



Queensland
Dengue
management plan
2015 – 2020

Title

Queensland dengue management plan 2015–2020

Authorisation

The *Queensland dengue management plan* is issued under the authority of the Queensland Chief Health Officer.

To meet the challenge of preventing or minimising dengue outbreaks in Queensland, Queensland Health in collaboration with local government and other key stakeholders have developed the Queensland dengue management plan 2015–2020 (DMP). This plan serves to guide and coordinate efforts to manage dengue in Queensland.

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Queensland dengue management plan 2015 – 2020

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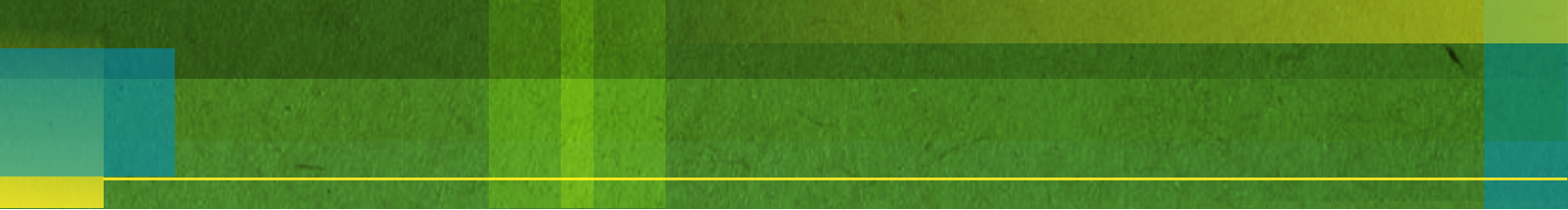
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Executive summary

The nature of dengue fever in Queensland is changing, as it is throughout the tropical and subtropical world. Dengue is now endemic in more than 100 countries worldwide, primarily in urban settings.

The World Health Organisation (WHO) indicates there are over 2.5 billion people (more than 40 per cent of the world's population) at risk from dengue. The current WHO estimate of global dengue cases is 50 to 100 million cases annually.

The transmission of dengue is associated with an expanding geographic distribution of the four dengue viruses and their mosquito vectors. The main vector of dengue, *Aedes aegypti* (*Ae. aegypti*) is widespread throughout urban tropical north Queensland and has been detected in many towns in sub-tropical Queensland as far south as Goomeri and Wondai in the south east and Charleville in the south west. *Aedes aegypti* is an urban, day-biting mosquito that feeds predominantly on humans.

In 2005, an exotic vector of dengue, *Aedes albopictus* (*Ae. albopictus*) was detected on Yorke Island and has since established on the majority of islands in the Torres Strait. This species presents a risk of introduction to the mainland. Importantly, the risk of dengue transmission in central and southern Queensland (and other jurisdictions) would be substantially increased if this vector became established on the mainland.

Recent changes in domestic water storage practices along with high numbers of imported cases of dengue among returning and international travellers in Queensland contribute to the risk of dengue outbreaks.

Outbreaks of dengue in north Queensland have increased in frequency and intensity since the early 1990s with annual outbreaks occurring. In 2003 and 2004, there were six outbreaks of dengue in north Queensland with a combined total of nearly 900 cases reported in Cairns, Townsville and the Torres Strait with two fatalities, the first recorded in Australia in many decades. In 2008 and 2009, more than 890 confirmed cases were reported in the largest dengue outbreak in Queensland for 50 years. From 2010 to 2014 annual outbreaks have continued with large numbers of cases. This highlights the public health risk posed to Queensland communities.

To meet the challenge of preventing or minimising dengue outbreaks throughout Queensland, Queensland Health, in collaboration with local government, have developed the Queensland dengue management plan 2015–2020 (DMP).

The DMP focuses on key areas integral to dengue management that are recognised as international best practice, i.e. transmission risk prioritisation, vector surveillance and control, case surveillance and public health management, outbreak management, and public awareness and community engagement.

1.1 Aim

The aim of the DMP is to keep Queensland free from endemic dengue and minimise the number of locally acquired dengue cases.

The DMP aims to achieve this by:

- improving disease surveillance
- enhancing and coordinating mosquito surveillance, and
- supporting prevention and control strategies to prevent local transmission from imported cases or to end each outbreak as quickly as possible.

1.2 Purpose

The purpose of the DMP is to provide strategic guidance on best practice public health management of dengue in Queensland including; surveillance, prevention and control methods. The DMP should inform the development of local operational plans for the prevention and control of dengue and its vectors.

1.3 Objectives

The DMP supports the prevention and control of dengue transmission in Queensland by:

- providing guidance on best practice vector surveillance
- supporting timely detection, reporting and public health management of all suspected dengue cases
- guiding effective and timely control methodologies to prevent local transmission of dengue
- reducing the spread of dengue vectors across Queensland into novel geographic areas
- supporting the adoption of protective behaviours by the public.

1.4 Scope

The DMP outlines three central components of dengue management:

- mosquito surveillance and control
- disease surveillance
- public awareness and community engagement.

The DMP provides strategic direction for the prevention and control of dengue viruses (DENVs) in Queensland. The plan provides guidance to, but does not substitute, the need for local operational plans. Public Health Units (PHUs) and local governments will develop and maintain local operational plans for mosquito surveillance and control.

The DMP calls for continued and improved collaboration in dengue management between Queensland Health, other government agencies and non-government stakeholders to ensure relevance to all interested parties.

The DMP does not include advice on the clinical management of people with dengue.

For up to date information on dengue in Queensland, visit Queensland Health's website: www.health.qld.gov.au/clinical-practice/guidelines-procedures/diseases-infection/diseases/mosquito-borne/dengue/

1.5 Legislation

The relevant legislation used in disease surveillance and mosquito management in Queensland are:

- *Public Health Act 2005*
- *Public Health Regulation 2005*
- *Pest Management Act 2001*
- *Pest Management Regulation 2003.*

There are two avenues available for controlling local government public health risks as defined in Chapter 2 Part 1 of the *Public Health Act 2005*. These are either an Approved Inspection Program (AIP) or an Authorised Prevention and Control Program (APCP).

The Director-General of Queensland Health or the Chief Executive Officer of a local government can approve an AIP under which authorised persons may enter places to monitor compliance with a regulation referring to public health risks. An APCP can be approved by the Chief Executive of a local Hospital and Health Service (HHS) or the Director-General of Queensland Health if there is, or is likely to be, an outbreak of a disease capable of transmission to humans by a designated pest, or a plague or infestation of a designated pest including mosquitoes.

The provisions for AIP are contained in Chapter 9 Part 4 of the *Public Health Act 2005* and those pertaining to APCP are contained in Chapter 2 Part 4 of the Act.

Under the *Public Health Regulation 2005* local governments require residents and occupiers of commercial premises to control mosquito breeding on their properties and maintain compliance of water tanks.

The *Pest Management Act 2001* requires all mosquito control activities involving the application of pesticides to be conducted by a licensed pest management technician with some exceptions (e.g. S-methoprene formulations and lethal ovitraps used for dengue control).

Reporting responsibilities of doctors, persons in charge of hospitals and directors of pathology laboratories in relation to notifiable diseases, including dengue fever, are outlined in Chapter 3 Part 2: Notifiable Condition Register of the *Public Health Act 2005*. The Act states that a Medical Officer must report a notifiable condition if the person has a clinical or provisional diagnosis. Please refer to the below website for detailed information on the *Public Health Act 2005* and the *Pest Management Act 2001*: https://www.legislation.qld.gov.au/Acts_SLs/Acts_SL_P.htm

2.1 What is dengue?

Dengue is an infection caused by one of four dengue viruses in the family Flaviviridae. Other diseases caused by flaviviruses include yellow fever, Japanese encephalitis and Murray Valley encephalitis. In terms of morbidity, mortality and economic costs, dengue is the most important mosquito-borne viral disease of humans.

Estimates from the WHO indicate there are over 2.5 billion people (more than 40 per cent of the world's population) at risk from dengue. Dengue is endemic in more than 100 countries in Africa, the Americas, the Eastern Mediterranean, South-East Asia and the Western Pacific. The World Health Organisation estimates there are 50 to 100 million global cases of dengue annually.

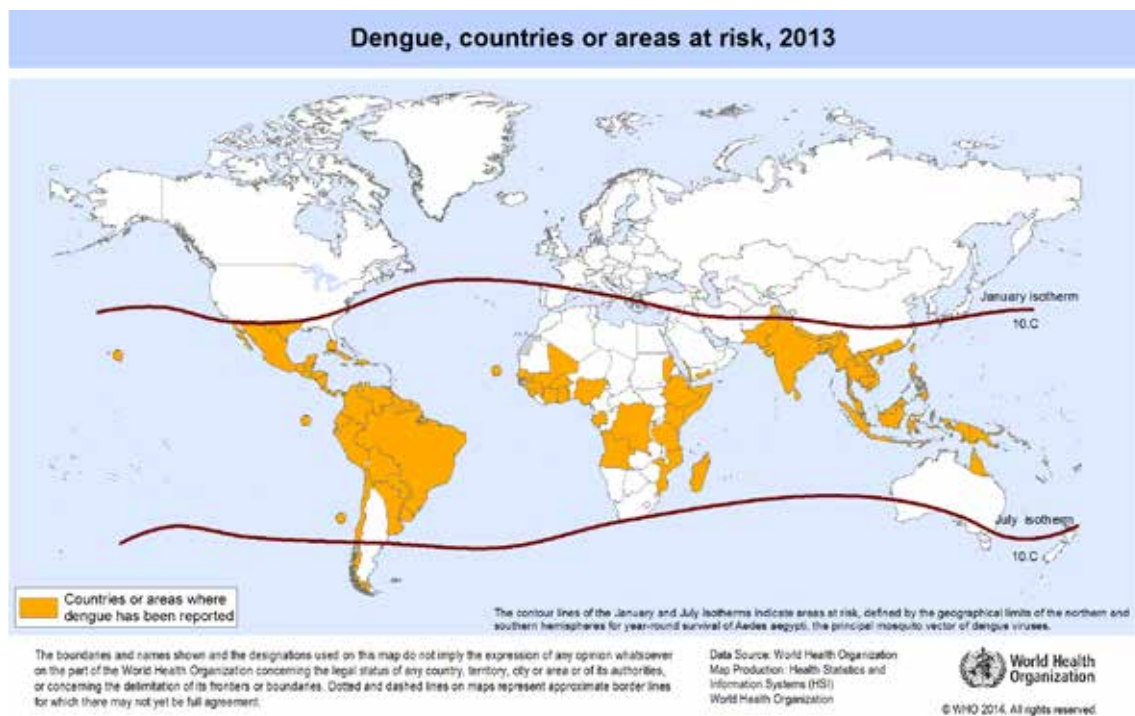


Figure 1: Countries/areas at risk of dengue transmission, 2013 (WHO 2014)

There are four dengue virus serotypes (DENV- 1, 2, 3 and 4) and genetic variants of these serotypes (genotypes) are found in different geographic locations. A person can acquire a maximum of four dengue infections during their lifetime, one infection with each dengue serotype. Infection with one dengue serotype confers immunity to that particular serotype, but may result in an increased risk of complications with subsequent infections of another serotype. Infection with a dengue virus may be subclinical (asymptomatic) or may cause illness ranging from a mild fever to a severe, even fatal, condition. Hospitalisation may be required depending on the severity of symptoms.

Severe dengue (also known as Dengue Haemorrhagic Fever) is characterized by plasma leakage leading to shock that can be fatal, particularly among young children. Approximately 2.5 per cent of people affected with severe dengue die, although with

timely treatment this rate is often reduced to less than one per cent. Vaccines for dengue are currently under development.

Typical dengue symptoms include:

- sudden onset of fever (lasting three to seven days) and extreme fatigue
- intense headache (especially behind the eyes)
- muscle, joint and back pain
- loss of appetite, vomiting and diarrhoea
- taste aberrations (metallic taste)
- skin rash
- minor bleeding (nose or gums).

The incidence of dengue worldwide is increasing. For example, recent cases of autochthonous dengue have been reported in Japan, Portuguese Madeira, Florida in the United States of America and several South Pacific island nations including Papua New Guinea, Fiji and New Caledonia. The escalating incidents of dengue can be attributed to increases in urbanisation, air travel and the international movement of goods, and the use and disposal of consumable and commercial goods, such as discarded car tyres, that provide mosquito habitat.

2.2 Epidemiology of dengue in Queensland

Dengue has historically been reported in most Australian states and territories, but locally acquired dengue has only been reported in north Queensland in recent decades.

Queensland has a history of dengue epidemics dating back to 1879, most of which occurred in north Queensland. Several notable dengue epidemics have occurred in Queensland since 1885. The first fatality attributed to dengue occurred in Charters Towers in 1885 and the first fatality attributed to severe dengue occurred in the same town during the 1897 epidemic, when 60 fatalities were recorded (30 of those were children).

There was a notable decrease in dengue incidence in Queensland from the late 1950s to the early 1980s, however outbreaks have increased in frequency and intensity since the early 1990s with the first two recorded fatalities in Australia in many decades.

On mainland Queensland, transmission of dengue viruses is limited by the distribution of the vector *Ae. aegypti* (see Figure 2). *Aedes aegypti* is widespread throughout urban tropical north Queensland and is present in many towns in sub-tropical Queensland as far south as Wondai and Goomeri in the south east and Charleville in the south west.

Dengue is not endemic in Queensland. However annual local outbreaks, currently confined to north Queensland, all begin with a single imported case. A single imported viraemic person unwell with dengue in an area populated by a dengue vector and human hosts can lead to a dengue outbreak.

Imported cases of dengue are regularly notified in Queensland. Queensland Health currently relies on surveillance by medical practitioners and diagnostic laboratories to

detect and report imported cases. The majority of imported cases are notified in large population centres in the south east and north of Queensland.

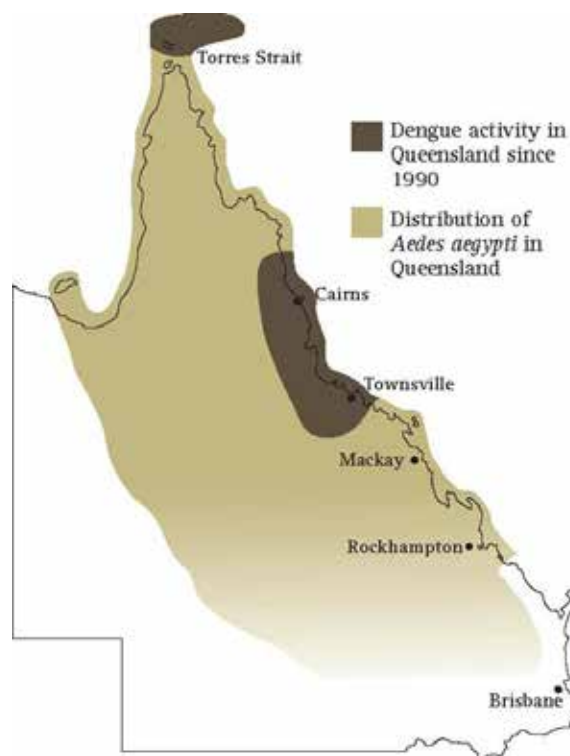


Figure 2: Distribution of *Aedes aegypti* and dengue activity in Queensland

Since 2005, the most common countries of acquisition for imported cases were Indonesia (35 per cent), Thailand (17 per cent), the Philippines (6 per cent) and Papua New Guinea (6 per cent). In this period 64 per cent (878) of imported dengue notifications were serotyped with the most common being serotype 1 (see Table 1).

Table 1: Proportion of overseas acquired dengue in Queensland from 2000 – 2014 by serotype

Proportion of overseas acquired notifications	Serotype 1	Serotype 2	Serotype 3	Serotype 4
	37%	30%	22%	10%

The number of both imported and locally acquired cases has increased in Queensland over recent years, as demonstrated in Table 2. This may be due to a number of factors including increased travel to endemic countries, increased awareness of the public health importance of dengue, and/or an increase in disease incidence.

Locally acquired dengue cases are seasonal, with approximately 75 per cent of cases notified from January to April. Since 2005, there have been 43 documented dengue outbreaks in Queensland with a total of 1,767 associated cases. The majority of these

outbreaks were attributed to dengue serotype 1 (19), followed by serotype 2 (12), serotype 3 (8) and serotype 4 (4). The largest outbreak in this period was of serotype 3 in 2008-09, comprising 898 confirmed cases.

Table 2. Dengue notifications by place of acquisition for Queensland 2005–2014

Year	Locally acquired	Proportion locally acquired	Overseas acquired	Proportion overseas acquired	Not stated/unknown	Proportion not stated/unknown	Total
2005	76	66%	38	33%	2	1%	116
2006	37	49%	35	46%	4	5%	76
2007	47	39%	68	57%	4	3%	119
2008	127	55%	98	43%	4	2%	229
2009	915	89%	108	11%	3	<1%	1026
2010	79	27%	206	72%	3	1%	288
2011	69	37%	117	63%	0	-	186
2012	28	11%	214	88%	2	1%	244
2013	222	45%	267	54%	1	<1%	490
2014	182	46%	213	54%	0	-	395
Total	1782	56%	1364	43%	23	1%	3169

2.3 Dengue vectors

In Queensland, dengue viruses are transmitted by the highly urban *Ae. aegypti* mosquito. *Aedes aegypti* lives primarily in domestic environments and is predominantly a day biting mosquito.

Historically, *Ae. aegypti* were widely distributed throughout south east Queensland until the 1950s. However with the recent reintroduction of domestic water storage devices and increased transport movements across the state, there may be the real potential for *Ae. aegypti* to re-establish in south east Queensland.

The geographic risk of dengue in Australia could change dramatically should exotic *Ae. albopictus* become established in novel locations. Despite not vectoring dengue as effectively as *Ae. aegypti*, this species was the sole vector for dengue outbreaks reported in Hawaii (2001) and Japan (2014). Its role in dengue outbreaks on mainland Australia will remain to be seen. Simulation models indicate that it has the capacity to spread through most of coastal Australia due to its greater tolerance to cold climates, potentially increasing the geographical area at risk of local dengue transmission.

To date, a mosquito control program by Queensland Health and the Commonwealth Government has prevented the further spread of this vector from the Torres Strait. An incursion onto the northernmost tip of Cape York in 2009 was successfully eradicated by Queensland Health and local government.

Endemic *Aedes scutellaris* is found in north Queensland, including the Torres Strait Islands and Cape York Peninsula and some studies suggest it is a secondary vector of dengue.

2.3.1 Larval habitat

Larvae of *Ae. aegypti* develop primarily in artificial containers holding water, including cans, buckets, jars, pot plant dishes, birdbaths, boats, tyres and tarpaulins. With the recent emphasis placed on domestic water storage in Queensland, roof gutters and poorly maintained rainwater tanks continue to be important potential larval habitats. These mosquito larvae can also inhabit natural sites such as bromeliads and fallen palm fronds. Subterranean sites such as wells, telecommunication pits and drain sumps can also be important larval habitats. In addition to artificial larval habitats, *Ae. albopictus* also inhabits other natural environments such as tree holes.

2.3.2 Adult mosquito behaviour

Unlike most mosquitoes that proliferate in swamps and bushland, *Ae. aegypti* is associated with urban areas. Adult *Ae. aegypti* rest indoors in dark places such as wardrobes and under beds. Females are easily disturbed when biting and prefer to bite humans during daylight hours. One dengue-infected female mosquito is capable of biting and infecting several people during one replete feed. Residents can manage exposure to this species because it does not disperse far from larval habitats and humans, provided that human hosts and oviposition sites are available. *Aedes albopictus* are more aggressive biters, feed predominately outdoors, may tolerate colder climates and may disperse farther than *Ae. aegypti*.

2.4 How does dengue spread?

Dengue is not transmitted directly from person to person (however transmission via blood transfusion is possible). Dengue is transmitted when an infective female vector mosquito bites a susceptible person. This person may become unwell 4 to 7 days later (onset range 3 to 14 days), a period of time known as the intrinsic incubation period (IIP).

An infected person can transmit the virus to a vector mosquito from shortly before the onset of fever to the end of the febrile period, usually 4 to 5 days. However for transmission risk assessment purposes, the duration of viraemia is usually estimated to be from the day before onset of fever until 12 days post onset.

After biting an infected person, an infected mosquito may be able to transmit the virus after 8 to 12 days, referred to as the extrinsic incubation period (EIP). The duration of the EIP is influenced by many factors such as ambient temperature, and has been reported to be as short as 5 days, which contributed to rapid transmission in the 2008-09 Cairns epidemic. The cycle of transmission between subsequent rounds of transmission to humans is usually estimated as 14 days during outbreaks (as illustrated in Figure 3). Consequently mosquito control activities need to be initiated urgently to reduce the likelihood of transmission.

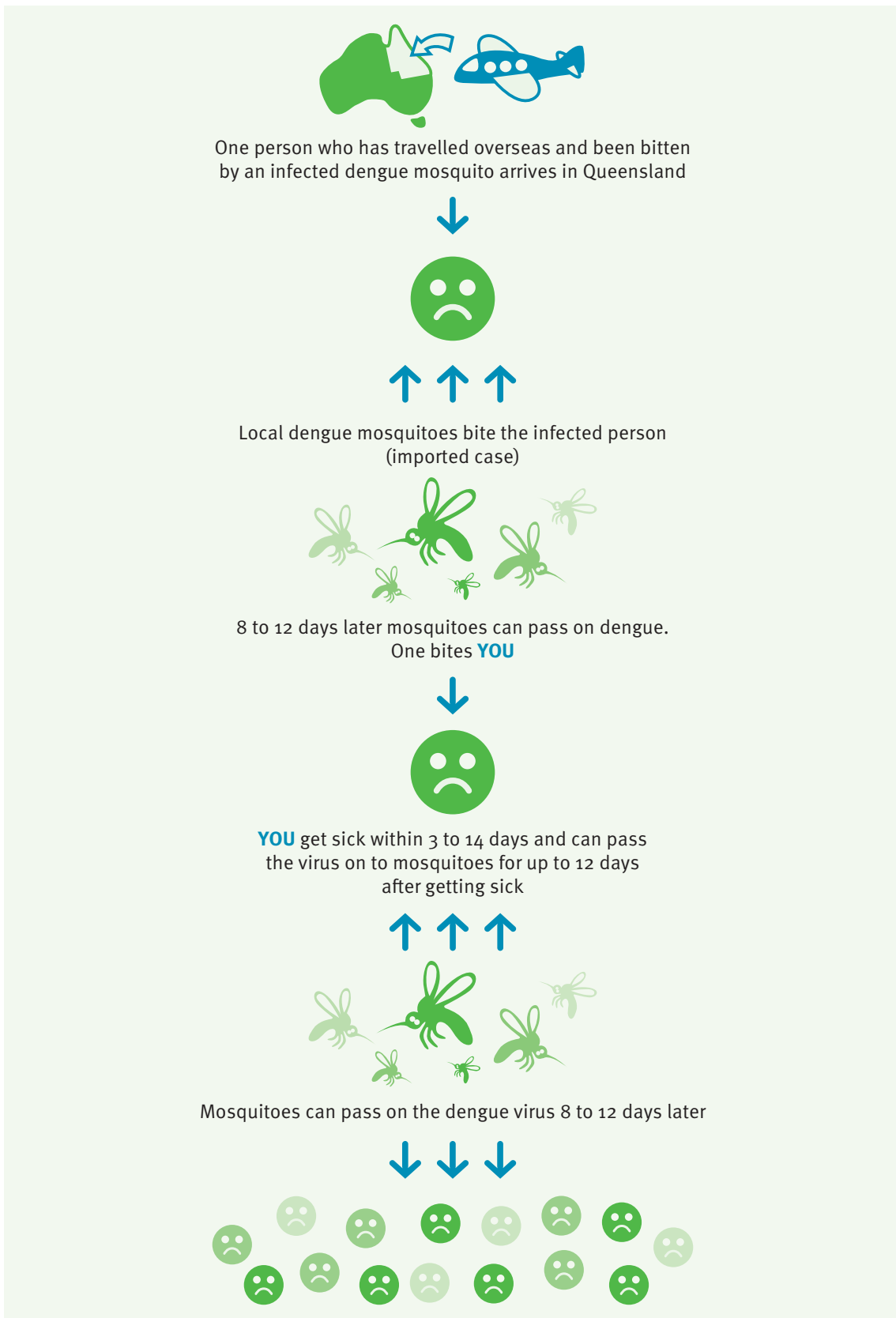


Figure 3: Dengue transmission cycle

2.5 Stakeholders and their roles

2.5.1 Public

Routine mosquito control and exclusion of mosquito larval habitats around domestic and commercial premises is the responsibility of the resident or property occupier (*Public Health Regulation 2005*). These activities may be enforced and/or supplemented by local governments and/or Queensland Health when there is a risk of a disease outbreak (*Public Health Act 2005*).

2.5.2 Local government

Local governments are delegated with administering sections of the *Public Health Act 2005* and *Public Health Regulation 2005* which relate to mosquitoes and mosquito habitats. Accordingly, local governments ensure that the public complies with relevant sections of the act to exclude the potential for mosquito breeding. Refer to the below website for further details:

https://www.legislation.qld.gov.au/Acts_SLs/Acts_SL_P.htm

Many local governments conduct mosquito management programs based on Integrated Pest Management principles. These programs include elements of chemical and bio-chemical control, habitat modification and public awareness. Other local governments rely only on public awareness campaigns and/or targeted treatment of known larval habitats to control mosquitoes.

2.5.3 Queensland Health

Queensland Health sets strategic direction and implements actions for the prevention of, and response to dengue outbreaks in Queensland. This includes:

- reporting notifications of dengue virus infections through the electronic notifiable conditions register
- monitoring incidence of dengue in Queensland
- confirming dengue diagnoses in a reference laboratory
- contact tracing of dengue case travel histories
- oversight of emergency vector control activities
- supporting and assisting local government with the implementation of mosquito surveillance and control activities for dengue vectors
- leading and conducting public awareness activities to promote self-protective behaviours by the public, including reducing mosquito habitat around homes and businesses
- monitoring the distribution of dengue vectors and conducting pesticide resistance testing on dengue vectors where relevant
- supporting local government through the provision of expert medical entomology advice
- developing relevant public health legislation and monitoring/supporting its administration.

2.5.4 Australian Government Department of Agriculture and Water Resources

The Australian Government Department of Agriculture and Water Resources (DAWR) is responsible for surveillance for exotic mosquitoes on behalf of the Australian Government Department of Health at international first ports of entry into Australia. The DAWR is also responsible for surveillance and control of exotic mosquitoes within a 400 m zone around first ports of entry. Where private property, both residential and commercial, is located within the 400 m zone, the DAWR, local government and Queensland Health plan appropriate surveillance and control measures in the event of an incursion by an exotic mosquito.

2.5.5 Australian Red Cross Blood Service

The Australian Red Cross Blood Service (ARCBS) manages blood supplies throughout Queensland. During a dengue outbreak blood supplies will be excluded from the outbreak location. Queensland Health notifies the ARCBS when an outbreak is declared.

Dengue Outbreak Risk

Queensland can be divided into three areas, based on local characteristics:

- **High Risk** – areas where at least one vector (*Ae. aegypti* or *Ae. albopictus*) is endemic, there is a regular influx of international travellers or residents who have returned from dengue endemic areas, and there is a recent history of dengue transmission (e.g. Cairns, Townsville, Torres Strait)
- **Moderate Risk** – areas where at least one vector (*Ae. aegypti* or *Ae. albopictus*) is present, relatively few viraemic travellers arrive from dengue endemic areas and where there is no recent history of other *Ae. aegypti* or *Ae. albopictus* vectored arboviruses (e.g. Rockhampton, Gladstone)
- **Low Risk** – areas without populations of primary vectors (e.g. currently Sunshine Coast, Brisbane and Gold Coast), but where there remains a risk of the introduction of primary vectors and there is a high frequency of travellers and residents who have visited dengue endemic areas.

The risk categorisation for a particular location or region is dynamic, and will vary both temporally and spatially across the area being considered. Nevertheless, locations with established populations of primary vectors are more likely to have a higher risk of local transmission than areas where these vectors are scarce. For instance, the risk of local transmission of dengue occurring in coastal north Queensland is very high given increasing travel from endemic countries and the presence of competent vectors with a demonstrated ability to sustain epidemic transmission. However, the risk of transmission classification for large parts of Queensland is uncertain due to the paucity of vector surveillance data.

Appropriate surveillance and control actions can mitigate the risk of DENV transmission. The following actions are recommended priorities for stakeholders, commensurate with the level of risk described above:

- **High risk areas**
 - routine surveillance of *Ae. aegypti* and/or *Ae. albopictus* populations
 - vector population suppression, as required
 - appropriate dengue case response, based on a high risk of transmission from imported cases and/or suspected local transmission
 - establishment and maintenance of efficient communication of notification data to vector control teams to ensure timely response.
- **Moderate risk areas**
 - regular surveillance, particularly with an aim to improve knowledge of the spatial distribution data of vectors
 - application of a risk assessment process to all case notifications
 - activation of response to case notifications commensurate with perceived transmission risk
 - vector population suppression as required
 - efficient communication of notification data to vector control teams to ensure timely risk-based response.

- **Low risk areas**

- surveillance to verify the absence of primary vectors, *Ae. aegypti* and *Ae. albopictus*, with a focus on high risk domestic and commercial premises during peak seasons (approx. Jan-March)
- application of a transmission risk assessment process to confirmed case notifications
- response planning for incursion of *Ae. aegypti* and *Ae. albopictus*
- stakeholder engagement to increase preparedness for incursion of *Ae. aegypti* and *Ae. albopictus*.

Where surveillance or response actions are based on consideration or assessment of transmission risk, a protocol for assessing risk should be implemented (Appendix 1).

Surveillance for *Ae. aegypti* and *Ae. albopictus* can determine vector distribution, estimate vector population density, identify productive larval habitats and define spatial and temporal risk factors related to DENV transmission. These can be used to prioritise the locations for and timing of vector control efforts. However, populations of container-inhabiting mosquito species can be difficult to monitor due to the highly localised nature of their distribution in some locations, and complex drivers of population dynamics, including climatic factors and human behaviours. The challenge for surveillance activities is to identify where, when and what vector species are present and at what densities. This information must be informative at appropriate spatial and temporal scales and gathered using limited human resources.

Mosquito surveillance should be conducted as regularly as required to provide meaningful comparative data. For example, where only presence or absence is being determined, a less frequent but large surveillance activity might suffice to confirm the status of low risk. However, in moderate or high transmission risk areas a more detailed temporal and spatial picture is required to inform control operations. Importantly, surveillance data should be of a consistent and high quality, standardised and kept in a format for ease of reference. Where possible, survey data should be mapped to aid visualization of the scale of surveillance activities.

4.1 Selection of surveillance locations

In many high risk areas, surveillance networks may be necessary. Elsewhere, surveillance will focus on residential and commercial premises that present the greatest public health risk. For example, some locations may have a history of inspections by local government or health authorities arising from complaints and/or dengue responses that warrants continued surveillance efforts.

Surveillance efforts will depend upon the availability of local resources. To maximise these efforts, the area or properties selected for inspection should be based on some assessment of risk (e.g. prior information regarding container inhabiting mosquitoes or disease transmission likelihood: Appendix 2). High risk premises are those that have frequent contact with viraemic travellers, provide large numbers of mosquito larval habitats and/or represent an opportunity for large numbers of people to be infected. High risk premises may be non-residential (e.g. high-traffic premises like backpacker accommodation which host a disproportionate number of viraemic international visitors). Conversely, individual residences, often regarded as ‘key premises’, may be high risk if they consistently support the production of large numbers of mosquitoes. Indeed, current data shows that transmission occurs at residential and commercial addresses, and that most dengue is imported by returning residents rather than international visitors.

Potential high/medium risk premises may include:

- older or poorly maintained households (potentially lacking air conditioning and insect screens or with gardens providing large amounts of shade and potential containers)
- backpackers/hostels/guest houses
- hospitals

- tyre dealers
- wrecking yards
- plant nurseries
- schools (pre-schools, primary, high schools, colleges, day-care centres)
- transit centres.

Geographical hot spots for potential virus transmission include:

- older or poorly maintained areas of town with non-screened housing (especially with a history of high *Ae. aegypti* numbers)
- areas that have supported previous dengue activity
- industrial areas (especially those with tyre yards and wreckers).

Each of the mosquito life stages (eggs, larvae, pupae, adults) requires different surveillance techniques for detection and monitoring (Appendix 3). As each methodology has limitations, integration of more than one surveillance methodology is recommended.

4.2 Adult mosquito surveillance

Sampling the adult vector population can provide essential data regarding vector distribution, seasonal population trends, transmission risk and evaluation of vector control interventions. In comparison with larval and pupal surveillance, adult surveillance methodologies are typically more sensitive. Adult presence can also be a reliable indicator of proximity to cryptic larval habitats.

In north Queensland PHUs, the Dengue Action Response Team (DART) use Biogents Sentinel (BG) traps and Gravid Aedes Traps (GATs) to monitor adult *Ae. aegypti* numbers in high risk areas. These traps are also deployed by some local authorities in other areas in Queensland to monitor *Ae. aegypti* and *Ae. albopictus* and may be particularly useful when deployed along potential pathways for incursion into new areas. In areas where target species are widespread, multiple traps can be used in a surveillance network to locate 'hot spots' of elevated vector populations and thus target management efforts.

Sweep net collection of mosquitoes attracted to humans is another sensitive means of detecting low-level infestations as they cover large areas rapidly. Field trials in north Queensland indicate that mosquitoes are still attracted to collectors wearing insect repellent. This strategy reduces the risk of mosquitoes landing and biting the collector but allows for a reliable collection of mosquitoes.

4.3 Egg surveillance

Aedes aegypti and *Ae. albopictus* deposit eggs in ovitraps. However, the morphological identification of eggs to species level is not practical and it is often necessary to rear eggs to at least fourth instar larvae for species identification. Alternatively, molecular identification of eggs or early instar larvae may be considered.

Ovitrap are inexpensive and sensitive, and not reliant on the detection and sampling of cryptic larval habitats. However, as with adult surveillance, ovitraps do not provide details regarding the type and availability of larval habitat.

4.4 Larval and pupal surveillance

The routine use of larval and pupal numbers (derived from container surveys) to assess vector presence and transmission risk is being superseded in favour of adult and egg surveillance methods. However, container surveys may comprise an important part of an operational surveillance and/or response program, particularly where characterisation and/or treatment of container habitats is required.

Container surveys can be used to infer the spatial distribution of the vector, and the diversity and availability of surface container habitats. However container surveys rarely provide information regarding the contribution of cryptic larval habitats including subterranean sites, roof gutters or rainwater tanks that may be more productive than surface containers.

Larval surveys may also provide a relative measure of density of larval habitats when they are used to derive *Stegomyia* indices including the Container, Breteau and House Indices. Generally, the more premises that are inspected, the more informative such indices can be, but the actual numeric thresholds for virus transmission are impossible to define in most situations, and will be strongly impacted by numerous additional factors including: number of viraemic imports into an area, adult mosquito biting rates, temperature and humidity (which affect mosquito survival and virus incubation times). Further, logistical problems associated with counting individual stages, distinguishing between morphologically similar species and, in some cases, poor correlation with adult mosquito densities has limited the application of these indices on an operational basis.

Traditional *Stegomyia* indices do not account for differences in the productivity of adult *Ae. aegypti* between containers. However, the concepts of 'key containers' and 'key container types' can be useful, and are defined as individual containers or container types that produce disproportionately more mosquitoes. For example, while tyres and drums may comprise only 10–20% of the total number of water-holding containers in some locations, they may account for the majority of total *Ae. aegypti* production. Likewise, key premises account for a disproportionate amount of the total adult production when compared with other premises. Importantly, identification of key container types and key premises will lead to site specific and cost-effective control programs if treatment can be focussed on key container types or premises that produce most of the adult *Ae. Aegypti*.

The risk of local transmission should be assessed for each DENV case notification (section 3.0). Any mosquito control response should be commensurate with this risk. Importantly, coastal north Queensland and Torres Strait communities are high risk, so mosquito control operations in dengue response zones are conducted urgently.

Risk assessments should utilise available tools and other relevant mosquito surveillance data. In response to a notified case, adult traps (BG or GAT) are recommended to identify and measure the relative abundance of vectors where there may be an unknown risk of exposure to daytime mosquito bites. Candidate addresses for response will be derived from the case travel history. Trap results should inform the necessity for emergency control operations in medium and low transmission risk regions of Queensland. Trap results may also enable respective addresses to be ranked into a priority list for any control operations.

The EIP is the incubation period of the virus inside the mosquito. After this period, the mosquito is infective to humans. The EIP, usually considered to be eight to 12 days, is temperature dependant with 95 per cent of EIPs between five and 33 days at 25°C and two to 15 days at 30°C, with means of 15 and 6.5 days, respectively.

The IIP is the incubation period of dengue virus in a human. After this period, the case may exhibit symptoms and seek medical attention. The duration of this period is variable depending on the circulating virus strain with 95 per cent of IIPs expected to be between three to 14 days, but is usually four to seven days.

The viraemic period is the timeframe that a human is infective to mosquitoes. This period begins usually a day before the onset of symptoms and generally tapers off until 12 days after onset of symptoms. Most cases are not viraemic after four to five days.

The key to effective vector control is speed and timeliness to ensure prompt and comprehensive control within dengue response zones around candidate addresses (residential and/or commercial). To prevent local transmission arising from an imported viraemic case, vector control teams must be notified of these cases within a time-frame that allows them to kill the adult mosquitoes that may have fed on a viraemic person before they become infective.

The timeliness of response to a locally transmitted case is also critical, but does not offer complete confidence of preventing further cases. Locally acquired cases only appear once a period equivalent to the sum of the EIP and the IIP has expired. After the EIP and IIP have lapsed, most of the mosquitoes responsible for the initial local transmission will already be dead and any control measures will therefore have little impact on transmission. Again, the major impact of any vector control effort will result from effects on newly infected mosquitoes within which the virus is replicating.

In the case of very short EIPs or long delays in case notification, vector control efforts may have little chance of killing infected adult mosquitoes in time to prevent transmission. Thus, the scale of any control program would have to increase dramatically and response actions revised. For example, if transmission was rapid due to a virus strain with a very short EIP, the speed at which interior residual spraying (IRS) could be conducted would be slower than the spread of the transmission. Further, lethal ovitraps (LO) will be ineffective if the EIP was less than the gonotrophic cycle (time taken to develop eggs after a blood meal). In this case, an area-wide response, aimed at suppressing the mosquito adult population over entire city blocks would have to be implemented.

Areas identified for mosquito control activities should be mapped for respective addresses determined from the case travel history. Each contact address should be assessed for risk and any response should be coordinated between Queensland Health and local government. In high risk regions, the control areas will be determined by experienced staff (e.g. PHU medical entomologists). The size of each response area should reflect the species involved, the timeliness of case notification, the duration of time spent by a case at a particular address, the abundance of the vector, environmental conditions and information describing previous DENV outbreaks in the area.

The aim of a response activity is to break the transmission cycle, by quickly killing infective mosquitoes and removing their oviposition sites. In high and medium risk areas this is achieved by house-to-house inspections (Appendix 4) of residential and/or commercial blocks within designated dengue response zones where vector control teams will perform the following activities as determined by the PHU medical entomologist:

Adult mosquito control:

- interior residual spray (IRS) of viraemic contact addresses, their nearest neighbours and other high risk properties as determined by the medical entomologist, and
- deployment of lethal ovitraps in large arrays within the specified area, and
- barrier and/or harbourage spraying.

Larval control:

- application of residual chemicals to all appropriate containers capable of holding water within the response area as determined by the medical entomologist, and
- source reduction – removal or mosquito-proofing of water-bearing containers.

Control measures targeting adult mosquitoes have a large and immediate impact on virus transmission, whereas larval control removes the subsequent generation of mosquitoes within the affected area (Appendix 5).

Control activities will be most effective where the community actively undertakes preventative behaviours. Fewer productive larval habitats should equate to fewer vector mosquitoes, and fewer mosquito bites reduce the risk of exposure to virus.

6.1 Source reduction

Source reduction, through the removal, destruction or treatment of larval habitats, can reduce the overall abundance of mosquitoes and therefore the likelihood of a viraemic person being bitten. However, source reduction does little to combat active transmission and is only effective in reducing populations if sufficient coverage of potential habitats is achieved.

All containers in residential, workplace and commercial premises that can collect water should be emptied or rendered ‘mosquito-proof’ (i.e. turned upside down, disposed of or filled with sand and mortar mix, or made free-draining). Property occupiers should

remove or treat vegetation that can hold water (e.g. fallen palm fronds and bromeliads). Suitable vegetation in and around communities should also be targeted in areas where *Ae. albopictus* is established. Rainwater tanks must be screened (gauze with less than 1mm aperture) to comply with the *Public Health Regulation 2005*.

Importantly, some cryptic sites such as subterranean pits that hold water and gutters may be overlooked during source reduction efforts if they are not particularly targeted.

6.2 Chemical application

Any chemical treatment or application conducted by a resident, contractor or health authority must be consistent with label recommendations. Contractors and health authorities must provide information about the chemical used and safety precautions in a 'Pest Control Advice'.

6.2.1 Larval chemical control

The treatment of containers with residual pyrethroids, insect growth regulators (e.g. S-methoprene) and monomolecular surface films (e.g. triflumuron) may turn some containers into effective egg sinks.

Insect growth regulators (IGR)

S-methoprene is available in a range of slow-release formulations (sand granules, pellets or briquets) and has low non-target toxicity. The chemical does not kill larvae, but prevents the emergence of adult mosquitoes. The product is activated when in contact with water, so it is also possible to 'pre-treat' dry containers. Sand granules and pellets can be applied to containers that are difficult to inspect (e.g. wells, drain sumps, bromeliads, roof gutters). Pellets provide residual activity for up to one month whereas briquets last approximately 3 months. However, in areas receiving frequent heavy rain (which may flush containers) more frequent use may be necessary. Briquets are registered for use in rainwater tanks and have been used during dengue outbreaks and *Ae. albopictus* suppression programs in the Torres Strait. However, this should be regarded as a temporary measure until tank screens can be repaired to comply with the *Public Health Regulation 2005*.

Monomolecular surface films

Triflumuron can be safely used in a wide variety of habitats, for mosquito control. This is especially useful in controlling late fourth instar larvae and pupae.

Surface sprays

Some domestic surface-sprays (indoor and outdoor) are registered for use against mosquitoes and can be used to pre-treat containers which may hold water. Some formulations have been shown to kill larvae and pupae and resting adults for up to five months.

Bacterial insecticides

The bacterial insecticide *Bacillus thuringiensis var. israelensis* (Bti) in various formulations can be used for residual control of *Ae. aegypti* or *Ae. albopictus* in small containers. Pretreatment of dry containers up to 8 weeks before flooding will not impact the efficacy of the product.

6.2.2 Adult chemical control

Interior residual spraying (IRS)

The aim of IRS is to kill infected mosquitoes before they have time to incubate and transmit the virus. *Aedes aegypti* (and to a lesser extent *Ae. albopictus*) rest (harbour) between blood meals in dark areas inside and under buildings. An effective way to target these adults is to apply residual insecticide (pyrethroid) to these surfaces. *Aedes aegypti* prefer to rest on the underside of furniture (tables, chairs, beds); in wardrobes and closets; on piles of dirty laundry and shoes, and other dark objects and in dark rooms.

Interior residual spraying is relatively slow and labour intensive (approx. 10 min per house). Permission to spray inside a house must be granted by the occupant. For dengue control, IRS is usually limited to viraemic contact addresses, their nearest neighbours and other high-risk properties. Information about the specific chemical used and safety precautions must be provided in the 'Pest Control Advice'.

Harbourage or barrier spraying

Barrier, or harbourage treatments involve the application of a pyrethroid insecticide to exposed surfaces around the area or property where mosquitoes may rest, creating a residual insecticidal barrier between the mosquito and human populations. Due to its association with sylvan habitats, harbourage spraying is particularly appropriate when targeting *Ae. albopictus*. For example, barrier treatments have been employed successfully in reducing *Ae. albopictus* in areas of the Torres Strait by targeting bushland areas on the fringe of the community and isolated clusters of vegetation within the community if they are suitable mosquito resting sites.

Lethal ovitraps

Lethal ovitraps target the older gravid, blood-fed mosquitoes which may be carrying virus. Lethal ovitraps are similar to standard ovitraps, but are treated with a residual insecticide to which gravid females are exposed when seeking to lay eggs. As the incubation period of most viruses is longer than the time between blood feeding and egg laying, the traps kill blood-fed, infected mosquitoes before they are capable of transmitting virus. Lethal ovitraps must be deployed in large arrays to be effective and used in conjunction with source reduction activities (as determined by the PHU medical entomologist). These traps need to be re-collected after one month before the chemical expires. Novel biodegradable designs have been trialled and are under development by north Queensland PHUs to remove the logistic impost to retrieve buckets.

6.3 Potential future directions in mosquito control

Control strategies are continually evolving. For example, in north Queensland, Eliminate Dengue (<http://www.eliminatedengue.com>) has been partly funded by the Queensland Government to trial a novel bio-control strategy that will reduce the ability of *Ae. aegypti* to transmit DENV. The approach is centred on releasing *Ae. aegypti* infected with selected strains of the bacterial endosymbiont *Wolbachia*. Field release trials in north Queensland have demonstrated that *Wolbachia* can be rapidly driven to fixation in populations by a process of selective inheritance, known as cytoplasmic incompatibility. International trials in dengue endemic areas are underway to determine what impact *Wolbachia*-infected *Ae. aegypti* populations will have on dengue transmission.

This section focuses on the public health aspects of disease surveillance, case notification and control of human cases of dengue. This section does not discuss the medical treatment of symptomatic cases. Doctors wishing to access dengue treatment protocols should contact their local infectious diseases physician.

7.1 Routine disease surveillance

Routine disease surveillance is the first defence against dengue with an emphasis on overseas acquired ('imported') cases. This is important as dengue outbreaks are initiated by an often undiagnosed viraemic traveller. Surveillance for dengue encompasses clinical and laboratory surveillance.

7.2 Clinical surveillance

Effective disease surveillance relies on general practitioners (GPs), emergency department doctors and laboratories notifying Queensland Health of possible cases of dengue, particularly in people who have recently arrived from tropical countries. Doctors are required under the provisions of the *Public Health Act 2005* to notify PHUs immediately upon clinical suspicion, rather than waiting for laboratory results.

Due to the risk of a viraemic traveller initiating an outbreak, surveillance for clinical cases of dengue is very important. If a viraemic international visitor does not have medical travel insurance to cover the costs associated with seeking medical assistance, a delay in, (or absence of) presentation may result, constituting a barrier to effective surveillance. If this situation arises and impacts negatively on effective outbreak management, a resolution may need to be sought at a local level. Early presentation and notification of cases enables action to be taken promptly to reduce the risk of local transmission.

If a case presents without a recent travel history, this may indicate local transmission and, potentially, the early stages of an outbreak. Any delay in notification of suspected dengue cases can mean the difference between managing a sporadic case and managing an outbreak with multiple cases.

7.3 Barriers to effective case notification

Early notification of suspected or confirmed dengue cases assists Queensland Health to identify if an outbreak has occurred. It is important for a case to have a correct laboratory diagnosis. Early detection of dengue cases can be delayed for the following reasons:

- cases not seeking prompt medical attention
- transient doctors who may be unfamiliar with the disease and appropriate laboratory tests
- lack of understanding of the range of clinical symptoms possible (mild to severe), resulting in milder cases not being diagnosed
- limited awareness amongst doctors regarding their legislative responsibility to notify suspected dengue cases to Queensland Health
- treating doctors may not requesting laboratory testing during an outbreak because they are confident of diagnosing dengue clinically

- lack of awareness of the value of laboratory confirmation for public health management of an outbreak.

7.4 Diagnostic testing

Early diagnosis is vital for rapid dengue control measures. Where possible, it is important to collect a blood sample for diagnosis during the acute phase of the illness. Whilst there are several diagnostic tests available for dengue (Appendix 6), the reactivity of each test depends on the timing during the illness that a blood sample is collected (refer Figure 4).

NS1 Elisa and/or PCR testing during the acute phase of the illness are recommended and allow rapid case identification. However it is also helpful to include serology as this facilitates comparison of acute and convalescent phase samples.

PHU staff can assist treating doctors to determine the appropriate tests to request.

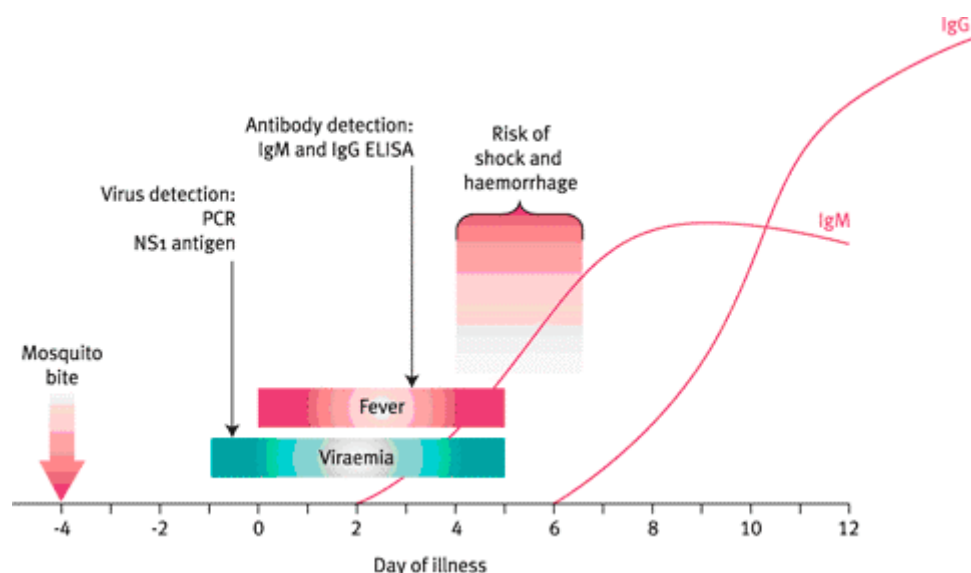


Figure 4: Typical primary dengue infection with timing of diagnostic tests

Treating doctors should take a travel history and note this on the pathology request. Differential diagnoses of Chikungunya and Zika viruses should also be considered and appropriate tests requested.

7.5 Laboratory notification

Dengue is a notifiable condition under the *Public Health Act 2005* in Queensland and laboratories are required to notify Queensland Health of positive dengue results.

Forensic and Scientific Services (FSS), Department of Health is the arbovirus reference laboratory for Queensland. Dengue tests are also performed by private and public laboratories in Queensland.

Forensic and Scientific Services is able to identify specific dengue serotypes, allowing more effective public health management of outbreaks. Virus genotyping is also possible, enabling tracking and comparison of the potential origins of dengue outbreaks.

7.6 Enhanced case surveillance and response

7.6.1 Case investigation

For every dengue notification in Queensland enhanced surveillance should be undertaken by public health nurses (PHN) from the PHU using the Dengue Case Report Form (Appendix 7) and the case interviewed to establish a travel history and other relevant information. Information and advice will be provided to the case regarding prevention activities to reduce the chance of transmission.

All notified dengue cases should be reported to the public health physician (PHP) and referred to the medical entomologist or manager of environment health who will undertake a risk assessment and instigate appropriate vector surveillance and or control measures based on risk levels (refer section 3: Dengue outbreak risk). In north Queensland there are dedicated Dengue Action Response Teams who manage the response. However in other areas of the state a collaborative response with local government would be required.

Public health nurses will liaise with the treating doctors and laboratory to ensure that the necessary laboratory test(s) are performed on suspected cases as soon as possible. If the blood sample has been collected within the first five days of illness and shown to be IgM negative, PCR or NS1 will be requested on an urgent basis (this should not delay case response in areas of high transmission risk).

When a locally acquired case is confirmed as viraemic in a high risk area all doctors that provide services in that area should be informed. They should be advised to consider dengue in people presenting with a febrile illness, arrange urgent dengue tests and promptly notify the local PHU of any clinically-suspect cases. Delays in notification may allow local transmission of dengue to occur undetected.

7.6.2 Dengue case management

The Case Report Form (Appendix 7) should be completed and entered into the electronic notifiable condition register for all suspected and confirmed cases of dengue in Queensland. Figure 5 illustrates the procedure followed by Queensland Health when a clinically suspected or confirmed case of dengue is reported. For further details on the public health management of dengue cases refer to:

<http://www.health.qld.gov.au/cdcg/index/dengue.asp>

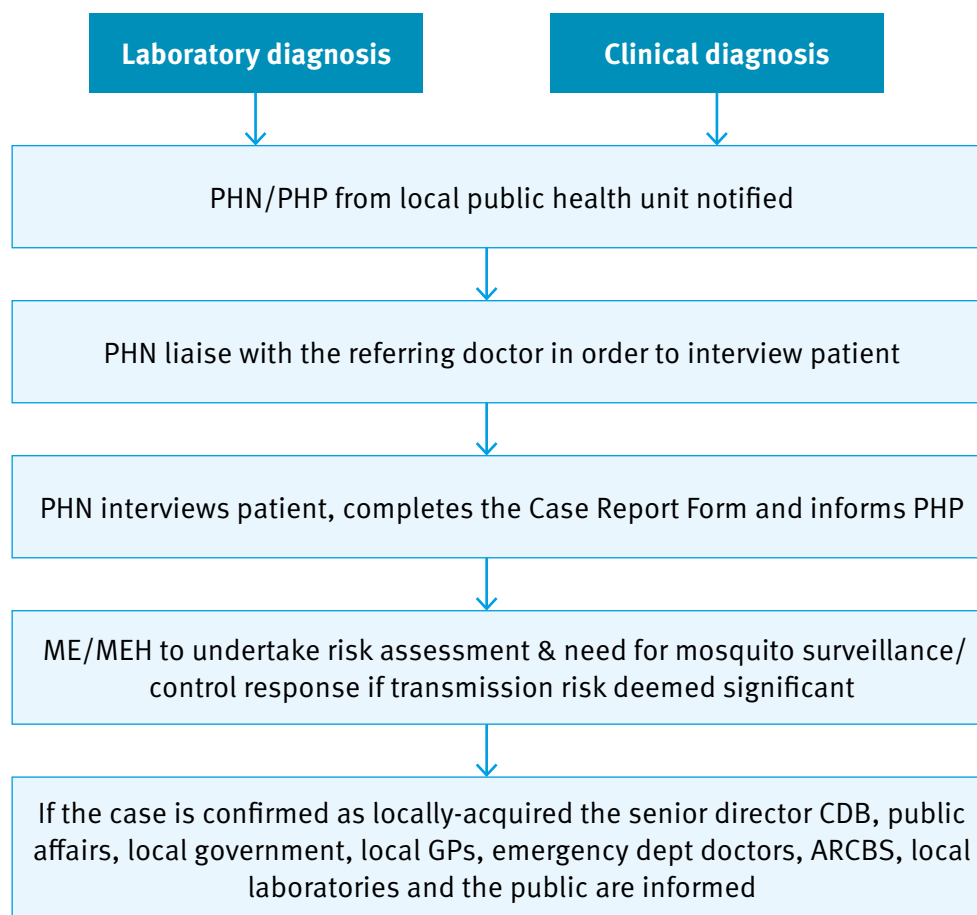


Figure 5. Notification and follow up of dengue cases

One case of locally acquired dengue constitutes an outbreak. In north Queensland PHUs, the DART perform vector control functions as core business, while local government are often required to assist with field work. The size and complexity of the outbreak will determine the level of response required. As an incident escalates, the existing CDC and DART functions may need to be supplemented with an emergency workforce sourced from within or beyond affected PHUs. To support these functions effectively and manage an outbreak, an Incident Management Team (IMT) may be established. An IMT should support and integrate rather than replace existing operational structures and should collaborate with stakeholders such as local government.

8.1 Communications

A communication strategy would be drafted by the IMT to inform GPs, hospital emergency departments, and local pathology laboratories to be on alert and immediately report suspected dengue cases and/or pathology results consistent with dengue.

The ARCBS will be notified of the dengue outbreak location and kept up to date of the outbreak progression.

The public should also be alerted to seek prompt medical attention if displaying symptoms consistent with dengue infection. Specific health protection advice and outbreak updates should be provided to the public via media releases and websites.

The IMT would provide regular situation reports to relevant stakeholders summarising information on the progress of the outbreak response.

8.2 Role of local government

Local government have the authority under the *Public Health Regulation 2005* to enforce legislation under which it is an offence for households and businesses to allow mosquito breeding on their premises.

During an outbreak Queensland Health works collaboratively with local government to minimise disease transmission by actively engaging and supporting the public and industry to reduce mosquito larval habitats in areas identified as actual or high risk for escalating and/or maintaining an outbreak.

8.3 Data management

During an outbreak all confirmed dengue (or “probable”) cases should be entered into the electronic notifiable conditions register and recorded on a geographic information system (GIS) that can be used by all relevant personnel involved in outbreak control. Locations visited by the case while viraemic should be mapped and control activities undertaken and recorded. The epidemiological outbreak curve should be developed and updated regularly to track outbreak progression.

8.4 Staffing

Staffing levels and competencies required to lead the outbreak response need to be identified. Planning for vector control activities should be undertaken in collaboration with local government. A pool of relief staff with the necessary skills and legislative authority, where required, should be identified as a matter of course. A training package for relief staff engaged in outbreak response should be available.

Under the Queensland Government *Workplace Health and Safety Act 1995* employers have an obligation to ensure the health and safety of all employees in the workplace.

For further details on the legislation refer to:

https://www.legislation.qld.gov.au/Acts_SLs/Acts_SL_W.htm

The prevention of dengue is the responsibility of both government (state and local) and the public. Mosquito control teams cannot eliminate mosquitoes in all homes and businesses in Queensland, hence an important element of dengue management is raising public awareness about the community's role in eliminating mosquito harbouring at home and in the workplace as well as supporting the adoption of protective behaviours. This can be achieved through targeted awareness campaigns and community engagement strategies.

Raising public awareness during the lead up to high risk dengue transmission periods involves informing the general public about:

- the risk of impending outbreaks and personal protective behaviours in the case of local transmission
- achievable actions around the home and workplace to reduce mosquito larval habitats
- protective measures when traveling to overseas locations where dengue is prevalent.

Population level awareness campaigns are designed to create and maintain awareness and motivation within the community. Messaging should convey a positive view of empowerment which supports personal responsibility and action rather than creating fear or panic.

Enhanced community awareness of dengue is supported via varying modalities including; social media, print, radio and television, convenience advertising (e.g. at airports) and promotional events which target community members, schools, workplaces and relevant industries.

Strategies should be planned and implemented in collaboration with key community stakeholders, including local government. Community engagement strategies could include:

- formal agreements with government departments and/or industry representative bodies to implement dengue preventative initiatives
- partnerships with public interest and community groups to provide access to simple, affordable and achievable measures to reduce mosquito larval habitats in and around the workplace and home.

In north Queensland, a public awareness campaign and community prevention initiatives are enhanced just before and throughout the wet season (Nov-April).

These strategies are targeted, and may include:

- source reduction in high risk suburbs
- vector suppression in high risk locations
- media liaison and media releases
- media conferences featuring media-trained, authoritative spokespeople
- advertising (TV, radio and print).

Key preventive messages include:

- disease facts and myths
- seeking medical attention promptly if unwell with a fever
- adoption of protective behaviour (e.g. use personal insect repellent)
- source reduction (e.g. clean up yards, tip out or dispose of unwanted containers, clean gutters, screen houses and water tanks etc.)
- public legal responsibility regarding domestic mosquito breeding.

In moderate to low risk areas there is also a need to support the general public to reduce container inhabiting mosquitoes as a prevention measure. This may require public awareness resources that identify the general benefit of reducing mosquitoes around the house without specifically focusing on dengue.

During outbreaks public awareness campaigns are intensified. Hospital and Health Service media staff working with PHU staff will inform the public of outbreak details.

Public awareness activities involve providing the public with updates on current outbreaks and information on simple measures to reduce the risk of dengue transmission. Activities include:

- providing media liaison and media releases
- coordinating a media based public awareness campaign with the Integrated Communications Branch, Department of Health
- providing media conferences featuring trained, authoritative spokespeople
- updating websites with current outbreak information
- keeping relevant agencies (e.g. tourism bodies, local government, Eliminate Dengue) informed to promote collaboration and minimise the risk of negative reactions to media and other dengue control strategies
- preparing departmental briefings as required.

In addition, residents and businesses in dengue prone areas are informed of the potential risks and provided information outlining prevention measures. For some establishments (e.g. hospitals and schools) customised dengue mosquito control programs are developed.

Key outbreak response messages include:

- signs and symptoms of dengue
- importance of seeking prompt medical advice for those with symptoms of dengue
- preventative measures.

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Appendix 1

A guide to managing imported dengue/chikungunya notifications in medium and low risk areas of Queensland

Acknowledgements

This guideline was developed by Metro South and Metro North Public Health Units (Medical Entomology and Communicable Disease Control), Hospital and Health Services, Queensland.

1: Aim

To apply a risk-based response to imported cases of dengue and chikungunya.

Operational responses will determine the presence/absence of primary vector species, their respective numbers in localised times and places, and complement mosquito surveillance programs being implemented through partnership arrangements between Queensland Health Public Health Units (PHU) and local government (LG).

Detection of *Aedes aegypti* in south east Queensland, or *Ae. albopictus* on mainland Queensland, will require urgent notification to the PHU Director/Public Health Physician and may activate emergency local, state or national response plans.

Confirmation of dengue transmission would activate the Queensland Dengue management plan 2015–2020.

Confirmation of chikungunya transmission may indicate the presence of primary vector species (*Ae. aegypti* or *Ae. albopictus*) or novel endemic vectors (e.g. *Ae. procax*, *Ae. vigilax* or *Coquillettidia linealis*). Identification of the vector species is therefore necessary to determine whether the Queensland Chikungunya management plan 2014–2019 is activated.

2: Case investigation—public health nurse (CDC)

On receipt of a notification the public health nurse (PHN) should immediately attempt to confirm the case based on the case definition. Refer communicable disease control guidelines:

<https://www.health.qld.gov.au/cdcg/index/dengue.asp>

If laboratory confirmation is delayed and the case is pending (e.g. clinically or serologically suggestive) case investigation should not be delayed.

NOTE: Case investigation should be undertaken in all areas across the state.

As soon as possible the PHN should call the notifying doctor or practice nurse (if doctor is unavailable) to obtain necessary details to complete the appropriate case report form and provide the GP with relevant information.

Information exchange should include but not be limited to:

- whether the treating doctor suspects infection with dengue viruses (DENV) on clinical diagnosis and/or chikungunya virus (CHIKV), presenting signs and symptoms and results of blood tests, etc.

- case contact details and addresses
- travel history, including potential travel to north Queensland
- whether the patient has been advised of diagnosis
- information for GP on testing for DENV/CHIKV for future reference if needed
- PHN to advise GP that a relevant PHU or LG may wish to contact patient.

PHN to provide any travel history to relevant PHU if it is suspected that infection was acquired in north Queensland.

PHN to gain case consent to share address details to relevant stakeholder (QH or LG) to conduct further interview, if required.

3: Risk assessment for vector response by local government or PHU, medical entomology or environmental health

Aim: To assign risk of DENV/CHIKV transmission to candidate cases.

4: Desk top activities (Table 1)

Confirm the period of viraemia in PHU or LG region. Generally no further action is required if the viraemic period occurred in winter months in central and southern Queensland.

Assess the timeliness of notification. Determine if there is a capacity to set trap(s) if the viraemic period was within 2-4 weeks and in a receptive area (as outlined below).

Assess receptivity of case addresses to vectors:

- check satellite imagery of properties surrounding contact address. Predominantly urban residential areas can support large primary vector populations whereas acreage blocks will not (unless *Ae. albopictus*)
- for DENV notifications - check for any mosquito risk rating of suburb, e.g. from latest survey data
- for CHIKV notifications - seek information on potential vector species.

Check whether the case reported exposure to daytime mosquito biting (refer Case Report Form Appendix 7) as *Aedes aegypti* bite during the day inside premises. *Aedes albopictus* bite aggressively during the day in shaded areas outside premises.

Discuss any intended response with experienced officers (e.g. medical entomologist).

Ring the case, request and confirm permission to set a trap and complete Table 1 and consent form if necessary.

5: Operational responses (Table 2)

DENV imports

- Set a mosquito trap (preferably an adult trap, e. g. BGS or Gravid Adult Trap) for interval appropriate for trap type chosen.
- Check the yard for any water-bearing containers. Collect representative sample of larvae for identification.

Appendix 1

- Provide the case with information on personal protection from mosquito bites and preventing mosquito breeding around the residential and/or work address.

CHIKV imports

- As above, and consider setting a CO2-baited light trap overnight if there is reason to suspect exposure to significant populations of potential vectors.

6: Data

File all collection/inspection results using relevant local spreadsheets and complete summary (e.g. Table 2).

Table 1: Risk matrix for activating an operational response to confirmed case(s) of imported DENV/CHIKV

Arbovirus imported	(DENV/CHIKV)		
	1.	2.	3.
Contact address			
Street number and name			
Suburb			
Case viraemic during risk months (e.g. 1 Dec – 31 Mar)?	Yes/No	Yes/No	Yes/No
Case viraemic within previous 2-4 weeks?	Yes/No	Yes/No	Yes/No
Suburb risk for primary vectors, based on previous surveillance data (low, medium, high, unknown)			
Suburb a risk for potential vectors (CHIKV cases only)?	Yes/No	Yes/No	Yes/No
Urban residential blocks dominant within 100m?	Yes/No	Yes/No	Yes/No
Daytime mosquito bites reported?	Yes/No	Yes/No	Yes/No
Proceed to request permission to set trap(s), inspect yard?	Yes/No	Yes/No	Yes/No

Table 2: Operational response matrix to confirmed case of imported DENV/CHIKV

Arbovirus Imported	DENV/CHIKV		
Contact Address	1.	2.	3.
Street No. and Name			
Suburb			
Adult mosquito trap set at n case address	Yes/No	Yes/No	Yes/No
Adult traps set at nearby shady properties?	Yes/No	Yes/No	Yes/No
Any larvae collected?	Yes/No	Yes/No	Yes/No
Primary vector species recorded from traps/collections?	Yes*/No	Yes/No	Yes/No
Potential vector species recorded (CHIKV only)?	Yes/No	Yes/No	Yes/No

* Detection of *Ae. albopictus*, or *Ae. aegypti* in south east Qld require urgent confirmation.

Appendix 2

Prioritisation of Queensland towns for container-inhabiting mosquito surveillance

This document describes factors for consideration when assigning priorities for container inhabiting mosquito (CIM) surveillance across Queensland based on perceived risk of:

- dengue virus (DENV) transmission
- exotic virus transmission (including Chikungunya virus: CHIKV), and
- exotic CIM incursion (primarily *Aedes albopictus*, but also including *Ae. aegypti* in locations where it is currently absent).

Aim

To identify regional towns and/or locations within towns where CIM surveillance effort should be invested.

Scope

To assess the risk (particularly in terms of potential DENV and CHIKV transmission) posed by CIMs (predominantly *Ae. aegypti* and *Ae. albopictus*) across Queensland it is necessary to identify towns/locations for which surveillance should be a priority. This will represent a platform for collaboration between government agencies to review/ implement CIM surveillance efforts.

Note:

- locations with a recent history of local dengue transmission are outside the scope of this exercise
- it is acknowledged that underlying this activity is a particular requirement to mitigate risk associated with the urban centres of southeast Queensland.

Four components (risk outcomes) are relevant to the scope of surveillance prioritisation:

- 1) expansion of *Ae. aegypti* distribution into locations where it is currently absent
- 2) incursion of *Ae. albopictus* into novel areas
- 3) local transmission of dengue viruses
- 4) local transmission of chikungunya virus.

Each of these risk outcomes is influenced by a suite of characteristics/factors that are unique to each town (listed in Table 1). Further, each of these factors contributes unequally to the risk outcomes listed above.

Table 1: The relative contribution of town/location characteristics to risk outcomes

Location characteristics*	Risk outcomes			
	<i>Ae. aegypti</i> presence	<i>Ae. albopictus</i> incursion risk	Dengue transmission risk	Chikungunya transmission risk
<i>Ae. aegypti</i> presence	n/a	✓	✓✓	✓✓
<i>Ae. aegypti</i> infestation	n/a	✓	✓✓	✓✓
<i>Ae. albopictus</i> presence	n/a	n/a	✓✓	✓✓
<i>Ae. albopictus</i> infestation	n/a	n/a	✓✓	✓✓
Human population size	✓	✓	✓	✓
# DENV importations			✓✓	✓
# CHIKV importations				✓✓✓
Industry traffic/conduit to industry	✓	✓	✓	✓
Location on major transport route	✓	✓		
Proximity to international port	✓	✓		
Tourism destination	✓	✓	✓	✓
Prevalence of rainwater tanks	✓	✓	✓	✓
Prevalence of other key water containers	✓	✓	✓	✓
Latitude/longitude	✓✓	✓✓	✓	✓
Human density/urbanisation	✓✓✓	✓✓	✓	✓
Prevalence of high-risk industries/infrastructure	✓	✓	✓	✓
Frequency of day-biting mosquito complaints	✓	✓		

* These characteristics represent risk factors which contribute to each risk outcome. Definitions of each provided in Table 2.

Appendix 2

Once risk factors are confirmed, towns or locations within towns may be characterised in terms of these factors, highlighting which towns/locations may be of most concern when evaluating surveillance priority. Towns may then be prioritised for surveillance, based on the risk profile generated when characterised in terms of the risk factors listed above. The surveillance prioritisation tool can be applied at different spatial scales, depending upon the required application. Thus, risk factors may be considered across suburbs within a particular town, within a local government area, or at a larger spatial scale, including state-wide application.

This list is dynamic, and will change. Importantly, the relative contribution of each risk factor to each risk outcome will vary between towns, according to the individual attributes of each town. Thus, the risk assessment process should be revised periodically.

It is anticipated that towns/locations would be assessed in terms of each of these characteristics or risk factors collaboratively by Queensland Health (medical entomologists, relevant environmental health officers) and relevant local government representatives/environmental health officers. Towns/locations should be described in as much detail as is possible for each risk factor using a matrix which provides simple comparison across towns/locations.

In the absence of information describing the status of a location in terms of these risk factors, consideration must be given to the likely importance that this status may have in contributing to overall risk (see Table 2 for how these factors contribute to risk). For example, if the presence or absence of suitable vectors is unknown for a town which otherwise has a number of attributes comprising significant risk, this may indicate an urgency for surveillance activities to determine the status of this town in terms of vector distribution.

Note that vector surveillance is relevant to regions both:

- 1) where distribution of *Ae. aegypti* is confirmed (to describe extent of *Ae. aegypti* and monitor for exotic CIMs)
- 2) where *Ae. aegypti* is currently absent or status is unknown (surveillance for both *Ae. aegypti* and *Ae. albopictus*).

Note, without further consideration, urban population centres of concern within the Brisbane City Council, Gold Coast City Council, Sunshine Coast Regional Council, Ipswich City Council, and other contiguous local government areas remain priorities for surveillance, specifically to confirm the absence of *Ae. aegypti* and *Ae. albopictus* in these locations. When considering the risk that other towns pose to urban population centres of concern, additional risk factors should be considered.

Table 2: Definitions of Risk Factors

Location characteristic	Definition	How does this influence risk?
<i>Ae. aegypti</i> presence:	<p>The known presence of <i>Ae. aegypti</i> in a location, based on existing / previous surveillance activities conducted within a “reasonable” time frame with “reasonable” sampling effort.</p> <p>Note that ‘absence’ is susceptible to sampling error, and may include locations where <i>Ae. aegypti</i> may be present, but is undetected. Also Note that a ‘reasonable’ time frame and sampling effort would need to be determined on a town-by-town basis by state and local authorities.</p>	<p>Detection of <i>Ae. aegypti</i> is a primary determinant of DENV (and CHIKV) transmission risk.</p> <p>Due to overlapping habitat requirements, the presence of <i>Ae. aegypti</i> may also indicate potential receptivity for other CIMs, including <i>Ae. albopictus</i>.</p> <p>The presence of a suitable vector is a prerequisite for local transmission.</p>
<i>Ae. aegypti</i> infestation:	<p>This refers to the degree of infestation of CIM and the suitability of the location for CIM persistence and proliferation. It includes observations of mosquito numbers, spatial distribution, availability of suitable containers, and measures of adult abundance. This includes any information which further describes the extent of CIM presence in a location upon which risk may be dependant.</p>	<p>A location with a widespread infestation may indicate that a location is highly suitable for the persistence of CIMs. High densities of CIMs can also indicate an elevated likelihood of virus transmission, due to increased frequency of interactions between vectors and hosts.</p>
<i>Ae. albopictus</i> presence:	<p>The known presence of <i>Ae. albopictus</i> in a location, based on existing / previous surveillance activities conducted within a ‘reasonable’ time frame with ‘reasonable’ sampling effort.</p> <p>Note that ‘absence’ is susceptible to sampling error, and may include locations where <i>Ae. albopictus</i> may be present, but is undetected.</p> <p>Also note that a ‘reasonable’ time frame and sampling effort would need to be determined on a town-by-town basis by state and local authorities.</p>	<p>Detection of <i>Ae. albopictus</i> is a primary determinant of DENV and CHIKV transmission risk.</p> <p>The presence of a suitable vector is a prerequisite for local transmission.</p>

Table 2: Definitions of Risk Factors (cont.)

Location characteristic	Definition	How does this influence risk?
<i>Ae. albopictus</i> infestation:	This refers to the degree of infestation of CIM and the suitability of the location for CIM persistence and proliferation. It includes observations of mosquito numbers, spatial distribution, availability of suitable containers, and measures of adult abundance. This includes any information which further describes the extent of CIM presence in a location upon which risk may be dependant.	A location with a widespread infestation may indicate that a location is highly suitable for the persistence of CIMs. High densities of CIMs can also indicate an elevated likelihood of virus transmission, due to increased frequency of interactions between vectors and hosts.
Human population size:	This describes the number of residents in a town and may be an indirect indication of extent of industrial and commercial activities, and the amount of 'traffic' that a town may experience.	Increased 'traffic' of people and goods represents additional opportunities for the importation of mosquitoes and/or viruses.
# DENV importations:	This data describes the number of DENV notifications recorded in each LGA (or town level, if available). It includes both imported cases (from international visitors and/or returning residents) and cases that may have been acquired elsewhere in Australia.	Frequent dengue importations (from either overseas or elsewhere in Qld) represent opportunities for local transmission events, where an appropriate vector is present. Thus, local transmission risk increases with increasing number of notifications. Notifications of cases acquired elsewhere may also indicate a mobile human population (likewise indicating risk of CHIKV importation). Introduction of virus is a prerequisite for local transmission.

Table 2: Definitions of Risk Factors (cont.)

Location characteristic	Definition	How does this influence risk?
# CHIKV importations:	As above, this data describes the number of imported CHIKV notifications recorded in each LGA (or town level, if available).	As above, each CHIKV notification represents an opportunity for local transmission in the presence of an appropriate vector.
Industry traffic/ conduit to industry:	This describes the ‘support role’ that a town/location may play for large industrial activities. A town can be considered a conduit to industry if it services industrial activities in nearby regions. For example, Moranbah and Clermont are the accommodation and service hubs for workers in large Bowen Basin mining ventures. These locations usually support a large itinerant population, a number of ‘fly in-fly out’ workers, and may provide a base for storage of equipment and other resources.	Increased ‘traffic’ through a location can provide opportunities for the transport of mosquitoes. Likewise, human ‘traffic’ (including itinerant workers) can provide a mechanism for the introduction of viruses.
Location on major transport route	This describes the location of a town along a major transport corridor or highway and thus describes the potential for considerable traffic through the town. Implicit in this is the presence of truck and traveller stops and other services.	Increased ‘traffic’ through a location can provide opportunities for human-assisted transport of mosquitoes, particularly if the site is a popular ‘rest/ overnight stop’. Likewise, human ‘traffic’ can provide a mechanism for the introduction of viruses.
Proximity to international port:	This describes the proximity of a town to an international port (including seaports) through which there is international movement of commodities and/or humans from locations where DENV or exotic mosquitoes of interest may be present.	Ports can provide an avenue for the importation of mosquitoes, particularly as desiccated eggs in imported goods.

Table 2: Definitions of Risk Factors (cont.)

Location characteristic	Definition	How does this influence risk?
Tourism destination:	This refers to the popularity of a town as a tourist destination.	Movement of people and goods provide a mechanism for human-assisted dispersal of mosquitoes, particularly via the movement of desiccated eggs. Likewise, international visitors (or visitors from locations where local transmission occurs) represent opportunities for the introduction of virus into novel locations.
Prevalence of rainwater tanks:	This refers to the prevalence/ density of rain water tanks across a town- particularly those that may provide suitable container larval habitat.	Rainwater tanks can provide a stable, long term larval habitat that, due to size, can moderate temperature extremes which may otherwise render smaller container habitats unsuitable.
Prevalence of other key water containers:	This factor describes a high prevalence of key water containers that may be unique to a particular town, or beyond what is expected in terms of productivity from other towns. For example, unique or plentiful subterranean sites (including wells, Telstra pits etc).	Key water containers can produce a disproportionate number of mosquitoes, when compared with other containers. Further, if these key containers are cryptic or difficult to treat, then this mosquito production may not be controlled.
Latitude/ longitude:	This describes the geographical location of the town (latitude and distance from the coast). This field also captures anything else that geographic location might determine that might influence suitability for mosquitoes. For example, it may serve as an indirect measure of relative humidity, rainfall etc.	Mosquitoes proliferate and can reach high population densities under high temperature and humidity. Warm temperatures can also increase the growth of virus and shorten the virus incubation periods, leading to an increase in the intensity of transmission. Rainfall can fill/refill containers, providing suitable larval habitats.

Table 2: Definitions of Risk Factors (cont.)

Location characteristic	Definition	How does this influence risk?
Human density/urbanisation:	This describes the distribution of human residences in a town/location, and includes a comparison of rural vs. suburban-type layout.	Domestic mosquitoes (<i>Ae. aegypti</i> in particular) thrive in urban environments. Notwithstanding limited dispersal, urbanisation presents opportunities for these mosquitoes to access habitat resources across multiple properties to establish and persist. In rural or semi-rural environments the distribution of domestic mosquitoes is more likely to be highly focal, and vectors are less likely to encounter numerous human hosts from different premises. DENV/CHIKV transmission is more likely if humans are in close proximity to each other (and exposed to mosquitoes).
Prevalence of high-risk industries/infrastructure	Refers to the prevalence of commercial and/or industrial premises which may present favourable CIM habitat and/or importation risk through the routine movement of containers which may harbour mosquitoes (including desiccated eggs).	Some industrial or commercial premises provide numerous habitats for CIMS. Further, movement of container habitats (tyres, pots, industrial machinery) may represent opportunities for the transport of desiccated eggs within such containers. Note that industries including plant nurseries and tyre yards have previous been implicated in the incursion of <i>Ae. aegypti</i> and/or <i>Ae. albopictus</i> .
Frequency of day-biting mosquito complaints	This refers to the number of complaints received from the public describing the incidence of mosquito biting occurring during the day (compared with typical crepuscular biting activity of many groundwater mosquitoes).	At a local level, public complaints of day-biting mosquitoes (particularly indoors) may be indicative of the biting behaviour of <i>Ae. aegypti</i> and/or <i>Ae. albopictus</i> .

Appendix 3

Dengue mosquito surveillance methods

Mosquito stage	Advantages	Disadvantages	Settings
Eggs			
Ovitrap	<ul style="list-style-type: none"> • Simple to operate • Inexpensive • Sensitive for low population densities due to long sampling period (1-4 weeks) • Eggs simple to transport to central lab 	<ul style="list-style-type: none"> • Labour and time intensive if rearing for morphological identification • High sample mortality • Delayed result (reduced early warning for exotics) • Ovipositing adults not killed or retained (exotics get away) • Containment/tracking issues during transport • Interference by animals, egg predators • Traps inactive when dry, water polluted or knocked over • Must recollect trap 	Suitable for remote areas due to ease of use and mailing of egg samples
Larvae			
Larval Survey including various collection methods (bulb pipette, sieve, aquarium net, aspirator)	<ul style="list-style-type: none"> • Immediate result • Identify type and quantity of larval habitats 	<ul style="list-style-type: none"> • Trained and skilled labour required for collection • Limited sampling period • Difficult to achieve large spatial coverage due to labour and time intensity • Potential environmental bias (e.g. rain) • Sample issues : transport and preservation • Extensive data recording requirements • Access constraints to cryptic, elevated, subterranean sites and locked or inaccessible premises 	Everywhere
Sentinel tyre/ bucket	<ul style="list-style-type: none"> • As above • Sensitive due to longer sampling period (4 weeks) • Suitable for deployment in dry conditions 	<ul style="list-style-type: none"> • As above (ovitrap) • Cleaning and maintenance • Further delay of results due to extended sampling period) • Bulky 	Dry/remote conditions Less regular checking

Mosquito stage	Advantages	Disadvantages	Settings
Adults			
BG trap	<ul style="list-style-type: none"> • Minimum 24 hours • Retains adults • Highly sensitive • Easy to use • Publicly accepted • Does not require CO₂ • Portable • Low numbers to identify 	<ul style="list-style-type: none"> • Expensive • Power to mains or battery (short duration and heavy) • Specimens can be damaged during collection • Secure deployment location required • Maintenance costs • Specimens may become desiccated/damaged 	Domestic locations that are protected from rain, e.g. carport, verandah
Gravid <i>Aedes</i> Trap (GAT)	<ul style="list-style-type: none"> • Sensitive • Easy to use • Publicly accepted • Does not require power • Does not require CO₂ • Portable • Moderate expense 	<ul style="list-style-type: none"> • Specimens may become damaged or mouldy (in humid environments) • Secure deployment location required 	Protected area (from rain)
Sweep net collections of mosquitoes attracted to humans	<ul style="list-style-type: none"> • Immediate result • Survey large areas with minimal time • Sensitive • Inexpensive • No power/CO₂ required 	<ul style="list-style-type: none"> • Collector exposure to mosquito bites and potential virus (collector may wear repellent) • Human ethics considerations difficult to standardise 	Indoors/ outdoors
Backpack aspirators	<ul style="list-style-type: none"> • Immediate result • Target specific resting sites 	<ul style="list-style-type: none"> • Intrusive for residents if done indoors • Less sensitive than BG trap • Heavy to carry • Mosquito has to be present at same time as operator, therefore timing can be critical 	Indoors/ outdoors

Appendix 3

Mosquito stage	Advantages	Disadvantages	Settings
Sample identification			
Morphological identification	<ul style="list-style-type: none"> • Cheap • Can be done in the field/ onsite • Immediate identification 	<ul style="list-style-type: none"> • Requires expertise • Difficult/unreliable if samples are damaged or if larvae are early instars • Unreliable if considering morphologically similar species • Impractical for eggs or pupae (require rearing) 	n/a
Molecular identification (PCR)	<ul style="list-style-type: none"> • Can be used for all life stages • Can pool large numbers of specimens or samples into one sample for analysis, reducing cost and time required to identify • Useful validation tool for absence of target species 	<ul style="list-style-type: none"> • Requires technical expertise • Cost (particularly in areas where sample pooling not appropriate) • Available only in central laboratory facilities (transport implications) 	

Appendix 4

Generic property inspection template

Organisation Logo	Organisation name Phone: _____ Fax: _____	For Office Use Only Ref No _____ Data Entered by: <input type="checkbox"/> Admin ID <input type="checkbox"/> Other _____ Date: _____
	Date of activities: _____ Activity: circle choice (Enter once per day, or when activities change) Dengue monitoring / Complaint / Research / Other Persons performing inspection: Circle or tick below	

Officer name (PMT-lic #)	Officer name (PMT-lic #)	Officer name (PMT-lic #)	Officer name (PMT-lic #)	Officer name (PMT-lic #)	Officer name (PMT-lic #)	
Officer name (PMT-lic #)	Officer name (PMT-lic #)	Officer name (PMT-lic #)	Officer name (PMT-lic #)	Officer name (PMT-lic #)	Officer name (PMT-lic #)	

Map Property Description: _____

Report to Council

Suburb: _____

House
 Unit
 Hostel
 Shop
 Industrial
 Vacant
 High Risk

St # _____ Unit # _____

Street Name: _____ Business Name: _____

Inspection Result: Access denied
 Full yard
 Front yard only
 Revisit required

Dog
 Locked
 Nobody home
 Refused entry
 Door hanger placed
 Refused Spray

Appendix 4

	# of Sites	Methoprene pellets (g)	Methoprene		Spray chemical A (ml)	Spray chemical B (ml)	Aquatain (ml)	Other tipped	Sample number / # Sites breeding
			Sand (g)	Briq (#)					
Roof guttering									
Palm fronds									
Bromeliads									
Pot plant base/ self-watering pots									
Striking buckets									
Drain trap									
Tarp / black plastic									
Fence post / pipe									
Boat / car									
Birdbath / water feature									
Garden equipment / wheelbarrow									
Tyre									
Container (sm < 2L)									
Container (med 2-20L)									
Container (Lrg > 20L)									
Pool / pond									
Ext furnishings/ under house					L	L			
Ext harbourage spray					L	L			
Interior Spray					L	L			

Type	Location description	Trap location notes	Provided to resident									
Lethal BG Light	<table border="1"> <tr><td>L3</td><td>C3</td><td>R3</td></tr> <tr><td>L2</td><td>C2</td><td>R2</td></tr> <tr><td>L1</td><td>C1</td><td>R1</td></tr> </table> <p>Street side</p>	L3	C3	R3	L2	C2	R2	L1	C1	R1	<p>_____</p> <p>_____</p> <p>_____</p> <p>_____</p>	<p>Surface spray provided? <input type="checkbox"/></p> <p>Repellent provided? <input type="checkbox"/></p>
L3	C3	R3										
L2	C2	R2										
L1	C1	R1										
Notes:												

Appendix 5

Vector control tools

Control strategy	Description	Target	Advantages	Disadvantages	Settings
Interior residual spray (IRS)	Application of residual insecticide to underside surfaces of furniture, resting areas and harbourage areas inside premise	Adult mosquitoes	Rapid killing of adult (male and female) mosquitoes inside the premise Residual action (ongoing control) Evidence for breaking virus transmission	Time consuming Restricted users require PMT license Invasive to resident, requires permission to access premises	Indoors
Lethal ovitrap (LO)	Water-filled container provided as a potential oviposition site containing an insecticide treated contact surface	Adult gravid mosquitoes	Effective at killing gravid mosquitoes Quick deployment Inexpensive No PMT license required for deployment Low toxicity delivery Residual activity (4 weeks)	Requires revisit for collection Can be knocked over or removed by resident	Outdoors (sheltered)
Harbourage spray (HR)	Application of insecticide to areas where mosquitoes may harbour, land or rest e.g. vegetation	Adult mosquitoes	Effective at reducing mosquitoes which rest outdoors (i.e. <i>Ae albopictus</i>) Residual activity	Uses higher quantities of insecticide May impact non-targets Application requires PMT license Requires specialised application equipment (backpack sprayer, truck mounted sprayer) Subject to environmental conditions Variable public acceptability	Outdoor
Source reduction (SR) and container treatment	Removal or insecticide treatment of containers which may otherwise provide larval habitat	Adult, pupal and larval mosquitoes	Immediately reduces the number of containers available for mosquitoes Moderate speed to treat an area No PMT license required for SR ONLY or treatment using S-methoprene	Must be repeated continuously to suppress populations No evidence for breaking virus transmission PMT licence required for applying residual spray	Outdoor

Appendix 6

Specific dengue tests

Test	Details	Where performed
NS1 ELISA	<p>This test detects the non-structural dengue virus protein NS1 in patient serum. The advantage of this test is that NS1 may be detectable in the blood of a dengue patient as early as Day 1 of onset and up to Day 9. As a result the test can detect dengue earlier than other serological tests which are based on the detection of dengue-specific IgM and IgG. In a primary infection the NS1 antigen can be detected several days before IgM develops and up to two weeks before IgG is present.</p> <p>It may also detect viral protein after the period in which PCR may detect viral RNA, meaning it can bridge a possible gap in detection capability between PCR and IgM or IgG serology tests.</p> <p>The test will detect NS1 antigen in patients infected with any of the four serotypes of dengue and is effective for diagnosis of both primary and secondary dengue infections.</p> <p>The “BioRad” form of the ELISA reports 91% sensitivity and 100% specificity. Dengue NS1 results are reported on auslab as REACTIVE, Non-reactive or Equivocal.</p>	<p>Cairns and Townsville Base Hospitals.</p> <p>Sullivan and Nicolaides Pathology Brisbane.</p>
PCR	<p>Dengue PCR test is a very specific test for dengue that is based on detection of actual virus RNA. The PCR is only useful during the first week of the illness (1-5 days following onset of symptoms) before rising IgM antibodies clear the virus from circulation. The sensitivity of the test can be affected by transport and storage conditions.</p> <p>A ‘detected’ dengue PCR test is confirmation of a recent dengue virus infection. A ‘not detected’ result however, must be interpreted with caution and in conjunction with IgM results. Where clinical suspicion of dengue is high a second sample should be collected to look for rising IgM antibodies.</p> <p>During an outbreak, PCR tests play an important part in the diagnosis of dengue. In 2003 approximately 50% of diagnoses were made through PCR tests.</p>	<p>FSS – Public Health Virology Laboratory Brisbane and Townsville Hospital.</p>
Flavivirus IgM capture EIA	<p>A flavivirus IgM screening test is performed on all referred reactive dengue IgM EIA specimens. The sample is screened using a pool of flaviviruses to detect specific anti-flavivirus IgM. The pooled flaviviruses are dengue serotypes 1 - 4, Japanese encephalitis, Kokobera, Kunjin, Alfuy, Murray Valley encephalitis and Stratford viruses.</p>	<p>FSS Public Health Virology Laboratory, Brisbane.</p>
Flavivirus - specific IgM and IgG EIAs (<i>confirmatory</i>)	<p>All equivocal or reactive flavivirus IgM capture EIA specimens are then further tested to determine the specific infecting flavivirus.</p>	<p>FSS Public Health Virology Laboratory, Brisbane</p>
Haemagglutination inhibition test (HAI)	<p>This test may identify the infecting flavivirus through measuring antibody titre levels to specific flaviviruses. A four-fold rise or fall in titres is required. Due to the development of the flavivirus IgM capture and specific typing EIA this test is now used infrequently. It is still used occasionally, however, to confirm apparent secondary dengue infections.</p>	<p>FSS Public Health Virology Laboratory, Brisbane.</p>

Test	Details	Where performed
<p>Dengue IgM & IgG EIA (<i>presumptive result</i>)</p>	<p>Once the dengue virus comes into contact with cells in the immune system, IgM antibodies are produced. Most typically IgM is reliably detectable 6 days after onset of symptoms but there have been reports of IgM appearing by day 1 and, in around 30-50% of patients, by day 3 post onset of illness. There is a greater risk of false negatives before day 6 (but these samples may be PCR positive).</p> <p>In some cases IgM can persist for months or years following a dengue infection. Due to the long term persistence of IgM in some individuals a single reactive IgM test result alone is not conclusive. It is necessary to demonstrate a rising (or falling) antibody titre between paired acute and convalescent serum samples collected 10 to 14 days apart before a laboratory confirmation is obtained.</p> <p>In primary dengue infections IgG antibodies appear several days after the appearance of IgM and can persist for a lifetime. A single IgG reactive specimen in the absence of IgM is suggestive of a past infection.</p> <p>In people with secondary dengue infections IgG will often be detectable at higher levels than IgM in an acute phase specimen. The IgG often precedes the appearance of IgM in secondary infections. Therefore if dengue IgM antibodies are not detected in a post day 3 sample in an acute illness, dengue IgG antibody levels should be determined.</p> <p>These tests are designed for screening purposes. While the tests are highly sensitive they suffer to varying degrees from cross reactivity with other flaviviruses. Unless the test is undertaken on a sample collected during an outbreak, the tests do not constitute a confirmed case of dengue, particularly where a single serum sample is tested in isolation.</p> <p>Commercially available tests for anti-dengue virus antibody (either IgG or IgM) are available from a number of companies and in a variety of formats including conventional EIA based formats and immunochromatographic rapid card type tests. Due to the variable specificity these tests display, in Queensland all samples that are reactive in a commercial test are referred to the FSS Public Health Virology Laboratory, Brisbane for confirmatory testing.</p> <p>Laboratories will report these results as ‘presumptive’ and confirmatory testing will be done at FSS. Based on this presumptive test report alone, GPs may mistakenly report to patients that dengue has been confirmed.</p>	<p>Both public hospitals and private pathology laboratories.</p>

Appendix 7

Dengue Case Report Form

Case name: DOB Notification ID:
First name Surname



Dengue Case Report Form

Public Health Unit Outbreak ID:
 Completed by: Date sent to NOCS:
 Telephone: Fax:

NOTIFICATION:

Date PHU notified: Date initial response:
 Notifier: Organisation:
 Telephone: Fax: Email:
 Treating Dr:
 Telephone: Fax: Email:

CASE DETAILS:

UR No:

Name:
First name Surname
 Date of birth: Age: Years Months Sex: Male Female
 Name of parent/carer:
 Aboriginal Torres Strait Islander Aboriginal & Torres Strait Islander Non-Indigenous Unknown
 English preferred language: Yes No – specify Ethnicity – specify
 Permanent address: Postcode:
 Home tel: Mob: Email:
 Occupation: Work telephone:
 Temporary address in Queensland (if different from permanent address): Postcode:
 Telephone: Mob: Email:
 General Practitioner: Dr
 Address: Postcode:
 Telephone: Fax: Email:

CLINICAL DETAILS:

Date of onset:	Date of first consultation:
Fever <input type="checkbox"/> Yes <input type="checkbox"/> No	Abnormal taste <input type="checkbox"/> Yes <input type="checkbox"/> No
Headache <input type="checkbox"/> Yes <input type="checkbox"/> No	Nausea/vomiting <input type="checkbox"/> Yes <input type="checkbox"/> No
Rash <input type="checkbox"/> Yes <input type="checkbox"/> No	Diarrhoea <input type="checkbox"/> Yes <input type="checkbox"/> No
Aches / Pains <input type="checkbox"/> Yes <input type="checkbox"/> No	Abnormal bruising/bleeding <input type="checkbox"/> Yes <input type="checkbox"/> No
Lethargy <input type="checkbox"/> Yes <input type="checkbox"/> No	Other
Itchiness <input type="checkbox"/> Yes <input type="checkbox"/> No	
Hospitalised due to this condition: <input type="checkbox"/> Yes <input type="checkbox"/> No	
Past history of Dengue: <input type="checkbox"/> Yes – specify <input type="checkbox"/> No <input type="checkbox"/> Unknown	

Case name:
First name Surname DOB/...../..... Notification ID:

LABORATORY: Laboratory: First collection date:/...../.....
 Lab Numbers: Private Lab: QH: Day blood

Test	Yes	No	Equiv	Pending	
NSI +ve	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Case Confirmed: <input type="checkbox"/> Yes <input type="checkbox"/> No
ELISA IgM +ve	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
ELISA IgG +ve	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Serotype:
Flavi IgM +ve	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	WCC:
Flavi IgG +ve	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Platelets:
PCR +ve	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	LFTs:
Suspected clinically, no bloods	<input type="checkbox"/>	<input type="checkbox"/>			Added tests:

EXPOSURE PERIOD:

Date:/...../..... to Date:/...../.....
(Onset -12 days) (Onset -3 days)
 During this time did the person: Travel overseas Yes No Date of arrival in Queensland:/...../.....

PLACE ACQUIRED:

Queensland Other Australian state/territory – *specify*
 Unknown Other country – *specify*

Places travelled and dates:

Home address: Screens Air con Mozzies

Work address: Screens Air con Mozzies

Other significant daytime address:

1. Screens Air con Mozzies

2. Screens Air con Mozzies

3. Screens Air con Mozzies

4. Screens Air con Mozzies

VIRAEMIC PERIOD:

Date:/...../..... to Date:/...../.....
(Onset -1 day) (Onset +12 days)

Home address: Screens Air con Mozzies

Other main daytime address/es:

1. Screens Air con Mozzies

2. Screens Air con Mozzies

3. Screens Air con Mozzies

4. Screens Air con Mozzies

Work during this period: Yes No Dates:

If Yes, name of work place: Address:

Appendix 7

Case name:
First name *Surname* DOB/...../..... Notification ID:

CONTACTS:

Name	Age	Recent possible dengue illness
.....	<input type="checkbox"/> Yes <input type="checkbox"/> No
.....	<input type="checkbox"/> Yes <input type="checkbox"/> No
.....	<input type="checkbox"/> Yes <input type="checkbox"/> No
.....	<input type="checkbox"/> Yes <input type="checkbox"/> No
.....	<input type="checkbox"/> Yes <input type="checkbox"/> No

Mosquito precautions discussed: Yes No Fact sheet sent: Yes No Date:/...../.....

Outcome: Survived Died Date of death:/...../..... Died of condition Unknown

NOTIFICATION DECISION: Confirmed – Dengue Probable – Dengue

COMMENTS:

Abbreviations and glossary

<i>Aedes aegypti</i>	The main mosquito vector of dengue viruses in Queensland
<i>Aedes albopictus</i>	Exotic dengue vector, detected and established throughout the Torres Strait (Qld) since 2005
Antigen	A substance which can induce a specific immune response and react with the products of that response
ARCBS	Australian Red Cross Blood Service
Assay	A laboratory test that can detect something (e.g. an antibody) and measure the amount (e.g. of the antibody) present
Authorised Person/ Officer	A person appointed as an authorised person under section 377 of the <i>Public Health Act 2005</i>
APCP	Authorised prevention and control program
BGS traps	BioGents Sentinel adult mosquito traps
CDC	Communicable disease control
CDB	Communicable diseases branch
CIM	Container inhabiting mosquito
DART	Dengue action response team
DAWR	Australian Government Department of Agriculture and Water Resource
Dengue	Infection caused by one of four serotypes of dengue viruses transmitted by <i>Aedes aegypti</i> and <i>Aedes albopictus</i>
DENV	Dengue viruses
DMP	Dengue management plan 2015–2020
EHO	Environmental health officer
EIA	Enzyme immunoassay: used to test biological samples (e.g. blood) for the presence of antibodies
EIP	Extrinsic incubation period
Endemic	The constant presence of a disease or infectious agent within a given geographic area or population group
Epidemic	The occurrence in a community or region of cases of an illness or other health-related event clearly in excess of what is expected
GIS	Geographic information system, electronic spatial information system used to analyse, manage and present data linked to location
GP	General practitioner
IgM and IgG	Immunoglobulin M and Immunoglobulin G; two classes of antibodies: in the case of dengue, IgM indicates a recent or acute infection whereas IgG indicates a prior infection
Imported case	A confirmed dengue case with recent travel history from a region where dengue is endemic
IIP	Intrinsic incubation period
IMT	Incident management team
IRS	Interior residual spray
LG	Local government
LO	Lethal ovitrap
ME	Medical entomologist
MEH	Manager environmental health
NS1 Elis	An assay that detects the non-structural protein 1 of dengue virus in patient serum
Outbreak	A localised, as opposed to generalised, epidemic (NB: One case of <i>locally-acquired</i> dengue in Queensland is deemed an outbreak)

PCR	Polymerase chain reaction (a laboratory technique used to amplify genetic sequence for identification which may be applied to the detection of dengue viruses)
PHP	Public health physician
PHN	Public health nurse
PHU	Public health unit
PMT	Pest management technician
FSS	Forensic and scientific services, Queensland Department of Health
Serotype	A strain of a micro-organism that is distinguished from others by serological (i.e. immunological) attributes
Vector	A living carrier that transports an infectious agent from an infected individual to a susceptible individual which, in the case of dengue viruses, is a mosquito
VCO	Vector control officer
Virus culture	The in-vitro isolation of a virus by propagation in culture medium
Viraemia	The presence of viruses in the blood
WHO	World Health Organization

