FIELD SURVEY AND SITE ASSESSMENT OF MOSQUITOES AT KINTYRE CAMP

IN JUNE AND DECEMBER 2011

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1. INTRODUCTION

Kintyre Camp is a base camp for the Cameco Uranium Mine located in the Great Sandy Desert about 270 km north east of Newman. Personnel deployed at Kintyre Camp complained of nuisance levels of biting mosquitoes after heavy rains during the warm summer months during the first quarter of 2011. This report presents the findings of a field survey at Kintyre Camp to assess mosquito numbers and potential mosquito breeding areas within the camp with a view to providing advice on priority management actions to minimise mosquito numbers during the next wet season.

2. POTENTIAL MOSQUITO BREEDING AREAS

There are several natural waterbodies within mosquito flight range of Kintyre Camp. These have the potential to be mosquito breeding areas. Furthermore, it is possible that breeding occurs in natural areas of ephemeral flooding after heavy rain.

Accommodation and mess buildings at Kintyre Camp are located about 150 m south of a waste water treatment facility that comprises holding pools, a settlement tank and an evaporation pond. The three components of the sewerage treatment facility all provide potential mosquito breeding sites (see Figures 1-4).

Within the Camp itself, water is permanently or regularly held in a vehicle washdown facility, a turkey nest dam and, possibly, the laydown area. Mosquitoes will be able to complete a life cycle if water is held in these facilities for seven days or more.

3. MOSQUITO ASSESSMENT

Field assessments of the extent of mosquito nuisance and potential breeding sites were conducted by Bennelongia and Cameco staff between 28 June and 1 July, 22 and 25 November, and 15 and 19 December 2011. A list of sites where sampling was undertaken is provided in Table 1. Some other sites were visually inspected and concluded not to have potential to support breeding or adult mosquitoes.

The main methods used to quantify mosquito occurrence or disease risk were larval surveys at breeding sites, carbon dioxide (CO_2) traps, inspections of potential mosquito resting sites, observations of biting mosquitoes and interviews with Camp personnel.

3.1. Breeding sites

Initially a survey was made of all the camp site buildings, core shed, workshop, and ablution areas and other infrastructure at Kintyre Camp to identify potential mosquito breeding sites. Potential sites were sampled for mosquito larvae using three techniques:

- Visual observations of mosquito larvae and pupae.
- Ladle counting technique. This method is used to provide estimates of abundance for waterbodies where mosquito larvae are known to be present (usually from visual observations).
- Sweep net using 250 micron mesh net to obtain a qualitative sample of invertebrates within a water body. Only effective where the water depth is more than a few centimetres.

Figure 1. Potential mosquito breeding areas.
A. CO_2 light trap.
B. Back of the kitchen showing an unscreened vent and surface water access beneath the building.
C. Water storage tank showing unscreened roof.
D. Evidence of surface water drainage and pooling under building.
E. Electrical maintenance access pit showing evidence of inundation.
F. Core Shed wash down facility with unavoidable pooling water.

Figure 2. Potential mosquito breeding areas.
A. Vehicle wash down facility with unavoidable pooling water.
B. Sunken sewerage settlement tanks at WWTP.
C. Heavily vegetated evaporation pond at WWTP.
D. Pooling water in evaporation pond at WWTO.
E. Turkey Nest dam.
F. Equipment laydown area.

Figure 3. Potential mosquito breeding areas.

A. WWTP showing primary ponds (fore ground) and evaporation pan (back ground)

B. Dense vegetation over most of the WWTP evaporation pan. In the fore ground is *Ipomoea muelleri* concealing patches of surface water.

C. WWTP big pool with low water level and Buffel Grass in the foreground and *Pluchea rubelliflora* around the edges of the pool.

D. WWTP linear trench normally concealed by grass showing water to a depth of 4 cm that hosts significant mosquito breeding.

E. Pool A with deeper water.

F. A CO_2 light trap adjacent to the meeting area –a reported mosquito biting location. Efficiency of the trap is reduced by ambient lighting that could not be eliminated.

Figure 4. Potential mosquito breeding areas.
A. Vehicle wash down facility. Standing water occurs here to a depth of about 30 cm at the distal end and overlies a heavy sediment load.
B. Core Shed fines settlement tank showing a lid covering one of 3 circular overflow tanks at the right.
C. Drill water retained in a shallow ditch
D. Piles of equipment in laydown area capable of holding water for extended periods during rain seasons.

3.2. CO_2 traps

CO_2 traps are recommended by the Western Australian Department of Health as an effective method of sampling adult mosquito populations when survey time is limited. The traps use dry ice to release CO_2 to attract mosquitoes, and incorporate a battery operated fan to both disperse the CO_2 and positively direct attracted mosquitoes into a cylindrical holding receptacle. The traps also included a small battery operated light as an additional mosquito attractant.

The traps were set away from ambient light an hour before dusk by suspending them from a tree branch or from a purpose built tripod (Figure 1a) so that the entrance to the capture net was set at about 60 cm above ground level. The traps were set up-wind of likely mosquito sources to facilitate CO_2 dispersal over the potential source, and to attract mosquitoes towards the trap. Traps were emptied an hour after dawn. The plastic containers holding trapped insects were placed directly into an 'Esky' containing dry ice for a period of ten minutes, after which the mosquitoes were transferred to a labelled vial

Table 1. List of sites sampled for mosquitoes.

Natural wetlands	**Camp infrastructure**
Rock Pool	Turkey nest dam
Pinbi Pool	Wash down facility
Duck Pool	Workshop
Waste water treatment plant	Camp office
WWTP small pool	First aid room
WWTP big pool	**Camp accommodation**
WWTP linear trench	Camp A block
WWTP settling tank	Camp B block
WWTP evaporation pond	Camp C block
	Camp D block

suitably buffered with tissue paper to prevent damage to diagnostic features and then placed in a freezer.

3.3. **Mosquito resting sites**

Populations of resting mosquitoes were assessed at three locations: the ablution area at the washdown facility, the ablution area at the workshop, and the camp office. Potential adult mosquito resting sites were inspected, including window ledges, building corners, under cupboard shelves and inside the diffuser covers of fluorescent light fittings.

3.4. **Biting mosquitoes**

The incidence of biting mosquitoes was assessed by observing mosquito settlement on the biologist's arm during two 30 minute assessment periods at the sewerage treatment facility at dusk and within the Camp at dawn.

3.5. **Interviews**

Interviews with mine site personnel were utilised to determine patterns of mosquito biting.

4. RESULTS AND DISCUSSION

Nine species were collected during the three periods of sampling (Table 2). There were five species of *Culex*, three *Aedes* and one *Anopheles*. Eight of these were collected as adults, while five were collected as larvae.

Discussions with Camp personnel identified several locations where pest levels of mosquitoes had occurred following summer rains. These included the meeting table located adjacent to the administration building, the outdoor seating area located in the centre of the accommodation buildings, and the kitchen veranda.

Moderate numbers of adult mosquitoes were collected in CO2 light traps on 29 June 2011 (21 at the office) and 24 and 25 November (15 at D Block, 19 and 23 at A Block and the WWTP). This coincided

with moderate nuisance levels, whereby staff could sit outside in the evening but some people were being bitten at an uncomfortable level.

In terms of likely breeding sites, the surveys in June, November and December suggested the following.

WWTP

Daily inspections showed that water depth in the pools within the WWTP fluctuated from 0 to 4 cm in the absence of rainfall. Very heavy cover of vegetation (80% of surface area) hampered an accurate assessment of breeding sites but it is considered likely that breeding was occurring, especially in the warmer months. In December 236 larvae, mostly of *Culex annulirostris/palpalis*, were collected in bailer surveys of the WWTP pools. Most breeding occurred in the small open pool surrounded by grass and *Ipomoea muelleri* (Figure 3b) and the linear trench (Figure 3d). The average numbers of larvae in five baler samples were 8.4 at the pool and 10.4 at the trench on 15 December, and 5.8 and 11.6 at the same sites on 19 December 2011. This coincided with a period of moderate mosquito biting incidence at Kintyre Camp. While the biting adults would have pupated a few days earlier, the larval numbers reported provide a guide to the larval densities associated with nuisance, if conditions are right, disease.

Camp

There was no evidence of surface water around the immediate confines of the camp and no evidence of mosquito breeding.

Wash down

There are two main potential breeding sites at the wash down.

- The vehicle wash down contains surface water in the concrete washing facility and the drainage sump (Figure 4a). Both sites contain hydrocarbon contamination typical of such facilities and no mosquito larvae were observed visually or recovered with the 250 um sweep net.
- The fines wash down at the core shed comprise a settlement apron that holds water to about 25cm depth and drains into a series of three small tanks each holding about 500 litres beneath aluminium lids (Figures 1f, 4b). The water in these tanks is very clear. Tadpoles and some water beetles but no mosquito larvae were observed visually. High levels of chironomid larvae were observed in the sediments of the fines apron water obtained with a 250 um sweep net. No mosquito larvae were recorded.

Turkey nest Dam

The dam contains water used for operational procedures and was about 1.2 metres deep x 10 metres long and 6 metres wide. A number of sweeps down the steep sided banks produced high numbers of invertebrates but no mosquito larvae.

Holding tank Borehole CWB16

This small holding sump is constructed as a temporary water supply for drilling operations. The drilling has been completed at this site but water remains in the sump (it is expected to be filled in). There is about 50 cm of water heavily contaminated with drilling fluids. There is a similar depth of grey drilling

Table 2. Mosquito sampling results.

Site	Date	Species	No.	Site	Date	Species	No.
Adult mosquitoes							
Camp A Block	25-Nov-11	*Aedes pseudonormanensis*	11	WWTP evap. pond	23-Nov-11	*Anopheles annulipes* s.l.	2
Camp A Block	16-Dec-11	*Aedes pseudonormanensis*	8	WWTP evap. pond	19-Dec-11	*Anopheles annulipes* s.l.	42
Camp A Block	25-Nov-11	*Anopheles annulipes* s.l.	1	WWTP evap. pond	23-Nov-11	*Culex annulirostris*	3
Camp A Block	16-Dec-11	*Anopheles annulipes* s.l.	5	WWTP evap. pond	19-Dec-11	*Culex annulirostris*	3
Camp C block	20-Jun-11	*Anopheles annulipes* s.l.	1	WWTP evap. pond	19-Dec-11	*Culex starkae*	1
Camp C block	20-Jun-11	*Culex annulirostris*	1				
Camp D Block	25-Nov-11	*Aedes pseudonormanensis*	3	**Larval mosquitoes**			
Camp D Block	25-Nov-11	*Aedes tremulus*	2	Duck Pool	23-Nov-11	*Culex annulirostris*	12
Camp D Block	25-Nov-11	*Anopheles annulipes* s.l.	9	Duck Pool	20-Jun-11	*Culex starkae*	2
Camp D Block	25-Nov-11	*Culex annulirostris*	1	Pinbi Pool	24-Nov-11	*Aedes pseudonormanensis*	6
Camp offiice	19-Dec-11	*Aedes pseudonormanensis*	1	Pinbi Pool	17-Dec-11	*Culex palpalis*	1
Camp offiice	25-Nov-11	*Aedes* sp.	1	Rock Poool	23-Nov-11	*Aedes pseudonormanensis*	2
Camp offiice	29-Jun-11	*Culex annulirostris*	18	WWTP big pool	24-Nov-11	*Anopheles annulipes* s.l.	17
Camp offiice	29-Jun-11	*Culex bitaeniorhynchus*	1	WWTP big pool	24-Nov-11	*Culex annulirostris*	25
Camp offiice	29-Jun-11	*Culex quinquefasciatus*	2	WWTP big pool	29-Jun-11	*Culex sp.*	1
Turkey next dam	24-Nov-11	*Anopheles annulipes* s.l.	4	WWTP small pool	24-Nov-11	*Anopheles annulipes* s.l.	6
WWTP big pool	25-Nov-11	*Aedes pseudonormanensis*	4	WWTP small pool	24-Nov-11	*Culex annulirostris*	32
WWTP big pool	17-Dec-11	*Aedes pseudonormanensis*	1	WWTP small pool	24-Nov-11	*Culex palpalis*	1
WWTP big pool	25-Nov-11	*Aedes* sp.	2	WWTP small pool	15-Dec-11	*Culex palpalpis*	9
WWTP big pool	25-Nov-11	*Anopheles annulipes* s.l.	14	WWTP small pool	19-Dec-11	*Culex palpalpis*	4
WWTP big pool	25-Nov-11	*Culex annulirostris*	4	WWTP linear trench	15-Dec-12	*Culex annulirostris*	40
WWTP settle tank	23-Nov-11	*Aedes tremulus*	1	WWTP linear trench	15-Dec-12	*Culex palpalpis*	10
WWTP evap.pond	19-Dec-11	*Aedes notoscriptus*	2	WWTP linear trench	19-Dec-11	*Culex annulirostris*	1
WWTP evap.pond	19-Dec-11	*Aedes pseudonormanensis*	15	WWTP linear trench	19-Dec-11	*Culex palpalpis*	4

sludge at the bottom. No mosquito larvae were observed visually or found in sweeps with the 250 um net.

Laydown
This facility holds a large amount of mining equipment. Bundles of empty 20 litre drums are stacked along the side and used tyres are also stacked in places. A number of empty water tanks are also stored there. Many of these items are likely to collect rainwater as most do not have lids and tyres are notorious for collecting water. The period of storage is unknown but during the wet season it is likely to persist for several days providing mosquito breeding habitat within 1.2km of camp.

4.1. **Mosquito control issues**

The most accurate method to identify problem mosquito breeding sites is to gain an understanding of which problem species are most abundant, and apply knowledge of their specific behaviours and habitat preferences to the identification of candidate sites. Larval samples from these sites can then be used to confirm whether or not the candidate sites require management. It might therefore be appropriate to conduct a mosquito survey during the wetter months when biting incidents are occurring.

With so little evidence of mosquitoes at the Camp during the dry and cool conditions in June, and relatively low numbers in November and December, the accurate identification of problem breeding sites remains uncertain. However, general observations made during the Camp site inspections suggest that the WWTP is the principal source of mosquito breeding. Other potential problem breeding sites associated with Camp infrastructure are highlighted below:

- The WWTP contains shallow pooled water surrounded by dense weed growth. Waste water treatment and disposal facilities are broadly recognised as potential breeding sites for mosquitoes and this is the case at Kintyre Camp. For this reason, consideration could be given to modifying the design of the WWTP to either eliminate pooling, or to construct deeper, steep and smooth sided pools with no aquatic vegetation or dense vegetation close to the pool perimeters. The pools should be easily accessible for maintenance, monitoring and the application of larvicides when required.
- None of the drainage pipe, or toilet vents connected to each building are currently fitted with insect mesh, which allows mosquito access to water pipes and the sewage system;
- The metal roof on the freshwater storage tank provides numerous entry points for adult mosquitoes. Although no mosquito larvae were collected using a sweep net during the June survey, water tanks are known to offer breeding habitat for mosquitoes and while accessible to adult mosquitoes, the water storage tank at Kintyre Camp is likely to provide suitable habitat for breeding during warm conditions. Chemical treatment with a surface film may provide appropriate treatment at this site, but consultation with the Shire Environmental Health Officer is advisable because the Department of Health no longer advocates the use of such films on drinking water (Douglas 2009). Alternatively, complete screening could be required.
- There was a strong hydrocarbon smell associated with the water in the vehicle wash down catchment sump that may have impacted mosquito breeding potential at this site.
- The turkey nest bore sump has steep smooth banks and most vegetation has been removed from close proximity to the water which minimises mosquito breeding and resting habitat at this site. In addition, surface disturbance generated by the bore pump reduces its breeding habitat value for many mosquitoes. However, it is located well within the dispersal range of many mosquito species, and its location to the south east of the Camp means that it is up wind of the

prevailing winds. Larval monitoring at this site, particularly during warm conditions is therefore considered appropriate.

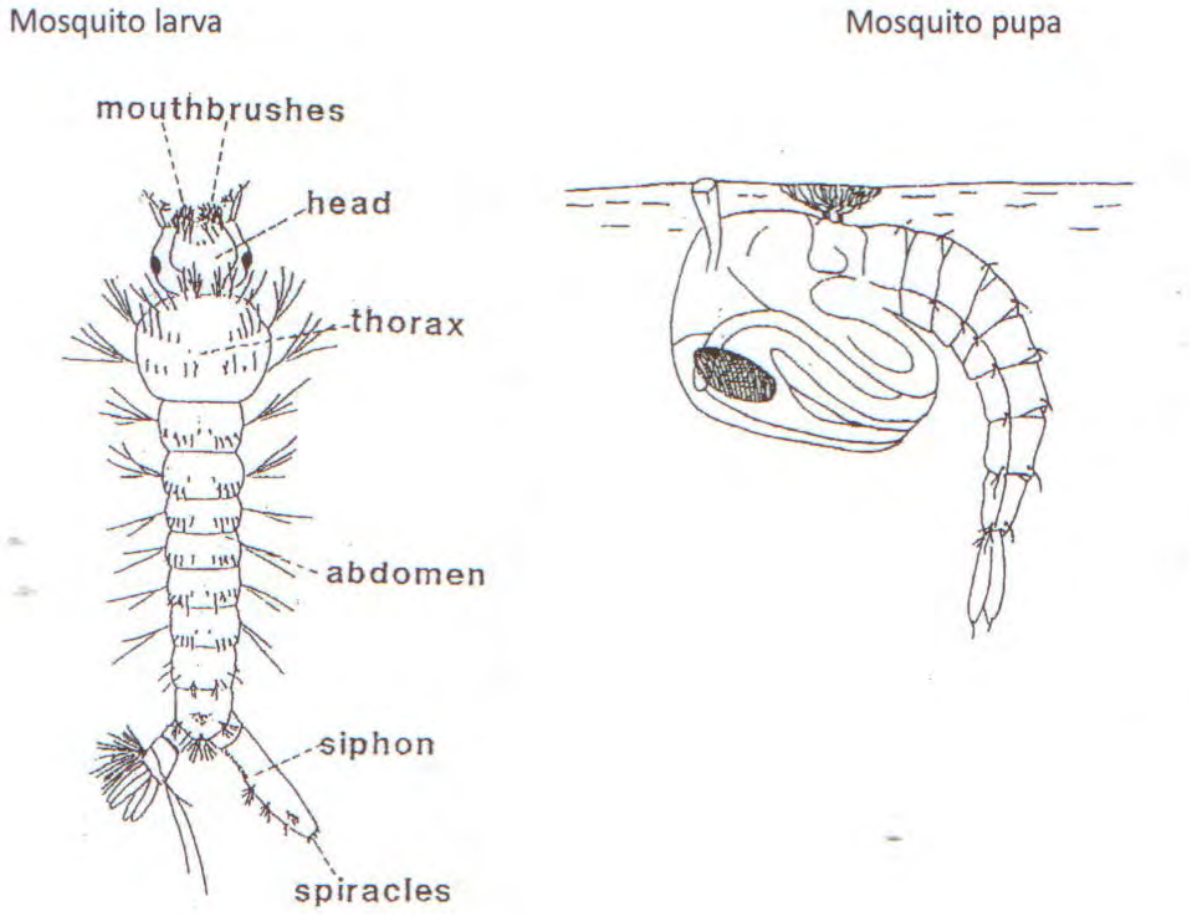
- Sumps and wash down facilities unavoidably provide standing water with the potential for mosquito breeding. While no larvae were collected, these facilities require monitoring to determine when chemical or biological control is required.

Despite identification of the WWTP as the main source of mosquitoes at Kintyre during relatively dry conditions, the East Pilbara is renowned for its periodic flooding events during the hot summer months. Under these conditions, mosquitoes will enter Kintyre Camp from numerous and extensive natural breeding areas. It is unlikely that these sources can be controlled and management initiatives to ensure effective screening and the use of protective clothing and repellents will always play a significant role in managing mosquitoes at this location.

APPENDIX A - EARLY SYMPTOMS OF MOSQUITO BORNE DISEASES

Ross River and Barmah Forest Viruses	Murray valley Encephalitis and Kunjin Virus
Flu-like illness	Headache
Tiredness	Fever
Headache	Nausea
Muscle pains	Vomiting
Enlarged glands	Neck stiffness
Sore throat	Disorientation
Fever	dizziness
Depression	
Tingling or numbness of extremities	
Rash – normally not itchy	
Joint pain – often in small symmetrical joints like fingers, knees and elbows. Pain can be acute with associated swelling and redness.	

APPENDIX B. GENERAL CHARACTERISTICS DISTINGUISHING MOSQUITO LARVAE AND PUPAE.



Sourced from Russell R. C. (2009) Mosquito Biology and Ecology. In 'Mosquito Management Manual'. (ED. Department of Health) pp.2 – 16 (Government of Western Australia: Perth).