GUIDEBOOK FOR BEST ENVIRONMENTAL PRACTICES

Vector Control at LTA Sites

Land Transport Authority

OWNER'S PARTICULARS

Name: _____

Designation: _____

Company: _____

Contract No: _____

Contact No: _____

Published by the Land Transport Authority

Enquiries can be directed to LTA Safety Division

Land Transport Authority

ACKNOWLEDGEMENT

The Land Transport Authority (LTA) would like to thank the National Environment Agency (NEA) for their invaluable contribution and support in producing this guidebook.

Special thanks also go out to all staff who have provided constructive feedbacks and suggestions and to those who have helped in one way or another.

Lastly, a big thank you to all our contractors for their continuous support and efforts in maintaining an environmental friendly site.

Land Transport Authority

Land Transport Authority

ENVIRONMENTAL POLICY STATEMENT

LTA is committed to nurture its staff to care and protect our environment. We incorporate environmental protection in our strategic decisions and conduct our business in a manner that balances the environmental and economic needs of the communities in which we operate.

We will:

- Comply fully with all relevant environmental legislation and regulations and meet or exceed good environmental practices;
- Work with our partners i.e., transport operators, contractors, suppliers, interest groups and other government agencies in a concerted effort to operate in an environmentally responsible manner;
- Create a cleaner and greener environment by making continuous efforts to be energy-efficient and to practice Reduce, Reuse and Recycle; and
- Monitor, evaluate and continually improve our environmental management practices to ensure efficient use of the limited resources.

Lim Bok Ngam
DCE(IFD)/AgCE

Date: 1 June 2010

FOREWORD

Singapore is internationally renowned for its clean environment and high standard of public health. We are one of the most attractive cities in the world to live, work and play in. The urban landscape of our city will however continue to change as our population and economy continue to grow.

Contributing to the changing urban landscape is our construction industry, which also has responsibility to ensure that their project sites are continually kept free of vector breeding and infestation. With the expanding Rapid Transit System (RTS) and the road network to meet the needs of the growing population, LTA too has a challenging task of ensuring that their construction activities do not contribute to any public health concerns such as the propagation of vectors.

NEA's Environmental Control Officer's Scheme and its Code of Practice for Environmental Control Officers are designed to help construction companies and site managers implement their vector control regime at construction sites. I am happy that we now have a new **Guidebook** to provide more information on practical measures that construction companies and site managers can adopt to prevent and control vectors. The publication also carries information on the diseases transmitted by specific vectors to help raise the industry's awareness on the importance of vector control.

Land Transport Authority

FOREWORD

I congratulate LTA for the efforts in developing this **Guidebook**, and sincerely hope that this publication will serve as a useful tool to guide the construction industry in its effort to help sustain a high standard of public health in Singapore.

Khoo Seow Poh
Director-General Public Health
National Environment Agency

CONTENT PAGE

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CHAPTER 1

INTRODUCTION TO VECTORS

1.1 VECTORS

Vectors are organisms that transmit diseases from one host to another but they do not cause diseases themselves. Under Section 2 of the Control of Vectors and Pesticides Act, a vector is known as:

"Any insect, including its egg, larva and pupa, and any rodent, including its young, carrying or causing, or capable of carrying or causing any disease to human beings."

In Singapore, there are five main vectors identified:

Mosquito[1]

(Source: http://coolaggregator.files.wordpress.com/2008/07/mosquito_65147_7.jpg)

Flea

(Source: http://www.lushlawn.net/images/flea.jpg)

Rodent

(Source: http://img1.tradeget.com/pestmanagement/QFHHCCQ41Rodent-Control.jpg)

Cockroach

(Source: http://www.landcareresearch.co.nz/research/biosystematics/invertebrates/invertid/images/AmericanCockroach1.jpg)

Fly

(Source: http://freedomwellness.files.wordpress.com/2009/06/housefly.jpg)

[1] For more information on mosquitoes, please refer to Page 89.

1.2 Vector-Borne Diseases

Diseases[2] which can be transmitted by the five main vectors are:

Vector	Diseases
Mosquito	Dengue and Dengue Haemorrhagic Fever
	Malaria
	Japanese Encephalitis
	Chikungunya
	West Nile Fever
	Filariasis
Flea	Plague
Rodent	Rat-bite Fever
	Leptospirosis
	Murine Typhus
Cockroach	Cholera
	Food-borne Diseases
Fly	Cholera
	Typhoid and Para Typhoid
	Salmonellosis
	Dysentery

[2] For more information on mosquito-borne diseases, please refer to Page 99.

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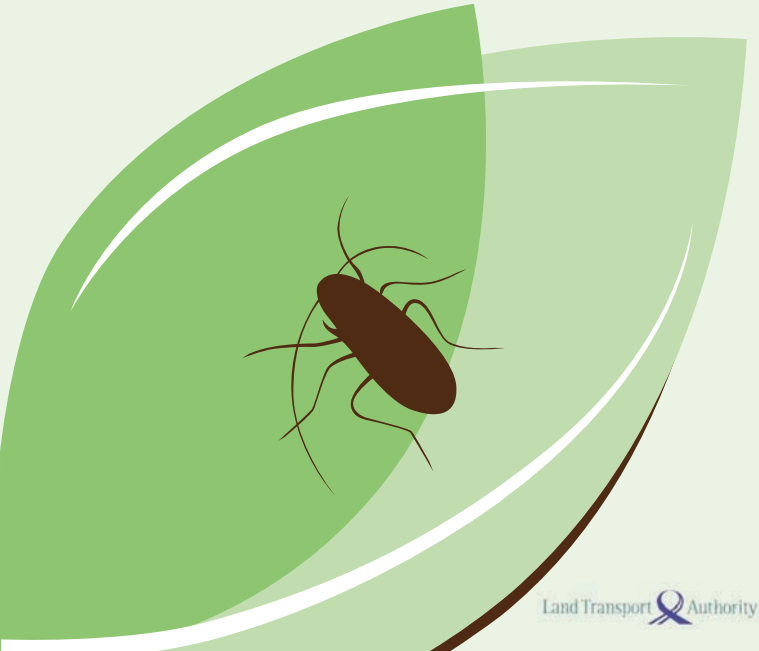
CHAPTER 2

OVERVIEW OF VECTOR CONTROL REQUIREMENTS



2.1 Legislation on Vector Control

2.1

Under Section 15(1) of the Control of Vectors and Pesticides Act

"No person shall create or cause or permit to be created any condition favourable to the propogation or harbouring of vectors."

Favourable conditions for the breeding of mosquitoes are created at the construction site.

2.2 Code of Practice (COP) for Environmental Control Officers (ECO)

Only salient points are being highlighted in this section.[3]

Vector Control

1. The contractor shall engage a competent Pest Control Company registered with the Building and Construction Authority (BCA) and the National Environment Agency (NEA) from the start of the project.
2. The pest control company shall submit a vector control programme and all service reports to the Environmental Health Department, NEA.
3. Regular checks of at least once a week shall be conducted on the construction site for mosquito breeding in worksites, bangsals and site offices.
4. Empty receptacles, pails, basins and other containers, equipment or machinery shall be kept indoors.
5. Construction wastes shall be promptly disposed into bulk waste containers and the containers shall be emptied daily.
6. Building materials shall be stored under shelter and at least 60cm above the ground so that the pest control operators can treat if any, collected / stagnant water below.

[3]For full details, please refer to COP for ECO.

2.2 Code of Practice (COP) for Environmental Control Officers (ECO)

7. Stagnant water shall be pumped out and ground depressions shall be covered with earth.

Ground depression was backfilled and leveled before being turfed to prevent water ponding and soil erosion.

8. Sand granular insecticide shall be applied into water collected in perforated bricks. Exposed brick holes shall be sealed up with cement.

9. Anti-mosquito oil shall be applied onto stagnant water at least once a week and to reapply after a rain as the oil will be washed away.

Pest control operator sprays anti-mosquito oil on stagnant water.

2.2 Code of Practice (COP) for Environmental Control Officers (ECO)

10. When there is a high population of adult mosquitoes and dengue outbreaks near the construction site, thermal fogging shall be carried out every day for a week.

Thermal fogging is conducted only when population of mosquitoes is high.

11. If the construction site is situated in a malaria-sensitive area, the pest control operators shall carry out residual-spraying of all inner and outer walls of bangsals and site offices once a month.

2.2 Code of Practice (COP) for Environmental Control Officers (ECO)

Measures to Prevent Fly and Rodent Infestation

1. Worksite shall be kept litter free at all times.

Littering at site premises.

2.2 Code of Practice (COP) for Environmental Control Officers (ECO)

2.2

2. Refuse bins shall be covered tightly at all times.

Refuse bin is properly covered.

2.2 Code of Practice (COP) for Environmental Control Officers (ECO)

3. Food provision shall be adequately covered and stored in rodent-proof rooms or cabinets at least 60cm above the ground.

Food are placed less than 60cm from the ground.

4. Pest control operators shall check for rodent burrows every week. Active burrows shall be treated with rodenticides for 3 consecutive days or until the rats are all dead, and then sealed with compacted earth.

Measures to Prevent Malaria

1. All foreign workers shall be screened for history of malaria and taken blood films to exclude parasite carriers.
2. Workers who were down with malaria shall do a follow up visit after their discharge; one month for those who are down with the *P. falciparum* infection and a monthly follow up visit for a period of six months for the *P. vivax* infection.

2.3 Requirements in LTA's Contractual General Specifications (GS)

Only salient points are being highlighted in this section.[4]

Safety, Health & Environmental (SHE) Personnel

Environmental Control Officer (ECO) must be aided by a team of environmental workers, employed solely for the purpose of environmental control.

Mosquito Control

1. Within 60 days of contract award, the contractor shall submit a detailed site specific proposal for vector control that includes the details of the pest control company, their track record and the proposed surveillance and control measures.
2. Chemicals to be used for treatment are subjected to the LTA Safety Division's approval.
3. Contractor must have an in-house pest control team to search and destroy any potential mosquito breeding grounds, especially after every rainfall, using the "zoning method".

[4]For full details, please refer to LTA's GS.

2.3 Requirements in LTA's Contractual General Specifications (GS)

2.3

4. Source reduction and effective drainage shall be the main forms of mosquito control. Environmental friendly applications, such as *Bacillus thuringiensis israelensis* (Bti) shall be used as far as possible to supplement source reduction.

Example of Bti dunks.

(Source: http://www.watergarden.com/store/product/Assessories/MosquitoDunks.jpgA.jpg)

Dictionary

Bti: *Bacillus thuringiensis israelensis* is a bacteria that infects and kills mosquito larvae quickly and efficiently, but is harmless to fish, birds, worms or any mammals.

2.3 Requirements in LTA's Contractual General Specifications (GS)

5. Ovitraps / gravitraps shall be used to monitor the population of adult mosquitoes. Monitoring results shall be submitted to the relevant agency.

Ovitrap is used to monitor mosquito population.

2.3 Requirements in LTA's Contractual General Specifications (GS)

2.3

6. All site offices / containers must have a sloping / pitched roof installed with the sides adequately shielded from the rain.

Site offices are erected with sloping / pitched roof.

7. Any person found on site to be a carrier of the dengue haemorrhagic fever virus, malaria or Japanese encephalitis shall be removed from the site for quarantine.

2.3 Requirements in LTA's Contractual General Specifications (GS)

Rodent Control

1. Source reduction shall be the main form of rodent control. Food consumption and storage must be strictly restricted to designated areas where lidded rubbish bins are available.
2. In-house pest control team shall also look out for evidences of rodents and their burrows during their rounds.

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CHAPTER 3

EFFECTIVE VECTOR CONTROL AT LTA SITES

3

Land Transport Authority

3.1 PDCA Cycle

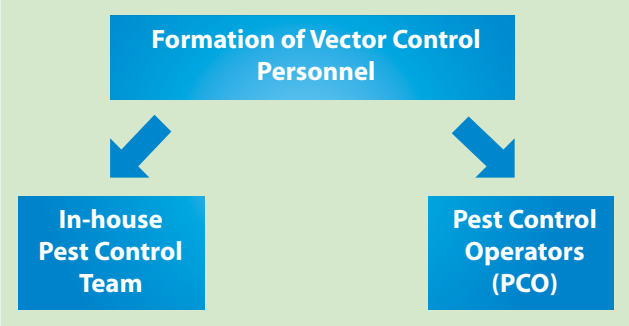
Effective control for vectors, in general at LTA sites follows Plan-Do-Check-Act (PDCA) cycle as shown below:

3.1

3.2 Resource Management

Human Resource

Contractor shall provide adequate competent personnel for the in-house team and engage licensed pest control operators for vector surveillance and control on site.



3.2 Resource Management

3.2

In-house Pest Control Team

In-house team usually consists of Environmental Control Officer (ECO) and trained / experienced workers to conduct the "search and destroy" activity at the construction site using the "zoning method".

Pest Control Operators (PCO)

PCO are engaged externally by the contractor to conduct vector control activities usually on a weekly basis to **supplement** the in-house vector control efforts. They have to be directed by the in-house team to the various potential breeding grounds / areas for vectors during their "search and destroy" activity.

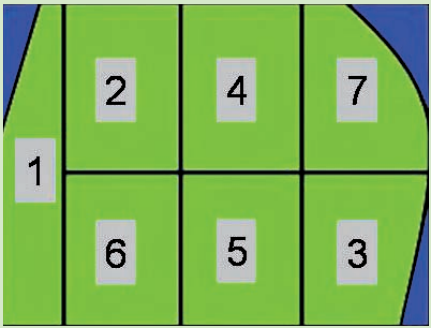
Material Resource

Vector control products, such as larvicide, rodenticide, cockroach spray, fly trapping sticker and etc. are essential to kill vectors and prevent their propagation on site.

3.3 Site Implementation

Zoning Method

1. The construction site has to be divided into a maximum of 7 zones for vector control, particularly mosquito control.



"Zoning method" used in vector control.

2. In-house pest control team will then carry out search and destroy efforts in one zone per day.
3. As such, they will effectively comb through the entire site in a week, which is also the average time span for mosquito larvae to turn into adults.

3.3 Site Implementation

"Search and Destroy" for Mosquito

"Search" for:

3.3

Water Bearing Receptacles and Water Ponding Areas

"Destroy" means:

- Remove all unwanted water bearing receptacles from site.
- Receptacles, pails, basins and containers shall be emptied and turned over after every use.
- Eliminate conditions prone to the unnecessary containment of water.

"Search" for:

Stagnant Water

"Destroy" means:

- Remove stagnant water immediately.

3.3 Site Implementation

"Search" for:

Water in "Hard to Reach" Areas

"Destroy" means:

- If stagnant water cannot be removed, apply Bti, anti-mosquito oil or larvicide to the water regularly to prevent mosquito breeding.

"Search and Destroy" for Rodent

"Search" for:

Active Rodent Burrows

"Destroy" means:

- PCO shall apply approved rodenticides to the active rodent burrows until the burrows become inactive. The burrows shall then be sealed.

3.3 Site Implementation

Checklist used for "Search and Destroy"

3.3

The checklist as shown in the subsequent page is a sample of partial checklist that can be used to facilitate the in-house team in their "search and destroy" activity for vector control.

To complete the checklist, all common breeding areas for vectors at the construction site (refer to Chapter 4) should be included in the checklist, where applicable. ECO shall brief the workers how to use the checklist before the activity starts.

3.3 Site Implementation

Items	Areas to Check	Checked	Findings*		Action Taken		*Description of Findings	Remarks
			Potential breeding	Vector breeding	Clear potential breeding	Use of chemical/ product		
1	**Construction Area**							
a	Discarded items and receptacles	☐	☐	☐	☐	☐		
b	Construction materials	☐	☐	☐	☐	☐		
c	Canvas sheets / plastic covers	☐	☐	☐	☐	☐		
d	Equipments and machineries	☐	☐	☐	☐	☐		

(Modified from the Guide Book on Prevention of Mosquito Breeding published by NEA)

*Indicate any vector breeding sites or irregularities in "Description of Findings".

3.3 Site Implementation

Housekeeping

3.3

A good housekeeping at construction site is essential to prevent the breeding of vectors, particularly mosquito breeding.

Given considerable factor that mosquitoes can only breed in water, all possible sources for stagnant water must be eliminated to prevent such favourable conditions at site.

Food waste must be properly covered and removed daily from site to prevent the propagation of rodents, cockroaches and flies.

Do you know?

Mosquitoes can even breed in the water with a diameter of a 20-cent coin.

3.3 Site Implementation

Maintaining Vegetation

Vegetation should be trimmed regularly to eliminate potential harbouring grounds for vectors.

Grass cutting in site premises.

3.3 Site Implementation

Mosquito Fogging (when necessary)

3.3

The fogging of mosquitoes can only be conducted by the PCO and should be carried out only when there is a high population of mosquitoes and a dengue outbreak in the vicinity of the construction site.

PCO is conducting mosquito fogging on site.

3.3 Site Implementation

Tips for Effective Mosquito Fogging

1. **Time:** At dusk (6pm) or dawn (6am).
2. **Weather:** Fogging cannot be done if it is raining.
3. **Wind:** Strong wind blows away or disperses the fog faster.
4. **Fogging sequence:** Begin by circling the site boundary before moving gradually into the site.
5. **Temperature:** Hot weather will cause air parcels to rise quickly, hence dispersing the fog.

3.3 Site Implementation

Staff Training

Training should be provided to:

3.3

- **In-house pest control team** on the basic knowledge of vector breeding and potential breeding grounds on site. In mosquito control, removing sources of stagnant water should be the first priority, followed by the application of larvicide.
- **General workers** on identifying and reporting of potential and actual breeding grounds for vectors found on site, particularly mosquito breeding and understanding the dangers and symptoms of vector-borne diseases.

Handbook for construction, factory and shipyard workers on "5 Simple Steps To Prevent Dengue" was explained and distributed to all workers.

3.3 Site Implementation

Awareness Programme

Vector awareness programme shall be held at least once a year as a refresher to all workers on the importance of maintaining a worksite that is free of vectors.

Dengue awareness talk was conducted by a NEA officer at site.

Exhibition of dengue prevention posters.

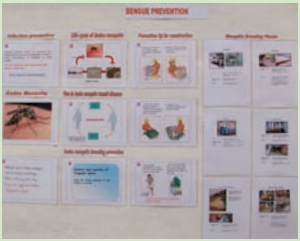
3.3 Site Implementation

Information on Vector Control

3.3

Updated information can be shared among all working personnel on site, be it cascading down to all workers from management level or disseminating within a work group via:

Bulletin Board



Information on dengue prevention.

Notice on incentive to workers who make successful report on the mosquito larva or pupa found on site.

3.3 Site Implementation

Banners

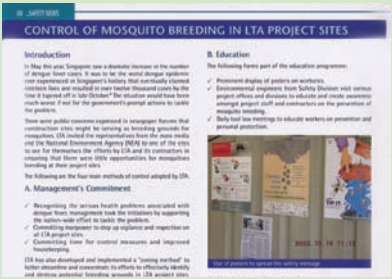
Banners of "Dengue Fever Alert" in different languages.

3.3 Site Implementation

3.3

Posters and Articles

Poster on vector control.



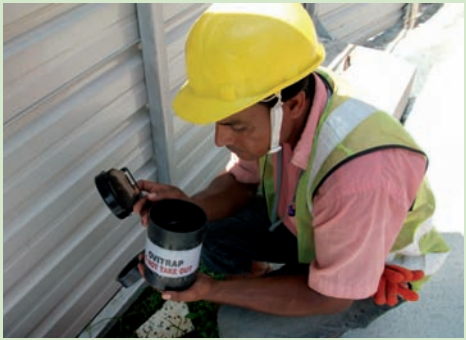
Article on "Control of Mosquito Breeding in LTA Project Sites".

3.4 Monitoring and Inspection

Monitoring Population of Mosquitoes

Ovitrap / gravitrap can be used on site to detect the presence and monitor the population of adult mosquitoes, particularly the *Aedes* mosquito. Thus, it provides an early warning to pre-empt any impending dengue outbreak in the vicinity.

The correct way of using the ovitrap / gravitrap is to place it on leveled ground and maintain it regularly. Monitoring of adult mosquito population can only be carried out effectively at areas with good housekeeping.



Monitoring of adult mosquito population using ovitrap.

3.4 Monitoring and Inspection

Inspection

3.4

On top of the "zoning method", inspection is carried out once a week by safety, health and environmental (SHE) manager to ensure "search and destroy" activity is carried out diligently by the in-house pest control team and PCO.

Present personnel often exchange their views during inspection to eliminate potential breeding of vectors and prevent them from propagating on site.

Environmental Weekly Inspection was conducted with subcontractors' supervisors.

3.5 Management Review

Environmental Meeting

To continually improve on the vector control at site, the following matters are highlighted to the management in the meeting, which will be held at least once a month for discussion:

Inspection Findings

To keep the site free from vectors, findings and measures taken during the site inspection are reported and discussed.

Investigation of Public Complaint / Feedback (if applicable)

Upon receiving a complaint / feedback with regard to potential breeding grounds at a construction site from the public, the contractor is expected to investigate and rectify the problem.

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CHAPTER 4

PREVENTIVE/ REMEDIAL MEASURES TO COMMON BREEDING GROUNDS FOR VECTORS

4

Land Transport Authority

4.1 Common Breeding Grounds for Mosquitoes

Areas	Common Breeding Grounds
Construction area	Discarded items; water bearing receptacles; construction materials; canvas sheets / plastic covers; equipments and machineries; puddles found on ground and concrete floor; water storage tanks, drums and containers; tanks and plants (awaiting utilization); bulk waste containers, skips and refuse bins; trenches; lift / construction shafts; drains / temporary channels; demolition debris; barriers; sump pits; poorly-maintained silt traps and vehicle washing bays; instrumentation boxes.

4.1 Common Breeding Grounds for Mosquitoes

Areas	Common Breeding Grounds
Storage yard	Discarded items; water bearing receptacles; construction materials; canvas sheets / plastic covers; equipments and machineries; puddles found on ground and concrete floor; empty drums and containers; tool and material storage boxes; chemical cans; new diesel drums; container stores.
Container office	Below air conditioners; water bearing receptacles.
Canteen	Domestic containers; discarded items; water bearing receptacles; refuse bins.

4.1 Common Breeding Grounds for Mosquitoes

Discarded Items and Water Bearing Receptacles

Water Stagnation in Receptacles

4.1

Stagnant water is found in discarded items and receptacles.

4.1 Common Breeding Grounds for Mosquitoes

Preventive / Remedial Measures

- Carry out regular cleaning and dispose all unwanted water bearing receptacles.
- As far as possible, remove stagnant water regularly.
- Apply anti-mosquito oil / larvicide to stagnant water regularly and reapply after a heavy rain.

4.1 Common Breeding Grounds for Mosquitoes

Construction Materials - Zinc Sheets, Form Works, Steel Bars, Metal Beams, Pipings, Uninstalled Toilets, Etc

Water Stagnation in Materials and Areas below Materials

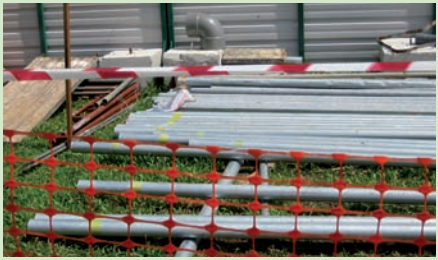
4.1

Stagnant water is found in construction materials and areas below the materials.

4.1 Common Breeding Grounds for Mosquitoes

Preventive / Remedial Measures

- Store construction materials under shelter.
- Place construction materials safely in an inclined position with opening / surface collecting water facing downward.



Pipes are stored safely in an inclined position.

- Apply anti-mosquito oil / larvicide regularly to stagnant water collected in construction materials and reapply after a heavy rain.
- Store construction materials at least 60cm above the ground so that water collected below can be easily reached and treated.

4.1 Common Breeding Grounds for Mosquitoes

Canvas Sheets / Plastic Covers

Water Stagnation on Canvas Sheets / Plastic Covers used for Covering Materials and Earth

4.1

Stagnant water is found on plastic cover and canvas sheet used for covering materials.

Preventive / Remedial Measures

- Canvas sheets / plastic covers must be pulled tightly and inspected daily.
- Stagnant water shall be removed regularly.

4.1 Common Breeding Grounds for Mosquitoes

Equipments and Machineries

Collection of Rainwater in Equipment and Machinery Parts

Rainwater is collected in an unused excavator bucket.

Preventive / Remedial Measures

- Turn over equipment parts that may collect water when they are not in use.
- As far as possible, remove stagnant water regularly.
- Apply anti-mosquito oil / larvicide regularly to stagnant water collected in equipment and machinery parts and reapply after a heavy rain.

4.1 Common Breeding Grounds for Mosquitoes

Puddles found on Ground and Concrete Floor at all Levels

Water Stagnation on Uneven Ground and Concrete Floor

4.1

Stagnant water is found on uneven ground and concrete floor.

4.1 Common Breeding Grounds for Mosquitoes

Preventive / Remedial Measures

- Backfill and level uneven ground / water ponding areas.

Ground depressions being filled and leveled.

- As far as possible, remove stagnant water regularly.
- Apply anti-mosquito oil / larvicide to stagnant water regularly and reapply after a heavy rain.

4.1 Common Breeding Grounds for Mosquitoes

Water Storage Tanks, Drums and Containers

Water stored in Tanks, Drums and Containers

4.1

Potential mosquito breeding areas.

Preventive / Remedial Measures

- Cover tanks, drums and containers properly.
- Maintain tanks, drums and containers regularly.
- Remove unused tanks, drums and containers from site.
- Apply larvicide to the stored water.

4.1 Common Breeding Grounds for Mosquitoes

Tanks and Plants (awaiting utilization)

Collection of Rainwater in Tanks and Plants (awaiting utilization)

Rainwater is collected in a treatment plant awaiting to be functioned at site.

4.1 Common Breeding Grounds for Mosquitoes

Preventive / Remedial Measures

- Cover top opening of tanks and plants with anti-mosquito netting and to replace them if damaged.

Top opening of sedimentation tank and water treatment plant, respectively, that are awaiting to be utilized, are covered with anti-mosquito netting.

- Turn on outlet valve to drain out rainwater in tanks and plants.
- Maintain tanks and plants regularly.

4.1 Common Breeding Grounds for Mosquitoes

Bulk Waste Containers, Skips and Refuse Bins

Collection of Rainwater in Containers, Skips and Bins and Areas below Containers and Skips

Rainwater is collected in skips, refuse bin and areas below skips.

4.1 Common Breeding Grounds for Mosquitoes

Preventive / Remedial Measures

- Cover waste and refuse bins properly at all times.

Waste and refuse bins are properly covered.

- Clear waste inside containers, skips and bins regularly.
- Apply anti-mosquito oil / larvicide regularly to stagnant water collected below containers and skips and reapply after a heavy rain.

4.1 Common Breeding Grounds for Mosquitoes

Trenches

Collection of Rainwater in Trenches

Rainwater is collected in a trench.

Preventive / Remedial Measures

- Pump out water from trenches periodically.
- Apply anti-mosquito oil / larvicide to stagnant water regularly and reapply after a heavy rain.

4.1 Common Breeding Grounds for Mosquitoes

Lift / Construction Shafts

Collection of Rainwater in Lift / Construction Shafts

Rainwater can be accumulated in a construction shaft.

Preventive / Remedial Measures

- Pump out water from lift / construction shafts regularly.
- Apply anti-mosquito oil / larvicide to stagnant water regularly and reapply after a heavy rain.

4.1 Common Breeding Grounds for Mosquitoes

Drains / Temporary Channels constructed for Drainage

Water Stagnation in Drains and Channels due to Blockages and Poor Gradient

Stagnant water is found in drains.

Preventive / Remedial Measures

- Carry out regular maintenance and clearing of leaves to prevent blockages.
- Provide sufficient access to drains and channels for easy maintenance.
- Regrade uneven drains and channels.

4.1 Common Breeding Grounds for Mosquitoes

Demolition Debris

Water Stagnation among Debris

Rainwater can be collected among debris.

Preventive / Remedial Measures

- Dispose of debris regularly.
- Improve on housekeeping.
- Apply anti-mosquito oil / larvicide regularly to stagnant water collected among debris and reapply after a heavy rain.

4.1 Common Breeding Grounds for Mosquitoes

Barriers

Collection of Rainwater in Barriers due to Missing Covers, Gaps and Cracks

Potential mosquito breeding in damaged and uncovered barriers.

4.1 Common Breeding Grounds for Mosquitoes

Preventive / Remedial Measures

- Cover or seal barriers properly.

Barriers with cover / seal.

- Replace damaged barriers.

4.1 Common Breeding Grounds for Mosquitoes

Sump Pits

Accumulation of Water in Pits

Water is accumulated in a sump pit.

Preventive / Remedial Measures

- Carry out regular cleaning / maintenance.
- Apply larvicide to stagnant water.

4.1 Common Breeding Grounds for Mosquitoes

Poorly-Maintained Silt Traps

Water Stagnation in Silt Traps

Water is accumulated in a silt trap due to chokage.

Preventive / Remedial Measures

- Desilt and maintain silt traps regularly to prevent chokage.
- Apply larvicide to stagnant water.

4.1 Common Breeding Grounds for Mosquitoes

Poorly-Maintained Vehicle Washing Bays

Water Stagnation in Washing Bays when not in use

Stagnant water is found in an unused washing bay.

Preventive / Remedial Measures

- Maintain washing bays regularly even when they are not in use.
- Apply anti-mosquito oil / larvicide to stagnant water regularly and reapply after a heavy rain.
- Seal up unused washing bays when they are no longer necessary.

4.1 Common Breeding Grounds for Mosquitoes

Instrumentation Boxes

Collection of Rainwater in Instrumentation Boxes

4.1

Rainwater is collected in an instrumentation box.

Preventive / Remedial Measures

- Cover instrumentation boxes properly.
- Apply larvicide to stagnant water.

Use of larvicide in instrumentation box.

4.1 Common Breeding Grounds for Mosquitoes

Empty Drums and Containers

Collection of Rainwater in Empty Drums and Containers

Rainwater is collected in a drum.

Preventive / Remedial Measures

- Turn over empty drums and containers to prevent collection of rainwater.
- Store empty drums and containers under shelter and away from the rain.

4.1 Common Breeding Grounds for Mosquitoes

Tool and Material Storage Boxes

Collection of Rainwater in Tool and Material Storage Boxes

4.1

Stagnant water is found in a material storage box.

Preventive / Remedial Measures

- Empty all water in tool and material storage boxes.
- Store tool and material storage boxes under shelter and away from the rain.

4.1 Common Breeding Grounds for Mosquitoes

Chemical Cans - Paint, Etc

Water Stagnation in Chemical Cans, including Collection of Rainwater on Lid of Cans

Stagnant water is found on the lid of chemical cans.

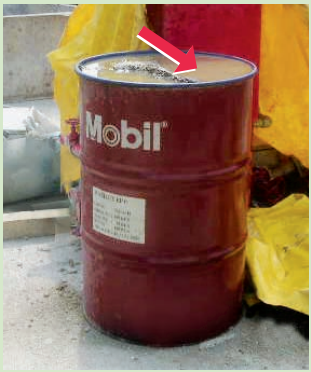
Preventive / Remedial Measures

- Store chemical cans under shelter and away from the rain.

4.1 Common Breeding Grounds for Mosquitoes

New Diesel Drums

Collection of Rainwater on Lid of New Drums



Rainwater is collected on the lid of a new diesel drum.

Preventive / Remedial Measures

- Store new drums under shelter and away from the rain.

4.1 Common Breeding Grounds for Mosquitoes

Container Offices / Stores

Water Stagnation on and below Roofing, in and below Containers

Rainwater is accumulated below roofing, in and below container stores.

4.1 Common Breeding Grounds for Mosquitoes

Preventive / Remedial Measures

- Erect sloping / pitched roof and avoid flat roofing to prevent collection of rainwater at the rooftop.

Pitched roofing is erected.

4.1

- Avoid using secondary roofing.
- Patch up holes and cracks on the roof to prevent accumulation of rainwater in the container.
- Extend roofing to minimize the gap between the roof and container.
- Maintain the containers and remove all water inside the containers regularly.
- Apply anti-mosquito oil / larvicide regularly to stagnant water collected below the containers and reapply after a heavy rain.

4.1 Common Breeding Grounds for Mosquitoes

Collection of Condensate below Air Conditioners

Condensate is accumulated on the floor right below an air conditioner.

Preventive / Remedial Measures

- Remove air conditioner drip trays.
- Install an effective piping system to channel out the condensate from air conditioners.
- Clear the condensate accumulated in the areas below air conditioners regularly.

4.2 Common Habitats for Rodents

Areas	Common Habitats
Construction area	Rodent burrows and nests in between construction materials and demolition debris; under canvas sheets; in bulk waste containers, skips and refuse bins; anywhere that provides shelter and privacy for rodents.
Storage yard	Rodent burrows and nests in between construction materials; under canvas sheets.
Container office	Storage space that provides shelter and privacy for rodents.
Canteen	Food storage rooms / cabinets; refuse bins.

4.2 Common Habitats for Rodents

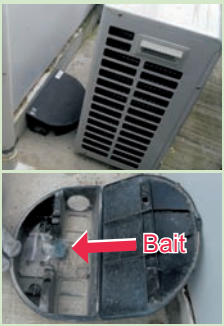
Rodent Burrows and Nests

Rodent burrow can be found at construction site.

(Source: http://www.critrcall.com/page/1r7us/Prairie_Dog_Control_Services.html)

Preventive / Remedial Measures

- Remove food sources at worksite and keep the food in canteen away from rodents.
- Apply rodenticides to active burrows found on site until burrows are rendered inactive. Seal inactive burrows.
- Bait and poison the rodents using feed baits or trap them using the rodent traps at their potential hiding places.



Use of feed bait in rodent control.

4.3 Common Habitats for Flies

Areas	Common Habitats
Construction area	Food waste and refuse bins; trenches and drains.
Canteen	Cooking pots and pans; food provision areas; refuse bins.

4.3 Common Habitats for Flies

Food Waste Bins

Food waste are not properly thrown into the bin and covered, thus leading to potential breeding of flies.

Preventive / Remedial Measures

- Use proper covered bins.
- Throw all food waste only inside the bins designated for food waste.
- Cover the bins properly at all times.
- Clear the bins regularly to avoid overfilling of waste.

4.3 Common Habitats for Flies

Food Provision Areas

Flies can breed at area that is full of residual food waste.

4.3

Preventive / Remedial Measures

- Keep the food provision areas clean at all times.
- Clean and dry the cooking pots, pans and utensils and other cooking equipments after use.
- Cover and store food on site properly at all times.
- Use fly controls near food provisions.

Fly trapping sticker is used at site canteen as a form of fly control.

CHAPTER 5

ASSESSMENT FOR VECTOR CONTROL

Land Transport Authority

5.1 Site Planning Stage

Areas	Relevant Questions
Vector control (in general)	Has the contractor: (a) submitted the Vector Control Plan to LTA? (b) engaged a Pest Control Company?
	Is the Pest Control Company registered with BCA and NEA?
	Is there an in-house team to conduct "search and destroy" activity on site?

5.2 Construction Stage

Areas	Relevant Questions
Vector control (in general)	Is "search and destroy" activity being conducted daily?
	Are workers using checklist similar to the one in Chapter 3 page 29 in their "search and destroy" activity?
	Is "zoning method" being applied in vector control, particularly mosquito control?
	Is there any on-site condition favourable to the propagation or harbouring of vectors?
	Are measures on vector control taken during the site inspection?
	Are potential and actual breeding grounds for vectors found on site being reported and discussed in the meeting?

5.2 Construction Stage

Areas	Relevant Questions
Vector control (in general)	Are workers given adequate training on identifying, destroying and reporting of potential and actual breeding grounds for vectors found on site?
	Are there any vector awareness programmes, such as dengue prevention being held on site?
	Did the contractor investigate and rectify the problem upon receiving a public complaint / feedback on the potential breeding of vectors on site?
	Is the contractor maintaining a good and effective housekeeping on site?
	Are vegetations being trimmed regularly?
	For workers who are feeling unwell, are they given immediate medical attention?

5.2 Construction Stage

Areas	Relevant Questions
Mosquito control	Have the potential mosquito breeding areas been identified and destroyed?
	Is there an effective drainage of stagnating water on site?
	Is the removal of stagnant water the first priority, followed by the application of anti-mosquito oil / larvicide?
	Are the site offices / containers erected with sloping / pitched roof?
	Are environmental friendly applications, such as Bti being placed in stagnant water that cannot be completely removed?
	Are ovitraps being used to monitor the population of adult mosquitoes?

5.2 Construction Stage

Areas	Relevant Questions
Mosquito control	In the event of high population of mosquitoes and a dengue outbreak near the construction site, did the Pest Control Operators (PCO) conduct thermal fogging on site?
	Upon receiving fines on mosquito breeding, did the contractor rectify the root cause to the breeding of mosquitoes?
	Have the foreign workers been screened for malaria?
Rodent control	Are there any food sources at worksite?
	Did the PCO apply an approved rodenticide into an active rodent burrow and seal it once it becomes inactive?
	Are feeding baits / traps being used for rodent control at their potential hiding places?

5.2 Construction Stage

Areas	Relevant Questions
Fly control	Do food handlers keep the canteen and cooking equipments clean at all times?
	Are the food in canteen properly covered and stored?
	Are fly controls being used in the canteen?
	Are the food waste bins covered properly at all times?
	Are food waste bins being cleared regularly?

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CHAPTER 6

INFORMATION ON MOSQUITOES AND MOSQUITO-BORNE DISEASES

Aedes Mosquito

In Singapore, there are more than 80 mosquito species. Many of them are not commonly found and seldom do they pose a threat to human beings. However, the types of mosquito that are of a major concern, belong to the genera *Aedes*, *Culex* and *Anopheles*.

Aedes mosquitoes are black in colour with white stripes on their body and legs. The types of *Aedes* mosquitoes that are commonly found are as follows:

(a) *Aedes aegypti*:

It has two distinct silvery white stripes on its ***thorax***. It breeds in clean stagnant water found in domestic households and rests indoors in cool dark places, on clothing, behind furniture and curtains. It usually bites during the day, transmitting the Dengue and Chikungunya virus.

(Source: http://upload.wikimedia.org/wikipedia/commons/2/2c/Aedes_aegypti_CDC-Gathany.jpg)

(b) *Aedes albopictus*:

It has a distinct middle silvery white stripe on its ***thorax***. It breeds in outdoor receptacles, ground depressions, canvas sheets, construction debris, holes in tree trunks and stems of Traveller's Palm. It prefers to rest outdoor in vegetation. It usually bites during the day, transmitting the Dengue, Chikungunya and West Nile fever virus.

(Source: http://mydogumentary.files.wordpress.com/2009/08/mosquito.jpg)

Dictionary

Thorax: A part of an animal's body that lies in between the head and the abdomen.

Culex Mosquito

Culex mosquitoes are greyish brown in colour and they bite during the night. Generally, they breed not only in clear water but also in organically-polluted water, such as grassy pools and vegetated ponds. They transmit the Japanese encephalitis (JE) virus, Lymphatic Filariasis and West Nile virus.

Anopheles Mosquito

Anopheles are brown with speckled wings and legs. At rest, their body is inclined at an angle to the surface. In general, *Anopheles* are night-biters.

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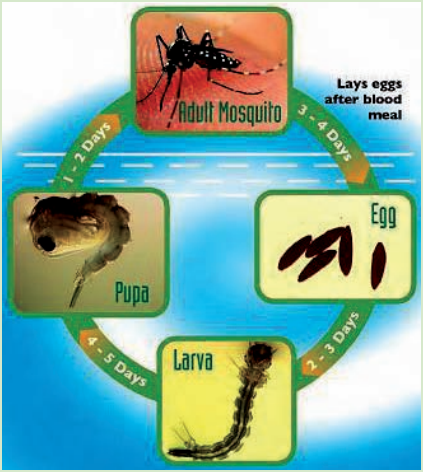
Anopheles sundaicus and ***Anopheles maculatus*** are vectors for malaria. *Anopheles sundaicus* breeds in brackish water found in swamps and coastal areas, whereas *Anopheles maculatus* breeds in clear, fresh water found in hillside streams and seepages.

Life Cycle of Mosquito

Mosquitoes undergo a complete ***metamorphosis***. It goes through 4 separate and distinct stages of development, namely egg, larva, pupa and adult. As the weather in Singapore is generally hot and humid, a complete life cycle from an egg to an adult mosquito usually takes around 7 days.



(Source from the Guide Book on Prevention of Mosquito Breeding published by NEA)

Dictionary

Metamorphosis: A biological process by which an insect physically develops with a conspicuous and relative abrupt change in its body structure after birth or hatching.

Life Cycle of Mosquito

Egg:

Culex and *Anopheles* lay their eggs directly on water while the *Aedes* lay their eggs on damp soil that will be flooded by water. The *Anopheles* eggs are unique in having distinct lateral floats on either side. The eggs of the *Culex* species stick together in clusters that look like a floating raft (which can contain 200 to 300 eggs).

Do you know?

Among these species, *Aedes* eggs are more viable as they can survive in dry conditions for 6 months to a year. Once they are exposed to water, they will hatch to larvae and continue with their life cycle.

Larva:

The larva rises up to the water surface to breathe. It feeds on particulate organic matter, microorganisms and algae from the water. It normally molts four times and increases in size each time. After the last molt, it emerges as a pupa.

Life Cycle of Mosquito

Pupa:

The pupa usually rests at the water surface to breathe before emerging to an adult mosquito in 1 to 2 days.

Adult:

Mosquitoes usually rest in cool, dark and humid places. Only female mosquitoes feed on blood as they need the protein from the blood to develop their eggs. The male mosquitoes however, feed on nectar and plant juices.

Do you know?

Aedes, Anopheles and *Culex* mosquitoes in Singapore could survive in natural environment for about 2 to 3 weeks.

Characteristics of Mosquito

Summary of the characteristics of the three mosquito species

	Aedes	*Culex*	*Anopheles*
Common Breeding Habitats	Clean stagnant water indoors or outdoors	Organically-polluted stagnant water or clear water	Seepages or brackish water
Biting Habit	Bite during the day	Bite during the night	Bite during the night
Transmit	Dengue virus, Chikungunya virus, West Nile fever virus	Japanese encephalitis virus, Lymphatic Filariasis, West Nile virus	Malaria

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Characteristics of Mosquito

Summary of the characteristics of the three mosquito species

	Aedes	*Culex*	*Anopheles*
Egg Laying	Lay eggs one at a time on damp soil that will be flooded by water	Lay eggs one at a time sticking them together in the shape of a raft on the surface of water	Lay eggs one at a time directly on water. The egg has distinct lateral floats on either side.
Larva Breathing	Protuding its ***siphon*** above water surface	Protuding its ***siphon*** above water surface	Through its ***spiracles***

Dictionary

Siphon: A projecting tubular part of some animals used for breathing.
Spiracles: Small openings found on the surface of some animals that connect to their respiratory systems.

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MOSQUITO-BORNE DISEASES

6

Land Transport Authority

Dengue Fever

Dengue fever and dengue haemorrhagic fever (a more severe form) are mosquito-borne viral diseases transmitted by the *Aedes* mosquito. There are 4 serotypes of dengue virus (dengue 1 to 4), which can infect human beings.

Do you know?

Infection with one serotype does not provide cross immunity against other serotypes.

Symptoms of Dengue Fever

You are suspected to have dengue fever if you have been bitten by a mosquito in the past 1 week and have 2 or more of the following symptoms:

1. Headache
2. Fever (usually lasting for 2-7 days)
3. Pain behind the eyes
4. Nausea and vomiting
5. Diarrhoea
6. Rashes
7. Muscle and joint pains

More severe symptoms of dengue haemorrhagic fever:

1. Bleeding from the nose, mouth and gums.
2. Bruises may appear as a sign of internal bleeding.
3. Dengue Shock Syndrome – A critical state of shock due to circulatory failure.

Severe cases may result in death.

Victim of dengue haemorrhagic fever.

(Source: http://www.scienceoxfordonline.com/wp-content/uploads/2009/12/dengue.jpg)

Malaria

An *Anopheles* mosquito infected with the *Plasmodium* parasite (mainly four types that cause malaria) is capable of spreading malaria to human beings through its bite. These parasites travel to the liver of an infected human being through the bloodstream and multiply itself in there before continuing to infect the red blood cells.

Symptoms of Malaria

You are suspected to have malaria if you have been bitten by a mosquito in the past 1 week and have 2 or more of the following symptoms:

1. Fever
2. Chills
3. Nausea
4. Headache
5. Sweating / Perspiring

More severe symptoms of malaria caused by *Plasmodium falciparum*:

1. Renal and liver failure
2. Shock and coma

Japanese Encephalitis (JE)

JE is a viral disease transmitted by the *Culex tritaeniorhynchus* and *Culex gelidus* mosquitoes from the infected domestic pigs and wild birds to both human beings and animals during the feeding process.

Do you know?

Only domestic pigs and wild birds are carriers of the JE virus.

You are suspected to have JE if you have been bitten by a mosquito in the past 2 weeks and have 2 or more of the following symptoms:

Mild infection: Occurs without apparent symptoms other than fever with headache.

More severe infection: The patient may experience quick onset of high fever, neck stiffness, disorientation, coma, tremors and spastic paralysis.

The case fatality rate is high among those with symptoms, and even those who recover may suffer from lasting damage to the central nervous system.

Chikungunya

Chikungunya is a viral illness transmitted to humans through the bite of an infected *Aedes* mosquito. This disease is usually non-fatal.

Symptoms of Chikungunya

You are suspected to have chikungunya if you have been bitten by a mosquito in the past 1 week and have 2 or more of the following symptoms:

1. Prolonged joint pain
2. Fever
3. Rash at the trunk region

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Treatment and Prevention

Tips for You

Seek immediate medical attention if you have been bitten by a mosquito in the past 2 weeks and have 2 or more of the disease symptoms.

Prevention of Mosquito Bites

1. Wear long sleeves and pants.
2. Apply mosquito repellent.
3. Install mosquito nets at dormitory windows.
4. Use mosquito coils / sprays.
5. Sleep under mosquito net.

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Land Transport Authority

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