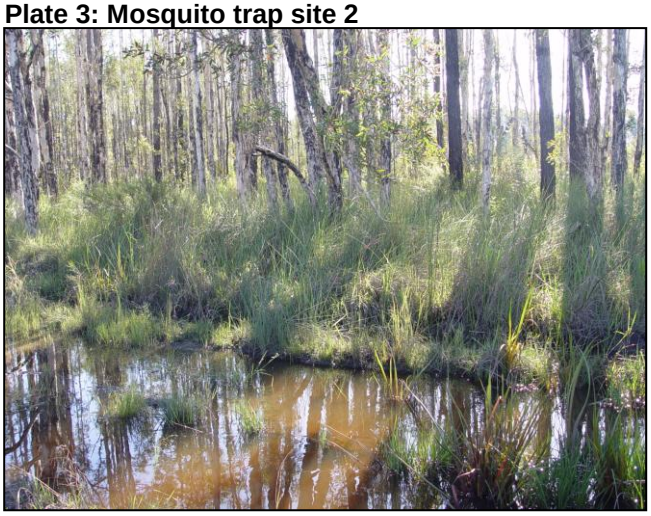
The most abundant mosquitoes collected were *Verrallina* Marks (mixed) *spp* 52&53 accounting for 38% of the total with an average of 1,026 per trap per night. Following next in abundance were *Coquillettidia linealis* (25.2% and averaging 680/trap/night) and *Aedes procax* (21% and averaging 567/trap/night). The three most abundant species collectively represented 84% of the mosquitoes represented during this study.

The most abundant species – *Verrallina* Marks (mixed) *spp* 52&53 are not considered to be of any public health or amenity risk as they are not know to transmit mosquito-borne disease nor are they noted for any significant nuisance biting attacks. Therefore if they are removed from further consideration of risk, the remaining most abundant species that are of note, *Coquillettidia linealis* and *Aedes procax* represent 46.2% of the total collection.

Other medically important species, but which were poorly represented, within the 2009 collections were *Culex annulirostris* (1.8%: Ave 48/trap/night); *Verrallina funerea* (1.7%: Ave 45/trap/night); and *Aedes vigilax* (0.6%: Ave 17/trap/night).

Trap location 2 (See Plate 3) produced the highest collections of the 4 trapping sites. It was adjacent to *Melaleuca* forest flooded by recent rain. Ground pools and emergent vegetation provides suitable habitat for many species including *Aedes procax* and *Coquillettidia linealis* that were abundant at this location.

Plate 3: Mosquito trap site 2



Trap location 4 (Plate 4) yielded the lowest number of mosquitoes. It was located within the vegetated margin of Lamerough Creek (See Plate 2).

Plate 4: Mosquito Trap Site 4

Table 1 summarises the adult mosquito collection and shows the range of abundance for each species and trap location with highest and lowest collections.

Table 1: Summary: Adult mosquito collections Bellvista 2 (April – May 2009)

Species	Average per trap	Percent of Collection	Range for all traps Highest/Lowest	Trap Location Highest/Lowest
Ve sp Marks 52/53	1026	38.0	3304/144	2/1
Cq linealis	680	25.2	2080/180	2/3
Ae procax	567	21.0	1816/66	1/4
Cq xanthagaster	142	5.2	380/4	3/4
Cx orbostiensis	80	3.0	280/8	2/4
Cx annulirostris	48	1.8	108/0	4/4
Cx whitmorei	46	1.7	96/0	1,2/3
Ve funerea	45	1.7	120/0	2/3
Ae ghanacola	19	0.7	56/4	1/1
Ae vigilax	17	0.6	56/0	2
Ae lineatopennis	11	0.4	48/0	4
Cq varagata	5	0.2	23/0	3
Ae multiplex	4	0.1	16/0	1
Ma uniformus	3	0.1	12/0	1
Ae burpengaryensis	3	0.1	16/0	2
Ae vittiger	3	0.1	8/0	2,3
An atratipes	3	0.1	8/0	3
An annulipies	2	0.1	8/0	1
Cx australicus	1	0.0	8/0	3
Ae notoscriptus	0	0.0	0/2	2
Collection		**100**	**7720/470**	**2/4**

5.2.1 Relevant Historical Mosquito Trapping Data

In addition to the more recent (2009) mosquito trapping undertaken for this report, mosquito risk has been informed by reference to historical mosquito trap data produced by the Author on adjacent development and investigation sites over the previous 5 years. Five trapping sites immediately to the east of Bellvista 2 investigated adult mosquito abundance during October to December 2004. Mosquito trapping was also undertaken associated with preliminary investigations on “Caloundra Downs” (now part of Caloundra South UDA) between October 2005 and April 2006. Three of these sites were located close to the Bellvista 2 site (with one site common to both studies). Plate 2 shows the locations of the relevant historical trapping sites (red and green star icons) in context with the more recent Bellvista 2 sites (yellow star icons).

(Oct-Dec 2005)

The adult mosquito collection on the 2004 study (green star icon – Plate 2) comprised 17 trap nights spanning 2 months. A total of 29,636 mosquitoes from 19 species and 6 genera were collected. The most abundant mosquito collected was *Aedes vigilax* at 36% of the total. Following in abundance were *Coquillettidia linealis* – 25%, *Verrallina* Marks sp # 122 – 4.3% and *Culex annulirostris* – 3.6%.

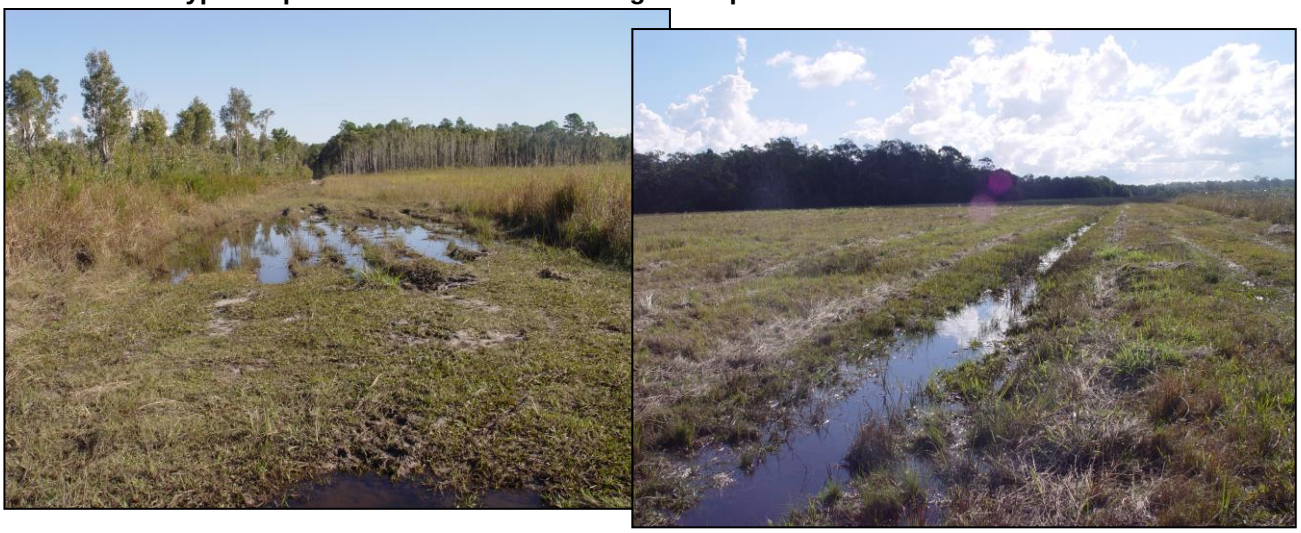
(Oct 2005 – April 2006)

For the three sites adjacent to the Bellvista 2 site (red star icons – Plate 2) , the 4 most abundant mosquito species recorded were (in order), *Verrallina* Marks *spp, Coquillettidia linealis, Aedes procax* and *Culex annulirostris*.

5.3 Mosquito Breeding Sites

Potential breeding habitat for mosquitoes were surveyed over the course of the 2009 study both on-site and near off-site. The major class of potential mosquito breeding relative to the development are the numerous fresh-water ephemeral stormwater filled ground pools and semi-permanent ground pools. Ephemeral ground pools (Plate 5 for typical examples) occupied a very significant proportion of the development site and adjacent lands. This type of habitat is preferred by a number of mosquito species collected during the study. These include (but are not limited to) *Culex annulirostris*, (possibly) *Aedes procax*, *Aedes vittiger,* and *Anopheles annulipies.*

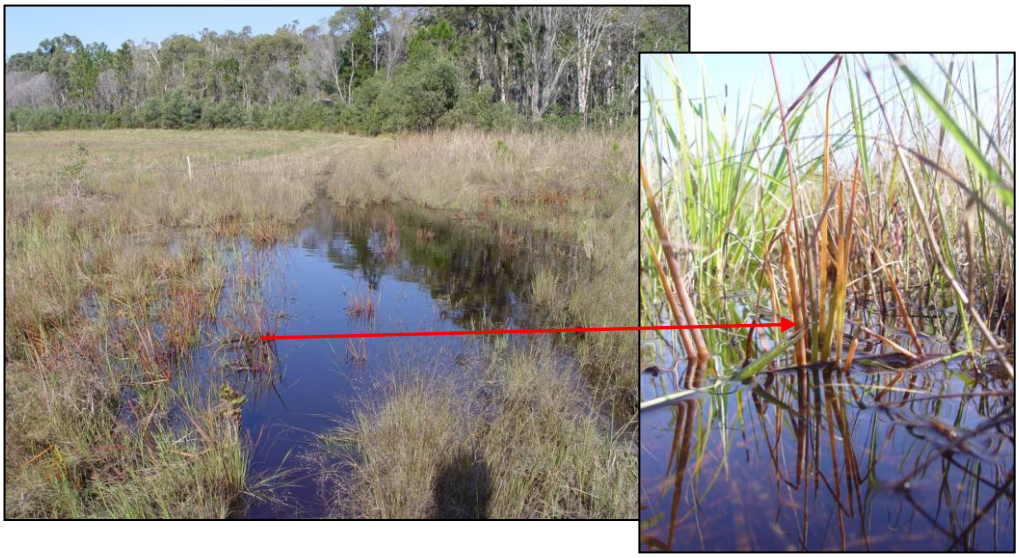
Plate 5: Typical ephemeral stormwater filled ground pools



Sampling of the ephemeral ground pools did not recover any mosquito larvae during the study. The absence of apparent breeding, especially for *Culex annulirostris* is consistent with its poor representation in adult trap results. The site demonstrated signs of recent flooding (recorded in April) and continuing

sheet flooding was observed following heavy rains as recorded in May 2009. The absence of *Culex annulirostris* in ground pools during late April and May is suspected to be the result of successive sheet flooding events flushing out these pools and not allowing re-colonising of the site by this species over the study period. It should be noted however that the habitat observed on-site is highly typical of that used by *Culex annulirostris* and it should be considered within the risk assessment despite its poor representation in traps. Semi-permanent ground pools occupy portions of the site and adjacent lands largely associated with natural and (old) constructed drainage channels. Such pools frequently support emergent vegetation including grasses, reeds and sedges. Plate 6 shows examples from the site typical of such semi-permanent sites with emergent vegetation.

Plate 6: Semi-permanent ground pools with emergent vegetation



One of the important mosquito species collected during the study was *Coquillettidia linealis*. This species was the second most abundant species collected in 2009 and was highly represented in the historical context. It is considered an important coastal vector of Ross River virus. *Coquillettidia linealis* is obligated to breed in permanent and semi-permanent ground pools where its immature stages (larva and pupa) attach themselves to the submerged stems of emergent vegetation. The specific breeding sites of this species are difficult to sample because of its sedentary nature attached to submerged vegetation. However due to its abundance in trap collections and the presence of typical habitat on and adjacent to the development site, it can be considered highly likely that it is produced over a wide area relevant to the development site where such habitat is present.

The important coastal mosquito *Aedes vigilax*, breeds in salt-marsh habitat. This species has a very wide dispersal range of more than 15km and adversely affects residential developments on the Sunshine Coast area including as far inland as the railway and hinterland villages. There is no breeding habitat of this species within approx 5km of the development site.

From the adult mosquito collection, it represented only 0.6% of the total in 2009 but 36% in Oct-Nov 2005. Its presence and absence is highly seasonal and subject to the variable rainfall and tidal flooding events within the salt-marshes adjoining Pumicestone Passage. Notwithstanding the relatively low numbers recorded during the 2009 study, from time to time, *Aedes vigilax* dispersing from salt-marsh breeding sites may occur in larger numbers generally across the region. On this basis, it will be considered as a potential threat for the purpose of risk management for the site.

5.4 Conclusions from Mosquito Trapping and Relevance to Human Health and Amenity

Adult mosquito collections obtained over 3 discrete but geographically close study sites widely separated in time between October 2004 and May 2009 have identified six species considered the most abundant. These are *Verrallina* Marks (mixed spp #s 52, 53, 122*) Coquillettidia linealis, Aedes procax, Culex annulirostris* and *Aedes vigilax.* Five of the 6 most abundant species collected at the Bellvista 2 site have potential to impact adversely on human health outcomes from the perspective of (1) direct transmission of disease and (2) secondary health impacts from nuisance biting.

It is fortunate that the most abundantly represented species, *Verrallina* Marks (mixed spp #s 52, 53 and122) are not considered able to directly transmit disease to humans. Secondary healthy impacts caused by biting nuisance are generally limited as these mosquitoes do not disperse far from their (generally) *Melaleuca* wetland type breeding sites. They do not effectively disperse *en mass* into built urban environments and they do not generally cause a nuisance biting issue in this context.

The remaining 4 most abundant mosquito species however have a more recognised threat regarding direct disease transmission and nuisance biting. All 4 are considered competent (vectors) for transmitting Ross River virus. *Aedes vigilax* and *Culex annulirostris* are also competent for transmission of Barmah Forest virus. These 4 species are also responsible for nuisance biting attacks. The degree of threat presented by each species (linked to their abundance) is somewhat influenced by the presence of suitable environmental conditions promoting breeding within each of their specific habitats, and the proximity of these habitats relative to their ability to disperse from breeding sites into the urban residential area.

Section 6 of this report addresses specific risk management issues relative to these 4 mosquito species in the context of the proposed development.

6.0 Assessment of mosquito risk

The Mosquito Risks Assessment methodology for this development was guided by the Australian and NZ standard for risk management AS/NZS 4360.

It gives a framework to consider risk in a disciplined approach that can be repeated in the future to evaluate changes in risk and measure outcomes. The risk management framework progresses through the following basic steps:

- **Identify the Hazard** (Mosquito borne disease, nuisance biting, public complaints)
- **In what Context** (The site's exposure to potential mosquito breeding, the design of the development)
- **Identify the Risks** (as a product of hazard and the likelihood of exposure)
- **Prioritise Risks** (What risks are important,)
- **Control the Important Risks**
- **Evaluate Control Effectiveness.**

6.1 Hazard Identification & Characterisation.

The identifiable hazards to the future residents of the development and the community at large include:

- Mosquito-borne disease transmission including Ross River virus and Barham Forest virus.
- Loss of amenity and lifestyle opportunities from mosquito biting activity.
- Potential future complaints to the Sunshine Coast Regional Council.

6.2 The Context of the Site Relative to the Hazards

The context of the site relative to mosquito hazards includes:

- The study recorded relatively high numbers of the medically important mosquito species *Coquillettidia linealis* and *Aedes procax.*
- Low numbers for the medically important species *Aedes vigilax, Culex annulirostris* and *Verrallina funerea* were recorded.
- Each of the above species is regarded as a public health risk as vectors mosquito borne disease including Ross River virus.
- The site contains significant ephemeral ground pools likely to support *Culex annulirostris* under more stable (non-flooding) conditions.
- Development will largely eliminate mosquito breeding habitat identified on-site.
- Near off-site ground pools to the south (in the Caloundra South investigation area) will remain for some time until future development eliminates much of these.
- Stormwater management for the site will include drainage based on wide swales adjacent to coastal heath.
- Some of the future drainage swales are to be modified to provide habitat for the Wallum froglet.
- The design of the development places roadways or open space outermost to the site boundary and acts as a buffer to short flight range mosquito species.

6.3 Risk Identification and Prioritisation

The site is currently exposed to *Coquillettidia linealis* breeding in semi-permanent ground pools associated with natural and constructed drainage lines. Ephemeral ground pools in *Melaleuca* forest across the site are likely the source of relatively high numbers of *Aedes procax*. Additional ephemeral ground pools in grassy cleared land will likely produce *Culex annulirostris* in large numbers under more moderate wet conditions.

At the present time, the likelihood of human exposure to these important species is high and should be managed to ensure the protection of future residents. The risk from other generally important species including *Aedes vigilax and Verrallina funerea*, in the context of this site is considered of low priority.

6.4 Risk Management Recommendations Response to Specific Outcome Issues for the Biting Insect Code

This section of the report addresses how the development would address the Specific Outcomes of the (Caloundra) City Plan - Biting Insect Code (7.4.3) and its attached Guidance Relevant to Biting Insects Code (11.6.5).

Biting Insect Code Outcome 1 - Siting and Design

Code Outcome 1 states:

> *"Development is sited and designed to minimise the risk to public health from insect-borne arboviruses and nuisance caused by biting insects."*

General

The Bellvista 2 development site in its current state has significant potential to produce ground water breeding mosquitoes including *Aedes procax* and *Culex annulirostris.* These mosquitoes, to varying degrees, likely invaded adjacent residential areas and cause biting nuisance and potential disease threat.

The engineering works required to fill and modify the site in preparation of residential allotments, roadways, stormwater works and open spaces for Bellvista 2 will significantly alter the current opportunity for ground pool breeding mosquitoes. Development of the site will permanently and significantly diminish the threat from these mosquitoes by engineering out their breeding sites. This is a positive benefit of the development for future residents and for the existing adjoining communities.

The future residents of Bellvista 2 however will be in relatively close proximity to the remaining off-site mosquito threats identified within this study. Their protection is considered within the development by use of appropriately sized

buffer zones between breeding habitat/harbourage locations for mosquitoes and residential allotments.

Specifics

The boundaries of Bellvista 2 are generally within the 2,000m watercourse proximity value referred to by the Biting Insect Code (north arm of Bells Ck and Lamerough Ck). Therefore to meet the Code's Guidance for Outcome 1; future home-builders should be encouraged to fit mesh screens on all dwelling windows and external doors to prevent mosquitoes entering habitable areas. This recommendation would be best achieved at the Building Application stage under a general condition of consent.

In addition to meeting the above guidance, consideration should be given to the proximity of breeding sites for *Coquillettidia linealis* and *Aedes procax* that will remain in habitat adjacent to the site. The development includes a buffer zone along its interface with Lamerough Creek. The buffer will be not less than 25 m wide and clear of vegetation except for mowed grass and sparsely distributed significant trees. The buffer zone final ground form should be made to eliminate isolated ground pools from forming and providing potential breeding habitat.

It is considered that a 25m buffer will adequately reduce passage of *Coquillettidia linealis* and *Aedes procax* breeding in habitat remaining in areas adjacent to the development site. The biting insect buffer will be clear of any significant vegetation but may contain roadways and overlap with fire protection zones (Plate 7 shows a typical example as recommended and constructed in the adjacent Pelican Waters Stage 5 development).

Plate 7: Biting insect buffer (including road reserve)

A buffer of any practical size (even exceeding 100m) would have limited benefit in reducing passage of long-range dispersing species such and *Aedes vigilax* and *Culex annulirostris*. On occasions where these species are active,

insect screening fitted by home-builders to external windows and doors of dwellings will provide general reduction in human domestic exposure (per the Biting Insect Code)

With respect to the proposed inclusion of compensatory habitat for the Wallum Froglet to be established within drainage corridors the following points are relevant:

- The obligate breeding site water quality for the acid frogs (as the name suggests) is low pH (ranges between 3.0 and 5.2) with water very low in organic nutrient. These conditions are generally counterproductive for significant mosquito breeding (Floore et al 1976).
- Competition for resources (especially in water of low nutrient value) between frog tadpoles and mosquito larvae are mutually detrimental to their production (Mokany and Shine 2003).
- There have been no observational references found for mosquitoes breeding in acid frog habitat.

It is considered that the inclusion of suitable compensatory habitat for the Wallum Froglet within the buffer adjacent to residential allotments will likely not significantly increase exposure of future residents to mosquitoes.

Biting Insect Code Outcome 2 – On Site Works

Code outcome 2 states:

> *"Development does not intensify the presence of or expand breeding sites for mosquito larvae"*

On-site works during construction of the development has some potential to produce opportunities suitable for freshwater breeding mosquitoes. Drainage works, temporary sediment basins, vehicle tracks and other potential habitat would be monitored for presence of mosquito breeding. If significant amounts of mosquito breeding were detected (say > 5 larvae per standard mosquito sample dipper) then corrective actions would be required. Corrective actions may be to fill or drain the offending breeding site.

Biting Insect Code Outcome 3 – Design and Use of Wetlands and Waterways

Code Outcome 3 states:

> *"New waterbodies or stormwater treatment wetlands / detention basins are designed to minimise the potential breeding opportunities of biting insects."*

As general guidance (Ref: NSW Dept of Lands and Water Conservation 1998), the following generic criteria for permanent water bodies within the development are:

- The batter around the constructed wetlands should be as steep as practical (within the design standards for public safety) to minimise shallow water (< 500mm) suited to mosquito breeding. If fencing is not used for public safety, a batter not greater than 1:6 is recommended.
- Normal water levels within a wetland should maintain at a minimum of 500mm water depth except for the margins.
- Improve opportunities for wind action to keep the water surface disturbed to reduce availability to mosquito larvae (require contact with stable surface film for respiration). Therefore basin margins should not be planted with shrubs or trees.
- Aquatic macrophytes should not be planted in more than 60% of shallow water (<500mm) around the margin. They should be clumped with separations of open water allowing wind disturbance on the water surface.

Detention basins should be designed to drain completely within 48 hours of flooding and be graded to exclude retention of any significant surface water beyond this time.

With specific reference to drainage corridors adjacent to residential allotments:

- The portion of the drainage corridor that may be within the designated 25m biting insect buffer should be planted with turf and be free of vegetation likely to provide harbourage for dispersing mosquitoes.

Biting Insect Code Outcome 4 – Biting Insect Control Measures

The biting insect controls for Bellvista 2 are based on recommending passive measures consisting of screening for residential dwelling windows and external doorways(per a standard Building Application Condition of Consent processes); and maintaining a not less than 25m cleared buffer on the interface with Lamerough Creek. Ground levels within the buffer zones should be engineered to eliminate depressions that create potential ground pool breeding sites.

No active control by way of application of control agents for either mosquito larvae control or adult control is proposed.

7.0 Conclusions

This report has recommended actions supporting the Caloundra South ILUP requirements for (Section 5.6) Environmental and Sustainable Development by addressing biting insects. In the absence of specific guidance from the ILUP, the framework used to assess biting insect issues was the (Caloundra)

City Plan – Biting Insect Code. This study has assessed information generated from physical entomological survey and review of the design of Bellvista 2.

In my opinion, the likely biting insect issues for this development could be adequately managed consistently with the Caloundra South ILUP through the implementation of the recommendations contained within this report.

From time to time, intensive outbreaks of mosquito activity may be experienced as a result of weather events and conditions such as prolonged rain or cyclonic storms. It is likely that the development will be subjected to some impact during these times, along with significant other areas of the Sunshine Coast. The controls outlined in this report are designed to accommodate relatively normal seasonal abundance of mosquitoes.

Darryl McGinn
Director
Mosquito Consulting Services Pty Ltd

References:

Floore, T.G., Harrison, B.A., and Eldridge, B.F. 1976. The Anopheles (Anopheles) Crucians Subgroup in the United States (Diptera: Culicidae). Mosquito Systematics. 8 (1).

Mokany, A. and Shine, R. 2003. Competition between tadpoles and mosquito larvae. Oecologia 135: 615-620.

Department of Land and Water Conservation New South Wales, 1998. The Constructed Wetlands Manual Volume 1, Chapter 13 pp 181-191.