

## Environmental Impact Assessment on Central Catchment Nature Reserve for the Proposed Cross Island Line

SITE INVESTIGATION ENVIRONMENTAL IMPACT  
ASSESSMENT REPORT – VOLUME II ENVIRONMENTAL  
BASELINE REPORT

01 February 2016

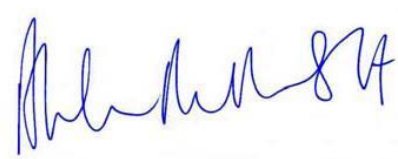


# Environmental Impact Assessment on Central Catchment Nature Reserve for the Proposed Cross Island Line

**Environmental Resources  
Management (S) Pte Ltd**

120 Robinson Road #10-01,  
Singapore 068913  
Telephone (65) 6324 9636  
Facsimile (65) 6226 1636  
Email [ermmsg@erm.com](mailto:ermmsg@erm.com)  
Website: [www.erm.com](http://www.erm.com)

Site Investigation Environmental Impact Assessment Report –  
Volume II Environmental Baseline Report

Client <b>Land Transport Authority Singapore</b>		Project No <b>0256660</b>			
Project Summary  The Land Transport Authority have commissioned ERM to undertake environmental impact assessment studies relating of the construction and operation of the Cross Island Line (CRL) at or in close proximity to the Central Catchment Nature Reserve (CCNR), in Singapore. The phased studies are:  - <i>Phase 1a</i> : Environmental Baseline - <i>Phase 1b</i> : EIA of the Site Investigation Works within the CCNR - <i>Phase 2</i> : EIA of the construction and operation of the CRL for the two route options.  This document presents the Environmental Baseline Report of the Site Investigation Environmental Impact Assessment for the Project. Information presented is based on secondary data available at the time of writing and environmental baseline data collected during the field surveys between October 2014 and November 2015.		Date <b>01 February 2016</b>			
		Approved by  <b>Alastair Scott</b> <i>Managing Partner, ERM (S) Pte Ltd</i>			
005	Site Investigation EIA Report – Volume II Environmental Baseline Report	WT	RF	AS	01.02.16
004	Site Investigation EIA Report – Volume II Environmental Baseline Report	SC	JS	AS	06.01.16
003	Site Investigation EIA Report – Volume II Environmental Baseline Report	SC	JS	AS	22.12.15
002	Site Investigation EIA Report – Volume II Environmental Baseline Report	FZ/SMC/NN	TF	AS	17.12.15
001	Site Investigation EIA Report – Volume II Environmental Baseline Report	FZ/JS/AJ/BB/EY/NN/JW	TF/IC/GK/TW	AS	25.11.15
Revision	Description	By	Checked	Approved	Date
This report has been prepared by Environmental Resources Management with all reasonable skill, care and diligence within the terms of the Contract with the client, incorporating our General Terms and Conditions of Business and taking account of the resources devoted to it by agreement with the client.  We disclaim any responsibility to the client and others in respect or any matters outside the scope of the above.  This report is confidential to the client and other relevant government agencies or statutory boards and we accept no responsibility of whatsoever nature to any other third parties ("Third Parties") to whom this report, or any part thereof, is made known. Any such Third Parties rely upon the report at their own risk.		Distribution  <input type="checkbox"/> Internal <input checked="" type="checkbox"/> Public  <input type="checkbox"/> Confidential			



## CONTENTS

<b>1</b>	<b>INTRODUCTION</b>	<b>1-1</b>
1.1	PURPOSE OF THIS REPORT	1-1
1.2	OVERVIEW OF THE PROJECT	1-1
1.3	OBJECTIVE AND APPROACH	1-1
1.4	REPORT STRUCTURE	1-3
<b>2</b>	<b>THE PROJECT</b>	<b>2-1</b>
2.1	INTRODUCTION	2-1
2.2	PROJECT LOCATION AND ALIGNMENT OPTIONS	2-1
2.3	STUDY AREA	2-3
2.4	GENERAL SITE SETTING	2-3
<b>3</b>	<b>GEOLOGY</b>	<b>3-1</b>
3.1	INTRODUCTION	3-1
3.2	STUDY AREA	3-1
3.3	SOURCES OF INFORMATION	3-1
3.4	REGIONAL GEOLOGY AND GEOMORPHOLOGY	3-1
3.5	LOCAL GEOLOGY OF THE STUDY AREA	3-3
<b>4</b>	<b>WATER ENVIRONMENT</b>	<b>4-1</b>
4.1	INTRODUCTION	4-1
4.2	STUDY AREA	4-1
4.3	SOURCES OF INFORMATION	4-2
4.4	CLIMATIC SETTING	4-4
4.5	MACRITCHIE RESERVOIR	4-6
4.6	MACRITCHIE RESERVOIR CATCHMENT AREA	4-7
4.7	CANALS	4-11
4.8	GROUNDWATER	4-13
<b>5</b>	<b>NOISE AND VIBRATION</b>	<b>5-1</b>
5.1	INTRODUCTION	5-1
5.2	STUDY AREA	5-1
5.3	SOURCES OF INFORMATION	5-3
5.4	NOISE AND VIBRATION SOURCES IN THE STUDY AREA	5-4
5.5	LOCAL AMBIENT NOISE ENVIRONMENT	5-5
5.6	LOCAL VIBRATION ENVIRONMENT	5-18

<b>6</b>	<b><i>CLIMATE AND AIR QUALITY</i></b>	<b>6-1</b>
6.1	<i>INTRODUCTION</i>	6-1
6.2	<i>STUDY AREA</i>	6-1
6.3	<i>SOURCES OF INFORMATION</i>	6-1
6.4	<i>REGIONAL AMBIENT AIR QUALITY</i>	6-3
6.5	<i>LOCAL AMBIENT AIR QUALITY</i>	6-5
<b>7</b>	<b><i>ECOLOGY AND BIODIVERSITY</i></b>	<b>7-1</b>
7.1	<i>INTRODUCTION</i>	7-1
7.2	<i>CLIMATE, FOREST ENVIRONMENT AND BIODIVERSITY OF SINGAPORE</i>	7-1
7.3	<i>STUDY AREA</i>	7-3
7.4	<i>CRITERIA FOR EVALUATION OF ECOLOGICAL AND BIODIVERSITY VALUE</i>	7-5
7.5	<i>RESULTS OF SECONDARY DATA REVIEW AND PRIMARY BASELINE SURVEYS</i>	7-7
7.5.1	<i>HABITATS AND VEGETATION</i>	7-8
7.5.2	<i>AVIFAUNA</i>	7-19
7.5.3	<i>TERRESTRIAL MAMMALS</i>	7-30
7.5.4	<i>HERPETOFAUNA</i>	7-42
7.5.5	<i>BUTTERFLIES AND ODONATES</i>	7-50
7.5.6	<i>AQUATIC COMMUNITY</i>	7-59
7.6	<i>OVERALL DISTRIBUTION OF SPECIES OF CONSERVATION INTEREST</i>	7-66
<b>ANNEX 1.0</b>	<b><i>CCNR TRAIL USER SURVEY</i></b>	
<b>ANNEX 2.0</b>	<b><i>PHOTOGRAPH LOG</i></b>	
<b>ANNEX 3.0</b>	<b><i>CCNR PHYSICAL STREAM SURVEY FINDINGS</i></b>	
<b>ANNEX 4.0</b>	<b><i>SURFACE WATER SURVEY LABORATORY RESULTS</i></b>	
<b>ANNEX 5.0</b>	<b><i>ACOUSTICS SURVEY RESULTS</i></b>	
<b>ANNEX 6.0</b>	<b><i>AIR QUALITY SURVEY RESULTS</i></b>	
<b>ANNEX 7.0</b>	<b><i>ECOLOGY AND BIODIVERSITY FIELD SURVEY METHODOLOGY</i></b>	
<b>ANNEX 8.0</b>	<b><i>SPECIES LISTS</i></b>	
<b>ANNEX 9.0</b>	<b><i>BASELINE INFORMATION FOR PROPOSED BOREHOLE LOCATIONS WITHIN THE CCNR</i></b>	



## **1 INTRODUCTION**

### **1.1 PURPOSE OF THIS REPORT**

This final report presents the findings from the baseline data gathering undertaken for the Environmental Impact Assessment (EIA) of the Cross Island Line (CRL) alignment options around the Central Catchment Nature Reserve (CCNR) area in Singapore (the 'Project').

This report has been prepared for the Land Transport Authority (LTA) by Environmental Resources Management (S) Pte Ltd (ERM) and presents the objectives, methodology and findings of the baseline environment.

### **1.2 OVERVIEW OF THE PROJECT**

The LTA intends to construct a new Mass Rapid Transit (MRT) line, the CRL, to provide a strategic underground rail link to enhance connectivity between the east/northeast and west of Singapore and to meet future transport demands. The CRL will be approximately 50 km in length and span the length of Singapore to connect Changi in the east to Jurong Industrial Estate in the west. The target for completion of construction and operation of the entire CRL MRT railway line is around 2030 (*LTA, 23 August 2013*<sup>1</sup>). Two alignment options are being considered in the CCNR, as shown in *Figure 1.1*.

As the CCNR is home to substantial native flora and fauna resources which are legally protected under the *Parks and Trees Act, 2006*, the LTA commissioned an EIA to determine the potential environmental impact of Project activities. The EIA considers two underground alignment options, one which would pass underneath the CCNR; and a second alignment that skirts the CCNR boundary. Project activities considered in the study will include geotechnical site investigation (SI) works required for the feasibility engineering; construction of the railway and associated facilities; and operation of the MRT line.

### **1.3 OBJECTIVE AND APPROACH**

The objective of documenting existing conditions is to provide a baseline against which the potential impacts identified during the scoping stage can be assessed.

The baseline for the Project has been developed from the review of existing information gathered from various sources (also referred to as secondary information) and field surveys (or primary data). Secondary information was gathered from in house databases, online sources, publications, libraries and technical agencies and authorities such as NParks, PUB, Urban Redevelopment Authority (URA), Ministry of National Development (MND) etc. Further details on the information sources and findings of the baseline characterization are reported within *Chapters 2 to 7*.

<sup>1</sup> Land Transport Authority (23 August 2013) **Cross Island Line**. Available at <http://www.lta.gov.sg/content/ltaweb/en/public-transport/projects/cross-island-line.html>.

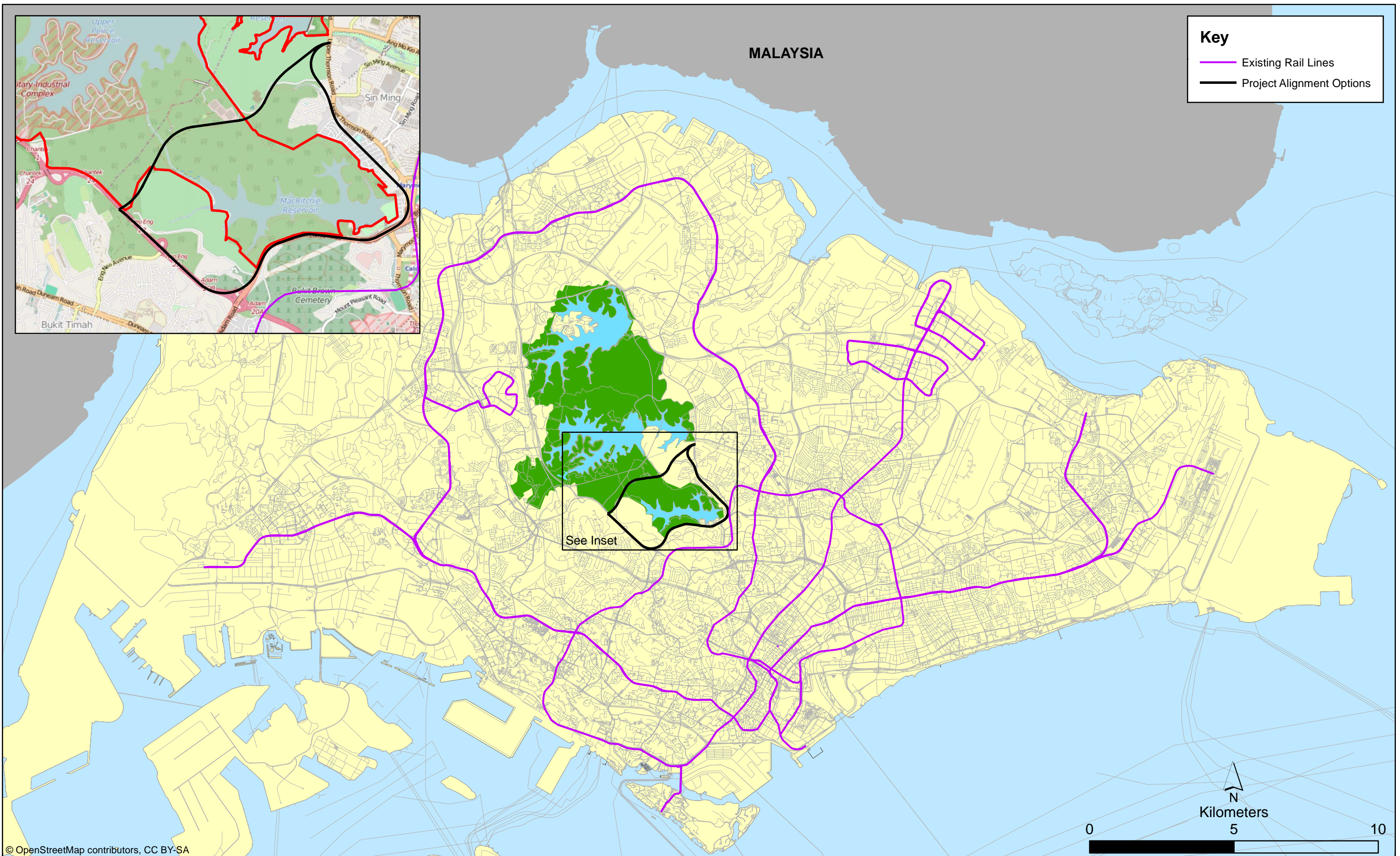


Figure 1.1 Cross Island Line and Project Location



## 1.4 REPORT STRUCTURE

The remainder of this report is organized as follows:

- *Chapter 2:* presents the Project location and setting;
- *Chapter 3:* outlines the general geology;
- *Chapter 4:* details the water environment, ie surface water and groundwater features;
- *Chapter 5:* presents the existing levels of noise and vibration;
- *Chapter 6:* presents the climate and air quality; and
- *Chapter 7:* details the baseline ecology and biodiversity of the Study Area.

Supporting information is provided in annexes as follows:

- *Annex 1.0:* CCNR trail user survey;
- *Annex 2.0:* Photograph log;
- *Annex 3.0:* Stream survey field records;
- *Annex 4.0:* Surface water survey laboratory results;
- *Annex 5.0:* Acoustic survey results;
- *Annex 6.0:* Air quality survey results;
- *Annex 7.0:* Ecological and biodiversity survey methodology;
- *Annex 8.0:* Primary ecology survey - species listing; and
- *Annex 9.0:* Ecological baseline information for proposed borehole locations

## 2 THE PROJECT

### 2.1 INTRODUCTION

This chapter of the report presents the Project location, the CRL alignment options being considered and the setting of the broader Study Area.

### 2.2 PROJECT LOCATION AND ALIGNMENT OPTIONS

The location of the CRL is illustrated in *Figure 2.1*. Two alignment options are being considered in the CCNR area:

- **Alignment Option 1:** from the Singapore Island Country Club (SICC) Island golf course to the Pan Island Expressway (PIE), beneath approximately 1.8 km of the CCNR MacRitchie forest to the south of Lower Peirce Reservoir, and north of MacRitchie Reservoir. No aboveground structures would be constructed within the CCNR itself. SI within the CCNR would be undertaken to determine the geotechnical characteristics of the underlying geology and inform the engineering feasibility study for the alignment option.
- **Alignment Option 2:** approximately 9 km in length, skirting the southernmost boundary of the CCNR. Alignment Option 2 would travel southeast from the SICC Island golf course under residential developments bounded by the MacRitchie forest and Upper Thomson Road. The alignment would then run west beneath Lornie Road before turning north at Adam Road to run under the PIE. Some surface structures would be required for Alignment 2 and the locations and impact assessment will be included in the construction and operation EIA for the Project. SI would also be required to determine the geotechnical characteristics of the underlying geology and inform the engineering feasibility study for the alignment option.

Further details of the CRL alignment options and the activities associated with the construction and operational phases of the Project are currently in the engineering feasibility stage and will be assessed within the Project EIA.



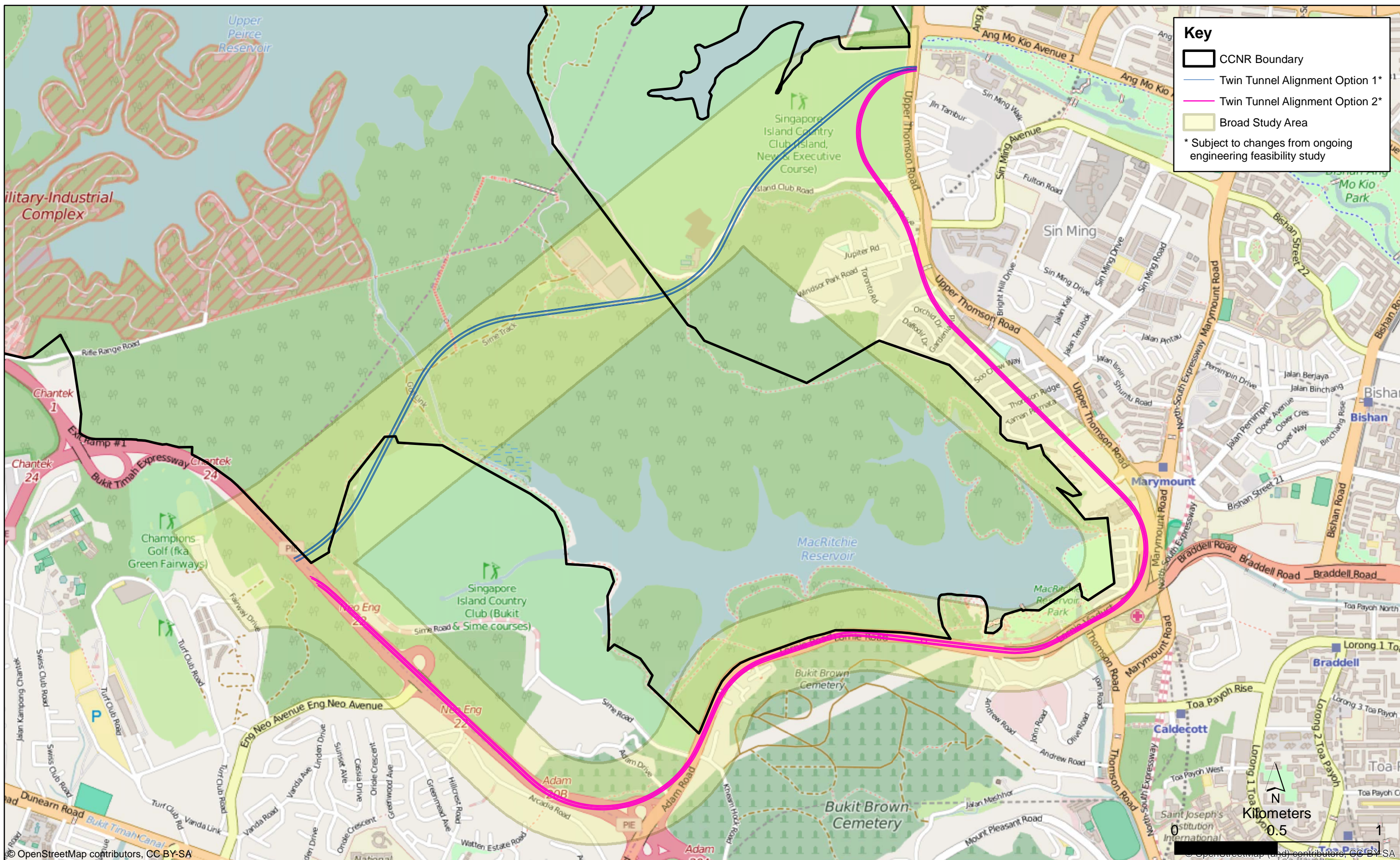


Figure 2.1 Alignment Options & Project Broad Study Area



## 2.3 STUDY AREA

The *Study Area* is the area of coverage for the EIA in order to adequately understand and describe the environmental baseline likely to be affected by the CRL. At a minimum, the Study Area will encompass the CRL footprint (for the two alignment options being considered) and its *Area of Influence* (AOI). The footprint will include the alignment itself and any activities or structures that would be located on the ground surface, for example the SI works. Committed developments that are at or in close proximity to the alignment and surface structures are also considered within the AOI. The Study Area for the Project is illustrated on *Figure 2.1*.

It should be noted that the AOI varies across the various environmental receptors (for example, air, water, noise etc), as it takes into account the nature of the affected resource/receptors, the source of impacts and the manner in which the resultant effects are likely to be propagated beyond the CRL footprint. These Study Areas are defined in more detail in *Chapters 3 to 7* for each environmental resource considered.

## 2.4 GENERAL SITE SETTING

As shown in the *URA Masterplan 2014* (*Figure 2.2*), the Study Area comprises predominantly of the CCNR (categorized as *open space*) and the SICC golf courses located to the east and west (designated for *sports & recreation*). The Study Area also includes densely populated areas characterized by multiple land uses and categorized by the URA as *residential areas, parks, utility, commercial and health and medical facilities*.

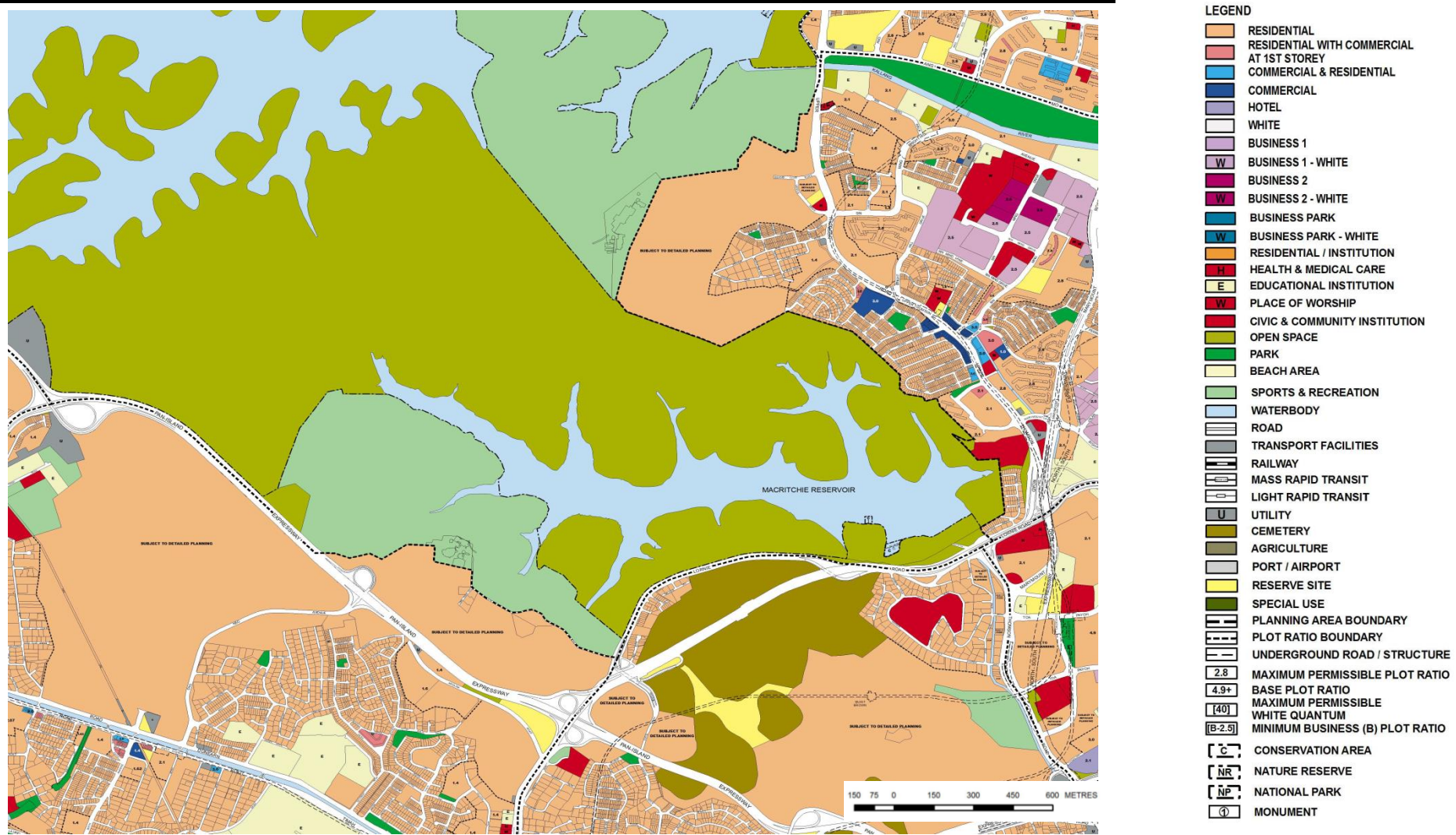
Review of maps and reconnaissance undertaken between July and December 2014, highlighted the following existing land uses within the Study Area:

- Ecological areas;
- Recreational areas;
- Residential areas;
- Places of worship;
- Educational institutions;
- Healthcare facilities such as clinics, home for the aged sick and hospitals;
- Utility infrastructure;
- Transport infrastructure; and
- Committed developments<sup>1</sup>.

<sup>1</sup> A development which is underway and is considered as part of the Project baseline.



Figure 2.2: URA Masterplan of the Study Area



Source: URA, 2014 (<http://www.ura.gov.sg>)

Ecological areas within the Study Area comprise of the designated CCNR, as well as forested areas outside the CCNR boundary which serve as ecological buffer zones, eg Windsor Interim Green; the forested area on the northern and western perimeter of SICC's Bukit-Sime golf courses; and the forested area on either side of the PIE. It is noted that SICC's Bukit-Sime golf course is home to several mature trees that have been labelled for conservation in accordance with NParks' request. In addition, the Bukit Brown Municipal Cemetery lies located along Lornie Road, south of MacRitchie Reservoir. Beyond its cultural and historical value, the Bukit Brown Municipal Cemetery is considered an ecologically rich site and falls under the Central Tree Conservation Area (TCA) designated under the *Parks and Trees (Preservation of Trees) Order 1991*<sup>2</sup>. TCAs are defined as areas with a large number of mature trees or extensive greenery, and were designated with the intention of minimizing the felling of mature trees. A review of aerial satellite imagery published by Google Earth<sup>3,4,5</sup> confirms that these areas outside the CCNR boundary are largely vegetated with forest and grassland.

Public trails within CCNR and MacRitchie Reservoir Park serve as key recreational areas within the Study Area for joggers, wildlife photographers and nature lovers, as well as a training and racing ground for cross-country athletes. The trails also provide access to the HSBC Tree Top Walk, located north of the Study Area (*Figure 2.3*). The easternmost corner of MacRitchie Reservoir has also been demarcated for recreational activities such as kayaking and fishing. Recreational areas outside the CCNR boundary comprise of the Venus Drive trail connecting Windsor Interim Green and the existing trails within the CCNR (*Figure 2.3*), as well as neighborhood parks along Island Garden Walk, Jupiter Road, Soo Chow Walk and Taman Permata (*Figure 2.2*). A survey of individuals utilizing key trails in the CCNR was conducted between December 2014 and February 2015. The findings are detailed in *Annex 1*. In summary, the trails in proximity to the Project alignment within the CCNR are utilized more during the weekends. Extrapolated results indicate that some trails could be utilized by up to 4,100 people during a weekend (rounded value extrapolated for Prunus and Petai Trails as detailed in *Annex A*) and 1,100 people during a weekday (rounded value extrapolated for MacRitchie Visitor's Centre).

Residences within the Study Area mostly comprise of black and white colonial-era bungalows, privately owned bungalows, terrace houses, semi-detached houses and low rise and high rise condominiums. These are located along the eastern boundary of the CCNR, south of the CCNR south of Lornie Road, and west of SICC's Bukit and Sime golf courses along Adam Drive (*Figure 2.4*).

Places of worship include the Hai Lam Sua Tee Kong Toa Temple and St Francis Convent located on the premises of Mount Alvernia Hospital (*Figure 2.4-C*). There is also a chapel located on the ground floor of the Mount Alvernia Hospital, where mass is conducted every morning (except Sundays) for patients, visitors and hospital staff.

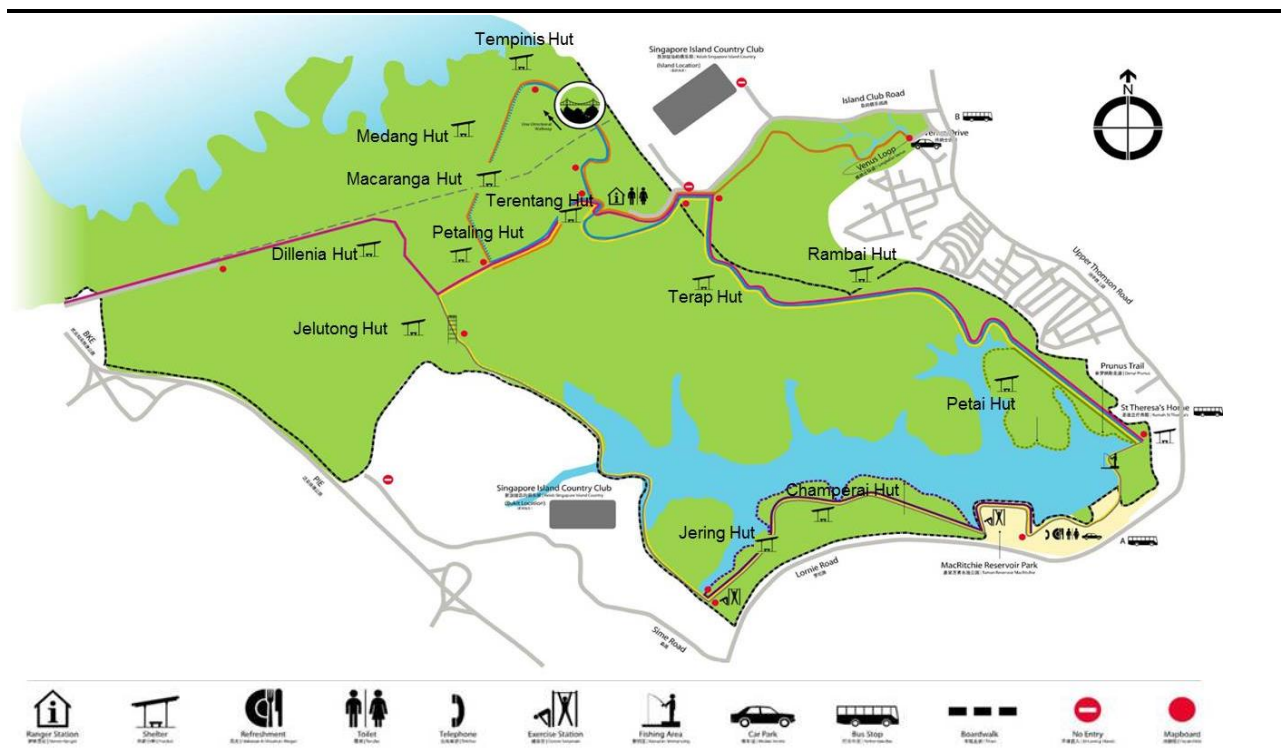
<sup>2</sup> Parks and Trees (Preservation of Trees) Order, Cap. 216, Schedule 2.

<sup>3</sup> Google Earth Pro 7.0 (19 October 2009) Windsor Interim Green 1°21'18.27"N, 103°49'10.77"E.

<sup>4</sup> Google Earth Pro 7.0 (19 October 2009) Sime Road 1°20'23.46"N, 103°48'33.17"E.

<sup>5</sup> Google Earth Pro 7.0 (19 October 2009) Lornie Road 1°20'22.96"N, 103°49'22.33"E.

**Figure 2.3: Public Trails within the Central Catchment Nature Reserve**



Source: NParks, 2015 (<http://www.nparks.gov.sg>)

Educational institutions include Raffles' Institution Junior College located at the cross junction of Marymount Road and Braddell Road, as well as two pre-school facilities located within the private estate along Westlake Avenue (Our Juniors' Schoolhouse<sup>6</sup> and Cherie Hearts Kids-at-Play<sup>7</sup>) (Figure 2.4-B).

Healthcare facilities include St Theresa's Home located between the CCNR and Upper Thomson Road, Assisi Hospice and Mount Alvernia Hospital (Figure 2.4-C). Thomson Plaza, located along Upper Thomson Road, houses several clinics and dental surgeries (Figure 2.4-B). A veterinary clinic with surgical facilities is also located within the private estate along Venus Road<sup>8</sup>.

Utility infrastructure within the Study Area includes MacRitchie Reservoir; the Bukit Kalang Service Reservoir operated by the PUB, pumps and installations for the operation and maintenance of the MacRitchie Reservoir; as well as SP Powergrid 6.6kV substations located within St Theresa's Home, and within private estates lining Upper Thomson Road (Figure 2.4-A and Figure 2.4-C). Other utility infrastructure such as electricity, gas and water mains, and telecommunication lines are typically installed 1 to 3 m underground, near developed areas outside the CCNR, as well as within or in proximity to the MacRitchie Reservoir Park and the Ranger Station within the CCNR.

Transportation infrastructure within the Study Area includes the major arterial roads, Upper Thomson Road and Lornie Road (Figure 2.4 A – Figure 2.4B). Upper Thomson Road is a dual three-lane major arterial road that connects the northern and central regions of Singapore. Lornie Road lies along the southern perimeter of the MacRitchie Reservoir and connects the PIE and the Central Expressway (CTE)

<sup>6</sup> Our Juniors Global Schoolhouse Pte Ltd (2014). **Find Your Closest Centre**. Retrieved from <http://www.ourjuniors.com.sg/find-your-closest-centre/>

<sup>7</sup> Cherie Hearts Kids-At-Play Pte Ltd (2013) **Contact Us**. Retrieved from <http://www.cherieheartskidsatplay.com.sg/contactus.html>

<sup>8</sup> Jireh Veterinary Clinic Pte Ltd (nd) **Location Map**. Retrieved from <http://www.jirehvets.com.sg/jirehmap.html>

through the MacRitchie viaduct flyover. A section of the PIE, which is one of two major expressways connecting the eastern and western regions of Singapore, runs along the western boundary of the CCNR. Other supporting transport facilities include bus stops along the aforementioned roads, and petrol kiosks operated by Shell, Esso and Singapore Petroleum Company (SPC) (*Figure 2.4-B and Figure 2.4-C*).

Other landmarks within the Study Area include areas of historical value and/or buildings or structures that have been accorded legal conservation status. These include:

- The water intake tower and connecting bridge at MacRitchie Reservoir, which was conserved as a reflection of late 19<sup>th</sup> century technology and construction methods (*URA, 13 December 2014*<sup>9</sup>);
- The iconic bandstand and bridge at MacRitchie Reservoir Park, which were conserved for nostalgic reasons (*URA, 13 December 2014*<sup>9</sup>);
- A Shinto shrine constructed in the forest at MacRitchie Reservoir in honor of fallen Japanese soldiers, and used for ceremonial events during the Japanese occupation of Singapore. Just prior to the surrender of the Japanese forces, the shrine was destroyed to prevent returning British forces from desecrating it. In 2002, the National Heritage Board (NHB) designated the ruins of the Shinto shrine as a historic site (*National Library Board, 2004*<sup>10</sup>); and
- Remnants of a former settlement or plantation village at Windsor Interim Green.

There are a number of committed developments that have been identified within or in proximity to the broad Study Area. The committed developments for which public information is available and are considered further within this EIA are summarized in *Table 2.1*.

<sup>9</sup> Urban Redevelopment Authority (13 December 2014) **Conservation – MacRitchie Reservoir**. Retrieved from <http://www.ura.gov.sg/uol/conservation/conservation-xml.aspx?id=MRP>

<sup>10</sup> National Library Board. (2004) **Singapore Infopedia – Syonan Jinja**. Retrieved from [http://eresources.nlb.gov.sg/infopedia/articles/SIP\\_236\\_2004-12-24.html](http://eresources.nlb.gov.sg/infopedia/articles/SIP_236_2004-12-24.html)



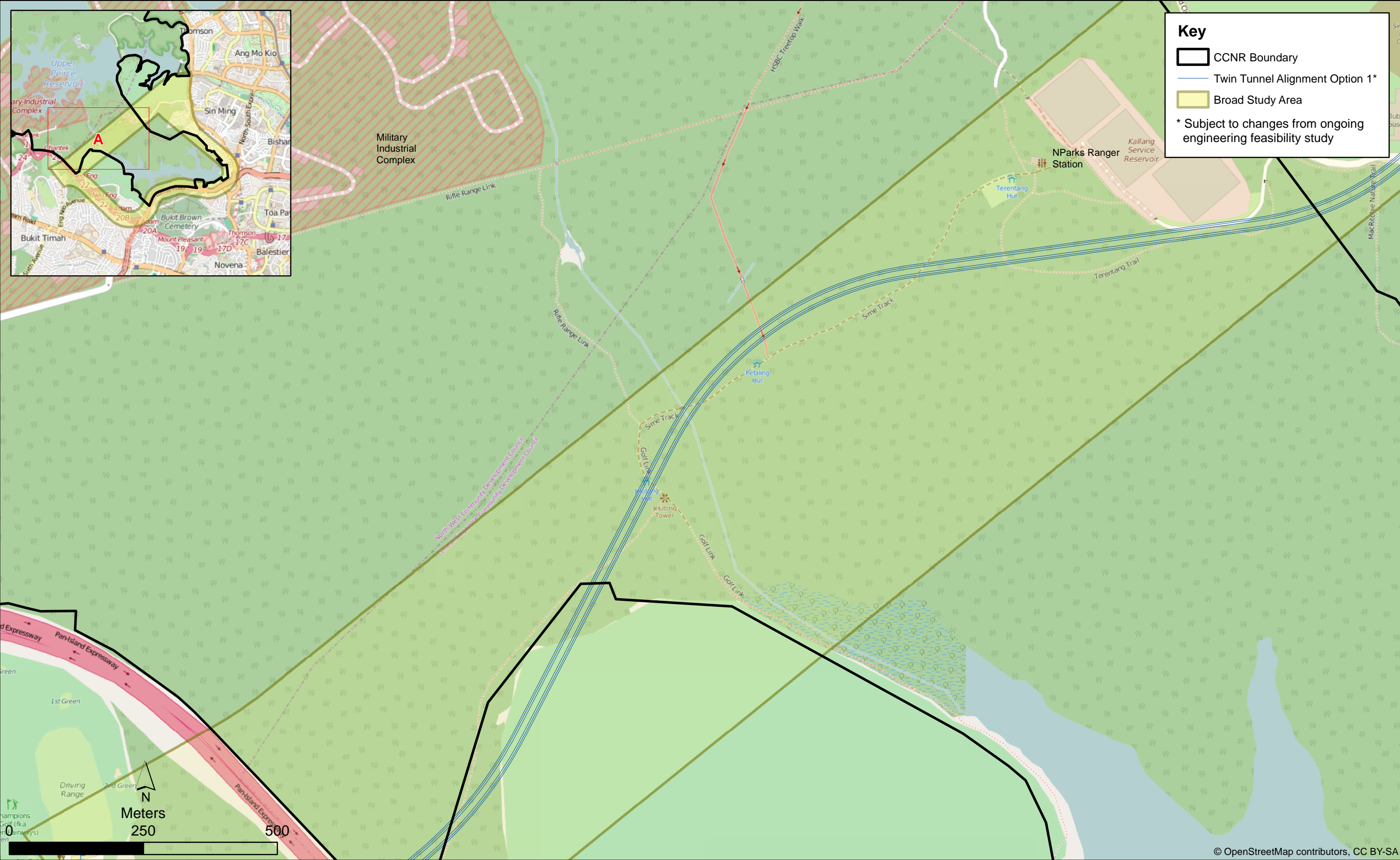


Figure 2.4a Land Uses within Broad Study Area



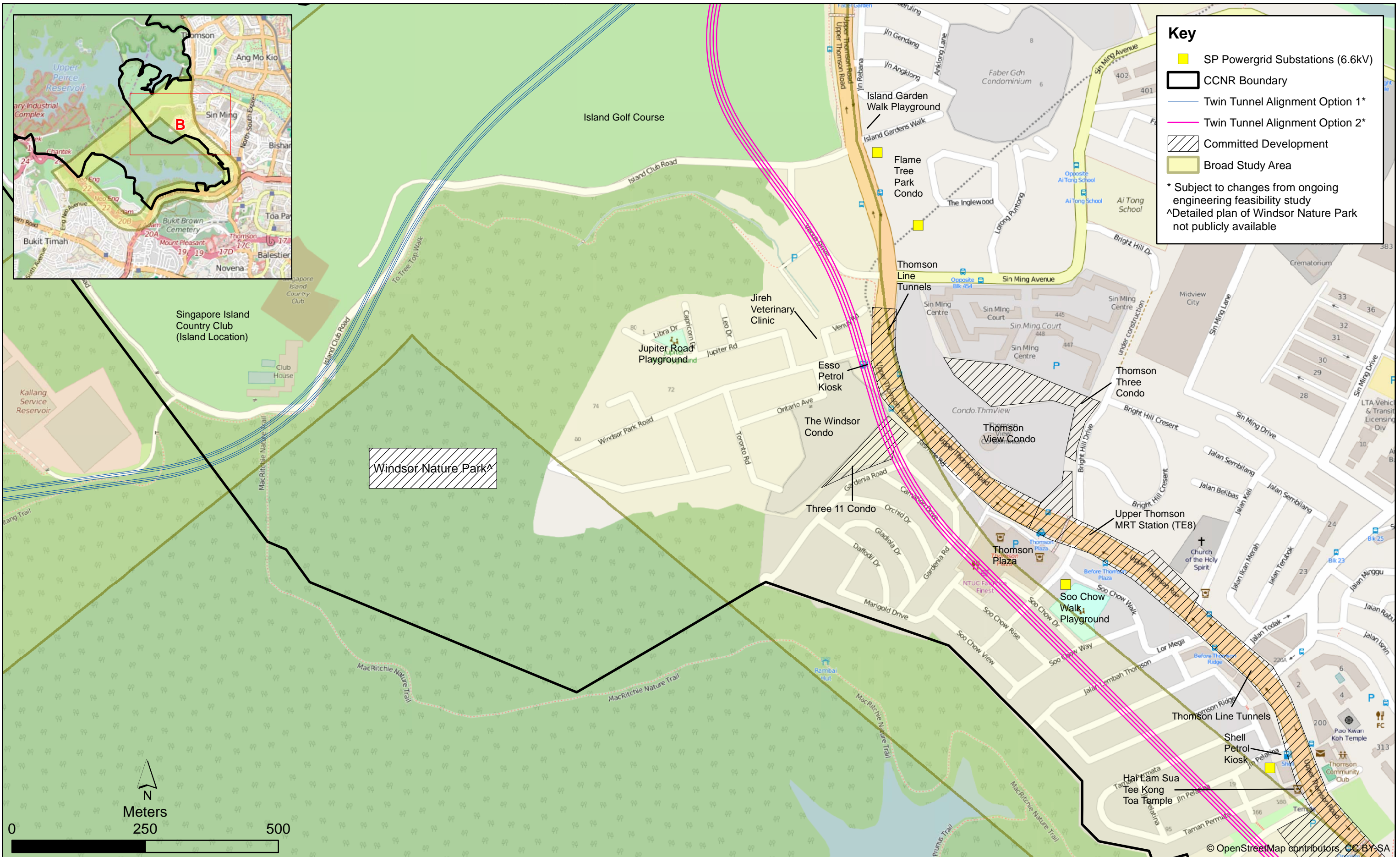


Figure 2.4b Land Uses within Broad Study Area







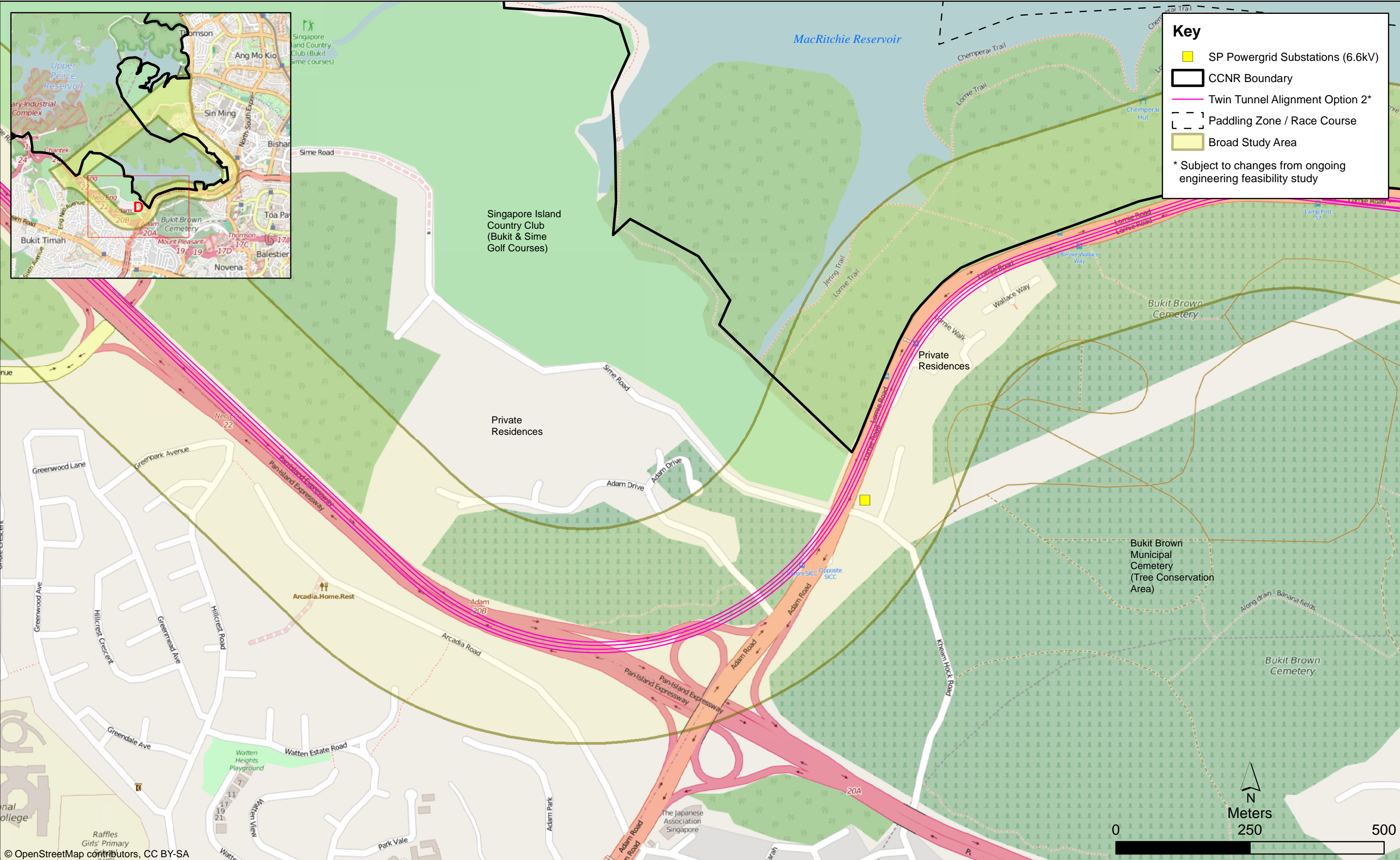


Figure 2.4d Land Uses within Broad Study Area





Figure 2.4e Land Uses within Broad Study Area



**Table 2.1: Committed Developments within the Study Area**

No.	Description	Location	Estimated Schedule
<b>Transport Infrastructure</b>			
1	Upper Thomson MRT Station & Tunnels for Thomson Line	Along Upper Thomson Road, commencing from Venus Drive intersection	2020 <sup>(Note 1)</sup>
2	North South Expressway tunnel section	East of Marymount Road, underlying Raffles Institution Junior College and east of Assisi Hospice	2016 to 2020 <sup>(Note 2)</sup>
3	Outer Ring Road	Connection of MacRitchie Viaduct Flyover and Adam Flyover, via Bukit Brown Municipal Cemetery	End 2017 <sup>(Note 3)</sup>
<b>Residential</b>			
4	Thomson Grand (condominium)	East of SICC Island Golf Course, along Upper Thomson Road	2015 <sup>(Note 4)</sup>
5	Thomson Three (condominium)	Bright Hill Drive	28 February 2017 <sup>(Note 4)</sup>
6	Three 11 (condominium)	Upper Thomson Road	31 December 2015 <sup>(Note 4)</sup>
<b>Recreational</b>			
7	Park Connector	Eastern and southern boundary of CCNR	2018 <sup>(Note 5)</sup>
8	MacRitchie Observation Tower	MacRitchie Reservoir Park	2018 <sup>(Note 5)</sup>
9	Windsor Nature Park	Windsor Interim Green	Mid 2015 to End 2016 <sup>(Note 6)</sup>
<b>Others</b>			
10	Assisi Hospice	Cross junction of MacRitchie Viaduct Flyover and Braddell Road	1Q 2017 <sup>(Note 4)</sup>
11	North South Cable Transmission Tunnel, Contract NS2, Ang Mo Kio ventilation building (permanent shaft) <sup>(Note 7)</sup>	Cross junction of Upper Thomson Road and Ang Mo Kio Avenue 1	April 2018 <sup>(Note 8)</sup>
12	North South Cable Transmission Tunnel, Contract NS3, Marymount equipment building (permanent shaft) <sup>(Note 7)</sup>	Bounded by Bishan Fire Station, Lornie Road and Marymount Road	April 2018 <sup>(Note 8)</sup>
13	PUB pipeline development <sup>(Note 9)</sup>	Phase 1 north of Kalang Service Reservoir and Phase 2 east of Kalang Service Reservoir	Phase 1 2016

**Notes**

- (1) Land Transport Authority (15 November 2013) **LTA Awards Two Contracts for Thomson Line's Springleaf and Upper Thomson Stations**. Available at <http://www.lta.gov.sg/apps/news/page.aspx?c=2&id=b71143b9-db2f-4b06-92d1-485d05f61d46>.
- (2) Land Transport Authority (16 September 2014) **North South Expressway**. Available at <http://www.lta.gov.sg/content/ltaweb/en/roads-and-motoring/projects/north-south-expressway-nse.html>
- (3) Land Transport Authority (2013) **Outer Ring Road System**. Available at <http://www.lta.gov.sg/content/ltaweb/en/roads-and-motoring/projects/outer-ring-road-system.html>.
- (4) ERM site surveys undertaken between July and December, 2014.
- (5) National Parks Board (26 May 2012) **NParks to Improve Access to Central Catchment Nature Reserve to Bring Singapore Closer to Nature**. Available at [http://www.nparks.gov.sg/cms/index.php?option=com\\_news&task=view&id=296&Itemid=247](http://www.nparks.gov.sg/cms/index.php?option=com_news&task=view&id=296&Itemid=247).
- (6) National Parks Board (14 February 2015) **Windsor Nature Park**. Available at <https://www.nparks.gov.sg/news/2015/2/factsheet-windsor-nature-park>
- (7) Singapore Power Ltd (2012) **Locations**. Available at <http://www.singaporepower.com.sg/iri/servlet/prt/portal/prtroot/docs/guid/30fa6aee-7c0b-3010-ee94-f045dbb40f4f>.
- (8) Singapore Power Ltd (2012) **Project Schedule**. Available at <http://www.singaporepower.com.sg/iri/servlet/prt/portal/prtroot/docs/guid/f0dcf4a7-f10a-3010-cc9f-93f9f10da3cc>.
- (9) Limited publicly available information available at the time of writing (LTA, 2015)

### 3 GEOLOGY

#### 3.1 INTRODUCTION

This chapter is intended to provide an overview of the regional geological setting and the geological conditions within the Study Area.

This chapter is structured as follows:

*Section 3.2* defines the Study Area;

*Section 3.3* presents the sources of information reviewed to develop the geological baseline;

*Section 3.4* details the regional geology of Singapore; and

*Section 3.5* presents the local geology based on secondary information review of the Study Area.

#### 3.2 STUDY AREA

The Study Area for the geological baseline comprises the area of the CCNR through which the alignment options are located and areas adjacent to the east, south and south-west boundaries of the CCNR, extending approximately 400 meters outward from the east and south, and up to 1,200 meters outward from the south west boundary (*Figure 3.1*). The geological baseline is intended for the purposes of undertaking the EIA and not engineering associated with the CRL development.

#### 3.3 SOURCES OF INFORMATION

Geological conditions were determined through a desk top review of available literature sources; geological reports and presentations, satellite and aerial photographic imagery, historical maps, topographic surveys, field observations and site investigation borehole data logs undertaken proximal to the CCNR. The CCNR is a designated nature reserve and accordingly there have been limited intrusive investigations of the geology, with the exception of some piling works associated with development of the HSBC TreeTops Walk and the Bukit Kalang storage reservoir. At the time of writing, no records of the aforementioned geological works were available.

#### 3.4 REGIONAL GEOLOGY AND GEOMORPHOLOGY

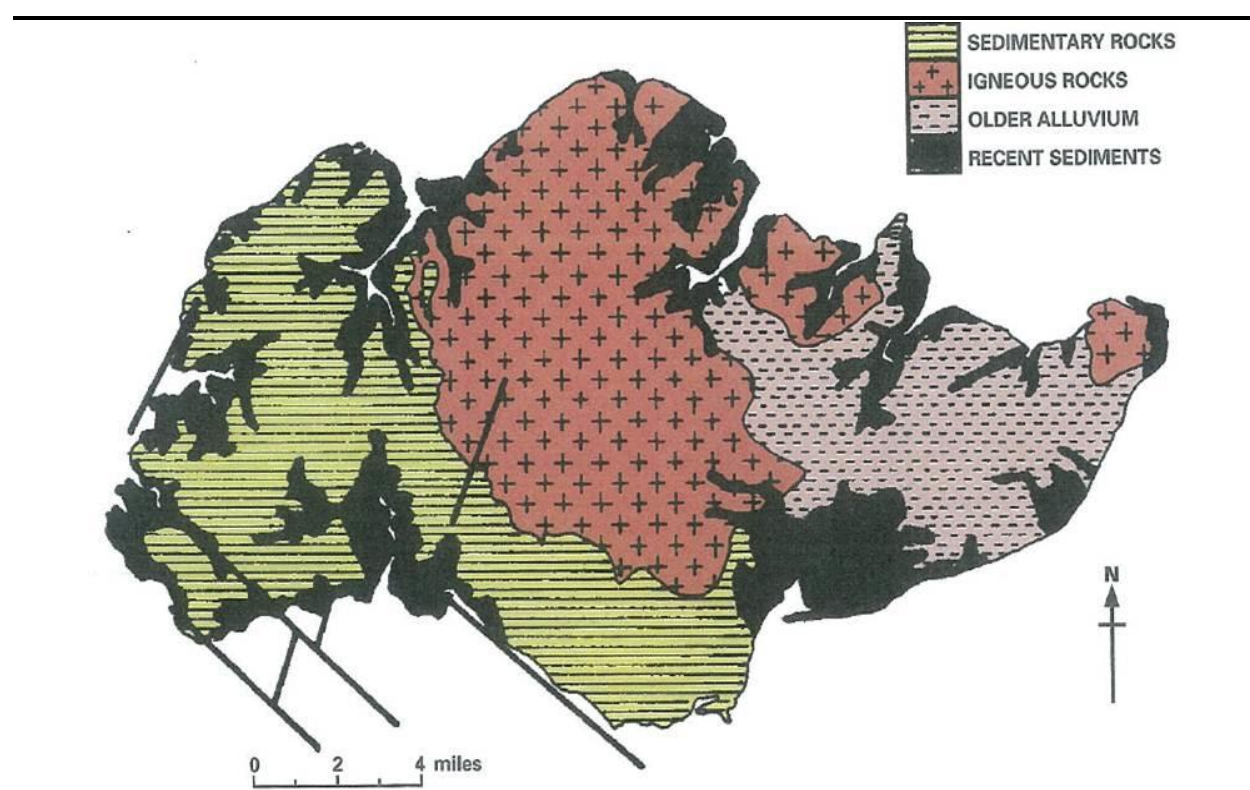
The land area of Singapore comprises Singapore Island and several smaller islands, with a total land mass of approximately 700 km<sup>2</sup>. Singapore Island is low-lying with approximately two-thirds of the island being less than 30 meters above sea level (m asl)<sup>1</sup>. It is characterized by several distinctive geomorphic areas which reflect the underlying geology. The most distinctive topography is found in the central areas of the island, associated with granites, with hills between 60 and 100 m in elevation and steep valleys<sup>1</sup>. The western area is also characterized by distinctive topography, with linear ridges defined by the strike of resistant sandstone and conglomerates associated with the sedimentary geology in the west<sup>1</sup>. The topography of the Old Alluvium on the easternmost areas of the island is

<sup>1</sup> Chia Lin Sien, Ausafur Rahman, Dorothy Tay H.H. (1991), *The Biophysical Environment of Singapore*, Singapore University Press, 1991, ISBN 9971-69-144-2

characteristically flat with elevations less than 40 m asl. Low lying coastal plains are reportedly coincident with the younger sedimentary units of the Tekong and Kallang Formations that formed in response to sea level change<sup>1</sup>. Additionally, these formations are dispersed throughout the higher elevations of Singapore Island as fluvial deposits unrelated to marine and near shore depositional environments.

The primary geological regions of Singapore comprise of sedimentary rock formations in the west and igneous rock formations in the east. Older alluvial sediments overlie the igneous rock formations in the east, with more recent alluvial sediments dispersed along the coastal shores and around the island as illustrated on *Figure 3.1*.

**Figure 3.1: Primary Geological Regions of Singapore**



Source: Alexander, F E S (1950) *The Geology of Singapore and the Surrounding Islands*. Singapore Government Press

### 3.4.1 Sedimentary Rocks, West

The sedimentary rocks in the western region consist primarily of purple to black mudstone, black shale, yellow sandstone, limestone and minor conglomerates<sup>2</sup>. Overlying the sedimentary rocks are weathered soils which are generally fine grained (silts and clays) in the south-eastern portion of this region with coarser grained sands in the north-west reflecting the parent rocks from which they were derived<sup>2</sup>. There are no known deposits of these sedimentary rocks within the Study Area and therefore the subdivision of these sediments is not discussed further.

<sup>2</sup> Anon (2009). *Geology of Singapore, 2nd Edition*, Defence Science and Technology Agency, 2009

### 3.4.2 Igneous Rocks, Central

The central portion of Singapore Island includes the highest summit, the Bukit Timah Hill, with an elevation of 163 m asl. The igneous host rock is predominantly the Bukit Timah Granite which forms the Bukit Timah Hill and other nearby hills in an area of rugged terrain. Soils in the area are derived from the igneous host rock. The Bukit Timah Granite underlies approximately one-third of Singapore Island and is considered the base bedrock of the island<sup>3</sup>.

The Study Area is contained entirely within this central area and its known geology is discussed further in *Section 3.5*.

### 3.4.3 Older Alluvial Sediments, East

The eastern part of the island is a low plateau characterized by erosion resulting in hills and valleys. The sediments consist of clayey sand with pebbles, generally becoming coarser grained with depth<sup>2</sup>. The sediments typically are not cemented but can be quite dense; they form part of a group of sediments aptly named 'Older Alluvial Sediments'. There are no known deposits of Older Alluvial Sediments within the Study Area and therefore the subdivision of these sediments is not discussed further.

### 3.4.4 Younger Alluvial Sediments, Entire Island

Sediments of alluvial and marine origin are dispersed throughout low lying areas, typically along the coast and river valleys. These younger sediments were deposited during periods of sea level change and major fluvial erosional events. The primary member of this group of sediments is the Kallang Formation. The Tekong Formation is a less common secondary member of sediments comprising terrestrial and alluvial deposits<sup>4</sup>. Alluvial sediments belonging to the Kallang Formation are present in the Study Area and are discussed further in *Section 3.5*.

## 3.5 LOCAL GEOLOGY OF THE STUDY AREA

### 3.5.1 Bukit Timah Granite

The Bukit Timah Granite is the principal parent rock of Singapore, predominantly underlying the center and north of Singapore and underlying the entirety of the Study Area<sup>1</sup>. The Bukit Timah Granite has been dated to the late Permian to middle Triassic period, approximately 200 to 250 million years ago. The principal minerals include quartz (30%), feldspar (60-65%), biotite and hornblende, with mineralogical variations from adamellite to granodiorite. Typically, the Bukit Timah Granite is rich in ferromagnesian minerals resulting in a more acidic composition. Individual minerals are medium to coarse grained, usually light grey and sometimes pinkish<sup>3</sup>.

The degree of weathering of the Bukit Timah granite across the region is influenced by the climatic conditions with the tropical monsoonal rainfall conditions that contribute to surface erosion and weathering. There are six main weathering profiles, from Grade VI, indicative of residual soil, to Grade

<sup>3</sup> Jian Zhao (17 January 2012). *Underground Space Development in Singapore Rocks*. PTRC and NCUS Workshop on Underground Space and Rock Cavern Development in Singapore, NTU.

<sup>4</sup> Aung Kyaw Htoon, Kyi Yu (6 June, 2009) *Late Pleistocene Geology of Singapore for Engineering Geologists*, MGSS Workshop.



I, indicative of freshly weathered granite<sup>3</sup>. The residual soil (Grade VI) and the completely weathered (Grade V) Bukit Timah Granite are typically characterized as reddish to yellowish brown sandy silt and silty sand. The highly weathered (Grade IV) and moderately weathered (Grade III) Bukit Timah Granite are typically characterized as moderately weak to strong granite, with closely spaced fractures. Slightly weathered (Grade II) and fresh (Grade I) Bukit Timah Granite are commonly described as moderately strong to very strong massive granites, with widely spaced irregular fractures. The fresh (Grade I) Bukit Timah granite has an average Uniaxial Compressive Strength of 180 megapascals (MPa), the highest being over 300 MPa; the weathered rock grades are characterized by much lower strengths.

Borehole log data available from LTA was reviewed to obtain a finer understanding of the geology of the Study Area. Review of the available information indicated competent granite bedrock may be encountered around approximately 31 m bgs overlain by residual soils and weathered granite bedrock. Typically, the depth to bedrock (and consequently the thickness of the residual soils) should relate to structural features such as faults and joints, both known and unknown. Where faults or increased fracture density occurs, the bedrock typically weathers at a higher rate due to the increased surface area in contact with weathering processes. At any known fault locations in the CCNR, as well as inferred locations such as within stream corridors, it would be likely that depths to competent bedrock may exceed the anticipated average depth of 31 m bgs.

### 3.5.2 Kallang Formation

The Kallang Formation originates from sediments deposited over the last 15,000 years, from the Holocene and late Pleistocene to the present. The Kallang Formation can be subdivided into five groups based on the type of depositional environment<sup>4</sup>. It is anticipated that the Kallang sedimentary units that may be encountered in the Study Area will comprise primarily alluvial and potentially transitional estuarine sediments. Kallang Formation deposits in this area are anticipated to occur in former river valleys, incised into the underlying Bukit Timah bedrock, along low lying areas and waterways, especially adjacent to the MacRitchie Reservoir.

The Kallang Formation sub-groups in the vicinity of the Study Area include Estuarine Clay, Fluvial Sand and Fluvial Clay sedimentary units. Estuarine Clay sedimentary units are typically characterized as dark brown to black, cohesive, very soft to soft peat, peaty clay or peaty sand with a high organic content. Fluvial Sand units are typically characterized as very loose brownish grey to grey, slightly gravelly and very silty fine to coarse sand. Fluvial Clay sedimentary units are typically characterized as hard, light yellowish grey to mottled brownish red, slightly gravelly sandy clay<sup>2</sup>. Review of borehole logs available from previous LTA infrastructure projects in the Study Area encountered the Kallang Formation, either as directly indicated in the logs or interpreted from the encountering of peat or organic material. Based on the available borehole logs, the average thickness of the Kallang Formation encountered was 6 m.

Estuarine Clay sedimentary units are located at lower elevations closer to the shoreline. As the Study Area is located at higher elevations (around 100 m asl) it is unlikely that Estuarine Clay sedimentary units would be encountered. It is, however, likely that Fluvial Sands and Fluvial clay sedimentary units would be encountered within the Study Area.

## 4 WATER ENVIRONMENT

### 4.1 INTRODUCTION

This chapter presents the baseline surface and groundwater environment of the Study Area.

The chapter is structured as follows:

- *Section 4.2* provides definition of the Study Area;
- *Section 4.3* lists information used to inform the baseline surface water and groundwater characteristics;
- *Section 4.4* provides a summary on the climate, precipitation patterns, humidity and sunlight intensity;
- *Section 4.5* describes the characteristics of MacRitchie Reservoir;
- *Section 4.6* outlines water features within the MacRitchie Reservoir Catchment area, their characteristic and water quality;
- *Section 4.7* summarizes the surface water canal data within the Study Area; and
- *Section 4.8* describes the current groundwater regime within the Study Area.

### 4.2 STUDY AREA

The baseline Study Area is defined as the areas encompassing the water resources (groundwater, streams, reservoirs, canals or other permanent or seasonal water bodies) within and adjacent to the Project. The Study Area also extends to uses immediately downstream or (in the case of groundwater) down gradient of the CRL pre-construction, construction and operational areas.

The PUB has primary responsibility for managing Singapore's water resources. With limited land to collect water and a high degree of urbanization with a dense population, Singapore faces challenges to become self-sufficient with regard to water resources and has developed the 'Four National Taps' to ensure sufficient supply for domestic and industrial needs<sup>1</sup>. These include water derived from local catchments, imported water, highly-purified reclaimed water (known as NEWater), and desalinated water. While groundwater is not used as a direct source of water today, surface water reservoirs across Singapore Island receive inflow from shallow groundwater.

The water resources considered for the Project include saturated wetland areas and streams within the CCNR immediately above and down hydraulic gradient of the alignment; the MacRitchie Reservoir and its use as a water supply to Singapore potable water treatment facilities; and channelized canals routing stormwater around the urbanized areas surrounding the eastern and southern section of the CCNR as illustrated in *Figure 4.1*.

<sup>1</sup> PUB (25 November 2014) *The Singapore Water Story*. Available at <http://www.pub.gov.sg/water/Pages/singaporewaterstory.aspx>

PUB operates a large water storage reservoir known as Bukit Kalang, located to the north east of Study Area, within the CCNR (*Figure 4.1*). It is understood that the water supply to Bukit Kalang is from PUB treatment plants and it is not directly fed from the water bodies identified in this Study Area.

#### **4.3 SOURCES OF INFORMATION**

The baseline information presented in this chapter draws upon a number of existing data sources. This includes information that has been provided by nature groups and government agencies of surface water and groundwater features in the Study Area.

In general, the information used to inform the project includes:

- Online publications from local government authorities such as annual reports, guidebooks, climatological monitoring;
- Topographical, geological and hydrogeological maps;
- Satellite and aerial photographic imagery;
- Water quality data for the streams within the MacRitchie Reservoir catchment area;
- Cross-island line discussion and position paper published by Nature Society Singapore;
- Soil investigation borehole data logs available for the area surrounding the CCNR; and
- Data provided by respective government agencies.

Primary data has also been collected, including visual inspections of surface water features along with identification of hydrological features, surface water quality sampling, and laboratory analysis of water samples. Given the sensitivity of the CCNR, no intrusive investigations<sup>2</sup> of the geology and hydrogeology have been undertaken as part of the Project.

Information from the aforementioned reviews and studies has been summarized and presented below in order to provide an overview of the baseline surface water and groundwater characteristics in the Study Area.

<sup>2</sup> In the context of this EIA, intrusive refers to the physical breaking of the ground surface and excavation of soil through the use of equipment such as drilling rigs, excavators etc.







## 4.4 CLIMATIC SETTING

### 4.4.1 Overview

Singapore consists of approximately 700 km<sup>2</sup><sup>3</sup> of land mass consisting mainly of Singapore Island and several smaller islands. Its location at the southern end of the Malay Peninsula, just 1 degree north of the equator, results in a hot, humid climate with extensive rainfall. This equatorial monsoon tropical climate is characterized by a Northeast Monsoon season generally from December to early March and a Southwest Monsoon from June to September<sup>4</sup>. The typical daily temperatures vary throughout the year between 23 °C and 34 °C, with the extremes ranging from 19.4 °C to 36.0 °C<sup>5</sup>.

### 4.4.2 Rainfall

The Northeast Monsoon is a relatively wet season with continuous moderate to heavy rainfall in the afternoons and early evenings. December is the month that receives the most rainfall in the year<sup>6</sup>. The Southwest Monsoon is typically characterized by short duration showers and thunderstorm activities between predawn and midday. Sumatra Squalls prevail within this period – these are thunderstorms that develop at night over Sumatra and move to Singapore with heavy rain lasting 1 to 2 hours in the early morning. The two inter-monsoon seasons are generally drier with showers occurring in the afternoon and early evening.

Singapore receives an average annual rainfall of about 2,348 mm based on a sum of the mean monthly total measured by the NEA from 1869 to 2014<sup>7</sup>. As shown in *Figure 4.2*, December has the highest monthly mean rainfall of 288.1 mm while the lowest is 158.6 mm in July.

<sup>3</sup> Department of Statistic (2014) **Yearbook of Statistic Singapore**. Available at [http://www.singstat.gov.sg/publications/publications\\_and\\_papers/reference/yearbook\\_2014/yos2014.pdf](http://www.singstat.gov.sg/publications/publications_and_papers/reference/yearbook_2014/yos2014.pdf)

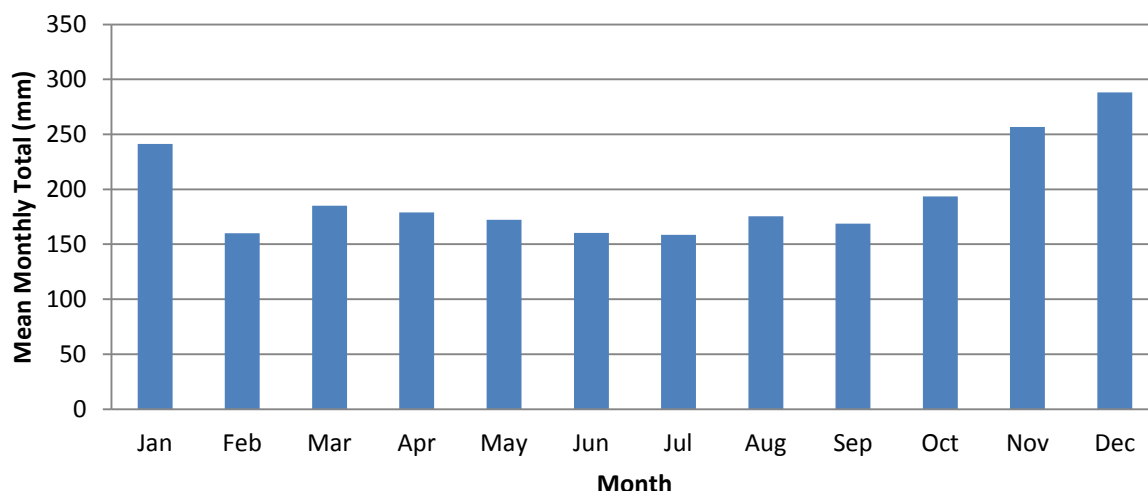
<sup>4</sup> National Environment Agency (10 June 2014) **Local Climatology**. Available at <http://www.nea.gov.sg/weather-climate/climate-information>

<sup>5</sup> National Environmental Agency (10 June 2014) **Local Climatology**. Available at <http://app2.nea.gov.sg/weather-climate/climate-information/local-climatology>

<sup>6</sup> National Environment Agency (8 Dec 2014) **Weather Statistics**. Available at <http://app2.nea.gov.sg/weather-climate/climate-information/weather-statistics>

<sup>7</sup> National Environmental Agency (10 February 2015) **Weather Statistics**. Available at <http://app2.nea.gov.sg/weather-climate/climate-information/weather-statistics>

**Figure 4.2: Mean Monthly Rainfall (1869 – 2015)**



**Source:** National Environment Agency, 10 February 2015 ([www.NEA.gov.sg](http://www.NEA.gov.sg))

The total amount of rainfall recorded in the Study Area in 2013 falls in a range of 2,900 mm to 3,200 mm and is 15 to 30% above the long-term mean for Singapore<sup>8</sup>.

#### 4.4.3 Relative Humidity

Humidity levels remain fairly constant throughout the year. The monthly 24-hour mean relative humidity recorded from 1929 to 1941 and 1948 to 2014 fall in the range of 82.7% to 86.8%. The highest relative humidity usually occurs in December due to the frequent rainfall events<sup>9</sup>.

#### 4.4.4 Sunlight Intensity

Being located near the equator, Singapore receives ample sunshine that results in daylight of 12 hours and an average sunshine of 5.4 hours every day. On average, 47% of daylight hours are sunny while the remaining 53% of daylight hours experience some percentage of cloud cover resulting in lower solar radiation<sup>10</sup>.

The Changi Meteorological Station measures the Ultraviolet Index (UVI) from 7am to 7pm on a daily basis. The UVI is an internationally recognized measure of solar UV radiation at the earth's surface. Typically, the highest UVIs are measured between 11 am and 3 pm, and are noted to be higher during the months where there is less cloud cover or when the position of the sun is directly over the equator (eg February to May and August to September)<sup>11</sup>.

<sup>8</sup> National Environmental Agency (2013) **Annual Weather Review**. Available at [http://app2.nea.gov.sg/docs/default-source/training-knowledge-hub/publications/annual-weather-review-\(2013\).pdf?sfvrsn=2](http://app2.nea.gov.sg/docs/default-source/training-knowledge-hub/publications/annual-weather-review-(2013).pdf?sfvrsn=2)

<sup>9</sup> National Environment Agency (10 February 2015) **Weather Statistics**. Available at <http://app2.nea.gov.sg/weather-climate/climate-information/weather-statistics>

<sup>10</sup> Climatemps (2014) **Sunshine & Daylight Hours in Singapore**. Available at <http://www.singapore.climatemps.com/sunlight.php>

<sup>11</sup> National Environmental Agency (27 January 2014) **Radiation & UV Index**. Available at <http://app2.nea.gov.sg/training-knowledge-hub/weather-climate/uvradiation-uvindex>

Further details on the climatic characteristics local to the Study Area of Singapore are described in *Chapter 6*.

#### 4.5 MACRITCHIE RESERVOIR

MacRitchie Reservoir is located in the center of Singapore, within a designated nature reserve as shown in *Figure 4.1*. The reservoir is known as Singapore's first reservoir<sup>12</sup>. In 1857, philanthropist Tan Kim Seng donated a sum of money to the Government of the Straits Settlements to help supply drinking water to the town of Singapore. The initial approach to securing a drinking water supply involved piping water uphill through earthenware pipes. This failed however, and the idea to develop the reservoir subsequently arose. Plans for building the reservoir were submitted to the Bengal Government in Calcutta in 1863, but the works were stalled several times due to financial issues before the earth embankment of the reservoir was finally constructed in 1867<sup>13</sup>. Subsequently, the associated pumps and distributing networks were developed and completed in 1877, and Singapore's first waterworks started its operation one year later<sup>14</sup>.

For the purpose of maintaining the water quality within the reservoir, the government prohibited use of the reservoir catchment area for agricultural purposes. By 1867, agricultural activities associated with gambier and pepper plantations had ceased, and the forest within the surrounding area was allowed to regenerate<sup>15</sup>, although plantations continued to persist immediately outside the watershed reserve. Notable plantations were the Chasseriau Estate to the south and southwest of MacRitchie Forest, and a rubber plantation where the Windsor Interim Green is currently located.

The reservoir has been enlarged twice since its initial development in 1867. The first occurred between 1891 and 1894 and the second in 1907, as a result of the increased potable water demand and periodic droughts. The enlargement works were also a result of an increase in inflow due to channelization of the Upper Kallang River<sup>14</sup>.

The current reservoir features an earth embankment dam and an outfall near Reservoir Road as illustrated in the photograph log appended as *Annex 2.0, Photo 1 - 3*. Water from the reservoir is transferred to a waterworks for treatment and is then distributed as potable water. Prior to discharge to the treatment plant, PUB continuously monitors the water quality from the reservoir to ensure compliance with their treatment system requirements.

To regulate water levels within the reservoir, PUB transfers water daily from Upper Peirce Reservoir via a channel (*Figure 4.1*). The channel begins as a concrete and brick-lined waterway (Stream Hd, *Annex 2.0, Photo 4*), from the northwest of MacRitchie Reservoir. It transitions to a natural stream after meeting streams He and Hc at the convergence point east of Dillenia hut. The natural stream then flows southwest and merges with streams Ha at Sime Track and Stream I at Golf Link. Aquatic plants were observed during the field surveys on the reservoir water surface adjacent to the Bukit Golf Course as shown in *Figure 4.3*.

<sup>12</sup> PUB (2013) **MacRitchie Reservoir**. Available at <http://www.pub.gov.sg/ABCWatersIM/macritchie.html>

<sup>13</sup> Ng PKL, Corlett RT, Tan HTW (2011) **Singapore Biodiversity** – An encyclopaedia of the Natural Environment and Sustainable Development. National University of Singapore. Pp. 552

<sup>14</sup> Mohamed Z (2014) **MacRitchie Reservoir**. Available at [http://eresources.nlb.gov.sg/infopedia/articles/SIP\\_159\\_2004-12-27.html](http://eresources.nlb.gov.sg/infopedia/articles/SIP_159_2004-12-27.html)

<sup>15</sup> Nature Society Singapore (6 January 2014) **Cross Island Line Working Group Report**.



In addition to water storage, MacRitchie Reservoir is used for recreational activities. The Singapore Canoe Federation runs a paddle lodge to the east of the reservoir for kayaking and canoeing activities. The Singapore Canoe Federation holds a license from PUB to use the reservoir for recreational kayaking and canoeing. The reservoir also plays host to occasional canoeing/kayaking competitions. Recreational fishing is also allowed at one designated fishing zone to the southeast of the reservoir, as illustrated on *Figure 4.1*. Fishing is closely regulated by PUB, which enforces strict rules such as the equipment type used; and prohibition of use of live bait to protect water quality<sup>16</sup>.

Water from the reservoir is also used for irrigation of the SICC's Bukit-Sime Golf Course located to the west as illustrated on *Figure 4.1*. To protect the water quality of the reservoir, PUB controls the type of fertilizers used and stored in the golf course and pesticide used on the golf course<sup>11</sup>.

#### 4.6 MACRITCHIE RESERVOIR CATCHMENT AREA

The main streams and their tributaries of the MacRitchie Reservoir catchment area are illustrated in *Figure 4.1*. The catchment has approximately 68 streams located within, varying in size from small, 6 m long trickles to approximately 1,350 m long and 0.002 m to 6 m wide watercourses. The streams shown in *Figure 4.1* were observed to be shallow with a minimum and maximum depth of 0.02 m and 1 m respectively, during the survey period in October 2014, and were noted to be perennial. In addition to the main streams there are numerous stormwater gullies within the Study Area which channel surface water runoff from the public trails during rainfall events. Some of these have been channelized, such as a gully flowing from northeast to southwest parallel to Sime track.

For ease of reporting, the main streams feeding into the reservoir are labelled I, Ha, Hd, Fa, Eb and Ma. Tributaries of the aforementioned streams are labelled Ia, Ib, Ic, Hb etc as illustrated in *Figure 4.1*.

Visual inspection of the main streams was undertaken in October 2014 and the following parameters were recorded: temperature, pH, total dissolved solids (TDS) and electric conductivity (EC). Field records are presented in *Annex 3.0* and key physical characteristics for the main streams that are located in close proximity to the proposed alignment are summarized in *Table 4.3*.

##### 4.6.1 Water Quality (Chemical) Survey of MacRitchie Reservoir Catchment Area

A primary baseline surface water quality (chemical parameters) survey was undertaken at the MacRitchie Reservoir catchment area which could potentially be influenced by the CRL works. Samples were analyzed by a laboratory approved by the Singapore Accreditation Council under the Singapore Laboratory Accreditation Scheme (SAC-SINGLAS). The sampling locations were selected to be representative of:

- The location of main streams outlined in *Table 4.3*;
- Their proximity and exposure to potential surface water impacts from activities undertaken during the SI works, pre-construction, construction and operational phases;
- Aquatic sensitivities as identified during the preliminary ecology and biodiversity field surveys; and

<sup>16</sup> PUB (2013) **MacRitchie Reservoir**. Available at <http://www.pub.gov.sg/ABCWatersIM/macritchie.html>

- Security and accessibility of each sampling location.

The location of each sampling point is illustrated on *Figure 4.3* and summary presented in *Table 4.4* alongside the rationale for selection of each location. Photographic records of each sampling location are also provided in *Annex 2.0*.

**Table 4.3: Summary of In-situ Parameters and Physical Characteristics of Main Streams**

Stream	Temp (°C)	pH	EC (µS/cm)	TDS (mg/L)	Key observation
I	26.0	5.8	40	10	The section of stream where sampling was undertaken was approximately 2 to 4 m wide with a depth of 0.16 m. Stream flow was fast and smooth and to the south. Stream surface was clear with no sign of woody debris but leaf litter was observed.
Ha	25.7	6.3	100	50	The width of the sampled stream ranged from 1.5 to 3 m with a depth of 0.45 m. Slow moving and stagnant water was observed. Stream surface was generally turbid and stained. Presence of substantial leaf litter and large woody debris was noted.
Hd	27.9	5.9	50	20	The width of the sampled stream ranged from 2 to 3 m and the depth was measured to be 0.3 m. Stream was flowing fast and to the south. Stream surface was slightly turbid with small amounts of leaf litter and woody debris observed.
Fa	25.9	6.2	10	0	The sampled stream was 1.0 to 1.5 m wide and 0.05 m deep. Water in the stream was stagnant and stained, and a significant amount of leaf litter was observed.
Ma	26.2	6.3	60	30	The sampled stream width ranged between 1.0 and 2.5 m and was approximately 0.55 m deep. Stream was moving fast and to the southeast. Stream surface was generally clear but small amounts of leaf litter and trash (eg water bottles) were observed.

**Source:** ERM, October 2014. Field Sampling

**Table 4.4: Rationale for Selected Reservoir Catchment Area Surface Water Sampling Points**

Sampling Point ID	Location	Rationale
SW 101	Along Rifle Range Link within CCNR	Representative of water quality upstream of Stream I
SW 102	At the bridge along Sime Track, near western perimeter of CCNR and SICC Bukit Golf Course	Representative of water quality upstream of proposed SI locations
SW 103	At the bridge next to Golf Link, near western perimeter of CCNR and SICC Bukit Golf Course	Representative of water quality downstream of proposed SI locations, and water quality downstream of stream I
SW 104	Next to Dillenia Hut within CCNR	Representative of water quality upstream of Stream Hd
SW 105	At the bridge near the junction of Sime Track and Rifle Range Link (within CCNR)	Representative of water quality downstream of proposed SI locations, and water quality downstream of stream Hd
SW 106	Along Sime Track, near Petaling Hut (within CCNR)	Representative of water quality downstream of proposed SI locations, and water quality downstream of stream Ha
SW 107	Along Sime Track, at the side of Terentang Hut (within CCNR)	Representative of water quality upstream of proposed SI locations, and water quality upstream of stream Ha
SW 108	Along Venus Link	Distinct aquatic environment
SW 109	Within SICC Island Golf Course	Distinct aquatic environment

At each location, surface water samples were retrieved by a disposable bailer and transported to a SAC-SINGLAS certified laboratory for analysis of the suite of parameters mentioned in *Table 4.5*. Samples were collected from streams or water bodies from existing trails and from the stream bank, ie there was no physical entry into streams. Prior to sampling at a new stream/water body, all field equipment was rinsed using water from the sampling site, and clean gloves were worn to avoid potential contamination of the samples.

Two rounds of sampling were undertaken at each location, Round 1 in December 2014 and Round 2 in January/February 2015. *Table 4.5* presents the results for both rounds of sampling, with the *PUB raw water quality guidelines*, *EPH (Quality Piped Drinking Water Regulations, 2008)* and the *World Health Organisation (WHO) Guidelines for Drinking-water Quality* included for reference. The full laboratory analysis report is appended in *Annex 4.0*.



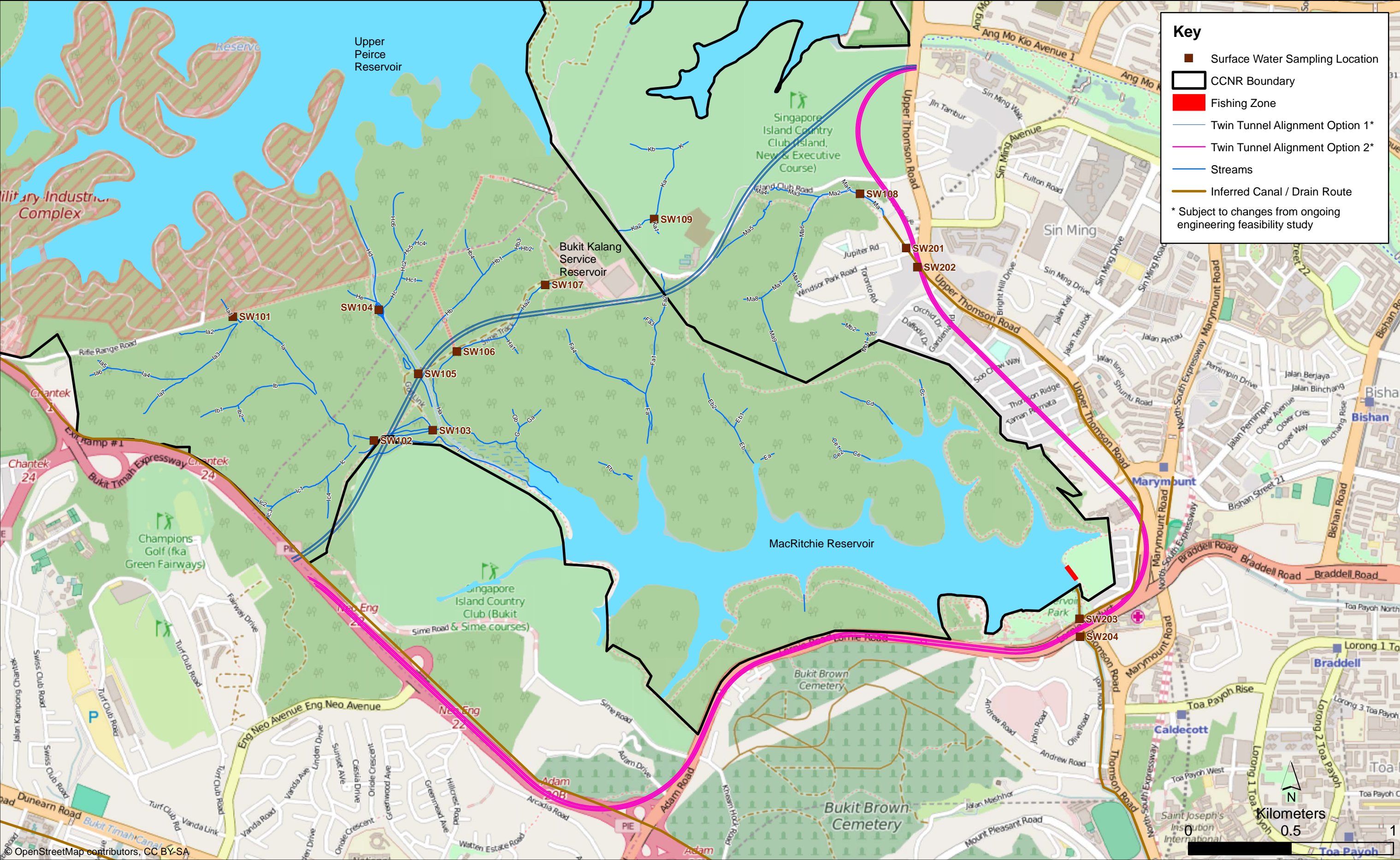


Figure 4.3 Surface Water Sampling Locations



## 4.7 CANALS

There are two canals in the Study Area as illustrated on *Figure 4.1*. Both canals are concrete-lined, 6 to 7 m wide, and were observed to contain a low volume of water during the November 2014 survey period. The canal running along Upper Thomson Road, to the east of the Study Area, was observed to begin from stream Ma; and the canal that runs along Thomson Road, located to the south of the Study Area was noted to connect to the outlet of MacRitchie Reservoir as shown in *Figure 4.1*. Review of the Singapore Blue Map<sup>17</sup> indicates that, these two canals form part of the central watershed and will ultimately flow to Marina Reservoir located to the south of the Study Area<sup>18</sup>. Similar to the MacRitchie Reservoir, water feeding to the Marina Reservoir is monitored and maintained to meet the PUB raw water standard and is treated and used for potable domestic and commercial supply. Marina Reservoir commenced operations in 2008 and has the largest catchment area of all the reservoirs in Singapore.

There is another concrete-lined drain running parallel to the PIE. Based on the location it is assumed to be part of the infrastructure for surface water runoff and drainage control of the PIE and the immediately surrounding areas. The outfall location from this concreted drain is unknown.

### 4.7.1 Water Quality of Canals

A primary baseline surface water quality survey was undertaken at the selected locations within the Study Area which would be potential influenced by the CRL works. The sampling locations were selected to be representative of:

- Their proximity and exposure to potential surface water impacts from activities undertaken during the SI works, pre-construction, construction and operational phases; and
- Security and accessibility of each sampling location.

The location of each sampling point is illustrated on *Figure 4.3* and summarized in *Table 4.6* alongside the rationale for the selection of each location. Photographic records of each sampling location are also provided in *Annex 2.0*.

<sup>17</sup> PUB (July 2011) **Overview of Singapore Drainage Management Approach**. Available at [http://www.pub.gov.sg/general/documents/overview\\_drainagemgmt.pdf](http://www.pub.gov.sg/general/documents/overview_drainagemgmt.pdf)

<sup>18</sup> PUB (2014) **Managing Stormwater for Our Future**. Available at <http://www.pub.gov.sg/managingflashfloods/Documents/ManagingStormwater.pdf>

**Table 4.5: Baseline Surface Water Quality Sampling Results for MacRitchie Catchment Area**

Parameter	Unit	LOR	EPH (Note 1)	WHO (Note 2)	SW101		SW102		SW103		SW104		SW105		SW106		SW107		SW108		SW109	
					R1	R2	R1	R2	R1	R2	R1	R2	R1	R2	R1	R2	R1	R2	R1	R2	R1	R2
Physical Parameters																						
Temp	°C	0.1	-	-	24.0	23.0	25.5	25.5	26.5	25.5	30.5	23.0	29.5	26.5	23.0	27.0	33.0	27.5	30.1	22.0	31.1	27.5
pH at 25°C	-	0.1	6.5 – 9.5	-	6.5	6.2	6.7	6.2	6.5	6.3	7.2	7.0	6.7	6.3	6.7	6.4	7.6	7.1	6.7	6.7	6.6	6.5
TSS	mg/L	5	-	-	6	<5	<5	<5	<5	<5	9	6	45	20	7	19	<5	<5	<5	<5	<5	10
TDS	mg/L	5	-	-	51	58	33	27	31	27	175	166	121	49	40	36	79	108	32	35	55	67
T	NTU	0.1	5	5	9.2	4.4	5.1	5.6	6.0	9.4	4.0	1.9	7.1	11.0	4.2	12.0	1.1	4.1	8.7	3.5	-	-
Chemical Parameters																						
DO	mg/L	0.1	-	-	6.95	7.2	7.20	7.43	6.78	6.61	7.83	7.4	7.29	7.16	6.96	7.13	8.19	8.22	6.74	7.2	7.94	7.97
COD	mg/L	1	-	-	7	5	4	2	6	2	8	12	11	6	8	6	3	3	7	6	9	<1
BOD <sub>5</sub> at 20°C	mg/L	2	-	-	5	4	<2	<2	<2	<2	5	7	<2	<2	4	<2	<2	<2	4	5	8	<2
O&G <sub>T</sub>	mg/L	5	-	-	<5	<5	<5	<5	<5	6	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
O&G <sub>H</sub>	mg/L	5	-	-	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Biological Parameters																						
E.coli	cfu/100m	-	<1	<1	94	<1	17	<1	17	124	9.3	<1	540	90	23	85	17	137	33	25	-	-

**Notes:**

<sup>(1)</sup> EPH (Quality of Piped Drinking Water) Regulations, 2008 (updated 1 Nov 2010). The standards were developed with reference to the WHO Guidelines for Drinking-water quality.

<sup>(2)</sup> WHO Guidelines for Drinking Water Quality, 4<sup>th</sup> Edition.

<sup>(3)</sup> Abbreviations: R1 – Round 1 (December 2014); R2 – Round 2 (January/February 2015); LOR: Level or Reporting; Temp – Temperature; TSS – Total Suspended Solids; TDS – Total Dissolved Solids; T – Turbidity; DO – Dissolved Oxygen; COD – Chemical Oxygen Demand; BOD<sub>5</sub> – Biological Oxygen Demand for 5 days; O&G<sub>T</sub> – Oil & Grease (Total); O&G<sub>H</sub> – Oil & Grease (Hydrocarbon).

**Table 4.6: Rationale for Selected Canal Surface Water Sampling Points**

Sampling Point ID	Location	Rationale
SW 201	Along Windsor Park Road	Representative of water quality upstream of proposed SI locations
SW 202	Along Upper Thomson Road, between Windsor Park Road and Gardenia Road	Representative of water quality downstream of proposed SI locations
SW 203	Between Island Landscape & Nursery, and the cross junction of Thomson Road and Upper Thomson Road	Representative of water quality downstream of potential SI work and the proposed vent building near the junction of Thomson Road and Upper Thomson Road
SW 204	Between Reservoir Road and the cross junction of Thomson Road and Upper Thomson Road	Representative of water quality upstream of potential SI work and the proposed vent building near the junction of Thomson Road and Upper Thomson Road

At each location, surface water samples were retrieved by a bailer and transported to a SINGLAS certified laboratory for analysis of a suite of parameters outlined in *Section 4.7*. Samples were collected from the canals, while standing near or on the existing trails and from the bank, ie there was no entry into the water. Prior to sampling at a new stream/water body, all field equipment was rinsed using water from the sampling site, and clean gloves were worn to avoid potential contamination.

Two rounds of sampling were planned for each location, Round 1 during December 2014 and Round 2 during January/February 2015. The baseline sampling results presented in Table 4.7 are compared against the water standards within the *Environmental Protection and Management (EPM) (Trade Effluent) Regulations, 2008*, for discharge to a controlled watercourses given the drainage system is connected to Marina Reservoir which does not receive any water supply from PUB.

#### **4.8 GROUNDWATER**

As detailed previously, no intrusive investigation works were undertaken to inform the hydrogeological characteristics within the CCNR. As the geology is generally understood however, the general groundwater conditions may be implied from the geological conditions and information on groundwater in similar geological terrain elsewhere on Singapore Island. Available logs from borings located adjacent to the eastern and southern boundaries of the CCNR have been used to further inform groundwater conditions across the Study Area.

An examination of maps and images of the CCNR, as well as field observations, indicated the presence of saturated soil conditions at the surface in low lying wetland areas and adjacent to waterways. Consequently, it is expected that shallow groundwater levels (0 m bgs to 1.0 m bgs) would occur in low lying wetland areas and adjacent to the streams and MacRitchie reservoir. Depth to groundwater near to areas of higher elevation, eg Tree Top Walk, are likely to be deeper than in those areas adjacent to the low lying surface water features identified.



**Table 4.7: Baseline Surface Water Quality Sampling Results for Canals**

Parameter	Unit	LOR	EPM (Trade Effluent) Regulations, 2008 (Note 1)	SW201		SW202		SW203		SW204	
				R1	R2	R1	R2	R1	R2	R1	R2
Physical parameters											
Temperature	°C	0.1	45	26.0	27.0	29.0	29.0	31.5	29.5	30.0	29.0
pH at 25°C	-	0.1	6 -9	7.0	6.8	7.0	7.0	7.1	7.1	7.1	7.1
TSS	mg/L	5	30	24	10	<5	7	<5	<5	<5	<5
TDS	mg/L	5	1,000	53	48	54	44	113	69	118	55
Chemical Parameters											
DO	mg/L	0.1	-	7.35	6.90	7.98	7.68	7.80	8.05	7.88	8.25
COD	mg/L	1	60	11	5	4	6	5	2	9	<1
BOD <sub>5</sub> at 20°C	mg/L	2	20	3	4	3	3	3	<2	3	<2
Oil & Grease (Total)	mg/L	5 (Note 2)	1	<5	<5	<5	<5	<5	<5	<5	<5
Oil & Grease (Hydrocarbon)	mg/L	5	-	<5	<5	<5	<5	<5	<5	<5	<5

**Notes:**

<sup>(1)</sup> Limits for discharge into a controlled watercourse were adopted for comparison.

<sup>(2)</sup> It is noted that the level of reporting (analytical detection limit) for oil & grease (total) is higher than the limit. However for the purpose of this EIA, oil and grease (hydrocarbons) is more applicable since Marina Bay reservoir is used to supply drinking water which human health will be the main concern.

<sup>(3)</sup> Abbreviations: LOR: Level of Reporting; TSS – Total Suspended Solids; TDS – Total Dissolved Solids; DO – Dissolved Oxygen; COD – Chemical Oxygen Demand; BOD<sub>5</sub> – Biological Oxygen Demand for 5 days; R1 – Round 1 (December 2014); R2 – Round 2 (January/February 2015).

Permeability field tests were conducted to allow hydraulic conductivity to be estimated in five of the boreholes which were completed in residual soils, slightly weathered to fresh Bukit Timah Granite, or moderate to highly weathered Bukit Timah Granite. The measurements collected from these tests correspond to literature values for the Bukit Timah Granite presented in Zhao (1998)<sup>19</sup>. Zhao (1998) also indicated that the rock mass hydraulic conductivity generally decreases with increasing depth. Zhao (2012)<sup>20</sup> suggested that very high permeability could occur at the soil-rock interface with higher flows in highly fractured rock mass.

While no available geochemical data for groundwater quality is available for the CCNR, it can be inferred that groundwater derived from Bukit Timah Granite bedrock or residual soils would have lower pH values than the groundwater derived from Kallang Formation sediments due to their mineralogical compositions.

<sup>19</sup> Zhao J (September 1998) **Rock Mass Hydraulic Conductivity of the Bukit Timah Granite**, Singapore, Engineering Geology, Volume 50, Issues 1–2

<sup>20</sup> Zhao J (17 January 2012) **Underground Space Development in Singapore Rocks**, PTRC and NCUS Workshop on Underground Space and Rock Cavern Development in Singapore

## 5 NOISE AND VIBRATION

### 5.1 INTRODUCTION

This chapter presents an overview of the baseline noise environment of the Study Area, including sources of and sensitive receptors to noise and vibration.

This chapter is structured as follows:

- *Section 5.2* defines the Study Area;
- *Section 5.3* presents the sources of information reviewed to develop the noise and vibration baseline;
- *Section 5.4* outlines the noise and vibration sources which contribute to the existing noise and vibration environment within the Study Area;
- *Section 5.5* describes the noise survey approach and the noise measurements; and
- *Section 5.6* describes the vibration survey approach and the vibration measurements.

### 5.2 STUDY AREA

The Study Area is defined as the area within which human or ecological receptors could be adversely affected by noise and vibration from Project activities, ie, pre-construction SI works, aboveground and underground construction works and operation of the railway. Construction noise from CRL will be emitted from aboveground activities such as SI works and construction activities at proposed facility building locations. Vibration may be generated from SI worksites (depending on the methodology used), from operation of the TBM along the railway alignment during the main construction phase and due to subsequent operation of the CRL Line. For the purpose of this study, the noise and vibration Study Area is therefore defined to be the broad Study Area that is shown in *Figure 5.1*.

Identification of human and ecological receptors that may be sensitive to noise and/or vibration from the pre-construction, construction and operational activities was undertaken based on a review of the alignment options, pre-construction activity locations and proposed facility building locations, as well as the current land uses and observations made during a reconnaissance of the Study Area. The potential receptors identified are presented in *Table 5.1*.

**Table 5.1: Potential Noise & Vibration Sensitive Receptors**

Receptor Category	Receptor Description	Potential Noise Sensitive Receptor (NSR) <sup>(Note 1)</sup>	Potential Vibration Sensitive Receptor (VSR) <sup>(Note 2)</sup>
<b>Alignment Option 1</b>			
Ecological	Ecological receptors within CCNR, Windsor Interim Green and SICC golf courses	✓	✓
Cultural	Historical artefacts within CCNR	✗	✓
Recreational area	SICC Bukit, Sime & Island golf courses, trails within CCNR	✓	✗
	Bishan Ang Mo Kio Park	✓	✗
<b>Alignment Option 2</b>			
Residential building <sup>(Note 3)</sup>	Flame Tree Park (condominium)	✓	✓
	Thomson View (condominium)	✓	✓
	Thomson Three (condominium) <sup>(Note 4)</sup>	✓	✓
	The Windsor (condominium)	✓	✓
	Three 11 (condominium) <sup>(Note 5)</sup>	✓	✓
	Lakeview Estate (privatized apartments)	✓	✓
	Thomson 800 (condominium)	✓	✓
	Lornie 18 (condominium)	✓	✓
	Private residences (Upper Thomson Road, Lornie Road, Sime Road and Adam Road)	✓	✓
Place of worship	Hai Lam Sua Tee Kong Toa Temple	✓	✗
	St Francis Convent	✓	✓
Educational institution	Raffles Institution (Junior College)	✓	✓
	Our Juniors' Schoolhouse (Thomson Branch)	✓	✓
	Cherie Hearts Kids-at-Play (Thomson)	✓	✓
Home for the aged sick	St Theresa's Home	✓	✓
	Assisi Hospice <sup>(Note 6)</sup>	✓	✓
Hospital	Mt Alvernia Hospital	✓	✓
	Jireh Veterinary Clinic Pte Ltd	✗	✓
Recreational area	Island Gardens Walk Playground	✓	✗
	SICC Island golf course	✓	✗
	Soo Chow Walk Playground	✓	✗
	Taman Permata Park	✓	✗
Ecological	Ecological receptors within CCNR, Windsor Interim Green and SICC Island golf course	✓	✓
	Bukit Brown Municipal Cemetery	✓	✗
	Ecological receptors within forested area along Adam Drive and Sime Road	✓	✓
Commercial buildings	Thomson Plaza	✓	✓
	Mediacorp Caldecott Broadcast Centre	✗	✓



Receptor Category	Receptor Description	Potential Noise Sensitive Receptor (NSR) <sup>(Note 1)</sup>	Potential Vibration Sensitive Receptor (VSR) <sup>(Note 2)</sup>
Utility	SP Powergrid 6.6kV Stations (Jalan Tambur, Island Garden, Soo Chow Garden, Jalan Pelatina, Lakeview Shpg Ctr, Thomson 800 and St Theresa's Home)	x	x <sup>1</sup>
Transport facility	Esso Petrol Station, Windsor Park Road	x	✓
	Shell Petrol Stations, Jalan Pelatina and Marymount Lane	x	✓
	SPC Petrol Station, Marymount Lane and Upper Thomson Road	x	✓

**Notes:**

- (1) NSRs include areas where quiet is important for the intended land use eg hospitals, schools, institutions of higher learning, homes for the aged sick, residential buildings located less than 150 m from the construction site<sup>2</sup>, libraries, theatres, places of worship, recording studios, concert halls, museums, monuments, certain historical sites and recreational parks<sup>3</sup>.
- (2) VSRs include land uses where vibration would be a source of annoyance to humans<sup>4</sup> and/or a source of disturbance to ecological receptors, or land uses with vibration-sensitive equipment such as hospital operating theatres, scientific laboratories and a range of industrial processes<sup>5</sup>.
- (3) Residential building includes any building which is used solely or partly as a hostel, hotel, serviced apartment, residence or private dwelling.
- (4) Estimated completion date of this property is 28 February 2017.
- (5) Estimated completion date of this property is 31 December 2015.
- (6) Ongoing expansion estimated for completion in 1Q 2017.

### 5.3 SOURCES OF INFORMATION

The following information was reviewed to build the existing noise and vibration environmental setting within the Study Area:

- Publicly available street directories developed by OpenStreetMap, Streetdirectory Pte Ltd and the Singapore government (OneMap);
- Satellite images published by Google;
- Topographical maps of the Study Area provided by NParks and SICC;
- NSS' discussion and position paper on the CRL<sup>6</sup>; and

<sup>1</sup> Singapore Power Ltd (2010) **Major Procurement Items**. Available at <http://www.singaporepower.com.sg/iri/servlet/prt/portal/prtroot/docs/guid/80da751a-8fb6-2e10-93a3-ff21cfff0e4c?spgtab=Procurement>

<sup>2</sup> Environmental Protection and Management (Control of Noise at construction Sites) Regulations (2011) Cap 94A, Section 77.

<sup>3</sup> British Standards Institute (2009) **Code of practice for noise and vibration control on construction and open sites: Part 2 Vibration**, BS 5228-2.

<sup>4</sup> United States Federal Administration (May 2006) **Transit Noise and Vibration Impact Assessment**, Office of Planning and Environment, Department of Transportation.

<sup>5</sup> Ungar EE, Sturz DH & Amick CH (July 1990) **Vibration Control Design of High Technology Facilities**, Sound and Vibration.

<sup>6</sup> Nature Society (Singapore) (18 July 2013) **Cross Island Line Discussion and Position Paper**. Available at [http://www.nss.org.sg/documents/\(NSS\)%20Cross-Island%20Line%20Position%20Paper.pdf](http://www.nss.org.sg/documents/(NSS)%20Cross-Island%20Line%20Position%20Paper.pdf)

- CRL working group report<sup>7</sup>.

Primary data gathering has also been undertaken through site walkovers and monitoring targeted at potential sensitive receptors to noise and vibration from the pre-construction, construction and operational activities of the alignment options.

## 5.4 NOISE AND VIBRATION SOURCES IN THE STUDY AREA

### 5.4.1 Ambient Noise Sources

Review of existing information available and site reconnaissance of the broad Study Area (July 2014 - February 2015) enabled identification of the following sources of ambient noise:

- Vehicular traffic along major roads along the eastern and southern boundaries of the CCNR, ie, Upper Thomson Road and Lornie Road, as well as the PIE;
- Low frequency humming from cooling towers at the SICC's Island location along Island Club Road;
- Ongoing construction works for developments along Upper Thomson Road, eg Thomson Grand, Three 11 and Thomson Three condominiums and Assisi Hospice expansion (scheduled completion dates are outlined in *Table 5.1*);
- Ongoing demolition of the Thomson Three showroom at the junction of Venus Drive and Upper Thomson Road;
- Aboveground construction activities associated with the construction of the Upper Thomson MRT station, the Thomson Line tunnels (scheduled completion in 2019) and Singapore Power's North South Transmission Cable (scheduled completion in 2Q 2018);
- Landscaping activities at the golf courses and open green areas such as grass cutting, leaf blowing and spraying of fertilizer using motorized equipment;
- Ongoing land clearance works, future construction activities and operations associated with the proposed development of a new road transecting Bukit Brown Municipal Cemetery (scheduled completion in 4Q 2017);
- Recreational users along public trails within the CCNR, and at designated canoeing zones within the MacRitchie Reservoir;
- Movement of vehicles and people within the CCNR, which were observed to occur within the CCNR area north of SICC's Bukit and Sime golf courses;
- Operation of maintenance vehicles by PUB along the access road to the Bukit Kalang Service Reservoir;
- Operation of maintenance trucks and cranes by NParks, for the clearance of fallen branches from existing trails within the CCNR;

<sup>7</sup> Cheong LF, Chua MAH, D'Rozario V, Jamal F, Khew SK, Koh JKH, Lim KKP, O'Dempsey T & Rajathurai S (5 January 2014) *Cross Island Line Working Group Report*.

- Overhead air traffic from nearby airbases;
- Wildlife vocalizations within the CCNR; and
- Thunder during storms occurring in the monsoon and inter-monsoon periods.

The predominant source of noise observed within the Study Area was vehicular traffic from the major arterial roads, viaducts and expressway, ie, PIE, as well as human activities, such as joggers and recreational users of existing trails.

#### 5.4.2 Vibration Sources

The following possible sources of vibration were identified from the site reconnaissance:

- Vehicular traffic along major roads along the eastern and southern boundaries of the CCNR, ie, Upper Thomson Road and Lornie Road;
- Vehicular traffic along trails within the CCNR;
- Operation of maintenance vehicles by PUB along the access road to the Bukit Kalang Service Reservoir;
- Operation of maintenance trucks and cranes by NParks, for the clearance of fallen branches from existing trails within the CCNR;
- Ongoing construction works for developments along Upper Thomson Road, eg Thomson Grand, Three 11 and Thomson Three condominiums and Assisi Hospice expansion (scheduled completion dates are outlined in *Table 5.1*);
- Ongoing demolition of the Thomson Three showroom at the junction of Venus Drive and Upper Thomson Road; and
- Ongoing tunnelling and construction works associated with the Thomson Line and the North South Cable Transmission Tunnel along Upper Thomson Road (scheduled completion dates are outlined in *Table 2.1*).

### 5.5 LOCAL AMBIENT NOISE ENVIRONMENT

A primary baseline noise survey was undertaken to establish noise levels due to existing sources within the Study Area in the absence of Project related activities, taking into consideration future land uses and developments.

#### 5.5.1 Baseline Noise Monitoring Points

Existing noise sources, the location of proposed aboveground SI works associated with the Project, as well as site security and accessibility were taken into account in the selection of representative baseline noise monitoring points illustrated on *Figure 5.1* within the Study Area. A list of the monitoring points is presented in *Table 5.2* alongside the rationale for selection of each location. Photographs of monitoring locations are outlined in *Annex 2.0, Photos 20 - 26*.



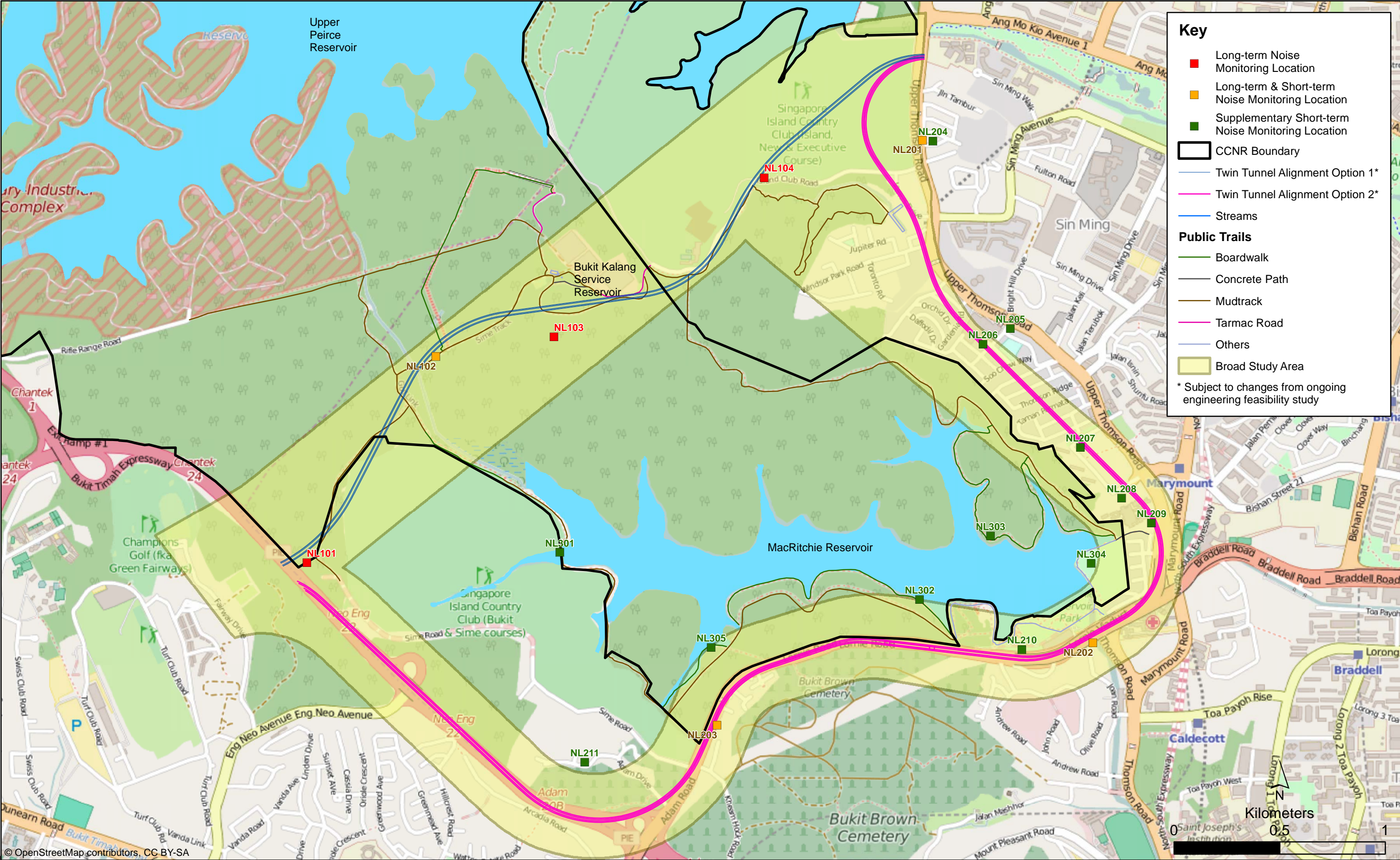


Figure 5.1 Locations of Noise Monitoring Points



**Table 5.2: Rationale for Selected Noise Monitoring Points**

Monitoring Point ID	Location	Rationale	Monitoring Period
<b>Alignment Option 1</b>			
NL101	End of Sime Road, along western perimeter of CCNR and SICC Bukit Golf Course	Representative of baseline noise levels in forested areas with exposure to traffic along the PIE	Long-term & supplementary short-term
NL102	Along Sime Track (within CCNR)	Representative of baseline noise levels in CCNR at areas frequented by visitors	Long-term, short-term and supplementary short-term
NL103	Along a former trail within CCNR	Representative of baseline noise levels at off trail areas within CCNR	Long-term
NL104	Lamppost 26 along Island Club Road	Representative of noise levels at Windsor Interim Green and CCNR areas near Island Club Road and SICC Island Golf Course	Long-term
<b>Alignment Option 2</b>			
NL201	Lamppost 133 along Upper Thomson Road	Representative of noise levels at residential areas with exposure to traffic along Upper Thomson Road	Long-term and short-term
NL202	Between Island Landscape & Nursery, and the cross junction of Thomson Road and Upper Thomson Road	Representative of noise levels at residential areas near the proposed vent building near the junction of Thomson Road and Upper Thomson Road	Long-term and short-term
NL203	Signpost near 10A Lornie Road	Representative of CCNR, forested areas (Bukit Brown Cemetery) and private residences with exposure to traffic along Lornie Road	Long-term and short-term
NL204	23 Jalan Rebana (separated from NL201 by tall hedges)	Representative of private residences visually shielded from Upper Thomson Road by hedges	Supplementary short-term
NL205	Intersection of Upper Thomson Road and Soo Chow Garden Walk	Representative of private residences exposed to ongoing Thomson Line construction	Supplementary short-term
NL206	Intersection of Soo Chow Drive and Soo Chow Garden Walk	Representative of private residences not immediately adjacent to Upper Thomson Road (approximately 130 m away)	Supplementary short-term
NL207	Undeveloped land between Lakeview Estate Block 97C and Upper Thomson Road	Representative of residents at Lakeview Estate	Supplementary short-term

Monitoring Point ID	Location	Rationale	Monitoring Period
NL208	Road reserve along Upper Thomson Road, between T212 worksite and St Theresa's Home	Representative of residents at St Theresa's Home	Supplementary short-term
NL209	St Theresa's Home entrance	Representative of residents at St Theresa's Home	Supplementary short-term
NL210	Road reserve between bus stop 5111 and MacRitchie Reservoir Park car park	Representative of CCNR areas and private residences located adjacent to the Lornie Road ramp and MacRitchie viaduct	Supplementary short-term
NL211	Road reserve along Adam Drive	Representative of private residences along Adam Drive	Supplementary short-term

## 5.5.2 Survey Approach

### Long-Term Monitoring Approach

At each long-term monitoring location, measurements were recorded at a height of 1.5 m from the ground (a minimum elevation of 1.2 m is required to avoid noise reflection from the ground), and at least 3 m from the nearest vertical reflective surface (to avoid noise reflection from facades), using a Type I Noise Meter<sup>8</sup>. 5 minute measurements were recorded continuously over a 1 week period to enable the reporting of  $L_{Aeq,5\text{ min}}$ ,  $L_{Aeq,1\text{ hr}}$  and  $L_{Aeq,12\text{ hr}}$  levels at these locations which are consistent with the periods that need to be considered for noise assessment in Singapore. Two rounds of monitoring were conducted for each long-term location, Round 1 in November/December 2014 and Round 2 in January/February 2015. Timing of the monitoring was aimed to capture the intermonsoon and monsoon periods as far as practicable given the timescales of the Project. Round 1 is therefore representative of the tail end of the inter-monsoon/start of Northeast monsoon while Round 2 is representative of the Northeast monsoon as reported by NEA<sup>9</sup>.

### Short-Term Monitoring Approach

As shown in *Table 5.2*, supplementary short-term (15 minute) measurements during peak and non-peak periods over one weekday and one weekend were undertaken at selected locations to enable reporting of peak and background noise levels ( $L_{Amax}$  and  $L_{A90}$ ) associated with passing traffic. At these locations, noise measurements were undertaken along with a count of vehicular traffic; or the number of people passing the site on foot as in the case of Sime Track. Consistent with the long-term monitoring approach, two rounds of monitoring were conducted for each short-term location, Round 1 in November/December 2014 and Round 2 in January/February 2015.

<sup>8</sup> Environment Agency (2002) **Horizontal Guidance for Noise Part 2 – Noise Assessment and Control**, Version 2, Integrated Pollution Prevention and Control (IPPC), Government of the United Kingdom.

<sup>9</sup> National Environment Agency (10 June 2014) **Local Climatology of Singapore: Seasons**. Available at <http://www.nea.gov.sg/weather-climate/climate-information>.

### Supplementary Short-Term Monitoring Approach

Short-term (15 minute) noise measurements and one-third octave band measurements were undertaken over one weekday and one weekend in January/March 2015 to account for baseline noise variations due to conditions or land uses unique to the selected locations. These readings were thereby used to supplement long-term monitoring undertaken at representative locations. Measurements were undertaken at adequate elevation height from the ground, and in free-field conditions to ensure the readings were not affected by reflection from the ground and nearby facades, ie a height of 1.5 m from the ground and at least 3 m from the nearest vertical reflective surface (to avoid noise reflection from the ground and from building facades).

### 5.5.3 Survey Findings

#### Long-Term Monitoring Results

$L_{Aeq,5\text{ min}}$ ,  $L_{Aeq,1\text{ hr}}$  and  $L_{Aeq,12\text{ hr}}$  results for each location as well as the relevant noise limits stipulated for construction worksites, are summarized in *Table 5.3* and *Table 5.4* respectively. Where multiple measurements were taken, the lowest values were presented to establish a conservative baseline. The full survey report is presented in *Annex 5.0* while the following provides a summary of the noise monitoring locations.

- **NL101:** Vehicular traffic plying the PIE approximately 100 m away, as well as wildlife vocalizations and wind-blown vegetation, comprise the predominant noise sources contributing to high baseline and background noise levels. Hourly measurements indicate that peak traffic conditions occur between 10 am and 5 pm (with extensions up to 8 pm observed), whereas low traffic conditions occur between 11 pm to 6 am on weekdays. Similarly, low traffic conditions occur during the same period on weekends. Peak traffic conditions were observable from measured readings from 4 pm to 5 pm, and between 7pm and 8 pm during weekends in December. These peaks were not observable during January.
- **NL102:** Human traffic from recreational users and other existing operations using the Sime track within the CCNR, contribute to infrequent peaks in measured baseline noise levels. Hourly measurements indicate that low activity along this track occurs between 4 and 8 am. Peak activity occurs between 9 and 11am; 12 and 2 pm; and 4 and 5 pm during the weekends. During the weekday, peak periods along the Sime track were slightly different during Round 1 and Round 2 of monitoring. In general, peaks occurred between 9 am to 12 noon, and 2 to 6 pm during Round 1; and between 9 to 10 am, and 2 to 4 pm during Round 2. Another peak in noise levels was observed at 7 pm regardless of weekday or weekend, or seasonal variations, indicating possible contribution from nocturnal activities, ie, wildlife vocalizations.
- **NL103:** Natural noises, ie, wildlife vocalizations, rustling of leaves contribute largely to the baseline noise levels measured at this off-trail location. A comparison of significant peaks occurring at 3 – 4 pm on 26 November 2014, Wednesday, at both NL102 and NL103, indicates that man-made noises from non-recreational activities undertaken west of the CCNR, may contribute to increased noise levels at NL103. A review of hourly measurements reveals that noise levels typically peak in the late morning or early afternoon, ie between 10 am to 1 pm; mid-afternoon from 3 pm – 6 pm; and between 7 to 8 pm.

- **NL104:** The predominant source of noise at this location comprise of vehicular traffic along Island Club Road. Other intermittent sources of noise include the operation of lawn mowers within the golf course, and noise from trekkers utilizing the Island Club Road. Hourly measurements across the weekdays and weekends for both Round 1 and Round 2 of monitoring remain fairly constant between 60 to 65 dB(A) from 6 am to 7pm, whereupon noise levels drop and fluctuate between 45 – 50 dB(A). This tallies with the opening hours of the Singapore Island Country Club's Island and New courses, ie, 6.30 am to 7 pm, and indicates that most vehicular traffic along Island Country Club Road are accessing the club facilities.
- **NL201:** The predominant source of noise at this location comprise of vehicles passing along Upper Thomson Road. Other intermittent sources of noise include wind-blown vegetation. Hourly measurements indicate that noise levels typically range between 70 and 80 dB(A) and remain fairly constant from 6 am to midnight, on weekdays and weekends. Slight peaks in noise levels occur were observed to occur between 8 and 9 am and from 6 to 7 pm. In general, noise levels measured in Round 1 of monitoring were lower than those in Round 2, which may be attributed to the lower volume of heavy vehicular traffic during first round of monitoring (55% and 59% lower during the respective peak and non-peak hours).
- **NL202:** The predominant source of noise at this location is vehicles passing along both Thomson Road and Upper Thomson Road. Deceleration and acceleration of buses at nearby bus stops was a notable source of vehicular noise at this location. In general, noise levels measured during Round 1 of monitoring were higher than those in Round 2. This may be attributable to the higher volume of light and heavy vehicles during the Round 1 (up to 3 times the volume of heavy vehicles during the peak periods, as compared to the Round 2). Measurements indicate that noise levels are typically high during the day (up to 70 dB(A)) due to traffic, and drop by approximately 9 dB(A) during the night-time off-peak hours. A distinct drop in noise levels can be observed from 8 pm to 4 am on weekdays and from midnight to 4 am on weekends.
- **NL203:** The predominant source of noise at this location is the passing of vehicles along Lornie Road. Noise levels are generally high and fairly constant throughout the day and evening, ie between 77 to 82 dB(A). Noise levels start to drop from 8 pm on weekdays, and from midnight on weekends, reaching a low of 71 – 73 dB(A) at 4 am. Noise levels start increasing steadily from 4 am till the morning peak hour of 7 am.

In general, daytime noise levels measured within the CCNR in Round 1 of monitoring were observed to be 7 – 10 dB(A) higher than those measured during Round 2. On the other hand, noise levels measured in the evening and night times were comparatively similar in both seasons. For most instances, this trend is attributable to the occurrence of thunderstorms in the day, as observed through a review of hourly rainfall data from NEA's recording station located within the Singapore Island Country Club (Island location). Other elevations in noise levels could be attributable to localized events such as the occurrence of large-scale operations within the CCNR during Round 1 of the noise survey, and potential movement and vocalization of animals in close proximity to the noise meters.

For noise levels measured outside the CCNR, these are generally high and fluctuations over the course of the day are generally consistent with traffic peak and non-peak hours, and traffic volume.



## Short-Term Monitoring Results

The observed number of people passing the site and the short-term noise measurements at Sime Track, ie, NL102 is summarized in *Table 5.5*. The vehicular traffic count and noise measurements and supplementary short-term noise measurements along Upper Thomson Road, Thomson Road and Lornie Road are summarized in *Table 5.6*. The full survey report is presented in *Annex 5.0*.

**Table 5.3: Long-term Noise Measurements at NL101 – NL104**

Averaging Period	Period		NL101	NL102	NL103	NL104	Observed Noise Sources Contributing to Baseline
Round 1							
L <sub>Aeq</sub> , 12hr	Weekday	Day	61	55	54	61	NL101: Vehicular traffic along the PIE; insect vocalizations, thunderstorms
		Evening	-	-	-	-	
		Night	58	50	46	57	
	Weekend	Day	62	55	54	61	NL102: Insect vocalizations; human activity (recreational users); overhead aircraft, thunderstorms and other operations
		Evening	-	-	-	-	
		Night	59	51	47	56	
L <sub>Aeq</sub> , 1hr	Weekday	Day	58	44	41	58	NL103: Insect vocalizations; overhead aircraft, thunderstorms
		Evening	59	50	45	58	
		Night	51	46	41	45	
	Weekend	Day	59	47	39	57	NL104: Vehicular traffic along Island Club Road; insect vocalizations, thunderstorms
		Evening	60	52	46	58	
		Night	56	48	44	47	
L <sub>Aeq</sub> , 5min	Weekday	Day	61	55	54	57	
		Evening	60	51	46	52	
		Night	58	49	46	55	
	Weekend	Day	62	55	57	61	
		Evening	61	54	47	59	
		Night	58	50	47	54	
Round 2							
L <sub>Aeq</sub> , 12hr	Weekday	Day	59	47	46	62	NL101: Vehicular traffic along the PIE; insect vocalizations
		Evening	-	-	-	-	
		Night	57	49	48	56	
	Weekend	Day	59	50	46	62	NL102: Insect vocalizations; human activity (recreational users); overhead aircraft (helicopter) and other operations
		Evening	-	-	-	-	
		Night	57	49	45	57	
L <sub>Aeq</sub> , 1hr	Weekday	Day	56	42	39	59	NL103: Insect vocalizations; overhead aircraft
		Evening	58	51	47	55	
		Night	53	46	44	48	
	Weekend	Day	56	43	42	60	NL104: Vehicular traffic along Island Club Road; insect vocalizations
		Evening	58	49	43	57	
		Night	53	45	43	47	
L <sub>Aeq</sub> , 5min	Weekday	Day	60	47	46	62	
		Evening	59	51	50	59	
		Night	56	48	46	54	
	Weekend	Day	59	50	46	62	
		Evening	59	51	46	59	
		Night	56	48	44	55	

**Table 5.4: Long-term Measurements for NL201 – NL203**

Averaging Period	Period		NL201	NL202	NL203	Observed Noise Sources Contributing to Baseline	
Round 1							
L <sub>Aeq</sub> , 12hr	Weekday	Day	74	69	79	NL201 Vehicular traffic along Upper Thomson Road, thunderstorms	
		Evening	-	-	-		
		Night	71	64	76		
	Weekend	Day	75	67	80	NL202 Vehicular traffic along Thomson Road and Lornie Road; flowing water within nearby open-air canal (after rainfall event), thunderstorms	
		Evening	-	-	-		
		Night	71	64	76		
L <sub>Aeq</sub> , 1hr	Weekday	Day	67	67	76		NL203 Vehicular traffic along Lornie Road, thunderstorms
		Evening	66	66	78		
		Night	57	56	70		
	Weekend	Day	73	65	78		
		Evening	73	66	78		
		Night	65	57	70		
L <sub>Aeq</sub> , 5min	Weekday	Day	74	69	79		
		Evening	72	67	78		
		Night	70	63	75		
	Weekend	Day	75	67	80		
		Evening	73	66	78		
		Night	70	62	75		
Round 2							
L <sub>Aeq</sub> , 12hr	Weekday	Day	76	66	81		NL201 Vehicular traffic along Upper Thomson Road
		Evening					
		Night	71	62	77		
	Weekend	Day	75	64	79		NL202 Vehicular traffic along Thomson Road and Lornie Road; flowing water within nearby open-air canal (after rainfall event)
		Evening					
		Night	71	61	77		
L <sub>Aeq</sub> , 1hr	Weekday	Day	74	65	80	NL203 Vehicular traffic along Lornie Road	
		Evening	73	64	79		
		Night	65	54	71		
L <sub>Aeq</sub> , 1hr	Weekend	Day	73	63	78		
		Evening	73	63	78		
		Night	65	54	70		
L <sub>Aeq</sub> , 5min	Weekday	Day	76	66	81		
		Evening	74	65	78		
		Night	70	60	76		
	Weekend	Day	75	64	79		
		Evening	73	63	78		
		Night	70	60	76		

**Table 5.5: Short-term Noise Measurements and Human Traffic Volume at NL102**

Period	Peak Hour <sup>(Note 1)</sup>				Off-Peak Hour			
	L <sub>90</sub> (Note 2)	L <sub>Aeq,15min</sub>	L <sub>max</sub> (Note 2)	Human Count	L <sub>90</sub> (Note 2)	L <sub>Aeq,15min</sub>	L <sub>max</sub> (Note 2)	Human Count
<b>Round 1</b>								
Weekday	46	56	77	17	47	60	81	0
Weekend	45	48	62	18	44	48	70	2
<b>Round 2</b>								
Weekday	40	54	84	7	45	50	77	5
Weekend	43	56	82	29	41	49	66	18

**Notes:**

<sup>(1)</sup> Peak hours within the CCNR was determined based on site observations made by NParks rangers, ie, after 3 pm on weekdays, and 9 – 11 am and 3 pm – 5pm on weekends.

<sup>(2)</sup> Values apply to the levels measured during the 15 minute survey.

**Table 5.6: Short-term Noise Measurements and Vehicular Traffic Volume at NL201, NL202 and NL203**

Monitoring Point ID	Period	Peak Hour <sup>(Note 1)</sup>						Off-Peak Hour					
		L <sub>A90</sub> (Note 2)	L <sub>Aeq,15min</sub>	L <sub>Amax</sub> (Note 2)	Vehicle Count			L <sub>A90</sub> (Note 2)	L <sub>Aeq,15min</sub>	L <sub>Amax</sub> (Note 2)	Vehicle Count		
					Light Vehicles (Note 3)	Heavy Vehicles (Note 4)	Motor-cycles				Light Vehicles	Heavy Vehicles	Motor-cycles
Round 1													
NL201	Weekday	63	74	95	660	155	71	63	74	94	500	138	69
	Weekend	64	74	98	653	117	31	63	76	98	532	115	22
NL202	Weekday	70	71	80	483	145	49	68	70	77	395	126	29
	Weekend	64	68	79	374	82	16	64	68	75	292	85	37
NL203	Weekday	73	78	88	1580	544	219	72	77	84	1,125	510	99
	Weekend	74	79	89	1373	324	67	74	79	91	1,189	308	57
Round 2													
NL201	Weekday	63	73	87	680	100	113	63	72	86	658	87	111
	Weekend	63	75	90	621	89	35	64	75	89	456	103	27
NL202	Weekday	62	66	81	376	44	39	61	64	75	250	78	16
	Weekend	62	65	73	268	78	26	61	65	77	244	63	12
NL203	Weekday	73	79	98	1230	173	114	70	78	97	821	208	98
	Weekend	71	79	95	1052	256	158	71	78	90	761	183	31

**Notes:**

- (1) Peak hours as defined in the LTA's *Code of Practice for Traffic Control at Work Zone* (23 July 2010)<sup>10</sup> -  
Monday to Friday: 7.30 – 9.30 am and 5 – 8 pm  
Saturday: 12 – 2pm
- (2) Values apply to the levels measured during the 15 minute survey.
- (3) Light vehicles comprise of family cars, sedans and non-commercial vans.
- (4) Heavy vehicles comprise of goods vans, lorries, cargo trucks, road tankers, buses, mobile construction vehicles, etc.

<sup>10</sup> Land Transport Authority (23 July 2010) *Code of Practice for Traffic Control at Work Zone*. 2<sup>nd</sup> Edition.



### ***Supplementary Short-Term Monitoring Results***

Observations of noise sources and their contribution to the short-term measurements were recorded and are appended in *Annex 5.0*. The supplementary short-term measurements and observed noise sources are summarized in *Table 5.7*. Where multiple measurements were taken, the lowest values were presented to establish a conservative baseline.

**Table 5.7: Supplementary Short-term Noise Measurements & Observed Noise Sources**

Monitoring Point ID	Period	L <sub>Aeq,5min</sub>	L <sub>A90</sub> (Note 1)	L <sub>A10</sub> (Note 1)	L <sub>Amax</sub> (Note 1)	L <sub>Amin</sub> (Note 1)	Observed Noise Source(s)
NL204	Weekday	69 – 70	62	72	81	55	Vehicular traffic - peak levels were due to heavy vehicles (buses, trucks) and motorcycles; wind-blown vegetation
	Weekend	69	60	72	76	52	
NL205	Weekday	71 – 73	62	74	85	58	Excavator bucket used for land consolidation and hammering activity at nearby construction worksite; vehicular traffic – peak levels were due to acceleration of passing buses; nearby pedestrian traffic
	Weekend	72 – 73	63	75	86	60	
NL206	Weekday	57 – 61	53	59	68	52	Distant and nearby vehicular traffic – peak levels were due to nearby vehicular traffic along Soo Chow Drive and Soo Chow Garden Walk; wind-blown vegetation; bird vocalizations; low frequency humming from Thomson Plaza generators; intermittent drilling and metal on metal sounds from nearby construction sites; overhead aircraft
	Weekend	58 – 66	52	60	73	51	
NL207	Weekday	55 – 59	52	58	69	49	Distant and nearby vehicular traffic – peak levels were due to passing cars and motorcycles nearby; wind-blown vegetation; piling works at Thomson Line construction worksite
	Weekend	56 – 59	54	58	69	52	
NL208	Weekday	61 – 62	57	63	70	54	Beeping from construction machinery, operation of excavator (clanging bucket) and piling at Thomson Line construction worksite; infrequent metal on metal sounds from SP Marymount construction worksite; bird vocalizations; wind-blown vegetation; nearby pedestrian traffic; distant and nearby vehicular traffic – peak levels were due to nearby traffic
	Weekend	62 – 63	57	64	71	55	
NL209	Weekday	62 – 64	59	63	68	56	Vehicular traffic – peak values were due to nearby traffic (lorry) and passing fire engine; bird vocalizations; pedestrian traffic; overhead aircraft (helicopter)
	Weekend	62	59	63	68	54	
NL210	Weekday	71 – 72	63	74	80	59	Distant and nearby vehicular traffic – peak values were due to nearby traffic and heavy vehicles (buses, trucks); pedestrian traffic; cyclists
	Weekend	71 – 78	63	74	82	57	
NL211	Weekday	51 – 56	50	52	57	49	Distant and nearby vehicular traffic – peak values were due to nearby passing lorry; bird vocalizations; overhead aircraft (helicopter)
	Weekend	54 – 55	51	56	63	49	
NL301	Weekday	49 – 51	45	51	59	42	Pedestrian traffic; insect and bird vocalizations; distant golf course buggy; golfers teeing off; distant boat engine; overhead aircraft; distant vehicular traffic along Lornie Road
	Weekend	48 – 52	45	50	59	42	

NL302	Weekday	58 – 68	48	62	70	46	Pedestrian traffic; algae clearing trawler (MacRitchie Reservoir) – peak value due to revving of engine; overhead aircraft; insect and bird vocalizations; wind blown vegetation; distant vehicular traffic along Lornie Road
	Weekend	48 – 53	44	49	63	43	
NL303	Weekday	48 – 63	46	50	60	44	Bird vocalizations; vehicular traffic – peak values due to cars and motorcycle traffic along Lornie Road and motorcycle traffic along Upper Thomson Road; wind blown vegetation; overhead aircraft; pedestrian traffic; kayakers (MacRitchie Reservoir); overhead aircraft (Round 1)
	Weekend	52 – 53	50	53	63	49	
NL304	Weekday	46 – 46	44	47	53	42	Pedestrian traffic; bird vocalizations; kayakers (training/preparation on land); vehicular traffic – observed values due to traffic along Lornie Road / MacRitchie Viaduct but no distinct peak; distant vehicular traffic along Upper Thomson Road occasionally audible
	Weekend	49 – 51	47	50	61	45	
NL305	Weekday	42 – 45	41	44	51	39	Bird and insect vocalizations; distant vehicular traffic along Lornie Road; pedestrian traffic; wind blown vegetation; overhead aircraft; algae clearing trawler (MacRitchie Reservoir, Round 1); distant kayakers (MacRitchie Reservoir, Round 1)
	Weekend	45 – 50	40	47	65	36	

**Notes:**

<sup>(1)</sup> Lowest value of the three measurements (taken over 15 minutes) was selected, to establish a conservative baseline. Each measurement has been averaged over 5 minutes.



## 5.6 LOCAL VIBRATION ENVIRONMENT

A primary baseline vibration survey was undertaken to establish indicative vibration levels due to existing sources within the Study Area in the absence of Project related activities.

### 5.6.1 Baseline Vibration Monitoring Points

Existing vibration sources and the locations of proposed aboveground SI works and potential vibration sensitive receptors (VSRs) were taken into account in the selection of representative baseline vibration monitoring points, illustrated on *Figure 5.2*. A list of the monitoring points is presented in *Table 5.8* alongside the rationale for selection of each location.

**Table 5.8: Rationale for Selected Vibration Monitoring Points**

Monitoring Point ID	Location	Rationale
<b>Alignment Option 1</b>		
VL101	Grass verge beside dirt trail, across from Jelutong Tower	Representative of baseline vibration levels due to existing activities along trails within the CCNR
VL102	Grass verge at cross junction of the Venus Link trail and the service road to PUB's Bukit Kalang Service Reservoir	Representative of baseline vibration levels due to vehicular and human traffic within the study area
<b>Alignment Option 2</b>		
VL201	Grass verge along Venus Drive	Representative of baseline vibration levels due to light vehicular traffic within an urban area
VL202	Grass verge at the cross junction of Lornie Road and an access road from Mount Alvernia Hospital	Representative of baseline vibration levels due to heavy vehicular traffic within an urban area

### 5.6.2 Survey Approach

Vibration monitoring was undertaken over one weekday using an INSTANTEL INC Ground Vibration Monitoring Equipment. The vibration sensor was aligned with the Jelutong Tower, and vibration levels along three axes were measured continuously. Peak particle velocity (PPV) readings were recorded at intervals of 5 minutes.

### 5.6.3 Survey Findings

PPV values measured along three axes at each location are summarized in *Table 5.8*. The full survey report is presented in *Annex 5.0*.



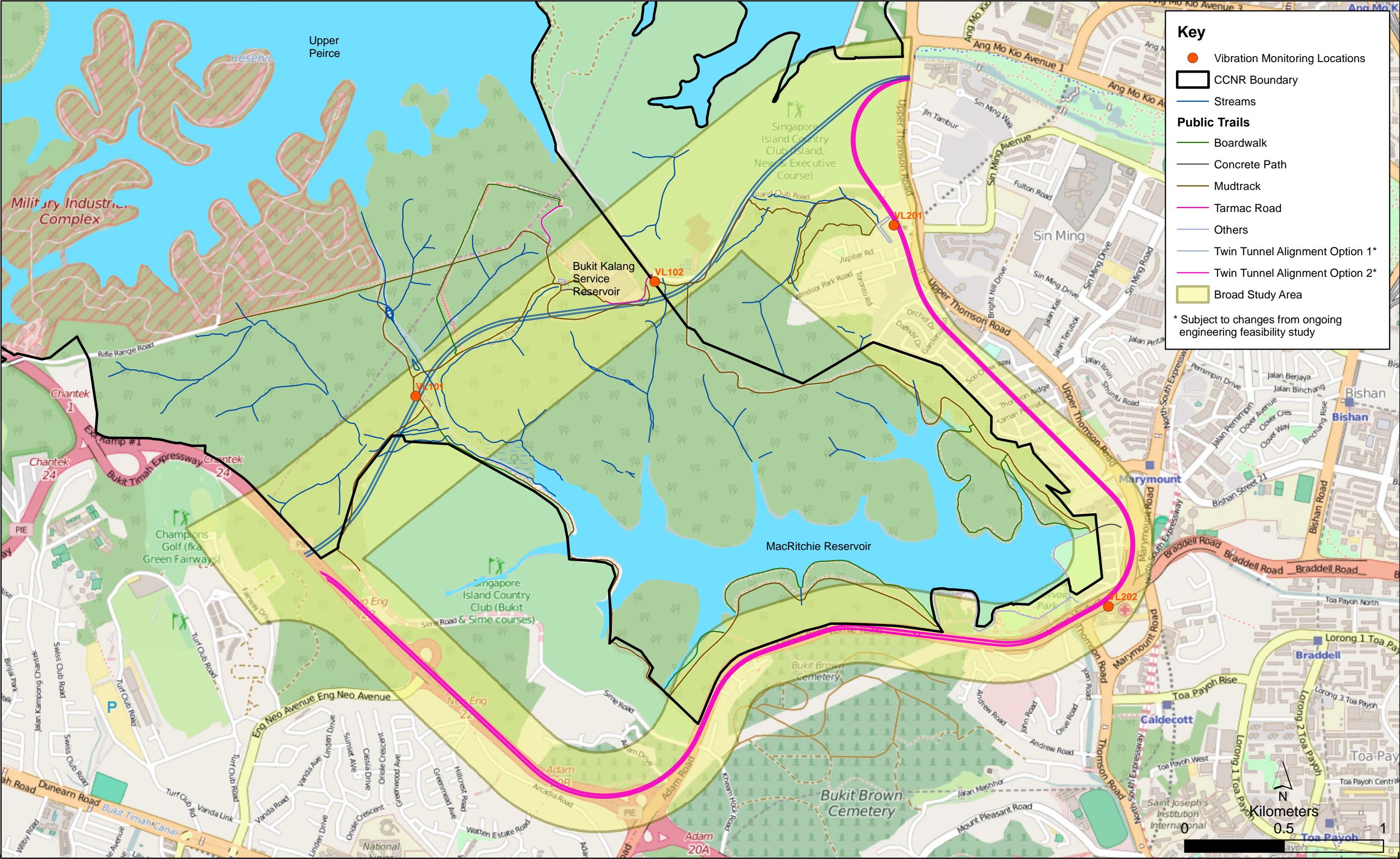


Figure 5.2 Locations of Vibration Monitoring Points



**Table 5.8: Rationale for Selected Vibration Monitoring Points**

Monitoring ID	Baseline Vibration Measurements, PPV (mm/s) <sup>(Note 1, Note 2)</sup>			Vibration Sources <sup>(Note 3)</sup>
	Transverse (X-axis)	Longitudinal (Y-axis)	Vertical (Z-axis)	
Alignment Option 1				
VL101	0.254	0.508	0.508	Joggers/trekkers, soldiers, workers undertaking painting of Jelutong Tower
VL102	0.889	0.762	0.254	Joggers/trekkers, vehicles (cars, lorries) along PUB service road and within 20 m of Island Club Road
Alignment Option 2				
VL201	0.762	0.635	0.762	Vehicles along Venus Drive, joggers/trekkers
VL202	0.508	0.635	0.889	Pedestrians, vehicles along Lornie Road

**Notes:**

- (1) Values presented are the maximum PPV logged over a 24 hour measurement period.
- (2) A minimum trigger level of 0.5 mm/s was set.
- (3) Sources as observed from previous site reconnaissance of the Study Area.

With the exception of VL101, all baseline vibration monitoring points were located between 1 and 2 m of a roadway. Horizontal vibration, ie vibration along the transverse and longitudinal axes, measured at these points is typical of vibration due to passing vehicular traffic. As per a study undertaken by the *Tunnelling and Underground Space Technology*<sup>11</sup>, general traffic passing between 2 – 6 m of a measurement point typically generate PPV between 0.1 and 0.4 mm/s, whereas heavy vehicles on poor road surfaces would generate PPV values of up to 0.8 mm/s. Relatively high baseline PPV recorded along the vertical axis at VL201 and VL202 could be due to the cumulative effect of heavy vehicular and pedestrian traffic.

PPV measured along the longitudinal and vertical axes at VL101, and along the transverse axis at VL102 are relatively high, ie > 0.8 mm/s, considering the position of the meters as well as the observed vibration sources during the installation of the meters (see photographs of the meter setups within *Annex 5.0* survey reports). In addition to contribution from users of the nearby trail, high PPV at VL101 could potentially be attributed to disturbance by fauna or recreational users within the CCNR. Similarly, as VL102 was situated at an off-trail location adjacent to roads that are not heavily utilized by vehicles, high PPV measured along the transverse axis might be attributed to disturbance by recreational users of the Venus Link trail.

<sup>11</sup> New BM (1990) **Ground vibration caused by construction works**. *Tunnelling and Underground Space Technology*, Vol 5 (3), p 179 – 190.



## 6 CLIMATE AND AIR QUALITY

### 6.1 INTRODUCTION

This chapter presents an overview of the baseline climate, meteorological conditions and ambient air quality of the Study Area. This chapter is structured as follows:

- *Section 6.2* defines the Study Area for understanding climate and air quality;
- *Section 6.3* presents the sources of information reviewed;
- *Section 6.4* describes the climate, meteorology and regional sources of emissions influencing air quality in Singapore; and
- *Section 6.5* describes the baseline ambient air quality of the Study Area.

### 6.2 STUDY AREA

The Study Area in this chapter is defined as the area within which human or ecological receptors could be adversely affected by atmospheric emissions from the SI works. The spatial extent of the Study Area is therefore defined by factors influencing dispersion of atmospheric emissions, such as terrain, meteorological conditions and the source of emissions. As described in *Chapter 2.0*, aboveground activities associated with the CRL development are limited to SI and the operation of equipment during construction and operational activities (eg, vehicular exhaust emissions). In consideration of the highly localized sources of emissions from CRL, the broad Study Area as shown in *Figure 2.1* is deemed adequate for the purpose of this study.

The Study Area also encompasses the human and ecological receptors that are sensitive to atmospheric emissions. These have been identified based on a review of land uses and observations made during site surveys undertaken for the Project. In general, these comprise of areas with a high proportion of vulnerable individuals, public open spaces used for outdoor recreational activities or events, residential dwellings, industrial land uses requiring clean rooms or operating equipment with large air intake needs, and areas of specific ecological interest. Air sensitive receptors (ASRs) therefore include ecological receptors within the Study Area, residential buildings, educational institutions, recreational areas, homes for the elderly and hospitals as further detailed in *Table 6.1*.

### 6.3 SOURCES OF INFORMATION

The following information was reviewed for this study:

- Long-term ambient air quality statistics published by the Ministry of the Environment and Water Resources (MEWR) and the Department of Statistics of the Ministry of Trade and Industry;
- Publicly available street directories developed by Streetdirectory Pte Ltd and the Singapore government (OneMap); and
- Climate, meteorological and ambient air quality data published by the NEA (as described further in *Section 6.4* and *Section 6.5*).

**Table 6.1: Potential Air Sensitive Receptors to the Project Activities**

Receptor Category	Receptor Description
<b>Alignment Option 1</b>	
Ecological	Ecological receptors within CCNR, Windsor Interim Green and SICC golf courses
Recreational area	Trails within CCNR
Recreational area	SICC Bukit, Sime & Island golf courses
<b>Alignment Option 2</b>	
Residential building	Flame Tree Park, Thomson View, Thomson Three <sup>Note 1</sup> , The Windsor, Three 11 <sup>Note 2</sup> , Thomson 800, Lornie 18 (condominiums)
	Lakeview Estate (privatized apartments)
	Private residences (Upper Thomson Road, Lornie Road, Sime Road & Adam Road)
Place of worship	Hai Lam Sua Tee Kong Toa Temple
	St Francis Convent
Educational institution	Raffles Institution (Junior College)
	Our Juniors' Schoolhouse (Thomson Branch)
	Cherie Hearts Kids-at-Play (Thomson)
Home for the aged sick	St Theresa's Home
	Assisi Hospice <sup>Note 3</sup>
Hospital	Mt Alvernia Hospital
	Jireh Veterinary Clinic Pte Ltd
Recreational area	Island Gardens Walk Playground
	SICC Island golf course
	Soo Chow Walk Playground
	Taman Permata Park
Ecological	Ecological receptors within CCNR, Windsor Interim Green & SICC golf courses
	Bukit Brown Municipal Cemetery
	Ecological receptors within forested area along Adam Drive and Sime Road

**Notes:**

<sup>(1)</sup> Estimated completion in 28 February 2017.

<sup>(2)</sup> Estimated completion in 31 December 2015.

<sup>(3)</sup> Ongoing expansion estimated for completion in 1Q 2017.

Primary data gathering was undertaken through site walkovers and short-term ambient air quality surveys near potentially sensitive receptors to establish an understanding of the baseline air quality.

## 6.4 REGIONAL AMBIENT AIR QUALITY

The ambient air quality of Singapore is monitored by the NEA via its telemetric air quality monitoring and management system (TAQMMS), which comprises 15 air monitoring stations located across the mainland and on Jurong Island<sup>1</sup>. Primary air quality indicators, namely sulfur dioxide (SO<sub>2</sub>), particulate matter (PM<sub>2.5</sub> and PM<sub>10</sub>), ozone, nitrogen dioxide (NO<sub>2</sub>) and carbon monoxide (CO) are monitored for determination of the Pollutant Standards Index (PSI), a locally developed index which provides an indication on air quality and resultant impact on human health. These species are also monitored for comparison against Singapore's 2020 ambient air quality targets which are based on the interim and final Air Quality Guideline (AQC) values published by the World Health Organisation (WHO) in 2005<sup>2</sup>. Over the last five years, ambient concentrations of the primary air quality indicators averaged over the island of Singapore were below the 2020 ambient air quality targets for both short-term and long-term averaging periods for most species, with the exception of SO<sub>2</sub>, ozone, PM<sub>2.5</sub> and PM<sub>10</sub><sup>3,4</sup>. The percentage of days within a year where the PSI was described as 'Good' (ie below 50) ranged between 91% and 96%. Air quality is also influenced by regional factors such as emissions from neighboring countries, climate and meteorological conditions as described further in the following sections.

### 6.4.1 Regional Sources of Emissions

The air quality in Singapore has been impacted to varying degrees over the past decades by transboundary haze from land and forest fires in Sumatra and Kalimantan. Haze typically occurs during Indonesia's dry period between the months of June and October when fires are set for land clearance by shifting agricultural communities, or in land tenure conflicts. Major haze events usually occur when annual fires are exacerbated by strong winds during the Southwest Monsoon and drought conditions induced by El Niño. However, other factors may also contribute to high pollutant levels. For example, the 2013 major haze event which occurred under neutral weather conditions was attributed to the deforestation, drainage and burning of large swathes of peatland in Indonesia which released a disproportionate amount of smoke and toxic gases as compared to emissions from the burning of forested land<sup>5</sup>. As a result, unusually high particulate matter levels were recorded across Singapore, resulting in PSI values in the 'Hazardous' range in June 2013<sup>6</sup>.

### 6.4.2 Climate

In general, Singapore experiences an equatorial monsoonal tropical climate, with warm, humid conditions throughout the year. Singapore has two main monsoon seasons which include the Northeast Monsoon season from December to early March and the Southwest Monsoon season from June to September. The Northeast Monsoon features rapid development of early afternoon and

<sup>1</sup> National Environment Agency (2013) **Environmental Protection Division Report 2013**, Environmental Protection Division.

<sup>2</sup> National Environment Agency (2012) **Air Quality and Targets**. Available at <http://www.nea.gov.sg/anti-pollution-radiation-protection/air-pollution-control>

<sup>3</sup> Ministry of the Environment and Water Resources (2014) **Key Environmental Statistics 2014**. Available at <http://app.mewr.gov.sg/data/imgCont/52/MEWR%20KES%202014.pdf>

<sup>4</sup> Ministry of the Environment and Water Resources (2013) **Key Environmental Statistics 2013**. Available at <http://app.mewr.gov.sg/web/Contents/Contents.aspx?id=195>

<sup>5</sup> Neo C C (7 Nov 2014) **Major haze episodes in region 'likely to be more frequent'**, TODAY, Mediacorp News Group.

<sup>6</sup> National Environment Agency (2013) **Annual Weather Review 2013**. Available at [http://app2.nea.gov.sg/docs/default-source/training-knowledge-hub/publications/annual-weather-review-\(2013\).pdf?sfvrsn=2](http://app2.nea.gov.sg/docs/default-source/training-knowledge-hub/publications/annual-weather-review-(2013).pdf?sfvrsn=2)



evening showers as well as monsoon surges leading to continuous moderate to heavy rains. Towards the end of this season, conditions are windy and relatively dry.

The Southwest Monsoon season features rain showers and thunderstorm activity between the late morning and early afternoon, which can be intense. Sumatra squalls (ie, thunderstorm lines that can bring about one to two hours of thunder and showers) are also common.

Separating the two monsoon seasons are the Inter-monsoon periods, which typically span from late March to May and October to November respectively. Thunderstorms, at times scattered or severe, can occur during these periods in the afternoon or early evenings. At other times, the weather is hot and dry<sup>7</sup>.

#### 6.4.3 Wind

Surface wind conditions in Singapore generally follow the prevailing monsoon flows. Winds during Inter-monsoon periods are usually light and tend to vary in direction on a daily basis. Mean monthly surface wind speeds range from 4 km/h to 10 km/h, with maximum wind gusts of up to 93 km/h during the passage of Sumatra squalls<sup>8</sup>.

#### 6.4.4 Temperature & Humidity

Typical temperatures in Singapore reach a high of 31°C to 34°C during the day and a low of 23°C to 26°C during the night. Daily mean maximum and minimum temperature recorded for Singapore over the last five years were consistent at approximately 31°C and 25°C respectively<sup>9</sup>.

The relative humidity in Singapore is high, with humidity levels rising to more than 90% during the mornings just before sunrise, and falling to about 60% in the afternoon on days when there is no rain. During periods of rain, relative humidity frequently reaches 100%<sup>10</sup>. The daily mean relative humidity over the last five years ranges between 82% and 85%.

#### 6.4.5 Rainfall

There is no distinct wet or dry season in Singapore. Rain falls every month of the year; however, there are two peaks of rainfall during December (Northeast Monsoon period) and April (Inter-monsoon period), whereas the drier months of the year typically fall in February and July.

According to the *Annual Weather Review*<sup>11</sup> published by the NEA, anomalies in average rainfall in recent years may sometimes be attributable to global weather phenomena such as El Niño (which led to lower

<sup>7</sup> National Environment Agency (2014) **Local Climatology**. Available at <http://app2.nea.gov.sg/weather-climate/climate-information/local-climatology>

<sup>8</sup> National Environment Agency (2013) **Sumatras**. Available at <http://app2.nea.gov.sg/training-knowledge-hub/weather-climate/sumatras>

<sup>9</sup> Ministry of Trade & Industry (2014) **Yearbook of Statistics Singapore 2014**, Department of Statistics.

<sup>10</sup> National Environment Agency (2014) **Local Climatology**. Available at <http://app2.nea.gov.sg/weather-climate/climate-information/local-climatology>

<sup>11</sup> National Environment Agency (2015). **Annual Weather Review**. Available at <http://www.nea.gov.sg/training-knowledge-hub/publications/annual-weather-review>

than average rainfall in 2009<sup>12</sup>) and La Niña (which led to higher than average rainfall in 2011<sup>13</sup>). Generally, however, rainfall anomaly composites for the ASEAN region for past El Niño years have indicated that drier than average conditions attributed to El Niño have been largely confined to southern and eastern ASEAN during the Northeast Monsoon. On 05 March 2015, the *United States National Oceanic and Atmospheric Administration* (USNOAA) declared the development of weak El Niño in the Pacific<sup>14</sup>. The latest forecast on 11 June 2015 indicated a strengthening El Niño and this was predicted to continue throughout 2015<sup>15</sup>.

Typhoons developing in the Pacific Ocean also contribute to Sumatra squalls, which are characterized by intense and heavy rainfall, as were observed in May 2011<sup>16</sup>, April 2012<sup>17</sup> and September through November 2013<sup>18</sup>. Rainfall distribution patterns indicate that annual rainfall occurring over the last three years in the central region of Singapore were 15 – 35% above the long-term average.

## 6.5 LOCAL AMBIENT AIR QUALITY

### 6.5.1 Local Emission Sources

Air emission sources local to the project area include vehicular emissions along roadways and from existing construction sites observed during site reconnaissance of the Study Area undertaken in July and October 2014.

The main sources of vehicular emissions within the Study Area are the roads on the boundary of the CCNR; namely Upper Thomson Road, Lornie Road and the PIE. Upper Thomson Road is a dual three-lane major arterial road that connects the Northern and Central regions of Singapore, and runs along the eastern boundary of the CCNR. Lornie Road lies along the southern perimeter of the MacRitchie Reservoir and serves as a major connecting road between the PIE and the Central Expressway (CTE). Due to heavy congestion along Lornie Road during peak hour traffic, a new dual four-lane road will be developed which transects the Bukit Brown Cemetery and connects Adam Flyover to the MacRitchie Viaduct. The road development is scheduled for completion in 2017<sup>19</sup>.

Other sources of vehicular emissions include NParks' maintenance vehicles operated on an ad-hoc basis within the CCNR, as well as lawn mowers operated within the golf courses bounding the CCNR.

<sup>12</sup> National Environment Agency (12 November 2014) **El Niño/La Niña Status Update**. Available at <http://www.nea.gov.sg/weather-climate/forecasts/el-nino-la-nina-status-update>

<sup>13</sup> National Environment Agency (5 July 2013) **Annual Weather Review 2011**. Available at <http://www.nea.gov.sg/training-knowledge-hub/publications/annual-weather-review-2011>

<sup>14</sup> National Oceanic and Atmospheric Administration (5 March 2015) **NOAA: Elusive El Niño Arrives**. Available at <http://www.noaanews.noaa.gov/stories2015/20150305-noaa-advisory-elnino-arrives.html>

<sup>15</sup> Climate Prediction Center/NCEP/NWS and the International Research Institute for Climate and Society (11 June 2015) **El Niño/ Southern Oscillation (ENSO) Diagnostic Discussion**. Available at [http://www.cpc.ncep.noaa.gov/products/analysis\\_monitoring/enso\\_advisory/ensodisc.pdf](http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/enso_advisory/ensodisc.pdf)

<sup>16</sup> National Environment Agency (5 July 2013) **Annual Weather Review 2011**. Retrieved from <http://www.nea.gov.sg/training-knowledge-hub/publications/annual-weather-review-2011>

<sup>17</sup> National Environment Agency (5 July 2013) **Annual Weather Review 2012**. Available at <http://www.nea.gov.sg/training-knowledge-hub/publications/annual-weather-review-2012>

<sup>18</sup> National Environment Agency (2013) **Annual Weather Review 2013**. Available at [http://www.nea.gov.sg/docs/default-source/training-knowledge-hub/publications/annual-weather-review-\(2013\).pdf?sfvrsn=2](http://www.nea.gov.sg/docs/default-source/training-knowledge-hub/publications/annual-weather-review-(2013).pdf?sfvrsn=2)

<sup>19</sup> Land Transport Authority (2014) **Outer Ring Road System**

Vehicular and equipment exhaust, and particulate matter are also generated by ongoing construction works for developments along Upper Thomson Road eg, Thomson Grand, Three 11 and Thomson Three condominiums and Assisi Hospice expansion, the Upper Thomson MRT station, the Thomson Line tunnels and Singapore Power's North South Transmission Cable.

### 6.5.2 Baseline Air Quality Survey

Based on the NEA monitoring results for period of 2011 to 2013, the short-term and long-term concentrations of PM<sub>10</sub> and PM<sub>2.5</sub> in the study area were above the Singapore 2020 and long-term ambient air quality targets.

### 6.5.3 Baseline Air Survey Methodology

A baseline air survey was undertaken to establish concentrations of key air quality indicators due to current and committed developments within the Study Area. As the sulphur content of fuel is regulated in Singapore<sup>20</sup>, atmospheric emissions of SO<sub>2</sub> from the Project sources are unlikely to be significant and are therefore screened out from further consideration. Further, contributions to NO<sub>2</sub> and CO levels from CRL development activities are expected to be small and can typically be managed through appropriate equipment specification. The baseline air survey therefore focused on establishing the baseline in terms of particulate matter, specifically very fine particles less than 2.5 microns in diameter (PM<sub>2.5</sub>) and fine particles less than 10 microns (PM<sub>10</sub>).

A Metone Aerosol Meter, a portable light-scattering dust meter, was used for short-term measurements over a period of 1 week at each monitoring location. The meters were installed in such a way as to avoid nearby obstructions that may affect the readings (*Annex 2.0, Photos 22 to 24*).

Representative short-term baseline noise monitoring points within the Study Area were selected in view of the baseline atmospheric emissions sources, and the locations of aboveground construction works and facility buildings associated with each alignment option. The rationale for the selected monitoring points is presented in *Table 6.2*, and the monitoring locations are shown in *Figure 6.2*.

**Table 6.2: Rationale for Selected Air Monitoring Points**

Monitoring Point ID	Location	Rationale
AQ101	Along Sime Track (within CCNR)	Representative of baseline air quality in CCNR at areas frequented by visitors
AQ102	Along a former trail within CCNR	Representative of baseline air quality at off trail areas within CCNR
AQ201	Between Island Landscape & Nursery, and the cross junction of Thomson Road and Upper Thomson Road	Representative of baseline air quality at sensitive receptors near proposed vent building

<sup>20</sup> National Environment Agency (2014) **Air Quality and Targets**. Available at <http://app2.nea.gov.sg/anti-pollution-radiation-protection/air-pollution-control>



Monitoring Point ID	Location	Rationale
AQ202	Signpost near 10A Lornie Road	Representative of CCNR, forested areas (Bukit Brown Cemetery) and private residences with exposure to traffic along Lornie Road

Two rounds of monitoring were carried out for points AQ101 to AQ202, Round 1 in November/December 2014 and Round 2 between January and February 2015. As with the approach for noise monitoring (*Chapter 5.5.2*), the timing of air monitoring was aimed at capturing the inter-monsoon and monsoon periods as far as practicable given the timescales of the Project. Round 1 is therefore representative of the tail end of the inter-monsoon/start of Northeast monsoon while Round 2 is representative of the Northeast monsoon as reported by NEA<sup>21</sup>.

<sup>21</sup> National Environment Agency (10 June 2014) *Local Climatology of Singapore: Seasons*. Available at <http://www.nea.gov.sg/weather-climate/climate-information>.



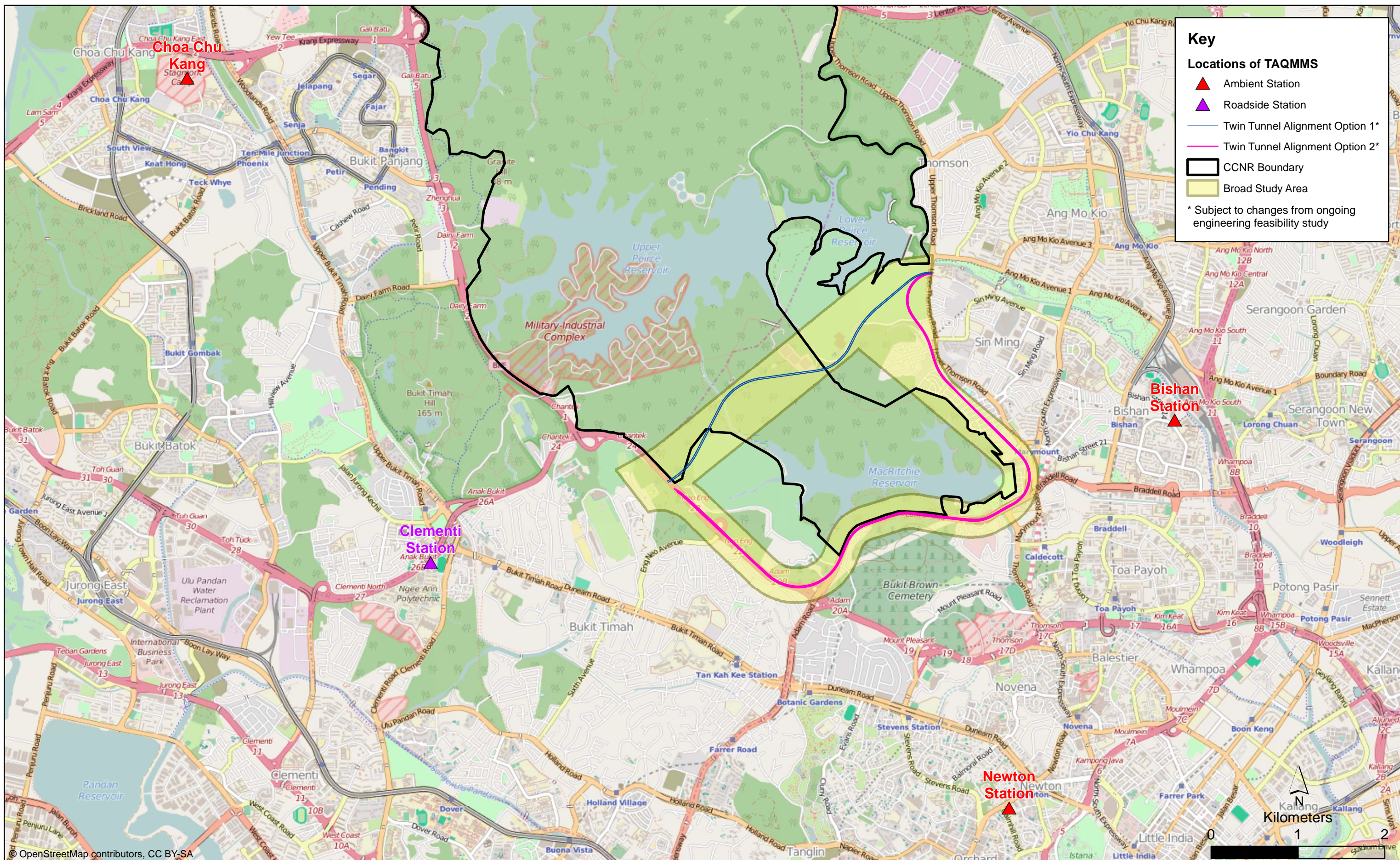


Figure 6.1 Locations of TAQMMS Stations Near Project Study Area



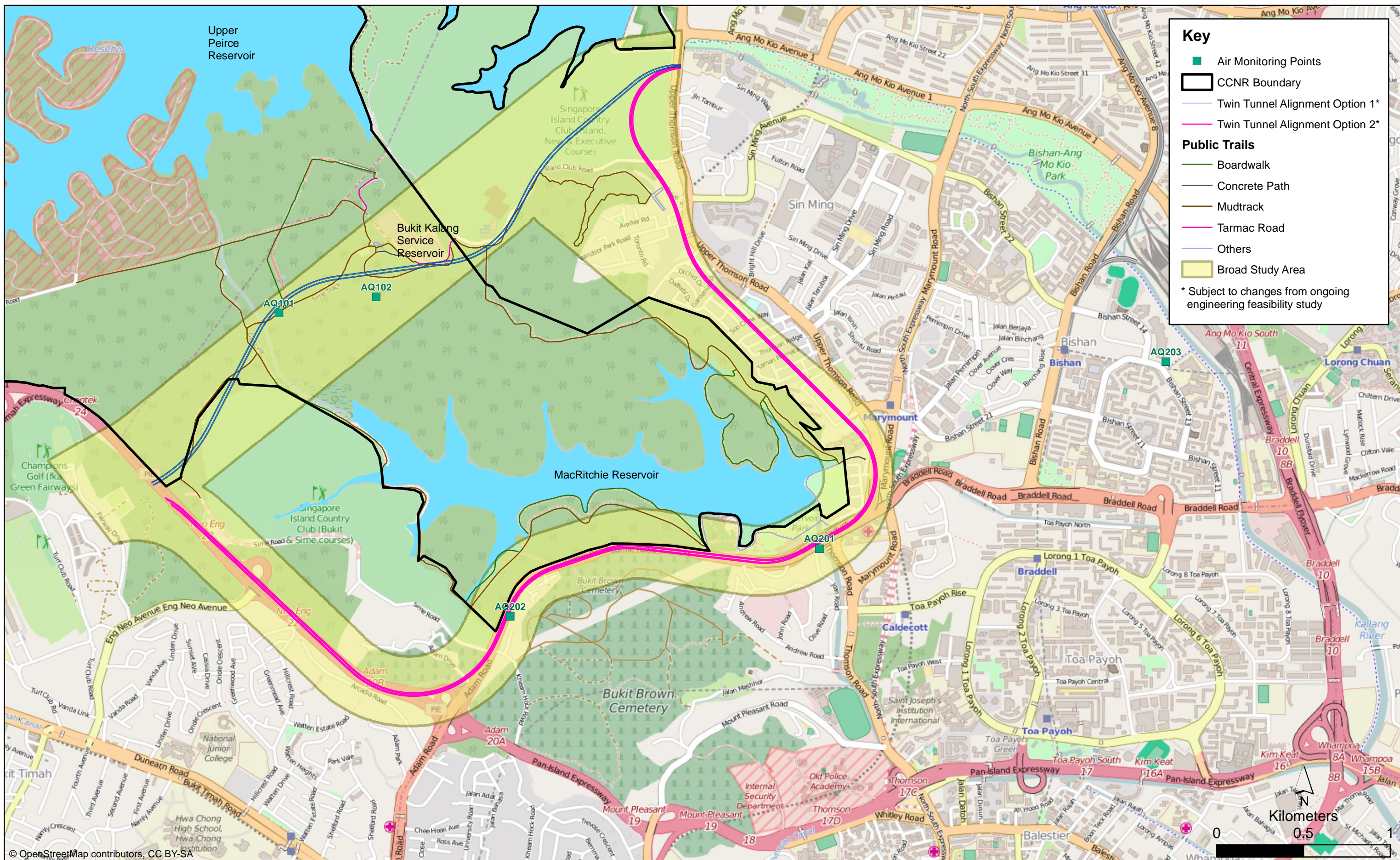


Figure 6.2 Locations of Air Monitoring Points



#### 6.5.4 Baseline Air Quality Results

Baseline air quality results for short-term PM<sub>10</sub> and PM<sub>2.5</sub> measurements over the two monitoring periods are shown in *Table 6.3*. The raw results obtained using the MetOne Aerocet 531S light scattering dust meter indicate that PM<sub>2.5</sub> levels in the Study Area were generally below the Singapore air quality target during the two weeks of monitoring; however, PM<sub>10</sub> concentrations from photometric measurements were above the standards on some days at AQ101, AQ102 and AQ202 during Round 1.

**Table 6.3: Baseline Air Quality Monitoring Results**

Point	Start Date	End Date	PM <sub>10</sub> (24hr) µg/m <sup>3</sup>	PM <sub>2.5</sub> (24hr) µg/m <sup>3</sup>	Start Date	End Date	PM <sub>10</sub> (24hr) µg/m <sup>3</sup>	PM <sub>2.5</sub> (24hr) µg/m <sup>3</sup>
	<i>Round 1<sup>(1)</sup></i>				<i>Round 2<sup>(1),(2)</sup></i>			
AQ101	24.11.14	25.11.14	<b>54.6</b>	11.6	02.02.15	03.02.15	9.3	2.7
	25.11.14	26.11.14	<b>74.0</b>	19.6	03.02.15	04.02.15	6.4	2.1
	26.11.14	27.11.14	<b>76.0</b>	29.2	04.02.15	05.02.15	16.1	3.7
	27.11.14	28.11.14	<b>62.7</b>	17.2	05.02.15	06.02.15	14.3	4.8
	28.11.14	29.11.14	31.4	3.7	06.02.15	07.02.15	11.5	3.0
	29.11.14	30.11.14	46.2	7.4	07.02.15	08.02.15	10.4	3.4
	30.11.14	01.12.14	46.3	9.5	08.02.15	09.02.15	7.1	2.7
AQ102	19.12.14	20.12.14	<b>87.7</b>	17.0	02.02.15	03.02.15	6.4	2.1
	20.12.14	21.12.14	<b>83.7</b>	20.7	03.02.15	04.02.15	6.9	2.1
	21.12.14	22.12.14	<b>55.0</b>	10.7	04.02.15	05.02.15	12.8	3.1
	22.12.14	23.12.14	29.2	4.7	05.02.15	06.02.15	19.2	6.5
	23.12.14	24.12.14	39.0	8.0	06.02.15	07.02.15	8.2	2.4
	24.12.14	25.12.14	<b>52.1</b>	7.8	07.02.15	08.02.15	6.8	2.5
	29.12.15	30.12.15	43.8	7.3	08.02.15	09.02.15	5.5	2.2
AQ201	03.12.14	04.12.14	21.7	4.3	16.01.15	17.01.15	5.2	2.2
	04.12.14	05.12.14	24.9	6.0	17.01.15	18.01.15	5.8	2.3
	05.12.14	06.12.14	13.0	3.1	18.01.15	19.01.15	9.1	3.8
	06.12.14	07.12.14	16.1	3.6	19.01.15	20.01.15	9.2	3.8
	07.12.14	08.12.14	19.1	5.9	20.01.15	21.01.15	10.7	5.5
	08.12.14	09.12.14	22.2	6.2	21.01.15	22.01.15	9.6	5.5
	09.12.14	10.12.14	32.4	8.5	22.01.15	23.01.15	7.2	3.9
AQ202	18.12.14	19.12.14	<b>52.1</b>	12.5	16.01.15	17.01.15	12.2	6.5
	19.12.14	20.12.14	<b>78.7</b>	20.6	17.01.15	18.01.15	13.6	6.7
	20.12.14	21.12.14	<b>53.4</b>	12.1	18.01.15	19.01.15	20.4	10.4
	21.12.14	22.12.14	48.6	9.8	19.01.15	20.01.15	19.4	10.1
	24.12.14	25.12.14	<b>63.5</b>	14.8	20.01.15	21.01.15	24.2	15.1
	29.12.14	30.12.14	41.1	10.2	21.01.15	22.01.15	22.2	15.2
	30.12.14	31.12.14	<b>81.2</b>	25.3	22.01.15	23.01.15	16.3	10.9

Notes:

<sup>(1)</sup> Bold value exceeds the applicable Singapore ambient Air quality target

<sup>(2)</sup> Round 2 values were adjusted to account for humidity through comparison with publicly available data collected over the same period using reference methods.

## 7 ECOLOGY AND BIODIVERSITY

### 7.1 INTRODUCTION

This chapter presents the baseline ecology and biodiversity environment of the Study Area.

The remainder of the chapter is structured as follows:

- *Section 7.2* summarizes the climate, forest environment and biodiversity of Singapore that places the Study Area within a regional context;
- *Section 7.3* defines the Study Area for this ecological assessment;
- *Section 7.4* defines the criteria for evaluating ecological and biodiversity value of findings in this ecological assessment;
- *Section 7.5* summarizes the findings of the secondary data review and details the findings of the primary baseline surveys undertaken; and
- *Section 7.6*; summarizes an overall distribution of species of conservation interest within the Study Area

### 7.2 CLIMATE, FOREST ENVIRONMENT AND BIODIVERSITY OF SINGAPORE

#### 7.2.1 Overview

Singapore covers a land area of approximately 700 km<sup>2</sup> (including reclaimed land) and consists of one main island with approximately 60 smaller offshore islands<sup>1</sup>. Singapore is nestled in the midst of the Indo-Malayan rainforest, one of three last remaining rainforest blocks in the world<sup>2</sup>. As outlined in *Chapter 6*, Singapore's tropical climate reflects its maritime position one degree north of the equator with fairly uniform temperature and pressure, high humidity and abundant rainfall which is fairly uniformly distributed throughout the year, although it tends to be greater during the Northeast monsoon. A summary of the monsoon seasons in Singapore is outlined in *Table 7.1*.

The seasonal cycle of monsoons and diurnal processes are the main determinants of the weather and temperatures. Water and air temperatures are generally fairly stable over the year, with water temperatures showing only small diurnal changes. A slight exception occurs in open bodies of standing water, such as the reservoirs within the CCNR, where water temperature variations are generally greater due to exposure to the sun.

<sup>1</sup> Convention on Biological Diversity – Singapore. (2014) Available at <http://www.cbd.int/countries/profile/default.shtml?country=sg>

<sup>2</sup> National Parks Board (2009) Conserving Our Biodiversity – Singapore's National Biodiversity Strategy and Action Plan



**Table 7.1: Singapore Monsoon Seasons**

Season	Duration	Weather Conditions
Northeast Monsoon – Wet Phase	December to January	Thundery afternoon showers, monsoon surges with period of widespread moderate to heavy rain for 15-19 days; with a mean rainfall 241-288 mm and a mean temperature 26.0 °C.
Northeast Monsoon – Dry Phase	February to early March	Generally drier and windy conditions; rainfall drops to 160-185 mm with an average 11-14 rain days. Temperature 26.5-27.0 °C.
Southwest Monsoon	June to September	Drier conditions. However, Sumatras (squall type thunderstorms) usually occur during this season. Rainfall ranges between 159-193 mm for 13-16 days. Temperature 27.1-27.8 °C.
Inter-monsoon	late March to May	Less rain and wind; rainfall ranges between 160-172 mm for 11-15 days. Temperature 26.5-27.7 °C.
	October to November	Rainfall starts to increase, ranging from 194-257 mm for 16-19 days. Temperature 26.5-27.1 °C.

Source: National Environment Agency, 2013 ([www.NEA.gov.sg](http://www.NEA.gov.sg))

## 7.2.2 Forest Environments in Singapore

Forest was the natural vegetation on almost all substrates in primeval Singapore. This consisted largely of lowland tropical dipterocarp rainforest, approximately 13% of mangrove forest, 5% of freshwater swamp forest and possibly some small areas of peat forest<sup>3,4</sup>. Although coastal settlements were present in Singapore prior to the 19<sup>th</sup> century contributing to some degree of clearance of coastal forests, there is no evidence of significant forest clearance in the interior of Singapore Island prior to this. Large tracts of forest were felled following the founding of Singapore as a British colony in 1819<sup>5</sup> for the cultivation and processing of gambier (*Uncaria gambir*) and pepper<sup>6</sup>. In 1884, Cantley reported that the remaining uncut forests were distributed in fragmented patches across the island, generally interspersed with Lalang (*Imperata cylindrica*) waste grassland<sup>7</sup>.

In 1883, the Bukit Timah Nature Reserve (BTNR) was established, primarily due to concerns surrounding the extent of deforestation in Singapore and its potential impacts on the local climate. Subsequently in 1884, the CCNR was established to include the watershed forests around the four inland reservoirs (MacRitchie, Upper Peirce, Lower Peirce and Upper Seletar). This comprised several primary forest patches and an area of primary freshwater swamp forest known as Nee Soon Swamp Forest (NSSF), illustrated in Figure 7.1. Presently, primary forest remnants are found only in these two nature reserves, predominantly in the BTNR and as fragmented patches in the CCNR.

<sup>3</sup> Corlett RT (1997) *The Vegetation in the Nature Reserves of Singapore* Gardens' Bulletin Singapore 49: 147-159

<sup>4</sup> Ng PKL, Corlett RT, Tan HTW (ed) (2011) *Singapore Biodiversity – An encyclopedia of the Natural Environment and Sustainable Development*. National University of Singapore. Pp. 552

<sup>5</sup> Corlett RT (1997) *The Vegetation in the Nature Reserves of Singapore* Gardens' Bulletin Singapore 49: 147-159

<sup>6</sup> O'Dempsey T (2014) *Singapore's Changing Landscape since circa 1800*. In Barnard TP (ed) *Nature Contained: Environmental Histories of Singapore*. NUS Press.

<sup>7</sup> Cantley N (1884) *Report on the forests of the Straits Settlement*. Singapore Printing Office. Singapore

### 7.2.3 Biodiversity in Singapore and Regional Distribution

Singapore is one of the most densely populated countries in the world with a population of around five million people. Despite the island's small size, dense population and highly urbanized environment, over 40,000 species of wild, native and non-microbial organisms can be found in Singapore<sup>8</sup>. Several non-native species can also be found in Singapore's managed habitats. These non-native species may constitute relatively high population numbers<sup>9</sup>.

Most flora and fauna species in Singapore can be found distributed across the wider region. A large proportion of plant species in Singapore occur widely in the core of Sundaland (ie Peninsular Malaysia, Sumatra, Borneo and West Java) with some species extending north into continental Asia and eastwards towards Australia. Invertebrate species in Singapore have been found to follow a similar regional distribution as flora species. Singapore's vertebrate fauna species can be found as far west as India, as far north as China and as far northeast as the Philippines, however, hardly any of the vertebrate species' ranges extend further southeast than Sulawesi.

Singapore possesses a number of endemic species. For plants, these are limited to , three species which are now considered globally extinct<sup>10</sup> as well as a further four species that are highly threatened,<sup>11,12,13</sup> three of which have been discovered since 2014, namely *Zingiber singaporensis*, *Hanguana triangulata* and *Hanguana rubinea*. For animals, Singapore is home to limited endemic species also, including one species of limpet, four species of crabs, one species of amphibian, one species of spider and one species of mammal.

## 7.3 STUDY AREA

The Study Area, for the purposes of ecology and biodiversity, is defined as the area within which ecological receptors (both terrestrial and aquatic) in and around the CCNR, could potentially be affected from the CRL development activities, ie pre-construction SI works, aboveground and underground construction works and operation of the railway.

Note that the CCNR in its entirety encompasses the forested watersheds of four inland reservoirs (MacRitchie, Upper Peirce, Lower Peirce and Upper Seletar) as well as the NSSF, as illustrated in Figure 7.1, and these central reservoirs present some physical barriers to wildlife movement and dispersal in the area. The CCNR is actually considered a highly fragmented habitat, with other barriers limiting wildlife movement and dispersal including fenced areas and several major roads such as Mandai Road and Mandai Lake Road to the North, the Bukit-Timah Expressway separating BTNR and CCNR to the west, and Old Upper Thomson Road to the east.

<sup>8</sup> Ng PKL, Corlett RT, Tan HTW (ed) (2011) *Singapore Biodiversity – An encyclopedia of the Natural Environment and Sustainable Development*. National University of Singapore. Pp. 552

<sup>9</sup> *Convention on Biological Diversity – Singapore*. (2014) Available at <http://www.cbd.int/countries/profile/default.shtml?country=sg>

<sup>10</sup> Ng PKL, Corlett RT, Tan HTW (ed) (2011) *Singapore Biodiversity – An encyclopedia of the Natural Environment and Sustainable Development*. National University of Singapore. Pp. 552

<sup>11</sup> Ng PKL, Corlett RT, Tan HTW (ed) (2011) *Singapore Biodiversity – An encyclopedia of the Natural Environment and Sustainable Development*. National University of Singapore. Pp. 552

<sup>12</sup> NParks News (2015) *Hanguana rubinea* and *Hanguana triangulata*. Available at <https://www.nparks.gov.sg/news/2015/6/factsheet-hanguana-rubinea-and-hanguana-triangulata>

<sup>13</sup> Leong-Skornickova J, Thame A, Chew PT (2014) *Notes on Singapore native Zingiberales I: A new species of Zingiber and notes on the identities of two further Zingiber taxa*. Gardens' Bulletin Singapore 66(2): 153-167

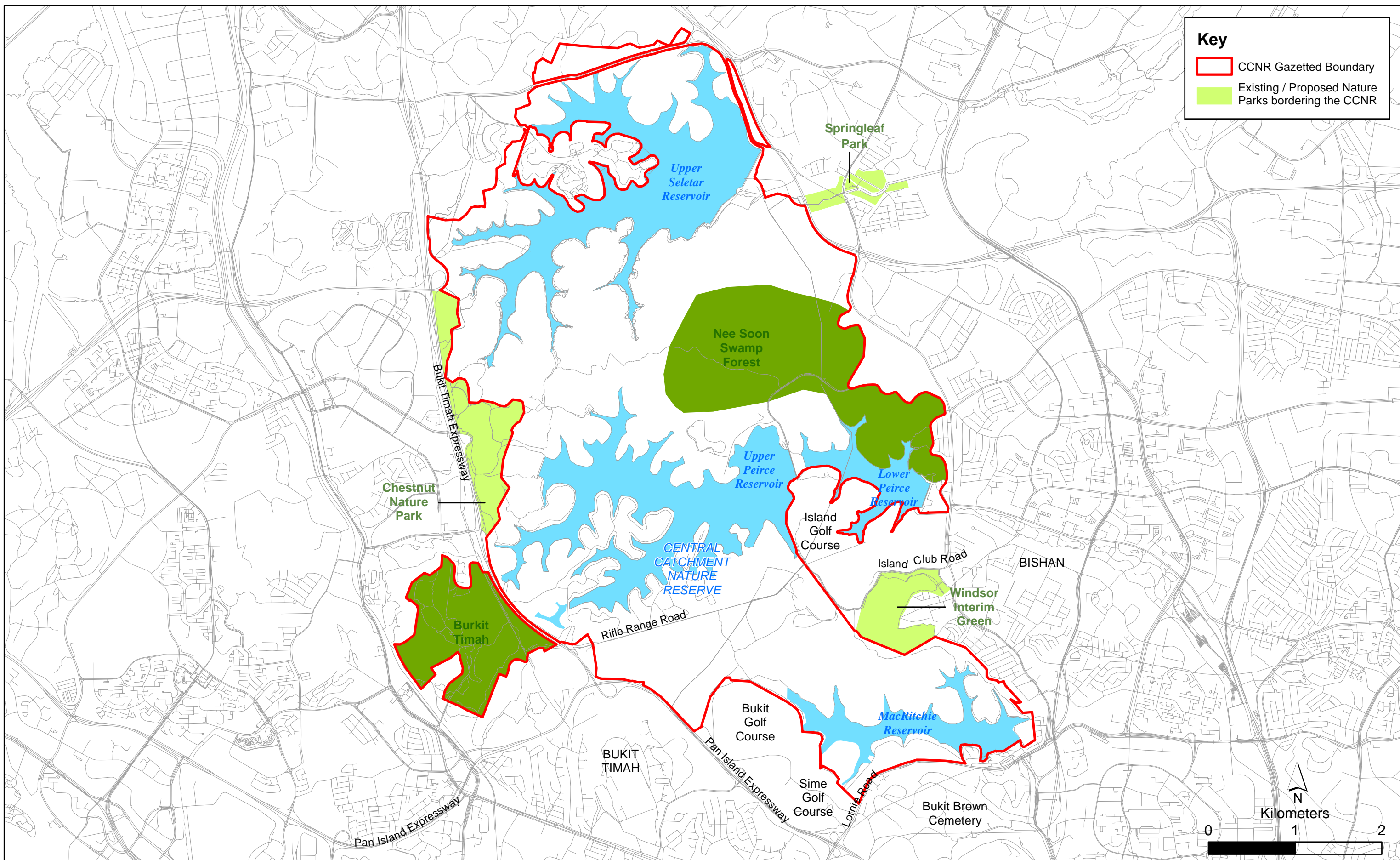


Figure 7.1 Reservoirs, Nee Soon Swamp Forest and Bukit Timah Forest within the CCNR and Adjoining Existing / Proposed Nature Parks



To a certain extent, the public trails within the CCNR and unofficial off-trail paths also serve to break up the continuity of the habitats, while the forest mix in the CCNR is varied such that the lack of a contiguous forest type may limit the movement of animals that are highly sensitive to forest habitat type. In addition to fragmentation effects, the CCNR also experiences several internal stressors throughout its entirety, from human use (eg high usage, night entry, illegal uses including mountain biking and poaching), developmental (eg pipe jacking, construction, urban developments in close proximity) and environmental pressures (eg release of domestic pets, invasion of exotic species, fire and storm damage). Although the impacts of individual pressures are localized, the stress exerted on the CCNR by all these pressures may have a cumulative effect. NParks has sought to relieve some of the pressures around the CCNR by creating buffer zones in the form of nature parks (ie Springleaf Nature Park, Windsor Nature Park, Chestnut Nature Park) aiming to relieve visitor pressure on the CCNR and provide additional green spaces for species to seek refuge in. In addition, in 2013, the eco-link wildlife crossing between BTNR and CCNR was completed to reconnect these two fragmented forests.

The Study Area only falls on the MacRitchie area of the CCNR. This forest area is fragmented due to the presence of forest trails and the MacRitchie reservoir which cuts off the Lornie forest from the MacRitchie core nature area. The Singapore Island Country Club's golf courses to the north and south of the forest also present barriers to animal dispersal to other parts of the CCNR and adjacent forests. The MacRitchie area also faces current and future pressures in the form of cross-country marathons, pipe jacking projects and siltation to its streams from earthworks.

As outlined in *Chapter 2*, for the purpose of this baseline, consideration is given to ecological receptors associated with the CRL footprint (for the two alignment options being considered) and its *Area of Influence* (AOI), including the alignment itself and any activities or structures that would be located on the ground surface, for example the SI works, and considering committed developments that are at or in close proximity to the alignment as well as surface structures. As illustrated on *Figure 2.1*, the Study Area includes part of the CCNR, green areas such as the golf courses and the aquatic environment of surface water bodies immediately above the alignments and immediately down hydraulic gradient of the alignment options.

#### **7.4 CRITERIA FOR EVALUATION OF ECOLOGICAL AND BIODIVERSITY VALUE**

The Evaluation of Ecological and Biodiversity Value takes into account the international standards including those set out in *International Finance Corporation Performance Standard 6 Biodiversity Conservation and Sustainable Management of Living Nature Resources* (January 2012) (IFC PS6), and guidance such as *Business and Biodiversity Offset Program Standard on Biodiversity Offsets* (January 2012) (BBOP Standard) and accompanying materials, but does not follow all aspect of these standards.

For the purpose of the impact assessment (following in *Volume III* and *Volume IV Chapter 7*) habitats recorded in the Study Area are evaluated as being of 'negligible', 'low', 'medium' or 'high' ecological and biodiversity value as defined by criteria set out in *Table 7.2*.

Note that designations of nature conservation interest (ie listing habitats or species as Endangered (EN), Vulnerable (VU), Near Threatened (NT), etc.) may differ between different recognized authorities. For example the IUCN publishes the *IUCN Red List of Threatened Species* to provide designations in the global context, whereas the Nature Society (Singapore)'s *Singapore Red Data Book 2008* provides designations in the state context. The *Singapore Red Data Book 2008* was prepared using IUCN guidelines which encourage nations to produce their own Red Lists of national (rather than

international) importance and therefore their criteria of determining designations are aligned with IUCN criteria. Given the differences in global and state contexts there are some differences in designations assigned to habitats and species between international and local lists. In these cases, all of the rationales underpinning the designations were considered in the context of the Project and the impacts identified.

**Table 7.2: Summary of the Habitat Sensitivity Value Definitions<sup>14</sup>**

Value	Definition Summary
Negligible	Habitats with negligible interest for biodiversity
Low	Habitats with no, or only a local designation/ recognition; habitats of significance for species listed as of Least Concern (LC) on <i>IUCN Red List of Threatened Species</i> (IUCN Red List) <sup>15</sup> or the <i>Singapore Red Data Book 2008</i> (RDB) <sup>16</sup> ; habitats which are common and widespread within the region; or habitats with low conservation interest based on expert opinion.
Medium	Habitats within nationally designated or recognized areas; habitats of significant importance to species which are Vulnerable (VU), Near Threatened (NT), or Data Deficient (DD) on the IUCN Red List or the RDB; habitats of significant importance for nationally restricted range species; habitats supporting nationally significant concentrations of migratory species and/ or congregatory species; and low value habitats used by species of medium value.
High	Habitats within internationally designated or recognized areas; habitats of significant importance to species which are globally Critically Endangered (CR) or Endangered (EN) on the IUCN Red List or the RDB; habitats of significant importance to endemic and/ or globally restricted-range species; habitats supporting globally significant concentrations of migratory species and/or congregatory species; highly threatened and/or unique ecosystems; habitats including areas associated with key evolutionary species; and low or medium value habitats used by high value species

<sup>14</sup> Value Definitions follow the ERM IA Standard, Annex B-9 ERM Biodiversity Standard and take into account IFC PS6 and guidance such as the BBOP Standard and accompanying materials,

<sup>15</sup> IUCN (2014) *IUCN Red List of Threatened Species™ 2014.3*. Available at [www.iucnredlist.org](http://www.iucnredlist.org)

<sup>16</sup> Davison GWH, Ng PKL and Ho HC. (2008) *Singapore Red Data Book*.

Table 7.3 summarizes how species are evaluated against set criteria.

**Table 7.3: Summary of Species' Sensitivity Value Definitions<sup>17</sup>**

Value	Definition Summary
Negligible	Species with no specific value or importance attached to them.
Low	Species: <ul style="list-style-type: none"> <li>• of LC on the IUCN Red List;</li> <li>• of LC in the <i>Singapore Red Data Book 2008</i> (RDB 2008)<sup>18</sup>; or</li> <li>• not meeting criteria for medium or high value.</li> </ul>
Medium	Species on IUCN Red List as VU, NT, or DD; <ul style="list-style-type: none"> <li>• protected under national legislation;</li> <li>• on RDB 2008 as VU, NT or DD;</li> <li>• nationally restricted range species, nationally important numbers of migratory or congregatory species;</li> <li>• not meeting criteria for high value; or</li> <li>• species vital to the survival of a medium value species.</li> </ul>
High	Species on IUCN Red list as CR or EN; <ul style="list-style-type: none"> <li>• on RDB 2008 as CR or EN;</li> <li>• having a globally restricted range (ie plants endemic to a site, or found globally at fewer than 10 sites, fauna having a distribution range (or globally breeding range for bird species) less than 50,000 km<sup>2</sup>);</li> <li>• internationally important numbers of migratory, or congregatory species;</li> <li>• key evolutionary species; or</li> <li>• vital to the survival of a high value species.</li> </ul>

## 7.5 RESULTS OF SECONDARY DATA REVIEW & PRIMARY BASELINE SURVEYS

Secondary data review and primary data gathering has been undertaken, including tailored surveys within the Study Area focusing on the habitats and vegetation for a suite of terrestrial vertebrate fauna, as well as specifically targeting avifauna, herpetofauna, butterflies and odonates, and the aquatic community. Full details of all field survey methodology are presented in *Annex 7.0*.

There is considerable literature regarding the biodiversity of the whole CCNR, with some studies focusing specifically on the Study Area around the MacRitchie Reservoir. When reviewing secondary data, care has been taken to try and ensure it is directly applicable to the Study Area rather than, for example, other areas of the CCNR. The following subsections detail the findings of the secondary data review as well as the primary baseline surveys undertaken to date for key taxa groups within the Study Area. Photographs of these groups are presented in *Annex 2.0*.

<sup>17</sup> Value Definitions follow the ERM IA Standard, Annex B-9 ERM Biodiversity Standard and take into account IFC PS6 and guidance such as the BBOP Standard and accompanying materials,

<sup>18</sup> Davison GWH, Ng PKL and Ho HC. (2008) *Singapore Red Data Book*.



### 7.5.1 Habitats and Vegetation

#### Secondary Data Review

The habitats and vegetation of the nature reserves have been mapped on a number of occasions by Wee (1964)<sup>19</sup>, Hill (1977)<sup>20</sup>, Wong *et al* (1994)<sup>21</sup>, Corlett (1997)<sup>22</sup> and Yee *et al* (2011)<sup>23</sup> and there have been various classifications of the forest types. The CRL WG Report (2014)<sup>24</sup> reviewed data on the habitat classification of the CCNR and supplemented it with casual field observations. The report largely adopted Wong *et al* (1994)'s classification of habitats in the area but introduced two additional classifications – wetland forest and wetland marsh. Classification of habitat types has been changing over time and *Table 7.4* summarizes the classification of habitat types in the CCNR by the various authors. The habitat map derived from the present baseline surveys is based on the most updated classification.

All the various classifications of habitat within the Study Area over time have been based on floristic surveys and analysis of structural elements derived from aerial photographs. It is believed that the best classification of vegetation/ habitats should be based primarily on information derived from floristic surveys. Therefore, further investigation has been made to supplement the floristic data reported in the literature to date, to allow the most accurate classification of habitats, as described in the following section.

Regarding vegetation, the first Singapore plant list was produced in the early 1900s and various updates have been made to date. In 1994, Turner<sup>25</sup> estimated that there were 1,196 forest vascular plants with more than 700 from the NSSF. Corlett (1997)<sup>26</sup> subsequently reported that there were 2,323 native species in Singapore including rediscoveries of some forest vascular plants that were previously thought to be extinct. The most recent checklist of the vascular flora of Singapore in 2009<sup>27</sup> lists a total of 4,180 native, naturalized and cultivated flora species from 1,580 genera, 243 families and six phyla (*Lycophyta*, *Filicinophyta*, *Cycadophyta*, *Pinophyta*, *Gnetophyta*, and *Magnoliophyta*). Of these, 2,145 species (51.3%) are native and 1,826 (43.7%) are exotic. The angiosperms (*Magnoliophyta*) are the dominant phylum, followed by ferns and fern allies (*Filicinophyta* and *Lycophyta*) and gymnosperms (*Pinophyta*, *Cycadophyta* and *Gnetophyta*). Specifically for vegetation within the Study Area, the most recent findings are from CRL WG Report (2014), which lists 315 different tree species within the MacRitchie Forest area compiled from tree survey data available from plots located within the MacRitchie Forest in addition to casual sightings (*Annex 8A*). Of these many trees are of conservation interest with 104 listed as nationally CR and 136 as either nationally EN or VU.

<sup>19</sup> Wee YC (1964) **A note on the vegetation of Singapore island**. *Malayan Forester* 27: 257-266

<sup>20</sup> Hill RD (1977) **The vegetation map of Singapore: A first approximation**. *Journal Tropical Geography*. 45: 26-33.

<sup>21</sup> Wong YK, Chew PT, Ibrahim AB (1994) **The Tree Communities of the Central Catchment Nature Reserve, Singapore** *The Gardens' Bulletin Singapore* 46:37-78

<sup>22</sup> Corlett RT (1997) **The Vegetation in the Nature Reserves of Singapore** *Gardens' Bulletin Singapore* 49: 147-159

<sup>23</sup> Yee ATK, Corlett RT, Liew S C, Tan HTW (2011) **The vegetation of Singapore – an updated map** *Gardens' Bulletin Singapore* 63(1&2): 205-212

<sup>24</sup> Cheong LF, Chua MAH, D'Rozario V, Jamal F, Khoo SK, Koh JKH, Lim KKP, O'Dempsey T and Rajathurai S (2014) **Cross Island Line Working Group Report**

<sup>25</sup> Turner IM, Tan HTW, Chua KS & Metcalfe DJ (1994) **Recent Botanical Collections from the Nature Reserves Singapore**. *The Gardens' Bulletin Singapore* 46: 1-36

<sup>26</sup> Corlett RT (1997) **The Vegetation in the Nature Reserves of Singapore** *Gardens' Bulletin Singapore* 49: 147-159

<sup>27</sup> Chong KY, Tan HTW, Corlett RT (2009) **A checklist of the Total Vascular Plant Flora of Singapore – Native, Naturalised and Cultivated Species**. *Raffles Museum of Biodiversity Research, National University of Singapore*

Regarding areas adjacent to but outside the CCNR and within the Study Area, Neo *et al* (2014)<sup>28</sup> published a checklist of vascular plant species for the Windsor Interim Green area (location indicated in Figure 7.1), sampling from the abandoned rubber plantation region of this area. A total of 311 species from 97 families were recorded from their surveys, of which 276 were native, 30 exotic, four cryptogenic, and one not yet assessed. Of the native species recorded, 60% are nationally threatened<sup>29</sup> with 57 nationally CR (three of which are likely to have persisted from cultivation rather than being from wild, native, genetic provenance), 49 nationally EN, and 75 nationally VU. A high occurrence of nationally CR species was recorded closer to the MacRitchie Trail in particular (ie near the old growth forest of MacRitchie Reservoir Park) with an abundance of dipterocarp saplings. Among the measured woody stems, Pará rubber (*Hevea brasiliensis*) was found to occur most frequently on average despite the abandonment of rubber plantations here about 40 years prior. Despite this the majority of plant species recorded in this study are native (89% of species recorded). Given these findings, the authors suggest that Windsor Interim Green is likely to be important as a refuge for many nationally threatened species and as a buffer to the CCNR.

<sup>28</sup> Neo L, Yee ATK, Chong KY, Yeoh YS, Tan HTW (2014) **The Vascular Plant Flora of Abandoned Plantations in Singapore IV: Windsor Forest**. Nature in Singapore 2014 7: 93-019

<sup>29</sup> Conservation status and nomenclature in their paper follows Chong *et al* (2009) (see reference above) with some 'updates based on our observations'

**Table 7.4: Classification of Forest Types from Secondary Data Review**

Author	Vegetation Types	Description
Wee (1964)	High forest (Found only in Bukit Timah)	Found only in Bukit Timah
	Regenerating high forest	-
	Regenerating swamp forest	-
	<i>Belukar tua</i>	Old secondary forest
	<i>Belukar muda</i>	Young secondary forest, shrubland, grassland and fernland
Hill (1977)	Lowland rain forest	-
	Freshwater swamp forest	-
	Tall secondary forest	Comprises trees with crowns mainly more than 10 m high.
	Low secondary forest	Comprises trees with crowns mainly 10 m high.
	Grass and scrub	This vegetation type includes <i>Dicranopteris</i> fernlands.
Wong <i>et al</i> (1994) <sup>Note 1</sup>	Type 1	Early successional vegetation with only scattered trees.
	Type 2	Consisting of several small-crowned trees 8-15 m tall.
	Type 3	Consisting of several taller, larger-crowned trees.
	Type 4	Consisting of some very large trees.
Corlett (1997) <sup>Note 2</sup>	Dryland primary forest	This is distinguished by the presence of huge individual trees, including dipterocarps. Corlett argues that given forest regeneration over a century or more since the patchwork created by the gambier cultivations has largely obscured distinctions between lightly cleared and heavily cleared areas, it is simplest and most informative to refer to these forest areas as 'primary forest' ie forest that has never been completely cleared, since the continuity of forest at these locations results in a richer flora than the secondary forests. Members of the Dipterocarpaceae (Anisoptera, Dipterocarpus, Hopea, Shorea) are dominant among the large trees and other prominent large tree species include members of the Burseraceae, <i>Adenanthera bicolor</i> (Leguminosae), <i>Dyera costulata</i> (Apocynaceae), <i>Gluta wallichii</i> (Anacardiaceae), <i>Ixonanthes icosandra</i> (Ixonanthaceae), <i>Koompassia malaccensis</i> (Leguminosae), and <i>Mangifera griffithii</i> (Anacardiaceae). The major families of smaller trees and shrubs are the Annonaceae, Euphorbiaceae, Lauraceae, Myrtaceae and Rubiaceae. Rattans are abundant in some of the primary forest patches and the other major families of large, woody climbers are the Rubiaceae ( <i>Uncaria</i> ), Annonaceae ( <i>Artabotrys</i> , <i>Fissistigma</i> ), Apocynaceae ( <i>Leuconotis</i> , <i>Willughbeia</i> ), Leguminosae ( <i>Dalbergia</i> , <i>Derris</i> , <i>Entada</i> , <i>Spatholobus</i> ) and Connaraceae ( <i>Rourea</i> ). Ferns and several families of monocotyledons dominate the herb flora but since herb diversity is low in Singapore's forests, it does not strongly differentiate habitat types.
	Primary freshwater swamp forest	Found only in the NSSF and therefore not detailed here



Author	Vegetation Types	Description
	Secondary forest	This is the most extensive vegetation type with a floristic continuum, even though different types of secondary forest may appear distinct on the ground and in aerial photographs. These stages of floristic continuum may be either due to the degree of site degradation (eg causing dense herbaceous ground cover and inhibiting tree growth) or 'time after abandonment' of cultivation and in some areas where fires have had an influence. The structural and floristic classifications of this vegetation type are not clear but it is argued that it can be arranged along a succession gradient, whether or not this represents time since initiation of succession. <i>Rhodomania cinerea</i> (Myrtaceae) is present and often dominant at all sites but other components are variable – at one extreme there are light-demanding pioneers such as <i>Adinandra dumosa</i> (Theaceae) and <i>Macaranga conifer</i> (Euphorbiaceae) reaching 8 to 15m canopy height, while at the other extreme these more light-demanding species have been eliminated and the forest is dominated by species of the families Myrtaceae, Buttiferae ( <i>Calophyllum</i> spp., <i>Garcinia</i> spp.) and Lauraceae ( <i>Litsea</i> spp.) as well as <i>Camposperma auriculatum</i> (Anacardiaceae), <i>Elaeocarpus</i> spp. (Elaeocarpaceae), <i>Gynotroches axillaris</i> (Rhizophoraceae), <i>Ixonanthes reticulata</i> (Ixonanthaceae) and <i>Timonius wallichianus</i> (Rubiaceae), reaching 15 to 25m canopy height.
	Non-forest vegetation	These are areas where exotic grasses and legumes dominate on the fringes of abandoned areas, and native grasses and Resam fern ( <i>Dicranopteris linearis</i> ) cover most of the open areas in the interior. These non-forest vegetated areas also contain shrubland dominated by <i>Melastoma malabathricum</i> (Melastomataceae), <i>Dillenia suffruticosa</i> (Dilleniaceae), <i>Adinandra dumosa</i> (Theaceae) and <i>Macaranga heynei</i> (Euphorbiaceae).
Yee <i>et al</i> (2011) <sup>Note 2</sup>	Primary forest	No details were provided on the floristic composition of each vegetation type.
	Old secondary forest	
	Young secondary forest	
	Freshwater swamp forest	
	Non-forested area	
CRL WG Report (2014)	Primary Forest	This class represents the species rich, dry lowland and coastal hill dipterocarp forest that covered much of the island prior to development beginning in the early 19th century. Typically it has never been subject to any agricultural activities but could have been previously logged or exploited for firewood during the 19th century, resulting in it being devoid of the large emergent trees associate with primeval forests. The continuity of forest occurrence on these sites contains a richer flora than even the oldest regrowth forests.
	Regrowth Forest A	This forest type is typically 100-150 year old regrowth forest most of which has reasonably diverse species makeup and with fully grown trees. The variety of mature seasonally fruiting trees in these communities provides a persistent habitat for native fauna. It is thought that these forests now occur in areas associated with gambier and pepper plantations during the early 19th century.
	Regrowth Forest B	This is species poor forest, typically Tiup Tiup ( <i>Adinandra dumosa</i> ), Cicada Tree ( <i>Ploarium alternifolia</i> ) and Silverback ( <i>Rodamnia cinerea</i> ) and a limited number of other hardy species ( <i>Macaranga</i> sp. and <i>Elaeocarpus</i> sp.) that are able to grow on poor soils. It is thought that these forests are the result of recent agriculture and or denuded soils resulting from earlier intensive agricultural practices.

Author	Vegetation Types	Description
	Resam	Some areas of the reserves are covered in Resam Fern ( <i>Dicranopteris linearis</i> ) as a result of intensive agriculture involving Tapioca and Liberian coffee plantations dating from the latter part of the 19th century. Sparse tree population indicated these areas are in early successional stage. It is thought that these areas do not represent normal regeneration and it is hoped that over time these may be reforested.
	Wetland Forest (Freshwater Swamp Forest)	Wetland Forest is a distinct habitat that is either permanently or occasionally inundated and is typically found in the flat alluvial plains of Singapore's drainage system. The species found in these forests are restricted to those that can thrive in these conditions. It is thought that some 600 species or approximately 30% of flora can be found in wetland forests with 400 species shared with the dry land forest, and an estimated 200 species that are endemic to the wetland habit. Some of the wetland species have special adaptations to this unique habitat featuring one or more adaptations such as floating fruits, complex stilt roots or plank buttresses for stability in the soft ground, and pneumatophore roots for gas exchange in stagnant and waterlogged soils. The largest contiguous area of wetland forest is found inside the CCNR and is generally known as the Nee Soon Freshwater Swamp Forest. There are also small remnant patches of swamp forest within the streams in the vicinity of the edges of the reservoirs, including in the CCNR. Outside the CCNR, most wetland forest had been converted for seasonal crops during the 19th and early part of the 20th centuries. Urbanization and associated canalization have further obliterated almost all of the remaining wetland forests outside the nature reserves.
	Wetland Marsh (Former Freshwater Swamp Forest)	The most significant wetland marsh occurs at the head of the MacRitchie reservoir. This area is thought to have been previously forested (as wetland forest) however cleared and channeled as a result of the Kalang Tunnel project in the late 1800's. The backlog of water from the head of the MacRitchie reservoir is also thought to have limited the succession of forest plants resulting in replacement with grasses and sedges more suited to the permanently inundated area.

**Notes:**

- <sup>(1)</sup> Wong *et al* (1994) used 1990 aerial photographs to delineate four forest vegetation types in the CCNR based on the structure of the forest. Ground truthing was subsequently conducted by means of plot sampling in each forest vegetation type.
- <sup>(2)</sup> Yee *et al* (2011) classified vegetation types based on visual inspection of satellite images of the BTNR and CCNR between 2003-2008, contour maps, and the previous works of Corlett (1997) and Turner (1996)<sup>30</sup>.

<sup>30</sup> Turner IM, Boo CM, Wong YK, Chew PT & Ali I (1996) Freshwater swamp forest in Singapore, with particular reference to that found around the Nee Soon Firing Ranges. Gardens Bulletin Singapore 48: 129–157

### Findings of Primary Baseline Data

The descriptions from the CRL WG Report (2014)<sup>31</sup> were adopted as a starting point for the habitat mapping and vegetation surveys; these descriptions were then reviewed using the full results of the vegetation surveys undertaken. Overall 218 tree species from all sampling plots have been recorded in the Study Area to date, dominated by *Calophyllum* spp., *Rhodamnia cinerea* and *Camptosperma* spp. Over 390 species have been recorded from transect surveys in the Study Area, although a number of species identification has not been confirmed. Full lists of flora recorded during transect and plot surveys are presented in *Annex 8H* and *8I*. *Table 7.5* indicates the number of tree species recorded within different habitats from these surveys.

**Table 7.5: Number of Trees within Sampling Plots of Different Habitats**

Habitat Type	No. of Families	No. of Genera	No. of Species	No. of Trees
Primary forest	35	71	127	282
Regrowth Forest A	40	65	94	261
Regrowth Forest B	27	38	57	189
Wetland Forest	20	24	31	161
Wetland Marsh	23	29	43	268
			<b>Total</b>	<b>1,161</b>

Based on the results from the primary baseline surveys, habitats were defined along with their vegetation classification and summary descriptions of each habitat are provided in *Table 7.6*. In addition, focused surveys along the indicative corridors 1 and 2 provided more detailed vegetation data as presented in *Annex 8I-2*. Along the Sime Trail, the most abundant tree species include mostly native, cultivated species such as *Camptosperma auriculata*, *Macaranga gigantea* and Tembusu (*Fagraea fragrans*) but also *Ficus aurata* (VU/RDB). The most abundant shrubs along this trail included *Dillenia suffruticosa* and the cultivated *Clidemia hirta* and climbers include *Smilax setosa*. A number of species identified of being of conservation interest along this trail were actually cultivated (eg the tree *Nephelium lappaceum* [CR/RDB], shrub *Oncosperma tigillaria* [VU/RDB]) but an estimated 14 species considered of conservation interest were recorded (See *Annex 8I-2*). Similarly along the Terentang Trail an estimated eight species of conservation interest were recorded including the trees *Alchornea villosa* (CR/RDB) and *Cratoxylum arborescens* (VU/RDB) and a threatened *Molineria* herb species. Along the Kalang Service Reservoir Road just two non-cultivated species of conservation interest were recorded, the tree *Gymnacranthera forbesii* (CR/RDB) and *Syzygium incarnatum* (EN/RDB), and along the Venus Trail Link just four such species were recorded (native trees *Alangium javanicum*, *Gironniera parvifolia*, *Gymnacranthera forbesii* and *Norrisia maior*).

<sup>31</sup> Cheong LF, Chua MAH, D'Rozario V, Jamal F, Khoon SK, Koh JKH, Lim KKP, O'Dempsey T and Rajathurai S (2014) **Cross Island Line Working Group Report**



Along Alignment Option 2 near the PIE and Lornie Road, the most abundant species included mainly cultivated, native tree species such as *Cinnamomum iners*, *Cratoxylum formosum*, *Macaranga gigantea* and *Syzygium campulatum*, as well as *Ficus lamponga* (CR/RDB). The most abundant shrubs along this trail included *Dillenia suffruticosa* and the cultivated *Melastoma malabathricum* and the climber *Tetracera indica* was also very common. A number of species identified of being of conservation interest in this area were actually cultivated but an estimated seven species considered of conservation interest including *Cyrtosperma merkusii* (VU/RDB), *Ficus aurata* (VU/RDB), *Ficus lamponga* (CR/RDB), *Peltophorum pterocarpum* (CR/RDB), *Pentace triptera* (EN/RDB), *Archidendron jiringa* (VU/RDB), *Santiria tomentosa* (EN/RDB), were recorded (See Annex 8I-2). Near Venus Drive however the native tree *Cerbera odollam* (VU/RDB) that was recorded was considered cultivated.

In close consultations with the EF Consultant the vegetation surveys also focused on proposed BH locations along Alignment Option 1 within and in the vicinity of the CCNR and these baseline data for each proposed borehole location are presented in Annex 9 (along with key fauna data).

Streams in the Study Area that were previously mapped by Murphy (1997)<sup>32</sup> were also ground-truthed as part of a stream verification exercise. Features and locations of each of the key accessible stream types are detailed in Annex 3B. Figure 7.2 presents the updated habitat map, including streams.

<sup>32</sup> Murphy DH (1997) *Odonata Biodiversity in the Nature Reserves of Singapore*. Proceedings of the Nature Reserves Survey Seminar. Gardens' Bulletin Singapore 49. 333-352

**Table 7.6: Habitat and Vegetation Classification with Descriptions**

Classification	Description
Primary Forest	<p>The canopy cover of this species rich dipterocarp forest was found to be approximately 100%, with emergent trees having DBH<sup>33</sup> 60-90 cm and reaching 40 to 50 m high. Primary species included <i>Shorea</i> spp. (<i>S. gratissima</i> and <i>S. pauciflora</i> are listed as EN while <i>S. curtisii</i> as VU by IUCN Red List (2015.02)), the nationally EN <i>Koompassia malaccensis</i> and CR <i>Dipterocarpus grandifloras</i>. Tree fall gaps where the canopy cover was 90-95% were occupied by more light-demanding pioneer species including <i>Campnosperma auriculatum</i>, <i>Dillenia suffruticosa</i>, <i>Rhodamia cinerea</i>, <i>Macaranga gigantea</i> and <i>Artocarpus</i> spp.</p> <p>Primary forest along MacRitchie Trail (McR02 in Figure A-3 of Annex 7.0) was considered the most pristine area of this forest type. It was densely stocked with a high diversity of large dipterocarp emergent trees. Species observed were <i>Shorea curtisii</i> (the Heritage Tree, Seraya), <i>S. pauciflora</i>, <i>S. gibbosa</i>, <i>S. ovalis</i>, <i>Dipterocarpus apterus</i> and the internationally VU <i>Hopea griffithii</i>, with a DBH of more than 60 cm and reaching 50 m tall. Size of some non-dipterocarps, like <i>Aquilaria malaccensis</i> (internationally VU), <i>K. malaccensis</i> and <i>Campnosperma squamatum</i> were also large, with a DBH 50-60 cm. Forest patches approaching the Shinto Shrine (OT2, OT4, OT6 in Figure A3 of Annex 7.0) were well represented by various emerging <i>Shorea</i> spp. with a 100% canopy cover. Other common species included <i>Lithocarpus ewyckii</i>, <i>Dyera costulata</i> and <i>Pentace triptera</i>.</p> <p>The transect MRPT02 (see Figure A-3 of Annex 7.0) itself appeared to be in an area of secondary forest at the edge of a forested area, adjacent to McRitchie Reservoir. However a further 10 m into the forest from observation showed that it was primary forest. Species of <i>Brackenridgea hookeri</i>, <i>Carallia brachiata</i> and <i>Rhodamnia cinerea</i> are common along the 5 m edge.</p> <p>Lornie Trail also contained this forest type, dominated by <i>Dipterocarpus</i> spp. and <i>Shorea</i> spp., with some emergent trees (<i>Shorea</i> spp., <i>D. costulata</i>, <i>Sindora leiocarpa</i> and <i>K. malaccensis</i>) having a DBH 70-90 cm and 40-45 m in height. The forest edge along the MacRitchie Reservoir was more open with a canopy cover of 50-70% and the number of <i>Shorea</i> spp. reduced.</p>
Regeneration Forest A	<p>Most of the surveyed transects fell within this forest type, which was usually found to be a mix of long-lived and short-lived secondary species. Dipterocarps were not recorded here, except a few individuals which presented along transect MRPT01 and CL03 (see Figure A-3 of Annex 7.0). Canopy coverage was still high as 90-100%. Long-lived secondary species comprised of <i>Campnosperma auriculatum</i>, <i>Alstonia angustifolia</i>, the nationally VU <i>A. spatulata</i>, <i>Pternandra echinata</i> and <i>Cratoxylum arborescens</i>; while short-lived secondary species, including <i>Macaranga gigantea</i>, <i>Rhodamia cinerea</i> and <i>Dillenia suffruticosa</i>, were confined to more open areas.</p> <p>Some patches were old enough to embrace primary species, including IUCN CR species <i>Shorea platycarpa</i>, <i>Aquilaria malaccensis</i>, <i>Litsea elliptica</i>, <i>Dialium platysepalum</i>, <i>Xanthophyllum affine</i>, <i>Lophopetalum multinervium</i> and <i>Lithocarpus sundaicus</i>. Over time, these species can grow up to 90 cm at DBH and 45 m tall as emergent trees.</p> <p>Transect ST03 (see Figure A-3 of Annex 7.0) was within the Wetland Marsh area but bordering Regeneration Forest A and was actually located on dry land. Secondary species of <i>Ficus lamponga</i>, <i>Dillenia suffruticosa</i>, <i>Macaranga gigantea</i> and <i>Symplocos rubiginosa</i> and the primary species, <i>Litsea elliptica</i>, were common in these areas.</p> <p>Transects in Venus Link (VL, see Figure A-3 of Annex 7.0) are part of a former rubber tree (<i>Hevea brasiliensis</i>) plantation<sup>34, 35</sup>. Besides rubber trees, the areas were dominated by cultivated crops such as <i>Nephelium lappaceum</i>, <i>Durio zibethinus</i>, <i>Cocos nucifera</i>, <i>Elaeis guineensis</i>, <i>Areca catechu</i>, <i>Musa</i> spp., <i>Daemocarpus longan</i>, <i>Lansium domesticum</i> and <i>Artocarpus heterophyllus</i>. The crops were intermixed with pioneer species like <i>Rhodamia cinerea</i>, <i>Campnosperma</i> spp., <i>Macaranga</i> spp. Canopy closure was about 90-100%.</p>

<sup>33</sup> DBH – Diameter at Breast Height

<sup>34</sup> Cheong LF, Chua MAH, D'Rozario V, Jamal F, Khoo SK, Koh JKH, Lim KKP, O'Dempsey T and Rajathurai S (2014) **Cross Island Line Working Group Report**

Classification	Description
	Resam Fern ( <i>Dicranopteris linearis</i> ) was also scattered in some areas of this habitat.
Regeneration Forest B	<p>Secondary forest with a mixture of ornamental plants and pioneer species. Canopy closure was between 50-70%. There was an abundance of <i>Caryota mitis</i>, <i>Cinnamomum iners</i>, <i>Syzygium cerinum</i>, and <i>Rhodamia cinerea</i> trees and it also included plenty of <i>Albizia falcataria</i>, <i>Cratoxylum formosum</i>, <i>Pometia pinnata</i>, <i>Alangium nobile</i>, <i>Pternandra echinata</i> and <i>Brackenridgea hookeri</i> trees.</p> <p>Resam Fern (<i>Dicranopteris linearis</i>) was also scattered in some areas of this habitat.</p>
Wetland Forest	<p>Flora surviving in this habitat type need to adapt to permanent or seasonal flooding and waterlogged soil. Therefore species diversity recorded here were not as high as other forest types described previously but had a more specific community, with Elaeocarpaceae and Rhizophoraceae having the highest abundance. Most Families were represented by one species only with the top three families (Apocynaceae, Myrtaceae and Phyllanthaceae) represented by three species.</p> <p>Dominant species included <i>Camposperma squamatum</i> and <i>Elaeocarpus floribundus</i>; and typical wetland flora like <i>Ilex cymosa</i>, <i>Cratoxylum arborescens</i> and <i>Pellacalyx axillaris</i>.</p>
Wetland Marsh	<p>Most of the species recorded are typical of seasonal wetland flora with small-sized trees. Some can be classified as tree shrubs, for instance <i>Dillenia suffruticosa</i> and <i>Ploiarium alternifolium</i> which commonly occurred in open places and alluvial soils.</p> <p>Elaeocarpaceae and Euphorbiaceae were found to be the major families in Wetland Marsh represented by four species each. Rhizophoraceae and Dilleniaceae were recorded in the highest abundance in the plots. Other abundant Families included Lauraceae, Phyllanthaceae and Bonnetiaceae. The dominant species were <i>Gynotroches axillaris</i>, <i>Ilex cymosa</i>, <i>Alstonia angustifolia</i>, <i>D. suffruticosa</i> and <i>P. alternifolium</i>.</p> <p>Resam Fern (<i>Dicranopteris linearis</i>) was also scattered in some areas of this habitat.</p>
Streams	These included Concrete Canals, which were typically found upstream and served to channel water quickly from upstream reservoirs (eg Upper Peirce Reservoir); Rural Streams (all found at the Windsor Interim Green); Forest Streams (observed to be well-shaded, single channel streams); Wetland Forest Streams (relatively flat, low flow gradient streams with muddy substrates which were found in Wetland Forest, experiencing occasional floods when flow volume is high and functioning as habitat for the nationally CR aquatic aroid, <i>Cryptocoryne griffithii</i> ); and Wetland marsh streams (found in Wetland Marsh – areas with relatively flat environments with low flow gradients and similarly to Wetland Forest Streams, experiencing occasional floods when flow volume is high). Features and locations of each stream type are detailed in <i>Annex 3B</i> .
Reservoir	This habitat represents the largest water body in the Study Area, surrounded by various terrestrial habitats described in this table. Water depth ranges from 5-10 m <sup>36</sup> . Streams, many of which feed into the reservoir, have been marked separately on the habitat map ( <i>Figure 7.2</i> ).

<sup>35</sup> Neo L, Yee ATK, Chong KY, Yeoh YS and Tan HTW (2014) **The Vascular Plant Flora of Abandoned Plantations in Singapore IV: Windsor Forest**. Nature in Singapore 7: 93–109

<sup>36</sup> Hendrich L, Balke M, Yang CM (2004) **Aquatic Coleoptera of Singapore: Species richness, ecology and conservation**. The Raffles Bulletin of Zoology 52(1): 97-145



Classification	Description
Isolated Forest	This habitat represents the main clusters of trees within Singapore Island and Bukit Golf Course as well as Regeneration Forest areas which have been disconnected from the main CCNR area by the Pan-Island Expressway and Lornie Road. This includes part of the forest of Bukit Brown Cemetery (see <i>Figure 7.1</i> ) within the Study Area. The construction of a new road within Bukit Brown Cemetery as part of the road system upgrade, will result in the fragmentation of the existing tree conservation area <sup>37</sup> . Locations of tree conservation areas are shown in <i>Figure A-1 of Annex 7.0</i> .
Golf Course/ Recreational Facilities	This habitat type includes mainly non-forested areas under intensive horticultural maintenance and represents the golf courses and some park areas. Scattered individuals of exotic, ornamental plants and pioneer species were found on grassland or the edge of reservoirs in this habitat. Recorded flora was dominated by <i>Fagraea fragrans</i> , <i>Calophyllum innophyllum</i> , <i>Cinnamomum iners</i> and <i>Payena lucida</i> . A number of small rain-fed, landscaped, ornamental ponds, as well as other less managed rain-fed small ponds, were also found in golf course areas of this habitat.
Developed Area	Buildings, developed and densely populated areas within the Study Area, typically outside the CCNR boundary, except the Bukit Kalang Service Reservoir. A variety of ornamental plants can be commonly found within these areas.

<sup>37</sup> LTA (2014) Outer Ring Road System. Retrieved from <http://www.lta.gov.sg/content/ltaweb/en/roads-and-motoring/projects/outer-ring-road-system.html>

### Overall Evaluation of Habitats & Vegetation

Primary Forest, Regeneration Forest, Wetland Forest and the Wetland Marsh are ecologically important due to their type diversity and connectivity. Primary Forest contained a high diversity of climax species, including dipterocarps and although species composition indicates that these areas are remnants of forest that has undergone selective or low intensity logging, it contains a better forest structure and higher canopy cover than other habitat types.

Regeneration Forest is undergoing succession from typical secondary species towards mature, old growth forest after different levels of agricultural activities more than a century ago.

Wetland Forest and the Wetland Marsh contain specific flora communities adapted to permanent or seasonal flooding and waterlogged soil. These areas act as important niche habitats for wildlife.

Golf Course/ Recreational Facilities support lower flora diversity, mainly acting as green corridors connecting forest patches, especially the one north of Lornie Road. Wildlife that is relatively tolerant to disturbance can disperse across different habitats through these areas.

Isolated Forests are utilized by fewer wildlife species due to their smaller size and fragmented nature, and are often surrounded by roads and heavy traffic. The forest quality in this habitat can be high, however, such as the tree conservation area within Bukit Brown Cemetery. Avifauna with high mobility is less affected than other terrestrial wildlife when crossing these areas.

Developed Area is of low ecological value as it is highly populated by humans and has undergone intensive disturbance.

All types of forest, wetland marsh, streams and the MacRitchie reservoir are within the NPark's Managed Area, with the exception of some patches of Regeneration Forest A at the edge. Conversely Isolated Forest, Golf Course/ Recreational Facilities and Developed Area (except the Bukit Kalang Service Reservoir) are all located outside the NParks' Managed Area (See *Figure 7.2*). Sensitivity values of these habitats were given in *Table 7.7* and *Table 7.8*.

**Table 7.7: Sensitivity Value of Different Habitats within NParks' Managed Area**

Habitat	Description	Sensitivity Value
Primary Forest	These habitats were found important/ significant for various species of flora and fauna, in particular globally Critically Endangered (CR) or Endangered (EN) on the IUCN Red List or the Singapore RDB. All of the habitats identified within NPark's Managed Area are ecologically linked, and therefore their sensitivities are considered together a whole with High Sensitivity Value.	High
Regeneration Forest A		High
Regeneration Forest B		High
Wetland Forest		High
Wetland Marsh		High
Streams		High
Reservoir		High

**Table 7.8: Sensitivity Value of Different Habitats outside NParks' Managed Area**

Habitat	Description	Sensitivity Value
Regeneration Forest A	Some patches of this habitat type are located outside NPark's Managed Area. Most of these patches are influenced by edge effects due to the highway or heavy traffic on roads or high usage of the adjacent golf courses. Less wildlife and species of conservation interest were found utilizing these areas. It should be noted that these areas were still considered as part of the habitats of significant importance for nationally restricted range species, with mostly avifauna flying over.	Medium
Regeneration Forest A – largely continuous with CCNR Regeneration Forest A	One particular patches of this habitat type which is outside NPark's Managed Area, is only separated by trail from the managed area and is therefore still ecologically linked to the large continuous forest within the NPark's Managed area (demarcated by black dotted boundary in <i>Figure 7.2</i> ). In addition there is anecdotal evidence of Sunda Pangolins ( <i>Manis javanica</i> ) (CR/RDB; CR/IUCN; CITES-II) using the nearby Bukit Golf course to forage in the evenings, suggesting that this area of Regeneration Forest A may be part of their daytime range.	High
Isolated Forest	Fragmented habitat of medium quality and used by common species. Some located within nationally designated or recognized areas such as the Tree Conservation Area in Bukit Brown Cemetery.	Medium
Golf Course/ Recreational Facilities	Low value habitats of significant importance for nationally restricted range species. This habitat type mainly acts as a green buffer/ corridor connecting forests.	Medium
Developed Area	Disturbed habitats with minimal interest for biodiversity overall.	Low

## 7.5.2 Avifauna

### Review of Secondary Avifauna Data in Singapore

A total of 439 bird species have been recorded in Singapore although 70 of these have not been observed in the last fifty years<sup>38</sup>. A total of 376 bird species are listed by NParks on the official Bird List for Singapore<sup>39</sup> but of these, 11 species have been recorded only 3 or less times in the past 50 years in Singapore. Lim (2009)<sup>40</sup> lists a total of 369 extant species in Singapore, of which 24 are introduced, mainly via the caged bird trade, a further 146 species are either resident to and/or breed in Singapore while the remaining 199 species are migrants. Of these 199 migrants, 115 are winter visitors, 32 are passage migrants and 33 are accidentals; breeding records of the remaining 19 migrant species have not been confirmed<sup>41</sup>. Detailed information on microhabitat, reproductive and feeding ecology is lacking for most bird species, with available literature mainly focused on bird distribution and conservation status.

<sup>38</sup> Lim K S (2009) *The Avifauna of Singapore*. K.S. Lim. Nature Society (Singapore), pp. 611.

<sup>39</sup> National Park Board (2015) *Bird List for the Species of Singapore*. Retrieved from <https://www.nparks.gov.sg/biodiversity/wildlife-in-singapore/species-list/bird>  
Compiled from a) Lim K S (2007) *Pocket checklist of the birds of the Republic of Singapore*. Nature Society (Singapore), b) Wang, L.K. & Hails, C. (2007) *An annotated checklist of the birds of Singapore*. Raffles Bulletin of Zoology Supplement 15.

<sup>40</sup> Lim K S (2009) *The Avifauna of Singapore*. K.S. Lim. Nature Society (Singapore), pp. 611.

<sup>41</sup> Lim K S (2009) *The Avifauna of Singapore*. K.S. Lim. Nature Society (Singapore), pp. 611.



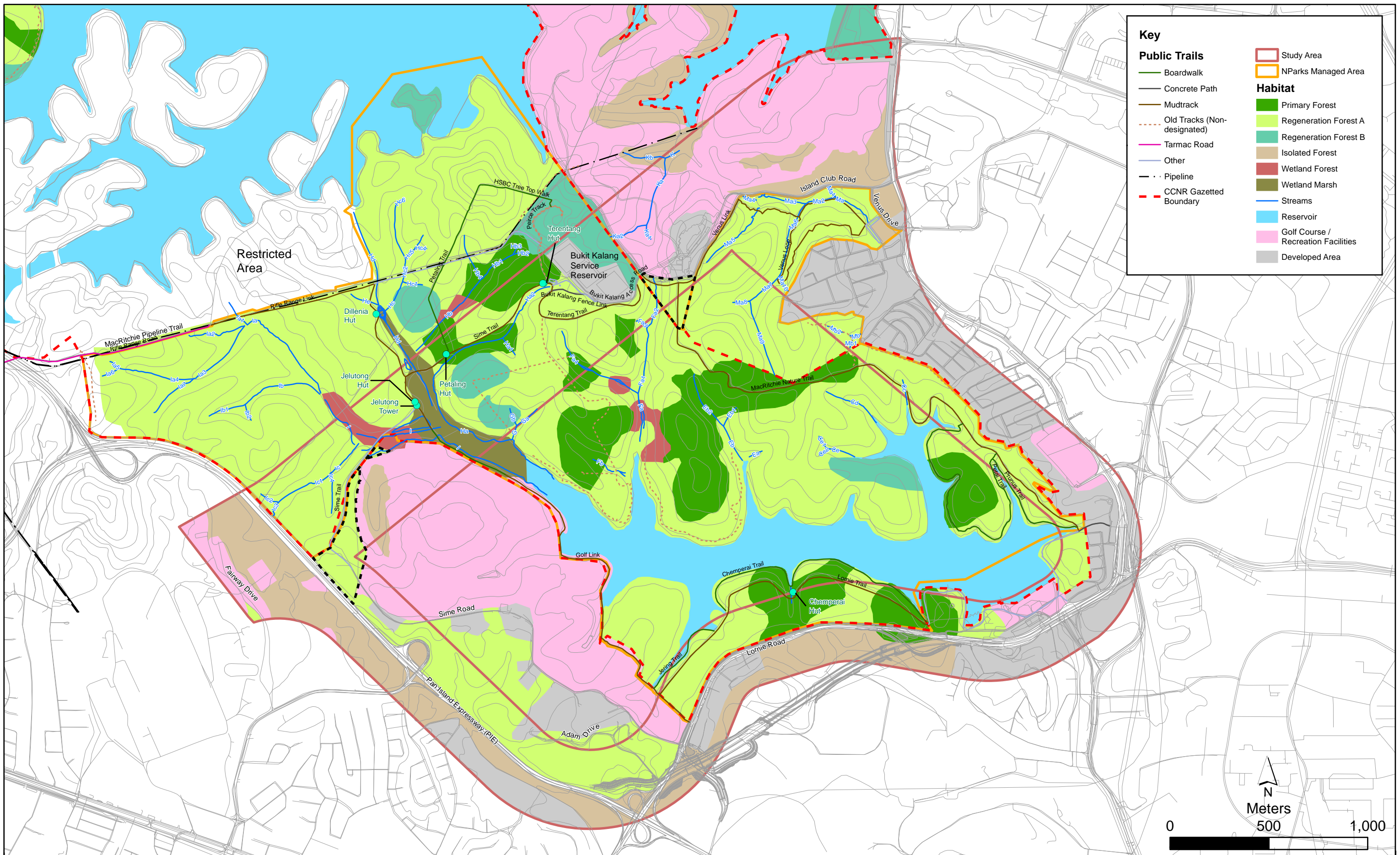


Figure 7.2 Habitat Map

March to May is considered the main breeding season, while high breeding activity also occurs in June and July, in Singapore<sup>42</sup>. The main breeding season coincides with the driest period of the year where there is highest insect (prey) abundance and optimum daylight for foraging. A secondary peak breeding season occurs in July and then declines sharply until November and December. Few species breed during the wet season or throughout the year<sup>43</sup>.

Migration months are typically from February to April and September to November. Three of the 118 passerines, namely the Asian Paradise-flycatcher (*Terpsiphone paradisi*), Barn Swallow (*Hirundo rustica*) and Grey Wagtail (*Motacilla cinerea*) regularly arrive as early as July. Most raptors like the Black Baza (*Aviceda leuphotes*) arrive later in October. For the return migration from February to April, the Black Baza together with Crested Honey Buzzard (*Pernis ptilorhyncus*) and Japanese Sparrowhawk (*Accipiter gularis*) are among the earliest to leave Singapore. Most migrants leave Singapore towards the end of April and only resident birds remain after June, including species such as Red Junglefowl (*Gallus gallus*), Purple Heron (*Ardea purpurea*), Sunda Scops-owl (*Otus lempiji*), Brahminy Kite (*Haliastur indus*), Emerald Dove (*Chalcophaps indica*), Green Pigeon (*Treron* spp.), Long-tailed Parakeet (*Psittacula longicauda*), Rufous Woodpecker (*Celeus brachyurus*), Bulbuls (*Pycnonotus* spp.), Tailorbirds (*Orthotomus* spp.) and Sunbirds (*Nectariniidae*).

### Review of Species Recorded in CCNR from Secondary Data

A total of 207 species were recorded in BTNR and the CCNR between 1993 to 1997<sup>44</sup>. The recent CRL WG Report in 2014 listed 218 species<sup>45</sup> as having been recorded within the CCNR MacRitchie area, generated from personal observations of one author (R Subaraj) and other reliable observers, over the past 28 years (*Annex 8B*). Of these listed birds the report gives a national conservation status of CR to 31 species, although all of these species are considered as either LC or NT by IUCN Red List (2015.02). Forty-three species (26 residents, 5 migrants, 12 visitors) were reported as forest specialists with 63 species (32 residents, 29 migrants, 2 visitors) mainly preferring woodland habitats.

The following six species were considered as possibly locally extinct at MacRitchie<sup>46</sup> according to the CRL WG Report:

- The White-Bellied Woodpecker (*Dryocopus javensis*) has a preference for mature trees in old secondary and freshwater swamp forests and can be found moving between the canopy and mid-storey. The last observation made at the MacRitchie Reservoir and the BTNR was in 1993. It is listed as CR by the Singapore Red Data Book (2008) but considered as LC by the IUCN Red List (2015.02) as it is widely distributed in Brunei Darussalam, China, India, Indonesia, Korea, Laos; Malaysia, Myanmar, Philippines, Thailand and Vietnam;
- The Scarlet Minivet (*Pericrocotus speciosus*) is an insectivore typically occurring in the canopy. It is considered as CR by the Singapore Red Data Book (2008) with a wide distribution in China, India,

<sup>42</sup> Lim K S (2009) *The Avifauna of Singapore*. K.S. Lim. Nature Society (Singapore), pp. 611.

<sup>43</sup> Lim K S (2009) *The Avifauna of Singapore*. K.S. Lim. Nature Society (Singapore), pp. 611.

<sup>44</sup> Lim K S (1997) *Bird Biodiversity in the Nature Reserves of Singapore*. Gardens' Bulletin Singapore 49: 225-244.

<sup>45</sup> Cheong LF, Chua MAH, D'Rozario V, Jamal F, Khoon SK, Koh JKH, Lim KKP, O'Dempsey T and Rajathurai S (2014) *Cross Island Line Working Group Report*

<sup>46</sup> Cheong LF, Chua MAH, D'Rozario V, Jamal F, Khoon SK, Koh JKH, Lim KKP, O'Dempsey T and Rajathurai S (2014) *Cross Island Line Working Group Report*



Indonesia, Malaysia, Myanmar, Philippines and Thailand and has not yet been assessed for the IUCN Red List (2015.02);

- The White-chested Babbler (*Trichastoma rostratum*) is uniquely associated with swampy areas and streams and therefore may be a potential indicator species. It is usually solitary and found at lower levels of vegetation. It is considered as CR by the Singapore Red Data Book (2008) and NT by the IUCN Red List (2015.02), with a distribution in Brunei Darussalam, Indonesia, Malaysia, Myanmar and Thailand;
- The Black-thighed Falconet (*Microhierax fringillarius*) is one of the smallest birds of prey. It is considered as CR by the Singapore Red Data Book (2008) but LC by IUCN Red List (2015.02) with a distribution in Brunei Darussalam, Indonesia, Malaysia, Myanmar and Thailand; and
- The Chinese Hwamei (*Leucodioptron canorum*) is an introduced species which is not native to Singapore and has not yet been assessed for the IUCN Red list. Its population may have dwindled to unsustainable numbers.

### Findings of Primary Baseline

For the bird surveys, an estimated 136 species were recorded from the main survey period from November 2014 to October 2015 (which included eight dedicated bird surveys of three to five days each). The species discovery curve has been created (Figure 7.3), which shows the asymptote has almost been reached. This indicates that most species across the survey period have been detected and that any further survey efforts (and extra MacKinnon Lists they would generate) would not likely to provide a substantial increase in diversity. During surveys conducted in June '15, no new bird species were recorded although further surveys conducted in September and October 2015 did record a further seven (7) species - Chinese Goshawk (*Accipiter soloensis*), Buffy Fish Owl (*Ketupa ketupu*), Blue-eared Kingfisher (*Alcedo menining*), Siberian Thrush (*Zoothera sibirica*), Yellow-rumped Flycatcher (*Ficedula zanthopygia*), White Wagtail (*Matacilla alba*) and Grey Wagtail (*Matacilla cinerea*). Given the overall checklist for the CCNR is 218 species<sup>47</sup>, 136 represents some 62% of the total for the whole CCNR area.

### Relative Abundance of Species

Relative abundance of species was generally low with just 39 of the total species (136) being recorded on ten or more occasions using the MacKinnon Lists technique. Of the ten species that were recorded most regularly, the Greater Racket-tailed Drongo (*Dicrurus paradiseus*) and the Striped Tit-babbler (*Macronous gularis*) were most abundant (Relative abundance 0.58) followed by the Germain's Swiftlet (*Aerodramus germani*) (0.47), Dark-necked Tailorbird (*Orthotomus atrogularis*) (0.46), Asian Glossy Starling (*Aplonis panayensis*) (0.44), Olive-winged Bulbul (*Pycnonotus plumosus*), Orange-bellied Flowerpecker (*Dicaeum trigonostigma*) and Long-tailed Parakeet (*Psittacula longicauda*) (all three 0.37), Arctic Warbler (*Phylloscopus borealis*) (0.34), Javan Myna (*Lonchura leucogastroides*) (0.31). Details are summarized in Annex 8J.

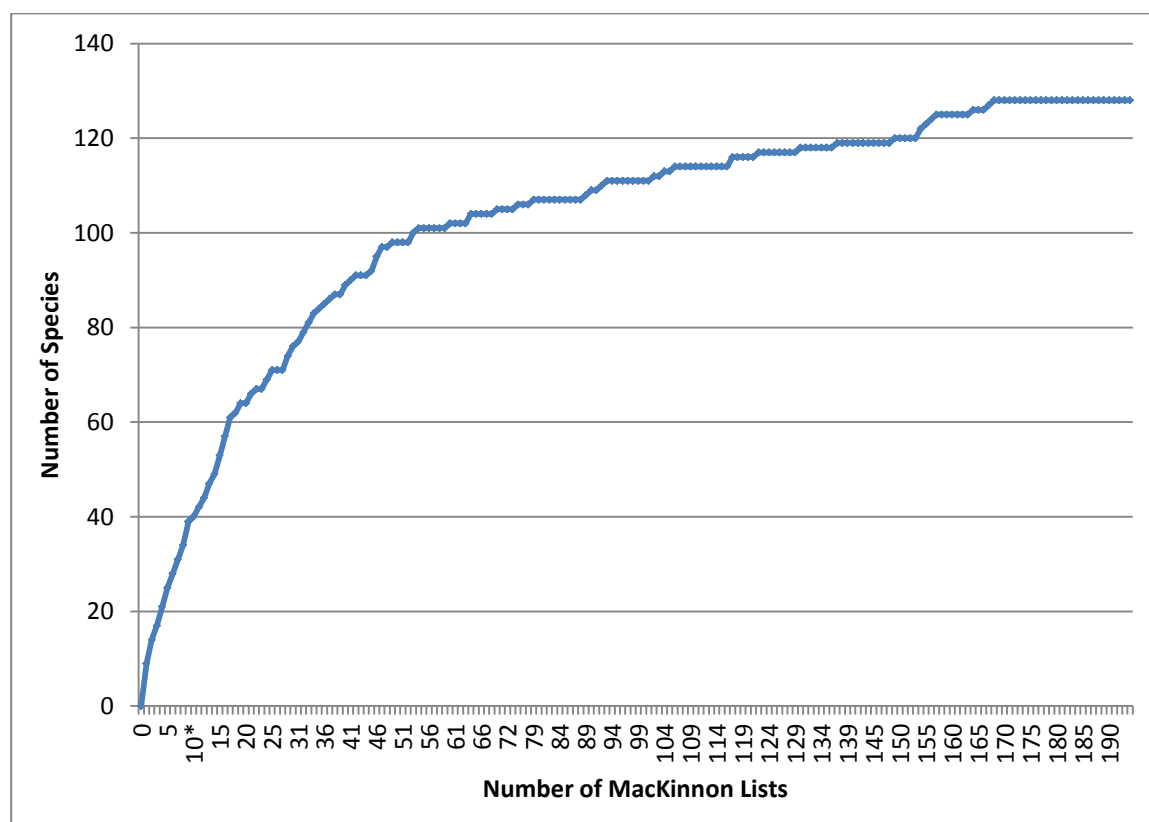
These species are all common in the CCNR and other than the Germain's Swiftlet (*Aerodramus germani*), all the species are associated with forest edge or primary forest, disturbed or secondary forest and

<sup>47</sup> Cheong LF, Chua MAH, D'Rozario V, Jamal F, Khoon SK, Koh JKH, Lim KKP, O'Dempsey T and Rajathurai S (2014) Cross Island Line Working Group Report



urban gardens Wells (1999, 2010)<sup>48,49</sup>. Germain's Swiftlet was regularly recorded feeding above the tree canopy within the Study Area. It should be noted, however, that due to the similarities between Germain's Swiftlet and the Black-nest Swiftlet (*Aerodramus maximus*), some of the latter species may also have been present, although they are generally thought to be uncommon<sup>50</sup>.

**Figure 7.3 Avifauna Species Discovery Curve\***



\*Note – some species were recorded prior to start of MacKinnon Lists and a number after asymptote had been reached

Twenty-seven (27) species were only recorded on one occasion during all surveys, with a further 25 only recorded on two to three occasions, indicating relatively low abundance, and these species represent a little under 40% of the species records for the survey. Some further analysis indicates that species in low abundance between November 2014 and June 2015 represent those that are migrants such as the Siberian Blue Robin (*Luscinia cyane*), Orange-headed Thrush (*Zoothera citrina*) and Blue-winged Pitta (*Pitta moluccensis*).

### Habitat Preference

No obvious trends were observed between species presence in primary versus regenerating forests within the CCNR and it is expected that birds will move throughout the forest landscape from primary forest to regenerating forests on a regular basis. From field surveys though, some species such as the

<sup>48</sup> Wells DR (1999) The birds of the Thai-Malay Peninsula (Vol. 1). Academic Press. Pp. 648

<sup>49</sup> Wells DR (2010) The birds of the Thai-Malay peninsula (Vol. 2). Bloomsbury Publishing. Pp. 848

<sup>50</sup> Yong DL, Lim KC & Lee TK (2013). Naturalist's guide to the birds of Singapore. John Beaufoy Publishers Ltd. Pp. 176

Chestnut-winged Babbler (*Stachyris erythroptera*) appeared to favor dense undergrowth and quality forest associated with mature regeneration forest or primary forest.

In general the habitat type which is used by the most different species is Regenerating Forest (A) with 93 of the total species recorded being found in this habitat. This finding is firstly a result of the fact that this habitat covers the largest proportion of Study Area, but also the secondary nature of the habitat provides additional niches not necessarily present in Primary Forest. The intermediate disturbance hypothesis is well known in tropical ecology, where species at both early and late successional stages coexist in habitat at intermediate levels of disturbance and therefore maximized biodiversity<sup>51</sup>. Of the other habitat types present, the Primary Forest was identified to support 52 species including some only recorded in this habitat (eg Chestnut-winged Babbler). Nocturnal survey results indicated that the Regeneration Forest A and Wetland Marsh along the channel and natural stream between the Rifle Range Road and Rifle Range Link might be key foraging and roosting area for owls (Buffy Fish Owl (*Ketupa ketupu*), Brown Hawk Owl (*Ninox scutulata*) and Sunda Scops Owl (*Otus lempiji*). The majority of other habitats within the Study Area, however, did not support species only associated with their particular habitat type, other than the Reservoir where a number of species not found in other habitats were recorded, including the Purple Heron (*Ardea purpurea*), Black-capped Kingfisher (*Halcyon pileata*), White-breasted Waterhen (*Amaurornis phoenicurus*), Little Egret (*Egretta garzetta*), Intermediate Egret (*Mesophoyx intermedia*), Great Egret (*Casmerodius albus*) and Yellow Bittern (*Ixobrychus eurhythmus*).

### Breeding

Initial avifauna surveys (November to March) fell outside the main breeding season for most residents, and no breeding behavior was observed although it was expected that as birds are habituated to a relatively high level of disturbance (from off trail activities and recreational use of the forest tracks), species would breed throughout the Study Area. Further surveys conducted in May and June did record evidence of breeding for at least five species. One juvenile Changeable Hawk Eagle (*Nisaetus cirrhatus*), considered as endangered in the Singapore Red Data Book (2008) and listed in CITES Appendix II, was observed in Regeneration Forest A to the south of CCNR near Bukit Golf Course and a Banded Woodpecker (*Chrysophlegma miniaceum*) was confirmed to be breeding near the Bukit Golf Course with a juvenile recorded. Three different Striped Tit-babbler (*Macronous gularis*) juveniles were recorded within the NParks managed area of the Study Area either in Regeneration Forest A or near Kalang Service Reservoir Developed Area and the active nest of a White-vented Myna (*Acridotheres javanicus*) was also recorded. Juveniles of Greater racket-tailed Drongo (*Dicrurus paradiseus*) and Common Tailorbird (*Orthotomus sutorius*) were also recorded within the NParks managed area of the Study Area within Regeneration Forest A. In addition to those species where breeding was confirmed, calls suggested attempted breeding for another five species (Plaintive Cuckoo *Cacomantis merulinus*, Square-tailed Drongo-Cuckoo *Surniculus lugubris*, Sunda Scops-owl *Otus lempiji*, Red-crowned Barbet *Megalaima rafflesii* all in Regeneration Forest A and Lineated Barbet *Megalaima lineata* in the Bukit Golf course. A number of nests were also recorded where identification of the nesting bird was not possible.

Overall evidence of attempted and confirmed breeding was recorded across the whole Study Area. Regeneration Forest A is the most common habitat in the Study Area and was also where most evidence of breeding was observed, while some evidence near the Kalang Service Reservoir and the Golf courses

<sup>51</sup> Wilkinson DM (1999) The Disturbing History of Intermediate Disturbance. *Oikos* 84(1): 145–147

was also noted. Annex 9 provides details of any breeding activity observed within the vicinity of the proposed BH locations.

### Specific Records of Note

One particular record for Long-tailed Parakeet (*Psittacula longicauda*) was taken where around 110 individuals were seen travelling in a north-easterly direction to the south of the Jelutong Tower. As this observation was made at dusk it is expected this flock was travelling to its roost, which is suspected to be located in Primary Forest to the east of the CCNR near the MacRitchie Trails.

Data was also collected from Sime Road near the Bukit Golf Course and Sime Golf Course and also from Adam Drive, where they are outside CCNR but within the Study Area. Of these locations, the latter is a historic low density housing area which still retains many large trees and had abundant bird life, with Long-tailed Parakeets (*Psittacula longicauda*), Javan Myna (*Acridotheres javanicus*) and Asian Glossy Starling (*Aplonis panayensis*) all being particularly abundant. In addition some other rarer species including the Square-tailed Drongo Cuckoo (*Surniculus lugubris*) and one juvenile Changeable Hawk Eagle (*Nisaetus cirrhatus*), considered as endangered in the Singapore Red Data Book (2008) and listed in CITES Appendix II, were also recorded in this location.

Most birds found in Venus Drive Car Park were congregated on two nearby fig trees and included common species such as Javan Myna (*Acridotheres javanicus*), Black-naped Oriole (*Oriolus chinensis*), Yellow-vented Bulbul (*Pycnonotus goiavier*) and Asian Glossy Starling (*Aplonis panayensis*).

Among the recordings, one recorded an owl during night surveys along the MacRitchie Nature Trail in June '15. Calls recorded confirmed that this species is the Brown Wood-Owl (*Strix leptogrammica*).<sup>52</sup> Although this species is not listed in Singapore's bird list (Lim 2009<sup>53</sup>) it was first discovered in Singapore on Pulau Ubin in 2007 and is mentioned in (Yong *et al.*, 2013<sup>54</sup>). All Strigiformes Owls, which this owl is, are listed in CITES Appendix II. Although it is not listed in Singapore Red Data Book (2008), Yong *et al.*, (2013) consider it 'nationally endangered'.

In addition to the above records, four records of a Babbler species were all taken close to the ranger station in primary / secondary forest. Some calls were recorded in this location in May 2015 to help confirm the identification of this Babbler species and it has now been verified by NParks as being the call of a Short-tailed Babbler (*Malacocincla malaccensis*) which had already been recorded elsewhere during the surveys.

### Species of Conservation Interest

Of the 136 avian species recorded throughout the survey period, 30 species of conservation interest were recorded and at least one other species (Flycatcher [*Rhinomyias* sp.]) whose identification was not confirmed. Nine (9) of these species however are listed due to being on CITES Appendix I or II but are not considered threatened in Singapore according to the Singapore Red Data Book. The statuses of these species of conservation interest are described further in Table 7.9.

<sup>52</sup> Personal communication with NParks. Email from J. LU, sent 16 October 2015, confirming identity of recorded species

<sup>53</sup> Lim K S (2009) *The Avifauna of Singapore*. K.S. Lim. Nature Society (Singapore), pp. 611.

<sup>54</sup> Yong DL, Lim KC & Lee TK (2013). *Naturalist's guide to the birds of Singapore*. John Beaufoy Publishers Ltd. Pp. 89



**Table 7.9 Avifauna of Conservation Interest Found in the Study Area during the Survey Period (Nov 2014 to Oct 2015)**

Common Name	Scientific Name	Description	Conservation Status (Source)
Red Junglefowl	<i>Gallus gallus</i>	Uncommon in Singapore  Recorded in Primary Forest and Regeneration Forests A areas in the present survey. Relative abundance in the Study Area was estimated at 0.12 with 17 sightings recorded.	EN (RDB) <sup>1</sup>
Purple Heron	<i>Ardea purpurea</i>	Considered common in Singapore. The species inhabits wetlands ie mangroves, swamps, mudflats, river banks, estuaries, ponds, open grasslands, canals, reed beds, marshes and paddy fields. Extended breeding season, with nest building seen from January to March, September, November and December, eggs in April, nestlings from January to September and in December, immature birds from March to May and July to September <sup>55</sup> .  Two sightings were recorded in Reservoir area in the present survey.	EN (RDB)
Black-crowned Night-heron	<i>Nycticorax nycticorax</i>	Considered uncommon in Singapore. There is only one definitely known wild colony of this species (20 – 50 nesting birds) in Singapore at Jurong Lake area <sup>1</sup> .  Recorded once in Regeneration Forest A area through camera trapping.	CR (RDB)
Changeable Hawk Eagle	<i>Nisaetus cirrhatus</i>	Considered uncommon in Singapore  Recorded in Regeneration Forest A and Reservoir areas. 20 sightings were recorded, providing an estimated abundance of 0.14 in the Study Area and additionally a juvenile was recorded in Regeneration Forest A near Bukit Gold Course.	EN (RDB) CITES II <sup>2</sup>
Japanese Sparrowhawk	<i>Accipiter gularis</i>	Considered common in Singapore and LC by IUCN Red List (2015.02). Listed on CITES as part of the Accipitridae family  Recorded in Regeneration Forest A on two occasions.	CITES II <sup>2</sup>
Besra	<i>Accipiter virgatus</i>	Considered common in Singapore and LC by IUCN Red List (2015.02). Listed on CITES as part of the Accipitridae family  Recorded on one occasion over the Golf Course habitat	CITES II <sup>2</sup>
Chinese Goshawk	<i>Accipiter soloensis</i>	Considered uncommon in Singapore. Listed on CITES as part of the Accipitridae family  On male recorded in flight over the Primary forest area of Sime Trail	CITES II <sup>2</sup>
Brahminy Kite	<i>Haliastur indus</i>	Considered common in Singapore. Listed on CITES as part of the Accipitridae family  Recorded five times, over Golf Course and Reservoir habitats	CITES II <sup>2</sup>
Grey-headed Fish Eagle	<i>Ichthyophaga ichthyaetus</i>	Considered rare in Singapore  Six records were taken in Wetland Marsh and Regeneration Forest A areas, providing an estimated relative abundance of 0.04 in the Study Area.	CR (RDB) CITES II <sup>2</sup>
Crested Serpent Eagle	<i>Spilornis cheela</i>	Considered rare in Singapore  One record of a bird flying overhead, over the MacRitchie Trail, Regeneration Forest A	CR (RDB) CITES II <sup>2</sup>

<sup>55</sup> The Birds of Singapore (October 2010) Available at [http://singaporebirds.net/npassers\\_04/purple\\_heron.html](http://singaporebirds.net/npassers_04/purple_heron.html)

Common Name	Scientific Name	Description	Conservation Status (Source)
White-bellied Sea-Eagle	<i>Haliaeetus leucogaster</i>	Considered common in Singapore  Four records over Reservoir and Regeneration Forest A habitats.	CITES II <sup>2</sup>
Peregrine Falcon	<i>Falco peregrinus</i>	Considered uncommon in Singapore. Listed on CITES Appendix I offering highest level of protection from trade.  One record over Regeneration Forest A	CITES I <sup>2</sup>
Red-wattled Lapwing	<i>Vanellus indicus</i>	Considered uncommon or rare in Singapore by Lim, K.S. (2007) and Wang, L.K. & Hails, C. (2007) respectively. Listed as Endangered in the Singapore Red Data Book.  One record during a night survey of Island Club Road on Bukit Golf Course in January.	EN (RDB)
Thick-billed Green Pigeon	<i>Treron curvirostra</i>	Considered rare in Singapore, although the population is estimated to be between 100–200 individuals <sup>1</sup>  Two records were taken in Primary Forest and Regeneration Forest A.	EN (RDB)
Long-tailed Parakeet	<i>Psittacula longicauda</i>	Considered common in Singapore but listed on CITES Appendix II  One of the most abundant species with 53 records giving a relative abundance of 0.36. Recorded in Primary Forest, Regeneration Forest A and B, and Park Area habitats.	CITES II <sup>2</sup>
Blue-crowned Hanging Parrot	<i>Loriculus galgulus</i>	Historically considered uncommon in Singapore but the population has dramatically increased recently, possibly as bird poaching has reduced, potentially justifying a reduction in its national conservation status from EN to VU.  10 records in Primary Forest and Non-Forest areas.	EN(VU) (RDB) CITES II
Tanimbar Cuckoo	<i>Cacatua goffini</i> (synonym: <i>Cactua goffiniana</i> )	Considered common in Singapore but listed on CITES Appendix I offering highest level of protection from trade.  Two records over Golf Course habitat	CITES I <sup>2</sup>
Square-tailed Drongo Cuckoo	<i>Surniculus lugubris</i>	Considered uncommon in Singapore, with an estimated resident population of 20–50 individuals <sup>1</sup>  Eight records were taken in Primary Forest and Regenerating Forest A areas.	CR (RDB)
Spotted Wood Owl	<i>Strix seloputo</i>	Considered rare in Singapore with a population around 22 <sup>1</sup> . Confirmed breeding in Singapore by mid-1986 <sup>56</sup>  Only one individual was found Primary Forest area.	CR (RDB)
Brown Wood-Owl	<i>Strix leptogrammica</i>	<u>This species is considered an uncommon resident in Singapore and previously know from primary and secondary forests, old plantations and occasionally scrub. Considered nationally endangered<sup>57</sup> but not listed in the Singapore RDB and listed as LC by IUCN. As a member of the Strigidae family it is also listed in CITES Appendix II.</u>  <u>One individual was heard calling in Primary Forest area during a night survey along MacRitchie Nature Trail in June 2015.</u>	CITES II <sup>2</sup>

<sup>56</sup> Wells DR (1999) **The birds of the Thai-Malay Peninsula** (Vol 1). Academic Press. Pp. 648

<sup>57</sup> Yong DL, Lim KC & Lee TK (2013). **Naturalist's guide to the birds of Singapore**. John Beaufoy Publishers Ltd. Pp. 89

Common Name	Scientific Name	Description	Conservation Status (Source)
Buffy-Fish Owl	<i>Alcedo meninting</i>	<p>Species was first discovered in Singapore on Pulau Ubin in 2007. Considered a rare resident in Singapore and previously known only from secondary forests and old plantations in western Pulau Ubin. Considered nationally endangered<sup>58</sup> but not listed in the Singapore RDB and listed as LC by IUCN. As a member of the Strigidae family it is also listed in CITES Appendix II.</p> <p>Birds are normally seen by reservoirs or rivers, hunting for fish, frogs, crustaceans and very rarely bats. This species was recorded twice along stream habitat at close range during the current surveys, in October 2015.</p>	CITES II <sup>2</sup>
Blue-eared Kingfisher	<i>Pycnonotus brunneus</i>	<p>This species is considered an uncommon resident which occurs along forested streams, mostly in the CCNR and especially in swampy forest where streams are abundant. Considered nationally endangered<sup>59</sup> and listed in the Singapore RDB as CR, but LC by IUCN.</p> <p>This species was recorded during both night and day surveys during the surveys in September and October 2015.</p>	CR (RDB)
Red-eyed Bulbul	<i>Pycnonotus brunneus</i>	<p>Considered uncommon in Singapore and recorded only in the forests of the water catchment area and Bukit Timah NR (Wells, 2010)<sup>60</sup></p> <p>Over ten records were taken in Primary Forest and Regeneration Forest A areas.</p>	EN (RDB)
Straw-headed Bulbul	<i>Pycnonotus zeylanicus</i>	<p>It is declining rapidly across its range due to the cage-bird trade and habitat loss within its rather specific habitat type. It is generally associated with riparian habitat or near waterbodies. Considered uncommon in Singapore with an estimated population of 100–200 individuals<sup>1</sup>. Singapore, Peninsular Malaysia and remote Kalimantan are the only places remaining that have moderately healthy populations of the species<sup>3</sup>.</p> <p>This species was recorded only once in Regenerating Forest A.</p>	EN (RDB) VU (IUCN) <sup>3</sup>
Chestnut-winged Babbler	<i>Stachyris erythroptera</i>	<p>Considered uncommon in Singapore</p> <p>Four records were taken in Regeneration Forest A areas.</p>	EN (RDB)
Hill Myna	<i>Gracula religiosa</i>	<p>Considered a common resident in Singapore, often seen in pairs or in large flocks of as many as thirty birds. Although common in Singapore, it has clearly declined in other parts of its range due to widespread trapping for the pet bird trade<sup>61</sup></p> <p>Six records were taken in Wetland Marsh and Regeneration Forest A areas.</p>	CITES II <sup>2</sup>
Oriental Magpie Robin	<i>Copsychus saularis</i>	<p>Considered uncommon in Singapore with an estimated population of less than 50 living on the main island of Singapore<sup>1</sup></p> <p>Six records were taken in Wetland Marsh and Regeneration Forest A areas.</p>	EN (RDB)

<sup>58</sup> Yong DL, Lim KC & Lee TK (2013). *Naturalist's guide to the birds of Singapore*. John Beaufoy Publishers Ltd. Pp. 89

<sup>59</sup> Yong DL, Lim KC & Lee TK (2013). *Naturalist's guide to the birds of Singapore*. John Beaufoy Publishers Ltd. Pp. 89

<sup>60</sup> Wells DR (2010). *The birds of the Thai-Malay Peninsula (Vol 2)*. Bloomsbury Publishing. Pp. 848

<sup>61</sup> Yong DL, Lim KC & Lee TK (2013). *Naturalist's guide to the birds of Singapore*. John Beaufoy Publishers Ltd. Pp. 89



Common Name	Scientific Name	Description	Conservation Status (Source)
White-rumped Shama	<i>Copsychus malabaricus</i>	Considered rare in Singapore, potentially justifying a reduction in its national conservation status from CR to EN by the Singapore Red Data Book authorities.  Three records were taken in Primary Forest and Regeneration Forest A areas.	CR(EN) (RDB)
Greater Green Leafbird	<i>Chloropsis sonnerati</i>	Considered rare in Singapore  Two records were taken in Regeneration Forest A area.	CR (RDB)
Brown-chested Jungle Flycatcher (identification of bird not confirmed)	<i>Rhinomyias</i> sp. suspected as <i>Rhinomyias brunneatus</i>	This species is considered a rare passage migrant and winter visitor in Singapore, traditionally passing through Singapore and route to wintering grounds in the Sumatran rainforest, with peak numbers observed in October and most gone by November. It is not listed on the Singapore Red Data Book but its small global population is declining due to destruction of lowland forest in its breeding and wintering grounds, giving it its IUCN status.  A bird suspected to be this species was observed in Regeneration Forest A and B in the present study, during an early December survey. It should also be noted that it is difficult to confirm this species as Brown-chested Jungle Flycatcher or Asian Brown Flycatcher through distant observation in the field. If it were Brown-chested Jungle Flycatcher, the birds would have remained longer than expected during migration.	VU (IUCN)

#### Notes

<sup>(1)</sup> RDB: Red Data Book (2008)

<sup>(2)</sup> CITES: Convention on International Trade in Endangered Species of Wild Fauna and Flora

<sup>(3)</sup> IUCN: *IUCN Red List of Threatened Species* (2015.02)

## Overall Evaluation of Avifauna

A total of 136 species have been recorded to date during the primary surveys, of which 18 are listed as threatened (VU, EN or CR) in the Singapore Red Data Book (2008) (out of a total of 56 species it lists with these statuses). One species, the Straw-headed bulbul (*Pycnonotus zeylanicus*), is listed as globally threatened (VU) on the IUCN Red List (2015.02). Another Flycatcher species, suspected to be the Brown-chested Jungle-flycatcher (*Rhinomyias brunneatus*), was also recorded during the surveys. This species is also listed as VU on the IUCN Red List (2015.02) and a rare passage migrant/ winter visitor in Singapore but its identification was not confirmed.

The relative abundance of most species was low with almost half the species only recorded on four or less occasions during the surveys. Of those species recorded, 39 were recorded on 10 or more occasions and the three most common species were the Greater racket-tailed Drongo (*Dicrurus paradiseus*), Striped Tit-babbler (*Macronous gularis*), Dark-necked Tailorbird (*Orthotomus atrogularis*) and Germain's Swiftlet (*Aerodramus germani*).

No obvious trends were observed between species presence in primary versus secondary or regenerating forest and it is expected that birds move across these habitats on a regular basis. The majority of species recorded were associated with secondary forest habitat, with the Regenerating Forest A supporting the highest species diversity and also being the habitat where most breeding was observed. Few species were recorded only in Primary Forest while various habitats, including the Wetland Marsh and Golf Course/ Recreation Facility areas adjacent to forest edges were found to

support other bird communities (eg Kingfisher and Heron which are associated with ponds and reservoir). Overall, the Study Area supports a high avifauna biodiversity across a variety of habitats.

### 7.5.3 Terrestrial Mammals, Including Bats

#### Review of Species from Secondary Data

There are over 50 species of terrestrial mammals including bats recorded in Singapore<sup>62,63</sup> of which at least 30 species are known to inhabit the Study Area<sup>64</sup> (Annex 8C). Using various capturing techniques (eg Harp trap, mist net, cage traps) and observational techniques, (eg bat detectors, transect), Teo and Rajathurai (1997) recorded 23 mammalian species within the MacRitchie area between 1987 and 1997<sup>65</sup> and this number appears to be increasing over time. This includes at least nine nationally CR and one EN mammal species listed in the Singapore Red Data Book (2008). Other species are considered relatively common within their distributional range. Nevertheless the presence of these nationally threatened species in MacRitchie area suggests that this forest patch is critical for the long term conservation of native species. The species richness is considered relatively high within the Nature Reserves because of its small size and habitat heterogeneity.

The remaining forest reserves in Singapore have been reduced to less than 2% of the total land area where the remaining populations of species may be threatened by genetic erosion and inbreeding<sup>66,67</sup>. In view of this, forested areas such as MacRitchie should be regarded as important refuge for many native forest-dwelling mammals. A relatively high number of mammalian species within the CCNR have been reported in the MacRitchie area and it has been noted as a stronghold for mammal diversity in Singapore.

The review of secondary literature also showed that at least 14 species of bat can be found in the Study Area, with four bat species listed as CR in the Singapore Red Data Book (Greater Woolly Horseshoe Bat [*Rhinolophus luctus*], Trefoil Horseshoe Bat [*Rhinolophus trifolius*], Malayan Slit-faced Bat [*Nycteris tragata*] and Naked Bulldog Bat [*Cheiromeles torquatus*]) and one listed on CITES Appendix II (Large Flying Fox [*Pteropus vampyrus*]). While some bats are more commonly found, the following bats presented in Table 7.10 are tightly associated with certain habitat types. These include the Grey Large-footed Myotis (*Myotis adversus*), Greater Bamboo Bat (*Tylonycteris robustula*) and Glossy Horseshoe Bat (*Rhinolophus lepidus*). These species, more detailed descriptions and corresponding conservation status are presented in Table 7.10.

<sup>62</sup> Cheong LF, Chua MAH, D'Rozario V, Jamal F, Khoon SK, Koh JKH, Lim KKP, O'Dempsey T and Rajathurai S (2014) Cross Island Line Working Group Report

<sup>63</sup> National Parks Board List of mammal species present in Singapore. (December 2014) Available at [http://www.nparks.gov.sg/cms/index.php?option=com\\_content&view=article&id=80:mammal-species&catid=18:species-list&Itemid=177](http://www.nparks.gov.sg/cms/index.php?option=com_content&view=article&id=80:mammal-species&catid=18:species-list&Itemid=177)

<sup>64</sup> Cheong LF, Chua MAH, D'Rozario V, Jamal F, Khoon SK, Koh JKH, Lim KKP, O'Dempsey T and Rajathurai S (2014) Cross Island Line Working Group Report

<sup>65</sup> Teo R and Rajathurai S (1997) Mammals, reptiles and amphibians in the nature reserves of Singapore - diversity, abundance and distribution. Gardens' Bulletin Singapore 49: 353–425

<sup>66</sup> Yee ATK, Corlett RT, Liew S C, Tan HTW (2011) The vegetation of Singapore – an updated map. Gardens' Bulletin Singapore 63(1&2): 205-212

<sup>67</sup> Noreen AME and Webb EL (2013). High Genetic Diversity in a Potentially Vulnerable Tropical Tree species Despite Extreme Habitat Loss. PLoS ONE, 8(12): 1–10

**Table 7.10: Bats in the Study Area**

Common Name	Scientific Name	Description	Conservation Status (Source)
Malayan Slit-faced Bat, Southeast Asian Hollow-faced Bat	<i>Nycteris tragata</i>	This species is only known from MacRitchie area when a roosting pair was captured in a culvert at Sime Forest in 1993 <sup>68</sup> . The wing morphology for this species indicates that it adapts to a slow, highly maneuverable flight when listening for prey on the ground and is able to take off from the ground with large prey items.	CR (RDB) <sup>1</sup>
Trefoil Horseshoe Bat	<i>Rhinolophus trifolius</i>	Four Trefoil Horseshoe Bats were rediscovered in MacRitchie area in 1994 and this species is believed to be restricted to primary forest.	CR (RDB)
Greater Woolly Horseshoe Bat	<i>Rhinolophus luctus</i>	The Greater Woolly Horseshoe Bat has only been identified using a bat detector in Singapore <sup>69</sup> and, similarly to the Trefoil Horseshoe bat, is believed to be restricted to the primary forest except for one record of an individual in a suburban area.	CR (RDB)
Naked Bulldog Bat	<i>Cheiromeles torquatus</i>	The large Naked Bulldog Bat has been seen only above the secondary forest canopy within the CCNR but the last known roost site for this species dates back to 1979 when a number of this species were captured from a derelict house near in Braddell Road. In 2005 a small flock was observed in flight at dusk at the Rifle Range Road forest and also from the top of Jelutong Tower, all within the MacRitchie area. Evidence suggests that females have one litter per year, with one young per birth and the young are retained at the roost while the mother is on feeding flights. <sup>70</sup>	CR (RDB)
Large Flying Fox	<i>Pteropus vampyrus</i>	This tree roosting species is tolerant to some habitat disturbance; it occurs in primary and secondary forest and uses adjacent agricultural areas for feeding. A study of the species habitat in the Philippines indicated that the species preferred natural forest to disturbed or agricultural areas. <sup>71</sup> In Singapore, a seasonal visitor or occasionally uses the forests in search of forest flowers and fruit. Virtually no permanent roosts are known in Singapore. <sup>72</sup>	CITES II
Common Fruit Bat, Lesser Dog-face Fruit Bat	<i>Cynopterus brachyotis</i>	This species can be found across a range of habitats ranging from orchards, gardens to forested tracts. It roosts in palms especially seed clusters of palms either solitary or in small groups of a few individuals in rural and urban landscapes and in forested areas. Bears a single young after a gestation period of 105-120 days. <sup>73</sup> In Singapore these species rely heavily on fruits as their primary food source, with common yellow stem fig <i>Ficus fistulosa</i> being a common food. Considered seed dispersers. <sup>74</sup>	
Cave Fruit Bat, Cave Nectar Bat	<i>Eonycteris spelaea</i>	Nectar feeders. This species is considered secure with over 400 individuals found outside CCNR, although only seven were rediscovered by Teo & Rajathurai (1997) <sup>75</sup> using mist netting	

<sup>68</sup> Pottie SA, Lane DJW, Kingston T and Lee BPY-H (2005) The microchiropteran bat fauna of Singapore. Acta Chiropterologica 7(2): 237-247

<sup>69</sup> Teo R and Rajathurai S (1997) Mammals, reptiles and amphibians in the nature reserves of Singapore - diversity, abundance and distribution. Gardens' Bulletin Singapore (49) 353-425

<sup>70</sup> Leong TM, Teo SC and Lim KKP (2009) The Naked Bulldog Bat, *Cheiromeles torquatus* in Singapore – Past and Present Records, with Highlights on its unique morphology (Microchiroptera: Molossidae). Nature in Singapore 2:215-230

<sup>71</sup> Bates P, Francis C, Gumal M, Bumrungsri S, Walston J, Heaney L and Mildenstein T (2008). *Pteropus vampyrus*. The IUCN Red List of Threatened Species. Version 2015.1. Available at [www.iucnredlist.org](http://www.iucnredlist.org)

<sup>72</sup> Leong TM and Chan KW (2011) Bats in Singapore – Ecological Roles and Conservation Needs. Proceedings of Nature Society, Singapore, Singapore's Conference on 'Nature Conservation for a Sustainable Singapore', 16 October 2011 pp41-64

<sup>73</sup> Csorba G, Bumrungsri S, Francis C, Bates P, Gumal M, Kingston T, Molur S and Srinivasulu C (2008). *Cynopterus brachyotis*. The IUCN Red List of Threatened Species. Version 2015.1. Available at [www.iucnredlist.org](http://www.iucnredlist.org)

<sup>74</sup> Leong TM and Chan KW (2011) Bats in Singapore – Ecological Roles and Conservation Needs. Proceedings of Nature Society, Singapore, Singapore's Conference on 'Nature Conservation for a Sustainable Singapore', 16 October 2011 pp41-64

<sup>75</sup> Teo R and Rajathurai S (1997) Mammals, reptiles and amphibians in the nature reserves of Singapore - diversity, abundance and distribution. Gardens' Bulletin Singapore (49) 353-425

Common Name	Scientific Name	Description	Conservation Status (Source)
Glossy Horseshoe Bat	<i>Rhinolophus lepidus</i>	This species is more common and can also be found in secondary forest.	
Pouch-bearing Bat	<i>Saccolaimus saccolaimus</i>	This species is common throughout all habitat types, from mangrove, primary and secondary forest, around water bodies and in urban areas.	
Whiskered Myotis	<i>Myotis muricola</i>	This species is common throughout all habitat types, from mangrove, primary and secondary forest, around water bodies and in urban areas. The Whiskered Myotis roosts individually or in small groups of up to ten individuals, in central curled banana leaves; it can also be found roosting on its own under open leaves.	
Grey Large-footed Myotis	<i>Myotis adversus</i>	This species is highly associated with fresh and brackish water bodies as 97 % of detections have been made in such habitats, including around reservoirs and adjacent channels. These bats have also been observed roosting in the weep holes of storm drains <sup>76,77</sup> .	
Lesser Asiatic Yellow House Bat	<i>Scotophilus kuhlii</i>	This species is common throughout all habitat types, from mangrove, primary and secondary forest, around water bodies and in urban areas. This bat is considered the most common echo-locating bat in Singapore and can be found flying in open areas of urban or suburban parkland and rural areas.	
Greater Bamboo Bat	<i>Tylonycteris robustula</i>	This bat roosts in groups in the internodes of bamboos using the slits made by beetles as points of access.	
Pipistrelle	<i>Pipistrellus</i> sp.	A small bat that is difficult to identify in the field without detailed examination. In 1997, Teo and Rajathurai recorded an unidentified pipistrelle which may have been the Javan pipistrelle ( <i>Pipistrellus javanicus</i> ), a species considered extinct in Singapore by Pottie <i>et al</i> (2005) but rediscovered in the Ayer Rajah Industrial Park in 2009 <sup>78</sup> .	

#### Notes

<sup>(1)</sup> RDB: Singapore Red Data Book (2008)

### Findings of Primary Baseline Data to Date

The overall mammal survey (ie combined effort of transect survey and camera trapping) recorded 12 families, 14 genera and 14 species of mammals. This list excludes unidentified species of squirrels and rodents recorded via camera trapping in the Study Area. Of the 14 mammal species recorded, the Sunda Pangolin (*Manis javanica*) is considered CR by IUCN (2015.02) and Greater Slow Loris (*Nycticebus coucang*) is listed as VU; ten other species are considered as LC (excluding domestic cats and dogs, both of which have not been assessed). According to Singapore Red Data Book (2008), the Sunda Pangolin (*M. javanica*), Greater Slow Loris (*N. coucang*) and Lesser Mousedeer (*Tragulus kanchil*) are considered as CR, while Horsfield's Flying Squirrel (*Iomys horsfieldii*) is considered EN; the remaining 10 species of mammals are not listed in the Singapore Red Data Book. Four species are listed in Appendix II of the CITES (Common Treeshrew [*Tupaia glis*], Greater Slow Loris [*N. coucang*], Sunda Pangolin [*M. javanica*] and Long-tailed Macaque [*Macaca fascicularis*]) with one in Appendix III (Common Palm Civet [*Paradoxurus hermaphroditus*]). Further details can be found in Table 7.11 and Annex 8K.

<sup>76</sup> Pottie SA, Lane DJW, Kingston T and Lee BP Y-H (2005) The microchiropteran bat fauna of Singapore. *Acta Chiropterologica* 7(2): 237-247

<sup>77</sup> Teo R and Rajathurai S (1997) Mammals, reptiles and amphibians in the nature reserves of Singapore - diversity, abundance and distribution. *Gardens' Bulletin Singapore* 49: 353-425

<sup>78</sup> Chan KW, Lim KKP, Leong TM (2009) The Javan pipistrelle, *Pipistrellus javanicus* (Mammalia: Chiroptera: Vespertilionidae) in Singapore. *Nature in Singapore* 2: 323-327



The sonograms of insectivorous bats encountered were recorded using the bat detector during the primary baseline surveys. Species identification posed a considerable challenge without an available bat sonogram database of Singapore for comparison during the preparation of this EIA study. However, bats were detected during transect surveys along Sime Trail and Golf Link in habitats including Primary Forest, Regeneration Forest A, Wetland Forest and Wetland Marsh. These areas were considered to be frequently used by insectivorous bats. Common fruit bats (probably *Cynopterus brachyotis*) were also directly observed during night transects along Sime Trail.

### *Findings of Transect Survey*

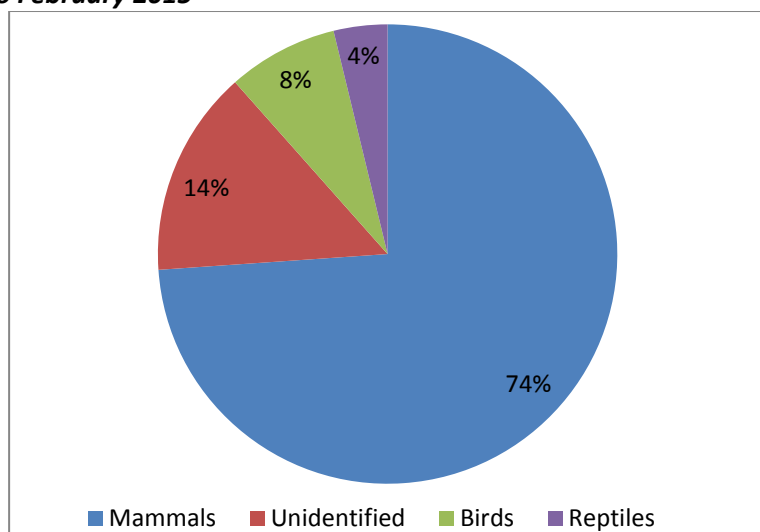
Transect surveys included both day and night transects amounting to 83:43 hours of walking. The most commonly encountered small mammal was the Plantain Squirrel (*Callosciurus notatus*) followed by the Slender squirrel (*Sundasciurus tenuis*). The other large mammal frequently observed during transects was the Long-tailed Macaque (*Macaca fascicularis*), particularly near the Venus Link. The Malayan Colugo (*Galeopterus variegatus*) was the most common nocturnal species recorded in these surveys.

### *Findings of Camera Trapping*

Ten (10) camera traps were set up over two time periods – from November 2014 to February 2015 and from September 2015 to November 2015. The initial deployment (November 2014 to February 2015) yielded a total number of 787 camera trap days over the survey period. A total of 502 wildlife photographs were exposed, equivalent to 50.2 shots per camera deployed. Approximately 14.5% of the total photographs could not be utilized due to poor angle of animal shots meaning the species could not be determined. Most of the unidentified animals consist of small mammals (Muridae and Sciuridae) which could not be identified even to genera level due to poor image quality. The other 429 photographs showed images of mammals (74%), birds (8%) and reptiles (4%) (Figure 7.4). Squirrels, Rodents and Long-tailed Macaques (*Macaca fascicularis*) were recorded in all camera locations. Humans were also recorded at 90% of the camera sites, indicating high human activity (mainly soldiers) even off-trail.

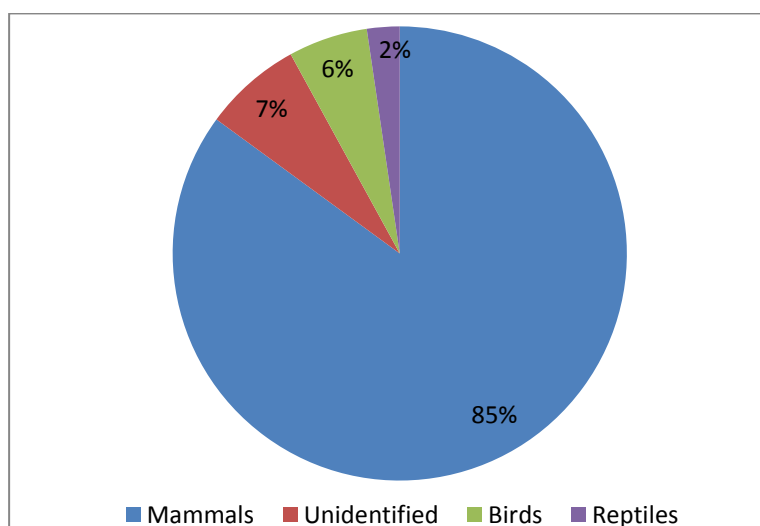
Most animals were photographed alone or in pairs, except for the Long-tailed Macaque (*Macaca fascicularis*) that was recorded in groups. The long-tailed macaque was the most commonly photographed animal (12.55%) followed by Plantain Squirrel (*Callosciurus notatus*) (9.16%). In contrast, three species of mammals were photographed only once during this study, a Domestic Dog (*Canis familiaris*), Domestic Cat (*Felis catus*) and a Red Muntjac (*Muntiacus muntjac*).

**Figure 7.4 Taxa Groups Captured by the Camera Traps Installed in the Study Area from November 2014 to February 2015**



The September-early November 2015 deployment of camera traps yielded a total number of 490 camera trap days over the survey period. A total of 301 wildlife photographs were exposed, equivalent to 33.4 shots per camera deployed. Approximately 7% of the total photographs could not be utilized due to poor angle of animal shots meaning the species could not be determined. Similar to previously, most of the unidentified animals consist of small mammals which could not be identified even to genera level due to poor image quality. The other 256 photographs showed images of mammals (85%), birds (6%) and reptiles (2%) (Figure 7.5) and overall 66.4% (n=200) of wildlife photographs were identified to species level.

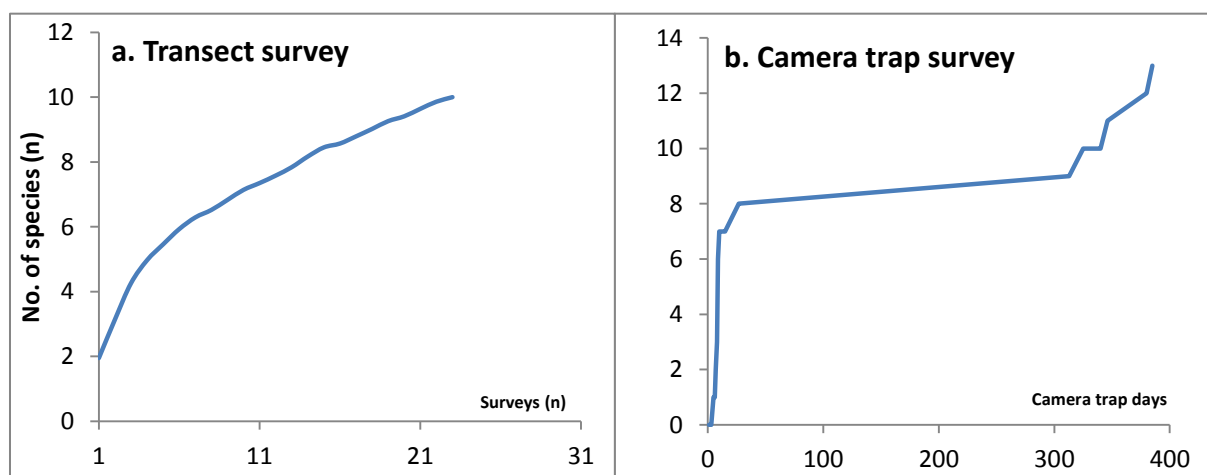
**Figure 7.5 Taxa Groups Captured by the Camera Traps Installed in the Study Area from September to November 2015**



Squirrels, Rodents and Long-tailed Macaques (*Macaca fascicularis*) were recorded in all camera locations. Humans were also recorded at 90% of the camera sites, indicating high human activity even off-trail.

The species accumulation curve using the transect (a) and camera trap (b) data did not reach an asymptote between November 2014 and February 2015, as sampling during these last months still recorded additional species, suggesting sampling saturation had not been reached after the initial camera deployment (Figure 7.6). Camera deployment between September and November 2015 however did not identify any new species suggesting sampling saturation had been reached.

**Figure 7.6 Species accumulation curve for both survey techniques (a. Transect & b. Camera trapping)**



One camera trap event captured two images of a Red Muntjac (*Muntiacus muntjak*) during initial set of camera deployment between November 2014 to February 2015 and another camera trap during the September 2015 to November 2015 deployment also recorded one individual likely to be a Red Muntjac. Both cameras were in similar locations, near the western end of the Sime Trail in Regeneration Forest A, one to the north and one to the south east of the trail). This species is regarded as locally extinct before the Second World War in Singapore in available literature<sup>79,80</sup>. The present results are probably the first recent records for Singapore since that time. One camera trap photograph possibly shows a male; it has rough antlers bearing small spikes with a whitish underpart below the neck, while the tail seems white below, which is in contrast to the entirely black and bushy tail of Sambar Deer (*Rusa unicolor*). The Sambar Deer is the only other large deer that could be found in the Study Area, having also been thought extinct once but since re-established a small population from a zoo escape<sup>81</sup>. Additional information will be needed to confirm the existence of Red Muntjac in the Study Area but the presence of this species in this study suggests that the CCNR is a potential refuge for this species.

An adult male domestic dog (*Canis familiaris*) was directly observed along the Terentang trail. The dog was observed walking along the trail but moved quietly into the forest area after noticing an observer approaching. Another domestic dog was suspected to be captured from camera trapping set near Terentang trail, but the fast movement of the animal produced an unclear image which made species identification difficult. A single photo record of an adult domestic cat (*Felis catus*) was recorded near the Venus trail. The photo was black and white and indicated no apparent markings on the body.

<sup>79</sup> Ng PKL, Corlett RT, Tan HTW (ed) (2011) Singapore Biodiversity – An encyclopedia of the Natural Environment and Sustainable Development. National University of Singapore. Pp. 552

<sup>80</sup> Baker N & Lim K (2008) Wild Animals of Singapore: A Photographic Guide to Mammals, Reptiles, Amphibians and Freshwater Fishes. Draco Publishing and Distribution Pte. Ltd. and Natural Society (Singapore). Pp. 180

<sup>81</sup> Chua MAH & Low CHS (2014) Sambar at Mandai. Singapore Biodiversity Records 2014: 193

## Activity Patterns

Activity patterns were only investigated for species with more than 15 independent photos namely Plantain Squirrel (*Callosciurus notatus*), Common Treeshrew (*Tupaia glis*), Long-tailed Macaque (*Macaca fascicularis*) and Wild Boar (*Sus scrofa*). Each photograph was printed with the date and time the picture was taken. Repetitive shots of the same species at the same location within one hour were also excluded (Kawanishi & Sunquist, 2004)<sup>82</sup>. It is assumed that the numbers of photographs taken at various times were correlated to activity levels of mammals (Mohd-Azlan & Sharma 2006; Kitamura et al, 2010)<sup>83,84</sup>. Time periods were pooled in one-hour intervals and activity levels of a species were measured by the percentage of the total qualified photographs.

Both the Common Treeshrew (*Tupaia glis*) and Plantain Squirrel (*Callosciurus notatus*) are strictly diurnal and showed at least two peaks in their daily activity level (Figure 7.7). Both the Long-tailed Macaque (*Macaca fascicularis*) and Wild Boar (*Sus scrofa*) are predominantly diurnal, with activity peaking at midday.

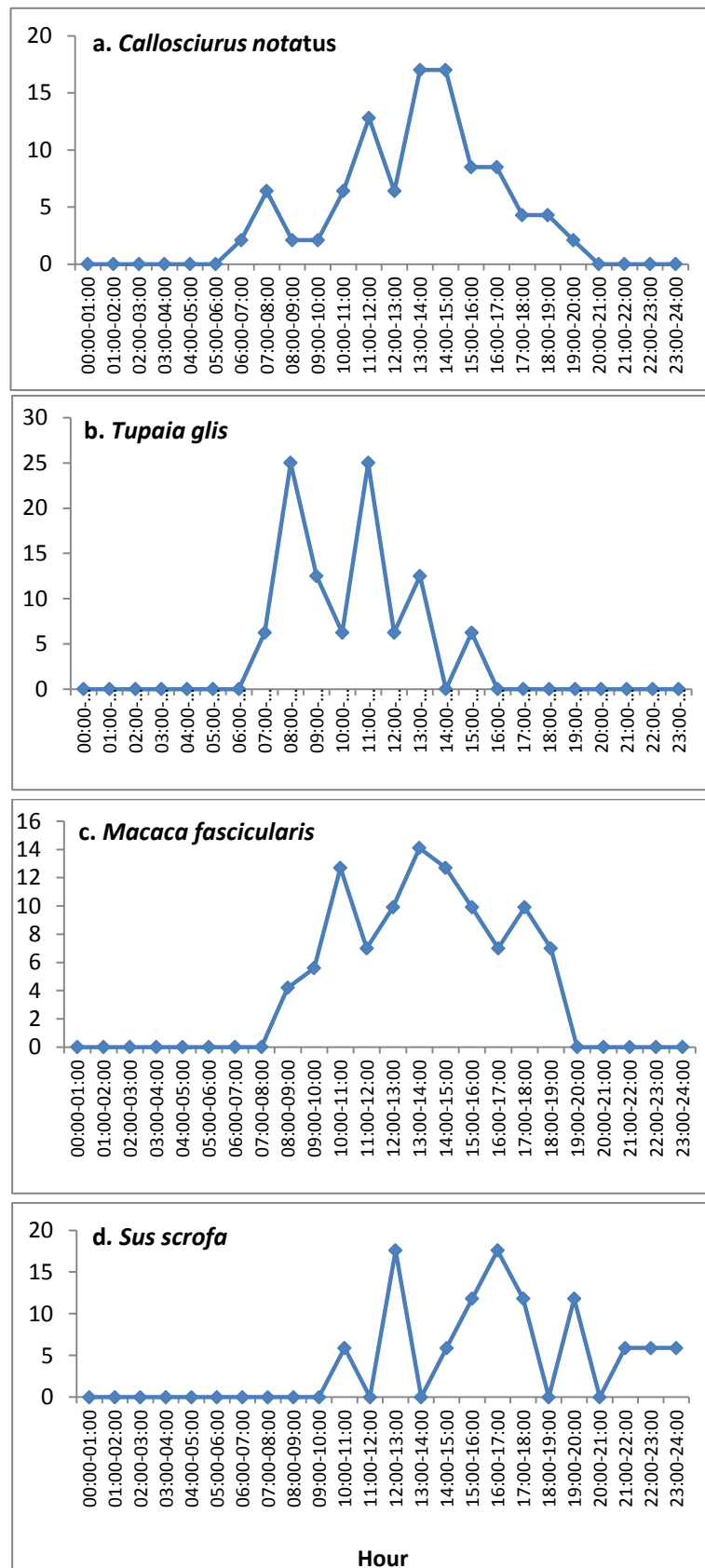
<sup>82</sup> Kawanishi K & Sunquist ME (2004) Conservation status of tigers in a primary rainforest of Peninsular Malaysia. Biological Conservation 120: 329-344

<sup>83</sup> Mohd-Azlan J & Sharma DSK (2006) The diversity and activity patterns of wild felids in a secondary forest in Peninsular Malaysia. Oryx 40: 1-6

<sup>84</sup> Kitamura S, Thong-Aree S, Madsri S & Poonswad P (2010) **Mammal diversity and conservation in a small isolated forest of southern Thailand**. The Raffles Bulletin of Zoology 58: 145-156



**Figure 7.7 Activity levels (%) of (a) *Callosciurus notatus*, (b) *Tupaia glis* (c) *Macaca fascicularis* and (d) *Sus scrofa* based on pooled camera trapping records in the Study Area over the survey period. Note the different scaling in percentage (%) of the vertical axis.**



## Overall Evaluation of Mammals

The current baseline surveys provided an update on the 12 mammal species (excluding domestic dog and domestic cat) out of the 30 which have been previously found and studied to varying extents in the Study Area. Their distribution reflected a level of habitat preference. As the number of mammal species occurring in the Study Area (both common and species of conservation interest) is not as many when compared to other well assessed taxa like avifauna and herpetofauna, secondary data from literature review has been presented together with field observations from the primary baseline survey in Table 7.11.

**Table 7.11 Terrestrial Mammals in the Study Area**

Common Name	Scientific Name	Description	Conservation Status (Source)
<b>Primates</b>			
Banded Langur	<i>Presbytis femoralis femoralis</i>	First described from Singapore in the early 19th century. It was confined to the BTNR and CCNR until 1987 and is now restricted to the CCNR <sup>85</sup> . The population was estimated as 18 to 23 individuals in two to three groups in the Nee Soon Swamp Forest and Lower Peirce Reservoir in 1997; a lone individual was observed at Three Stone Hill. A survey in 2012 estimated there were approximately 40 individuals in five to six groups inhabiting in CCNR but it remains uncertain whether these new groups have expanded into the Study Area <sup>86</sup> . The population is assumed to be growing as six births were reported between 2008 and 2010, with at least one birth season in June to July <sup>87</sup> .  Not detected in the baseline survey.	CR (RDB) <sup>1</sup> VU (IUCN) <sup>2</sup> CITES II <sup>3</sup>
Greater Slow Loris	<i>Nycticebus coucang</i>	The only slow loris considered native to Singapore. The other two species, the Bengal Slow Loris ( <i>Nycticebus bengalensis</i> ) and Pygmy Slow Loris ( <i>Nycticebus pygmaeus</i> ), are likely to be escaped pets if seen in the wild. Most of the anecdotal observations of the Greater Slow Loris were made within the BTNR and CCNR from 1965 to 2014. The only ecological study of this nocturnal and solitary species in Singapore to date encompassed seven sites including the Thomson Ridge at the MacRitchie Reservoir and results of the survey could only confirm the animal's occurrence in NSSF <sup>88</sup> . This omnivorous species have been reported in in primary and secondary lowland forest, orchards and plantations <sup>89</sup> . This cryptic species moves across canopy gaps by using rattans and lianas, maintaining these plant structures seems critical to the survival of these animals and preventing them from falling victim to road kills.  A single observation of this species was made during a night transect at the Wetland Marsh with Wetland Forest and Regeneration Forest A nearby. It was found near the forest edge on a medium sized tree, climbing quickly before disappearing into the canopy. The current survey extended its southern limit of distribution within CCNR.	CR (RDB) VU (IUCN) CITES I

<sup>85</sup> Yang CM and Lua HK (1988) A report of a banded leaf monkey found dying near the Bukit Timah Nature Reserve. Pangolin 1: 23

<sup>86</sup> Ang A, Srivathsan A, Md.-Zain BM, Ismail M and Meier R (2012) **Low genetic variability in the recovering urban banded leaf monkey population of Singapore.** Raffles Bulletin of Zoology 60: 589–594

<sup>87</sup> Ang A, Ismail M, and Meier R (2010) Reproduction and infant pelage coloration of the banded leaf monkey in Singapore. Raffles Bulletin of Zoology 58: 411–415

<sup>88</sup> Fam SD, Lee BPY-H and Shekelle M (2014) **The Conservation Status Of Slow Lorises *Nycticebus* spp. in Singapore.** Endangered Species Research 25: 69–77

Common Name	Scientific Name	Description	Conservation Status (Source)
Long-tailed Macaque	<i>Macaca fascicularis</i>	<p>One of the most common mammals in Singapore. Withstands secondary and disturbed forest, often forages on the ground.</p> <p>During the baseline surveys, it was observed in high numbers especially near the forest edges and near areas with higher human activity (eg Visitor's center, main road). Often seen in groups of 2 to 30 with a mean of 5.56 (SD, 6.08) individuals. Frequently observed along trails in Regeneration Forest, some are observed in Primary Forest and Non-Forest habitat and readily enter open areas including Golf Club premises.</p>	CITES II
<b>Gliding Mammals</b>			
Horsfield's Flying Squirrel	<i>Iomys horsfieldii</i>	<p>Solitary and nocturnal. This species has been reported to utilize tree hollows for nesting and distributed in primary forest, orchards and plantation<sup>90</sup>.</p> <p>Two individuals were observed during night transects on tree branches approximately 15 m and 20m high respectively in Primary Forest. One climbed quietly disappearing among the canopy, and neither glided when spotted.</p>	EN (RDB)
Red Giant Flying Squirrel	<i>Petaurista petaurista</i>	<p>Last seen at MacRitchie in 1986 and little is known about the ecology of this elusive species.</p> <p>Not detected in the baseline survey.</p>	CR (RDB)
Malayan Colugo	<i>Galeopterus variegatus</i>	<p>Solitary and nocturnal. Truly arboreal and having a skin membrane along the body and tail which allows it to glide among trees when extended. Although not listed on the Singapore Red Data Book and considered as LC by IUCN Red List, it is one of only two species in the Family Cynocephalidae. Sightings records in MacRitchie are still too unclear to generate a precise population estimate compared to the BTNR and Singapore Zoological Gardens but females appear to be more territorial than males<sup>91</sup>.</p> <p>Frequently observed in Primary and Regeneration Forest A and B at night. Previous study suggest that this species prefers dense canopy cover (&gt;95%)<sup>92</sup>. Even though <i>G. variegatus</i> has been reported to be relatively insensitive to disturbance arising from proximity to forest edge, the continuity of forest canopies alongside with mature forest is vital for the survival of this species. A total of nine observations were made for this species.</p>	LC (IUCN)
<b>Ground-dwelling mammals</b>			
Lesser Mouse-deer	<i>Tragulus kanchil</i>	<p>Restricted to CCNR, this ground dwelling species is crepuscular mostly solitary. It feeds on leaves, shoots, fungi and fallen fruit in forests and orchards<sup>93,94</sup>.</p> <p>One individual was observed during the night transect walk in Regeneration Forest. This species was more frequently detected by camera trapping, with a record at 50% of the camera locations during the first camera trap deployment and 22% during the second camera trap deployment.</p>	CR (RDB)

<sup>89</sup> Ng PKL, Corlett RT, Tan HTW (ed) (2011) Singapore Biodiversity – An encyclopedia of the Natural Environment and Sustainable Development. National University of Singapore. Pp. 552

<sup>90</sup> Payne J, Francis CM & Phillips K (2005) **A field guide to the mammals of Borneo**. The Sabah Society and WWF Malaysia, Kota Kinabalu. Pp.332

<sup>91</sup> Lim NT and Ng PKL (2003) **The abundance of flying lemurs (*Cynocephalus variegatus*) in Singapore**. Nanyang Technological University

<sup>92</sup> Lim NT, Giam X, Byrnes G & Clements GR (2013) Occurrence of the Sunda colugo (*Galeopterus variegatus*) in the tropical forests of Singapore: A Bayesian approach. Mammalian Biology 78: 63-67

<sup>93</sup> Payne J, Francis CM & Phillips K (2005) **A field guide to the mammals of Borneo**. The Sabah Society and WWF Malaysia, Kota Kinabalu. Pp.332

Common Name	Scientific Name	Description	Conservation Status (Source)
Sunda Pangolin	<i>Manis javanica</i>	<p>This species depends on a diet of termites and ants. An ecological study of a female Sunda Pangolin in Pulau Tekong, Singapore, revealed that its peak activity levels were between 03:00 and 06:00hrs, with a home range of 5.63-6.97 ha<sup>95</sup>. The home range of the male was found to be 4-10 times larger. The study observed that the Sunda Pangolin's den could either be within clumps of tall grasses or in hollows of large trees (DBH &gt; 50cm) above the ground. It was also found that the pangolin uses underground burrows or tree hollows as natal dens for raising their young. These natal dens were either revisited or used only once, with a mean period of nine days. A young Sunda Pangolin was observed in early October and maternal care lasted approximately 3-4 months.</p> <p>Sunda Pangolin was not observed during the transect survey except a dead body without obvious external injury was found on a stream at Venus Link. This nocturnal species was recorded through camera traps with nine independent photographs in Primary Forest and Regeneration Forest A and B.</p>	CR (RDB, IUCN) CITES II
Wild Boar	<i>Sus scrofa</i>	<p>This is the largest resident terrestrial mammal in Singapore. Current population is likely to have originated from individuals that swam across Johor Straits. It inhabits forest, scrubland and mangroves. They are known to dig into the ground for roots and worms and signs of these foraging activities are commonly observed.</p> <p>No direct observation but signs such as earth diggings and tracks were frequently observed during the transect walks. 20% of the camera trap sites recorded this species between November 2014-February 2015 and over 55% between September–November 2015. This species was frequently recorded in Regeneration Forest A.</p>	
<b>Carnivores</b>			
Small-toothed Palm Civet	<i>Arctogalidia trivirgata</i>	<p>Nocturnal, generally solitary and omnivorous. It is primarily arboreal and mostly found in mature forest, rarely found in disturbed habitats. It now appears to be confined to the CCNR, with one record along the Petaling Trail of the MacRitchie area in 2003<sup>96</sup>. Threatened by loss of preferred habitat and illegal trapping.</p> <p>Not detected in the baseline survey.</p>	CR (RDB)
Masked Palm Civet	<i>Paguma larvata</i>	<p>Its status in Singapore is indeterminate with only two sightings in Singapore, with one doubtful observation in Pulau Tekong in 1990 and the other in the Sime Road area of MacRitchie in 1994. The latter case however could not rule out an escaped captive individual<sup>97</sup>.</p> <p>Not detected in the baseline survey.</p>	CR (RDB)

<sup>94</sup> Ng PKL, Corlett RT, Tan HTW (ed) (2011) Singapore Biodiversity – An encyclopedia of the Natural Environment and Sustainable Development. National University of Singapore. Pp. 552

<sup>95</sup> Lim NTL and Ng PKL (2007) Home range, activity cycle and natal den usage of a female Sunda pangolin *Manis javanica* (Mammalia: Pholidota) in Singapore. Endangered Species Research 3: 1–8

<sup>96</sup> Chua MAH, Lim KKP, Low CHS (2012) **The diversity and status of the civets (Viverridae) of Singapore**. Small Carnivore Conservation. 47: 1-10

<sup>97</sup> Chua MAH, Lim KKP, Low CHS (2012) **The diversity and status of the civets (Viverridae) of Singapore**. Small Carnivore Conservation. 47: 1-10



Common Name	Scientific Name	Description	Conservation Status (Source)
Large Indian Civet	<i>Viverra zibetha</i>	Indeterminate status in Singapore. It was trapped only once recently in 1990 in Jalan Bahar. With no confirmed sighting for at least 18 years, unconfirmed sightings were reported across Singapore, including one at Lornie Road, CCNR <sup>98</sup> .  Not detected in the baseline survey.	CR (RDB)
Common Palm Civet	<i>Paradoxurus hermaphroditus</i>	The easiest civet to be observed despite its solitary, arboreal and nocturnal or crepuscular habit. It can be found in forest, scrubland, parkland and mangrove and even gardens or building roofs in urbanized areas.  This species was camera trapped in Primary and Regeneration Forest A. This species spent substantial amount of time on the ground even though it is regarded as arboreal.	
Malay Civet	<i>Viverra tangalunga</i>	Active on the ground and larger than the arboreal civets. Only rediscovered by camera trapping in the MacRitchie forest in 2012 with an uncertain origin of either an escape or from a relict natural population <sup>99</sup> . The latter case would credit a nationally CR status. Studies from other regions suggest that it has a home range of 71-143 ha, seldom straying more than 600 m away from the forest edge.  Not detected in the baseline survey.	
<b>Tree Shrew and Squirrels</b>			
Common Tree Shrew	<i>Tupaia glis</i>	Unrelated to squirrel although with similar size and a bushy tail. It has a longer, pointed snout than squirrels and can be found in a variety of habitats including forest, scrubland and parklands. It is less arboreal than squirrels and can be seen foraging for insects and fruits in the day.  It was less frequently encountered compared to the Plain-tan Squirrel ( <i>Callosciurus notatus</i> ). Observation was made in Primary, Regeneration and Wetland Forest. Nine observations were made for this species and ninety-seven camera trap photographs included this species also.	CITES II
Shrew-faced Ground Squirrel	<i>Rhinosciurus laticaudatus</i>	Only being recently photographed and camera trapped in CCNR in 2011. One observation at Sime Forest in 2012 with a lack of photographic evidence <sup>100</sup> .  Not detected in the baseline survey.	CR (RDB)
Plantain Squirrel	<i>Callosciurus notatus</i>	The most commonly encountered diurnal small mammals together with Slender Squirrel ( <i>Sundasciurus tenuis</i> ) in MacRitchie area.  It was frequently observed in all forest types and Wetland Marsh, foraging on fruits and seeds. This species was occasionally observed in pairs (Mean =1.14 individuals/siting). Higher activity was observed near the Venus transects along the secondary forest probably due to better visibility of the sparse understorey and the availability of fruit trees. A total of 63 observations were made along transects.	

<sup>98</sup> Chua MAH, Lim KKP, Low CHS (2012) **The diversity and status of the civets (Viverridae) of Singapore**. Small Carnivore Conservation. 47: 1-10

<sup>99</sup> Lim NTL and Ou Yang (2012) Occurrence of the Malay Civet, *Viverra Tangalunga* (Mammalia: Carnivora: Viverridae) in Singapore. Nature in Singapore 5: 79–81

<sup>100</sup> Lim NTL and Yeo A W M (2012) **Records of the shrew-faced squirrel, *Rhinosciurus laticaudatus* (Mammalia: Rodentia: Sciuridae), in Singapore**. Nature in Singapore 5: 165–170

Common Name	Scientific Name	Description	Conservation Status (Source)
Slender Squirrel	<i>Sundasciurus tenuis</i>	Commonly encountered in MacRitchie area. Found mainly in forest and park areas.  Observed in similar habitat as for Plantain Squirrel ( <i>Callosciurus notatus</i> ) but less frequently observed. A total of 17 observations were made for this species.	

#### Notes

<sup>(1)</sup> RDB: *Red Data Book* (2008)

<sup>(2)</sup> IUCN: *IUCN Red List of Threatened Species* (2015.02)

<sup>(3)</sup> CITES: *Convention on International Trade in Endangered Species of Wild Fauna and Flora*

This survey adds to the growing literature on the distribution and activity patterns of mammalian species in Singapore especially in the CCNR. As expected the mammal diversity in Nature Reserves in Singapore is relatively high when compared to other natural areas in Singapore<sup>101</sup>. In general the mammalian richness in this survey is consistent to that reported in the literature and previous surveys. The present study reports approximately 24% of the about 50 terrestrial mammalian species in Singapore, but it should be noted that non-intrusive methods (ie, involving no sampling/ground excavation/ entering streams etc) were applied during the surveys. Species that were not detected in this study do not represent absence. Species from the Family Muridae, Pteropodidae and the Order Insectivora were not detected during the transect walks and could not be evaluated. Even though representatives from some of these families may have been caught in the camera trap photographs, species identification is nearly impossible due to their small size among leaf litter. Therefore these species are unrepresented in this study.

### 7.5.4 Herpetofauna (Amphibians and Reptiles)

#### Review of Species from Secondary Data

There were 72 species of reptiles in total in CCNR, with 50 species known to inhabit the MacRitchie area by the time of Teo and Rajathurai (1997)<sup>102</sup>. Further literature review up to the present day (early 2015) suggests there are 59 species of reptiles now, with three CR, 18 EN and 12 VU species on the Singapore Red Data Book<sup>103</sup> (Annex 8D). Of the 59 reptiles, at least two species recorded are alien species (Red-eared Slider [*Trachemys scripta elegans*] and Cuban Slider [*Trachemys decussate*]). Red-eared sliders are abundant in MacRitchie Reservoir largely due to human releases (eg pet owners or releases on Vesak Day) and are listed among the “100 of the World’s Worst Invasive Alien Species” by the Invasive Species Specialist Group (ISSG) of the International Union for Conservation of Nature (IUCN). They are aggressive and may ecologically out-compete native freshwater turtles.

In 1997, Teo and Rajathurai recorded 25 species of amphibians in CCNR, with 15 species from the MacRitchie area. In its 2013 Working Group Report, the NSS recorded 17 species of amphibians in the

<sup>101</sup> Teo R and Rajathurai S (1997) Mammals, reptiles and amphibians in the nature reserves of Singapore - diversity, abundance and distribution. Gardens' Bulletin Singapore 49: 353–425

<sup>102</sup> Teo R and Rajathurai S (1997) Mammals, Reptiles and Amphibians in the Nature Reserves of Singapore - Diversity, Abundance and Distribution. Gardens' Bulletin Singapore 49: 353–425

<sup>104</sup> Cross A (1944–1945) *Notes on the species of Ophidia and Lacertilia obtained at Sime Road Internment Camp, Singapore*. A series of type-written manuscripts at the Lee Kong Chian Natural History Museum, Singapore.

wider MacRitchie area, including species such as the Cinnamon Bush Frog (*Nyctixalus pictus*) which was not found in 1997 survey, and this is considered to be the latest available information.

As most of the herpetofauna have a cryptic lifestyle and some are only active at night, observations of these animals are rarely made (eg only once per year) although they may either be truly rare or actually more common than expected but difficult to encounter. Compared to avifauna and mammals, herpetofauna was generally overlooked in early studies. Early records, primarily by former British civil servants and resident European naturalists, provide only general locality records (eg Thomson Road). Several additional records have been mentioned in the type-written manuscripts by Alexander Cross, presumably a British civilian, who interned at the Sime Road Camp during the Japanese occupation of Singapore between 1942 and 1944. Cross' reports include a number of species from the Sime Road area (presumably, near the Singapore Country Club, where the camp was located). Species recorded by Cross (1944–1945)<sup>104</sup> included the lizard *Lygosoma bowringii* and the snakes Blue-necked Keelback (*Macropisthodon rhodomelas*), Black Spitting Cobra (*Naja sumatrana*), Common Malayan Racer (*Coelognathus radiates*), Banded Malayan Coral Snake (*Calliophis intestinalis*), Painted Mock Viper (*Psammodynastes pictus*), House Wolf Snake (*Lycodon capucinus*) and Brown Kukri Snake (*Oligodon purpurascens*). These species have not been found in this area since, possibly due to habitat modification in Sime Road in the past 70 years.

Due to intensive research efforts on this cryptic group of animals in the last few decades, combined with the help of modern techniques analyzing DNA, additional records of herpetofauna in the MacRitchie area, or even new species for the country, can be expected. In order to provide a holistic reflection of herpetofaunal diversity in the Study Area, specimen records were also examined in museum collections in the Lee Kong Chian Natural History Museum in addition to undertaking a literature review.

### Findings of Primary Baseline Data

A total of 32 species of reptiles and 17 species of amphibians have been recorded from the primary baseline surveys. Species of conservation interest, as per the IUCN Red List (2015.02), the Singapore Red Data Book (2008) and the CITES Appendices I and II, are detailed in *Table 7.12*.

### Specific Records of Note

The Singapore Bent-toed gecko (*Cyrtodactylus majulah*) was first described in 2012 and has not yet been assessed by the Singapore Red Data Book (2008) or the IUCN Red List (2015.02). It has been recorded in Pulau Bintan in the Riau Archipelago of Indonesia as well as in Singapore in the forested areas of the CCNR. The finding of a gravid female in late February indicates a possible breeding season at that point<sup>105</sup>. This species has principally been recorded in the NSSF area of the CCNR, outside the MacRitchie area, with all specimens found 0.75–2 m above the ground in dense vegetation intersected by small streams. While predominantly occurring in swamp-forest, it was also recorded in old secondary lowland forest in the Upper Peirce Reservoir Park. The primary baseline survey of this study confirmed its existence in the Wetland Forest of MacRitchie area.

<sup>104</sup> Cross A (1944–1945) *Notes on the species of Ophidia and Lacertilia obtained at Sime Road Internment Camp, Singapore*. A series of type-written manuscripts at the Lee Kong Chian Natural History Museum, Singapore.

<sup>105</sup> Grismer LL, Wood, Jr PL and Lim KKP (2012) *Cyrtodactylus majulah*, a new species of bent-toes gecko (Reptilia: Squamata: Gekkonidae) from Singapore and the Riau Archipelago. *The Raffles bulletin of Zoology* 60(2): 487-499

The Asian Softshell Turtle from Peninsular Malaysia and Singapore has recently been shown to be a distinct species (ie *Amyda ornata*) from the original species complex (*Amyda cartilaginea*)<sup>106</sup>. The present primary baseline survey recorded this species for the first time within the MacRitchie area, and it is only the third record with locality information from Singapore, with the previous records being from NSSF and the Singapore Botanical Gardens<sup>107</sup>. As softshell turtles are highly aquatic and disperse through stream networks, they potentially occur throughout the Study Area regardless of habitat type.

The main observed faunal assemblage differences, was the scarcity / absence of several squamata and amphibian groups in the dryer months compared to the relatively wet periods of the year. Frog species such as Copper-cheeked Frog (*Hylarana labialis*) and Chorus Frog species (*Microhyla* spp. [*M. butleri* and *M. mantheyi*]), that were abundant in the wetter months were not observed during the dryer months. Calls of species associated with marsh habitats, including Golden-eared Rough-sided Frog (*Hylarana baramica*) and Masked Rough-sided Frog (*H. laterimaculata*) were also heard less often from the same sites. During September surveys also, no eggs or larval stages amphibian species could be detected, suggesting limited, if any, breeding by the local frog species at this time of the year.

Native herpetofauna may be affected by introduced species (being preyed on or competing for resources). The present survey detected some non-native herpetofauna which were noted here. Cricket Frog (*Fejervarya* aff. *limnocharis*) recorded in the grassland at the edge of Regeneration Forest A at Venus Link may represent either a new cryptic species or an introduced species, as it shares morphological and acoustic attributes with *F. teraiensis* from the northern Indian Subcontinent. Confirmed as a non-native frog to Singapore is the American Bull Frog (*Lithobates catesbeianus*). One adult of this species was found in a pond at the MacRitchie Visitor Centre during the present survey, the species being released by practitioners of Buddhism<sup>108</sup>. No breeding population of this species is on record, either at the MacRitchie site, or elsewhere in Singapore. Non-native reptiles observed during present survey included Red-eared Slider Turtle (*Trachemys scripta*), which is native to Neotropical regions and is introduced via pet trade. It is considered one of the top 100 global invasive species<sup>109</sup>. Numerous individuals were observed foraging, defending territory and basking in the MacRitchie Reservoir. A Saltwater Crocodile (*Crocodylus porosus*), was reportedly observed in the MacRitchie Reservoir in 2006 although it was not detected during our primary baseline surveys. This individual was possibly an escapee<sup>110</sup>; there is a native population at the coastal and mangrove areas of Singapore<sup>111</sup>.

<sup>106</sup> Fritz U, Gemel R, Kehlmaier C, Vamberger M & Praschag P (2014) Phylogeography of the Asian softshell turtle *Amyda cartilaginea* (Boddaert, 1770): evidence for a species complex. *Vertebrate Zoology*, 64(2):229–243

<sup>107</sup> Yong K (1990) On two species of softshell turtles native to Singapore, including a note on *Lissemys punctata* (Lacépède, 1788) (Reptilia: Testudines: Trionychidae). *The Raffles Bulletin of Zoology* 38(1): 27-30

<sup>108</sup> Das I, Yaakob NS, Sukumaran J, & Leong TM (2014) **Conservation status of amphibians of Malaysia and Singapore.** In: **Conservation biology of amphibians of Asia.** Amphibian biology. Vol. 11. Decline in the Eastern Hemisphere. pp:281–299. Heatwole H & Das I (Eds). Natural History Publications (Borneo) Sdn Bhd., Kota Kinabalu.

<sup>109</sup> Lowe SJ, Browne M & Boudjelas S (2004) **100 of the World's Worst Invasive Alien Species.** IUCN/SSC Invasive Species Specialist Group. Available at <http://www.iissg.org/publications.htm#worst100>

<sup>110</sup> Crocodile spotted at MacRitchie Reservoir. Available at <http://www.fishingkaki.com/forum/viewtopic.php?t=24498>

<sup>111</sup> Baker N & Lim K (2008) **Wild Animals of Singapore: A Photographic Guide to Mammals, Reptiles, Amphibians and Freshwater Fishes.** Draco Publishing and Distribution Pte. Ltd. and Natural Society (Singapore). Pp. 180



## Overall Evaluation of Herpetofauna

A total of 49 herpetofauna species have been recorded from the Study Area, with the primary baseline surveys yielding 32 reptile species and 17 amphibian species respectively (*Annex 8L*). Herpetofauna of conservation interest recorded in the Study Area have been summarized in *Table 7.12* based on historic records as well as the primary baseline surveys. Descriptions and conservation status are included, if available. The separation of Copper-cheeked Frog (*Hylarana labialis*) from *H. raniceps* being a recent one<sup>112</sup>, this nominal species is classified within a wider concept of *H. raniceps*, and once distributional data and population sizes are taken into consideration, a higher level of threat may emerge.

**Table 7.12 Herpetofauna of Conservation Interest Recorded in the Study Area**

Common Name	Scientific Name	Description	Conservation Status (Source)
<b>Skinks</b>			
Brown Tree Skink	<i>Dasia grisea</i>	Discovered at MacRitchie in 1994, arboreal and diurnal. Confined to Primary Forest.  Not detected in present survey.	EN (RDB) <sup>1</sup>
Malayan swamp skink (Undescribed)	<i>Sphenomorphus</i> sp.	Usually found near freshwater streams of mature secondary forest. One observation was made in MacRitchie in March 2009 at night <sup>113</sup> and one suspected juvenile along Sime Track, northwest of MacRitchie Reservoir in January 2015. <sup>114</sup>  A juvenile has been encountered on the trail close to the edge of stream in Primary Forest and Regeneration Forest A. Therefore likely to occur in the Wetland Forest area also.	CR (RDB)
Striped Sun Skink	<i>Eutropis rugiferus</i>	Observed once at Thomson Ridge in 1998 and recent record from June 2014 at same location  Not detected in present survey.	EN (RDB)
<b>Agamid and Flying Lizards</b>			
Black-bearded Flying Dragon	<i>Draco melanopogon</i>	Confined to mature forest  Not detected in present survey.	VU (RDB)
Five-banded Flying Dragon	<i>Draco quinquefasciatus</i>	Confined to mature forest and restricted in the CCNR. First recorded in Singapore in 2001.  Four were recorded during the surveys. One was found in quiescent state in Regeneration Forest A near Primary Forest and another in Primary Forest A, on a tree trunk behind the Jelutong Hut. One juvenile was recorded on low vegetation within and one adult on the trunk of a small tree, both within Regeneration Forest A.	EN (RDB)
Earless Agamid	<i>Aphaniotis fusca</i>	MacRitchie in 1997, confined to the north of MacRitchie Reservoir.  One was found sleeping on sapling in the Primary Forest with Regeneration Forest and Wetland Forest nearby.	EN (RDB)

<sup>112</sup> Stuart BL, Inger RF & Voris HK (2006) High levels of cryptic species diversity revealed by sympatric lineages of Southeast Asian forest frogs. *Biology Letters* 2:470–474

<sup>113</sup> Baker N (2013) **Malayan swamp skink *Sphenomorphus* sp. at MacRitchie forest.** Singapore Biodiversity Records 2013: 59

<sup>114</sup> Subaraj S (2015) **Malayan swamp skink *Sphenomorphus* sp. at Sime forest.** Singapore Biodiversity Records 2015: 28

Common Name	Scientific Name	Description	Conservation Status (Source)
<b>Geckos</b>			
Peninsular Rock Gecko	<i>Cnemaspis peninsularis</i>	Uncommon in MacRitchie. Mainly found on tree trunks and rocks, with an exceptional case in a culvert. Treated as Kendall's Rock Gecko ( <i>Cnemaspis kendallii</i> ) before <sup>115</sup> .  One was observed in Primary Forest.	VU as <i>Cnemaspis kendallii</i> (RDB)
Lowland Dwarf Gecko	<i>Hemiphyllodactylus typus</i>	Three observed on leaves of trees one night in Primary Forest in present survey; one was observed feeding on small invertebrates. Another adult was observed in Regeneration Forest A near Wetland Marsh on a different night survey and another adult recorded near the roof of a wooden shelter in Regeneration Forest A.	VU (RDB)
<b>Monitors</b>			
Clouded Monitor	<i>Varanus nebulosus</i>	Stronghold in MacRitchie.  Numerous observed foraging and basking	CITES I
Malayan Water Monitor	<i>Varanus salvator</i>	Commonly seen in mangroves, reservoir fringes and urban canals. A small population is known from the south-western portion of the MacRitchie Reservoir  One encountered in tree hole along the forest edge of Regeneration Forest A and one along a stream within Regeneration Forest A	CITES II
<b>Turtles</b>			
Malayan Box Terrapin (also named South Asian Box Turtle, Southeast Asian Box Turtle)	<i>Cuora amboinensis</i>	Commonly encountered in reservoirs and streams in 1997 surveys of the nature reserves <sup>116</sup> . This species is considered to have a relatively small and stable population in Singapore. <sup>2</sup>  One encountered in Wetland Marsh area near the Golf Link boardwalk.	VU (IUCN) <sup>2</sup> CITES II <sup>3</sup>
Malayan Flatshell Terrapin	<i>Notochelys platynota</i>	One observed in a stream near Wetland Marsh and Regeneration Forest A at present study.	EN (RDB) VU (IUCN) CITES II
Giant Asian pond terrapin	<i>Heosemys grandis</i>	Likely to be an introduced species. It was new to MacRitchie when an adult was found in 2014 in a shallow freshwater stream in the secondary forest of Venus Drive <sup>117</sup> .  One was observed in a stream near Wetland Marsh and Regeneration Forest A during the present study.	VU (IUCN) CITES II

<sup>115</sup> Grismer LL, Wood PJL, Anuar S, Riyanto A, Ahmad N, Muin MA, Sumontha M, Grismer JL, Onn CK, Quah ESH & Pauwels OSA (2014) Systematics and natural history of Southeast Asian Rock Geckos (genus *Cnemaspis* Strauch, 1887) with descriptions of eight new species from Malaysia, Thailand, and Indonesia. *Zootaxa* 3880(1): 1–147

<sup>116</sup> Teo R and Rajathurai S (1997) Mammals, Reptiles and Amphibians in the Nature Reserves of Singapore - Diversity, Abundance and Distribution. *Gardens' Bulletin Singapore* 49: 353–425

<sup>117</sup> Law IS (2014) **Giant Asian pond terrapin at Venus Drive forest**. *Singapore Biodiversity Records* 2014: 255

Common Name	Scientific Name	Description	Conservation Status (Source)
Spiny Hill Terrapin	<i>Heosemys spinosa</i>	Juveniles are found closer to water bodies whereas adults can be found farther away from water in drier forests. Juveniles were previously found in Primary and Regeneration Forest in 2004 and 2014, indicating presence of potential breeding sites <sup>118,119</sup>  During the survey, four adults were located in Primary and Regeneration Forest with streams nearby. Sime Trail was likely to be their home range.	VU (RDB) EN (IUCN) CITES II
Asian Softshell Turtle	<i>Amyda ornata</i>	First record of the MacRitchie area. Recorded in shallow (ca. 5 cm) water in a channel along Venus Trail during the survey of this study. Initially attempted to hide its head and forebody under vegetation debris of bank.	EN (RDB) VU as <i>A. cartilaginea</i> (IUCN) CITES II
Malayan Forest Softshell Turtle	<i>Dogania subplana</i>	Requires clean forest streams. A record was made from Rifle Range Forest within MacRitchie <sup>120</sup> .  Not detected in present survey.	CR (RDB) CITES II
<b>Crocodile</b>			
Estuarine Crocodile	<i>Crocodylus porosus</i>	Recorded in MacRitchie Reservoir and is likely an escapee.  Not detected in present survey.	CR (RDB) CITES I
<b>Snakes</b>			
Big-eye Green Whip Snake	<i>Ahaetulla mycterizans</i>	Restricted to mature and secondary forest. A recent record was made in 2014 in Venus Drive <sup>121</sup> . Diurnal and arboreal.  Not detected in present survey.	CR (RDB)
Red-tailed Racer	<i>Gonyosoma oxycephalum</i>	Arboreal. May be easily overlooked due to good camouflage amongst green foliage.  Not detected in present survey.	EN (RDB)
Orange-bellied Ringneck	<i>Gongylsoma baliodeirum</i>	Largely confined to forest  Not detected in present survey.	EN (RDB)
Twin-barred tree Snake	<i>Chrysopelea pelias</i>	Confined to forest. Majority of previous observations were road kills <sup>122</sup> . Arboreal and glides as a means of locomotion.  One was found in the Primary Forest with Regeneration Forest and Wetland Forest nearby during the present survey.	VU (RDB)
Elegant bronzeback	<i>Dendrelaphis formosus</i>	Known only from the CCNR. An adult was found in MacRitchie forest, Windsor end near Gardenia Road entrance in February 2014 <sup>123</sup> .  Not detected in present survey.	EN (RDB)

<sup>118</sup> Lim KKP (2014) **Dead juvenile spiny terrapin at Sime forest**. Singapore Biodiversity Records 2014: 73

<sup>119</sup> Chua MAH (2014) **Juvenile spiny terrapin at MacRitchie forest**. Singapore Biodiversity Records 2014: 142

<sup>120</sup> Cheong LF, Chua MAH, D'Rozario V, Jamal F, Khoon SK, Koh JKH, Lim KKP, O'Dempsey T and Rajathurai S (2014) **Cross Island Line Working Group Report**

<sup>121</sup> Ng MCF (2014) **Big-eye green whip snake at Venus Drive**. Singapore Biodiversity Records 2014: 21

<sup>122</sup> Teo R and Rajathurai S (1997) Mammals, Reptiles and Amphibians in the Nature Reserves of Singapore - Diversity, Abundance and Distribution. Gardens' Bulletin Singapore 49: 353–425

<sup>123</sup> Neo L and Yee ATK (2014) **Elegant bronzeback at MacRitchie forest**. Singapore Biodiversity Records 2014: 59

Common Name	Scientific Name	Description	Conservation Status (Source)
Dog-toothed Cat Snake	<i>Boiga cynodon</i>	Apart from CCNR forests, this species also occurs in degraded habitat on Pulau Ubin.  Not detected in present survey.	EN (RDB)
Gold-ringed Cat Snake	<i>Boiga dendrophila</i>	Apart from CCNR forests, this species also occurs in mangroves.  One was found in Regeneration Forest A with streams nearby during the present survey and a juvenile was recorded off a boardwalk near a Wetland Forest Area.	VU (RDB)
Wagler's Pit-viper	<i>Tropidolaemus wagleri</i>	An ambush predator found in forests and mangrove habitats.  A number of records in Primary, Regeneration and Wetland Forest. One was found on the Jelutong Tower during the present surveys.	EN (RDB)
Blue Malayan Coral Snake	<i>Calliophis bivirgatus</i>	Venomous and feeds mainly on other snakes including the Orange-bellied Ringneck ( <i>Gongylosoma baliodeirum</i> ) and Barred Kukri Snake ( <i>Oligodon signatus</i> ) <sup>124,125</sup> . Can be found in secondary forest.  Not detected in present survey.	VU (RDB)
Barred Kukri Snake	<i>Oligodon signatus</i>	Confined to the mature forest. This species has been recorded in both north and south of MacRitchie Reservoir <sup>126</sup> .  Not detected in present survey.	CR (RDB)
Variable Reed Snake	<i>Calamaria lumbricoidea</i>	Difficult to observe because of its burrowing habit  Not detected in present survey.	EN (RDB)
Pink-headed Reed Snake	<i>Calamaria schlegeli</i>	Difficult to observe because of its burrowing habit. An individual was recently recorded at Venus Loop in August 2014 <sup>127</sup>  Not detected in present survey.	VU (RDB)
Dwarf Reed Snake	<i>Pseudorabdion longiceps</i>	Ground-living and nocturnal. An individual has been observed on the boardwalk of Golf Link close to Jelutong Tower in February 2014 <sup>128</sup> .  One dead specimen observed during present surveys; a tread-upon individual found on path and one live specimen also recorded in Regeneration Forest A along the Rifle Range Link.	EN (RDB)
Blue-necked Keelback	<i>Macropisthodon rhodomelas</i>	Diurnal and terrestrial species that feeds largely on frogs and is known to be venomous. In Singapore, mainly recorded from the CCNR.  Observed in Regeneration Forest A of Sime Trail in the present survey.	EN (RDB)

<sup>124</sup> Mejia M (2014) **Blue Malayan coral snake biting orange-bellied ringneck**. Singapore Biodiversity Records 2014: 110

<sup>125</sup> Xu W and Teo YT (2013) **Blue Malayan coral snake biting barred kukri snake**. Singapore Biodiversity Records. 2013: 82-83

<sup>126</sup> Thomas N and Chua J (2014) **Blue Malayan coral snake biting barred kukri snake**. Singapore Biodiversity Records. 2014: 163-164

<sup>127</sup> Groenewoud D (2014) **Pink-headed reed snake at Venus Drive forest with a note on its bite**. Singapore Biodiversity Records 2014: 220-221

<sup>128</sup> Low BW and Ngiam RWJ (2014) **Dwarf reed snake at MacRitchie forest**. Singapore Biodiversity Records 2014: 77



Common Name	Scientific Name	Description	Conservation Status (Source)
Spotted Keelback	<i>Xenochrophis maculatus</i>	This semi-aquatic snake inhabits open lowland forests, near streams and ditches. Recorded in the secondary forest of Venus Drive, amongst leaf litter a temporary forest pool <sup>129</sup> .  Recently-shed skin of the keelback was found in pond within Bukit Golf Course with Marsh and Wetland Forest nearby during the present survey.	VU (RDB)
Reticulated Python	<i>Broghammerus reticulatus</i>	The largest snake in Singapore and is widespread in CCNR. It often makes use of drainage and sewerage system.  One was observed in Regeneration Forest A of Venus Link during the present survey.	CITES II as <i>Python reticulatus</i>
White-bellied Rat Snake	<i>Ptyas fusca</i>	Terrestrial, oviparous and diurnal species that is often found near and in water. Feeds on lizards and rats and appears to be non-venomous. Recorded only in the CCNR in Singapore.  Observed in sleeping on low vegetation in Regeneration Forest A in the present survey.	EN (RDB)
King Cobra	<i>Ophiophagus hannah</i>	World's largest venomous snake  Not detected in present survey	EN (RDB) VU (IUCN)
<b>Frogs</b>			
Manthey's Chorus Frog	<i>Microhyla mantheyi</i>	A few choruses recorded from Primary and Wetland Forest in present survey	CR (RDB)
Golden-eared Rough-sided Frog	<i>Hylarana baramica</i>	Advertisement calls heard as choruses in Wetland Forest in present survey	VU (RDB)
Cinnamon Bush Frog	<i>Nyctixalus pictus</i>	Call of one male heard in the Primary Forest with Regeneration Forest and Wetland Forest nearby during the present survey	VU (RDB)
Black-spotted Sticky Frog	<i>Kalophrynus limbooliati</i>	Population in Singapore was found to be another species <sup>130</sup> .  Not detected in present survey as it seldom comes out among leave litter.	VU as <i>Kalophrynus pleurostigma</i> (RDB)

#### Notes

(1) RDB: Red Data Book (2008)

(2) IUCN: IUCN Red List of Threatened Species

(3) Some turtles species found in Singapore are threatened at the international level due to massive trade throughout its distribution range in Asia. However, Singapore appears to possess a relatively healthy population which contributes to more positive conservation status for certain species in the Red Data Book as compared to the IUCN Red List.

In general the herpetofauna richness in this survey is consistent to that reported in the literature and previous surveys. The present study reported 32 and 17 species of reptile and amphibian respectively (Annex 8L), but it should be noted that non-intrusive methods (ie involving no ground excavation/sampling/entering into streams etc) were applied during the surveys. Species that are not detected in this study do not represent absence, especially those herpetofaunal species that are adapted to digging and life underground which would have gone unnoticed. Examples of these include the swamp or forest specialist species, Four-ridged Toad (*Ingerophrynus quadriporcatus*) and the nationally VU Black-spotted Sticky Frog (*Kalophrynus limbooliati*). Two nationally threatened forest-

<sup>129</sup> Ng NFC (2014) **Spotted keelback at Venus Drive**. Singapore Biodiversity Records 2014: 20

<sup>130</sup> Matsui M, Nishikawa K, Belabut DM, Ahmad N & Yong HS (2012). A new species of *Kalophrynus* (Amphibia, Anura, Microhylidae) from southern Peninsular Malaysia. Zootaxa 3155:38–46

dwelling species, Manthey's Chorus Frog (*Microhyla mantheyi*) and Cinnamon Bush Frog (*Nyctixalus pictus*), were recorded exclusively on the basis of acoustic data but not observed directly during the survey. From literature, Manthey's Chorus Frog (*Microhyla mantheyi*) was described in 2007 while Black-spotted Sticky Frog (*Kalophrynus limbooliati*) and Singapore Bent-Toed Gecko (*Cyrtodactylus majulah*) have been described in Singapore in the last decade<sup>131,132,133</sup>. The snake Haas's Bronzeback (*Dendrelaphis haasi*) was a new record for the MacRitchie area in 2013<sup>134</sup>. All these discoveries, together with the results from the present survey, show that the Study Area supports a high diversity of herpetofauna.

### 7.5.5 Butterflies and Odonates (Dragonflies & Damselflies)

#### Butterflies - Review of Species from Secondary Data

The species of butterflies in any particular area depend largely on the habitats or food sources present. In Singapore, butterflies can be found in several habitat types including the lowland forests within the CCNR and BTNR, open country areas including isolated forested areas and gardens, mangroves and urban areas especially those that possess significant soft landscaping. The majority of Singapore's butterfly species are found in the forest reserves (an estimated 60%) as these habitats are home to majority of the butterfly host and food plants. Butterflies in forest areas are generally either sun-loving, nectar-feeding and found at the top of tree canopies and clearings, or ground inhabiting species that feed on rotting fruit, tree sap, carrion, faeces, urine and sweat.

Currently there are over 300 species of butterflies recorded and extant in Singapore<sup>135,136,137</sup> and the large majority of these occur in the nature reserves with over 70 rare species<sup>138</sup>. Records of butterflies specifically in the Study Area are mainly collected by amateur enthusiasts and photographers and to some extent butterfly researchers. It is likely that over 190 species of butterflies can be found within the Study Area, of which six are listed as VU, EN or CR in the Singapore Red Data Book (2008). Details of these butterflies, and other notable species, obtained from the Singapore Red Data Book (2008) and supplemented by information from the Butterflycircle website are provided in *Table 7.13*.

The information on the host plants of butterfly species in Singapore is limited. Flowering plants (both native and exotic) that are popular with several butterfly species include the *Lantana camara*, *Melastoma malabathricum*, *Asystasia gangetica micrantha*, *Mikania micrantha*, and *Stachytarpheta indica*. Some *Syzygium* spp. trees in full bloom also attract swarms of butterflies and several butterfly species (subfamily: Danaeinae) are attracted to *Heliotropium indicum*.

<sup>131</sup> Das I, Yaakob NS & Sukumaran J (2007) A new species of *Microhyla* (Anura: Microhylidae) from the Malay Peninsula. *Hamadryad* 31:304–314

<sup>132</sup> Matsui M, Nishikawa K, Belabut DM, Ahmad N & Yong HS (2012). A new species of *Kalophrynus* (Amphibia, Anura, Microhylidae) from southern Peninsular Malaysia. *Zootaxa* 3155:38–46

<sup>133</sup> Grismer LL, Wood PL & Lim KKP (2012) *Cyrtodactylus majulah*, a new species of bent-toed gecko (Reptilia: Squamata: Gekkonidae) from Singapore and Riau Archipelago. *Raffles Bulletin of Zoology* 60:487–499

<sup>134</sup> Yeo SH (2013) **Haas's bronzeback at MacRitchie forest**. *Singapore Biodiversity Records* 2013: 113

<sup>135</sup> Khew SK (1997) Butterfly Biodiversity in Singapore with Particular Reference to the Central Catchment. *Gardens Bulletin* 49(1): 273-296

<sup>136</sup> Hian S N S (2001) **A Guide to Common Butterflies of Singapore** Singapore Science Centre

<sup>137</sup> **Butterflies of Singapore** (December 2014) Retrieved from <http://butterflycircle.blogspot.com/>

<sup>138</sup> Khew SK (1997) Butterfly Biodiversity in Singapore with Particular Reference to the Central Catchment. *Gardens Bulletin* 49(1): 273-296

Plant species that are known to be important to butterfly species of conservation interest within the Study Area include the *Asystasia gangetica micrantha*, *Aristolochia tagala*, *Combretum sundaicum*, *Dalbergia rostrata*, *Dendrophoe pentandra*, *Entada spiralis*, *Lantana camara*, *Macaranga bancana*, *Macaranga gigantea*, *Passiflora* spp., *Poikilospermum suaveolens*, *Saraca* spp., *Scurrula ferruginea*, *Stachytarpheta indica*, *Syzygium* spp. and *Zanthoxylum* spp..

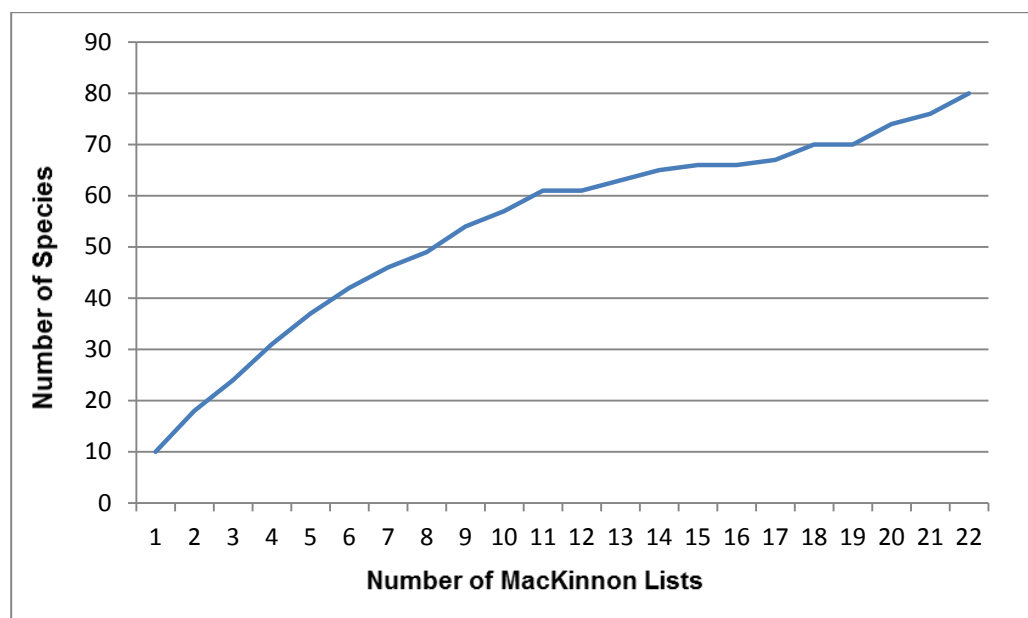
The Study Area is important for butterfly species in Singapore, with at least 190 species recorded there out of an approximate 310 extant butterfly species in Singapore. Research has also reportedly found that natural forest mosaics like those present at MacRitchie are important for butterfly diversity <sup>(139)</sup>, however specific details are not publicly available for inclusion.

### Butterflies - Findings of Primary Baseline Data to Date

A total of 84 species in 8 families were recorded during the initial baseline surveys between November 2014 to June 2015. No species of conservation interest were found. Common Grass Yellow (*Eurema hecabe*) was the most abundant (recorded in 13/22 lists), followed by Common Mormon (*Papilio polytes*) (11/22) and Common Five-Ring (*Ypthima baldus newboldi*) (10/22), while 18 of the 82 species were recorded on two of the 22 lists and 34 only on one. Magpie Crow (*Euploea radamanthus*) and Common Palmfly (*Elymnias hypremnestra*) had insufficient records and were excluded from the MacKinnon List. Additional surveys were conducted in September and October 2015 but yielded no additional species to the list of butterfly species observed.

The species accumulation trend shows that the number of recorded species continued to increase over the study period (Figure 7.8), suggesting sampling saturation has not been reached.

**Figure 7.8 Butterfly Species Discovery Curve**



<sup>139</sup> Vijay (2006) An Investigation of the Ecology of Butterflies in Natural Forest Gaps Within an Area of Secondary Rainforest in Singapore. (Unpublished BSc Thesis. University of Edinburgh)

### **Overall Evaluation - Butterflies**

Although no species of conservation interest was found during the primary baseline survey, 84 out of the 310 species recorded in Singapore were found (27% of total). It shows that the Study Area houses a relatively rich diversity of butterflies inhabiting various habitats and indicates high habitat quality overall (*Annex 8M*). This is a conservative figure as the species accumulation curve suggests that there may be more species recorded with continuous effort. However the baseline survey provided additional ground-truthed information to supplement the secondary review data.



**Table 7.13: Butterflies Species of Conservation Interest Recorded in the Study Area, as per Review of Secondary Data**

Common Name	Scientific Name	Description	Conservation Status (Source)
<i>CR, EN and VU listed species</i>			
Blue Helen	<i>Papilio prexaspes prexaspes</i>	A forest-dependent Swallowtail butterfly, its solitary form is usually observed primarily within the CCNR. First discovered in the Chestnut Drive area in the late 1990s, it is now believed to be a resident species. Males have frequently been observed puddling at sandy stream banks and damp footpaths within the forest where there is decomposing organic material but this species has also been observed flying amongst the canopy. This species has been observed feeding on the flowers of the <i>Asystasia gangetica micrantha</i> , <i>Lantana</i> spp., <i>Saraca</i> spp. and various <i>Syzygium</i> spp.	VU (RDB) <sup>Note 1</sup>
Common Birdwing	<i>Troides helena cerberus</i>	It is the only extant butterfly species in Singapore listed on the CITES Appendices. It is listed as VU given its dependence on the availability of its host plant <i>Aristolochia tagala</i> . It is a forest species but is drawn to cultivated areas where its host plant is found and has been recorded at the treetop level, occasionally descending to feed on flowering plants. It is widely distributed from northern India to Hong Kong, through Thailand, Malaysia and Singapore to the Indonesian islands and is not assessed in the IUCN Red List (2015.02).	VU (RDB)
Plain Lacewing	<i>Cethosia penthesilea methypsea</i>	It was first discovered in the 1990s in Singapore and recorded as a new taxon in the Singapore checklist in 1991 at the forest edge adjacent to nature reserves. Regular localized citing followed throughout the 1990s, although its closely related cousin, the Malay Lacwewing ( <i>Cethosia hypsea hypsina</i> ), was much more commonly seen. There were no records from circa 2000 until recently in 2014, when it was re-recorded after an apparent 14 year absence, with at least three individuals recorded. A <i>Passiflora</i> spp. is thought to be its caterpillar host plant and this species frequents forested areas within the nature reserves, often feeding on <i>Lantana camara</i> and <i>Stachytarpheta indica</i> . It is distributed in Myanmar, Thailand, Malaysia and Singapore and is not assessed in the IUCN Red List (2015.02).	CR (RDB)
Chocolate Sailor Banded Royal	<i>Neptis harita harita</i>	This species is restricted to several sites in the nature reserves and areas in northern Singapore. It can be found along the edges of forested areas at the nature reserves, most frequently in the northern parts of the CCNR. Adults are sun-loving and can be seen visiting flowers and feeding on fruits. The caterpillar host plant of this species is considered to be <i>Poikilospermum suaveolens</i> which is rare in Singapore and therefore likely to be a factor for the infrequent sightings of Chocolate Sailors. It is found throughout Southeast Asia.	VU (RDB)
Dark Flat	<i>Tapena thwaitesi bornea</i>	This butterfly has only been found in the CCNR and was considered 'very rare' in the Malay Peninsula in the 1990s <sup>140</sup> . However in Singapore, there has been a good number of sightings of the Dark Flat made each year. Its distribution appears to be restricted to the CCNR and BTNR and its caterpillar local host plant is believed to be <i>Dalbergia rostrata</i> . It is distributed from Peninsular Malaysia to Borneo.	EN (RDB)

<sup>140</sup> Fleming WA (1991) **Butterflies of West Malaysia and Singapore** Second edition. Longman Malaysia, Kuala Lumpur, Malaysia

Common Name	Scientific Name	Description	Conservation Status (Source)
Storey's Palmer	<i>Zela storeyi</i>	It was previously misclassified as <i>Zela zenon</i> and was re-classified in 2004. The genus <i>Zela</i> comprises some very rare species of butterfly in the Malaysian and Singapore and its caterpillars typically feed on rattan. This is the only representative found in Singapore so far and is most often encountered within the nature reserves, including one record in September 2012 in a patch of forest. It is distributed in Peninsular Malaysia, Singapore and Borneo.	CR (RDB)
<b>Species listed as "Presumed Nationally Extinct" or Data Deficient</b>			
NA <sup>Note 2</sup>	<i>Arhopala amphimuta amphimuta</i>	These two species possess almost indistinguishable underside markings. <i>Arhopala amphimuta amphimuta</i> is presumed nationally extinct and insufficient data is available for the assessment of conservation status for <i>Arhopala major major</i> data. Records of adults have largely occurred in the CCNR and BTNR where their respective host plants <i>Macaranga bancana</i> and <i>Macaranga gigantea</i> are relatively abundant. These butterflies are considered forest species.	NE (RDB)
NA	<i>Arhopala major major</i>		DD (RDB)
Large Four-line Blue	<i>Nacaduba pactolus odon</i>	Rediscovered in 2009, this species is almost indistinguishable in flight from other existing species of <i>Nacaduba</i> in Singapore. Although these species are uncommon in Singapore, adults have been sighted in multiple locations such as the CCNR, Southern Ridges, western wastelands and an offshore island, usually in sunlit spots in the vicinity of its host plant. Its caterpillar local host plant is <i>Entada spiralis</i> .	
Jewel Four-line Blue	<i>Nacaduba sanaya elioti</i>	Rediscovered in 2008, this species is almost indistinguishable when in flight from other existing species of <i>Nacaduba</i> in Singapore.	
Detached Dart	<i>Potanthus trachala tytleri</i>	Re-discovered in early 2011	
Great Orange Awlet	<i>Burara etelka</i>	It is now rarely encountered in Singapore and its caterpillar host plant is <i>Combretum sundaicum</i> , a common creeping weed in the CCNR. Given as "Rare" by RDB under the name of <i>Bibasis etelka</i> .	
Banded Redeye	<i>Gangara lebadea lebadea</i>	Considered to be 'Rare' in the Malay Peninsula <sup>141</sup> . There is little information regarding this species in Singapore.	NE (RDB)
Great Imperial	<i>Jacoona anasuja anasuja</i>	There is insufficient data to assess the conservation status of Great Imperial but it is rarely recorded in Singapore with only sightings mainly from the CCNR as well as small pockets of wooded areas to the west and north. It appears to be a tree-top dweller and its caterpillar host plants are <i>Dendrophloe pentandra</i> and <i>Scurrula ferruginea</i> .	
<b>Notes:</b> <sup>(1)</sup> RDB: Singapore Red Data Book (2008) <sup>(2)</sup> No common name is available for these species			

<sup>141</sup> Fleming W A (1991) **Butterflies of West Malaysia and Singapore** Second edition. Longman Malaysia, Kuala Lumpur, Malaysia

### Odonates - Review of Species from Secondary Data

Odonates include both true dragonflies and damselflies. These species have aquatic larvae which are carnivorous and can be affected by the water quality and ambient properties of the aquatic environments in which they live. All odonates are predatory in nature and feed on smaller insects including other odonates. Odonates serve as important food sources for birds, spiders and robber flies<sup>142</sup>. Currently there are over 120 species of odonates which have been recorded in Singapore, with 124 species up to 2010<sup>143,144</sup>. Murphy (1997)<sup>145</sup> documented 79 species from the CCNR and BTNR, noting that at there were at least eight more species that were difficult to capture for a more rigorous verification. Of the species Murphy recorded, 64 are likely to be from the Study Area. In 2012, a study conducted within the CCNR noted 16 odonate species along Petaling Trail in the Study Area<sup>146</sup>. In general, odonates are commonly studied in Singapore and the Study Area is likely to be home to around 87 species (*Annex 8F*).

Since Murphy's 1997 publication, there has been an alleged loss of several species, in particular those associated with forested to open stream habitats with fringing bank vegetation. This includes the Green Metalwing (*Neurobasis chinensis*). Another 19 species are listed as CR by the Singapore Red Data Book (2008). None of these are threatened species on the IUCN Red List (2015.02). All odonates of conservation interest from both secondary data and the surveys are summarized in *Table 7.13*.

### Odonates - Findings of Primary Baseline Data to Date

A total of 45 species in 11 families were recorded in 16 MacKinnon Lists from surveys conducted between November 2014 to June 2015. No confirmed species of conservation interest were found. However, the Stream Cruiser (*Macromia cincta*) and Lesser Stream Cruiser (*Macromia cydippe*) were regarded as rare and very rare in Singapore, respectively. Another 11 species were regarded as uncommon in Singapore. The present record of Fiery Gem (*Libellago aurantiaca*) is probably new to the Study Area and one further *Libellago* species was recorded near Bukit Golf course and a photograph is shown in *Annex 2*. Identification of this species has not been confirmed. Among the 45 species recorded, 9 species were only recorded in one among 16 lists and a further three species were recorded once incidentally. Additional surveys were conducted in September and October 2015 but yielded no additional species to the list of odonates observed.

Among all odonates recorded Common Parasol (*Neurothemis fluctuans*) was the most abundant (recorded in 14/16 lists), followed by Common Blue Skimmer (*Orthetrum glaucum*) (9/16), Spine-tufted Skimmer (*Orthetrum chrysis*) (9/16), Blue Sprite (*Pseudagrion microcephalum*) (8/16),

<sup>142</sup> Ng PKL, Corlett RT, Tan HTW (ed) (2011) Singapore Biodiversity – An encyclopedia of the Natural Environment and Sustainable Development. National University of Singapore. Pp. 552

<sup>143</sup> Tang HB, Ken WL, Hämäläinen M (2010) *A photographic guide to the Dragonflies of Singapore* Raffles Museum of Biodiversity Research

<sup>144</sup> Norma-Rashid, Cheong YLF, Lua HK and Murphy DH (2008). *The Dragonflies (Odonata) of Singapore: Current Status Records and Collections of the Raffles Museum of Biodiversity Research*. Raffles Museum of Biodiversity Research, Singapore. Available at [http://rmbr.nus.edu.sg/raffles\\_museum\\_pub/Dragonfly\\_of\\_Singapore.pdf](http://rmbr.nus.edu.sg/raffles_museum_pub/Dragonfly_of_Singapore.pdf)

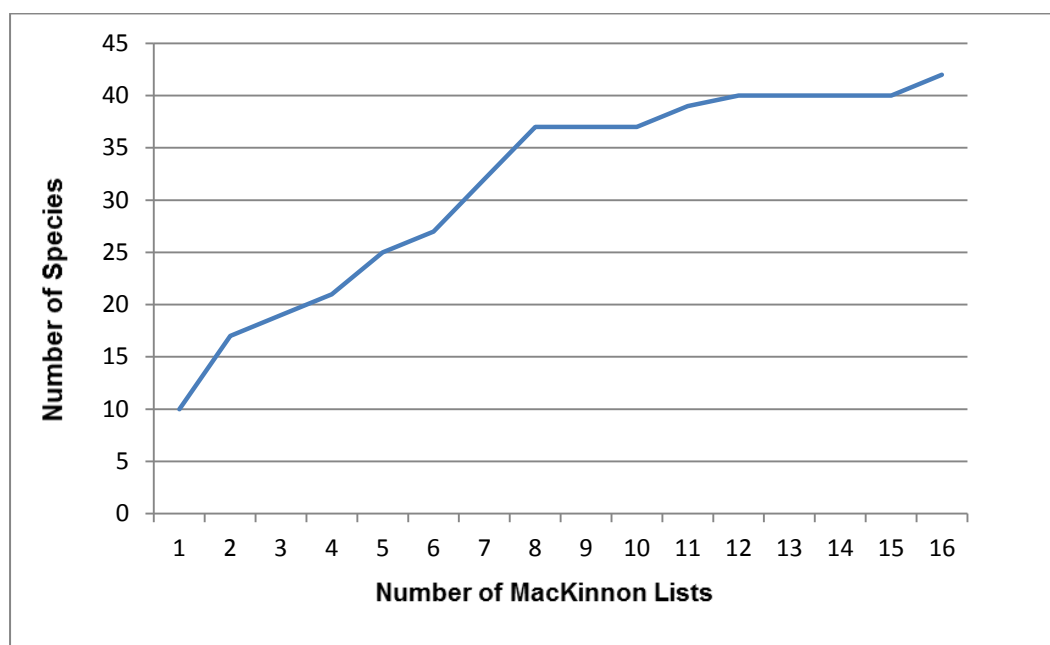
<sup>145</sup> Murphy DH (1997) *Odonate Biodiversity in Nature Reserves of Singapore*. Gardens Bulletin 49(1): 333-352

<sup>146</sup> Cheong YJ (2013) Study of Odonata species across streams and small ponds in fragmented forest part of Singapore.

Common Scarlet (*Crocothemis servilia*) (8/16) and Common Redbolt (*Rhodothemis rufa*) (8/16). Details can be referred in Annex 8N.

The species accumulation trend showed that the number of recorded species began to slow down at list 8, but still showed a trend of increase toward the end of the study period (Figure 7.9), suggesting further effort would record additional species.

**Figure 7.9 Odonate Species Discovery Curve**



### Overall Odonates Evaluation

All odonates depend on aquatic habitats to reproduce and some species forage in the same habitat, although some species forage far away from water and even migrate for long distance as adults. The presence of odonates, species composition, as well as abundance are important indicators of aquatic environment. The survey results show the importance of the Study Area for odonates which forms part of the odonate biodiversity stronghold in Peninsular Malaysia and Singapore<sup>147</sup>. All natural streams, wetland forest, wetland marshes, ponds, reservoirs and even channels are important habitats for odonates, especially the Wetland Marsh along Golf Link and the Regeneration Forest A in Old Track (GL01 and OT01 in Figure A-3, Annex 7.0), where the rare Stream Cruiser (*Macromia cincta*) and the very rare Lesser Stream Cruiser (*Macromia cydippe*) were observed.

Out of the 14 families of odonate recorded in Singapore, 3 families were absent in this study (Family Amphipterygidae, Family Megapodagrionidae and Family Platystictidae). Members of these families inhabit forest streams and dense forest habitats.

Only one member of the Family Gomphidae was recorded during primary baseline surveys (*Ictinophus decorates*), out of a total of nine species of this family known to occur in Singapore.

<sup>147</sup> Orr AG (2005) *Dragonflies of Peninsular Malaysia and Singapore*. Natural History Publications (Borneo). Pp. 127



Most members in this group utilize natural streams to breed and forage. Their presence or absence is a strong indicator of the water quality and siltation of streams. In other areas of the Oriental Region such as Hong Kong, Guangdong and Taiwan, members of this family usually emerge in April to August and have relatively short flight periods<sup>148,149,150</sup>.

Aeshnids (Family Aeshnidae) are also under represented in this study, with one species (*Gynacantha subinterrupta*) recorded out of ten on the Singapore list. Members in this family are strong flyers and seldom perch. Some are crepuscular and hence difficult to observe directly in the field.

Table 7.14 below lists all the odonates of conservation interest that have been recorded in the Study Area, both from the review of secondary data and the primary surveys.

**Table 7.14 Odonates of Conservation Interest Recorded in the Study Area**

Common Name	Scientific Name	Description	Conservation Status (Source)
<b>Damselflies</b>			
Green Metalwing	<i>Neurobasis chinensis</i>	First recorded in MacRitchie Reservoir in 1962 and the last observation made in 1970. Usually found at moderate to fast flowing clear forest streams or near waterfalls. It is believed to be extinct nationally due to habitat loss although it is considered common in Malaysia and listed as LC in the IUCN Red List (2015.02).	NE (RDB) <sup>1</sup>
Blue-nosed sprite	<i>Archibasis melanocyana</i>	Confined to MacRitchie Reservoir <sup>151</sup>	CR (RDB)
Violet Sprite/ Oval-spotted sprite	<i>Archibasis viola</i>		CR (RDB)
Variable Sprite/ Tiny midget	<i>Argiocnemis rubescens rubeola</i>	Found in the convergence streams and pools of the Upper MacRitchie basin. These convergence streams and pools comprise a variety of microhabitats including fairly open areas with scattered small trees and shaded edges and smaller, fully shaded pools <sup>152</sup> .	CR (RDB)
Dwarf Wisp/ Nana midget	<i>Agriocnemis nana</i>	Similar habitats as <i>Argiocnemis rubescens rubeola</i> , along more open streams.	CR (RDB)
Paddletail	<i>Oligoaeschna amata</i>		CR (RDB)
Blue-spotted Flatwing	<i>Podolestes orientalis</i>		CR (RDB)
Grey Sprite	<i>Pseudagrion pruinsum</i>		CR (RDB)
Red-tailed Sprite	<i>Teinobasis ruficollis</i>	Similar habitats as <i>Argiocnemis rubescens rubeola</i>	CR (RDB)
Grey Sprite	<i>Pseudagrion pruinsum</i>		CR (RDB)
<b>Dragonflies</b>			
Giant Hawker	<i>Tetracanthagyna plagiata</i>		CR (RDB)
Rise Clubtail	<i>Leptogomphus risi</i>		CR (RDB)

<sup>148</sup> Agriculture, Fisheries and Conservation Department (2011), **The Dragonflies of Hong Kong**. Friends of the Country Park, Cosmos Books Ltd., Hong Kong. Pp. 383

<sup>149</sup> Cao MH (2011) **Taiwan Dragonflies 120**. Wildbird Society of Taipei, Taiwan. Pp. 128

<sup>150</sup> Wu HD (2012) **Huizhou Dragonflies**. China Forestry Publishing House, China. Pp. 191

<sup>151</sup> Murphy DH (1997) Odonate Biodiversity in Nature Reserves of Singapore. Gardens Bulletin 49(1): 333-352

<sup>152</sup> Murphy DH (1997) Odonate Biodiversity in Nature Reserves of Singapore. Gardens Bulletin 49(1): 333-352

Common Name	Scientific Name	Description	Conservation Status (Source)
Handsome Grenadier	<i>Agrionoptera sexlineata</i>		CR (RDB)
Green-eyed Percher	<i>Chalybeothemis fluviatilis</i>		CR (RDB)
Lined Forest-skimmer	<i>Cratilla lineata</i>	First recorded in Singapore on a night safari in Aug 2006. Reported to occur in small shallow ponds in closed forest and forested swamps. Widely distributed in South and South-East Asia. Also recorded during PUB survey of MacRitchie Reservoir between Dec 2006 and July 2008 when it was found in areas with more marsh vegetation in secluded arms of the reservoir where shoreline vegetation was thick and the aquatic plant <i>Eleocharis retroflexa</i> and cicada tree <i>Ploiarium alternifolium</i> was found in great quantity.	CR (RDB)
Restless Demon	<i>Indothemis limbata</i>		CR (RDB)
Striped Grenadier	<i>Nesoxenia lineata</i>		CR (RDB)
Banded Skimmer	<i>Pseudothemis jorina</i>		CR (RDB)
Bronze Flutterer	<i>Rhyothemis obsolescens</i>		CR (RDB)
Saddlebag Glider/ Red Glider Dragonfly	<i>Tramea transmarina euryale</i>		CR (RDB)
Handsome Grenadier	<i>Agrionoptera sexlineata</i>		CR (RDB)
Shadowdancer	<i>Idionyx yolanda</i>	This species has been recorded several times each year up till 2010, suggesting its conservation status is less threatened than previously stated <sup>153,154</sup>	CR (RDB)

**Notes:**

<sup>(3)</sup> RDB: Singapore Red Data Book (2008)

Murphy (1997) noted that habitat could serve as an indicator of the types of species present at a particular locality. However, he observed that there were exceptions as some species found in a certain habitat were not found in similar environments at another location. Some species and their associated habitats are listed below:

- Blue-sided Satinwing (*Euphaea impar*) occasionally appears in the fringes of swamp forest but is more typically found at feeder streams or swamps in the CCNR and favors higher water speeds. It may be a possible indicator of erosion.
- Interrupted Threadtail (*Prodasineura interrupta*) occurs with Crescent Threadtail (*P. notostigma*) in the lower NSSF but not in similar habitats in the upper Nee Soon basin and other drainage systems.
- Treehugger (*Tyriobapta torrida*) and Scarlet Grenadier (*Lathrecista asiatica*) are found in the convergence streams and pools of the Upper MacRitchie basin. These convergence streams and pools comprise a variety of microhabitats including fairly open areas with scattered small trees and shaded edges and smaller, fully shaded pools.

<sup>153</sup> Tan HB, Ken WL, Hämäläinen M (2010) **A photographic guide to the Dragonflies of Singapore** Raffles Museum of Biodiversity Research

<sup>154</sup> Quek A (2014) **Dragonflies & Damselflies of Singapore - Dragonfly (46b) – *Idionyx yolanda*, male**. Retrieved from <http://singaporeodonata.wordpress.com/2014/09/>

- A CR damselfly, the Grey sprite (*Pseudagrion pruinsum*), and the common Yellow Featherlegs (*Copera marginipes*) were recorded in the meter pond along stream H.
- Crenulated Spreadwing (*Lestes praemorusus decipiens*) and Green-eyed Percher (*Chalybiothemis fluviatilis*) can only be found at MacRitchie Reservoir. The reservoir is also known to support odonate species that are independent of forest.

Overall the Study Area possesses several habitats favored by odonates and where several species of conservation interest have been recorded. As such, it can be considered as a key environment for odonates in Singapore.

### 7.5.6 Aquatic Community including Freshwater Fish and Decapod Crustaceans

#### Review of Species from Secondary Data

The terrestrial aquatic environment in Singapore includes both open fresh waters (such as artificial ponds, lakes in public parks, gardens and woodlands as well as open drainage and monsoon canals) and forest fresh waters (including shaded ponds, ditches and small temporary puddles as well as reservoirs and their wetland perimeter areas and forested springs and streams in nature reserves). Water depths vary but generally there is no deep water; all flowing waters rarely exceed two meters outside the monsoon season and the freshwater reservoirs such as MacRitchie, Peirce and Seletar are approximately 5-10 m deep at most<sup>155</sup>. The low topography of Singapore restricts its range of habitats and there are only temporary rapidly-flowing torrents and springs while brackish estuarine waters often extend up a large portion of each stream's total length<sup>156</sup>. Generally due to Singapore's relatively small size also, running water usually exists as short, shallow and slow flowing streams, as are found within the Study Area.

For the current review of the aquatic community, the focus is mainly on freshwater fish with consideration also of decapod crustaceans (crabs, prawns and shrimps), however, some information about other invertebrates is also included as well as a mention of aquatic invertebrates.

#### Freshwater Fish

A catalogue of freshwater fish of Singapore was first established in 1966 by E. R. Alfred and the current literature suggests there are over 65 species of freshwater fish in Singapore, including both native and exotic species<sup>157</sup>. Field studies have helped ascertain which of these species can be found in the Study Area, particularly a taxonomic review of freshwater fish of Singapore and a survey of the nature reserves (CCNR and BTNR) in the 1990s.<sup>158,159</sup> It is thought that around 75 native and

<sup>155</sup> Hendrich L, Balke M, Yang CM (2004) **Aquatic Coleoptera of Singapore: Species richness, ecology and conservation** The Raffles Bulletin of Zoology 52(1): 97-145

<sup>156</sup> Munro AD (1990) **Singapore Freshwater Fishes**. In: Chou L M & P K L Ng (eds.) Essays in Zoology. Papers Commemorating the 40th Anniversary of the Department of Zoology, National University of Singapore. National University of Singapore, Department of Zoology, Singapore. Pp. 97-125.

<sup>157</sup> NParks (2014) **List of Freshwater Fish Species Present in Singapore**. Available at [http://www.nparks.gov.sg/cms/index.php?option=com\\_content&view=article&id=84:freshwater-fish-species&catid=18:species-list&Itemid=191](http://www.nparks.gov.sg/cms/index.php?option=com_content&view=article&id=84:freshwater-fish-species&catid=18:species-list&Itemid=191)

<sup>158</sup> Ng PKL and Lim KKP (1996) **The freshwater fishes of Singapore**. Journal of the Singapore National Academy of Science. 22: 109 – 123.

<sup>159</sup> Ng PKL and Lim KKP (1997) The Diversity and Conservation Status of fishes in the Nature Reserves of Singapore. Gardens Bulletin 49(1): 245-265

exotic fish species occur in the MacRitchie Reservoir and the streams that feed it, approximately half of which are introduced (or exotic) species. Ng and Lim (1997), (acknowledging that recent surveys on the fish fauna within the nature reserves was not exhaustive due to some streams and reservoir inlets being difficult to access) list 26 extant native fish species that might occur within the MacRitchie Reservoir (within the CCNR area outside NSSF but not necessarily MacRitchie). Their findings also suggest that 60% of Singapore's extant native fish species are confined to waterways under forest cover and are only present in the CCNR and BTNR, with NSSF seemingly the most important area since a disproportionately large number of native species were recorded there and 11 species were known *only* from there or had their major populations there.

The Singapore Red Data Book (2008)<sup>160</sup> lists fifteen freshwater fish species that are CR or EN, all of which live only in natural streams under the canopy of mature forest. Recent surveys by Subaraj (2013)<sup>161</sup> have confirmed records of two species listed in the Red Data Book in the Study Area (Slender Walking Catfish *Clarias nieuhofii* and Harlequin Rasbora (*Trigonostigma heteromorpha*). Ng and Lim (1997) also reported four of these listed species were present in the MacRitchie Reservoir or streams and swamps in the Sime Road Forest area including: Harlequin Rasbora (*Trigonostigma heteromorpha*); The Malayan Pygmy Rasbora/ Dwarf Rasbora (*Boraras maculatus*); Barbel-less Chemperas (*Cyclocheilichthys apogon*); and Malayan Leaf-fish/ Sunda Leaf-fish (*Nandus nebulosus*). In addition it is uncertain whether a further two listed species, the Six-banded Tiger Barb *Systomus hexazona* (formerly *Puntius hexazona*), and Malayan Pikehead/ Brown Pikehead (*Luciocephalus pulcher*) are present in the MacRitchie area. Therefore overall the literature suggests that up to seven freshwater fish species listed in the Singapore Red Data Book (2008) (ie almost 50%) are present in the Study Area. Available data suggest that two species of conservation interest, the Pikehead (*Luciocephalus pulcher*) and the Six-banded barb (*Systomus hexazona*) which prior to 2005 were known only from deep within the CCNR, have extended their range and occur in MacRitchie Reservoir, where they were locally abundant at locations where they occurred. The Harlequin rasbora (*Trigonostigma heteromorpha*) had also not been previously recorded from the reservoir itself, but had been recorded previously from streams in the Sime Road area. The report also noted that the five species of conservation interest that it recorded came from swamp-type habitats in the tips of some of the northern inlets, which were extensions of the swamp forest system with the CCNR. These habitats also appeared to be nurseries for many of the larger fish species found elsewhere in the reservoir (eg the giant gourami [*Osphronemus goramy*]), as noted by the high number of juveniles caught in these areas.

Freshwater fish in the Study Area, reported from secondary data, are listed in *Annex 8G*. Further detail on each of these species which are of conservation interest, is provided in *Table 7.15* together with the primary baseline survey results.

Finally the existence and problem of introduced, exotic species into Singapore's aquatic systems should be noted since they are often known to displace native species, or have other undesirable effects on native wildlife. The aquarium fish trade and the food fish trade are the main contributors to this exotic fish diversity with many species having adapted well to conditions independent of human husbandry and established self-sustaining populations in the wild, even if their survival may not be long-term. About 52 introduced fish species have been recorded in

<sup>160</sup> Davison GWH, Ng PKL and Ho HC. (2008) **Singapore Red Data Book**.

<sup>161</sup> Data not published



Singapore's freshwaters of which 17 have established feral populations<sup>162</sup>. One such example for species found in the MacRitchie area is the distribution of native Asian common walking catfish (*Clarias batrachus*) (itself normally an invasive species) declining due to the introduction and establishment of the introduced African sharptooth catfish (*Clarias gariepinus*)<sup>163</sup>. The NUS biodiversity surveys also noted very large numbers of smaller alien species such as the Indochinese glass perchlet (*Parambassis siamensis*) and red-tailed rasbora (*Rasbora borapetensis*) found within the swamp-type habitats in the tips of some of the northern inlets were concerning given the their connectivity with, and therefore potential encroachment into, the swamp forests within the rest of the CCNR that could impact on the native fish fauna. The issue of exotic populations in the aquatic community also affects the decapod crustaceans.

### Decapod Crustaceans

Decapod crustacean fauna of Singapore have mostly been discovered and described in the last 25 years. They include some of the very few species that are endemic to Singapore, namely three crab species that are totally freshwater and produce few numbers of large eggs that hatch directly as juveniles or highly developed larvae (Singapore freshwater crab *Johora singaporensis*, Johnson's Freshwater Crab *Irmengardia johnsoni* and Swamp Forest Crab *Parathelphusa reticulata*)<sup>164</sup>.

The literature generally talks of the threat to native decapod crustaceans from introduced species and the management of this threat (such as from the Australian, Red-Claw crayfish *Cherax quadricarinatus*). It also reports that many species of these decapods are extremely sensitive to polluted or silted water and talks of the need to preserve patches of natural forest large enough to maintain good water quality for successful conservation efforts.<sup>(165)</sup> Although not found in the MacRitchie area of the CCNR but rather only in the Nee Soon Swamp Forest, the population decline of the Singapore freshwater crab *Johora singaporensis* is suggested as being as a result of anthropogenic acidification of a tropical freshwater system (in the Nee Soon Swamp Forest), highlighting the issue of potential acidification of streams from acid rainfall as a threat to decapods<sup>(166)</sup>.

### Other Aquatic Invertebrates

One hundred and one (101)<sup>167,168</sup> aquatic beetle species have been recorded in Singapore of which eight are believed to be locally extinct, and 27 species are listed as threatened<sup>169</sup>. Overall at least seven species are known from MacRitchie area, including:

<sup>162</sup> Ng PKL and Lim KKP (1997) The Diversity and Conservation Status of fishes in the Nature Reserves of Singapore. Gardens Bulletin 49(1): 245-265

<sup>163</sup> Ng HH, Low BW, Kwik JTB, Yeo D C J (2013) **The tables are turned: an invasive species under potential threat** Biological Invasions 16(8):1567-1571

<sup>164</sup> Ng PKL, Corlett RT, Tan HTW (ed) (2011) Singapore Biodiversity – An encyclopedia of the Natural Environment and Sustainable Development. National University of Singapore. Pp. 552

<sup>165</sup> Cumberlidge N, Ng PKL, Yeo DCJ, Magalhaes C, Campos MR (2009) **Freshwater crabs and the biodiversity crisis: importance, threats, status, and conservation challenges**. Biological Conservation 142: 1665–1673

<sup>166</sup> Ng DJJ, Yeo DCJ, Sivasothi N, Ng PKL (2014) Conservation challenges and action for the Critically Endangered Singapore freshwater crab *Johora singaporensis*. Oryx

<sup>167</sup> Hendrich L, Balke M, Yang CM (2004) **Aquatic Coleoptera of Singapore: Species richness, ecology and conservation**. The Raffles Bulletin of Zoology 52(1): 97-145

<sup>168</sup> Jach MA, Diaz JA, Skale A (2013) **The Hydraenidae (Coleoptera) of the Republic of Singapore**. The Raffles Bulletin of Zoology 61(1): 53-71

- *Amphipos mater sumatrensis* (Family: Hydrophilidae), a native water beetle considered widespread and common in Singapore and 3 in MacRitchie Reservoir;
- *Hydraena* (Hydraenopsis) *michaelbalkei* recorded in a shaded pool with grass near the Sime Road and is so far known only from Singapore at MacRitchie Reservoir;
- *Hydraena* (Hydraenopsis) *yangae*, found on the sandy margin of a very shallow and slow flowing, shaded stream, near Rifle Range Road;
- *Hydrocanthus indicus* including close to Sime Road;
- *Hydaticus reductus*;
- *Dineutus* (Spinodineutes) *spinosus*;
- *Enochrus icterus*;
- *Orectochilus* sp. (a Whirligig beetle), known to be native with a restricted and common status in both Singapore and the MacRitchie Reservoir; and
- An undescribed *Bagous* sp.

In addition other secondary data available suggests nine native water skaters (Family: Gerridae) and a water treader (Family: Gyrinidae) have been recorded from the MacRitchie Reservoir:

- *Amemboa* cf. *brevifasciata*. Listed as restricted and uncommon in both Singapore and more locally in the MacRitchie Reservoir
- *Aquarius adalaidis*. Listed as widespread and common in Singapore but uncommon and/or restricted in the MacRitchie Reservoir;
- *Limnogonus fossarum fossarum*. Listed as widespread and common in Singapore but restricted and common in the MacRitchie Reservoir
- *Limnometra ciliate*. Listed as restricted and common in Singapore but uncommon and/or restricted in the MacRitchie Reservoir;
- *Metrocoris tenuicornis*. Listed as restricted and common in Singapore
- *Neogerris parvulus*. Listed as widespread and common in Singapore but uncommon and/or restricted in the MacRitchie Reservoir;
- *Ptilomera tigrina*. Listed as restricted and common in Singapore but rare and/or restricted in the MacRitchie Reservoir
- *Rhagadotarsus kraepelini*. Listed as widespread and common in Singapore and the MacRitchie Reservoir;
- *Ventidius hungerfordi*. Listed as restricted and common in both Singapore and more locally in the MacRitchie Reservoir; and
- *Mesovelgia hovarhi*. Listed as widespread and common in Singapore but restricted and common in the MacRitchie Reservoir.

In addition Blakely et al (2014) sampled for macroinvertebrates in a number of locations within the MacRitchie Reservoir Catchment area.

### Findings of Primary Data

A total of 23 sampling sites were surveyed at the following locations: Forest streams within the CCNR ie along Sime Trail and Golf Link; forest streams outside the CCNR ie along Venus Link and Ponds at

<sup>169</sup> Hendrich L, Balke M, Yang CM (2004) *Aquatic Coleoptera of Singapore: Species richness, ecology and conservation*. The Raffles Bulletin of Zoology 52(1): 97-145

three golf courses ie Bukit, Sime and Island Golf Course, where the latter included some edges of Lower Pierce Reservoir.

At least 14 freshwater fish species were observed and spotted in the forest streams located within and outside the CCNR using bank-side observation technique. The most diverse fish species found belonged to the Family Cyprinidae with five species followed by Channidae and Hemiramphidae with two species each. The most dominant fish species found in the forest streams was the Malayan Pygmy Halfbeak (*Dermogenys collettei*) followed by Two-Spotted Rasbora (*Rasbora elegans*), Saddle Barb (*Systemus banskii*), Common Snakehead (*Channa striata*), White Spot (*Apllocheilus panchax*) and Harlequin Rasbora (*Trigonostigma heteromorpha*). Details can be referred to Annex 8P.

The highest fish diversities were recorded at Sime Trail and Golf Link during the surveys, with a total of nine fish species. Both of these sites could be characterized as riverine forest pools. At the Venus Link, the highest fish diversity was recorded at V1 and V2 with a total of seven fish species. Most of the fish observed at the Study Area were at adult or sub-adult stages. According to Singapore Red Data Book (2008), besides the Harlequin Rasbora (*Trigonostigma heteromorpha*), which is listed as *Endangered*, most other fish species observed were either categorized as *Restricted To Few Areas but Common* or *Widespread and Common*. One Malayan Boneytongue (*Scleropages formosus*) was observed at S4 from a bridge along the Sime Trail and this species is listed as *Endangered* on the IUCN Red List (2015.02). However, it is considered to be an introduced species in Singapore<sup>170</sup> and therefore not of conservation interest. All fish species observed were also listed as *Native* except for the Malayan Boneytongue described previously and the guppy (*Peocilia reticulata*), which are both Introduced species. Guppies were only found in the streams along the Venus Link. Aquatic species of conservation interest are summarized in Table 7.15.

Macroinvertebrates ie freshwater prawns and crabs were also observed in the forest streams. Freshwater prawns (*Macrobrachium* spp.) were recorded at three locations ie two points along Sime Trail and one point at Venus Link. An unidentified freshwater crab was recorded near Sime Trail during the night survey.

Aquatic insects, particularly the Water Boatman (Corixidae) was observed at almost all the sites surveyed indicating good water quality prevailing in the forest streams.

Fish were not observed at ponds surveyed within the three golf courses except for unidentified fingerlings at the Bukit Golf Course. According to the golf course manager at Island Course, the ponds within the golf course have been stocked with Chinese carp.

Fish were also not observed at the sites surveyed at the edge of Lower Peirce Reservoir. However, an interview with a worker at the site indicated that Giant River Catfish (*Wallago attu*), Giant Snakehead (*Channa micropeltes*), Common Snakehead (*C. striata*), Marbled Gudgeon (*Oxyeleotris marmorata*) and freshwater ray were found in the reservoir.

<sup>170</sup> Baker N (2013) Juvenile Asian arowana at Lower Peirce. Singapore Biodiversity Records 2013: 21

**Table 7.15: Aquatic Species of Conservation Interest Recorded in the Study Area**

Common Name	Scientific Name	Description	Conservation Status (Source)
<b>Freshwater Fish</b>			
Slender Walking Catfish	<i>Clarias nieuhoifii</i>	<p>It was reported to have been recorded in the CCNR as well as in Pulau Tekong in Singapore and is also native to Cambodia, Indonesia (Jawa, Kalimantan, Sumatra), Malaysia (Peninsular Malaysia, Sarawak), Philippines, Thailand and Vietnam. Still abundant in many parts of its known distribution<sup>171</sup>.</p> <p>Nocturnal, bottom-dwelling and carnivorous and found in well shaded forest streams and swamps with acidic waters.</p> <p>Not detected in present survey.</p>	CR (RDB) <sup>1</sup>
Harlequin Rasbora	<i>Trigonostigma heteromorpha</i>	<p>Restricted to the CCNR although it is also found in Malaysia (Peninsular Malaysia) and Thailand and is not listed as threatened species on the IUCN Red List (2015.02). The key threat is its popularity as an aquarium fish but also forest destruction. It is reported to be mainly insectivorous and found in upper and middle water levels.</p> <p>This was the only species of conservation interest observed during the present surveys, confined to Sime Trail and Golf Link.</p>	EN (RDB)
Malayan Pygmy Rasbora/ Dwarf Rasbora	<i>Boraras maculatus</i>	<p>Restricted to the CCNR in Singapore, found only in small numbers at very few locations. It is also found in Malaysia (Peninsular Malaysia) and Thailand and is not listed as threatened species on the IUCN Red List (2015.02). The key threat is its popularity as an aquarium fish. It is reported to be found in quiet forest streams with slow-flowing acidic waters.</p> <p>Not detected in present survey.</p>	CR (RDB)
Barbel-less Chemperas/ Beardless Bard	<i>Cyclocheilichthys apogon</i>	<p>Restricted to the CCNR in Singapore although it is also found in Cambodia; Indonesia (Kalimantan, Sumatra); Malaysia (Peninsular Malaysia, Sarawak); and Thailand. Key threats are listed as habitat degradation. It is reported to inhabit shaded forest streams where it dwells in midwater and feeds on small aquatic invertebrates.</p> <p>Not detected in present survey.</p>	EN (RDB)
Malayan Leaf-fish/ Sunda Leaf-fish	<i>Nandus nebulosus</i>	<p>Restricted to the CCNR in Singapore although it is also found in Cambodia; Indonesia (Java, Kalimantan, Sumatra); Malaysia (Peninsular Malaysia, Sarawak); and Thailand. Key threats are listed as habitat degradation and illegal collection. It is reported to inhabit slow-flowing, well shaded forest streams in Singapore and be a solitary fish with cryptic coloration.</p> <p>Not detected in present survey.</p>	CR (RDB)

<sup>171</sup> IUCN (2014) Red List of Threatened Species. Available at [www.iucnredlist.org](http://www.iucnredlist.org)



Common Name	Scientific Name	Description	Conservation Status (Source)
Six-banded Tiger Barb	<i>Systomus hexazona</i> (formerly <i>Puntius hexazona</i> )	Restricted to the CCNR in Singapore. It also reports this species is found in the Peninsula Malaysia, Sumatra and Borneo with key threats being habitat destruction and illegal collection. It is reported to be an omnivorous and gregarious fish that frequents middle and lower water levels and can be found in undisturbed, shaded streams in swamp-forest, with flowing acidic water.  Not detected in present survey.	CR (RDB)
Malayan Pikehead/ Brown Pikehead	<i>Luciocephalus pulcher</i>	Restricted to the CCNR in Singapore but also found in Peninsula Malaysia, Sumatra and Borneo. Key threats are considered to be habitat destruction and illegal collection due to its value as an aquarium fish but this species is not listed on the IUCN Red List <sup>172</sup> . It is reported to occur in streams and flooded forest among dense vegetation and be a mouth brooder with highly protrusible jaws <sup>173</sup> .  Not detected in present survey.	CR (RDB)
<b>Decapod Crustaceans</b>			
Johnson's Freshwater Crab	<i>Irmengardia johnsoni</i>	Endemic to Singapore. Although it is recorded in the BTNR and mainly from NSSF in the CCNR, it has been confirmed to occur in the Sime Road area of the Study Area, from a stream running through a 'secondary forest' with clay-sand substratum and gently flowing water with a pH of 6 <sup>174</sup> . This species prefers slower parts of shaded streams, and sometimes is found under rocks, but usually among leaf litter with muddy substrates and predominantly feeds on dead leaves and freshwater oligochaete worms <sup>175</sup> .  Not detected in present survey.	EN (RDB) VU (IUCN)
Temasek Shrimp	<i>Caridina temasek</i>	Endemic until being found in Peninsular Malaysia, Sarawak and West Kalimantan. In Singapore it has been described in just one small stream in the Sime Road area from a stream draining into the northwestern arm of MacRitchie Reservoir, in the same location as where Johnson's Freshwater Crab <i>Irmengardia johnsoni</i> has been recorded. <sup>(176)</sup>  Not detected in present survey.	EN (RDB)
Riverine alpheid shrimp	<i>Potamalpheops amnicus</i>	The specimens recorded from Singapore are potentially the result of water transfer from Johor (in nearby Malaysia) to Singapore but have been described from the stream draining into the northwestern arm of the MacRitchie Reservoir. This shrimp burrows into soft mud along the stream's edges is restricted to acid forest freshwater streams.  Not detected in present survey.	EN (RDB) EN (IUCN)

**Notes:**

<sup>(1)</sup> RDB: Red Data Book of Singapore (2008)

<sup>172</sup> IUCN (2014) **Red List of Threatened Species**. Available at [www.iucnredlist.org](http://www.iucnredlist.org)

<sup>173</sup> FishBase. **Luciocephalus pulcher**. Available at <http://www.fishbase.org/summary/Luciocephalus-pulcher.html>

<sup>174</sup> Choy SC, Ng DJJ (1991) A New Species of Freshwater Atyid Shrimp, *Cardinia temasek* (Decapoda: Caridae: Atyidae) from Singapore. Raffles Bulletin of Zoology 39(2): 265-277

<sup>175</sup> Esser L, Cumberlidge N (2008) *Irmengardia johnsoni* The IUCN Red List of Threatened Species. Version 2014.3. Available at <http://www.iucnredlist.org/details/134929/0>

<sup>176</sup> Choy SC, Ng DJJ (1991) A New Species of Freshwater Atyid Shrimp, *Cardinia temasek* (Decapoda: Caridae: Atyidae). The Raffles Bulletin of Zoology 39(2): 265-277

### Overall Aquatic Community Evaluation

The streams that were surveyed indicated that they were in a reasonably pristine state, despite the fact that the forested catchment surrounding it appeared disturbed and, to a very limited extent, developed for recreation. The dominance of Cyprinids is characteristic of the natural ichthyofaunal profile of most equivalent streams and rivers in the Indo Malayan region<sup>177</sup>. The exception to this would be in peat swamps, estuarine areas and others, none of which apply to the Study Area.

CCNR and is a vital stronghold for Singapore's freshwater biodiversity. Of the 15 species of freshwater fish listed in the Singapore Red Data Book (2008) all live only in natural streams under the canopy of mature forest and such habitats are found mainly within the wider CCNR of Singapore, emphasizing the importance of this wider area to these taxa. Specifically seven of the species listed in the Singapore Red Data Book (2008) as CR or EN have been found within MacRitchie area. This confirms the importance of the shaded forest streams in this section of the CCNR that have slightly acidic waters where these species are generally confined to. Studies have noted the limited accessibility of all streams within the Study Area and therefore spatial results may be distorted. However, various studies have noted the presence of species of conservation interest across a number of families at the streams draining from Upper Peirce Reservoir to MacRitchie Reservoir in the south west of the MacRitchie Reservoir and near the Sime Road, emphasizing the ecological importance of these streams. Working to the precautionary principle, streams in the MacRitchie area in less accessible locations that are further from human disturbance are highly likely to have equal if not more ecological importance.

### 7.6 OVERALL DISTRIBUTION OF SPECIES OF CONSERVATION INTEREST

Overall the evidence from reviewed literature and the primary baseline surveys suggest that the CCNR is of high ecological and biodiversity value. *Figure 7.10* and *Figure 7.11* illustrate the indicative locations of fauna of conservation interest recorded to date. These locations reflect different habitat types and areas that are important to various wildlife species although the range of different species must be considered when reflecting on where they were recorded and the extent of habitat(s) that they might use. Outside the NParks managed area, the Study Area is generally of lower ecological and biodiversity value, including more urbanized areas and habitat on the fringes of such development. There are some areas, however, such as Regeneration Forest A outside the NParks managed area, that still maintain high ecological and biodiversity value, such as that near Bukit Golf Course which is separated from the NParks managed area only by a narrow trail and is largely one continuous area of Regeneration Forest A up to the golf course fairway boundary.

<sup>177</sup> Revenga C & Kura Y (2003) *Status and Trends of Biodiversity of Inland Water Ecosystems*. Secretariat of the Convention on Biological Diversity, Montreal, Technical Series no. 11.

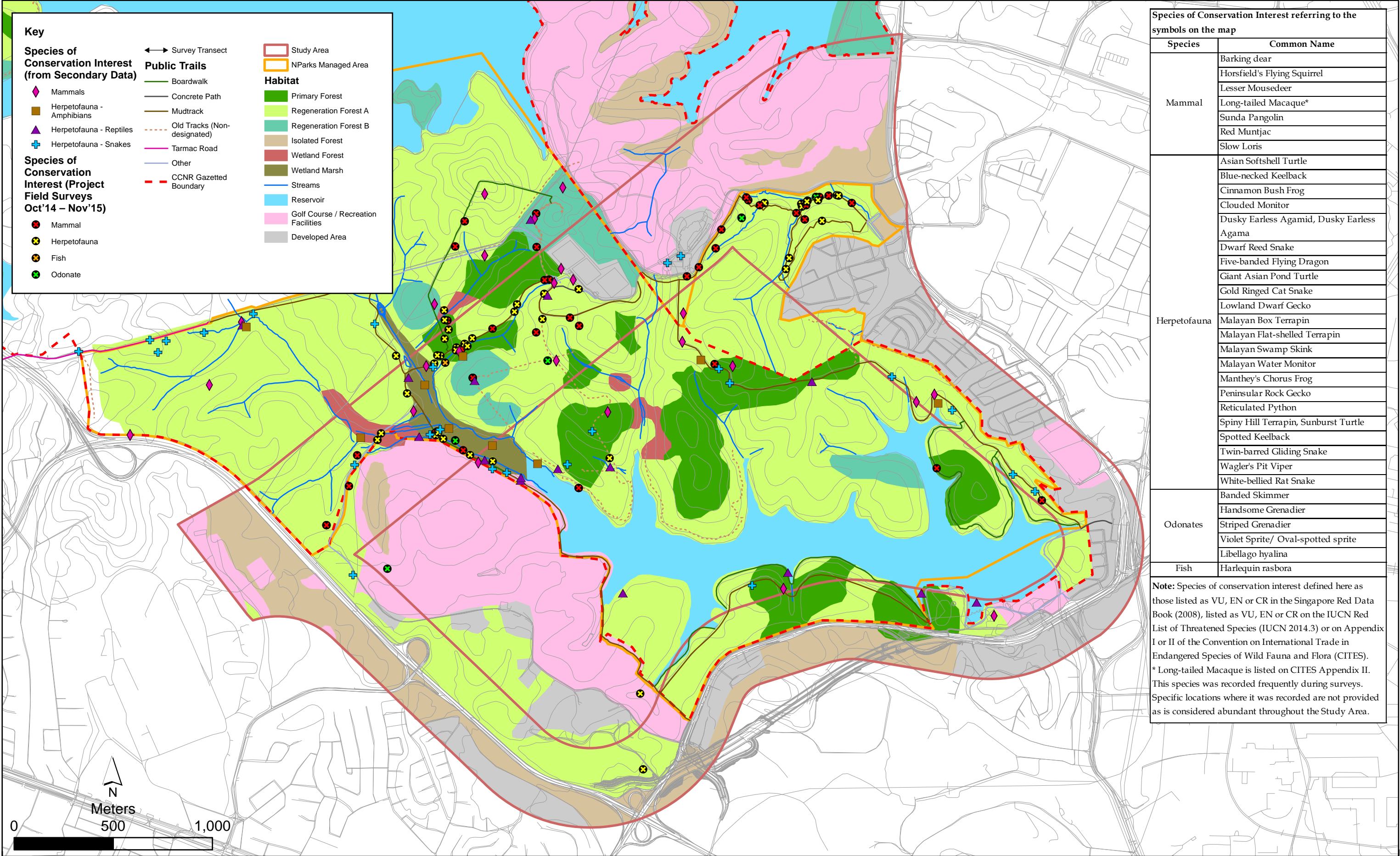


Figure 7.10 Species of Conservation Interest (Mammal, Herpetofauna, Odonate and Fish)



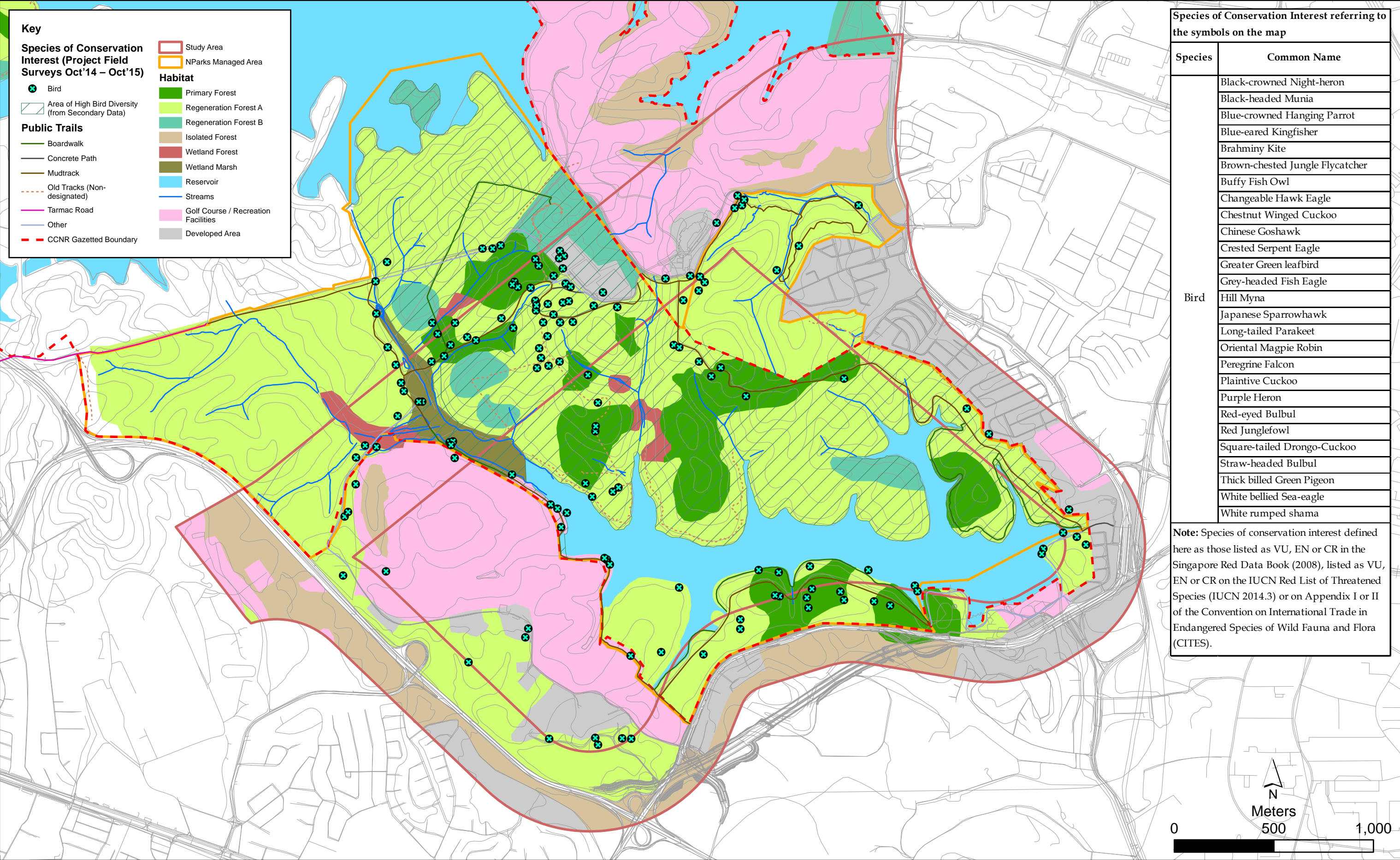


Figure 7.11 Species of Conservation Interest (Avifauna)



## Annexes

Annex 1.0

## CCNR Trail User Survey

## ANNEX 1.0 CCNR TRAIL USER SURVEY

This annex outlines the methodology and findings of human user count surveys of selected trails within the CCNR.

### A1.1 METHODOLOGY

The objective of the survey was to establish a baseline number of human users utilizing public areas of the CCNR in proximity to areas of the proposed SI within CCNR.

#### A1.1.1 User Count Locations

The following three locations (as illustrated on *Figure A-1*) were selected to conduct the survey, based on the potential mobilization and demobilization routes for the SI related vehicles and areas where proposed SI would be completed:

- *Location A*: Intersection of Sime Track-Rifle Range Link-Golf Link,
- *Location B*: Intersection of MacRitchie Nature Trail-Venus Trail-Terentang Trail, and
- *Location C*: MacRitchie Reservoir Visitor's center, where the intersection of extensions of Chemperai, Lornie, Prunus and Petai Trails is located.

**Figure A.1: User Count Survey Locations**



### **A1.1.2 Survey Period and Protocol**

Surveys were completed during the months of December 2014, January 2015 and February 2015. At each location, human users numbers were recorded during a weekday morning (0730 to 1430) and afternoon (1330 to 1930); and a weekend morning and afternoon to capture peak and off peak user times.

Two surveyors recorded the number of users at each location along with the nature of trail use during the prescribed timeframes. Surveyors noted the direction in which each trail user was headed towards to provide an understanding of how the trails are typically utilized.

### **A1.2 FINDINGS**

Recreational users of the CCNR trails generally consisted of walkers/hikers, joggers/runners, and cyclists. Results of the survey are presented in *Table A-1* for each major trail in the CCNR and sorted according to time of day, and nature of use.



**Table A-1: Summary Findings of Survey**

Trail Name	Number of Users (Sorted by Time of Day)				Number of Humans Utilizing Trails (Sorted by Activity) <sup>(Note 1)</sup>			
	Weekday AM	Weekday PM	Weekend AM	Weekend PM	Walkers/Hikers	Joggers/ Runners	Bicycles	Others
Sime Trail	157	212	1,407	602	201 <b>1426</b>	163 <b>580</b>	0 <b>1</b>	5 <b>6</b>
Golf Link	168	228	1,516	600	210 <b>1,515</b>	164 <b>601</b>	0 <b>0</b>	22 <b>0</b>
Rifle Range Link	15	20	135	96	13 <b>179</b>	5 <b>49</b>	0 <b>1</b>	17 <b>2</b>
Prunus and Petai Trails	245	656	2,773	1,354	728 <b>3,269</b>	162 <b>684</b>	11 <b>24</b>	0 <b>150</b>
Chemperai and Lornie Trails	478	476	2,284	737	800 <b>2,136</b>	150 <b>710</b>	4 <b>22</b>	0 <b>153</b>
Venus Trail	338	32	568	426	326 <b>911</b>	41 <b>83</b>	3 <b>0</b>	0 <b>0</b>
MacRitchie Nature Trail	293	48	1,141	744	223 <b>1,292</b>	118 <b>591</b>	0 <b>0</b>	0 <b>2</b>
Terentang Trail	495	68	1,493	1,042	471 <b>1,943</b>	89 <b>590</b>	3 <b>0</b>	0 <b>2</b>
MacRitchie Visitor's Centre	437	628	993	1147	938 <b>2,019</b>	120 <b>100</b>	7 <b>18</b>	0 <b>3</b>

**Notes:**

Note 1: Weekend values are in bold

### A1.3 ESTIMATED NUMBER OF ANNUAL USERS

The estimated volume of people utilizing the trails within the Project area were extrapolated based on a methodology developed for the *National Bicycle and Pedestrian Documentation Project*<sup>1</sup> (NBPDP). Results of the extrapolation are presented in *Table A-2* and an example of the derivation calculation is detailed in *Box A1.1*.

**Table A-2: Estimated Number of Users per Trail**

Trail Name	Number of Users <sup>(Note 1)</sup>				
	Per Weekday	Per Weekend	Per Week	Per Month	Per Year
Sime Trail	375	2,009	7,024	30,413	364,956
Golf Link	403	2,116	7,427	32,158	385,896
Rifle Range Link	35	231	778	3,368	40,416
Prunus and Petai Trails	938	4,127	15,072	65,261	783,132
Lornie and Chemperai Trails	959	3,021	12,082	52,315	627,780
Venus Trail	367	994	4,175	20,415	244,980
MacRitchie Nature Trail	337	1,885	6,534	28,292	339,504
Terentang Trail	558	2,535	9,188	39,784	477,408
MacRitchie Visitor's Centre	1,086	2,140	10,121	43,823	525,876

**Notes:**

Note 1: Values were adjusted according to adjustment factors derived from the NBPDP methodology to account for the variation in number of users on different days of the week.

<sup>1</sup> ITE Pedestrian & Bicycle Council, National Bicycle and Pedestrian Documentation (NBPDP) project methodology. Available at: <http://bikepeddocumentation.org/downloads/>

**Box A1.1: Sample Calculations for Number of Users at Sime Trail**Adjusted Weekday Daily Count

$$\begin{aligned} &= \left( \frac{\text{Morning Count (Monday)}}{\text{Adjustment Factor (Monday)}} + \frac{\text{Afternoon Count (Thursday)}}{\text{Adjustment Factor (Thursday)}} \right) \times \text{weightage of 5 weekdays}^1 \div 5 \text{ weekdays per week} \\ &= \left( \frac{157}{14\%} + \frac{212}{12\%} \right) \times \frac{14\%+13\%+12\%+12\%+14\%}{100\%} \div 5 \\ &= 375 \end{aligned}$$

Adjusted Weekend Daily Count

$$\begin{aligned} &= \left( \frac{\text{Weekend morning count}}{\text{Weekend adjustment factor}} + \frac{\text{Weekend afternoon count}}{\text{Weekend adjustment factor}} \right) \times \text{weightage of two weekends} \div 2 \text{ weekend days per week} \\ &= \left( \frac{1407}{18\%} + \frac{602}{18\%} \right) \times \frac{18\%+18\%}{100\%} \div 2 \\ &= 2,009 \end{aligned}$$

Adjusted Weekly Count

$$\begin{aligned} \text{Adjusted weekly count A} &= \left( \frac{\text{Morning Count (Monday)}}{\text{Adjustment Factor (Monday)}} + \frac{\text{Afternoon Count (Thursday)}}{\text{Adjustment Factor (Thursday)}} \right) \\ &= 2,888 \end{aligned}$$

$$\begin{aligned} \text{Adjusted weekly count B} &= \left( \frac{\text{Weekend morning count}}{\text{Weekend adjustment factor}} + \frac{\text{Weekend afternoon count}}{\text{Weekend adjustment factor}} \right) \\ &= 11,161 \end{aligned}$$

$$\begin{aligned} \text{Adjusted weekly count} &= \frac{\text{count A} + \text{count B}}{2} \\ &= \frac{2,888 + 11,161}{2} \\ &= 7,024 \end{aligned}$$

Adjusted Monthly Count<sup>2</sup>

$$\begin{aligned} \text{Adjusted monthly count} &= \text{adjusted weekly count} \times \text{average number of weeks per month} \\ &= 7,024 \times 4.33 \\ &= 30,413 \end{aligned}$$

Adjusted Annual Count

$$\begin{aligned} \text{Adjusted annual traffic volume} &= \text{adjusted monthly count} \times \text{number of months per year} \\ &= 30,413 \times 12 \\ &= 364,956 \end{aligned}$$

<sup>1</sup> Daily Adjustment Factors are as follows: Monday (14%), Tuesday (13%), Wednesday (12%), Thursday (12%), Friday (14%), Saturday (18%) and Sunday (18%).

<sup>2</sup> Monthly adjustment factors were provided as per the NBPD methodology to account for changes in season. For the purposes of this study, monthly adjustment factors have not been adopted as there is little seasonal variation in Singapore throughout the year.

Annex 2.0

## Photograph Log



## Annex 2.0: Photograph Log Index

Category	Page Number	Photo Range
MacRitchie Reservoir	1	1-6
Surface Water Sampling Locations	2-4	7-19
Noise Monitoring Locations	4-5	20-26
Air Monitoring Locations	5	27-30
Vegetation and Habitat	6-9	31-50
Avifauna	9-21	51-117
Mammals	21-25	118-143
Herpetofauna	26-30	144-174
Butterflies	31-36	175-208
Odonates	36-44	209-253
Aquatic Habitat and Fauna	44-55	254-323

# Photograph Log



**Photo 1:** Dam and outfall of MacRitchie reservoir, near Reservoir Road



**Photo 2:** Outfall of MacRitchie Reservoir, continue underneath the cross junction of Thomson Road and Upper Thomson Road



**Photo 3:** View of reservoir's outfall from the dam



**Photo 4:** Stream Hd and PUB reservoir interchange waterway



**Photo 5:** The Paddle Lodge operated by Singapore Canoe Federation (SCF)



**Photo 6:** Irrigation Pond at SICC Bukit golf course

**Project:** 0256660 Cross Island Line

**Client :** Land Transport Authority



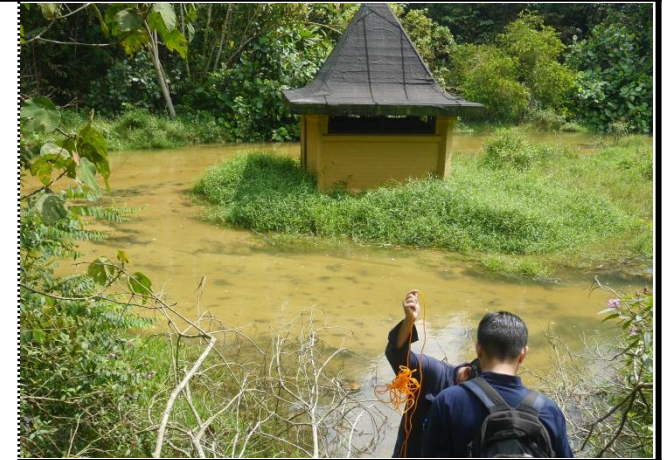
# Photograph Log



**Photo 7:** Surface Water Sampling Location SW101



**Photo 8:** Surface Water Sampling Location SW102



**Photo 9:** Surface Water Sampling Location SW103



**Photo 10:** Surface Water Sampling Location SW104



**Photo 11:** Surface Water Sampling Location SW105



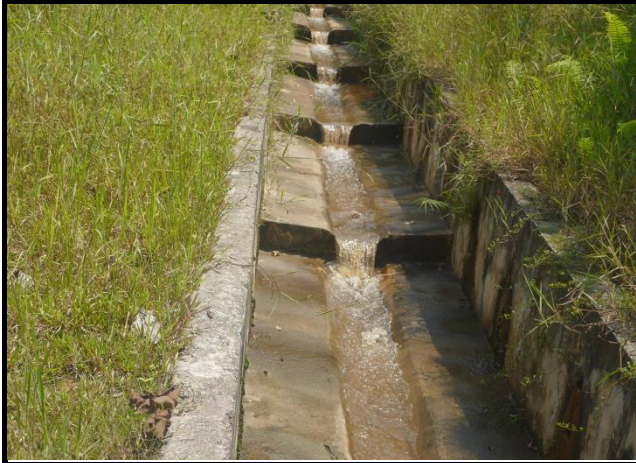
**Photo 12:** Surface Water Sampling Location SW106

**Project:** 0256660 Cross Island Line

**Client :** Land Transport Authority



# Photograph Log



**Photo 13:** Surface Water Sampling Location SW107



**Photo 14:** Surface Water Sampling Location SW108



**Photo 15:** Surface Water Sampling Location SW109



**Photo 16 :** Surface Water Sampling Location SW110



**Photo 17:** Surface Water Sampling Location SW111



**Photo 18:** Surface Water Sampling Location SW112

**Project:** 0256660 Cross Island Line

**Client :** Land Transport Authority



# Photograph Log



**Photo 19:** Surface Water Sampling Location SW113



**Photo 20:** Noise Monitoring Location NL101



**Photo 21:** Noise Monitoring Location NL102



**Photo 22:** Noise Monitoring Location NL103



**Photo 23:** Noise Monitoring Location NL104



**Photo 24:** Noise Monitoring Location NL201

**Project:** 0256660 Cross Island Line

**Client :** Land Transport Authority



# Photograph Log



**Photo 25:** Noise Monitoring Location NL202



**Photo 26:** Noise Monitoring Location NL203



**Photo 27:** Air Monitoring Location AQ101



**Photo 28:** Air Monitoring Location AQ102



**Photo 29:** Air Monitoring Location AQ201



**Photo 30:** Air Monitoring Location AQ202

**Project:** 0256660 Cross Island Line

**Client :** Land Transport Authority



# Photograph Log



**Photo 31:** The forest floor of primary forest (PF1) is completely shaded and clear with undergrowth.



**Photo 32:** *Dillenia grandifolia* tree was recorded in both primary (PF2) and secondary forest (RA3).



**Photo 33:** Regrowth Forest B is characterized by smaller trees and less developed canopy structure. Canopy closure was 85 – 90% in RB4.



**Photo 34:** Wetland forest is dominated by *Ploiarium alternifolium* and *Alstonia angustifolia* trees.



**Photo 35:** Small-sized *Gynotroches axillaris*, *Dillenia suffruticosa* and *Ploiarium alternifolium* trees dominate the Wetland Marsh vegetation.



**Photo 36:** *Eugeissona tristis* (Bertam), the stemless clumping palm, is one of the most widespread forest floor plants in the Study Area.

**Project:** 0256660 Cross Island Line

**Client :** Land Transport Authority



# Photograph Log



**Photo 37:** Emergent *Koompassia malaccensis* (left) and *Lophopetalum multinervium* (right) trees standing side by side in primary forest (PF5).



**Photo 40:** *Hopea griffithii* can usually be found in undisturbed primary forest. This emergent tree recorded in McR02 transect is globally Vulnerable and Critically Endangered in Singapore.



**Photo 38:** A large emergent tree of *Dyera costulata* measuring 126 cm diameter at breast height.



**Photo 41:** *Aquilaria malaccensis* is commonly found in Primary and Regrowth Forest A. It is listed in Appendix II of CITES and is Vulnerable globally and in Singapore.



**Photo 39:** Emergent *Shorea curtisii* tree with prominent buttress found in McR02. In Peninsula Malaysia this tree species is commonly found in hill dipterocarp forest.



**Photo 42:** *Aquilaria malaccensis* seedlings can often be found underneath their parent trees.

**Project:** 0256660 Cross Island Line

**Client :** Land Transport Authority



# Photograph Log



**Photo 43:** A young *Shorea gratissima* tree recorded in PF 1. The conservation status of this tree species is Endangered globally and Critically Endangered in Singapore.



**Photo 46:** This *Palaquium obovatum* tree is a source of gutta-percha, a natural latex, used for insulating materials, decorative furniture, golf balls core and dental cement.



**Photo 44:** *Ficus lamponga* tree is common in secondary forest. The fruits of this fig tree are eaten by insects, birds and animals throughout the year.



**Photo 47:** Transect ST06 – Common vegetation include *Dillenia suffruticosa*, *Vitex pinnata*, *Cinnamomum iners* and *Gironniera nervosa*.



**Photo 45:** Tagged trees in McR04, *Prunus polystachya* (left) and *Parkia speciosa* (right). Tree tagging is a great way to communicate the importance of forest to the society.



**Photo 48:** Transect MRPT01 – *Palaquium macrophyllum* tree standing adjacent the boardwalk.

**Project:** 0256660 Cross Island Line

**Client :** Land Transport Authority



# Photograph Log



**Photo 49:** *Gymnacranthera forbesii* tree on transect McR04



**Photo 50:** Transect GL01 – Figure shows *Dillenia suffruticosa*, *Syzygium cerinum* (large trunk) and *Ficus benjamina* (with aerial roots)



**Photo 51:** Red Junglefowl (*Gallus gallus*)



**Photo 52:** Purple Heron (*Ardea purpurea*)



**Photo 53:** Changeable Hawk Eagle (*Nisaetus cirrhatus*)



**Photo 54:** Brahminy Kite (*Haliastur indus*)

**Project:** 0256660 Cross Island Line

**Client :** Land Transport Authority



# Photograph Log



**Photo 55:** Grey-headed Fish Eagle (*Ichthyophaga ichthyaetus*)



**Photo 56:** White-bellied Sea-Eagle (*Haliaeetus leucogaster*)



**Photo 57:** Emerald Dove (*Chalcophaps indica*)



**Photo 58:** Pink-necked Green Pigeon (*Treron vernans*)



**Photo 59:** Thick-billed Green Pigeon (*Treron curvirostra*)



**Photo 60:** Spotted Dove (*Spilopelia chinensis*)

**Project:** 0256660 Cross Island Line

**Client :** Land Transport Authority

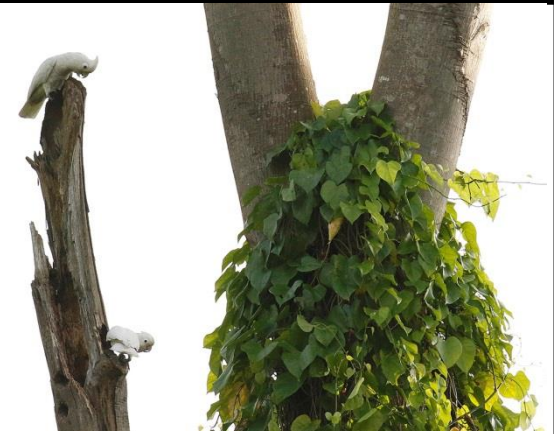
# Photograph Log



**Photo 61:** Long-tailed Parakeet (*Psittacula longicauda*)



**Photo 62:** Blue-crowned Hanging Parrot (*Loriculus galgulus*)



**Photo 63:** Tanimbar Cockatoo (*Cacatua goffini*)



**Photo 64:** Chestnut-breasted Malkoha (*Phaenicophaeus sumatranus*)



**Photo 65:** Malaysian Hawk-cuckoo (*Hierococcyx fugax*)



**Photo 66 :** Sunda Scops-owl (*Otus lempiji*)

**Project:** 0256660 Cross Island Line

**Client :** Land Transport Authority



# Photograph Log



**Photo 67:** Brown Hawk-owl (*Ninox scutulata*)



**Photo 68:** Large-tailed Nightjar (*Caprimulgus macrurus*)



**Photo 69:** Grey-Rumped Treeswift (*Hemiprocne longipennis*)



**Photo 70:** Oriental Dollar Bird (*Eurystomus orientalis*)



**Photo 71:** White throated Kingfisher (*Halcyon smyrnensis*)



**Photo 72:** Oriental Dwarf Kingfisher (*Ceyx erithacus*)

**Project:** 0256660 Cross Island Line

**Client :** Land Transport Authority

# Photograph Log



**Photo 73:** Collared Kingfisher  
(*Todiramphus chloris*)



**Photo 74:** Blue-tailed Bee-eater  
(*Merops philippinus*)



**Photo 75:** Lineated Barbet (*Megalaïma lineata*)



**Photo 76:** Common Flameback  
(*Dinopium javanense*)



**Photo 77:** Laced Woodpecker  
(*Piccus vittatus*)



**Photo 78:** Hooded Pitta (*Pitta sordida*)

**Project:** 0256660 Cross Island Line

**Client :** Land Transport Authority



# Photograph Log



**Photo 79:** Common Iora (*Aegithina tiphia*)



**Photo 80:** Brown Shrike (*Lanius cristatus*)



**Photo 81:** Tiger Shrike (*Lanius tigrinus*)



**Photo 82:** Black-napped Oriole (*Oriolus chinensis*)



**Photo 83:** Greater racket-tailed Drongo (*Dicrurus paradiseus*)



**Photo 84:** Asian Paradise Flycatcher (*Terpsiphone paradisi*)

**Project:** 0256660 Cross Island Line

**Client :** Land Transport Authority



# Photograph Log



**Photo 85:** Straw-headed Bulbul  
(*Pycnonotus zeylanicus*)



**Photo 86:** Pacific Swallow (*Hirundo tahitica*)



**Photo 87:** Arctic Warbler  
(*Phylloscopus borealis*)



**Photo 88:** Dark-necked Tailorbird  
(*Orthotomus atrogularis*)



**Photo 89:** Abbott's Babbler  
(*Malacocincla abbotti*)



**Photo 90:** Striped Tit-babbler  
(*Macronous gularis*)

**Project:** 0256660 Cross Island Line

**Client :** Land Transport Authority



# Photograph Log



**Photo 91:** Asian Fairy Bluebird (*Irena puella*) Male



**Photo 92:** Asian Fairy Bluebird (*Irena puella*) Female



**Photo 93:** Hill Myna (*Gracula religiosa*)



**Photo 94:** White-vented Myna (*Acridotheres javanicus*)



**Photo 95:** Asian Glossy Starling (*Aplonis panayensis*) Male



**Photo 96:** Orange-headed Thrush (*Zoothera citrina*)

**Project:** 0256660 Cross Island Line

**Client :** Land Transport Authority



# Photograph Log



**Photo 97:** Mugimaki Flycatcher (*Ficedula mugimaki*) Female



**Photo 98:** Oriental Magpie Robin (*Copsychus saularis*) Male



**Photo 99:** Asian Brown Flycatcher (*Muscicapa dauurica*)



**Photo 100:** Dark-sided Flycatcher (*Muscicapa sibirica*)



**Photo 101:** Orange Bellied Flowerpecker (*Dicaeum trigonostigma*)



**Photo 102:** Scarlet-backed Flowerpecker (*Dicaeum cruentatum*)

**Project:** 0256660 Cross Island Line

**Client :** Land Transport Authority



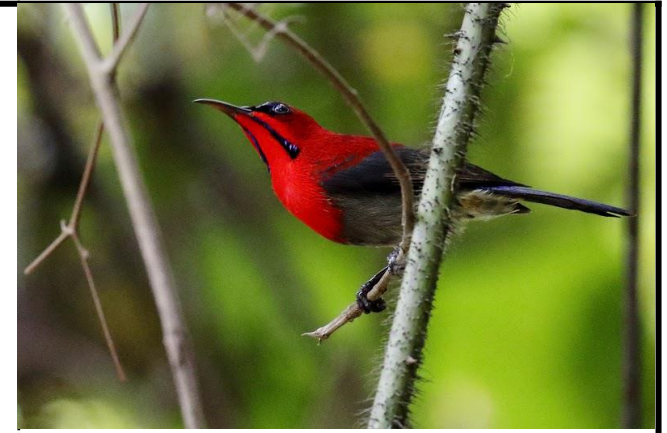
# Photograph Log



**Photo 103:** Olive-backed Sunbird (*Cinnyris jugularis*) Male



**Photo 104:** Van Hasselt's Sunbird (*Leptocoma brasiliana*) Male



**Photo 105:** Crimson Sunbird (*Aethopyga siparaja*) Male



**Photo 106:** Brown-throated Sunbird (*Anthreptes malacensis*) Male



**Photo 107:** Chestnut Munia (*Lonchura atricapilla*)



**Photo 108:** Scaly-breasted Munia (*Lonchura punctulata*)

**Project:** 0256660 Cross Island Line

**Client :** Land Transport Authority



# Photograph Log



**Photo 109:** White-rumped Shama (*Copsychus malabaricus*)



**Photo 110:** Yellow-vented Bulbul (*Pycnonotus goiaver*)



**Photo 111:** Blue eared Kingfisher (*Alcedo meninting*)



**Photo 112:** Eurasian Kingfisher (*Alcedo atthis*)



**Photo 113:** Yellow rumped flycatcher (*Ficedula zanthopygia*)



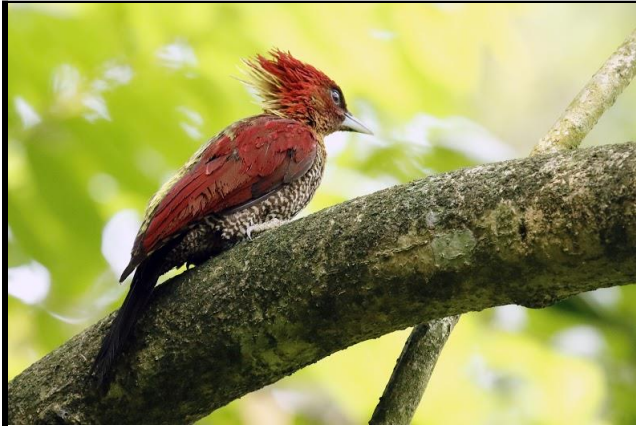
**Photo 114:** Forest Wagtail (*Dendronanthus indicus*)

**Project:** 0256660 Cross Island Line

**Client :** Land Transport Authority



# Photograph Log



**Photo 115:** Banded Woodpecker (*Chrysophlegma miniaceum*)



**Photo 116:** Red headed Barbet (*Eubucco bourcierii*)



**Photo 117:** Buffy Fish Owl (*Ketupa ketupu*)



**Photo 118:** Lesser Mousedeer (*Tragulus kanchil*) was observed during a night transect along the rifle range trail- note the scar.



**Photo 119:** Lesser Mousedeer (*Tragulus kanchil*) camera trapped near the Rifle range area.



**Photo 120:** Lesser Mousedeer (*Tragulus kanchil*) note the scar on the body-similar to the individual recorded from transect survey (Photo 118).

**Project:** 0256660 Cross Island Line

**Client :** Land Transport Authority



# Photograph Log



**Photo 121:** *Tragulus* sp. recorded by camera trap in October 2015



**Photo 1212** The Plantain Squirrel (*Callosciurus notatus*) is the most common small mammal observed during the day transect.



**Photo 123:** The Slender Squirrel (*Sundasciurus tenuis*) is less frequently encountered compared to the Plantain Squirrel.



**Photo 124:** The Malayan Colugo (*Galeopterus variegatus*) is the most common nocturnal mammal observed.



**Photo 125:** Malayan Colugo (*Galeopterus variegatus*) red morph



**Photo 126:** Wild Boar (*Sus scrofa*) is relatively common in the study area.

**Project:** 0256660 Cross Island Line

**Client :** Land Transport Authority



# Photograph Log



**Photo 127:** Direct observation of a Common Palm Civet (*Paradoxurus hermaphroditus*) during night transect .



**Photo 128:** Direct observation of a Common Palm Civet (*Paradoxurus hermaphroditus*) during a night transect in October 2015.



**Photo 129:** The Common Palm Civet, (*Paradoxurus hermaphroditus*) was recorded at 50% of the camera location.



**Photo 130:** A dead Sunda Pangolin (*Manis javanica*) was found at Venus Link.



**Photo 131:** Sunda Pangolin (*Manis javanica*) identified as Critically Endangered by the IUCN was recorded in 20% of the camera location.



**Photo 132:** Sunda Pangolin (*Manis javanica*)

**Project:** 0256660 Cross Island Line

**Client :** Land Transport Authority



# Photograph Log



**Photo 133:** Horsfield's Flying Squirrel (*Iomys horsfieldii*)



**Photo 134:** A Red Muntjac (*Muntiacus muntjak*) recorded near the rifle range trail.



**Photo 135:** Red Muntjac (*Muntiacus muntjak*) note the small antlers.



**Photo 136:** Barking deer (*Muntiacus muntjak*) photographed in October 2015.



**Photo 137:** A suspected domestic dog (*Canis familiaris*) recorded near Terentang trail, the fast movement of the animal made species identification difficult



**Photo 138:** : Long-tailed Macaque (*Macaca fascicularis*) camera trapped foraging in the forest.

**Project:** 0256660 Cross Island Line

**Client :** Land Transport Authority



# Photograph Log



**Photo 139:** The Long-tailed Macaque (*Macaca fascicularis*) are frequently encountered in the study area.



**Photo 140:** Long-tailed Macaque (*Macaca fascicularis*) readily enter open areas including golf club areas



**Photo 141:** Partial image of a cat (*Felis catus*) was camera trapped near Venus trail.



**Photo 142:** A poor image of a cat (*Felis catus*) recorded near the Venus trail.



**Photo 143:** *Homo sapiens* photographed in 90% of the cameras.



**Photo 144:** *Aphaniotis fusca*

**Project:** 0256660 Cross Island Line

**Client :** Land Transport Authority



# Photograph Log



**Photo 145:** *Bronchocela cristatella*



**Photo 146:** *Cnemaspis peninsularis*



**Photo 147:** *Cyrtodactylus majulah*



**Photo 148:** *Draco quinquefasciatus*



**Photo 149:** Five-banded Flying Dragon (*Draco quinquefasciatus*) (Juvenile)



**Photo 150:** *Hemiphyllodactylus typus*

**Project:** 0256660 Cross Island Line

**Client :** Land Transport Authority



# Photograph Log



**Photo 151:** *Eutropis multifasciatus*



**Photo 152:** *Hemidactylus frenatus*



**Photo 153:** *Ptyas fusca*



**Photo 154:** *Tropidolaemus wagleri* (female)



**Photo 155:** *Tropidolaemus wagleri* (male)



**Photo 156:** Gold-ringed Cat Snake (*Boiga dendrophila*)

**Project:** 0256660 Cross Island Line

**Client :** Land Transport Authority



# Photograph Log



**Photo 157:** *Pseudorabdion longiceps*



**Photo 158:** *Varanus nebulosus*



**Photo 159:** Malayan Box Terrapin (*Cuora amboinensis*)



**Photo 160:** Spiny Hill Terrapin (*Heosemys spinosa*)



**Photo 161:** *Trachemys scripta elegans*



**Photo 162:** *Amyda ornata*

**Project:** 0256660 Cross Island Line

**Client :** Land Transport Authority



# Photograph Log



**Photo 163:** American Bull Frog (*Lithobates catesbeianus*)



**Photo 164:** *Duttaphrynus melanostictus*



**Photo 165:** *Fejervarya* aff. *limnocharis*



**Photo 166:** *Fejervarya cancrivora*



**Photo 167:** *Hylarana labialis*



**Photo 168:** *Leptobrachium nigrops*

**Project:** 0256660 Cross Island Line

**Client :** Land Transport Authority



# Photograph Log



**Photo 169:** *Limnonectes blythii*



**Photo 170:** *Occidozyga laevis*



**Photo 171:** *Hylarana erythraea*



**Photo 172:** *Kaloula pulchra*



**Photo 173:** *Limnonectes malesianus*



**Photo 174:** *Microhyla heymonsi*

**Project:** 0256660 Cross Island Line

**Client :** Land Transport Authority



# Photograph Log



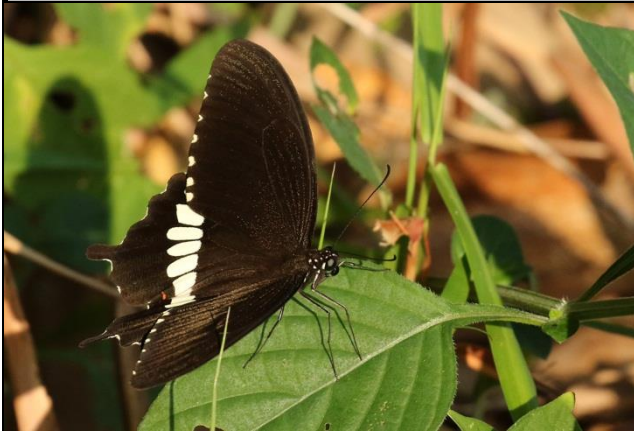
**Photo 175:** *Graphium antiphates* (Papilionidae)



**Photo 176:** *Papilio clytia* (Papilionidae)



**Photo 177:** *Papilio helenus* (Papilionidae)



**Photo 178:** *Papilio polytes* (Papilionidae)



**Photo 179:** *Euploea eyndhovii* (Danainae)



**Photo 180:** *Elymnias hypermnestra* (Satyrinae)

**Project:** 0256660 Cross Island Line

**Client :** Land Transport Authority



# Photograph Log



**Photo 181:** *Mycalesis perseus cepheus* (Satyrinae)



**Photo 182:** *Mycalesis visala phamis* (Satyrinae)



**Photo 183:** *Orsotriaena medus* (Satyrinae)



**Photo 184:** *Athyma nefte subrata* (Nymphalidae)



**Photo 185:** *Euthalia nonina* (Nymphalidae)



**Photo 186:** *Junonia almana* (Nymphalidae)

**Project:** 0256660 Cross Island Line

**Client :** Land Transport Authority



# Photograph Log



**Photo 187:** *Junonia hedonia ida* (Nymphalidae)



**Photo 188:** *Lasippa tiga* (Nymphalidae)



**Photo 189:** *Lexias canescens* (Nymphalidae)



**Photo 190:** *Lexias pardalis* (Nymphalidae)



**Photo 191:** *Moduza procris* (Nymphalidae)



**Photo 192:** *Tanaecia pelea pelea* (Nymphalidae)

**Project:** 0256660 Cross Island Line

**Client :** Land Transport Authority



# Photograph Log



**Photo 193:** *Araotes lapithis* (Lycaenidae)



**Photo 194:** *Caleta elna* (Lycaenidae)



**Photo 195:** *Eooxylides tharis* (Lycaenidae)



**Photo 196:** *Jamides celeno* (Lycaenidae)



**Photo 197:** *Miletus biggsii* (Lycaenidae)



**Photo 198:** *Zeltus amasa* (Lycaenidae)

**Project:** 0256660 Cross Island Line

**Client :** Land Transport Authority



# Photograph Log



**Photo 199:** *Burara harisa* (Hesperiidae)



**Photo 200:** *Erionota thrax* (Hesperiidae)



**Photo 201:** *Eetion elia* (Hesperiidae)



**Photo 202 :** *Caltoris cormasa* (Hesperiidae)



**Photo 203:** *Iambrix salsala* (Hesperiidae)



**Photo 204:** *Pyroneura latoia* (Hesperiidae)

**Project:** 0256660 Cross Island Line

**Client :** Land Transport Authority



# Photograph Log



**Photo 205:** *Potanthus omaha* (Hesperiidae)



**Photo 206:** *Telicota colon* (Hesperiidae)



**Photo 207:** *Zeuxidia amethystus* (Nymphalidae)



**Photo 208:** *Eulaceura osteria* (Nymphalidae)



**Photo 209:** *Vestalis amethystina* (Male)  
Family Calopterygidae



**Photo 210:** *Euphaea impar* (Male)  
Family Euphaeidae

**Project:** 0256660 Cross Island Line

**Client :** Land Transport Authority



# Photograph Log



**Photo 211:** *Lestes praemorsus* (Male)  
Family Lestidae



**Photo 212:** *Amphinemesis gracilis* (Female)  
Family Coenagrionidae



**Photo 213:** *Archibasis viola* (Male)  
Family Coenagrionidae



**Photo 214:** *Ceriagrion cerinorubellum* (Male)  
Family Coenagrionidae



**Photo 215:** *Pseudagrion australasiae* (Female)  
Family Coenagrionidae



**Photo 216:** *Pseudagrion australasiae* (Male)  
Family Coenagrionidae

**Project:** 0256660 Cross Island Line

**Client :** Land Transport Authority



# Photograph Log



**Photo 217:** *Pseudagrion microcephalum* (Female)  
Family Coenagrionidae



**Photo 218:** *Pseudagrion microcephalum* (Male)  
Family Coenagrionidae



**Photo 219:** *Prodasineura notostigma* (Male)  
Family Protoneuridae



**Photo 220:** *Copera marginipes* (Female)  
Family Platycnemididae



**Photo 221:** *Epophthalmia vittigera* (Male)  
Family Corduliidae



**Photo 222:** *Macromia cincta* (Male)  
Family Corduliidae

**Project:** 0256660 Cross Island Line

**Client :** Land Transport Authority

# Photograph Log



**Photo 223:** *Macromia cincta* (Female)  
Family Corduliidae



**Photo 224:** *Macromia cydippe* (Male)  
Family Corduliidae



**Photo 225:** *Acisoma panorpoides* (Male)  
Family Libellulidae



**Photo 226:** *Agrionoptera insignis* (Female)  
Family Libellulidae



**Photo 227:** *Agrionoptera sexlineata* (Male)  
Family Libellulidae



**Photo 228:** *Brachydiplax chalybea* (Male)  
Family Libellulidae

**Project:** 0256660 Cross Island Line

**Client :** Land Transport Authority



# Photograph Log



**Photo 229:** *Cratilla metallica* (Female)  
Family Libellulidae



**Photo 230:** *Crocothemis servilia* (Male)  
Family Libellulidae



**Photo 231:** *Diplacodes nebulosa* (Male)  
Family Libellulidae



**Photo 232:** *Hydrobasileus croceus* (Tandem pair)  
Family Libellulidae



**Photo 233:** *Lathrecista asiatica* (Male)  
Family Libellulidae



**Photo 234:** *Nannophya pygmaea* (Male)  
Family Libellulidae

**Project:** 0256660 Cross Island Line

**Client :** Land Transport Authority



# Photograph Log



**Photo 235:** *Nesothenia lineata* (Female)  
Family Libellulidae



**Photo 236:** *Orchithemis pulcherrima* (Male)  
Family Libellulidae



**Photo 237:** *Orchithemis pulcherrima* (Female)  
Family Libellulidae



**Photo 238:** *Orthetrum chrysis* (Tandem pair)  
Family Libellulidae



**Photo 239:** *Orthetrum glaucum* (Female)



**Photo 240:** *Orthetrum glaucum* (Male)

**Project:** 0256660 Cross Island Line

**Client :** Land Transport Authority

# Photograph Log



**Photo 241:** *Orthetrum testaceum* (Male, first on right)



**Photo 242:** *Orthetrum sabina* (Male)



**Photo 243:** *Rhyothemis triangularis* (Male)  
Family Libellulidae



**Photo 244:** *Trithemis aurora* (Male)  
Family Libellulidae



**Photo 245:** *Tyriobapta torrida* (Male)  
Family Libellulidae



**Photo 246:** *Urothemis signata insignata* (Male)  
Family Libellulidae

**Project:** 0256660 Cross Island Line

**Client :** Land Transport Authority



# Photograph Log



**Photo 247:** *Neurothemis fluctuans* (Male)  
Family Libellulidae



**Photo 248:** *Pseudothemis jorina* (Male)  
Family Libellulidae



**Photo 249:** *Ictinophus decoratus* ( Male)  
Family Gomphidae



**Photo 250:** *Gynacantha subinterrupta* (Male)



**Photo 251:** *Libellago hyalina* (Female)  
Family Chlorocyphidae  
Potential first record in the CCNR



**Photo 252:** *Diplacodes trivialis* (Male)  
Family Libellulidae

**Project:** 0256660 Cross Island Line

**Client :** Land Transport Authority



# Photograph Log



**Photo 253 :** *Ictinogomphus decoratus* (Male)  
Family Gomphidae



**Photo 254:** A view of the riverine pool at S1 located  
along the Sime Track.



**Photo 255:** Riverbank heavily vegetated at S1.



**Photo 256:** Forest snakehead (*Channa lucius*)  
spotted at S1.



**Photo 257:** Malayan forest halfbeak  
(*Hemirhamphodon pogonognathus*) spotted at S1.



**Photo 258:** Rubbish and debris found at S1.

**Project:** 0256660 Cross Island Line

**Client :** Land Transport Authority

# Photograph Log



**Photo 259:** Smaller riverine pool (S2) located downstream of S1.



**Photo 260:** Forest snakehead (*Channa lucius*) found at S2.



**Photo 261:** *Heosemys grandis* observed at S2.



**Photo 262:** Common snakehead (*Channa striata*) found in the forest stream along the Golf Link.



**Photo 263:** Marbled gudgeon (*Oxyeleotris marmorata*) found in the forest stream along the Golf Link.



**Photo 264:** Freshwater prawn (genus *Macrobrachium*) spotted during the night survey on 10<sup>th</sup> February at S2.

**Project:** 0256660 Cross Island Line

**Client :** Land Transport Authority



# Photograph Log



**Photo 265:** Water discharged from the dam/treatment plan with high sedimentation at S3. Sampling was not carried out.



**Photo 266:** Turbid water at S4. Riparian fringe dense with leaf litter.



**Photo 267:** Stream was flooded and fast flowing at S4. Water was clearer during the survey on 9<sup>th</sup> January.



**Photo 268:** Shallow forest stream at S5. Pond bottom with extensive patches of leaf litter.



**Photo 269 :** Riparian consist of disturbed forest vegetation at S5.



**Photo 270:** Spanner barb (*Systemus lateristriga*) observed at S5.

**Project:** 0256660 Cross Island Line

**Client :** Land Transport Authority



# Photograph Log



**Photo 271:** Harlequin rasbora (*Trigonostigma heteromorpha*) observed at S5.



**Photo 272:** Two-spotted barb (*Rasbora elegans*) observed at S5.



**Photo 273:** A view of the wetland area with broad shallow stream at S6.



**Photo 274:** Another view of the wetland area with shallow stream at S6.



**Photo 275:** Whitespot (*Aplocheilichthys panchax*) spotted at S6.



**Photo 276:** Freshwater prawn (genus *Macrobrachium*) observed at S6.

**Project:** 0256660 Cross Island Line

**Client :** Land Transport Authority



# Photograph Log



**Photo 277:** Unidentified freshwater crab spotted during the night survey on 10<sup>th</sup> February at S6.



**Photo 280:** Spanner barb (*Systomus lateristriga*) and two-spotted bard (*Rasbora elegans*) observed at S8.



**Photo 278:** S7 represented by small rivulet. No flow observed and seems to be a transient channel holding rain water. Sampling was not carried out.



**Photo 281:** Forest stream (C1) adjacent to broad walk along Sime Track.



**Photo 279:** S8 represents a forest stream with riparian of mixed tree populations.



**Photo 282:** Forest stream bottom with extensive leaf litter at C1.

**Project:** 0256660 Cross Island Line

**Client :** Land Transport Authority



# Photograph Log



**Photo 283:** Small forest stream underlying broad walk choked with debris at C2.



**Photo 284:** Forest stream with "ponding" at C3 located along the Sime Track.



**Photo 285:** Malayan forest halfbeak (*Hemirhamphodon pogonognathus*) and Harlequin rasbora (*Trigonostigma heteromorpha*) spotted at C3.



**Photo 286:** Stream at V1 runs through a heavily modified landscape .



**Photo 287:** Stream at V1 subject to sedimentation.



**Photo 288:** Malayan pygmy halfbeak (*Dermogenys collettei*) observed at V1.

**Project:** 0256660 Cross Island Line

**Client :** Land Transport Authority



# Photograph Log



**Photo 289:** Water slightly turbid with oil slick found at V1 during the visit on 23<sup>rd</sup> January 2015 suggesting some upstream disturbance.



**Photo 290:** Forest stream at V2 with vegetative detrital material lines the banks.



**Photo 291:** Walking catfish (*Clarias batrachus*) spotted at V2.



**Photo 292:** Saddle barbs (*Systomus banksi*) found at V2.



**Photo 293:** Common snakehead (*Channa striata*) spotted at V2.



**Photo 294:** V3 is a forest pool along the main stem of the stream observed at V1.

**Project:** 0256660 Cross Island Line

**Client :** Land Transport Authority



# Photograph Log



**Photo 295:** V4 is a forest stream with well vegetated riparian fringe. Turbid water observed on 22<sup>nd</sup> January 2015.



**Photo 296:** Clearer water observed at V4 on 23<sup>rd</sup> January 2015.



**Photo 297:** Freshwater prawn (genus *Macrobrachium*) observed at V4.



**Photo 298:** A view of the long pond at Bukit Golf Course.



**Photo 299:** Impounding structure-dead barrier with overflow to main MacRitchie Reservoir.



**Photo 300:** Discharge area within MacRitchie Reservoir with extensive Hydrilla beds and other aquatic weeds.

**Project:** 0256660 Cross Island Line

**Client :** Land Transport Authority

# Photograph Log



**Photo 301:** A close view of Hydrilla bed.



**Photo 302:** Pond edges observed with patches of filamentous algae.



**Photo 303:** A view of the long pond from the 2nd weir at Bukit Golf Course.



**Photo 304:** Unidentified fingerlings observed in the pond near weir 2 at Bukit Golf Course.



**Photo 305:** A view of the pond near weir 3 at Bukit Golf Course.



**Photo 306:** Foaming observed at the base of the weir 3 spillway.

**Project:** 0256660 Cross Island Line

**Client :** Land Transport Authority



# Photograph Log



**Photo 307:** Pond bottom covered with leaf litter from surrounding hills .



**Photo 308:** A view of the pond downstream of weir 4 at Bukit Golf Course.



**Photo 309:** A view of the pond upstream of weir 4 at Bukit Golf Course.



**Photo 310:** Unidentified fingerlings at pond near weir 5.



**Photo 311:** A view of the pond upstream of weir 4 at Bukit Golf Course.



**Photo 312:** Pond SC1 at Sime Golf Course – linked by a small channel to the Mac Ritchie Reservoir.

**Project:** 0256660 Cross Island Line

**Client :** Land Transport Authority

# Photograph Log



**Photo 313:** Turbid water at pond SC1 characterized by high plankton count.



**Photo 314:** Patches of Hydrilla found throughout the pond surface at SC1.



**Photo 315:** Drainage infrastructure from surrounding channeled to the pond SC1.



**Photo 316:** A view of pond SC2 - a long pond.



**Photo 317:** Pond SC2 drains to Mac Ritchie Reservoir through a dead weir.



**Photo 318:** Water at Pond SC2 turbid and high in plankton count.

**Project:** 0256660 Cross Island Line

**Client :** Land Transport Authority



# Photograph Log



**Photo 319:** A view of Pond IC1 at Island Golf Course.



**Photo 320:** A view of Pond IC2 at Island Golf Course.



**Photo 321:** A view of Pond IC3 at Island Golf Course.



**Photo 322:** At the edge of Lower Peirce Reservoir (LP1) - water turbid with high plankton count.



**Photo 323:** At the edge of Lower Peirce Reservoir (LP2).

**Project:** 0256660 Cross Island Line

**Client :** Land Transport Authority



## Annex 3.0

# Stream Survey

Annex 3A

## Stream Survey Field Sheets

### Annex 3A: Stream Survey Field Sheet Index

Stream	Page Number
MA	2
MA	4
MA	6
MA1	8
MA2	10
MA3	12
MA6	14
MA6	16
MA10	18
CC	20
HA	22
HA	24
HA	26
HA	28
HA	30
HD (wetland)	32
HD (PUB Pipeline)	34
HE	36
FA4	38
FA4	40
FB	42
HB	44
HD	46
HC	48
HC5 & HC6	50
HB4	52
MA5	54
I	56
I	58
IC	60
IC4	62
Chemperai Hut	64



## Field Record Sheet

<b>Name of Surveyors:</b> Cheong Shu Min & Eva Yew		<b>Location:</b> CCNR			
<b>Stream ID:</b> MA		<b>Coordinates:</b> N 01°35'96.1" E 103°82'69.5" (MA001) & N 01°35'98.0" E 103°82'69.1" (MA002)			
<b>Date of Survey:</b> 28 Oct 2014		<b>Time of Survey:</b> 9:24 am			
<b>Photo record:</b> MA_001 to MA_013					
<b>WEATHER</b>	<table style="width: 100%; border: none;"> <tr> <td style="width: 50%; vertical-align: top;"> <b>Now</b>  <input type="checkbox"/> Storm (Heavy rain)  <input type="checkbox"/> Rain (Steady rain)  <input type="checkbox"/> Shower (Intermittent)  <input type="checkbox"/> Cloud Cover  <input checked="" type="checkbox"/> Clear/Sunny  <b>Temperature</b> <u>28</u> °C </td> <td style="width: 50%; vertical-align: top;"> <b>Past 24 Hours</b>  <input checked="" type="checkbox"/> Storm (Heavy rain)  <input type="checkbox"/> Rain (Steady rain)  <input type="checkbox"/> Shower (Intermittent)  <input type="checkbox"/> Cloud Cover  <input type="checkbox"/> Clear/Sunny </td> </tr> </table>			<b>Now</b> <input type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input checked="" type="checkbox"/> Clear/Sunny <b>Temperature</b> <u>28</u> °C	<b>Past 24 Hours</b> <input checked="" type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input type="checkbox"/> Clear/Sunny
<b>Now</b> <input type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input checked="" type="checkbox"/> Clear/Sunny <b>Temperature</b> <u>28</u> °C	<b>Past 24 Hours</b> <input checked="" type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input type="checkbox"/> Clear/Sunny				
<b>RIPARIAN VEGETATION</b>	<b>Indicate the dominant type and record the dominant species present:</b> <input type="checkbox"/> Trees <input type="checkbox"/> Shrubs <input checked="" type="checkbox"/> Grasses <input checked="" type="checkbox"/> Herbaceous <b>Dominant Species Present</b> _____				
<b>AQUATIC VEGETATION</b>	<b>Indicate the dominant type and record the dominant species present:</b> <input type="checkbox"/> Rooted Emergent <input checked="" type="checkbox"/> Rooted Submergent <input type="checkbox"/> Rooted Floating <input type="checkbox"/> Floating Algae <input type="checkbox"/> Attached Algae <b>Dominant Species Present</b> _____				
<b>AQUATIC FAUNA</b>	<b>Notes:</b> <ul style="list-style-type: none"> <li>Dragonfly (common red) + Blue</li> <li>Small fish observed (~ 5-10)</li> </ul>				

<b>STREAM CHARACTERISATION</b>	<b>Occurrence</b> <input checked="" type="checkbox"/> Perennial <input type="checkbox"/> Intermittent  <b>Stream Type</b> <input type="checkbox"/> "Tree-country" Forest stream <input checked="" type="checkbox"/> "Open-country" Stream <input checked="" type="checkbox"/> Concrete canal, drain <input type="checkbox"/> Other _____	<b>Characteristics of Water Flow</b> <input checked="" type="checkbox"/> Fast, with roughness <input type="checkbox"/> Fast, smooth <input type="checkbox"/> Slow, gentle <input type="checkbox"/> Pool <input type="checkbox"/> Trickle <b>Channelized</b> <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No
	<b>STREAM FEATURES</b>	<b>Estimated Length Sampled</b> _____ m <b>Estimated Stream Width</b> <u>1.5 - 2.0</u> m <b>Estimated Stream Depth</b> <u>22.5</u> cm <b>Canopy Cover</b> <input checked="" type="checkbox"/> Open <input type="checkbox"/> Partly Open/Shaded <input type="checkbox"/> Shaded <b>Light intensity</b> <u>9.78 - 11.94</u> Klux
<b>WATER QUALITY</b>	<b>Temperature</b> <u>26.0</u> °C <b>Electrical Conductivity</b> <u>0040</u> µS/cm <b>pH</b> <u>7.1</u> <b>Total Suspended Solids</b> <u>0020</u> mg/L	<b>Odor</b> <input checked="" type="checkbox"/> Normal/None <input type="checkbox"/> Sewage <input type="checkbox"/> Petroleum <input type="checkbox"/> Chemical <input type="checkbox"/> Fishy <input checked="" type="checkbox"/> Other <u>Trash (bottle)</u> <b>Water Surface Oils</b> <input type="checkbox"/> Slick <input checked="" type="checkbox"/> Sheen <input type="checkbox"/> Gloss <input type="checkbox"/> Fleck <input type="checkbox"/> None <input type="checkbox"/> Other _____

SEDIMENT/ SUBSTRATE (IF VISIBLE)			
Inorganic Substrate Components		Organic Substrate Components	
Substrate Type	% Composition in Sampling Reach	Substrate Type	% Composition in Sampling Reach
Bedrock		Detritus such as sticks, wood, coarse plant materials	75
Boulder		Mud	
Cobble		Other	
Gravel			
Sand			
Silt	5		
Clay	20		

## Field Record Sheet

<b>Name of Surveyors:</b> Cheong Shu Min & Eva Yew		<b>Location:</b> CCNR			
<b>Stream ID:</b> MA		<b>Coordinates:</b> N 01°36'03.3" E 103°82'64.5"			
<b>Date of Survey:</b> 28 Oct 2014		<b>Time of Survey:</b> 9:55 am			
<b>Photo record:</b> MA_014 to MA_026					
<b>WEATHER</b>	<table style="width: 100%; border: none;"> <tr> <td style="width: 50%; vertical-align: top;"> <b>Now</b>  <input type="checkbox"/> Storm (Heavy rain)  <input type="checkbox"/> Rain (Steady rain)  <input type="checkbox"/> Shower (Intermittent)  <input type="checkbox"/> Cloud Cover  <input checked="" type="checkbox"/> Clear/Sunny  <b>Temperature</b>___ °C </td> <td style="width: 50%; vertical-align: top;"> <b>Past 24 Hours</b>  <input checked="" type="checkbox"/> Storm (Heavy rain)  <input type="checkbox"/> Rain (Steady rain)  <input type="checkbox"/> Shower (Intermittent)  <input type="checkbox"/> Cloud Cover  <input type="checkbox"/> Clear/Sunny </td> </tr> </table>			<b>Now</b> <input type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input checked="" type="checkbox"/> Clear/Sunny <b>Temperature</b> ___ °C	<b>Past 24 Hours</b> <input checked="" type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input type="checkbox"/> Clear/Sunny
<b>Now</b> <input type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input checked="" type="checkbox"/> Clear/Sunny <b>Temperature</b> ___ °C	<b>Past 24 Hours</b> <input checked="" type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input type="checkbox"/> Clear/Sunny				
<b>RIPARIAN VEGETATION</b>	<b>Indicate the dominant type and record the dominant species present:</b> <input type="checkbox"/> Trees <input type="checkbox"/> Shrubs <input checked="" type="checkbox"/> Grasses <input checked="" type="checkbox"/> Herbaceous <b>Dominant Species Present</b> _____				
<b>AQUATIC VEGETATION</b>	<b>Indicate the dominant type and record the dominant species present:</b> <input checked="" type="checkbox"/> Rooted Emergent <input type="checkbox"/> Rooted Submergent <input type="checkbox"/> Rooted Floating <input type="checkbox"/> Floating Algae <input checked="" type="checkbox"/> Attached Algae <b>Dominant Species Present</b> _____				
<b>AQUATIC FAUNA</b>	<b>Notes:</b> <ul style="list-style-type: none"> <li>Dragonfly (common red) + Blue</li> <li>Small fish observed (~ 5-10)</li> </ul>				



<b>STREAM CHARACTERISATION</b>	<b>Occurrence</b> <input checked="" type="checkbox"/> Perennial <input type="checkbox"/> Intermittent  <b>Stream Type</b> <input type="checkbox"/> "Tree-country" Forest stream <input checked="" type="checkbox"/> "Open-country" Stream <input type="checkbox"/> Concrete canal, drain <input type="checkbox"/> Other _____	<b>Characteristics of Water Flow</b> <input type="checkbox"/> Fast, with roughness <input checked="" type="checkbox"/> Fast, smooth <input type="checkbox"/> Slow, gentle <input type="checkbox"/> Pool <input type="checkbox"/> Trickle  <b>Channelized</b> <input type="checkbox"/> Yes <input type="checkbox"/> No
<b>STREAM FEATURES</b>	<b>Estimated Length Sampled</b> _____ m <b>Estimated Stream Width</b> <u>1.0 - 1.2</u> m <b>Estimated Stream Depth</b> <u>17.0</u> cm <b>Canopy Cover</b> <input type="checkbox"/> Open <input checked="" type="checkbox"/> Partly Open/Shaded <input type="checkbox"/> Shaded <b>Light intensity</b> <u>3.31 - 8.86 Klux</u>	<b>Stream Surface</b> <input type="checkbox"/> Clear <input checked="" type="checkbox"/> Slightly Turbid <input type="checkbox"/> Turbid <input type="checkbox"/> Stained Presence of Leaf Litter <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No If Yes, % cover <u>20</u> Large Woody Debris <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No If Yes, % cover _____
<b>WATER QUALITY</b>	<b>Temperature</b> <u>26.2</u> °C <b>Electrical Conductivity</b> <u>0030</u> µS/cm <b>pH</b> <u>6.4</u> <b>Total Suspended Solids</b> <u>0010</u> mg/L	<b>Odor</b> <input checked="" type="checkbox"/> Normal/None <input type="checkbox"/> Sewage <input type="checkbox"/> Petroleum <input type="checkbox"/> Chemical <input type="checkbox"/> Fishy <input checked="" type="checkbox"/> Other <u>Trash (pen marker)</u>  <b>Water Surface Oils</b> <input type="checkbox"/> Slick <input checked="" type="checkbox"/> Sheen <input type="checkbox"/> Gloss <input type="checkbox"/> Fleck <input type="checkbox"/> None <input type="checkbox"/> Other _____

SEDIMENT/ SUBSTRATE (IF VISIBLE)			
Inorganic Substrate Components		Organic Substrate Components	
Substrate Type	% Composition in Sampling Reach	Substrate Type	% Composition in Sampling Reach
Bedrock		Detritus such as sticks, wood, coarse plant materials	40
Boulder		Mud	40
Cobble		Other	
Gravel			
Sand			
Silt			
Clay	20		

## Field Record Sheet

<b>Name of Surveyors:</b> Cheong Shu Min & Eva Yew		<b>Location:</b> CCNR			
<b>Stream ID:</b> MA		<b>Coordinates:</b> N 01°36'07.0" E 103°82'57.2"			
<b>Date of Survey:</b> 28 Oct 2014		<b>Time of Survey:</b> 10:03 am			
<b>Photo record:</b> MA_027 to MA_043					
<b>WEATHER</b>	<table style="width: 100%; border: none;"> <tr> <td style="width: 50%; vertical-align: top;"> <b>Now</b>  <input type="checkbox"/> Storm (Heavy rain)  <input type="checkbox"/> Rain (Steady rain)  <input type="checkbox"/> Shower (Intermittent)  <input type="checkbox"/> Cloud Cover  <input checked="" type="checkbox"/> Clear/Sunny  <b>Temperature</b>___ °C </td> <td style="width: 50%; vertical-align: top;"> <b>Past 24 Hours</b>  <input checked="" type="checkbox"/> Storm (Heavy rain)  <input type="checkbox"/> Rain (Steady rain)  <input type="checkbox"/> Shower (Intermittent)  <input type="checkbox"/> Cloud Cover  <input type="checkbox"/> Clear/Sunny </td> </tr> </table>			<b>Now</b> <input type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input checked="" type="checkbox"/> Clear/Sunny <b>Temperature</b> ___ °C	<b>Past 24 Hours</b> <input checked="" type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input type="checkbox"/> Clear/Sunny
<b>Now</b> <input type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input checked="" type="checkbox"/> Clear/Sunny <b>Temperature</b> ___ °C	<b>Past 24 Hours</b> <input checked="" type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input type="checkbox"/> Clear/Sunny				
<b>RIPARIAN VEGETATION</b>	<b>Indicate the dominant type and record the dominant species present:</b> <input type="checkbox"/> Trees <input type="checkbox"/> Shrubs <input checked="" type="checkbox"/> Grasses <input checked="" type="checkbox"/> Herbaceous <b>Dominant Species Present</b> _____				
<b>AQUATIC VEGETATION</b>	<b>Indicate the dominant type and record the dominant species present:</b> <input checked="" type="checkbox"/> Rooted Emergent <input type="checkbox"/> Rooted Submergent <input type="checkbox"/> Rooted Floating <input type="checkbox"/> Floating Algae <input type="checkbox"/> Attached Algae <b>Dominant Species Present</b> _____				
<b>AQUATIC FAUNA</b>	<b>Notes:</b> <ul style="list-style-type: none"> <li>Red dragonfly</li> <li>Halfbeaks observed in stream (possibly Malayan Pygmy Halfbeak)</li> </ul>				

<b>STREAM CHARACTERISATION</b>	<b>Occurrence</b> <input checked="" type="checkbox"/> Perennial <input type="checkbox"/> Intermittent  <b>Stream Type</b> <input type="checkbox"/> "Tree-country" Forest stream <input checked="" type="checkbox"/> "Open-country" Stream <input type="checkbox"/> Concrete canal, drain <input type="checkbox"/> Other _____	<b>Characteristics of Water Flow</b> <input type="checkbox"/> Fast, with roughness <input checked="" type="checkbox"/> Fast, smooth <input type="checkbox"/> Slow, gentle <input type="checkbox"/> Pool <input type="checkbox"/> Trickle  <b>Channelized</b> <input type="checkbox"/> Yes <input type="checkbox"/> No
	<b>STREAM FEATURES</b>	<b>Estimated Length Sampled</b> _____ m <b>Estimated Stream Width</b> <u>1.0 - 2.0</u> m <b>Estimated Stream Depth</b> <u>16.5</u> cm <b>Canopy Cover</b> <input checked="" type="checkbox"/> Open <input type="checkbox"/> Partly Open/Shaded <input type="checkbox"/> Shaded <b>Light intensity</b> <u>3.31 - 8.86 Klux</u>
<b>WATER QUALITY</b>	<b>Temperature</b> <u>25.9</u> °C <b>Electrical Conductivity</b> <u>0030</u> µS/cm <b>pH</b> <u>6.4</u> <b>Total Suspended Solids</b> <u>0010</u> mg/L	<b>Odor</b> <input checked="" type="checkbox"/> Normal/None <input type="checkbox"/> Sewage <input type="checkbox"/> Petroleum <input type="checkbox"/> Chemical <input type="checkbox"/> Fishy <input checked="" type="checkbox"/> Other <u>Trash (bottles, cans)</u>  <b>Water Surface Oils</b> <input type="checkbox"/> Slick <input checked="" type="checkbox"/> Sheen <input type="checkbox"/> Gloss <input type="checkbox"/> Fleck <input type="checkbox"/> None <input type="checkbox"/> Other _____

SEDIMENT/ SUBSTRATE (IF VISIBLE)			
Inorganic Substrate Components		Organic Substrate Components	
Substrate Type	% Composition in Sampling Reach	Substrate Type	% Composition in Sampling Reach
Bedrock		Detritus such as sticks, wood, coarse plant materials	50
Boulder		Mud	20
Cobble		Other	
Gravel			
Sand			
Silt	10		
Clay	20		



## Field Record Sheet

<b>Name of Surveyors:</b> Cheong Shu Min & Eva Yew		<b>Location:</b> CCNR			
<b>Stream ID:</b> MA1		<b>Coordinates:</b> N 01°36'09.0" E 103°82'52.9" (MA006) N 01°36'10.7" E 103°82'52.0" (MA007)			
<b>Date of Survey:</b> 28 Oct 2014		<b>Time of Survey:</b> 10:15 am			
<b>Photo record:</b> MA1_001 to MA1_011					
<b>WEATHER</b>	<table style="width: 100%; border: none;"> <tr> <td style="width: 50%; vertical-align: top;"> <b>Now</b>  <input type="checkbox"/> Storm (Heavy rain)  <input type="checkbox"/> Rain (Steady rain)  <input type="checkbox"/> Shower (Intermittent)  <input type="checkbox"/> Cloud Cover  <input checked="" type="checkbox"/> Clear/Sunny  <b>Temperature</b>___ °C </td> <td style="width: 50%; vertical-align: top;"> <b>Past 24 Hours</b>  <input checked="" type="checkbox"/> Storm (Heavy rain)  <input type="checkbox"/> Rain (Steady rain)  <input type="checkbox"/> Shower (Intermittent)  <input type="checkbox"/> Cloud Cover  <input type="checkbox"/> Clear/Sunny </td> </tr> </table>			<b>Now</b> <input type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input checked="" type="checkbox"/> Clear/Sunny <b>Temperature</b> ___ °C	<b>Past 24 Hours</b> <input checked="" type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input type="checkbox"/> Clear/Sunny
<b>Now</b> <input type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input checked="" type="checkbox"/> Clear/Sunny <b>Temperature</b> ___ °C	<b>Past 24 Hours</b> <input checked="" type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input type="checkbox"/> Clear/Sunny				
<b>RIPARIAN VEGETATION</b>	<b>Indicate the dominant type and record the dominant species present:</b> <input checked="" type="checkbox"/> Trees <input type="checkbox"/> Shrubs <input type="checkbox"/> Grasses <input checked="" type="checkbox"/> Herbaceous <b>Dominant Species Present</b> _____				
<b>AQUATIC VEGETATION</b>	<b>Indicate the dominant type and record the dominant species present:</b> <input type="checkbox"/> Rooted Emergent <input type="checkbox"/> Rooted Submergent <input type="checkbox"/> Rooted Floating <input type="checkbox"/> Floating Algae <input type="checkbox"/> Attached Algae <b>Dominant Species Present</b> _____				
<b>AQUATIC FAUNA</b>	<b>Notes:</b> <ul style="list-style-type: none"> <li>Fish observed (possibly Saddle Barb)</li> </ul>				

<b>STREAM CHARACTERISATION</b>	<b>Occurrence</b> <input checked="" type="checkbox"/> Perennial <input type="checkbox"/> Intermittent  <b>Stream Type</b> <input checked="" type="checkbox"/> "Tree-country" Forest stream <input type="checkbox"/> "Open-country" Stream <input checked="" type="checkbox"/> Concrete canal, drain <input type="checkbox"/> Other _____	<b>Characteristics of Water Flow</b>  <input type="checkbox"/> Fast, with roughness <input type="checkbox"/> Fast, smooth <input checked="" type="checkbox"/> Slow, gentle <input type="checkbox"/> Pool <input type="checkbox"/> Trickle  <b>Channelized</b> <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No
<b>STREAM FEATURES</b>	<b>Estimated Length Sampled</b> _____ m <b>Estimated Stream Width</b> _____ m <b>Estimated Stream Depth</b> <u>4.0 - 7.0</u> cm <b>Canopy Cover</b> <input checked="" type="checkbox"/> Open <input type="checkbox"/> Partly Open/Shaded <input type="checkbox"/> Shaded <b>Light intensity</b> <u>2.69 - 2.93 Klux</u>	<b>Stream Surface</b>  <input type="checkbox"/> Clear <input checked="" type="checkbox"/> Slightly Turbid <input type="checkbox"/> Turbid <input type="checkbox"/> Stained  Presence of Leaf Litter <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No  If Yes, % cover <u>70</u>  Large Woody Debris <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No  If Yes, % cover _____
<b>WATER QUALITY</b>	<b>Temperature</b> <u>26.8</u> °C <b>Electrical Conductivity</b> <u>0030</u> µS/cm <b>pH</b> <u>6.5</u> <b>Total Suspended Solids</b> <u>0010</u> mg/L	<b>Odor</b> <input checked="" type="checkbox"/> Normal/None <input type="checkbox"/> Sewage <input type="checkbox"/> Petroleum <input type="checkbox"/> Chemical <input type="checkbox"/> Fishy <input checked="" type="checkbox"/> Other <u>Trash (bottles, Trash bag)</u>  <b>Water Surface Oils</b> <input type="checkbox"/> Slick <input type="checkbox"/> Sheen <input type="checkbox"/> Gloss <input type="checkbox"/> Fleck <input checked="" type="checkbox"/> None <input type="checkbox"/> Other _____

SEDIMENT/ SUBSTRATE (IF VISIBLE)			
Inorganic Substrate Components		Organic Substrate Components	
Substrate Type	% Composition in Sampling Reach	Substrate Type	% Composition in Sampling Reach
Bedrock		Detritus such as sticks, wood, coarse plant materials	80
Boulder		Mud	5
Cobble		Other	
Gravel			
Sand			
Silt	5		
Clay	10		

## Field Record Sheet

<b>Name of Surveyors:</b> Cheong Shu Min & Eva Yew		<b>Location:</b> MacRitchie CCNR			
<b>Stream ID:</b> MA2		<b>Coordinates:</b> N 01°36'07.3" E 103°82'50.5"			
<b>Date of Survey:</b> 28 Oct 2014		<b>Time of Survey:</b> 10:03 am			
<b>Photo record:</b> MA2_001 to MA2_011 & MA2 & MA3_001					
<b>WEATHER</b>	<table style="width: 100%; border: none;"> <tr> <td style="width: 50%; vertical-align: top;"> <b>Now</b>  <input type="checkbox"/> Storm (Heavy rain)  <input type="checkbox"/> Rain (Steady rain)  <input type="checkbox"/> Shower (Intermittent)  <input type="checkbox"/> Cloud Cover  <input checked="" type="checkbox"/> Clear/Sunny  <b>Temperature</b>___ °C </td> <td style="width: 50%; vertical-align: top;"> <b>Past 24 Hours</b>  <input checked="" type="checkbox"/> Storm (Heavy rain)  <input type="checkbox"/> Rain (Steady rain)  <input type="checkbox"/> Shower (Intermittent)  <input type="checkbox"/> Cloud Cover  <input type="checkbox"/> Clear/Sunny </td> </tr> </table>			<b>Now</b> <input type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input checked="" type="checkbox"/> Clear/Sunny <b>Temperature</b> ___ °C	<b>Past 24 Hours</b> <input checked="" type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input type="checkbox"/> Clear/Sunny
<b>Now</b> <input type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input checked="" type="checkbox"/> Clear/Sunny <b>Temperature</b> ___ °C	<b>Past 24 Hours</b> <input checked="" type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input type="checkbox"/> Clear/Sunny				
<b>RIPARIAN VEGETATION</b>	<b>Indicate the dominant type and record the dominant species present:</b> <input checked="" type="checkbox"/> Trees <input type="checkbox"/> Shrubs <input type="checkbox"/> Grasses <input checked="" type="checkbox"/> Herbaceous <b>Dominant Species Present</b> _____				
<b>AQUATIC VEGETATION</b>	<b>Indicate the dominant type and record the dominant species present:</b> <input type="checkbox"/> Rooted Emergent <input type="checkbox"/> Rooted Submergent <input type="checkbox"/> Rooted Floating <input type="checkbox"/> Floating Algae <input type="checkbox"/> Attached Algae <b>Dominant Species Present</b> _____				
<b>AQUATIC FAUNA</b>	<b>Notes:</b> <ul style="list-style-type: none"> <li>Halfbeaks observed in upstream</li> <li>Fish observed in downstream (possibly Saddle Barb)</li> </ul>				



<b>STREAM CHARACTERISATION</b>	<b>Occurrence</b> <input checked="" type="checkbox"/> Perennial <input type="checkbox"/> Intermittent  <b>Stream Type</b> <input checked="" type="checkbox"/> "Tree-country" Forest stream <input type="checkbox"/> "Open-country" Stream <input type="checkbox"/> Concrete canal, drain <input type="checkbox"/> Other _____	<b>Characteristics of Water Flow</b> <input type="checkbox"/> Fast, with roughness <input checked="" type="checkbox"/> Fast, smooth <input type="checkbox"/> Slow, gentle <input type="checkbox"/> Pool <input type="checkbox"/> Trickle  <b>Channelized</b> <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No
	<b>STREAM FEATURES</b>	<b>Estimated Length Sampled</b> _____ m <b>Estimated Stream Width</b> <u>1.0 - 1.5</u> m <b>Estimated Stream Depth</b> <u>6.5</u> cm <b>Canopy Cover</b> <input type="checkbox"/> Open <input checked="" type="checkbox"/> Partly Open/Shaded <input type="checkbox"/> Shaded <b>Light intensity</b> <u>5.1 4 - 5.99</u> Klux
<b>WATER QUALITY</b>	<b>Temperature</b> <u>26.4</u> °C <b>Electrical Conductivity</b> <u>0030</u> µS/cm <b>pH</b> <u>6.3</u> <b>Total Suspended Solids</b> <u>0010</u> mg/L	<b>Odor</b> <input checked="" type="checkbox"/> Normal/None <input type="checkbox"/> Sewage <input type="checkbox"/> Petroleum <input type="checkbox"/> Chemical <input type="checkbox"/> Fishy <input type="checkbox"/> Other  <b>Water Surface Oils</b> <input type="checkbox"/> Slick <input type="checkbox"/> Sheen <input type="checkbox"/> Gloss <input type="checkbox"/> Fleck <input checked="" type="checkbox"/> None <input type="checkbox"/> Other _____

SEDIMENT/ SUBSTRATE (IF VISIBLE)			
Inorganic Substrate Components		Organic Substrate Components	
Substrate Type	% Composition in Sampling Reach	Substrate Type	% Composition in Sampling Reach
Bedrock		Detritus such as sticks, wood, coarse plant materials	30
Boulder		Mud	10
Cobble		Other	
Gravel			
Sand			
Silt	30		
Clay	30		

## Field Record Sheet

<b>Name of Surveyors:</b> Cheong Shu Min & Eva Yew		<b>Location:</b> CCNR			
<b>Stream ID:</b> MA3		<b>Coordinates:</b> N 01°36'05.0" E 103°82'40.3"			
<b>Date of Survey:</b> 28 Oct 2014		<b>Time of Survey:</b> 10:46 am			
<b>Photo record:</b> MA3_001 to MA3_010					
<b>WEATHER</b>	<table style="width: 100%; border: none;"> <tr> <td style="width: 50%; vertical-align: top;"> <b>Now</b>  <input type="checkbox"/> Storm (Heavy rain)  <input type="checkbox"/> Rain (Steady rain)  <input type="checkbox"/> Shower (Intermittent)  <input type="checkbox"/> Cloud Cover  <input checked="" type="checkbox"/> Clear/Sunny  <b>Temperature</b>___ °C </td> <td style="width: 50%; vertical-align: top;"> <b>Past 24 Hours</b>  <input checked="" type="checkbox"/> Storm (Heavy rain)  <input type="checkbox"/> Rain (Steady rain)  <input type="checkbox"/> Shower (Intermittent)  <input type="checkbox"/> Cloud Cover  <input type="checkbox"/> Clear/Sunny </td> </tr> </table>			<b>Now</b> <input type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input checked="" type="checkbox"/> Clear/Sunny <b>Temperature</b> ___ °C	<b>Past 24 Hours</b> <input checked="" type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input type="checkbox"/> Clear/Sunny
<b>Now</b> <input type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input checked="" type="checkbox"/> Clear/Sunny <b>Temperature</b> ___ °C	<b>Past 24 Hours</b> <input checked="" type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input type="checkbox"/> Clear/Sunny				
<b>RIPARIAN VEGETATION</b>	<b>Indicate the dominant type and record the dominant species present:</b> <input checked="" type="checkbox"/> Trees <input type="checkbox"/> Shrubs <input type="checkbox"/> Grasses <input checked="" type="checkbox"/> Herbaceous <b>Dominant Species Present</b> _____				
<b>AQUATIC VEGETATION</b>	<b>Indicate the dominant type and record the dominant species present:</b> <input type="checkbox"/> Rooted Emergent <input type="checkbox"/> Rooted Submergent <input type="checkbox"/> Rooted Floating <input type="checkbox"/> Floating Algae <input type="checkbox"/> Attached Algae <b>Dominant Species Present</b> _____				
<b>AQUATIC FAUNA</b>	<b>Notes:</b>   				

<b>STREAM CHARACTERISATION</b>	<b>Occurrence</b> <input checked="" type="checkbox"/> Perennial <input type="checkbox"/> Intermittent  <b>Stream Type</b> <input checked="" type="checkbox"/> "Tree-country" Forest stream <input type="checkbox"/> "Open-country" Stream <input type="checkbox"/> Concrete canal, drain <input type="checkbox"/> Other _____	<b>Characteristics of Water Flow</b> <input type="checkbox"/> Fast, with roughness <input checked="" type="checkbox"/> Fast, smooth <input type="checkbox"/> Slow, gentle <input type="checkbox"/> Pool <input type="checkbox"/> Trickle <b>Channelized</b> <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No
	<b>STREAM FEATURES</b>	<b>Estimated Length Sampled</b> _____ m <b>Estimated Stream Width</b> <u>1.0 - 2.5</u> m <b>Estimated Stream Depth</b> <u>5.5</u> cm <b>Canopy Cover</b> <input type="checkbox"/> Open <input checked="" type="checkbox"/> Partly Open/Shaded <input type="checkbox"/> Shaded <b>Light intensity</b> _____
<b>WATER QUALITY</b>	<b>Temperature</b> <u>26.2</u> °C <b>Electrical Conductivity</b> <u>0060</u> µS/cm <b>pH</b> <u>6.3</u> <b>Total Suspended Solids</b> <u>0030</u> mg/L	<b>Odor</b> <input checked="" type="checkbox"/> Normal/None <input type="checkbox"/> Sewage <input type="checkbox"/> Petroleum <input type="checkbox"/> Chemical <input type="checkbox"/> Fishy <input checked="" type="checkbox"/> Other <u>Trash (bottles, cans)</u> <b>Water Surface Oils</b> <input type="checkbox"/> Slick <input type="checkbox"/> Sheen <input type="checkbox"/> Gloss <input type="checkbox"/> Fleck <input checked="" type="checkbox"/> None <input type="checkbox"/> Other _____

SEDIMENT/ SUBSTRATE (IF VISIBLE)			
Inorganic Substrate Components		Organic Substrate Components	
Substrate Type	% Composition in Sampling Reach	Substrate Type	% Composition in Sampling Reach
Bedrock		Detritus such as sticks, wood, coarse plant materials	10
Boulder		Mud	
Cobble		Other	
Gravel			
Sand			
Silt	80		
Clay	10		



## Field Record Sheet

<b>Name of Surveyors:</b> Cheong Shu Min & Eva Yew		<b>Location:</b> CCNR			
<b>Stream ID:</b> MA6		<b>Coordinates:</b> N 01°35'99.8" E 103°82'37.8"			
<b>Date of Survey:</b> 28 Oct 2014		<b>Time of Survey:</b> 10:53 am			
<b>Photo record:</b> MA6_001 to MA6_014					
<b>WEATHER</b>	<table style="width: 100%; border: none;"> <tr> <td style="width: 50%; vertical-align: top;"> <b>Now</b>  <input type="checkbox"/> Storm (Heavy rain)  <input type="checkbox"/> Rain (Steady rain)  <input type="checkbox"/> Shower (Intermittent)  <input type="checkbox"/> Cloud Cover  <input checked="" type="checkbox"/> Clear/Sunny  <b>Temperature</b>___ °C </td> <td style="width: 50%; vertical-align: top;"> <b>Past 24 Hours</b>  <input checked="" type="checkbox"/> Storm (Heavy rain)  <input type="checkbox"/> Rain (Steady rain)  <input type="checkbox"/> Shower (Intermittent)  <input type="checkbox"/> Cloud Cover  <input type="checkbox"/> Clear/Sunny </td> </tr> </table>			<b>Now</b> <input type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input checked="" type="checkbox"/> Clear/Sunny <b>Temperature</b> ___ °C	<b>Past 24 Hours</b> <input checked="" type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input type="checkbox"/> Clear/Sunny
<b>Now</b> <input type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input checked="" type="checkbox"/> Clear/Sunny <b>Temperature</b> ___ °C	<b>Past 24 Hours</b> <input checked="" type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input type="checkbox"/> Clear/Sunny				
<b>RIPARIAN VEGETATION</b>	<b>Indicate the dominant type and record the dominant species present:</b> <input checked="" type="checkbox"/> Trees <input type="checkbox"/> Shrubs <input type="checkbox"/> Grasses <input checked="" type="checkbox"/> Herbaceous <b>Dominant Species Present</b> _____				
<b>AQUATIC VEGETATION</b>	<b>Indicate the dominant type and record the dominant species present:</b> <input type="checkbox"/> Rooted Emergent <input type="checkbox"/> Rooted Submergent <input type="checkbox"/> Rooted Floating <input type="checkbox"/> Floating Algae <input type="checkbox"/> Attached Algae <b>Dominant Species Present</b> _____				
<b>AQUATIC FAUNA</b>	<b>Notes:</b> <ul style="list-style-type: none"> <li>Dragonfly</li> <li>Halfbeaks</li> </ul>				

<b>STREAM CHARACTERISATION</b>	<b>Occurrence</b> <input checked="" type="checkbox"/> Perennial <input type="checkbox"/> Intermittent  <b>Stream Type</b> <input checked="" type="checkbox"/> "Tree-country" Forest stream <input type="checkbox"/> "Open-country" Stream <input type="checkbox"/> Concrete canal, drain <input type="checkbox"/> Other _____	<b>Characteristics of Water Flow</b> <input type="checkbox"/> Fast, with roughness <input checked="" type="checkbox"/> Fast, smooth <input type="checkbox"/> Slow, gentle <input type="checkbox"/> Pool <input type="checkbox"/> Trickle <b>Channelized</b> <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No
	<b>STREAM FEATURES</b>	<b>Estimated Length Sampled</b> _____ m <b>Estimated Stream Width</b> _____ m <b>Estimated Stream Depth</b> <u>9.5</u> cm <b>Canopy Cover</b> <input type="checkbox"/> Open <input checked="" type="checkbox"/> Partly Open/Shaded <input type="checkbox"/> Shaded <b>Light intensity</b> <u>5.75 - 8.65 Klux</u>
<b>WATER QUALITY</b>	<b>Temperature</b> <u>26.2</u> °C <b>Electrical Conductivity</b> <u>0020</u> µS/cm <b>pH</b> <u>6.4</u> <b>Total Suspended Solids</b> <u>0010</u> mg/L	<b>Odor</b> <input checked="" type="checkbox"/> Normal/None <input type="checkbox"/> Sewage <input type="checkbox"/> Petroleum <input type="checkbox"/> Chemical <input type="checkbox"/> Fishy <input type="checkbox"/> Other <b>Water Surface Oils</b> <input type="checkbox"/> Slick <input type="checkbox"/> Sheen <input type="checkbox"/> Gloss <input type="checkbox"/> Fleck <input checked="" type="checkbox"/> None <input type="checkbox"/> Other _____

SEDIMENT/ SUBSTRATE (IF VISIBLE)			
Inorganic Substrate Components		Organic Substrate Components	
Substrate Type	% Composition in Sampling Reach	Substrate Type	% Composition in Sampling Reach
Bedrock		Detritus such as sticks, wood, coarse plant materials	10
Boulder		Mud	
Cobble		Other	
Gravel			
Sand			
Silt	75		
Clay	15		

## Field Record Sheet

Name of Surveyors: Cheong Shu Min & Eva Yew		Location: CCNR			
Stream ID: <b>MA6</b>		Coordinates: N 01°35'93.1" E 103°82'34.8"			
Date of Survey: 28 Oct 2014		Time of Survey: 11:04 am			
Photo record: MA6_015 to MA6_039					
<b>WEATHER</b>	<table style="width: 100%; border: none;"> <tr> <td style="width: 50%; vertical-align: top;"> <b>Now</b>  <input type="checkbox"/> Storm (Heavy rain)  <input type="checkbox"/> Rain (Steady rain)  <input type="checkbox"/> Shower (Intermittent)  <input type="checkbox"/> Cloud Cover  <input checked="" type="checkbox"/> Clear/Sunny  <b>Temperature</b>___ °C                 </td> <td style="width: 50%; vertical-align: top;"> <b>Past 24 Hours</b>  <input checked="" type="checkbox"/> Storm (Heavy rain)  <input type="checkbox"/> Rain (Steady rain)  <input type="checkbox"/> Shower (Intermittent)  <input type="checkbox"/> Cloud Cover  <input type="checkbox"/> Clear/Sunny                 </td> </tr> </table>			<b>Now</b> <input type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input checked="" type="checkbox"/> Clear/Sunny <b>Temperature</b> ___ °C	<b>Past 24 Hours</b> <input checked="" type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input type="checkbox"/> Clear/Sunny
<b>Now</b> <input type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input checked="" type="checkbox"/> Clear/Sunny <b>Temperature</b> ___ °C	<b>Past 24 Hours</b> <input checked="" type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input type="checkbox"/> Clear/Sunny				
<b>RIPARIAN VEGETATION</b>	<b>Indicate the dominant type and record the dominant species present:</b> <input checked="" type="checkbox"/> Trees <input type="checkbox"/> Shrubs <input type="checkbox"/> Grasses <input checked="" type="checkbox"/> Herbaceous <b>Dominant Species Present</b> _____				
<b>AQUATIC VEGETATION</b>	<b>Indicate the dominant type and record the dominant species present:</b> <input type="checkbox"/> Rooted Emergent <input type="checkbox"/> Rooted Submergent <input type="checkbox"/> Rooted Floating <input type="checkbox"/> Floating Algae <input type="checkbox"/> Attached Algae <b>Dominant Species Present</b> _____				
<b>AQUATIC FAUNA</b>	<b>Notes:</b>				



<b>STREAM CHARACTERISATION</b>	<b>Occurrence</b> <input checked="" type="checkbox"/> Perennial <input type="checkbox"/> Intermittent  <b>Stream Type</b> <input checked="" type="checkbox"/> "Tree-country" Forest stream <input type="checkbox"/> "Open-country" Stream <input type="checkbox"/> Concrete canal, drain <input type="checkbox"/> Other _____	<b>Characteristics of Water Flow</b> <input checked="" type="checkbox"/> Fast, with roughness <input type="checkbox"/> Fast, smooth <input type="checkbox"/> Slow, gentle <input type="checkbox"/> Pool <input type="checkbox"/> Trickle  <b>Channelized</b> <input type="checkbox"/> Yes <input type="checkbox"/> No
<b>STREAM FEATURES</b>	<b>Estimated Length Sampled</b> _____ m <b>Estimated Stream Width</b> <u>1.0 - 1.7</u> m <b>Estimated Stream Depth</b> <u>5.0</u> cm <b>Canopy Cover</b> <input type="checkbox"/> Open <input checked="" type="checkbox"/> Partly Open/Shaded <input type="checkbox"/> Shaded <b>Light intensity</b> <u>1.75 - 2.36 Klux</u>	<b>Stream Surface</b> <input checked="" type="checkbox"/> Clear <input type="checkbox"/> Slightly Turbid <input type="checkbox"/> Turbid <input type="checkbox"/> Stained Presence of Leaf Litter <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No If Yes, % cover <u>10</u> Large Woody Debris <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No If Yes, % cover _____
<b>WATER QUALITY</b>	<b>Temperature</b> <u>26.0</u> °C <b>Electrical Conductivity</b> <u>0020</u> µS/cm <b>pH</b> <u>6.4</u> <b>Total Suspended Solids</b> <u>0010</u> mg/L	<b>Odor</b> <input checked="" type="checkbox"/> Normal/None <input type="checkbox"/> Sewage <input type="checkbox"/> Petroleum <input type="checkbox"/> Chemical <input type="checkbox"/> Fishy <input checked="" type="checkbox"/> Other <u>Trash (plastic bag)</u>  <b>Water Surface Oils</b> <input type="checkbox"/> Slick <input type="checkbox"/> Sheen <input type="checkbox"/> Gloss <input type="checkbox"/> Fleck <input checked="" type="checkbox"/> None <input type="checkbox"/> Other _____

SEDIMENT/ SUBSTRATE (IF VISIBLE)			
Inorganic Substrate Components		Organic Substrate Components	
Substrate Type	% Composition in Sampling Reach	Substrate Type	% Composition in Sampling Reach
Bedrock		Detritus such as sticks, wood, coarse plant materials	10
Boulder		Mud	10
Cobble		Other	
Gravel	10		
Sand	50		
Silt	10		
Clay			

## Field Record Sheet

Name of Surveyors: Cheong Shu Min & Eva Yew		Location: CCNR			
Stream ID: <b>MA10</b>		Coordinates: N 01°35'71.6" E 103°82'30.2" N 01°35'68.5" E 103°82'30.7"			
Date of Survey: 28 Oct 2014		Time of Survey: 11:17 am			
Photo record: MA10_001 to MA10_016					
<b>WEATHER</b>	<table style="width: 100%; border: none;"> <tr> <td style="width: 50%; vertical-align: top;"> <b>Now</b>  <input type="checkbox"/> Storm (Heavy rain)  <input type="checkbox"/> Rain (Steady rain)  <input type="checkbox"/> Shower (Intermittent)  <input type="checkbox"/> Cloud Cover  <input checked="" type="checkbox"/> Clear/Sunny  <b>Temperature</b>___ °C                 </td> <td style="width: 50%; vertical-align: top;"> <b>Past 24 Hours</b>  <input checked="" type="checkbox"/> Storm (Heavy rain)  <input type="checkbox"/> Rain (Steady rain)  <input type="checkbox"/> Shower (Intermittent)  <input type="checkbox"/> Cloud Cover  <input type="checkbox"/> Clear/Sunny                 </td> </tr> </table>			<b>Now</b> <input type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input checked="" type="checkbox"/> Clear/Sunny <b>Temperature</b> ___ °C	<b>Past 24 Hours</b> <input checked="" type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input type="checkbox"/> Clear/Sunny
<b>Now</b> <input type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input checked="" type="checkbox"/> Clear/Sunny <b>Temperature</b> ___ °C	<b>Past 24 Hours</b> <input checked="" type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input type="checkbox"/> Clear/Sunny				
<b>RIPARIAN VEGETATION</b>	<b>Indicate the dominant type and record the dominant species present:</b> <input checked="" type="checkbox"/> Trees <input type="checkbox"/> Shrubs <input type="checkbox"/> Grasses <input checked="" type="checkbox"/> Herbaceous <b>Dominant Species Present</b> _____				
<b>AQUATIC VEGETATION</b>	<b>Indicate the dominant type and record the dominant species present:</b> <input type="checkbox"/> Rooted Emergent <input type="checkbox"/> Rooted Submergent <input type="checkbox"/> Rooted Floating <input type="checkbox"/> Floating Algae <input type="checkbox"/> Attached Algae <b>Dominant Species Present</b> _____				
<b>AQUATIC FAUNA</b>	<b>Notes:</b>				

<b>STREAM CHARACTERISATION</b>	<b>Occurrence</b> <input checked="" type="checkbox"/> Perennial <input type="checkbox"/> Intermittent  <b>Stream Type</b> <input checked="" type="checkbox"/> "Tree-country" Forest stream <input type="checkbox"/> "Open-country" Stream <input checked="" type="checkbox"/> Concrete canal, drain <input type="checkbox"/> Other _____	<b>Characteristics of Water Flow</b> <input type="checkbox"/> Fast, with roughness <input type="checkbox"/> Fast, smooth <input checked="" type="checkbox"/> Slow, gentle <input type="checkbox"/> Pool <input type="checkbox"/> Trickle <b>Channelized</b> <input type="checkbox"/> Yes <input type="checkbox"/> No
<b>STREAM FEATURES</b>	<b>Estimated Length Sampled</b> _____ m <b>Estimated Stream Width</b> <u>1.0 - 2.5</u> m <b>Estimated Stream Depth</b> <u>29.0</u> cm <b>Canopy Cover</b> <input type="checkbox"/> Open <input checked="" type="checkbox"/> Partly Open/Shaded <input type="checkbox"/> Shaded <b>Light intensity</b> <u>6.44 - 29.52 Klux</u>	<b>Stream Surface</b> <input checked="" type="checkbox"/> Clear <input type="checkbox"/> Slightly Turbid <input type="checkbox"/> Turbid <input type="checkbox"/> Stained Presence of Leaf Litter <input type="checkbox"/> Yes <input type="checkbox"/> No If Yes, % cover <u>50</u> Large Woody Debris <input type="checkbox"/> Yes <input type="checkbox"/> No If Yes, % cover _____
<b>WATER QUALITY</b>	<b>Temperature</b> <u>26.7</u> °C <b>Electrical Conductivity</b> <u>0140</u> µS/cm <b>pH</b> <u>6.2</u> <b>Total Suspended Solids</b> <u>0070</u> mg/L	<b>Odor</b> <input checked="" type="checkbox"/> Normal/None <input type="checkbox"/> Sewage <input type="checkbox"/> Petroleum <input type="checkbox"/> Chemical <input type="checkbox"/> Fishy <input checked="" type="checkbox"/> Other <u>Trash (food package), Gravel</u> <b>Water Surface Oils</b> <input type="checkbox"/> Slick <input type="checkbox"/> Sheen <input type="checkbox"/> Gloss <input type="checkbox"/> Fleck <input checked="" type="checkbox"/> None <input type="checkbox"/> Other _____

SEDIMENT/ SUBSTRATE (IF VISIBLE)			
Inorganic Substrate Components		Organic Substrate Components	
Substrate Type	% Composition in Sampling Reach	Substrate Type	% Composition in Sampling Reach
Bedrock		Detritus such as sticks, wood, coarse plant materials	10
Boulder		Mud	
Cobble		Other	
Gravel	20		
Sand	70		
Silt			
Clay			



## Field Record Sheet

Name of Surveyors: Cheong Shu Min & Eva Yew		Location: CCNR	
Stream ID: CC		Coordinates:	
Date of Survey:		Time of Survey: 12:40 pm	
Photo record: CC001 to CC019			
<b>WEATHER</b>	<div style="display: flex; justify-content: space-between;"> <div style="width: 48%;"> <p><b>Now</b></p> <p><input type="checkbox"/> Storm (Heavy rain)</p> <p><input type="checkbox"/> Rain (Steady rain)</p> <p><input type="checkbox"/> Shower (Intermittent)</p> <p><input type="checkbox"/> Cloud Cover</p> <p><input checked="" type="checkbox"/> Clear/Sunny</p> <p>Temperature ____ °C</p> </div> <div style="width: 48%;"> <p><b>Past 24 Hours</b></p> <p><input checked="" type="checkbox"/> Storm (Heavy rain)</p> <p><input type="checkbox"/> Rain (Steady rain)</p> <p><input type="checkbox"/> Shower (Intermittent)</p> <p><input type="checkbox"/> Cloud Cover</p> <p><input type="checkbox"/> Clear/Sunny</p> </div> </div>		
<b>RIPARIAN VEGETATION</b>	<p><b>Indicate the dominant type and record the dominant species present:</b></p> <p><input checked="" type="checkbox"/> Trees</p> <p><input type="checkbox"/> Shrubs</p> <p><input type="checkbox"/> Grasses</p> <p><input type="checkbox"/> Herbaceous</p> <p><b>Dominant Species Present</b> _____</p>		
<b>AQUATIC VEGETATION</b>	<p><b>Indicate the dominant type and record the dominant species present:</b></p> <p><input type="checkbox"/> Rooted Emergent</p> <p><input type="checkbox"/> Rooted Submergent</p> <p><input type="checkbox"/> Rooted Floating</p> <p><input type="checkbox"/> Floating Algae</p> <p><input type="checkbox"/> Attached Algae</p> <p><b>Dominant Species Present</b> _____</p>		
<b>AQUATIC FAUNA</b>	<p><b>Notes:</b></p>          		

<b>STREAM CHARACTERISATION</b>	<b>Occurrence</b> <input type="checkbox"/> Perennial <input type="checkbox"/> Intermittent  <b>Stream Type</b> <input checked="" type="checkbox"/> "Tree-country" Forest stream <input type="checkbox"/> "Open-country" Stream <input type="checkbox"/> Concrete canal, drain <input type="checkbox"/> Other _____	<b>Characteristics of Water Flow</b> <input type="checkbox"/> Fast, with roughness <input type="checkbox"/> Fast, smooth <input type="checkbox"/> Slow, gentle <input checked="" type="checkbox"/> Pool <input type="checkbox"/> Trickle  <b>Channelized</b> <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No
	<b>STREAM FEATURES</b>	<b>Estimated Length Sampled</b> _____ m <b>Estimated Stream Width</b> <u>20 - 60</u> cm <b>Estimated Stream Depth</b> _____ cm <b>Canopy Cover</b> <input type="checkbox"/> Open <input type="checkbox"/> Partly Open/Shaded <input checked="" type="checkbox"/> Shaded <b>Light intensity</b> <u>3.42 - 3.67 Klux</u>
<b>WATER QUALITY</b>	<b>Temperature</b> <u>26.4</u> °C <b>Electrical Conductivity</b> <u>0020</u> µS/cm <b>pH</b> <u>7.2</u> <b>Total Suspended Solids</b> <u>0</u> mg/L	<b>Odor</b> <input checked="" type="checkbox"/> Normal/None <input type="checkbox"/> Sewage <input type="checkbox"/> Petroleum <input type="checkbox"/> Chemical <input type="checkbox"/> Fishy <input type="checkbox"/> Other  <b>Water Surface Oils</b> <input type="checkbox"/> Slick <input type="checkbox"/> Sheen <input type="checkbox"/> Gloss <input type="checkbox"/> Fleck <input checked="" type="checkbox"/> None <input type="checkbox"/> Other _____

SEDIMENT/ SUBSTRATE (IF VISIBLE)			
Inorganic Substrate Components		Organic Substrate Components	
Substrate Type	% Composition in Sampling Reach	Substrate Type	% Composition in Sampling Reach
Bedrock		Detritus such as sticks, wood, coarse plant materials	70
Boulder		Mud	
Cobble		Other	
Gravel			
Sand			
Silt	30		
Clay			

## Field Record Sheet

<b>Name of Surveyors:</b> Cheong Shu Min & Eva Yew		<b>Location:</b> CCNR			
<b>Stream ID:</b> HA		<b>Coordinates:</b> N 01°21'11.3" E 103°48'27.9"			
<b>Date of Survey:</b> 31 Oct 2014		<b>Time of Survey:</b> 10:15 am			
<b>Photo record:</b> HA_001 to HA_015					
<b>WEATHER</b>	<table style="width: 100%; border: none;"> <tr> <td style="width: 50%; vertical-align: top;"> <b>Now</b>  <input type="checkbox"/> Storm (Heavy rain)  <input type="checkbox"/> Rain (Steady rain)  <input type="checkbox"/> Shower (Intermittent)  <input type="checkbox"/> Cloud Cover  <input type="checkbox"/> Clear/Sunny  <b>Temperature</b>___ °C </td> <td style="width: 50%; vertical-align: top;"> <b>Past 24 Hours</b>  <input type="checkbox"/> Storm (Heavy rain)  <input type="checkbox"/> Rain (Steady rain)  <input type="checkbox"/> Shower (Intermittent)  <input type="checkbox"/> Cloud Cover  <input type="checkbox"/> Clear/Sunny </td> </tr> </table>			<b>Now</b> <input type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input type="checkbox"/> Clear/Sunny <b>Temperature</b> ___ °C	<b>Past 24 Hours</b> <input type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input type="checkbox"/> Clear/Sunny
<b>Now</b> <input type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input type="checkbox"/> Clear/Sunny <b>Temperature</b> ___ °C	<b>Past 24 Hours</b> <input type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input type="checkbox"/> Clear/Sunny				
<b>RIPARIAN VEGETATION</b>	<b>Indicate the dominant type and record the dominant species present:</b> <input checked="" type="checkbox"/> Trees <input type="checkbox"/> Shrubs <input type="checkbox"/> Grasses <input checked="" type="checkbox"/> Herbaceous <b>Dominant Species Present</b> _____				
<b>AQUATIC VEGETATION</b>	<b>Indicate the dominant type and record the dominant species present:</b> <input type="checkbox"/> Rooted Emergent <input type="checkbox"/> Rooted Submergent <input type="checkbox"/> Rooted Floating <input type="checkbox"/> Floating Algae <input type="checkbox"/> Attached Algae <b>Dominant Species Present</b> _____				
<b>AQUATIC FAUNA</b>	<b>Notes:</b>				



<b>STREAM CHARACTERISATION</b>	<b>Occurrence</b> <input checked="" type="checkbox"/> Perennial <input type="checkbox"/> Intermittent  <b>Stream Type</b> <input checked="" type="checkbox"/> "Tree-country" Forest stream <input type="checkbox"/> "Open-country" Stream <input type="checkbox"/> Concrete canal, drain <input type="checkbox"/> Other _____	<b>Characteristics of Water Flow</b>  <input type="checkbox"/> Fast, with roughness <input type="checkbox"/> Fast, smooth <input checked="" type="checkbox"/> Slow, gentle <input checked="" type="checkbox"/> Pool <input type="checkbox"/> Trickle  <b>Channelized</b> <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No
<b>STREAM FEATURES</b>	<b>Estimated Length Sampled</b> <u>20</u> m <b>Estimated Stream Width</b> <u>1.5 - 3.0</u> m <b>Estimated Stream Depth</b> <u>10 - 45</u> cm <b>Canopy Cover</b> <input type="checkbox"/> Open <input checked="" type="checkbox"/> Partly Open/Shaded <input type="checkbox"/> Shaded <b>Light intensity</b> <u>1.93-3.12 Klux</u>	<b>Stream Surface</b> <input checked="" type="checkbox"/> Clear <input type="checkbox"/> Slightly Turbid <input type="checkbox"/> Turbid <input type="checkbox"/> Stained  Presence of Leaf Litter <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No  If Yes, % cover <u>50</u>  Large Woody Debris <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No  If Yes, % cover _____
<b>WATER QUALITY</b>	<b>Temperature</b> <u>25.7</u> °C <b>Electrical Conductivity</b> <u>0100</u> µS/cm <b>pH</b> <u>6.3</u> <b>Total Suspended Solids</b> <u>0050</u> mg/L	<b>Odor</b> <input checked="" type="checkbox"/> Normal/None <input type="checkbox"/> Sewage <input type="checkbox"/> Petroleum <input type="checkbox"/> Chemical <input type="checkbox"/> Fishy <input type="checkbox"/> Other  <b>Water Surface Oils</b> <input type="checkbox"/> Slick <input type="checkbox"/> Sheen <input type="checkbox"/> Gloss <input type="checkbox"/> Fleck <input checked="" type="checkbox"/> None <input type="checkbox"/> Other _____

SEDIMENT/ SUBSTRATE (IF VISIBLE)			
Inorganic Substrate Components		Organic Substrate Components	
Substrate Type	% Composition in Sampling Reach	Substrate Type	% Composition in Sampling Reach
Bedrock		Detritus such as sticks, wood, coarse plant materials	50
Boulder		Mud	5
Cobble		Other	
Gravel			
Sand	20		
Silt	20		
Clay	5		

## Field Record Sheet

Name of Surveyors: Cheong Shu Min & Eva Yew		Location: CCNR			
Stream ID: HA		Coordinates:			
Date of Survey: 21 Oct 2014		Time of Survey: 10:45 am			
Photo record: HA_016 to MA_032					
<b>WEATHER</b>	<table style="width: 100%; border: none;"> <tr> <td style="width: 50%; vertical-align: top;"> <b>Now</b>  <input type="checkbox"/> Storm (Heavy rain)  <input type="checkbox"/> Rain (Steady rain)  <input type="checkbox"/> Shower (Intermittent)  <input type="checkbox"/> Cloud Cover  <input checked="" type="checkbox"/> Clear/Sunny  <b>Temperature</b>___ °C </td> <td style="width: 50%; vertical-align: top;"> <b>Past 24 Hours</b>  <input type="checkbox"/> Storm (Heavy rain)  <input type="checkbox"/> Rain (Steady rain)  <input type="checkbox"/> Shower (Intermittent)  <input type="checkbox"/> Cloud Cover  <input checked="" type="checkbox"/> Clear/Sunny </td> </tr> </table>			<b>Now</b> <input type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input checked="" type="checkbox"/> Clear/Sunny <b>Temperature</b> ___ °C	<b>Past 24 Hours</b> <input type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input checked="" type="checkbox"/> Clear/Sunny
<b>Now</b> <input type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input checked="" type="checkbox"/> Clear/Sunny <b>Temperature</b> ___ °C	<b>Past 24 Hours</b> <input type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input checked="" type="checkbox"/> Clear/Sunny				
<b>RIPARIAN VEGETATION</b>	<b>Indicate the dominant type and record the dominant species present:</b> <input checked="" type="checkbox"/> Trees <input type="checkbox"/> Shrubs <input type="checkbox"/> Grasses <input checked="" type="checkbox"/> Herbaceous <b>Dominant Species Present</b> _____				
<b>AQUATIC VEGETATION</b>	<b>Indicate the dominant type and record the dominant species present:</b> <input type="checkbox"/> Rooted Emergent <input type="checkbox"/> Rooted Submergent <input type="checkbox"/> Rooted Floating <input type="checkbox"/> Floating Algae <input type="checkbox"/> Attached Algae <b>Dominant Species Present</b> _____				
<b>AQUATIC FAUNA</b>	<b>Notes:</b> <ul style="list-style-type: none"> <li>Damselfly and dragonfly observed</li> <li>Forest snakehead observed</li> </ul>				

<b>STREAM CHARACTERISATION</b>	<b>Occurrence</b> <input checked="" type="checkbox"/> Perennial <input type="checkbox"/> Intermittent  <b>Stream Type</b> <input checked="" type="checkbox"/> "Tree-country" Forest stream <input type="checkbox"/> "Open-country" Stream <input type="checkbox"/> Concrete canal, drain <input type="checkbox"/> Other _____	<b>Characteristics of Water Flow</b> <input checked="" type="checkbox"/> Fast, with roughness <input checked="" type="checkbox"/> Fast, smooth <input type="checkbox"/> Slow, gentle <input type="checkbox"/> Pool <input type="checkbox"/> Trickle <b>Channelized</b> <input type="checkbox"/> Yes <input type="checkbox"/> No
	<b>STREAM FEATURES</b>	<b>Estimated Length Sampled</b> _____ m <b>Estimated Stream Width</b> <u>0.75 - 3.5</u> m <b>Estimated Stream Depth</b> <u>25</u> cm <b>Canopy Cover</b> <input type="checkbox"/> Open <input checked="" type="checkbox"/> Partly Open/Shaded <input type="checkbox"/> Shaded <b>Light intensity</b> <u>3.82 - 6.10 Klux</u>
<b>WATER QUALITY</b>	<b>Temperature</b> <u>26.2</u> °C <b>Electrical Conductivity</b> <u>0070</u> µS/cm <b>pH</b> <u>5.8</u> <b>Total Suspended Solids</b> <u>0030</u> mg/L	<b>Odor</b> <input checked="" type="checkbox"/> Normal/None <input type="checkbox"/> Sewage <input type="checkbox"/> Petroleum <input type="checkbox"/> Chemical <input type="checkbox"/> Fishy <input type="checkbox"/> Other <b>Water Surface Oils</b> <input type="checkbox"/> Slick <input type="checkbox"/> Sheen <input type="checkbox"/> Gloss <input type="checkbox"/> Fleck <input checked="" type="checkbox"/> None <input type="checkbox"/> Other _____

SEDIMENT/ SUBSTRATE (IF VISIBLE)			
Inorganic Substrate Components		Organic Substrate Components	
Substrate Type	% Composition in Sampling Reach	Substrate Type	% Composition in Sampling Reach
Bedrock		Detritus such as sticks, wood, coarse plant materials	30
Boulder		Mud	
Cobble		Other	
Gravel			
Sand	20		
Silt	40		
Clay	10		



## Field Record Sheet

<b>Name of Surveyors:</b> Cheong Shu Min Eva Yew		<b>Location:</b> CCNR			
<b>Stream ID:</b> HA		<b>Coordinates:</b> N 01°21'06.5" E 103°48'23.8"			
<b>Date of Survey:</b> 31 Oct 2014		<b>Time of Survey:</b> 11.15 am			
<b>Photo record:</b> HA_042 to HA_052					
<b>WEATHER</b>	<table style="width: 100%; border: none;"> <tr> <td style="width: 50%; vertical-align: top;"> <b>Now</b>   <input type="checkbox"/> Storm (Heavy rain)  <input type="checkbox"/> Rain (Steady rain)  <input type="checkbox"/> Shower (Intermittent)  <input type="checkbox"/> Cloud Cover  <input checked="" type="checkbox"/> Clear/Sunny  <b>Temperature</b>___ °C           </td> <td style="width: 50%; vertical-align: top;"> <b>Past 24 Hours</b>   <input type="checkbox"/> Storm (Heavy rain)  <input type="checkbox"/> Rain (Steady rain)  <input type="checkbox"/> Shower (Intermittent)  <input type="checkbox"/> Cloud Cover  <input checked="" type="checkbox"/> Clear/Sunny           </td> </tr> </table>			<b>Now</b>  <input type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input checked="" type="checkbox"/> Clear/Sunny <b>Temperature</b> ___ °C	<b>Past 24 Hours</b>  <input type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input checked="" type="checkbox"/> Clear/Sunny
<b>Now</b>  <input type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input checked="" type="checkbox"/> Clear/Sunny <b>Temperature</b> ___ °C	<b>Past 24 Hours</b>  <input type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input checked="" type="checkbox"/> Clear/Sunny				
<b>RIPARIAN VEGETATION</b>	<b>Indicate the dominant type and record the dominant species present:</b>  <input checked="" type="checkbox"/> Trees <input type="checkbox"/> Shrubs <input type="checkbox"/> Grasses <input type="checkbox"/> Herbaceous <b>Dominant Species Present</b> _____				
<b>AQUATIC VEGETATION</b>	<b>Indicate the dominant type and record the dominant species present:</b>  <input type="checkbox"/> Rooted Emergent <input type="checkbox"/> Rooted Submergent <input type="checkbox"/> Rooted Floating <input type="checkbox"/> Floating Algae <input type="checkbox"/> Attached Algae <b>Dominant Species Present</b> _____				
<b>AQUATIC FAUNA</b>	<b>Notes:</b>  <ul style="list-style-type: none"> <li>Damselfly and dragonfly observed</li> <li>Swampy marsh</li> </ul>				

<b>STREAM CHARACTERISATION</b>	<b>Occurrence</b> <input checked="" type="checkbox"/> Perennial <input type="checkbox"/> Intermittent  <b>Stream Type</b> <input checked="" type="checkbox"/> "Tree-country" Forest stream <input type="checkbox"/> "Open-country" Stream <input type="checkbox"/> Concrete canal, drain <input type="checkbox"/> Other _____	<b>Characteristics of Water Flow</b>  <input type="checkbox"/> Fast, with roughness <input type="checkbox"/> Fast, smooth <input type="checkbox"/> Slow, gentle <input checked="" type="checkbox"/> Pool <input type="checkbox"/> Trickle  <b>Channelized</b> <input type="checkbox"/> Yes <input type="checkbox"/> No
<b>STREAM FEATURES</b>	<b>Estimated Length Sampled</b> <u>10</u> m <b>Estimated Stream Width</b> _____ m <b>Estimated Stream Depth</b> <u>3</u> cm <b>Canopy Cover</b> <input type="checkbox"/> Open <input checked="" type="checkbox"/> Partly Open/Shaded <input type="checkbox"/> Shaded <b>Light intensity</b> <u>2.46 - 2.50 Klux</u>	<b>Stream Surface</b>  <input type="checkbox"/> Clear <input checked="" type="checkbox"/> Slightly Turbid <input type="checkbox"/> Turbid <input checked="" type="checkbox"/> Stained  Presence of Leaf Litter <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No  If Yes, % cover <u>80</u>  Large Woody Debris <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No  If Yes, % cover <u>50</u>
<b>WATER QUALITY</b>	<b>Temperature</b> <u>28.3</u> °C <b>Electrical Conductivity</b> <u>0230</u> µS/cm <b>pH</b> <u>5.8</u> <b>Total Suspended Solids</b> <u>0110</u> mg/L	<b>Odor</b> <input checked="" type="checkbox"/> Normal/None <input type="checkbox"/> Sewage  <input type="checkbox"/> Petroleum <input type="checkbox"/> Chemical <input type="checkbox"/> Fishy <input type="checkbox"/> Other  <b>Water Surface Oils</b> <input type="checkbox"/> Slick <input checked="" type="checkbox"/> Sheen <input type="checkbox"/> Gloss <input type="checkbox"/> Fleck  <input checked="" type="checkbox"/> None <input type="checkbox"/> Other _____

SEDIMENT/ SUBSTRATE (IF VISIBLE)			
Inorganic Substrate Components		Organic Substrate Components	
Substrate Type	% Composition in Sampling Reach	Substrate Type	% Composition in Sampling Reach
Bedrock		Detritus such as sticks, wood, coarse plant materials	80
Boulder		Mud	
Cobble		Other	
Gravel			
Sand			
Silt	10		
Clay	10		

## Field Record Sheet

<b>Name of Surveyors:</b> Cheong Shu Min & Eva Yew		<b>Location:</b> CCNR			
<b>Stream ID:</b> HA		<b>Coordinates:</b> N 01°36'23.0" E 103°48'43.0			
<b>Date of Survey:</b> 31 Oct 2014		<b>Time of Survey:</b> 12:00 pm			
<b>Photo record:</b> HA_053 to HA_070					
<b>WEATHER</b>	<table style="width: 100%; border: none;"> <tr> <td style="width: 50%; vertical-align: top;"> <b>Now</b>  <input type="checkbox"/> Storm (Heavy rain)  <input type="checkbox"/> Rain (Steady rain)  <input type="checkbox"/> Shower (Intermittent)  <input type="checkbox"/> Cloud Cover  <input checked="" type="checkbox"/> Clear/Sunny  <b>Temperature</b>___ °C </td> <td style="width: 50%; vertical-align: top;"> <b>Past 24 Hours</b>  <input type="checkbox"/> Storm (Heavy rain)  <input type="checkbox"/> Rain (Steady rain)  <input type="checkbox"/> Shower (Intermittent)  <input type="checkbox"/> Cloud Cover  <input checked="" type="checkbox"/> Clear/Sunny </td> </tr> </table>			<b>Now</b> <input type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input checked="" type="checkbox"/> Clear/Sunny <b>Temperature</b> ___ °C	<b>Past 24 Hours</b> <input type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input checked="" type="checkbox"/> Clear/Sunny
<b>Now</b> <input type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input checked="" type="checkbox"/> Clear/Sunny <b>Temperature</b> ___ °C	<b>Past 24 Hours</b> <input type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input checked="" type="checkbox"/> Clear/Sunny				
<b>RIPARIAN VEGETATION</b>	<b>Indicate the dominant type and record the dominant species present:</b> <input type="checkbox"/> Trees <input type="checkbox"/> Shrubs <input checked="" type="checkbox"/> Grasses <input type="checkbox"/> Herbaceous <b>Dominant Species Present</b> _____				
<b>AQUATIC VEGETATION</b>	<b>Indicate the dominant type and record the dominant species present:</b> <input type="checkbox"/> Rooted Emergent <input type="checkbox"/> Rooted Submergent <input type="checkbox"/> Rooted Floating <input type="checkbox"/> Floating Algae <input checked="" type="checkbox"/> Attached Algae <b>Dominant Species Present</b> _____				
<b>AQUATIC FAUNA</b>	<b>Notes:</b> <ul style="list-style-type: none"> <li>Dragonfly observed</li> </ul>				



<b>STREAM CHARACTERISATION</b>	<b>Occurrence</b> <input type="checkbox"/> Perennial <input checked="" type="checkbox"/> Intermittent  <b>Stream Type</b> <input type="checkbox"/> "Tree-country" Forest stream <input type="checkbox"/> "Open-country" Stream <input checked="" type="checkbox"/> Concrete canal, drain <input type="checkbox"/> Other _____	<b>Characteristics of Water Flow</b> <input checked="" type="checkbox"/> Fast, with roughness <input type="checkbox"/> Fast, smooth <input type="checkbox"/> Slow, gentle <input type="checkbox"/> Pool <input type="checkbox"/> Trickle <b>Channelized</b> <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No
<b>STREAM FEATURES</b>	<b>Estimated Length Sampled</b> <u>20</u> m <b>Estimated Stream Width</b> _____ m <b>Estimated Stream Depth</b> <u>2</u> cm <b>Canopy Cover</b> <input type="checkbox"/> Open <input type="checkbox"/> Partly Open/Shaded <input type="checkbox"/> Shaded <b>Light intensity</b> <u>79.0 - 79.8 Klux</u>	<b>Stream Surface</b> <input type="checkbox"/> Clear <input type="checkbox"/> Slightly Turbid <input type="checkbox"/> Turbid <input type="checkbox"/> Stained Presence of Leaf Litter <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No If Yes, % cover _____ Large Woody Debris <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No If Yes, % cover _____
<b>WATER QUALITY</b>	<b>Temperature</b> <u>29.8</u> °C <b>Electrical Conductivity</b> <u>0010</u> µS/cm <b>pH</b> <u>5.8</u> <b>Total Suspended Solids</b> <u>0</u> mg/L	<b>Odor</b> <input checked="" type="checkbox"/> Normal/None <input type="checkbox"/> Sewage <input type="checkbox"/> Petroleum <input type="checkbox"/> Chemical <input type="checkbox"/> Fishy <input type="checkbox"/> Other <b>Water Surface Oils</b> <input type="checkbox"/> Slick <input type="checkbox"/> Sheen <input type="checkbox"/> Gloss <input type="checkbox"/> Fleck <input checked="" type="checkbox"/> None <input type="checkbox"/> Other _____

SEDIMENT/ SUBSTRATE (IF VISIBLE)			
Inorganic Substrate Components		Organic Substrate Components	
Substrate Type	% Composition in Sampling Reach	Substrate Type	% Composition in Sampling Reach
Bedrock		Detritus such as sticks, wood, coarse plant materials	
Boulder		Mud	
Cobble		Other	
Gravel			
Sand			
Silt			
Clay			

## Field Record Sheet

Name of Surveyors: Cheong Shu Min & Eva Yew		Location: CCNR			
Stream ID: <span style="color: green;">Channel @ HA</span>		Coordinates: N 01°21'15.8"    E 103°48'38.0"			
Date of Survey: 31 Oct 2014		Time of Survey: 1:20 pm			
Photo record:					
<b>WEATHER</b>	<table style="width: 100%; border: none;"> <tr> <td style="width: 50%; vertical-align: top;"> <b>Now</b>  <input type="checkbox"/> Storm (Heavy rain)  <input type="checkbox"/> Rain (Steady rain)  <input type="checkbox"/> Shower (Intermittent)  <input type="checkbox"/> Cloud Cover  <input checked="" type="checkbox"/> Clear/Sunny  <b>Temperature</b>___ °C </td> <td style="width: 50%; vertical-align: top;"> <b>Past 24 Hours</b>  <input type="checkbox"/> Storm (Heavy rain)  <input type="checkbox"/> Rain (Steady rain)  <input type="checkbox"/> Shower (Intermittent)  <input type="checkbox"/> Cloud Cover  <input checked="" type="checkbox"/> Clear/Sunny </td> </tr> </table>			<b>Now</b> <input type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input checked="" type="checkbox"/> Clear/Sunny <b>Temperature</b> ___ °C	<b>Past 24 Hours</b> <input type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input checked="" type="checkbox"/> Clear/Sunny
<b>Now</b> <input type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input checked="" type="checkbox"/> Clear/Sunny <b>Temperature</b> ___ °C	<b>Past 24 Hours</b> <input type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input checked="" type="checkbox"/> Clear/Sunny				
<b>RIPARIAN VEGETATION</b>	<b>Indicate the dominant type and record the dominant species present:</b> <input checked="" type="checkbox"/> Trees <input type="checkbox"/> Shrubs <input type="checkbox"/> Grasses <input type="checkbox"/> Herbaceous <b>Dominant Species Present</b> _____				
<b>AQUATIC VEGETATION</b>	<b>Indicate the dominant type and record the dominant species present:</b> <input type="checkbox"/> Rooted Emergent <input type="checkbox"/> Rooted Submergent <input type="checkbox"/> Rooted Floating <input type="checkbox"/> Floating Algae <input type="checkbox"/> Attached Algae <b>Dominant Species Present</b> _____				
<b>AQUATIC FAUNA</b>	<b>Notes:</b> <ul style="list-style-type: none"> <li>Damselfly and dragonfly observed</li> <li>The channel is semi-dried up</li> </ul>				

<b>STREAM CHARACTERISATION</b>	<b>Occurrence</b> <input type="checkbox"/> Perennial <input checked="" type="checkbox"/> Intermittent  <b>Stream Type</b> <input checked="" type="checkbox"/> "Tree-country" Forest stream <input type="checkbox"/> "Open-country" Stream <input type="checkbox"/> Concrete canal, drain <input type="checkbox"/> Other _____	<b>Characteristics of Water Flow</b>  <input type="checkbox"/> Fast, with roughness <input type="checkbox"/> Fast, smooth <input type="checkbox"/> Slow, gentle <input checked="" type="checkbox"/> Pool <input type="checkbox"/> Trickle  <b>Channelized</b> <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No
	<b>STREAM FEATURES</b>	<b>Estimated Length Sampled</b> <u>20</u> m <b>Estimated Stream Width</b> <u>1.0</u> m <b>Estimated Stream Depth</b> <u>17</u> cm <b>Canopy Cover</b> <input type="checkbox"/> Open <input type="checkbox"/> Partly Open/Shaded <input checked="" type="checkbox"/> Shaded <b>Light intensity</b> <u>1.3 - 1.4 Klux</u>
<b>WATER QUALITY</b>	<b>Temperature</b> <u>27.4</u> °C <b>Electrical Conductivity</b> <u>0080</u> µS/cm <b>pH</b> <u>6.2</u> <b>Total Suspended Solids</b> <u>0040</u> mg/L	<b>Odor</b> <input checked="" type="checkbox"/> Normal/None <input type="checkbox"/> Sewage  <input type="checkbox"/> Petroleum <input type="checkbox"/> Chemical <input type="checkbox"/> Fishy <input type="checkbox"/> Other  <b>Water Surface Oils</b> <input type="checkbox"/> Slick <input type="checkbox"/> Sheen <input type="checkbox"/> Gloss <input type="checkbox"/> Fleck <input checked="" type="checkbox"/> None <input type="checkbox"/> Other _____

SEDIMENT/ SUBSTRATE (IF VISIBLE)			
Inorganic Substrate Components		Organic Substrate Components	
Substrate Type	% Composition in Sampling Reach	Substrate Type	% Composition in Sampling Reach
Bedrock		Detritus such as sticks, wood, coarse plant materials	50
Boulder		Mud	30
Cobble		Other	
Gravel			
Sand			
Silt	10		
Clay	10		



## Field Record Sheet

<b>Name of Surveyors:</b> Cheong Shu Min & Eva Yew		<b>Location:</b> CCNR			
<b>Stream ID:</b> HD wetland		<b>Coordinates:</b> N 01°21'20.2" E 103°48'17.1"			
<b>Date of Survey:</b> 31 Oct 2014		<b>Time of Survey:</b> 2:03 pm			
<b>Photo record:</b> HD_001 to HD_013					
<b>WEATHER</b>	<table style="width: 100%; border: none;"> <tr> <td style="width: 50%; vertical-align: top;"> <b>Now</b>  <input type="checkbox"/> Storm (Heavy rain)  <input type="checkbox"/> Rain (Steady rain)  <input type="checkbox"/> Shower (Intermittent)  <input type="checkbox"/> Cloud Cover  <input checked="" type="checkbox"/> Clear/Sunny  <b>Temperature</b>___ °C                 </td> <td style="width: 50%; vertical-align: top;"> <b>Past 24 Hours</b>  <input type="checkbox"/> Storm (Heavy rain)  <input type="checkbox"/> Rain (Steady rain)  <input type="checkbox"/> Shower (Intermittent)  <input type="checkbox"/> Cloud Cover  <input checked="" type="checkbox"/> Clear/Sunny                 </td> </tr> </table>			<b>Now</b> <input type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input checked="" type="checkbox"/> Clear/Sunny <b>Temperature</b> ___ °C	<b>Past 24 Hours</b> <input type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input checked="" type="checkbox"/> Clear/Sunny
<b>Now</b> <input type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input checked="" type="checkbox"/> Clear/Sunny <b>Temperature</b> ___ °C	<b>Past 24 Hours</b> <input type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input checked="" type="checkbox"/> Clear/Sunny				
<b>RIPARIAN VEGETATION</b>	<b>Indicate the dominant type and record the dominant species present:</b> <input type="checkbox"/> Trees <input type="checkbox"/> Shrubs <input checked="" type="checkbox"/> Grasses <input checked="" type="checkbox"/> Herbaceous <b>Dominant Species Present</b> _____				
<b>AQUATIC VEGETATION</b>	<b>Indicate the dominant type and record the dominant species present:</b> <input type="checkbox"/> Rooted Emergent <input type="checkbox"/> Rooted Submergent <input type="checkbox"/> Rooted Floating <input type="checkbox"/> Floating Algae <input checked="" type="checkbox"/> Attached Algae <b>Dominant Species Present</b> _____				
<b>AQUATIC FAUNA</b>	<b>Notes:</b> <ul style="list-style-type: none"> <li>Damselfly and dragonfly concentrated</li> </ul>				

<b>STREAM CHARACTERISATION</b>	<b>Occurrence</b> <input checked="" type="checkbox"/> Perennial <input type="checkbox"/> Intermittent  <b>Stream Type</b> <input type="checkbox"/> "Tree-country" Forest stream <input checked="" type="checkbox"/> "Open-country" Stream <input checked="" type="checkbox"/> Concrete canal, drain <input type="checkbox"/> Other _____	<b>Characteristics of Water Flow</b>  <input type="checkbox"/> Fast, with roughness <input checked="" type="checkbox"/> Fast, smooth <input type="checkbox"/> Slow, gentle <input type="checkbox"/> Pool <input type="checkbox"/> Trickle  <b>Channelized</b> <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No
	<b>STREAM FEATURES</b>	<b>Estimated Length Sampled</b> <u>20</u> m <b>Estimated Stream Width</b> <u>2.0 - 3.0</u> m <b>Estimated Stream Depth</b> <u>3.0</u> cm <b>Canopy Cover</b> <input checked="" type="checkbox"/> Open <input type="checkbox"/> Partly Open/Shaded <input type="checkbox"/> Shaded <b>Light intensity</b> <u>36.0 - 50.1 Klux</u>
<b>WATER QUALITY</b>	<b>Temperature</b> <u>27.9</u> °C <b>Electrical Conductivity</b> <u>0050</u> µS/cm <b>pH</b> <u>5.9</u> <b>Total Suspended Solids</b> <u>0020</u> mg/L	<b>Odor</b> <input type="checkbox"/> Normal/None <input type="checkbox"/> Sewage <input type="checkbox"/> Petroleum <input type="checkbox"/> Chemical <input type="checkbox"/> Fishy <input type="checkbox"/> Other  <b>Water Surface Oils</b> <input type="checkbox"/> Slick <input type="checkbox"/> Sheen <input type="checkbox"/> Gloss <input type="checkbox"/> Fleck <input type="checkbox"/> None <input type="checkbox"/> Other _____

SEDIMENT/ SUBSTRATE (IF VISIBLE)			
Inorganic Substrate Components		Organic Substrate Components	
Substrate Type	% Composition in Sampling Reach	Substrate Type	% Composition in Sampling Reach
Bedrock		Detritus such as sticks, wood, coarse plant materials	
Boulder		Mud	
Cobble		Other	
Gravel			
Sand	50		
Silt	30		
Clay	20		

## Field Record Sheet

<b>Name of Surveyors:</b> Cheong Shu Min & Eva Yew		<b>Location:</b> CCNR			
<b>Stream ID:</b> HD (PUB pipeline)		<b>Coordinates:</b> N 01°21'20.2" E 103°48'17.1"			
<b>Date of Survey:</b> 31 Oct 2014		<b>Time of Survey:</b> 2:15 pm			
<b>Photo record:</b> HD_014 to HD_023					
<b>WEATHER</b>	<table style="width: 100%; border: none;"> <tr> <td style="width: 50%; vertical-align: top;"> <b>Now</b>  <input type="checkbox"/> Storm (Heavy rain)  <input type="checkbox"/> Rain (Steady rain)  <input type="checkbox"/> Shower (Intermittent)  <input type="checkbox"/> Cloud Cover  <input checked="" type="checkbox"/> Clear/Sunny  <b>Temperature</b>___ °C </td> <td style="width: 50%; vertical-align: top;"> <b>Past 24 Hours</b>  <input type="checkbox"/> Storm (Heavy rain)  <input type="checkbox"/> Rain (Steady rain)  <input type="checkbox"/> Shower (Intermittent)  <input type="checkbox"/> Cloud Cover  <input checked="" type="checkbox"/> Clear/Sunny </td> </tr> </table>			<b>Now</b> <input type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input checked="" type="checkbox"/> Clear/Sunny <b>Temperature</b> ___ °C	<b>Past 24 Hours</b> <input type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input checked="" type="checkbox"/> Clear/Sunny
<b>Now</b> <input type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input checked="" type="checkbox"/> Clear/Sunny <b>Temperature</b> ___ °C	<b>Past 24 Hours</b> <input type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input checked="" type="checkbox"/> Clear/Sunny				
<b>RIPARIAN VEGETATION</b>	<b>Indicate the dominant type and record the dominant species present:</b> <input type="checkbox"/> Trees <input type="checkbox"/> Shrubs <input type="checkbox"/> Grasses <input type="checkbox"/> Herbaceous <b>Dominant Species Present</b> _____				
<b>AQUATIC VEGETATION</b>	<b>Indicate the dominant type and record the dominant species present:</b> <input checked="" type="checkbox"/> Rooted Emergent <input type="checkbox"/> Rooted Submergent <input type="checkbox"/> Rooted Floating <input type="checkbox"/> Floating Algae <input checked="" type="checkbox"/> Attached Algae <b>Dominant Species Present</b> _____				
<b>AQUATIC FAUNA</b>	<b>Notes:</b> <ul style="list-style-type: none"> <li>Damselfly and dragonfly observed</li> <li>Halfbeaks observed in stream</li> </ul>				



<b>STREAM CHARACTERISATION</b>	<b>Occurrence</b> <input checked="" type="checkbox"/> Perennial <input type="checkbox"/> Intermittent  <b>Stream Type</b> <input type="checkbox"/> "Tree-country" Forest stream <input type="checkbox"/> "Open-country" Stream <input checked="" type="checkbox"/> Concrete canal, drain <input type="checkbox"/> Other _____	<b>Characteristics of Water Flow</b>  <input type="checkbox"/> Fast, with roughness <input type="checkbox"/> Fast, smooth <input checked="" type="checkbox"/> Slow, gentle <input type="checkbox"/> Pool <input type="checkbox"/> Trickle  <b>Channelized</b> <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No
<b>STREAM FEATURES</b>	<b>Estimated Length Sampled</b> <u>20</u> m <b>Estimated Stream Width</b> <u>4.0-5.0</u> m <b>Estimated Stream Depth</b> <u>50</u> cm <b>Canopy Cover</b> <input type="checkbox"/> Open <input checked="" type="checkbox"/> Partly Open/Shaded <input type="checkbox"/> Shaded <b>Light intensity</b> <u>3.8 - 4.0 Klux</u>	<b>Stream Surface</b>  <input type="checkbox"/> Clear <input checked="" type="checkbox"/> Slightly Turbid <input type="checkbox"/> Turbid <input type="checkbox"/> Stained  Presence of Leaf Litter <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No  If Yes, % cover <u>10</u>  Large Woody Debris <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No  If Yes, % cover <u>10</u>
<b>WATER QUALITY</b>	<b>Temperature</b> <u>28.1</u> °C <b>Electrical Conductivity</b> <u>0060</u> µS/cm <b>pH</b> <u>6.1</u> <b>Total Suspended Solids</b> <u>0030</u> mg/L	<b>Odor</b> <input checked="" type="checkbox"/> Normal/None <input type="checkbox"/> Sewage  <input type="checkbox"/> Petroleum <input type="checkbox"/> Chemical <input type="checkbox"/> Fishy <input type="checkbox"/> Other  <b>Water Surface Oils</b> <input type="checkbox"/> Slick <input type="checkbox"/> Sheen <input type="checkbox"/> Gloss <input type="checkbox"/> Fleck <input checked="" type="checkbox"/> None <input type="checkbox"/> Other _____

SEDIMENT/ SUBSTRATE (IF VISIBLE)			
Inorganic Substrate Components		Organic Substrate Components	
Substrate Type	% Composition in Sampling Reach	Substrate Type	% Composition in Sampling Reach
Bedrock		Detritus such as sticks, wood, coarse plant materials	10
Boulder		Mud	
Cobble		Other	
Gravel			
Sand	30		
Silt	40		
Clay	20		

## Field Record Sheet

Name of Surveyors: Cheong Shu Min & Eva Yew		Location: CCNR			
Stream ID: HE		Coordinates: N 01°21'22.7" E 103°48'14.3"			
Date of Survey: 31 Oct 2014		Time of Survey: 2:26 pm			
Photo record: HE_001 to HE_009					
<b>WEATHER</b>	<table style="width: 100%; border: none;"> <tr> <td style="width: 50%; vertical-align: top;"> <b>Now</b>  <input type="checkbox"/> Storm (Heavy rain)  <input type="checkbox"/> Rain (Steady rain)  <input type="checkbox"/> Shower (Intermittent)  <input type="checkbox"/> Cloud Cover  <input checked="" type="checkbox"/> Clear/Sunny  <b>Temperature</b>___ °C                 </td> <td style="width: 50%; vertical-align: top;"> <b>Past 24 Hours</b>  <input type="checkbox"/> Storm (Heavy rain)  <input type="checkbox"/> Rain (Steady rain)  <input type="checkbox"/> Shower (Intermittent)  <input type="checkbox"/> Cloud Cover  <input checked="" type="checkbox"/> Clear/Sunny                 </td> </tr> </table>			<b>Now</b> <input type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input checked="" type="checkbox"/> Clear/Sunny <b>Temperature</b> ___ °C	<b>Past 24 Hours</b> <input type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input checked="" type="checkbox"/> Clear/Sunny
<b>Now</b> <input type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input checked="" type="checkbox"/> Clear/Sunny <b>Temperature</b> ___ °C	<b>Past 24 Hours</b> <input type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input checked="" type="checkbox"/> Clear/Sunny				
<b>RIPARIAN VEGETATION</b>	<b>Indicate the dominant type and record the dominant species present:</b> <input checked="" type="checkbox"/> Trees <input type="checkbox"/> Shrubs <input type="checkbox"/> Grasses <input type="checkbox"/> Herbaceous <b>Dominant Species Present</b> _____				
<b>AQUATIC VEGETATION</b>	<b>Indicate the dominant type and record the dominant species present:</b> <input type="checkbox"/> Rooted Emergent <input type="checkbox"/> Rooted Submergent <input type="checkbox"/> Rooted Floating <input type="checkbox"/> Floating Algae <input type="checkbox"/> Attached Algae <b>Dominant Species Present</b> _____				
<b>AQUATIC FAUNA</b>	<b>Notes:</b> <ul style="list-style-type: none"> <li>Damselfly observed</li> </ul>				

<b>STREAM CHARACTERISATION</b>	<b>Occurrence</b> <input checked="" type="checkbox"/> Perennial <input type="checkbox"/> Intermittent  <b>Stream Type</b> <input checked="" type="checkbox"/> "Tree-country" Forest stream <input type="checkbox"/> "Open-country" Stream <input type="checkbox"/> Concrete canal, drain <input type="checkbox"/> Other _____	<b>Characteristics of Water Flow</b>  <input type="checkbox"/> Fast, with roughness <input type="checkbox"/> Fast, smooth <input checked="" type="checkbox"/> Slow, gentle <input type="checkbox"/> Pool <input type="checkbox"/> Trickle  <b>Channelized</b> <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No
<b>STREAM FEATURES</b>	<b>Estimated Length Sampled</b> <u>20</u> m <b>Estimated Stream Width</b> <u>1.5 - 2.5</u> m <b>Estimated Stream Depth</b> <u>3.0</u> cm <b>Canopy Cover</b> <input type="checkbox"/> Open <input type="checkbox"/> Partly Open/Shaded <input checked="" type="checkbox"/> Shaded <b>Light intensity</b> <u>6.4 - 8.0 Klux</u>	<b>Stream Surface</b> <input checked="" type="checkbox"/> Clear <input type="checkbox"/> Slightly Turbid <input type="checkbox"/> Turbid <input type="checkbox"/> Stained  Presence of Leaf Litter <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No  If Yes, % cover <u>10</u>  Large Woody Debris <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No  If Yes, % cover _____
<b>WATER QUALITY</b>	<b>Temperature</b> <u>27.3</u> °C <b>Electrical Conductivity</b> <u>0030</u> µS/cm <b>pH</b> <u>6.2</u> <b>Total Suspended Solids</b> <u>0010</u> mg/L	<b>Odor</b> <input checked="" type="checkbox"/> Normal/None <input type="checkbox"/> Sewage <input type="checkbox"/> Petroleum <input type="checkbox"/> Chemical <input type="checkbox"/> Fishy <input type="checkbox"/> Other  <b>Water Surface Oils</b> <input type="checkbox"/> Slick <input type="checkbox"/> Sheen <input type="checkbox"/> Gloss <input type="checkbox"/> Fleck <input checked="" type="checkbox"/> None <input type="checkbox"/> Other _____

SEDIMENT/ SUBSTRATE (IF VISIBLE)			
Inorganic Substrate Components		Organic Substrate Components	
Substrate Type	% Composition in Sampling Reach	Substrate Type	% Composition in Sampling Reach
Bedrock		Detritus such as sticks, wood, coarse plant materials	10
Boulder		Mud	
Cobble		Other	
Gravel			
Sand			
Silt	70		
Clay	20		



## Field Record Sheet

<b>Name of Surveyors:</b> Cheong Shu Min & Eva Yew		<b>Location:</b> CCNR			
<b>Stream ID:</b> FA4		<b>Coordinates:</b> N 01°35'46.5" E 103°81'31.4"			
<b>Date of Survey:</b> 3 Nov 2014		<b>Time of Survey:</b> 9:34 am			
<b>Photo record:</b> FA4_001 to FA4_010					
<b>WEATHER</b>	<table style="width: 100%; border: none;"> <tr> <td style="width: 50%; vertical-align: top;"> <b>Now</b>  <input type="checkbox"/> Storm (Heavy rain)  <input type="checkbox"/> Rain (Steady rain)  <input type="checkbox"/> Shower (Intermittent)  <input type="checkbox"/> Cloud Cover  <input checked="" type="checkbox"/> Clear/Sunny  <b>Temperature</b>___ °C </td> <td style="width: 50%; vertical-align: top;"> <b>Past 24 Hours</b>  <input type="checkbox"/> Storm (Heavy rain)  <input type="checkbox"/> Rain (Steady rain)  <input type="checkbox"/> Shower (Intermittent)  <input type="checkbox"/> Cloud Cover  <input checked="" type="checkbox"/> Clear/Sunny </td> </tr> </table>			<b>Now</b> <input type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input checked="" type="checkbox"/> Clear/Sunny <b>Temperature</b> ___ °C	<b>Past 24 Hours</b> <input type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input checked="" type="checkbox"/> Clear/Sunny
<b>Now</b> <input type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input checked="" type="checkbox"/> Clear/Sunny <b>Temperature</b> ___ °C	<b>Past 24 Hours</b> <input type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input checked="" type="checkbox"/> Clear/Sunny				
<b>RIPARIAN VEGETATION</b>	<b>Indicate the dominant type and record the dominant species present:</b> <input checked="" type="checkbox"/> Trees <input type="checkbox"/> Shrubs <input type="checkbox"/> Grasses <input type="checkbox"/> Herbaceous <b>Dominant Species Present</b> _____				
<b>AQUATIC VEGETATION</b>	<b>Indicate the dominant type and record the dominant species present:</b> <input type="checkbox"/> Rooted Emergent <input type="checkbox"/> Rooted Submergent <input type="checkbox"/> Rooted Floating <input type="checkbox"/> Floating Algae <input type="checkbox"/> Attached Algae <b>Dominant Species Present</b> _____				
<b>AQUATIC FAUNA</b>	<b>Notes:</b> <ul style="list-style-type: none"> <li>Damselfly and dragonfly observed</li> </ul>				

<b>STREAM CHARACTERISATION</b>	<b>Occurrence</b> <input type="checkbox"/> Perennial <input checked="" type="checkbox"/> Intermittent  <b>Stream Type</b> <input checked="" type="checkbox"/> "Tree-country" Forest stream <input type="checkbox"/> "Open-country" Stream <input type="checkbox"/> Concrete canal, drain <input type="checkbox"/> Other _____	<b>Characteristics of Water Flow</b>  <input type="checkbox"/> Fast, with roughness <input type="checkbox"/> Fast, smooth <input type="checkbox"/> Slow, gentle <input checked="" type="checkbox"/> Pool <input type="checkbox"/> Trickle  <b>Channelized</b> <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No
	<b>STREAM FEATURES</b>	<b>Estimated Length Sampled</b> <u>15</u> m <b>Estimated Stream Width</b> <u>1.0 - 1.5</u> m <b>Estimated Stream Depth</b> <u>5.0</u> cm <b>Canopy Cover</b> <input type="checkbox"/> Open <input type="checkbox"/> Partly Open/Shaded <input checked="" type="checkbox"/> Shaded <b>Light intensity</b> <u>1.0 - 1.1</u> Klux
<b>WATER QUALITY</b>	<b>Temperature</b> <u>25.9</u> °C <b>Electrical Conductivity</b> <u>0010</u> µS/cm <b>pH</b> <u>6.2</u> <b>Total Suspended Solids</b> <u>0</u> mg/L	<b>Odor</b> <input checked="" type="checkbox"/> Normal/None <input type="checkbox"/> Sewage  <input type="checkbox"/> Petroleum <input type="checkbox"/> Chemical <input type="checkbox"/> Fishy <input type="checkbox"/> Other  <b>Water Surface Oils</b> <input type="checkbox"/> Slick <input type="checkbox"/> Sheen <input type="checkbox"/> Gloss <input type="checkbox"/> Fleck <input checked="" type="checkbox"/> None <input type="checkbox"/> Other _____

SEDIMENT/ SUBSTRATE (IF VISIBLE)			
Inorganic Substrate Components		Organic Substrate Components	
Substrate Type	% Composition in Sampling Reach	Substrate Type	% Composition in Sampling Reach
Bedrock		Detritus such as sticks, wood, coarse plant materials	90
Boulder		Mud	10
Cobble		Other	
Gravel			
Sand			
Silt			
Clay			

## Field Record Sheet

<b>Name of Surveyors:</b> Cheong Shu Min & Eva Yew		<b>Location:</b> CCNR			
<b>Stream ID:</b> FA4		<b>Coordinates:</b> N 01°35'32.8" E 103°81'36.3"			
<b>Date of Survey:</b> 3 Nov 2014		<b>Time of Survey:</b> 10:06 am			
<b>Photo record:</b> FA4_011 to FA4_030					
<b>WEATHER</b>	<table style="width: 100%; border: none;"> <tr> <td style="width: 50%; vertical-align: top;"> <b>Now</b>  <input type="checkbox"/> Storm (Heavy rain)  <input type="checkbox"/> Rain (Steady rain)  <input type="checkbox"/> Shower (Intermittent)  <input type="checkbox"/> Cloud Cover  <input checked="" type="checkbox"/> Clear/Sunny  <b>Temperature</b>___ °C </td> <td style="width: 50%; vertical-align: top;"> <b>Past 24 Hours</b>  <input type="checkbox"/> Storm (Heavy rain)  <input type="checkbox"/> Rain (Steady rain)  <input type="checkbox"/> Shower (Intermittent)  <input type="checkbox"/> Cloud Cover  <input checked="" type="checkbox"/> Clear/Sunny </td> </tr> </table>			<b>Now</b> <input type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input checked="" type="checkbox"/> Clear/Sunny <b>Temperature</b> ___ °C	<b>Past 24 Hours</b> <input type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input checked="" type="checkbox"/> Clear/Sunny
<b>Now</b> <input type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input checked="" type="checkbox"/> Clear/Sunny <b>Temperature</b> ___ °C	<b>Past 24 Hours</b> <input type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input checked="" type="checkbox"/> Clear/Sunny				
<b>RIPARIAN VEGETATION</b>	<b>Indicate the dominant type and record the dominant species present:</b> <input checked="" type="checkbox"/> Trees <input type="checkbox"/> Shrubs <input type="checkbox"/> Grasses <input type="checkbox"/> Herbaceous <b>Dominant Species Present</b> _____				
<b>AQUATIC VEGETATION</b>	<b>Indicate the dominant type and record the dominant species present:</b> <input type="checkbox"/> Rooted Emergent <input type="checkbox"/> Rooted Submergent <input type="checkbox"/> Rooted Floating <input type="checkbox"/> Floating Algae <input type="checkbox"/> Attached Algae <b>Dominant Species Present</b> _____				
<b>AQUATIC FAUNA</b>	<b>Notes:</b> <ul style="list-style-type: none"> <li>Fish observed; no damselfly or dragonfly</li> </ul>				



<b>STREAM CHARACTERISATION</b>	<b>Occurrence</b> <input checked="" type="checkbox"/> Perennial <input type="checkbox"/> Intermittent  <b>Stream Type</b> <input checked="" type="checkbox"/> "Tree-country" Forest stream <input type="checkbox"/> "Open-country" Stream <input type="checkbox"/> Concrete canal, drain <input type="checkbox"/> Other _____	<b>Characteristics of Water Flow</b> <input type="checkbox"/> Fast, with roughness <input checked="" type="checkbox"/> Fast, smooth <input checked="" type="checkbox"/> Slow, gentle <input type="checkbox"/> Pool <input type="checkbox"/> Trickle <b>Channelized</b> <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No
<b>STREAM FEATURES</b>	<b>Estimated Length Sampled</b> <u>15</u> m <b>Estimated Stream Width</b> <u>1.0 - 1.7</u> m <b>Estimated Stream Depth</b> <u>10.0</u> cm <b>Canopy Cover</b> <input type="checkbox"/> Open <input type="checkbox"/> Partly Open/Shaded <input checked="" type="checkbox"/> Shaded <b>Light intensity</b> <u>0.38 - 0.42 Klux</u>	<b>Stream Surface</b> <input checked="" type="checkbox"/> Clear <input type="checkbox"/> Slightly Turbid <input type="checkbox"/> Turbid <input type="checkbox"/> Stained Presence of Leaf Litter <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No If Yes, % cover <u>85</u> Large Woody Debris <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No If Yes, % cover _____
<b>WATER QUALITY</b>	<b>Temperature</b> <u>25.9</u> °C <b>Electrical Conductivity</b> <u>0010</u> µS/cm <b>pH</b> <u>5.1</u> <b>Total Suspended Solids</b> <u>0</u> mg/L	<b>Odor</b> <input checked="" type="checkbox"/> Normal/None <input type="checkbox"/> Sewage <input type="checkbox"/> Petroleum <input type="checkbox"/> Chemical <input type="checkbox"/> Fishy <input type="checkbox"/> Other <b>Water Surface Oils</b> <input type="checkbox"/> Slick <input type="checkbox"/> Sheen <input type="checkbox"/> Gloss <input type="checkbox"/> Fleck <input checked="" type="checkbox"/> None <input type="checkbox"/> Other _____

SEDIMENT/ SUBSTRATE (IF VISIBLE)			
Inorganic Substrate Components		Organic Substrate Components	
Substrate Type	% Composition in Sampling Reach	Substrate Type	% Composition in Sampling Reach
Bedrock		Detritus such as sticks, wood, coarse plant materials	85
Boulder		Mud	10
Cobble		Other	
Gravel			
Sand	5		
Silt			
Clay			

## Field Record Sheet

<b>Name of Surveyors:</b> Cheong Shu Min & Eva Yew		<b>Location:</b> CCNR			
<b>Stream ID:</b> FB		<b>Coordinates:</b> N 01°34'83.8" E 103°81'52.3"			
<b>Date of Survey:</b> 3 Nov 2014		<b>Time of Survey:</b> 11:09 am			
<b>Photo record:</b> FB_001 to FB_019					
<b>WEATHER</b>	<table style="width: 100%; border: none;"> <tr> <td style="width: 50%; vertical-align: top;"> <b>Now</b>  <input type="checkbox"/> Storm (Heavy rain)  <input type="checkbox"/> Rain (Steady rain)  <input type="checkbox"/> Shower (Intermittent)  <input type="checkbox"/> Cloud Cover  <input checked="" type="checkbox"/> Clear/Sunny  <b>Temperature</b>___ °C </td> <td style="width: 50%; vertical-align: top;"> <b>Past 24 Hours</b>  <input type="checkbox"/> Storm (Heavy rain)  <input type="checkbox"/> Rain (Steady rain)  <input type="checkbox"/> Shower (Intermittent)  <input type="checkbox"/> Cloud Cover  <input checked="" type="checkbox"/> Clear/Sunny </td> </tr> </table>			<b>Now</b> <input type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input checked="" type="checkbox"/> Clear/Sunny <b>Temperature</b> ___ °C	<b>Past 24 Hours</b> <input type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input checked="" type="checkbox"/> Clear/Sunny
<b>Now</b> <input type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input checked="" type="checkbox"/> Clear/Sunny <b>Temperature</b> ___ °C	<b>Past 24 Hours</b> <input type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input checked="" type="checkbox"/> Clear/Sunny				
<b>RIPARIAN VEGETATION</b>	<b>Indicate the dominant type and record the dominant species present:</b> <input checked="" type="checkbox"/> Trees <input type="checkbox"/> Shrubs <input type="checkbox"/> Grasses <input type="checkbox"/> Herbaceous <b>Dominant Species Present</b> _____				
<b>AQUATIC VEGETATION</b>	<b>Indicate the dominant type and record the dominant species present:</b> <input type="checkbox"/> Rooted Emergent <input type="checkbox"/> Rooted Submergent <input type="checkbox"/> Rooted Floating <input type="checkbox"/> Floating Algae <input type="checkbox"/> Attached Algae <b>Dominant Species Present</b> _____				
<b>AQUATIC FAUNA</b>	<b>Notes:</b> <ul style="list-style-type: none"> <li>Small stream passing under a concrete bridge</li> </ul>				

<b>STREAM CHARACTERISATION</b>	<b>Occurrence</b> <input checked="" type="checkbox"/> Perennial <input type="checkbox"/> Intermittent  <b>Stream Type</b> <input checked="" type="checkbox"/> "Tree-country" Forest stream <input type="checkbox"/> "Open-country" Stream <input checked="" type="checkbox"/> Concrete canal, drain <input type="checkbox"/> Other _____	<b>Characteristics of Water Flow</b>  <input type="checkbox"/> Fast, with roughness <input type="checkbox"/> Fast, smooth <input checked="" type="checkbox"/> Slow, gentle <input type="checkbox"/> Pool <input type="checkbox"/> Trickle  <b>Channelized</b> <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No
	<b>STREAM FEATURES</b>	<b>Estimated Length Sampled</b> _____ m <b>Estimated Stream Width</b> _____ m <b>Estimated Stream Depth</b> <u>3.0</u> cm <b>Canopy Cover</b> <input type="checkbox"/> Open <input type="checkbox"/> Partly Open/Shaded <input checked="" type="checkbox"/> Shaded <b>Light intensity</b> <u>0.42 - 0.44 Klux</u>
<b>WATER QUALITY</b>	<b>Temperature</b> <u>25.9</u> °C <b>Electrical Conductivity</b> <u>0010</u> µS/cm <b>pH</b> <u>4.6/4.1</u> <b>Total Suspended Solids</b> <u>0</u> mg/L	<b>Odor</b> <input checked="" type="checkbox"/> Normal/None <input type="checkbox"/> Sewage <input type="checkbox"/> Petroleum <input type="checkbox"/> Chemical <input type="checkbox"/> Fishy <input type="checkbox"/> Other  <b>Water Surface Oils</b> <input type="checkbox"/> Slick <input type="checkbox"/> Sheen <input type="checkbox"/> Gloss <input type="checkbox"/> Fleck <input checked="" type="checkbox"/> None <input type="checkbox"/> Other _____

SEDIMENT/ SUBSTRATE (IF VISIBLE)			
Inorganic Substrate Components		Organic Substrate Components	
Substrate Type	% Composition in Sampling Reach	Substrate Type	% Composition in Sampling Reach
Bedrock		Detritus such as sticks, wood, coarse plant materials	85
Boulder		Mud	10
Cobble		Other	
Gravel			
Sand			
Silt			
Clay	5		



## Field Record Sheet

<b>Name of Surveyors:</b> Cheong Shu Min & Eva Yew		<b>Location:</b> CCNR			
<b>Stream ID:</b> HB		<b>Coordinates:</b> N 01°35'50.5" E 103°80'76.3"			
<b>Date of Survey:</b> 3 Nov 2014		<b>Time of Survey:</b> 12:58 Pm			
<b>Photo record:</b> MA_027 to MA_043					
<b>WEATHER</b>	<table style="width: 100%; border: none;"> <tr> <td style="width: 50%; vertical-align: top;"> <b>Now</b>  <input type="checkbox"/> Storm (Heavy rain)  <input type="checkbox"/> Rain (Steady rain)  <input type="checkbox"/> Shower (Intermittent)  <input type="checkbox"/> Cloud Cover  <input checked="" type="checkbox"/> Clear/Sunny  <b>Temperature</b>___ °C </td> <td style="width: 50%; vertical-align: top;"> <b>Past 24 Hours</b>  <input type="checkbox"/> Storm (Heavy rain)  <input type="checkbox"/> Rain (Steady rain)  <input type="checkbox"/> Shower (Intermittent)  <input type="checkbox"/> Cloud Cover  <input checked="" type="checkbox"/> Clear/Sunny </td> </tr> </table>			<b>Now</b> <input type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input checked="" type="checkbox"/> Clear/Sunny <b>Temperature</b> ___ °C	<b>Past 24 Hours</b> <input type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input checked="" type="checkbox"/> Clear/Sunny
<b>Now</b> <input type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input checked="" type="checkbox"/> Clear/Sunny <b>Temperature</b> ___ °C	<b>Past 24 Hours</b> <input type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input checked="" type="checkbox"/> Clear/Sunny				
<b>RIPARIAN VEGETATION</b>	<b>Indicate the dominant type and record the dominant species present:</b> <input checked="" type="checkbox"/> Trees <input type="checkbox"/> Shrubs <input type="checkbox"/> Grasses <input checked="" type="checkbox"/> Herbaceous <b>Dominant Species Present</b> _____				
<b>AQUATIC VEGETATION</b>	<b>Indicate the dominant type and record the dominant species present:</b> <input type="checkbox"/> Rooted Emergent <input type="checkbox"/> Rooted Submergent <input type="checkbox"/> Rooted Floating <input type="checkbox"/> Floating Algae <input checked="" type="checkbox"/> Attached Algae <b>Dominant Species Present</b> _____				
<b>AQUATIC FAUNA</b>	<b>Notes:</b> <ul style="list-style-type: none"> <li>Yellow, small dragonfly observed at water surface</li> <li>Small fish (~5-6cm)</li> <li>White halfbeaks observed</li> </ul>				

<b>STREAM CHARACTERISATION</b>	<b>Occurrence</b> <input type="checkbox"/> Perennial <input type="checkbox"/> Intermittent  <b>Stream Type</b> <input checked="" type="checkbox"/> "Tree-country" Forest stream <input type="checkbox"/> "Open-country" Stream <input type="checkbox"/> Concrete canal, drain <input type="checkbox"/> Other _____	<b>Characteristics of Water Flow</b> <input type="checkbox"/> Fast, with roughness <input type="checkbox"/> Fast, smooth <input checked="" type="checkbox"/> Slow, gentle <input type="checkbox"/> Pool <input type="checkbox"/> Trickle <b>Channelized</b> <input type="checkbox"/> Yes <input type="checkbox"/> No
	<b>STREAM FEATURES</b>	<b>Estimated Length Sampled</b> <u>20</u> m <b>Estimated Stream Width</b> <u>2.0 - 6.0</u> m <b>Estimated Stream Depth</b> <u>3.0</u> cm <b>Canopy Cover</b> <input checked="" type="checkbox"/> Open <input type="checkbox"/> Partly Open/Shaded <input type="checkbox"/> Shaded <b>Light intensity</b> <u>16.52 - 17.93 Klux</u>
<b>WATER QUALITY</b>	<b>Temperature</b> <u>27.4</u> °C <b>Electrical Conductivity</b> <u>0010</u> µS/cm <b>pH</b> <u>4.9</u> <b>Total Suspended Solids</b> <u>0</u> mg/L	<b>Odor</b> <input checked="" type="checkbox"/> Normal/None <input type="checkbox"/> Sewage <input type="checkbox"/> Petroleum <input type="checkbox"/> Chemical <input type="checkbox"/> Fishy <input type="checkbox"/> Other <b>Water Surface Oils</b> <input type="checkbox"/> Slick <input type="checkbox"/> Sheen <input type="checkbox"/> Gloss <input type="checkbox"/> Fleck <input checked="" type="checkbox"/> None <input type="checkbox"/> Other _____

SEDIMENT/ SUBSTRATE (IF VISIBLE)			
Inorganic Substrate Components		Organic Substrate Components	
Substrate Type	% Composition in Sampling Reach	Substrate Type	% Composition in Sampling Reach
Bedrock		Detritus such as sticks, wood, coarse plant materials	20
Boulder		Mud	20
Cobble		Other	
Gravel			
Sand	30		
Silt	10		
Clay	20		

## Field Record Sheet

Name of Surveyors: Cheong Shu Min & Eva Yew		Location: CCNR			
Stream ID: HD (under Sime Track)		Coordinates: N 01°35'28.5" E 103°80'63.4"			
Date of Survey: 3 Nov 2014		Time of Survey: 13:15 pm			
Photo record: HD_024 to HD_035					
<b>WEATHER</b>	<table style="width: 100%; border: none;"> <tr> <td style="width: 50%; vertical-align: top;"> <b>Now</b>  <input type="checkbox"/> Storm (Heavy rain)  <input type="checkbox"/> Rain (Steady rain)  <input type="checkbox"/> Shower (Intermittent)  <input type="checkbox"/> Cloud Cover  <input checked="" type="checkbox"/> Clear/Sunny  <b>Temperature</b>___ °C </td> <td style="width: 50%; vertical-align: top;"> <b>Past 24 Hours</b>  <input type="checkbox"/> Storm (Heavy rain)  <input type="checkbox"/> Rain (Steady rain)  <input type="checkbox"/> Shower (Intermittent)  <input type="checkbox"/> Cloud Cover  <input checked="" type="checkbox"/> Clear/Sunny </td> </tr> </table>			<b>Now</b> <input type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input checked="" type="checkbox"/> Clear/Sunny <b>Temperature</b> ___ °C	<b>Past 24 Hours</b> <input type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input checked="" type="checkbox"/> Clear/Sunny
<b>Now</b> <input type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input checked="" type="checkbox"/> Clear/Sunny <b>Temperature</b> ___ °C	<b>Past 24 Hours</b> <input type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input checked="" type="checkbox"/> Clear/Sunny				
<b>RIPARIAN VEGETATION</b>	<b>Indicate the dominant type and record the dominant species present:</b> <input checked="" type="checkbox"/> Trees <input type="checkbox"/> Shrubs <input type="checkbox"/> Grasses <input checked="" type="checkbox"/> Herbaceous <b>Dominant Species Present</b> _____				
<b>AQUATIC VEGETATION</b>	<b>Indicate the dominant type and record the dominant species present:</b> <input type="checkbox"/> Rooted Emergent <input type="checkbox"/> Rooted Submergent <input type="checkbox"/> Rooted Floating <input type="checkbox"/> Floating Algae <input type="checkbox"/> Attached Algae <b>Dominant Species Present</b> _____				
<b>AQUATIC FAUNA</b>	<b>Notes:</b> <ul style="list-style-type: none"> <li>Forest snakehead observed in 2 days (~45cm)</li> <li>Damselfly and dragonfly</li> <li>At least of 2 other species of fish</li> </ul>				



<b>STREAM CHARACTERISATION</b>	<b>Occurrence</b> <input checked="" type="checkbox"/> Perennial <input checked="" type="checkbox"/> Intermittent  <b>Stream Type</b> <input checked="" type="checkbox"/> "Tree-country" Forest stream <input type="checkbox"/> "Open-country" Stream <input type="checkbox"/> Concrete canal, drain <input type="checkbox"/> Other _____	<b>Characteristics of Water Flow</b> <input type="checkbox"/> Fast, with roughness <input type="checkbox"/> Fast, smooth <input checked="" type="checkbox"/> Slow, gentle <input type="checkbox"/> Pool <input type="checkbox"/> Trickle <b>Channelized</b> <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No
	<b>STREAM FEATURES</b>	<b>Estimated Length Sampled</b> <u>10</u> m <b>Estimated Stream Width</b> <u>4.0 - 5.0</u> m <b>Estimated Stream Depth</b> <u>50 - 100</u> cm <b>Canopy Cover</b> <input type="checkbox"/> Open <input type="checkbox"/> Partly Open/Shaded <input checked="" type="checkbox"/> Shaded <b>Light intensity</b> <u>2.54-2.57 Klux</u>
<b>WATER QUALITY</b>	<b>Temperature</b> <u>27.1</u> °C <b>Electrical Conductivity</b> <u>0050</u> µS/cm <b>pH</b> <u>5.1</u> <b>Total Suspended Solids</b> <u>0020</u> mg/L	<b>Odor</b> <input checked="" type="checkbox"/> Normal/None <input type="checkbox"/> Sewage <input type="checkbox"/> Petroleum <input type="checkbox"/> Chemical <input type="checkbox"/> Fishy <input checked="" type="checkbox"/> Other <b>Water Surface Oils</b> <input type="checkbox"/> Slick <input type="checkbox"/> Sheen <input type="checkbox"/> Gloss <input type="checkbox"/> Fleck <input checked="" type="checkbox"/> None <input type="checkbox"/> Other _____

SEDIMENT/ SUBSTRATE (IF VISIBLE)			
Inorganic Substrate Components		Organic Substrate Components	
Substrate Type	% Composition in Sampling Reach	Substrate Type	% Composition in Sampling Reach
Bedrock		Detritus such as sticks, wood, coarse plant materials	50
Boulder		Mud	20
Cobble		Other	
Gravel			
Sand			
Silt	30		
Clay			

## Field Record Sheet

<b>Name of Surveyors:</b> Cheong Shu Min & Eva Yew		<b>Location:</b> CCNR			
<b>Stream ID:</b> HC		<b>Coordinates:</b> N 01°35'72.6" E 103°80'58.4"			
<b>Date of Survey:</b> 3 Nov 2014		<b>Time of Survey:</b> 1:37 pm			
<b>Photo record:</b> HC2_001 to HC2_015					
<b>WEATHER</b>	<table style="width: 100%; border: none;"> <tr> <td style="width: 50%; vertical-align: top;"> <b>Now</b>  <input type="checkbox"/> Storm (Heavy rain)  <input type="checkbox"/> Rain (Steady rain)  <input type="checkbox"/> Shower (Intermittent)  <input type="checkbox"/> Cloud Cover  <input type="checkbox"/> Clear/Sunny  <b>Temperature</b>___ °C </td> <td style="width: 50%; vertical-align: top;"> <b>Past 24 Hours</b>  <input type="checkbox"/> Storm (Heavy rain)  <input type="checkbox"/> Rain (Steady rain)  <input type="checkbox"/> Shower (Intermittent)  <input type="checkbox"/> Cloud Cover  <input type="checkbox"/> Clear/Sunny </td> </tr> </table>			<b>Now</b> <input type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input type="checkbox"/> Clear/Sunny <b>Temperature</b> ___ °C	<b>Past 24 Hours</b> <input type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input type="checkbox"/> Clear/Sunny
<b>Now</b> <input type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input type="checkbox"/> Clear/Sunny <b>Temperature</b> ___ °C	<b>Past 24 Hours</b> <input type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input type="checkbox"/> Clear/Sunny				
<b>RIPARIAN VEGETATION</b>	<b>Indicate the dominant type and record the dominant species present:</b> <input checked="" type="checkbox"/> Trees <input type="checkbox"/> Shrubs <input type="checkbox"/> Grasses <input checked="" type="checkbox"/> Herbaceous <b>Dominant Species Present</b> _____				
<b>AQUATIC VEGETATION</b>	<b>Indicate the dominant type and record the dominant species present:</b> <input type="checkbox"/> Rooted Emergent <input type="checkbox"/> Rooted Submergent <input type="checkbox"/> Rooted Floating <input type="checkbox"/> Floating Algae <input type="checkbox"/> Attached Algae <b>Dominant Species Present</b> _____				
<b>AQUATIC FAUNA</b>	<b>Notes:</b> <ul style="list-style-type: none"> <li>Fish observed</li> </ul>				

<b>STREAM CHARACTERISATION</b>	<b>Occurrence</b> <input checked="" type="checkbox"/> Perennial <input type="checkbox"/> Intermittent  <b>Stream Type</b> <input checked="" type="checkbox"/> "Tree-country" Forest stream <input type="checkbox"/> "Open-country" Stream <input type="checkbox"/> Concrete canal, drain <input type="checkbox"/> Other _____	<b>Characteristics of Water Flow</b> <input type="checkbox"/> Fast, with roughness <input checked="" type="checkbox"/> Fast, smooth <input type="checkbox"/> Slow, gentle <input type="checkbox"/> Pool <input type="checkbox"/> Trickle <b>Channelized</b> <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No
	<b>STREAM FEATURES</b>  <b>Estimated Length Sampled</b> <u>20</u> m <b>Estimated Stream Width</b> _____ m <b>Estimated Stream Depth</b> <u>2.0</u> cm <b>Canopy Cover</b> <input type="checkbox"/> Open <input type="checkbox"/> Partly Open/Shaded <input checked="" type="checkbox"/> Shaded <b>Light intensity</b> <u>1.37 - 1.41 Klux</u>	<b>Stream Surface</b> <input checked="" type="checkbox"/> Clear <input type="checkbox"/> Slightly Turbid <input type="checkbox"/> Turbid <input type="checkbox"/> Stained Presence of Leaf Litter <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No If Yes, % cover <u>15</u> Large Woody Debris <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No If Yes, % cover _____
<b>WATER QUALITY</b>	<b>Temperature</b> <u>26.3</u> °C <b>Electrical Conductivity</b> <u>0010</u> µS/cm <b>pH</b> <u>5.3</u> <b>Total Suspended Solids</b> <u>0</u> mg/L	<b>Odor</b> <input checked="" type="checkbox"/> Normal/None <input type="checkbox"/> Sewage <input type="checkbox"/> Petroleum <input type="checkbox"/> Chemical <input type="checkbox"/> Fishy <input type="checkbox"/> Other <b>Water Surface Oils</b> <input type="checkbox"/> Slick <input type="checkbox"/> Sheen <input type="checkbox"/> Gloss <input type="checkbox"/> Fleck <input checked="" type="checkbox"/> None <input type="checkbox"/> Other _____

SEDIMENT/ SUBSTRATE (IF VISIBLE)			
Inorganic Substrate Components		Organic Substrate Components	
Substrate Type	% Composition in Sampling Reach	Substrate Type	% Composition in Sampling Reach
Bedrock		Detritus such as sticks, wood, coarse plant materials	20
Boulder		Mud	
Cobble		Other	
Gravel			
Sand	50		
Silt	30		
Clay			



## Field Record Sheet

Name of Surveyors: Cheong Shu Min & Eva Yew		Location: CCNR			
Stream ID: <b>HC5 &amp; HC6</b>		Coordinates: N 01°35'80.30" E 103°80'59.0"			
Date of Survey: 3 Nov 2014		Time of Survey: 1:53 pm			
Photo record: HC5 & HC6_001 to HC5 & HC6_020					
<b>WEATHER</b>	<table style="width: 100%; border: none;"> <tr> <td style="width: 50%; vertical-align: top;"> <b>Now</b>  <input type="checkbox"/> Storm (Heavy rain)  <input type="checkbox"/> Rain (Steady rain)  <input type="checkbox"/> Shower (Intermittent)  <input type="checkbox"/> Cloud Cover  <input checked="" type="checkbox"/> Clear/Sunny  <b>Temperature</b>___ °C                 </td> <td style="width: 50%; vertical-align: top;"> <b>Past 24 Hours</b>  <input type="checkbox"/> Storm (Heavy rain)  <input type="checkbox"/> Rain (Steady rain)  <input type="checkbox"/> Shower (Intermittent)  <input type="checkbox"/> Cloud Cover  <input checked="" type="checkbox"/> Clear/Sunny                 </td> </tr> </table>			<b>Now</b> <input type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input checked="" type="checkbox"/> Clear/Sunny <b>Temperature</b> ___ °C	<b>Past 24 Hours</b> <input type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input checked="" type="checkbox"/> Clear/Sunny
<b>Now</b> <input type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input checked="" type="checkbox"/> Clear/Sunny <b>Temperature</b> ___ °C	<b>Past 24 Hours</b> <input type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input checked="" type="checkbox"/> Clear/Sunny				
<b>RIPARIAN VEGETATION</b>	<b>Indicate the dominant type and record the dominant species present:</b> <input checked="" type="checkbox"/> Trees <input type="checkbox"/> Shrubs <input type="checkbox"/> Grasses <input type="checkbox"/> Herbaceous <b>Dominant Species Present</b> _____				
<b>AQUATIC VEGETATION</b>	<b>Indicate the dominant type and record the dominant species present:</b> <input type="checkbox"/> Rooted Emergent <input type="checkbox"/> Rooted Submergent <input type="checkbox"/> Rooted Floating <input type="checkbox"/> Floating Algae <input type="checkbox"/> Attached Algae <b>Dominant Species Present</b> _____				
<b>AQUATIC FAUNA</b>	<b>Notes:</b>				

<b>STREAM CHARACTERISATION</b>	<b>Occurrence</b> <input checked="" type="checkbox"/> Perennial <input type="checkbox"/> Intermittent  <b>Stream Type</b> <input checked="" type="checkbox"/> "Tree-country" Forest stream <input type="checkbox"/> "Open-country" Stream <input type="checkbox"/> Concrete canal, drain <input type="checkbox"/> Other _____	<b>Characteristics of Water Flow</b>  <input type="checkbox"/> Fast, with roughness <input type="checkbox"/> Fast, smooth <input checked="" type="checkbox"/> Slow, gentle <input type="checkbox"/> Pool <input type="checkbox"/> Trickle  <b>Channelized</b> <input type="checkbox"/> Yes <input type="checkbox"/> No
<b>STREAM FEATURES</b>	<b>Estimated Length Sampled</b> <u>10</u> m <b>Estimated Stream Width</b> <u>2.0</u> m <b>Estimated Stream Depth</b> <u>3.0</u> cm <b>Canopy Cover</b> <input type="checkbox"/> Open <input checked="" type="checkbox"/> Partly Open/Shaded <input type="checkbox"/> Shaded <b>Light intensity</b> <u>4.63 - 24.07 Klux</u>	<b>Stream Surface</b> <input checked="" type="checkbox"/> Clear <input type="checkbox"/> Slightly Turbid <input type="checkbox"/> Turbid <input type="checkbox"/> Stained  Presence of Leaf Litter <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No  If Yes, % cover <u>80</u>  Large Woody Debris <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No  If Yes, % cover <u>30</u>
<b>WATER QUALITY</b>	<b>Temperature</b> <u>26.38</u> °C <b>Electrical Conductivity</b> <u>0010</u> µS/cm <b>pH</b> <u>5.2</u> <b>Total Suspended Solids</b> <u>0</u> mg/L	<b>Odor</b> <input checked="" type="checkbox"/> Normal/None <input type="checkbox"/> Sewage <input type="checkbox"/> Petroleum <input type="checkbox"/> Chemical <input type="checkbox"/> Fishy <input type="checkbox"/> Other  <b>Water Surface Oils</b> <input type="checkbox"/> Slick <input type="checkbox"/> Sheen <input type="checkbox"/> Gloss <input type="checkbox"/> Fleck <input checked="" type="checkbox"/> None <input type="checkbox"/> Other _____

SEDIMENT/ SUBSTRATE (IF VISIBLE)			
Inorganic Substrate Components		Organic Substrate Components	
Substrate Type	% Composition in Sampling Reach	Substrate Type	% Composition in Sampling Reach
Bedrock		Detritus such as sticks, wood, coarse plant materials	80
Boulder		Mud	10
Cobble		Other	
Gravel			
Sand	10		
Silt			
Clay			

## Field Record Sheet

<b>Name of Surveyors:</b> Cheong Shu Min & Eva Yew		<b>Location:</b> CCNR			
<b>Stream ID:</b> HB4		<b>Coordinates:</b> N 01°35'83.0" E 103°80'87.5"			
<b>Date of Survey:</b> 3 Nov 2014		<b>Time of Survey:</b> 2:18 pm			
<b>Photo record:</b>					
<b>WEATHER</b>	<table style="width: 100%; border: none;"> <tr> <td style="width: 50%; vertical-align: top;"> <b>Now</b>  <input type="checkbox"/> Storm (Heavy rain)  <input type="checkbox"/> Rain (Steady rain)  <input type="checkbox"/> Shower (Intermittent)  <input type="checkbox"/> Cloud Cover  <input checked="" type="checkbox"/> Clear/Sunny  <b>Temperature</b>___ °C                 </td> <td style="width: 50%; vertical-align: top;"> <b>Past 24 Hours</b>  <input type="checkbox"/> Storm (Heavy rain)  <input type="checkbox"/> Rain (Steady rain)  <input type="checkbox"/> Shower (Intermittent)  <input type="checkbox"/> Cloud Cover  <input checked="" type="checkbox"/> Clear/Sunny                 </td> </tr> </table>			<b>Now</b> <input type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input checked="" type="checkbox"/> Clear/Sunny <b>Temperature</b> ___ °C	<b>Past 24 Hours</b> <input type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input checked="" type="checkbox"/> Clear/Sunny
<b>Now</b> <input type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input checked="" type="checkbox"/> Clear/Sunny <b>Temperature</b> ___ °C	<b>Past 24 Hours</b> <input type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input checked="" type="checkbox"/> Clear/Sunny				
<b>RIPARIAN VEGETATION</b>	<b>Indicate the dominant type and record the dominant species present:</b> <input checked="" type="checkbox"/> Trees <input type="checkbox"/> Shrubs <input type="checkbox"/> Grasses <input checked="" type="checkbox"/> Herbaceous <b>Dominant Species Present</b> _____				
<b>AQUATIC VEGETATION</b>	<b>Indicate the dominant type and record the dominant species present:</b> <input type="checkbox"/> Rooted Emergent <input type="checkbox"/> Rooted Submergent <input type="checkbox"/> Rooted Floating <input type="checkbox"/> Floating Algae <input type="checkbox"/> Attached Algae <b>Dominant Species Present</b> _____				
<b>AQUATIC FAUNA</b>	<b>Notes:</b> <div style="height: 100px;"></div>				



<b>STREAM CHARACTERISATION</b>	<b>Occurrence</b> <input checked="" type="checkbox"/> Perennial <input type="checkbox"/> Intermittent  <b>Stream Type</b> <input checked="" type="checkbox"/> "Tree-country" Forest stream <input type="checkbox"/> "Open-country" Stream <input checked="" type="checkbox"/> Concrete canal, drain <input type="checkbox"/> Other _____	<b>Characteristics of Water Flow</b>  <input type="checkbox"/> Fast, with roughness <input type="checkbox"/> Fast, smooth <input checked="" type="checkbox"/> Slow, gentle <input type="checkbox"/> Pool <input type="checkbox"/> Trickle  <b>Channelized</b> <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No
	<b>STREAM FEATURES</b>	<b>Estimated Length Sampled</b> <u>10</u> m <b>Estimated Stream Width</b> _____ m <b>Estimated Stream Depth</b> <u>3.0</u> cm <b>Canopy Cover</b> <input type="checkbox"/> Open <input type="checkbox"/> Partly Open/Shaded <input checked="" type="checkbox"/> Shaded <b>Light intensity</b> <u>1.42 - 1.44 Klux</u>
<b>WATER QUALITY</b>	<b>Temperature</b> <u>26.6</u> °C <b>Electrical Conductivity</b> <u>0010</u> µS/cm <b>pH</b> <u>6.2</u> <b>Total Suspended Solids</b> <u>0</u> mg/L	<b>Odor</b> <input checked="" type="checkbox"/> Normal/None <input type="checkbox"/> Sewage <input type="checkbox"/> Petroleum <input type="checkbox"/> Chemical <input type="checkbox"/> Fishy <input checked="" type="checkbox"/> Other <u>Trash (plastic bag)</u>  <b>Water Surface Oils</b> <input type="checkbox"/> Slick <input type="checkbox"/> Sheen <input type="checkbox"/> Gloss <input type="checkbox"/> Fleck <input checked="" type="checkbox"/> None <input type="checkbox"/> Other _____

SEDIMENT/ SUBSTRATE (IF VISIBLE)			
Inorganic Substrate Components		Organic Substrate Components	
Substrate Type	% Composition in Sampling Reach	Substrate Type	% Composition in Sampling Reach
Bedrock		Detritus such as sticks, wood, coarse plant materials	15
Boulder		Mud	10
Cobble		Other	
Gravel			
Sand	30		
Silt	30		
Clay	15		

## Field Record Sheet

<b>Name of Surveyors:</b> Cheong Shu Min & Eva Yew		<b>Location:</b> MacRitchie CCNR			
<b>Stream ID:</b> MA5		<b>Coordinates:</b> N 01°36'02.8" E 103°82'19.1"			
<b>Date of Survey:</b> 3 Nov 2014		<b>Time of Survey:</b> 3:43 pm			
<b>Photo record:</b>					
<b>WEATHER</b>	<table style="width: 100%; border: none;"> <tr> <td style="width: 50%; vertical-align: top;"> <b>Now</b>   <input type="checkbox"/> Storm (Heavy rain)  <input type="checkbox"/> Rain (Steady rain)  <input type="checkbox"/> Shower (Intermittent)  <input type="checkbox"/> Cloud Cover  <input checked="" type="checkbox"/> Clear/Sunny  <b>Temperature</b>___ °C </td> <td style="width: 50%; vertical-align: top;"> <b>Past 24 Hours</b>   <input type="checkbox"/> Storm (Heavy rain)  <input type="checkbox"/> Rain (Steady rain)  <input type="checkbox"/> Shower (Intermittent)  <input type="checkbox"/> Cloud Cover  <input checked="" type="checkbox"/> Clear/Sunny </td> </tr> </table>			<b>Now</b>  <input type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input checked="" type="checkbox"/> Clear/Sunny <b>Temperature</b> ___ °C	<b>Past 24 Hours</b>  <input type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input checked="" type="checkbox"/> Clear/Sunny
<b>Now</b>  <input type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input checked="" type="checkbox"/> Clear/Sunny <b>Temperature</b> ___ °C	<b>Past 24 Hours</b>  <input type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input checked="" type="checkbox"/> Clear/Sunny				
<b>RIPARIAN VEGETATION</b>	<b>Indicate the dominant type and record the dominant species present:</b>  <input checked="" type="checkbox"/> Trees <input type="checkbox"/> Shrubs <input type="checkbox"/> Grasses <input type="checkbox"/> Herbaceous <b>Dominant Species Present</b> _____				
<b>AQUATIC VEGETATION</b>	<b>Indicate the dominant type and record the dominant species present:</b>  <input type="checkbox"/> Rooted Emergent <input type="checkbox"/> Rooted Submergent <input type="checkbox"/> Rooted Floating <input type="checkbox"/> Floating Algae <input type="checkbox"/> Attached Algae <b>Dominant Species Present</b> _____				
<b>AQUATIC FAUNA</b>	<b>Notes:</b>  <ul style="list-style-type: none"> <li>Halfbeaks</li> <li>Small fish (unknown species)</li> </ul>				

<b>STREAM CHARACTERISATION</b>	<b>Occurrence</b> <input checked="" type="checkbox"/> Perennial <input type="checkbox"/> Intermittent  <b>Stream Type</b> <input checked="" type="checkbox"/> "Tree-country" Forest stream <input type="checkbox"/> "Open-country" Stream <input type="checkbox"/> Concrete canal, drain <input type="checkbox"/> Other _____	<b>Characteristics of Water Flow</b> <input checked="" type="checkbox"/> Fast, with roughness <input checked="" type="checkbox"/> Fast, smooth <input type="checkbox"/> Slow, gentle <input type="checkbox"/> Pool <input type="checkbox"/> Trickle <b>Channelized</b> <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No
	<b>STREAM FEATURES</b>  <b>Estimated Length Sampled</b> <u>10</u> m <b>Estimated Stream Width</b> <u>0.75-1.0</u> m <b>Estimated Stream Depth</b> <u>6.5</u> cm <b>Canopy Cover</b> <input type="checkbox"/> Open <input type="checkbox"/> Partly Open/Shaded <input checked="" type="checkbox"/> Shaded <b>Light intensity</b> <u>0.81 - 0.85 Klux</u>	<b>Stream Surface</b> <input checked="" type="checkbox"/> Clear <input type="checkbox"/> Slightly Turbid <input type="checkbox"/> Turbid <input type="checkbox"/> Stained Presence of Leaf Litter <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No If Yes, % cover <u>10</u> Large Woody Debris <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No If Yes, % cover _____
<b>WATER QUALITY</b>	<b>Temperature</b> <u>27.1</u> °C <b>Electrical Conductivity</b> <u>0030</u> µS/cm <b>pH</b> <u>6.7</u> <b>Total Suspended Solids</b> <u>0010</u> mg/L	<b>Odor</b> <input checked="" type="checkbox"/> Normal/None <input type="checkbox"/> Sewage <input type="checkbox"/> Petroleum <input type="checkbox"/> Chemical <input type="checkbox"/> Fishy <input type="checkbox"/> Other <b>Water Surface Oils</b> <input type="checkbox"/> Slick <input type="checkbox"/> Sheen <input type="checkbox"/> Gloss <input type="checkbox"/> Fleck <input checked="" type="checkbox"/> None <input type="checkbox"/> Other _____

SEDIMENT/ SUBSTRATE (IF VISIBLE)			
Inorganic Substrate Components		Organic Substrate Components	
Substrate Type	% Composition in Sampling Reach	Substrate Type	% Composition in Sampling Reach
Bedrock		Detritus such as sticks, wood, coarse plant materials	10
Boulder		Mud	
Cobble		Other	
Gravel			
Sand	20		
Silt	50		
Clay	20		



## Field Record Sheet

<b>Name of Surveyors:</b> Cheong Shu Min & Eva Yew		<b>Location:</b> CCNR			
<b>Stream ID:</b> I		<b>Coordinates:</b> N 01°34'98.9" E 103°80'74.0"			
<b>Date of Survey:</b> 4 Nov 2014		<b>Time of Survey:</b> 8:57 am			
<b>Photo record:</b> I_001 to I_014					
<b>WEATHER</b>	<table style="width: 100%; border: none;"> <tr> <td style="width: 50%; vertical-align: top;"> <b>Now</b>  <input type="checkbox"/> Storm (Heavy rain)  <input type="checkbox"/> Rain (Steady rain)  <input type="checkbox"/> Shower (Intermittent)  <input type="checkbox"/> Cloud Cover  <input checked="" type="checkbox"/> Clear/Sunny  <b>Temperature</b>__ °C </td> <td style="width: 50%; vertical-align: top;"> <b>Past 24 Hours</b>  <input type="checkbox"/> Storm (Heavy rain)  <input type="checkbox"/> Rain (Steady rain)  <input type="checkbox"/> Shower (Intermittent)  <input type="checkbox"/> Cloud Cover  <input checked="" type="checkbox"/> Clear/Sunny </td> </tr> </table>			<b>Now</b> <input type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input checked="" type="checkbox"/> Clear/Sunny <b>Temperature</b> __ °C	<b>Past 24 Hours</b> <input type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input checked="" type="checkbox"/> Clear/Sunny
<b>Now</b> <input type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input checked="" type="checkbox"/> Clear/Sunny <b>Temperature</b> __ °C	<b>Past 24 Hours</b> <input type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input checked="" type="checkbox"/> Clear/Sunny				
<b>RIPARIAN VEGETATION</b>	<b>Indicate the dominant type and record the dominant species present:</b> <input checked="" type="checkbox"/> Trees <input type="checkbox"/> Shrubs <input type="checkbox"/> Grasses <input type="checkbox"/> Herbaceous <b>Dominant Species Present</b> _____				
<b>AQUATIC VEGETATION</b>	<b>Indicate the dominant type and record the dominant species present:</b> <input type="checkbox"/> Rooted Emergent <input type="checkbox"/> Rooted Submergent <input type="checkbox"/> Rooted Floating <input type="checkbox"/> Floating Algae <input type="checkbox"/> Attached Algae <b>Dominant Species Present</b> _____				
<b>AQUATIC FAUNA</b>	<b>Notes:</b> <ul style="list-style-type: none"> <li>Fish observed</li> <li>Stream area flooded after heavy rain</li> </ul>				

<b>STREAM CHARACTERISATION</b>	<b>Occurrence</b> <input checked="" type="checkbox"/> Perennial <input type="checkbox"/> Intermittent  <b>Stream Type</b> <input checked="" type="checkbox"/> "Tree-country" Forest stream <input type="checkbox"/> "Open-country" Stream <input type="checkbox"/> Concrete canal, drain <input type="checkbox"/> Other _____	<b>Characteristics of Water Flow</b> <input type="checkbox"/> Fast, with roughness <input checked="" type="checkbox"/> Fast, smooth <input type="checkbox"/> Slow, gentle <input type="checkbox"/> Pool <input type="checkbox"/> Trickle <b>Channelized</b> <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No
	<b>STREAM FEATURES</b>	<b>Estimated Length Sampled</b> <u>10</u> m <b>Estimated Stream Width</b> <u>2.0 - 4.0</u> m <b>Estimated Stream Depth</b> <u>16</u> cm <b>Canopy Cover</b> <input type="checkbox"/> Open <input type="checkbox"/> Partly Open/Shaded <input checked="" type="checkbox"/> Shaded <b>Light intensity</b> <u>1.13 - 1.34 Klux</u>
<b>WATER QUALITY</b>	<b>Dam stream (Upstream)</b> <b>Temperature</b> <u>26.0</u> °C <b>Electrical Conductivity</b> <u>0040 (0030)</u> µS/cm <b>pH</b> <u>6.8 (5.8)</u> <b>Total Suspended Solids</b> <u>0010 (0010)</u> mg/L	<b>Odor</b> <input checked="" type="checkbox"/> Normal/None <input type="checkbox"/> Sewage <input type="checkbox"/> Petroleum <input type="checkbox"/> Chemical <input type="checkbox"/> Fishy <input type="checkbox"/> Other <b>Water Surface Oils</b> <input type="checkbox"/> Slick <input type="checkbox"/> Sheen <input type="checkbox"/> Gloss <input type="checkbox"/> Fleck <input checked="" type="checkbox"/> None <input type="checkbox"/> Other _____

SEDIMENT/ SUBSTRATE (IF VISIBLE)			
Inorganic Substrate Components		Organic Substrate Components	
Substrate Type	% Composition in Sampling Reach	Substrate Type	% Composition in Sampling Reach
Bedrock		Detritus such as sticks, wood, coarse plant materials	35
Boulder		Mud	35
Cobble		Other	
Gravel			
Sand			
Silt	15		
Clay	15		

## Field Record Sheet

Name of Surveyors: Cheong Shu Min & Eva Yew		Location: CCNR			
Stream ID: I		Coordinates: N 01°34'98.8" E 103°80'47.3"			
Date of Survey: 4 Nov 2014		Time of Survey: 9:23 am			
Photo record: I_015 to I_025					
<b>WEATHER</b>	<table style="width: 100%; border: none;"> <tr> <td style="width: 50%; vertical-align: top;"> <b>Now</b>  <input type="checkbox"/> Storm (Heavy rain)  <input type="checkbox"/> Rain (Steady rain)  <input type="checkbox"/> Shower (Intermittent)  <input type="checkbox"/> Cloud Cover  <input checked="" type="checkbox"/> Clear/Sunny  <b>Temperature</b>___ °C                 </td> <td style="width: 50%; vertical-align: top;"> <b>Past 24 Hours</b>  <input type="checkbox"/> Storm (Heavy rain)  <input type="checkbox"/> Rain (Steady rain)  <input type="checkbox"/> Shower (Intermittent)  <input type="checkbox"/> Cloud Cover  <input checked="" type="checkbox"/> Clear/Sunny                 </td> </tr> </table>			<b>Now</b> <input type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input checked="" type="checkbox"/> Clear/Sunny <b>Temperature</b> ___ °C	<b>Past 24 Hours</b> <input type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input checked="" type="checkbox"/> Clear/Sunny
<b>Now</b> <input type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input checked="" type="checkbox"/> Clear/Sunny <b>Temperature</b> ___ °C	<b>Past 24 Hours</b> <input type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input checked="" type="checkbox"/> Clear/Sunny				
<b>RIPARIAN VEGETATION</b>	<b>Indicate the dominant type and record the dominant species present:</b> <input checked="" type="checkbox"/> Trees <input type="checkbox"/> Shrubs <input type="checkbox"/> Grasses <input type="checkbox"/> Herbaceous <b>Dominant Species Present</b> _____				
<b>AQUATIC VEGETATION</b>	<b>Indicate the dominant type and record the dominant species present:</b> <input type="checkbox"/> Rooted Emergent <input type="checkbox"/> Rooted Submergent <input type="checkbox"/> Rooted Floating <input type="checkbox"/> Floating Algae <input type="checkbox"/> Attached Algae <b>Dominant Species Present</b> _____				
<b>AQUATIC FAUNA</b>	<b>Notes:</b> <ul style="list-style-type: none"> <li>Dragonfly observed</li> </ul>				



<b>STREAM CHARACTERISATION</b>	<b>Occurrence</b> <input checked="" type="checkbox"/> Perennial <input type="checkbox"/> Intermittent  <b>Stream Type</b> <input checked="" type="checkbox"/> "Tree-country" Forest stream <input type="checkbox"/> "Open-country" Stream <input type="checkbox"/> Concrete canal, drain <input type="checkbox"/> Other _____	<b>Characteristics of Water Flow</b> <input type="checkbox"/> Fast, with roughness <input type="checkbox"/> Fast, smooth <input checked="" type="checkbox"/> Slow, gentle <input checked="" type="checkbox"/> Pool <input type="checkbox"/> Trickle <b>Channelized</b> <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No
<b>STREAM FEATURES</b>	<b>Estimated Length Sampled</b> <u>20</u> m <b>Estimated Stream Width</b> <u>2.0 - 5.5</u> m <b>Estimated Stream Depth</b> <u>100</u> cm <b>Canopy Cover</b> <input type="checkbox"/> Open <input checked="" type="checkbox"/> Partly Open/Shaded <input type="checkbox"/> Shaded <b>Light intensity</b> <u>0.62 - 0.66 Klux</u>	<b>Stream Surface</b> <input type="checkbox"/> Clear <input type="checkbox"/> Slightly Turbid <input checked="" type="checkbox"/> Turbid <input type="checkbox"/> Stained Presence of Leaf Litter <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No If Yes, % cover <u>25</u> Large Woody Debris <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No If Yes, % cover _____
<b>WATER QUALITY</b>	<b>Temperature</b> <u>26.0</u> °C <b>Electrical Conductivity</b> <u>0030</u> µS/cm <b>pH</b> <u>6.2</u> <b>Total Suspended Solids</b> <u>0010</u> mg/L	<b>Odor</b> <input checked="" type="checkbox"/> Normal/None <input type="checkbox"/> Sewage <input type="checkbox"/> Petroleum <input type="checkbox"/> Chemical <input type="checkbox"/> Fishy <input checked="" type="checkbox"/> Other <u>Trash (bottles)</u> <b>Water Surface Oils</b> <input type="checkbox"/> Slick <input type="checkbox"/> Sheen <input type="checkbox"/> Gloss <input type="checkbox"/> Fleck <input checked="" type="checkbox"/> None <input type="checkbox"/> Other _____

SEDIMENT/ SUBSTRATE (IF VISIBLE)			
Inorganic Substrate Components		Organic Substrate Components	
Substrate Type	% Composition in Sampling Reach	Substrate Type	% Composition in Sampling Reach
Bedrock		Detritus such as sticks, wood, coarse plant materials	25
Boulder		Mud	60
Cobble		Other	
Gravel			
Sand			
Silt			
Clay	15		

## Field Record Sheet

<b>Name of Surveyors:</b> Cheong Shu Min & Eva Yew		<b>Location:</b> CCNR			
<b>Stream ID:</b> IC		<b>Coordinates:</b> N 01°34'77.8" E 103°80'27.3"			
<b>Date of Survey:</b> 4 Nov 2013		<b>Time of Survey:</b> 9:39 am			
<b>Photo record:</b> IC_001 to IC_008					
<b>WEATHER</b>	<table style="width: 100%; border: none;"> <tr> <td style="width: 50%; vertical-align: top;"> <b>Now</b>  <input type="checkbox"/> Storm (Heavy rain)  <input type="checkbox"/> Rain (Steady rain)  <input type="checkbox"/> Shower (Intermittent)  <input type="checkbox"/> Cloud Cover  <input checked="" type="checkbox"/> Clear/Sunny  <b>Temperature</b>___ °C </td> <td style="width: 50%; vertical-align: top;"> <b>Past 24 Hours</b>  <input type="checkbox"/> Storm (Heavy rain)  <input type="checkbox"/> Rain (Steady rain)  <input type="checkbox"/> Shower (Intermittent)  <input type="checkbox"/> Cloud Cover  <input checked="" type="checkbox"/> Clear/Sunny </td> </tr> </table>			<b>Now</b> <input type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input checked="" type="checkbox"/> Clear/Sunny <b>Temperature</b> ___ °C	<b>Past 24 Hours</b> <input type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input checked="" type="checkbox"/> Clear/Sunny
<b>Now</b> <input type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input checked="" type="checkbox"/> Clear/Sunny <b>Temperature</b> ___ °C	<b>Past 24 Hours</b> <input type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input checked="" type="checkbox"/> Clear/Sunny				
<b>RIPARIAN VEGETATION</b>	<b>Indicate the dominant type and record the dominant species present:</b> <input checked="" type="checkbox"/> Trees <input type="checkbox"/> Shrubs <input type="checkbox"/> Grasses <input type="checkbox"/> Herbaceous <b>Dominant Species Present</b> _____				
<b>AQUATIC VEGETATION</b>	<b>Indicate the dominant type and record the dominant species present:</b> <input type="checkbox"/> Rooted Emergent <input type="checkbox"/> Rooted Submergent <input type="checkbox"/> Rooted Floating <input type="checkbox"/> Floating Algae <input type="checkbox"/> Attached Algae <b>Dominant Species Present</b> _____				
<b>AQUATIC FAUNA</b>	<b>Notes:</b>				

<b>STREAM CHARACTERISATION</b>	<b>Occurrence</b> <input checked="" type="checkbox"/> Perennial <input type="checkbox"/> Intermittent  <b>Stream Type</b> <input checked="" type="checkbox"/> "Tree-country" Forest stream <input type="checkbox"/> "Open-country" Stream <input type="checkbox"/> Concrete canal, drain <input type="checkbox"/> Other _____	<b>Characteristics of Water Flow</b>  <input type="checkbox"/> Fast, with roughness <input type="checkbox"/> Fast, smooth <input checked="" type="checkbox"/> Slow, gentle <input type="checkbox"/> Pool <input type="checkbox"/> Trickle  <b>Channelized</b> <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No
<b>STREAM FEATURES</b>	<b>Estimated Length Sampled</b> <u>20</u> m <b>Estimated Stream Width</b> <u>1.0-1.5</u> m <b>Estimated Stream Depth</b> <u>4.0</u> cm <b>Canopy Cover</b> <input type="checkbox"/> Open <input checked="" type="checkbox"/> Partly Open/Shaded <input type="checkbox"/> Shaded <b>Light intensity</b> <u>0.62 - 0.66 Klux</u>	<b>Stream Surface</b>  <input type="checkbox"/> Clear <input checked="" type="checkbox"/> Slightly Turbid <input type="checkbox"/> Turbid <input checked="" type="checkbox"/> Stained  Presence of Leaf Litter <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No  If Yes, % cover <u>40</u>  Large Woody Debris <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No  If Yes, % cover <u>10</u>
<b>WATER QUALITY</b>	<b>Temperature</b> <u>25.4</u> °C <b>Electrical Conductivity</b> <u>0020</u> µS/cm <b>pH</b> <u>6.3</u> <b>Total Suspended Solids</b> <u>0010</u> mg/L	<b>Odor</b> <input checked="" type="checkbox"/> Normal/None <input type="checkbox"/> Sewage  <input type="checkbox"/> Petroleum <input type="checkbox"/> Chemical <input type="checkbox"/> Fishy <input type="checkbox"/> Other  <b>Water Surface Oils</b> <input type="checkbox"/> Slick <input type="checkbox"/> Sheen <input type="checkbox"/> Gloss <input type="checkbox"/> Fleck <input checked="" type="checkbox"/> None <input type="checkbox"/> Other _____

SEDIMENT/ SUBSTRATE (IF VISIBLE)			
Inorganic Substrate Components		Organic Substrate Components	
Substrate Type	% Composition in Sampling Reach	Substrate Type	% Composition in Sampling Reach
Bedrock		Detritus such as sticks, wood, coarse plant materials	40
Boulder		Mud	50
Cobble		Other	
Gravel			
Sand			
Silt			
Clay	10		



## Field Record Sheet

Name of Surveyors: Cheong Shu Min & Eva Yew		Location: CCNR			
Stream ID: IC4		Coordinates: N 01°34'62.8" E 103°80'27.3"			
Date of Survey: 4 Nov 2014		Time of Survey: 12:31 pm			
Photo record: IC4_001 to IC4_006					
<b>WEATHER</b>	<table style="width: 100%; border: none;"> <tr> <td style="width: 50%; vertical-align: top;"> <b>Now</b>  <input type="checkbox"/> Storm (Heavy rain)  <input type="checkbox"/> Rain (Steady rain)  <input type="checkbox"/> Shower (Intermittent)  <input type="checkbox"/> Cloud Cover  <input checked="" type="checkbox"/> Clear/Sunny  <b>Temperature</b>___ °C                 </td> <td style="width: 50%; vertical-align: top;"> <b>Past 24 Hours</b>  <input type="checkbox"/> Storm (Heavy rain)  <input type="checkbox"/> Rain (Steady rain)  <input type="checkbox"/> Shower (Intermittent)  <input type="checkbox"/> Cloud Cover  <input checked="" type="checkbox"/> Clear/Sunny                 </td> </tr> </table>			<b>Now</b> <input type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input checked="" type="checkbox"/> Clear/Sunny <b>Temperature</b> ___ °C	<b>Past 24 Hours</b> <input type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input checked="" type="checkbox"/> Clear/Sunny
<b>Now</b> <input type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input checked="" type="checkbox"/> Clear/Sunny <b>Temperature</b> ___ °C	<b>Past 24 Hours</b> <input type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input checked="" type="checkbox"/> Clear/Sunny				
<b>RIPARIAN VEGETATION</b>	<b>Indicate the dominant type and record the dominant species present:</b> <input checked="" type="checkbox"/> Trees <input type="checkbox"/> Shrubs <input type="checkbox"/> Grasses <input checked="" type="checkbox"/> Herbaceous <b>Dominant Species Present</b> _____				
<b>AQUATIC VEGETATION</b>	<b>Indicate the dominant type and record the dominant species present:</b> <input type="checkbox"/> Rooted Emergent <input type="checkbox"/> Rooted Submergent <input type="checkbox"/> Rooted Floating <input type="checkbox"/> Floating Algae <input type="checkbox"/> Attached Algae <b>Dominant Species Present</b> _____				
<b>AQUATIC FAUNA</b>	<b>Notes:</b>				

<b>STREAM CHARACTERISATION</b>	<b>Occurrence</b> <input checked="" type="checkbox"/> Perennial <input type="checkbox"/> Intermittent  <b>Stream Type</b> <input checked="" type="checkbox"/> "Tree-country" Forest stream <input type="checkbox"/> "Open-country" Stream <input type="checkbox"/> Concrete canal, drain <input type="checkbox"/> Other _____	<b>Characteristics of Water Flow</b> <input type="checkbox"/> Fast, with roughness <input type="checkbox"/> Fast, smooth <input checked="" type="checkbox"/> Slow, gentle <input type="checkbox"/> Pool <input checked="" type="checkbox"/> Trickle  <b>Channelized</b> <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No
	<b>STREAM FEATURES</b>	<b>Estimated Length Sampled</b> <u>20</u> m <b>Estimated Stream Width</b> _____ m <b>Estimated Stream Depth</b> <u>2</u> cm <b>Canopy Cover</b> <input type="checkbox"/> Open <input type="checkbox"/> Partly Open/Shaded <input checked="" type="checkbox"/> Shaded <b>Light intensity</b> <u>1.48 - 1.69 Klux</u>
<b>WATER QUALITY</b>	<b>Temperature</b> _____ °C <b>Electrical Conductivity</b> <u>0020</u> μS/cm <b>pH</b> <u>5.9</u> <b>Total Suspended Solids</b> <u>0010</u> mg/L	<b>Odor</b> <input checked="" type="checkbox"/> Normal/None <input type="checkbox"/> Sewage <input type="checkbox"/> Petroleum <input type="checkbox"/> Chemical <input type="checkbox"/> Fishy <input type="checkbox"/> Other  <b>Water Surface Oils</b> <input type="checkbox"/> Slick <input type="checkbox"/> Sheen <input type="checkbox"/> Gloss <input type="checkbox"/> Fleck <input checked="" type="checkbox"/> None <input type="checkbox"/> Other _____

SEDIMENT/ SUBSTRATE (IF VISIBLE)			
Inorganic Substrate Components		Organic Substrate Components	
Substrate Type	% Composition in Sampling Reach	Substrate Type	% Composition in Sampling Reach
Bedrock		Detritus such as sticks, wood, coarse plant materials	80
Boulder		Mud	20
Cobble		Other	
Gravel			
Sand			
Silt			
Clay			

## Field Record Sheet

<b>Name of Surveyors:</b> Cheong Shu Min Eva Yew		<b>Location:</b> MacRitchie CCNR			
<b>Stream ID:</b> Chemperai Hut		<b>Coordinates:</b> N 01°34'98.8" E 103°80'47.3"			
<b>Date of Survey:</b> 28 Oct 2014		<b>Time of Survey:</b> 3:00 pm			
<b>Photo record:</b> CPR_001 to CPR_010					
<b>WEATHER</b>	<table style="width: 100%; border: none;"> <tr> <td style="width: 50%; vertical-align: top;"> <b>Now</b>  <input checked="" type="checkbox"/> Storm (Heavy rain)  <input type="checkbox"/> Rain (Steady rain)  <input type="checkbox"/> Shower (Intermittent)  <input type="checkbox"/> Cloud Cover  <input type="checkbox"/> Clear/Sunny  <b>Temperature</b>___ °C           </td> <td style="width: 50%; vertical-align: top;"> <b>Past 24 Hours</b>  <input checked="" type="checkbox"/> Storm (Heavy rain)  <input type="checkbox"/> Rain (Steady rain)  <input type="checkbox"/> Shower (Intermittent)  <input type="checkbox"/> Cloud Cover  <input type="checkbox"/> Clear/Sunny           </td> </tr> </table>			<b>Now</b> <input checked="" type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input type="checkbox"/> Clear/Sunny <b>Temperature</b> ___ °C	<b>Past 24 Hours</b> <input checked="" type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input type="checkbox"/> Clear/Sunny
<b>Now</b> <input checked="" type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input type="checkbox"/> Clear/Sunny <b>Temperature</b> ___ °C	<b>Past 24 Hours</b> <input checked="" type="checkbox"/> Storm (Heavy rain) <input type="checkbox"/> Rain (Steady rain) <input type="checkbox"/> Shower (Intermittent) <input type="checkbox"/> Cloud Cover <input type="checkbox"/> Clear/Sunny				
<b>RIPARIAN VEGETATION</b>	<b>Indicate the dominant type and record the dominant species present:</b> <input checked="" type="checkbox"/> Trees <input type="checkbox"/> Shrubs <input type="checkbox"/> Grasses <input checked="" type="checkbox"/> Herbaceous <b>Dominant Species Present</b> _____				
<b>AQUATIC VEGETATION</b>	<b>Indicate the dominant type and record the dominant species present:</b> <input type="checkbox"/> Rooted Emergent <input type="checkbox"/> Rooted Submergent <input type="checkbox"/> Rooted Floating <input type="checkbox"/> Floating Algae <input type="checkbox"/> Attached Algae <b>Dominant Species Present</b> _____				
<b>AQUATIC FAUNA</b>	<b>Notes:</b>          				



<b>STREAM CHARACTERISATION</b>	<b>Occurrence</b> <input type="checkbox"/> Perennial <input type="checkbox"/> Intermittent  <b>Stream Type</b> <input checked="" type="checkbox"/> "Tree-country" Forest stream <input type="checkbox"/> "Open-country" Stream <input type="checkbox"/> Concrete canal, drain <input type="checkbox"/> Other _____	<b>Characteristics of Water Flow</b> <input checked="" type="checkbox"/> Fast, with roughness <input type="checkbox"/> Fast, smooth <input type="checkbox"/> Slow, gentle <input type="checkbox"/> Pool <input type="checkbox"/> Trickle <b>Channelized</b> <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No
	<b>STREAM FEATURES</b>	<b>Estimated Length Sampled</b> _____ m <b>Estimated Stream Width</b> _____ m <b>Estimated Stream Depth</b> <u>6.52</u> cm <b>Canopy Cover</b> <input type="checkbox"/> Open <input checked="" type="checkbox"/> Partly Open/Shaded <input type="checkbox"/> Shaded <b>Light intensity</b> <u>3.50 - 4.14 Klux</u>
<b>WATER QUALITY</b>	<b>Temperature</b> <u>25.2</u> °C <b>Electrical Conductivity</b> <u>0020</u> µS/cm <b>pH</b> <u>6.4</u> <b>Total Suspended Solids</b> <u>0010</u> mg/L	<b>Odor</b> <input checked="" type="checkbox"/> Normal/None <input type="checkbox"/> Sewage <input type="checkbox"/> Petroleum <input type="checkbox"/> Chemical <input type="checkbox"/> Fishy <input type="checkbox"/> Other <b>Water Surface Oils</b> <input type="checkbox"/> Slick <input type="checkbox"/> Sheen <input type="checkbox"/> Gloss <input type="checkbox"/> Fleck <input checked="" type="checkbox"/> None <input type="checkbox"/> Other _____

SEDIMENT/ SUBSTRATE (IF VISIBLE)			
Inorganic Substrate Components		Organic Substrate Components	
Substrate Type	% Composition in Sampling Reach	Substrate Type	% Composition in Sampling Reach
Bedrock		Detritus such as sticks, wood, coarse plant materials	40
Boulder		Mud	
Cobble		Other	
Gravel			
Sand	10		
Silt	35		
Clay	15		

Annex 3B

## Stream Baseline Information

## ANNEX 3B STREAM MAPPING

### A3B.1 MAPPING OF STREAMS

All streams known within the Study Area were verified, as far as access and survey principles allowed, during the stream mapping exercise. Non-intrusive and non-harmful baseline survey techniques meant that some very remote streams that would have involved significant trampling through dense vegetation cover to access, were deemed inaccessible. These included the streams marked as Ea, Eb, Ce and Cd, Fa2 and Mb. All other streams were accessed.

Streams that were sampled in the stream mapping exercise were generally found to be acidic in nature (pH4.9-7.2), with average electrical conductivity and total dissolved solids ranging from 10-40  $\mu$ S/cm and 0-40mg/L respectively. Water temperature ranged from 26.0 to 28.9°C. Anomalies in readings were found at some points in two stream systems and these streams were found to be experiencing varying degrees of disturbance.

The streams which were visited have been categorized as follows:

- Concrete canal – Some streams possessed segments that have been heavily modified into concrete canals. These segments were typically found upstream and served to channel water quickly from upstream reservoirs (eg Upper Peirce Reservoir) to forest streams at lower elevations.
- Rural streams – These were all found at the Windsor Interim Green.
- Forest streams – These were observed to be well-shaded, single channel streams.
- Wetland forest streams – These streams were found in relatively flat, low flow gradient and tree-dominated environments. Braided flows can be observed in some streams and the entire area floods when flow volume is high. The substrate is muddy, waterlogged and unstable.
- Wetland marsh streams – These streams were found in relatively flat environments with low flow gradients. Similarly to wetland forest streams, braided flow can be observed in some streams and the entire area may be flooded when flow volume is high but these streams are distinguished from those in the wetland forest by their riparian vegetation which comprises short, herbaceous vegetation and grass.

Sampling for pH, total dissolved solids, conductivity and temperature was conducted at various points along streams using a handheld water meter [Hanna HI 9811-5]. The depth of water was also measured and the microhabitat of each stream system was recorded. . Microhabitats within each stream system were very varied and a summary of the results of the stream verification exercise are presented in *Table 1*.

Ditches were found along the trails and water was observed flowing in these depressions only after successive rain events. These ephemeral flows may increase the number of microhabitats available for aquatic organisms during the wet season. As these ditches direct flow towards perennial streams that eventually feed into MacRitchie Reservoir and are relevant to surface run-off, details have been included in *Table 1*.

**Table 1: Verification of Streams during the Surveys**

Stream System/Tributaries	Direction of flow	Verified	Unconfirmed	Comments
Streams identified by Murphy (1997)				
Ma	W to E (towards Windsor estates)	Ma1, Ma2, Ma3, Ma4, Ma5, Ma6, Ma7, Ma10	Ma8, Ma9	Ma5 may extend further south than indicated on the map. Ma10 was downstream of a construction site where high electrical conductivity and TSS were recorded.
Hc, Hd, He	N to S &  E to W at lower reaches	Lower reaches of Hd leading to wetland at Dillenia Hut, He, Hc, Hc2, Hc4, Hc5, Hc6	Continuity of Hd from Dillenia Hut wetland	
Hb	E to W	Hb  Hb4	Hb1, Hb2, Hb3	
Ha, G	E to W	Ha, Ha2	Ha1, G, Ga, Gb	Could not verify if Ha flowed to reservoir distinctly, but confirmed presence of wetland forest area at transects GL01 & GL02.
I	W to E	Ia1, Ic, Ic4, I	Ia2, Ia3, Ia4, Ia5, Ia6, Ia7, Ib1, Ib2, Ib3, Ic1, Ic2, Ic3, Ic4	
F	N to S	Fa4, Fb	Fa, Fa1, Fa2, Fa3	Could not verify convergence of Fa4 and Fa1 into Fa. Searched specifically for Fa2 at Venus Link Trail but saw no signs of a stream.
Cc	N to S	Yes		Possibly not a stream originating from a forest source but an indentation of the shoreline of MacRitchie Reservoir.
Stream near Chemperai Hut	S to N	Yes		Visited after rain. Stream flowed across the walking trail leading into MacRitchie Reservoir. Unsure if ephemeral.
Channels for ephemeral flow    Direction of Flow			Comments	
Deep ditch/channel west of Sime Track	N to S, into Hd pool at Sime Track	After successive rain events, a small volume of water was found flowing here, eventually emptying into Hd pool at Sime Track.    The ditch originates from the area near the Ranger Station and runs parallel to Sime Track.    Its upper segment at the grassy portion of Sime Track is a concrete canal and it transitions into an earth ditch with a thick layer of leaf litter upon entering the forested section of Sime Track.		
Deep ditch/channel slight west of Jelutong Hut	S to N, leading into forest (potentially feeding into the end of Hd)	This seemed to originate south of Sime Track and connected to the forest on the other side of the trail via a culvert.    After successive rain events, a significant volume of water was found flowing in the ditch, towards the forested area where Hd is expected to be found.		



## **A3B.2**      **STREAM SYSTEM DESCRIPTIONS**

### **4B.2.1**    **"M" Streams**

These are in general two streams types in the M system, rural (*Figure 1*) and forest streams. The area surrounding M stream system appeared to have been a former settlement. Agricultural crops such as coconuts, palm oil and rambutan trees were found growing in the forested areas beside the stream.

Stream Ma is characteristic of rural stream. It is poorly shaded and riparian vegetation is grass dominated. Rooted submergents were observed and substrate was silty and clayey with a lot of plant matter. Trash was found in the stream and there was a section that was clogged up with bottles, plastic bags and coconuts from former plantations. An oil sheen could be observed on some parts of Ma. Further downstream Ma transitions to a concrete canal leading towards residential estates at Windsor.

**Figure 1:**      ***Stream Ma (Open Country Stream)***



**Figure 2:**        *Trash observed at Stream Ma*



Stream *Ma2* is upstream of *Ma* and is partially shaded at one side by a line of trees and herbaceous vegetation. There is a walking path on the other side of the stream. Water flow was fast and clear and the substrate was fine (ie silt, clay) with plant

**Figure 3:**        *Stream Ma2 is an open canopy forest stream*



Streams *Ma1*, *Ma3*, *Ma4*, *Ma5*, *Ma6*, *Ma7*, *Ma8*, *Ma9*, *Ma10* are characteristic of forest streams and were observed to be smooth flowing. Substrate at all streams was largely silty with some amounts of clay and sand. Some streams were observed flowing under footbridges (ie Streams *Ma5*, *Ma6*, *Ma10*). Stream *Ma1* was observed to be flowing from the north, passing under Island Club Road. The banks along Stream *Ma6* were observed to be deeply eroded.

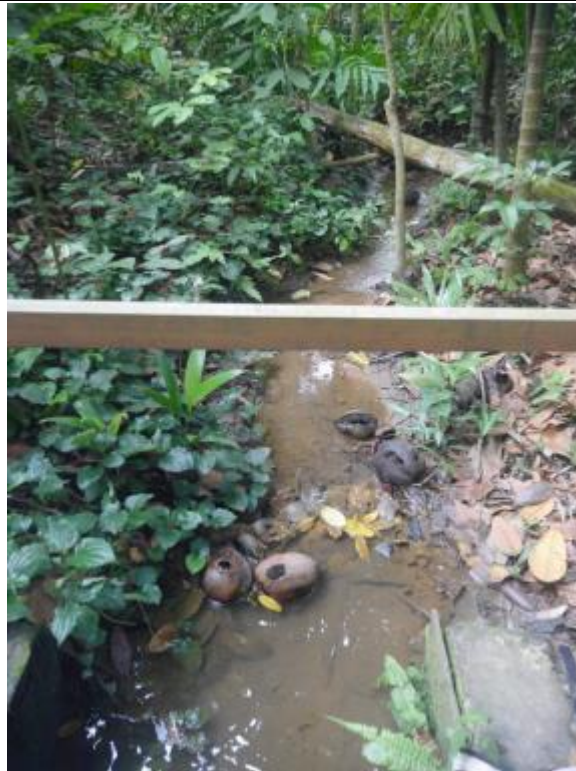
**Figure 4:**        **Stream *Ma1***



Stream *Ma10* was verified to cross beneath Venus Trail Loop via a culvert and found to be immediately downstream of construction site. Silt curtains were observed on the upper reach of Stream *Ma10* (Figure 5) during survey at the end of October 2014. Sampling of the water quality at Stream *Ma10* during the surveys revealed high electrical conductivity with a reading of 140  $\mu\text{S}/\text{cm}$  and total dissolved solids of 70mg/L. Despite possible pollution in *Ma10*, fish (unknown species) were seen in the stream.



**Figure 5:**      **Stream Ma5**



**Figure 6:**      **Stream Ma6**





**Figure 5:**        *Silt Curtains at Stream Ma10*



**Figure 8:**        *Culvert at Stream Ma10*



#### 4B.2.2 “Hd” Streams (Sime Track Area A)

*Hd* is approximately 3 km long and can be broadly classified into three stream types – concrete canal, open wetland marsh, and forest stream.

The upstream segment of *Hd* prior to the wetland marsh at Dillenia Hut is a brick and concrete canal linking Upper Peirce Reservoir to MacRitchie Forest. It was constructed by PUB as a conduit to transfer water from Upper Peirce Reservoir to MacRitchie Reservoir. The segment of Stream *Hd* which lies north of the trail that follows the MacRitchie Pipeline has a steep incline to efficiently channel water down towards MacRitchie. Concrete blocks are present in the middle of this steep canal to diffuse the energy of water flow.

South of the Pipeline, *Hd* transitions to canal roughly 5m wide with a gentler incline/gradient (*Figure 9*). Substrate was observed to have even distributions of gravel and sand. Woody vegetation surrounds the canal on both sides and large branches (ie woody debris) were found in the channel. This channel converges with Stream *He* downstream and empties into an open wetland marsh at Dillenia Hut.

**Figure 6:** Concrete canal *Hd*



Stream *He* is a shaded forest stream possessing substrate which is mostly sandy with some proportion of silt (*Figure 10*). The stream crosses a path linking Rifle Range Link to the trail that follows the MacRitchie Pipeline, and stepping logs have been placed within the stream to help people cross it. Stream *He* converges with the concrete canal *Hd* and both streams lead to the wetland marsh (*Figure 11*).



**Figure 7:**        *He forest stream*



**Figure 11:**        *Convergence of He forest stream and Hd canal*



In his 1997 odonate study, Murphy referred to the wetland at Dillenia Hut as a “meter pond”. There are several braided channels and flow was observed to be fast but gentle. At times of flooding, the water level can rise as high as the PUB service hut located in the middle of the wetland (*Figure 9*). The area is very open and riparian vegetation comprises mostly Dillenia shrub.

Vegetation found on earth mounds in the wetland area between braided channels was herbaceous and short. Conspicuous algae mats can be seen in the water and substrate is largely sandy with some proportion of silt and clay. Water flow was fast but smooth and high odonate activity was observed.

**Figure 9:** *Hd wetland as seen from Hd canal-He convergence point*





**Figure 10: Hd wetland**



*Hd* at Sime Track was a pool of relatively still water (*Figure 11*). Vegetation around *Hd* was found to be on relatively waterlogged ground and with several *Dillenia* stands.

**Figure 11: Hd Pool at Sime Track**



Streams *Hc1-6* are a series of shaded forest streams. The lower reaches of Stream *Hc* (ie *Hc*, *Hc2*) are surrounded by trees and the substrate is sandy. Stream *Hc2* was found to run beneath the trail that follows the MacRitchie Pipeline (about 10m elevation) and was connected under the trail by a culvert. Water flow was fast and smooth. Similarly, there is a tree dominated stream habitat at the upper reaches of Stream *Hc* (ie *Hc5*, *Hc6*). However, flows at these streams were slower and there were a lot of leaf litter and large woody debris.

#### 4B.2.3 “Hb” System

The accessible segment of Stream *Hb* was an open wetland marsh habitat that could be viewed from a wooden bridge at Petaling Trail (*Figure 12*). The substrate at Stream *Hb* and its physical appearance were similar to *Hd* wetland at Dillenia Hut. Braided channels of flow were observed. Conspicuous algae mats were observed in the water and riparian vegetation was tree dominated. Vegetation found on earth mounds in the wetland area between braided channels was herbaceous and short. Odonate activity was high and fish were seen.

**Figure 12:** *Hb* wetland at Petaling Trail



Stream *Hb4* was accessed via the trail that follows the MacRitchie Pipeline. Similar to Stream *Hc2*, Stream *Hb4* runs beneath the trail and is connected by a culvert (*Figure 13*). Stream *Hb4* is characteristic of a closed canopy forest stream (*Figure 14*).



**Figure 13:**      *Culvert at Stream Hb4*



**Figure 14:**      *Stream Hb4*



#### 4B.2.4 “Ha” System

Similar to *Hd* streams, *Ha* comprises a number of stream types – concrete canal and forest stream. The entire *Ha* stream system is located in a steep valley along Sime Track.

*Ha2* originates from the Bukit Kalang Service Reservoir and approximately 50 m of its upstream segment is a concretized canal (Figure 15). The gradient of the canal is steep and it is understood that PUB periodically flushes water out of the Service Reservoir down *Ha2*. This concrete segment is embedded at the base of a grassy hill and there is not sheltered. *Ha2* transitions abruptly from concrete canal to forest stream and continues along Sime Track.

**Figure 15:** *Ha2 Concrete Canal and grassy hill*



The forest streams of *Ha2* and *Ha* are very similar (Figure 16) and the stream varies from single to braided channels (Figure 17). The streams also vary in depth from shallow segments of 2-3 cm to deeper segments of 20-45 cm. Substrate is mostly silty and layers of leaf litter were typically observed.



**Figure 16:**     *Ha Forest Stream*



**Figure 17:**     *Braided flow at Ha*



As mentioned above, Streams *Ha2* and *Ha* experience episodes of flooding when PUB releases water from the Bukit Kalang Service Reservoir down these streams to MacRitchie Reservoir. The quality of this water, including its ion composition and concentration, are unclear. Readings of the water along Streams *Ha2* and *Ha* showed that there was high electrical conductivity and total dissolved solids at 80-230  $\mu\text{S}/\text{cm}$  and 30-110 mg/L respectively. Water in the concrete segment of Stream *Ha2* had lower readings in comparison (10 $\mu\text{S}/\text{cm}$  and 0mg/L). This could suggest that the water released from Bukit Kalang is of high electrical conductivity. Higher readings were only obtained at downstream Streams *Ha2* and *Ha* because water would have flowed very rapidly down the steep, concrete canal. It would then subsequently pool and deposit its load at the slower flowing forest streams with gentler gradients.

#### 4B.2.5 “I” streams

The upstream segments of Stream *I* comprises forest country streams. Downstream, Stream *I* transitions to a wetland forest stream type (*Figure 18*), continuing till it enters a marshland at Golf Link. It subsequently re-enters a wetland forest and eventually flows into MacRitchie Reservoir. It must be noted that the forest bounded by Rifle Range Link and Sime Track is currently utilized on a frequent basis. There were several trails in the forest and some were observed to cut across the streams.

**Figure 18:** *I Wetland Forest Stream*



Streams *Ic* and *Ic4* are well-shaded, forest country streams (*Figure 19* and *Figure 20*) Riparian vegetation at both streams is largely dominated by trees and ferns. Both streams had muddy bottoms but Stream *Ic4* had a higher proportion of leaf litter. Water flow at Stream *Ic4* was slow and almost trickling whereas Stream *Ic* had a slow but steadier flow.

**Figure 19:**      *Stream Ic*





**Figure 20:**      **Stream Ic4 (Wider stream width and relatively lesser leaf litter than Ic)**



Part of Stream I runs beneath Sime Track, under a concrete bridge structure similar to the one under which *Hd* pool at Sime Track was found. Dominant vegetation along the stream bank observed was *Dillenia suffruticosa*, and fish and odonates were spotted in and around the stream. There was a large pile of floating trash comprising Styrofoam pieces and plastic bottles. The bridge structure and trash can be observed in *Figure 21*.



**Figure 21:**      *Trash at Stream I under Sime Track*



After passing under Sime Track, Stream I proceeds towards Golf Link Trail and passes below a bridge built over the trail (Figure 22). During heavy rain, Stream I typically floods and overflows across this bridge. After the bridge, Stream I runs parallel to the boardwalk at Golf Link (Figure 26). Stream I was observed to flow over a larger area and a distinct flow channel could not be discerned. The soil in the area was observed to be heavily waterlogged.

**Figure 22:**      *Section of Stream I that passes under Golf Link Trail*



**Figure 23:**      *Stream I along Golf Link Boardwalk*



*Ia4* was viewed from the trail that follows the MacRitchie Pipeline and substrate appeared to be sandy (Figure 24).

**Figure 24:**      *Stream Ia4 viewed from elevated vantage point*



#### 4B.2.6 “Fa” stream

Stream *Fa4* was verified at two points approximately 400m apart. In general, Stream *Fa4* is characteristic of a closed canopy, shaded forest stream (Figure 25). The upper reach of Stream *Fa4* was observed to possess a muddy substratum. Water was still and choked with large amounts of leaf litter. The stream also seemed to be partially blocked by mature *Pandanus* sp.



**Figure 25:**      **Stream Fa4 (At upper sampling point)**



The downstream section of Stream *Fa4* had slightly faster water flow with relatively lower amounts of leaf litter (*Figure 26*). Some fish were observed but their identities could not be ascertained. Riparian vegetation was observed to be dominated by *Pandanus* sp.

**Figure 26:**      **Stream Fa4 (At lower sampling point)**



#### 4B.2.7 “Cc” Stream and Stream near Chemperai Hut

Stream Cc was observed to be a very narrow and indistinct channel. The verification exercise began from the indicated origin of Stream Cc (Murphy 1997) but water was only observed further downstream and it appeared to be a stagnant pool (Figure 27). The channel was clogged with leaf litter. A few paces downstream revealed that Stream Cc opened up abruptly to MacRitchie Reservoir (Figure 28). As such, it is uncertain whether Stream Cc sees intermittent flow, or is an indentation of the shoreline of MacRitchie Reservoir.

**Figure 27:** Stream Cc outlet to MacRitchie Reservoir





**Figure 28:**      *MacRitchie Reservoir as viewed from Stream Cc*



The stream near Chemperai Hut was visited after a heavy rainfall event. The stream was observed running across the trail, past Chemperai Hut and towards MacRitchie Reservoir. Stepping stones had been placed across the trail to enable people to cross the stream (*Figures 29 & 30*). Stream substrate was observed to be largely silty with some sand and leaf litter. The stream environment on both sides of the trail looked distinctly different. The upstream reach of the stream was observed to have flooded the surrounding forest whereas downstream past Chemperai Hut the stream ran in a single channel (*Figures 31*).



**Figure 29:**      *Chemperai Hut Stream Upstream*



**Figure 30:**      *Stepping stones across trail*



**Figure 31:**      *Chemperai Hut Stream Downstream*



#### Annex 4.0

### Surface Water Survey Laboratory Results





ALS Technichem (S) Pte Ltd  
121 Genting Lane #04-01  
ALS Building Singapore 349572  
T: +65 6589 0118 F: +65 6283 9689  
Co Reg No. 198403076R  
[www.alsglobal.com](http://www.alsglobal.com)

## REPORT

OUR REF NO : ATS/ENV/P8/1-13/15/pl

DATE : 11 February, 2015

Page 1 of 4

COMPANY : Environmental Resources Management (S) Pte Ltd  
120 Robinson Road #10-01,  
Singapore 068913

DATE ANALYSED : 21, 26 & 28 January, 2015

DATE COMPLETED : 05 February, 2015

SAMPLE DESCRIPTION : Fourteen samples of water were sampled by ALS representatives  
on 21, 26 & 28 January, 2015 with references :-

Project ID : 0256660/C1001

Sample ID	Date
SW101_R2	28 Jan 2015 @1415hrs
SW102_R2	26 Jan 2015 @1318hrs
SW103_R2	26 Jan 2015 @1309hrs
SW104_R2	28 Jan 2015 @1201hrs
SW105_R2	26 Jan 2015 @1300hrs
SW106_R2	26 Jan 2015 @1336hrs
SW107_R2	26 Jan 2015 @1348hrs
SW108_R2	28 Jan 2015 @1112hrs
SW109_R2	21 Jan 2015 @0917hrs
SW201_R2	21 Jan 2015 @0937hrs
SW201_R2 Dup	21 Jan 2015 @0950hrs
SW202_R2	21 Jan 2015 @0945hrs
SW203_R2	21 Jan 2015 @1035hrs
SW204_R2	21 Jan 2015 @1020hrs





ALS Technichem (S) Pte Ltd  
121 Genting Lane #04-01  
ALS Building Singapore 349572  
T: +65 6589 0118 F: +65 6283 9689  
Co Reg No. 198403076R  
www.alsglobal.com

OUR REF NO : ATS/ENV/P8/1-13/15/pl

11 February, 2015

COMPANY : Environmental Resources Management (S) Pte Ltd

Page 2 of 4

RESULTS : On analysis, the following results were obtained:-

Tests	APHA Method 22 <sup>nd</sup> Ed., 2012	Level Of Reporting	Sample Markings/Results			
			SW101_R2	SW102_R2	SW103_R2	SW104_R2
Total Suspended Solid, mg/L	2540D	5	<5	<5	<5	6
Oil & Grease (Total), mg/L	5520B	5	<5	5	6	<5
Oil & Grease (Hydrocarbon),mg/L	5520F	5	<5	<5	<5	<5
Dissolved Oxygen, mg/L	4500 OG	0.1	7.2	7.43	6.61	7.4
Chemical Oxygen Demand, mg/L	5220C	1	5	2	2	12
Biochemical Oxygen Demand, mg/L (5 days @20°C)	5210B	2	4	<2	<2	7
Total Dissolved Solids, mg/L	2540C	5	58	27	27	166
pH @25 deg C	4500 H+B	0.1	6.2	6.2	6.3	7.0
Temperature, °C	2550B	0.1	23.0	25.5	25.5	23.0
Turbidity, NTU	2130B	0.1	4.4	5.6	9.4	1.9
Total E. Coli Count, MPN/100ml sample	9221E/F	1	<1	<1	124	<1

Tests	APHA Method 22 <sup>nd</sup> Ed., 2012	Level Of Reporting	Sample Markings/Results			
			SW105_R2	SW106_R2	SW107_R2	SW108_R2
Total Suspended Solid, mg/L	2540D	5	20	19	<5	<5
Oil & Grease (Total), mg/L	5520B	5	<5	<5	<5	<5
Oil & Grease (Hydrocarbon),mg/L	5520F	5	<5	<5	<5	<5
Dissolved Oxygen, mg/L	4500 OG	0.1	7.16	7.13	8.22	7.2
Chemical Oxygen Demand, mg/L	5220C	1	6	6	3	6
Biochemical Oxygen Demand, mg/L (5 days @20°C)	5210B	2	<2	<2	<2	5
Total Dissolved Solids, mg/L	2540C	5	49	36	108	35
pH @25 deg C	4500 H+B	0.1	6.3	6.4	7.1	6.7
Temperature, °C	2550B	0.1	26.5	27.0	27.5	22.0
Turbidity, NTU	2130B	0.1	11.0	12.0	4.1	3.5
Total E. Coli Count, MPN/100ml sample	9221E/F	1	90	85	137	25







ALS Technichem (S) Pte Ltd  
121 Genting Lane #04-01  
ALS Building Singapore 349572  
T: +65 6589 0118 F: +65 6283 9689  
Co Reg No. 198403076R  
www.alsglobal.com

OUR REF NO : ATS/ENV/P8/1-13/15/pl

11 February, 2015

COMPANY : Environmental Resources Management (S) Pte Ltd

Page 3 of 4

RESULTS : On analysis, the following results were obtained:-

Tests	APHA Method 22 <sup>nd</sup> Ed., 2012	Level Of Reporting	Sample Markings/Results		
			SW109_R2	SW201_R2	SW201_R2 Dup
Total Suspended Solid, mg/L	2540D	5	<5	10	10
Oil & Grease (Total), mg/L	5520B	5	<5	<5	<5
Oil & Grease (Hydrocarbon),mg/L	5520F	5	<5	<5	<5
Dissolved Oxygen, mg/L	4500 OG	0.1	7.97	6.90	6.90
Chemical Oxygen Demand, mg/L	5220C	1	<1	5	5
Biochemical Oxygen Demand, mg/L (5 days @20°C)	5210B	2	<2	4	4
Total Dissolved Solids, mg/L	2540C	5	67	48	46
pH @25 deg C	4500 H+B	0.1	6.5	6.8	6.8
Temperature, °C	2550B	0.1	27.5	27.0	26.5

Tests	APHA Method 22 <sup>nd</sup> Ed., 2012	Level Of Reporting	Sample Markings/Results		
			SW202_R2	SW203_R2	SW204_R2
Total Suspended Solid, mg/L	2540D	5	7	<5	<5
Oil & Grease (Total), mg/L	5520B	5	<5	<5	<5
Oil & Grease (Hydrocarbon),mg/L	5520F	5	<5	<5	<5
Dissolved Oxygen, mg/L	4500 OG	0.1	7.68	8.05	8.25
Chemical Oxygen Demand, mg/L	5220C	1	6	2	<1
Biochemical Oxygen Demand, mg/L (5 days @20°C)	5210B	2	3	<2	<2
Total Dissolved Solids, mg/L	2540C	5	44	69	55
pH @25 deg C	4500 H+B	0.1	7.0	7.1	7.1
Temperature, °C	2550B	0.1	29.0	29.5	29.0

Remarks : Duplicate sample was carried out on SW201\_R2







ALS Technichem (S) Pte Ltd  
121 Genting Lane #04-01  
ALS Building Singapore 349572  
T: +65 6589 0118 F: +65 6283 9689  
Co Reg No. 198403076R  
[www.alsglobal.com](http://www.alsglobal.com)

OUR REF NO : ATS/ENV/P8/1-13/15/pl

11 February, 2015

COMPANY : Environmental Resources Management (S) Pte Ltd

Page 4 of 4

#### QA/QC Results

- a) A duplicate analysis was performed on one of the water samples (SW201\_R2) to gauge test differences within samples.
- b) Method blank was run in each batch of analysis to check background interference, if any.
- c) A summarized QC report on recoveries of Lab Control Samples(LCS) and Method Blank

Test(units in mg/L)	Method Blank
Oil & Grease (Total)	<5
Oil & Grease (Hydrocarbon)	<5
Chemical Oxygen Demand	<1
Biochemical Oxygen Demand (5 days @ 20°C)	<2
Total Suspended Solid	<5
Total Dissolved Solid	<5

Test	LCS, % recovery	Acceptance Criteria, %
Oil & Grease	92	75-125
Chemical Oxygen Demand	100	75-125
Biochemical Oxygen Demand (5 days @ 20deg C)	97	75-125
pH	100	90-110
Turbidity	100	95-105

ALS TECHNICHEM (S) PTE LTD

TAN TEONG HUAT  
B.Sc., M.Sc., MSNIC.



ALS Technichem (S) Pte Ltd  
121 Genting Lane #04-01  
ALS Building Singapore 349572  
T: +65 6589 0118 F: +65 6283 9689  
Co Reg No. 198403076R  
[www.alsglobal.com](http://www.alsglobal.com)

## REPORT

OUR REF NO : ATS/ENV/P8/49-61/14/pl

DATE : 31 December, 2014

Page 1 of 4

COMPANY : Environmental Resources Management (S) Pte Ltd  
120 Robinson Road #10-01,  
Singapore 068913

DATE ANALYSED : 24 & 26 November, 2014, 03 & 24 December, 2014

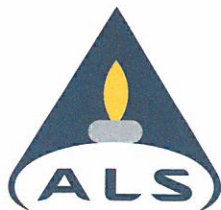
DATE COMPLETED : 03, 11 & 31 December, 2014

SAMPLE DESCRIPTION : Thirteen samples of water were sampled by ALS representatives  
on 24, 26 November, 2014 & 03 & 31 December, 2014 with references :-

Project ID : 0256660/C1001

Sample ID	Date
SW101_R1	26 Nov 2014 @1500hrs
SW102_R1	24 Nov 2014 @1140hrs
SW103_R1	24 Nov 2014 @1150hrs
SW104_R1	24 Nov 2014 @1119hrs
SW105_R1	24 Nov 2014 @1106hrs
SW106_R1	26 Nov 2014 @1300hrs
SW107_R1	26 Nov 2014 @1248hrs
SW108_R1	26 Nov 2014 @1212hrs
SW109_R1	24 Dec 2014 @1015hrs
SW201_R1	03 Dec 2014 @1110hrs
SW201_R1 Dup	03 Dec 2014 @1110hrs
SW202_R1	03 Dec 2014 @1130hrs
SW203_R1	03 Dec 2014 @1035hrs
SW204_R1	03 Dec 2014 @1050hrs





ALS Technichem (S) Pte Ltd  
121 Genting Lane #04-01  
ALS Building Singapore 349572  
T: +65 6589 0118 F: +65 6283 9689  
Co Reg No. 198403076R  
[www.alsglobal.com](http://www.alsglobal.com)

OUR REF NO : ATS/ENV/P8/49-61/14/pl

31 December, 2014

COMPANY : Environmental Resources Management (S) Pte Ltd

Page 2 of 4

RESULTS : On analysis, the following results were obtained:-

Tests	APHA Method 22 <sup>nd</sup> Ed., 2012	Level Of Reporting	Sample Markings/Results			
			SW101_R1	SW102_R1	SW103_R1	SW104_R1
Total Suspended Solid, mg/L	2540D	5	6	<5	<5	9
Oil & Grease (Total), mg/L	5520B	5	<5	<5	<5	<5
Oil & Grease (Hydrocarbon),mg/L	5520F	5	<5	<5	<5	<5
Dissolved Oxygen, mg/L	4500 OG	0.1	6.95	7.20	6.78	7.83
Chemical Oxygen Demand, mg/L	5220C	1	7	4	6	8
Biochemical Oxygen Demand, mg/L (5 days @20°C)	5210B	2	5	<2	<2	5
Total Dissolved Solids, mg/L	2540C	5	51	33	31	175
pH @25 deg C	4500 H+B	0.1	6.5	6.7	6.5	7.2
Temperature, °C	2550B	0.1	24.0	25.5	26.5	30.5
Turbidity, NTU	2130B	0.1	9.2	5.1	6.0	4.0
Total E. Coli Count, MPN/100ml sample	9221E/F	1	94	17	17	9.3

Tests	APHA Method 22 <sup>nd</sup> Ed., 2012	Level Of Reporting	Sample Markings/Results			
			SW105_R1	SW106_R1	SW107_R1	SW108_R1
Total Suspended Solid, mg/L	2540D	5	45	7	<5	<5
Oil & Grease (Total), mg/L	5520B	5	<5	<5	<5	<5
Oil & Grease (Hydrocarbon),mg/L	5520F	5	<5	<5	<5	<5
Dissolved Oxygen, mg/L	4500 OG	0.1	7.29	6.96	8.19	6.74
Chemical Oxygen Demand, mg/L	5220C	1	11	8	3	7
Biochemical Oxygen Demand, mg/L (5 days @20°C)	5210B	2	<2	4	2	4
Total Dissolved Solids, mg/L	2540C	5	121	40	79	32
pH @25 deg C	4500 H+B	0.1	6.7	6.7	7.6	6.7
Temperature, °C	2550B	0.1	29.5	23.0	33.0	30.1
Turbidity, NTU	2130B	0.1	7.1	4.2	1.1	8.7
Total E. Coli Count, MPN/100ml sample	9221E/F	1	540	23	17	33







ALS Technichem (S) Pte Ltd  
121 Genting Lane #04-01  
ALS Building Singapore 349572  
T: +65 6589 0118 F: +65 6283 9689  
Co Reg No. 198403076R  
www.alsglobal.com

OUR REF NO : ATS/ENV/P8/49-61/14/pl

31 December, 2014

COMPANY : Environmental Resources Management (S) Pte Ltd

Page 3 of 4

RESULTS : On analysis, the following results were obtained:-

Tests	APHA Method 22 <sup>nd</sup> Ed., 2012	Level Of Reporting	Sample Markings/Results		
			SW109_R1	SW201_R1	SW201_R1 Dup
Total Suspended Solid, mg/L	2540D	5	<5	24	23
Oil & Grease (Total), mg/L	5520B	5	<5	<5	<5
Oil & Grease (Hydrocarbon),mg/L	5520F	5	<5	<5	<5
Dissolved Oxygen, mg/L	4500 OG	0.1	7.94	7.35	7.42
Chemical Oxygen Demand, mg/L	5220C	1	9	11	11
Biochemical Oxygen Demand, mg/L (5 days @20°C)	5210B	2	8	3	3
Total Dissolved Solids, mg/L	2540C	5	55	53	51
pH @25 deg C	4500 H+B	0.1	6.6	7.0	7.0
Temperature, °C	2550B	0.1	31.1	26.0	26.0
Turbidity, NTU	2130B	0.1	-	-	-
Total E. Coli Count, MPN/100ml sample	9221E/F	1	-	-	-

Tests	APHA Method 22 <sup>nd</sup> Ed., 2012	Level Of Reporting	Sample Markings/Results		
			W202_R1	SW203_R1	SW204_R1
Total Suspended Solid, mg/L	2540D	5	<5	<5	<5
Oil & Grease (Total), mg/L	5520B	5	<5	<5	<5
Oil & Grease (Hydrocarbon),mg/L	5520F	5	<5	<5	<5
Dissolved Oxygen, mg/L	4500 OG	0.1	7.98	7.80	7.88
Chemical Oxygen Demand, mg/L	5220C	1	4	5	9
Biochemical Oxygen Demand, mg/L (5 days @20°C)	5210B	2	3	3	3
Total Dissolved Solids, mg/L	2540C	5	54	113	118
pH @25 deg C	4500 H+B	0.1	7.0	7.1	7.1
Temperature, °C	2550B	0.1	29.0	31.5	30.0
Turbidity, NTU	2130B	0.1	-	-	-
Total E. Coli Count, MPN/100ml sample	9221E/F	1	-	-	-

Remarks : Duplicate sample was carried out on SW201\_R1





ALS Technichem (S) Pte Ltd  
121 Genting Lane #04-01  
ALS Building Singapore 349572  
T: +65 6589 0118 F: +65 6283 9689  
Co Reg No. 198403076R  
[www.alsglobal.com](http://www.alsglobal.com)

OUR REF NO : ATS/ENV/P8/49-61/14/pl

31 December, 2014

COMPANY : Environmental Resources Management (S) Pte Ltd

Page 4 of 4

#### QA/QC Results

- a) A duplicate analysis was performed on one of the water samples (SW201\_R1) to gauge test differences within samples.
- b) Method blank was run in each batch of analysis to check background interference, if any.
- c) A summarized QC report on recoveries of Lab Control Samples(LCS) and Method Blank

Test(units in mg/L)	Method Blank
Oil & Grease (Total)	<5
Oil & Grease (Hydrocarbon)	<5
Chemical Oxygen Demand	<1
Biochemical Oxygen Demand (5 days @ 20°C)	<2
Total Suspended Solid	<5
Total Dissolved Solid	<5

Test	LCS, % recovery	Acceptance Criteria, %
Oil & Grease	92	75-125
Chemical Oxygen Demand	86	75-125
Biochemical Oxygen Demand (5 days @ 20deg C)	92	75-125
pH	101	90-110
Turbidity	101	95-105

ALS TECHNICHEM (S) PTE LTD

PANSY TEO B.Y.  
B.Sc., M.Sc., MSNIC.

Annex 5.0

## Acoustics Survey Results



Noise



**ALS Technichem (S) Pte Ltd**

121 Genting Lane #04-01, Singapore 349572  
Tel: (65) 6589 0118 Fax : (65) 6283 9689 E-mail: [alssg@alsglobal.com](mailto:alssg@alsglobal.com)  
Co. Reg No. 198403076R

Our Ref: ATS/IH/23/15TTH

Date: 10 March 2015

**NOISE MONITORING REPORT**

**For**

**ENVIRONMENTAL RESOURCES MANAGEMENT (S) PTE LTD  
120 ROBINSON ROAD #10-01,  
SINGAPORE 068913**

---

Chai Wai Hang  
Senior Field Chemist

---

Tan Teong Huat  
Senior Manager  
BSc, MSc (SHE Tech.), MSNIC

*This Report shall not be reproduced except in full without prior approval of Management  
This Report may not be used for advertising purposes*

## EXECUTIVE SUMMARY

ALS Technichem (S) Pte Ltd has carried out two rounds of noise monitoring around Central Catchment Nature Reserve (MacRitchie) Singapore. The first round of monitoring started on 24<sup>th</sup> November to 26<sup>th</sup> December 2014 and followed by the second round of monitoring which carried out on 16<sup>th</sup> January to 2<sup>nd</sup> February 2015. The objective of this monitoring is to establish a baseline and to determine whether the noise level at the selected points is in compliance with the limits as per stipulated in the National Environment Agency's (NEA) Environmental Protection & Management Act – Environmental Protection & Management (Control of Noise at Construction Sites) Regulations, 2011 Revised Ed.

In general, the results obtained at all monitoring points were in compliance with the National Environment Agency's (NEA) Environmental Protection & Management Act – Environmental Protection & Management (Control of Noise at Construction Sites) Regulations, 2011 Revised Ed except periods listed in the following tables:

	Category of Noise Regulated Period	Period	NL101	NL102	NL103
<b>First round of survey (R1)</b>	*12 hours	7am-7pm	Day 1 - 7	Day 1,2,3 & 6	Day 1,3 & 6
		7pm-7am	Day 1 - 7	Day 1,2,4,5,6 & 7	Day 1,2 & 7
	*5 Minutes	7am-7pm	-	-	-
		7pm-10pm	Day 1 - 7	Day 1,2,4,5 & 7	Day 1,2 & 7
		10pm-7am	Day 1 - 7	Day 7	-
	*1 hour	7am-7pm	N.A	N.A	N.A
		7pm-7am	N.A	N.A	N.A
<b>Second round of survey (R2)</b>	*12 hours	7am-7pm	Day 1,4,5,6 & 7	-	-
		7pm-7am	Day 1 - 7	Day 1,2,5 & 6	Day 1,3 & 6
	*5 Minutes	7am-7pm	-	-	-
		7pm-10pm	Day 1 - 7	Day 2	Day 1
		10pm-7am	Day 1 - 7	-	-
	*1 hour	7am-7pm	N.A	N.A	N.A
		7pm-7am	N.A	N.A	N.A
<b>*Limit of Affected Hospitals, schools, institutions of higher learning, homes for the aged sick, etc.</b>					



Category of Noise Regulated Period	Period	Round 1 of Survey	Round 2 of Survey
		NL104_R1	NL104_R2
*12 hours	7am-7pm	-	-
	7pm-7am	-	-
*5 Minutes	7am-7pm	-	-
	7pm-10pm	-	-
	10pm-7am	-	-
*1 hour	7am-7pm	N.A	N.A
	7pm-7am	N.A	N.A
<b>*Limit of Affected Buildings (other than those above)</b>			

	Category of Noise Regulated Period	Period	NL201	NL202	NL203
First round of survey (R1)	*12 hours	7am-7pm	Day 1,3,4,5 & 7	-	Day 1-7
		7pm-7am	N.A	N.A	N.A
	*5 Minutes	7am-7pm	Day 3	-	Day 5 & 6
		7pm-10pm	Day 1-7	Day 2, 4 & 5	Day 1-7
		10pm-7am	Day 1-7	Day 1-7	Day 1-7
	*1 hour	7am-7pm	N.A	N.A	N.A
		7pm-7am	Day 1,2,4,5,6 & 7	Day 1,2,3,4, 6 & 7	Day 1,2,3,4,5 & 7
Second round of survey (R2)	*12 hours	7am-7pm	Day 1,4,5,6 & 7	-	Day 1-7
		7pm-7am	N.A	N.A	N.A
	*5 Minutes	7am-7pm	-	-	Day 2 (except 7am-7pm) & 3
		7pm-10pm	Day 1-7	Day 2 & 3	Day 1-7
		10pm-7am	Day 1-7	Day 1-7	Day 1-7
	*1 hour	7am-7pm	N.A	N.A	N.A
		7pm-7am	Day 1,2,4,5,6 & 7	Day 1(except 2000-2200), Day 2 (except 1900-2200), Day4(except 2000-2200)& (0400-0500), Day5(except 2000-2200)& (0300-0500) Day6 & Day 7	Day 1,2,4,5,6 & 7
*Limit of Affected Residential Buildings Located Less Than 150m From Construction site where the noise is being emitted					

From the graphs, we can observe the daily noise pattern of 7 days continuous of monitoring at all points. As NL101, NL201, NL202 and NL203 were located near to the major roadside/expressway hence the major noise source for these locations is mainly from vehicular noise. Therefore, similar graph patterns are observed from these four locations. And among the four locations, NL201 and NL203 have shown higher noise level and this is probably due to high traffic volume from these major roads (as per tabulated in Table 4 and Table 62).

On another note, NL102 & NL103 (which are located inside the Central Catchment Nature Reserve) and NL104 (which is located at Island Club Road) have shown fluctuation of noise pattern at the period of 7am-7pm. And this is probably due to human activities (jogging and jungle tracking). Other activities such as army shooting training and army aircraft passing over head have also been observed during site checking for NL102 and NL103. In addition, the predominant noise source for NL104 would probably be the vehicular noise along the Island Club Road. Insect noise is probably the main noise source during the period of 7pm-7am and a quite constant of noise pattern was observed during this period of time for these three locations.

In general, noise level obtained from Round 1 (monitoring period: Nov 14-Dec 14) is slightly higher than Round 2 (monitoring period: Jan 15-Feb 15) at most locations. In our opinion, this is probably due to the rainfall season during December period.

In conclusion, monitoring of the baseline noise level of these points is recommended when the construction work is commenced. This exercise will help to determine the presence of any nuisance noise contribution on their daily operations and activities to their immediate neighbouring occupants on site.

## LIST OF CONTENT

### Table of Contents

EXECUTIVE SUMMARY.....	1-3
LIST OF CONTENT .....	4
LIST OF TABLE.....	5
LIST OF FIGURE.....	6
LIST OF ABBREVIATION .....	6
1.0 INTRODUCTION .....	7
1.1 Objectives .....	7
1.2 Scope of Work .....	7
2.0 SAMPLING AND FIELD MONITORING .....	9
2.1 Sampling Equipment.....	9
2.2 Sampling Locations.....	9
2.3 Detail of Noise Monitoring Point (Round 1) .....	3
3.0 SAMPLING METHODOLOGY .....	15
3.1 Calibration of Sound Level Meter .....	15
4.0 LOCATION INDEX / SAMPLING SCHEDULE / TEST RESULTS(Round 1) .....	16
5.0 DETAIL OF NOISE MONITORING POINT (Round 2).....	127
6.0 LOCATION INDEX / SAMPLING SCHEDULE / TEST RESULTS(Round 2).....	129
7.0 EVALUATION & DISCUSSION.....	243
8.0 REFERENCES .....	243

APPENDIX 1: Calibration Certificate of Field Equipment

APPENDIX 2: Site Photo



## LIST OF TABLE

Table 1: Maximum permitted noise level for construction work commenced after 1st October 2007.....	8
Table 2: Identified noise sources near to the monitoring points (Round 1).....	133
Table 3: Traffic volume for peak and off peak hour (Round 1).....	144
Table 4: Traffic volume for peak and off peak hour (Round 1).....	144
Table 5: Summary of sound level meter setting .....	155
Table 6-9: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 12 hours (Round 1) .....	166-18
Table 10-12: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 5 minutes (Round 1).....	19-21
Table 13-61: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour (Round 1).....	22-70
Table 62: Summary of results for short term noise level measurement ( $L_{max}$ , $L_{Aeq}$ & $L_{90}$ ) over 15 minutes (Round 1) .....	120
Table 63-69: Summary of noise level (Round 1).....	121-127
Table 70: Identified noise sources near to the monitoring points (Round 2).....	1327
Table 71: Traffic volume for peak and off peak hour (Round 2).....	148
Table 72: Traffic volume for peak and off peak hour (Round 2).....	148
Table 73-76: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 12 hours (Round 2) .....	1629-131
Table 77-79: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 5 minutes (Round 2).....	132-134
Table 80-128: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour (Round 2) .....	135-183
Table 129: Summary of results for short term noise level measurement ( $L_{max}$ , $L_{Aeq}$ & $L_{90}$ ) over 15 minutes (Round 2).....	233
Table 130-136: Summary of noise level (Round 2) .....	234-240

## LIST OF FIGURE

	Page
Figure 1-3: Sampling Location	9-11
Figure 4-52: Daily noise level measured at NL101,102,103,104, 201, 202 & 203 (Round 1)	71-119
Figure 53-101: Daily noise level measured at NL101,102,103,104, 201, 202 & 203 (Round 2)	184-232

## LIST OF ABBREVIATION

dB(A)

Decibel A

## 1.0 INTRODUCTION

ALS TECHNICHEM (S) PTE LTD (hereafter as “ALS”) has been appointed as the contractor to perform the Noise Monitoring around the Central Catchment Natural Reserve (MacRitchie) Singapore, as request by Environmental Resources Management (S) Pte Ltd (hereafter as “ERM”).

### 1.1 Objectives

The objective of the monitoring is to determine whether the baseline noise levels emitted around the Central Catchment Natural Reserve (MacRitchie) Singapore was in compliance with the limits stipulated in the National Environment Agency's (NEA) Environmental Protection & Management Act – Environmental Protection & Management (Control of Noise at Construction Sites) Regulations, 2011 Revised Ed. The information can be used as a point of reference for future environmental monitoring and decision-making.

### 1.2 Scope of Work

The scope of works for the noise monitoring included:

1. Preparation of Noise Monitoring Plan;
2. Noise Monitoring station setup and sampling at selected seven sampling points, namely Point NL101-NL104 and NL201-NL203 (sampling point was dictated by ERM);
3. Determination of equivalent noise level ( $L_{Aeq}$ ) over a period of 24 hour period on a 5 minutes interval as a baseline to be conducted over a week. Measured noise level were analyzed according to regulatory limit:
  - Two specified period according to the Part I, Second Schedule, Maximum Permissible Noise Levels For Construction Work Commenced On or After 1<sup>st</sup> October 2007, National Environment Agency's (NEA) Environmental Protection & Management Act – Environmental Protection & Management (Control of Noise at Construction Sites) Regulations, 2011 Revised Ed.
  - Three specified period according to the Part II, Second Schedule, Maximum Permissible Noise Levels For Construction Work Commenced On or After 1<sup>st</sup> October 2007, National Environment Agency's (NEA) Environmental Protection & Management Act – Environmental Protection & Management (Control of Noise at Construction Sites) Regulations, 2011 Revised Ed.
  - Three specified period according to the Part III, Second Schedule, Maximum Permissible Noise Levels For Construction Work Commenced On or After 1<sup>st</sup> October 2007, National Environment Agency's (NEA) Environmental Protection & Management Act – Environmental Protection & Management (Control of Noise at Construction Sites) Regulations, 2011 Revised Ed.
4. Determination of noise level ( $L_{Aeq}$ ,  $L_{max}$  and  $L_{90}$ ) over a period of 15 minutes at NL102, NL201, NL202 and NL203 monitoring points on a weekday and weekend (Saturday);
5. Assessing the noise level against the adopted standard; and
6. Providing a report outlining the findings and results of the study.



### 1.2.1 Monitoring Requirement

Noise is measured in decibel (dB) with reference to the frequency of noise, 'A' weighting was selected for this entire monitoring. The 'FAST' response was selected to measure the noise levels. It is used for the measurement of time-varying sounds with a response time of 0.125 seconds which is similar to human ear response.

Table 1 lists the maximum permitted noise level of specified period based on type of affected buildings as per Second Schedule of National Environment Agency's (NEA) Environmental Protection & Management Act – Environmental Protection & Management (Control of Noise at Construction Sites) Regulations, 2011 Revised Ed.

**Table 1: Maximum permitted noise level for construction work commenced after 1<sup>st</sup> October 2007**

PART I			
Type of affected Buildings	*Maximum permitted noise level in decibels (A)		
	7am – 7pm	7pm – 7am	
Hospital, Schools, Institutions of higher learning, homes for the aged sick etc.	60	50	
Residential buildings located less than 150m from the construction site where the noise is being emitted	75	-	
Buildings (other than above)	75	65	
*reckoned as an equivalent continuous noise level over a period of 12 hours			
PART II			
	7am – 7pm	7pm – 10pm	10pm – 7am
Hospital, Schools, Institutions of higher learning, homes for the aged sick etc.	-	-	-
Residential buildings located less than 150m from the construction site where the noise is being emitted	-	65	55
Buildings (other than above)	-	-	-
*reckoned as an equivalent continuous noise level over a period of 1 hour			
PART III			
	7am – 7pm	7pm – 10pm	10pm – 7am
Hospital, Schools, Institutions of higher learning, homes for the aged sick etc.	75	55	55
Residential buildings located less than 150m from the construction site where the noise is being emitted:- (i) on Monday to Saturday	90	70	55
(ii) on Sundays & Public Holiday	75	55	55
Buildings (other than above)	90	70	70
*reckoned as an equivalent continuous noise level over a period of 5 minutes			

## 2.0 SAMPLING AND FIELD MONITORING

ALS has performed all the required sampling for noise level monitoring at selected locations.

### 2.1 Sampling Equipment

A portable Quest SoundPro SP DL-1 Sound Level Meter (Class 1) was used to measure noise levels of the selected points. This instrument complies with the standards as specified in the International Electrotechnical Commission Publication 651 (Class 1) and Publication 804 (Type 1).

### 2.2 Sampling Locations

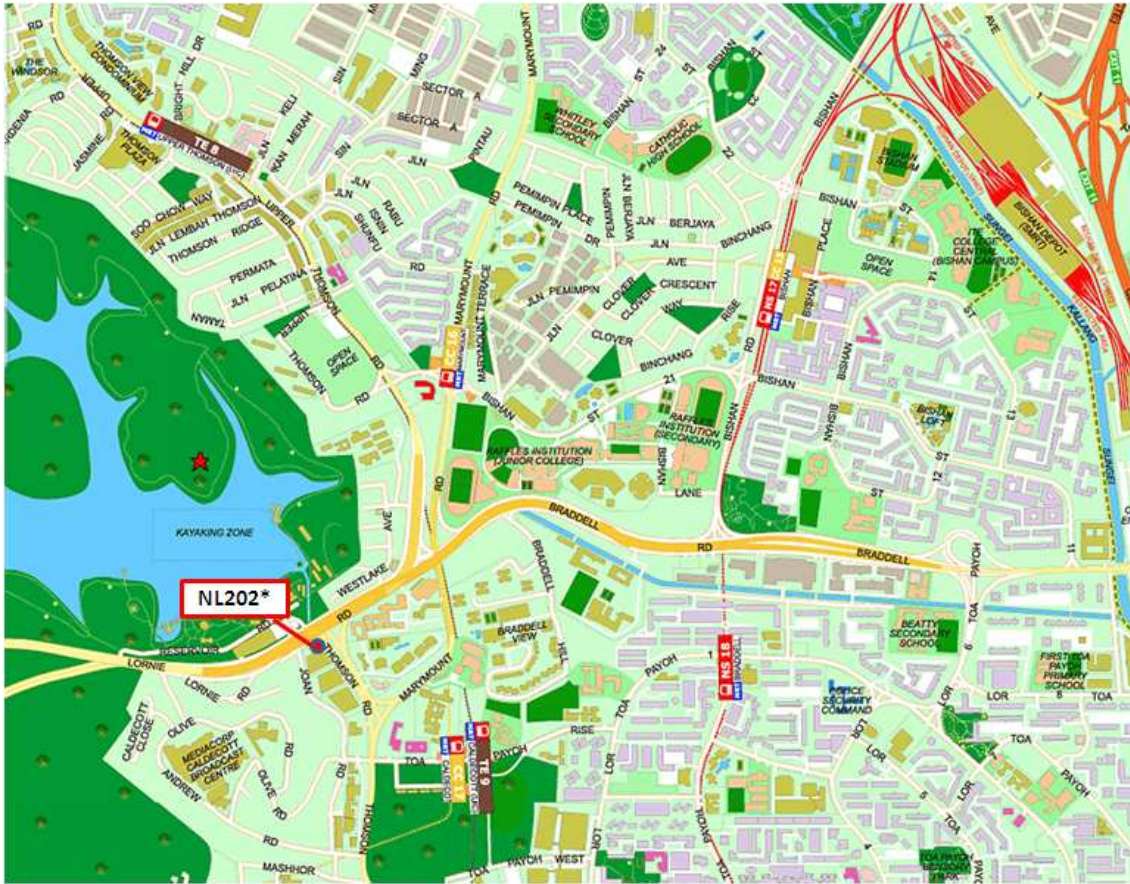
Figures 1 – 3 illustrate the sampling locations for this monitoring program.



**Figure 1: Sampling Locations**

Remarks: \* Denote Human/Traffic counts and short-term measurement were taken





**Figure 3: Sampling Locations**

Remarks: \* Denote Human/Traffic counts and short-term measurement were taken



# **Noise Monitoring (First Round of Survey)**

Date of Survey: 24<sup>th</sup> November to 26<sup>th</sup> December 2014

### 2.3 Detail of Noise Monitoring Point

There were a total of seven noise monitoring points have been selected, namely NL 101\_R1-104\_R1 & NL 201\_R1-203\_R1. The monitoring points were dictated by ERM. During the noise measurement, it was noted a range of possible noise sources at the respective monitoring points that may contribute to the overall ambient noise levels. The detail of the monitoring points and identified noise sources near to the monitoring points are listed in Table 2 on the day of monitoring. In addition, Table 3&4 lists the number of vehicles and motorbikes which traveled along the respective areas of concerned during the 2 periods (peak and off peak hours) for each individual location on selected date is listed as below.

**Table 2: Identified noise sources near to the monitoring points**

Monitoring Point	Date		Time (hr)		Noise Sources
	Start	Stop	Start	Stop	
NL101_R1	17/12/14	24/12/14	0904	0856	Traffic noise (vehicles) from PIE, Insect noise
NL102_R1	24/11/14	01/12/14	1100	1100	Insect noise, human activity, army shooting training, army aircraft passing over head.
NL103_R1	24/11/14	01/12/14	1230	1230	Insect noise, army aircraft passing over head
NL104_R1	19/12/14	26/12/14	1700	1700	Traffic noise (vehicles) from Island club road, Insect Noise
NL201_R1	19/12/14	26/12/14	1629	1627	Traffic noise (vehicles) from Upper Thomson road.
NL202_R1	03/12/14	12/12/14	1100	1057	Traffic noise (vehicles) from Thomson Road and Lornie road, noise from water canal (after raining).
NL203_R1	09/12/14	16/12/14	1204	1159	Traffic noise (vehicles) from Lornie road

**Table 3: Human Traffic volume for peak and off peak hour**

Location	Weekend / Weekday	Peak Hour			Off Peak hour		
		Human	Heavy Vehicles	Motor-bikes	Human	Heavy Vehicles	Motor-bikes
NL102_R1	Weekend	18	NA	NA	2	NA	NA
	Weekday	17	NA	NA	0	NA	NA

Remarks:

- a) Peak Hour - (9am to 11am) & (3pm to 5pm) for weekend  
- After 3pm for weekday
- b) Non-peak Hour – Hours other than above

**Table 4: Vehicular Traffic volume for peak and off peak hour**

Location	Weekend / Weekday	Peak Hour			Off Peak hour		
		Vehicles	Heavy Vehicles	Motor-bikes	Vehicles	Heavy Vehicles	Motor-bikes
NL201_R1	Weekend	653	117	31	532	115	22
	Weekday	660	155	71	500	138	69
NL202_R1	Weekend	374	82	16	292	85	37
	Weekday	483	145	49	395	126	29
NL203_R1	Weekend	1373	324	67	1189	308	57
	Weekday	1580	544	219	1125	510	99

Remarks:

- a) Traffic volume was noted based on 15 minutes duration of each period;
- b) The heavy vehicles included trucks, vans, lorries and buses (involve in business).  
The vehicles included family car, four-wheel car and small vehicle which are non commercial.
- c) Peak Hour - (7.30am – 9.30am) & (5.00pm-8.00pm) for weekday  
- 12pm-2pm for weekend  
Non-Peak Hour – Hours other than above

### 3.0 SAMPLING METHODOLOGY

The measuring instruments shall be installed in such a way so that the measurements are not affected by external factors (draft, vibration, wind, magnetic field, etc). Measurement shall be carried out at 1.2-1.5m from the ground or working level.

The equivalent continuous noise level ( $L_{Aeq}$ ) was measured by using the sound level meter for 5 minutes interval datalog over 24 hours sampling period at the selected monitoring point. Table 5 summarized the sound level meter set up in this study. To determine the noise level on specified period, the recorded noise data was then analyzed by using *QuestSuite* Software.

**Table 5: Summary of sound level meter setting**

Parameter	setting
Response	Fast
Frequency weighting for RMS	A
Measurement range	30 – 120 dB
Exchange Rate (Q)	3

#### 3.1 Calibration of Sound Level Meter

All sound level meters were calibrated by an accredited laboratory under ISO/IEC 17025 standard. The certificates of field equipment's calibrations were attached in Appendix 1. Sound level meter used for ambient noise survey shall have its calibration certified by an authorized calibration laboratory within one year of the actual measurement sessions.



#### 4.0 LOCATION INDEX / SAMPLING SCHEDULE / TEST RESULTS

Location index, sampling schedule and their respective test results obtained were tabulated and reflected our findings on 24<sup>th</sup> November to 26<sup>th</sup> December 2014.

Please refer to Table 6 to 61 and the daily noise level at all monitoring points were illustrated in Figure 4 to 52 and sampling locations at Figure 1 to 3.

**Table 6: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 12 hours**

Monitoring Point	Weekend / Weekday	Noise levels Leq in dB (A)	
		7am – 7pm	7pm – 7am
NL101_R1	Day 1	<b>65.4</b>	<b>59.0</b>
	Day 2	<b>60.8</b>	<b>59.4</b>
	Day 3	<b>65.8</b>	<b>59.6</b>
	Day 4 (weekend)	<b>61.9</b>	<b>59.8</b>
	Day 5 (weekend)	<b>62.5</b>	<b>59.2</b>
	Day 6	<b>61.4</b>	<b>58.2</b>
	Day 7	<b>61.3</b>	<b>58.7</b>
NL102_R1	Day 1	<b>60.8</b>	<b>54.7</b>
	Day 2	<b>61.9</b>	<b>57.8</b>
	Day 3	<b>72.1</b>	49.8
	Day 4	56.4	<b>54.6</b>
	Day 5	55.1	<b>52.6</b>
	Day 6 (weekend)	<b>63.7</b>	<b>51.3</b>
	Day 7 (weekend)	55.3	<b>57.6</b>
<b>*Limit of Affected Hospitals, schools, institutions of higher learning, homes for the aged sick, etc.</b>		60	50

Remark: \*Maximum Permissible Noise Level (reckoned as equivalent continuous noise level over a period of 12 hours)

**BOLD** denote the noise level has exceeded the respective permissible limit

**Table 7: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 12 hours**

Monitoring Point	Weekend / Weekday	Noise levels Leq in dB (A)	
		7am – 7pm	7pm – 7am
NL103_R1	Day 1	<b>60.8</b>	<b>51.4</b>
	Day 2	58.5	<b>52.7</b>
	Day 3	<b>63.6</b>	48.1
	Day 4	56.5	46.0
	Day 5	54.3	45.9
	Day 6 (weekend)	<b>62.9</b>	47.4
	Day 7 (weekend)	53.9	<b>57.3</b>
<b>*Limit of Affected Hospitals, schools, institutions of higher learning, homes for the aged sick, etc.</b>		60	50

Remark: \* Maximum Permissible Noise Level (reckoned as equivalent continuous noise level over a period of 5 minutes)

**BOLD** denote the noise level has exceeded the permissible limit

**Table 8: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 12 hours**

Monitoring Point	Weekend / Weekday	Noise levels Leq in dB (A)	
		7am – 7pm	7pm – 7am
NL104_R1	Day 1	62.1	57.3
	Day 2 (Weekend)	62.1	58.1
	Day 3 (Weekend)	62.1	57.8
	Day 4	60.8	56.2
	Day 5	62.4	56.2
	Day 6	60.8	57.7
	Day 7	65.7	56.5
<b>*Limit of Affected Buildings (other than those above)</b>		75	65

Remark: \* Maximum Permissible Noise Level (reckoned as equivalent continuous noise level over a period of 5 minutes)

**Table 9: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 12 hours**

Monitoring Point	Weekend / Weekday	Noise levels Leq in dB (A)	
		7am – 7pm	7pm – 7am
NL201_R1	Day 1	<b>75.8</b>	71.9
	Day 2 (weekend)	74.7	71.2
	Day 3 (weekend)	<b>75.4</b>	70.8
	Day 4	<b>75.2</b>	70.9
	Day 5	<b>75.2</b>	70.7
	Day 6	74.3	71.8
	Day 7	<b>77.7</b>	70.5
NL202_R1	Day 1	71.2	64.1
	Day 2	72.0	69.8
	Day 3	70.5	65.7
	Day 4 (weekend)	67.3	63.7
	Day 5 (weekend)	72.6	65.1
	Day 6	70.9	65.1
	Day 7	69.1	64.7
NL203_R1	Day 1	<b>80.4</b>	76.9
	Day 2	<b>80.1</b>	76.3
	Day 3	<b>79.9</b>	76.7
	Day 4	<b>79.1</b>	76.4
	Day 5 (weekend)	<b>79.9</b>	76.3
	Day 6 (weekend)	<b>79.8</b>	76.4
	Day 7	<b>79.9</b>	76.3
<b>*Limit of Affected Residential Buildings Located Less Than 150m From Construction site where the noise is being emitted</b>		75	NA

Remark: \*Maximum Permissible Noise Level (reckoned as equivalent continuous noise level over a period of 12 hours)

NA denote Not Available

**BOLD** denote the noise level has exceeded the respective permissible limit

**Table 10: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 5 minutes**

Monitoring Point	Day	Noise levels Leq in dB (A)		
		7am – 7pm	7pm – 10pm	10pm – 7am
NL101_R1	Day 1	65.4	<b>60.7</b>	<b>58.2</b>
	Day 2	60.8	<b>60.3</b>	<b>59.1</b>
	Day 3	65.8	<b>61.2</b>	<b>59.0</b>
	Day 4 (weekend)	61.9	<b>62.8</b>	<b>58.1</b>
	Day 5 (weekend)	62.5	<b>60.8</b>	<b>58.4</b>
	Day 6	61.4	<b>59.9</b>	<b>57.5</b>
	Day 7	61.3	<b>60.3</b>	<b>58.0</b>
NL102_R1	Day 1	60.8	<b>58.3</b>	52.3
	Day 2	61.9	<b>63.0</b>	51.7
	Day 3	72.1	51.4	49.1
	Day 4	56.4	<b>59.3</b>	50.3
	Day 5	55.1	<b>55.3</b>	51.1
	Day 6 (weekend)	63.7	53.6	50.2
	Day 7 (weekend)	55.3	<b>59.5</b>	<b>56.5</b>
NL103_R1	Day 1	60.8	<b>56.0</b>	47.0
	Day 2	58.5	<b>57.2</b>	48.6
	Day 3	63.6	49.3	47.7
	Day 4	56.5	45.9	46.0
	Day 5	54.3	46.6	45.7
	Day 6 (weekend)	62.9	50.9	46.6
	Day 7 (weekend)	53.9	<b>61.9</b>	53.1
<b>*Limit of Affected Hospitals, schools, institutions of higher learning, homes for the aged sick, etc.</b>		75	55	55

Remark: \* Maximum Permissible Noise Level (reckoned as equivalent continuous noise level over a period of 5 minutes)  
NA denote Not Available  
**BOLD** denote the noise level has exceeded the permissible limit



**Table 11: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 5 minutes**

Monitoring Point	Day	Noise levels Leq in dB (A)		
		7am – 7pm	7pm – 10pm	10pm – 7am
NL104_R1	Day 1	62.1	61.1	54.5
	Day 2 (Weekend)	62.1	62.1	55.1
	Day 3 (Weekend)	62.1	61.2	55.7
	Day 4	60.8	59.4	54.3
	Day 5	62.4	59.4	54.2
	Day 6	60.8	61.6	54.8
	Day 7	65.7	59.3	55.0
<b>*Limit of Affected Buildings (other than those above)</b>		90	70	70

Remark: \* Maximum Permissible Noise Level (reckoned as equivalent continuous noise level over a period of 5 minutes)

NA denote Not Available

**BOLD** denote the noise level has exceeded the permissible limit

**Table 12: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 5 minutes**

Monitoring Point	Day	Noise levels Leq in dB (A)		
		7am – 7pm	7pm – 10pm	10pm – 7am
NL201_R1	Day 1	75.8	<b>74.1</b>	<b>70.9</b>
	Day 2 (weekend)	74.8	<b>73.2</b>	<b>70.0</b>
	Day 3 (weekend)	<b>75.4</b>	<b>72.9</b>	<b>69.7</b>
	Day 4	75.2	<b>73.3</b>	<b>69.6</b>
	Day 5	75.2	<b>73.1</b>	<b>69.5</b>
	Day 6	74.3	<b>74.1</b>	<b>70.6</b>
	Day 7	77.7	<b>72.4</b>	<b>69.6</b>
NL202_R1	Day 1	71.2	66.9	<b>62.5</b>
	Day 2	72.0	<b>71.9</b>	<b>68.8</b>
	Day 3	70.5	69.2	<b>63.4</b>
	Day 4 (weekend)	67.3	<b>66.1</b>	<b>62.4</b>
	Day 5 (weekend)	72.6	<b>68.4</b>	<b>63.0</b>
	Day 6	70.9	67.4	<b>62.7</b>
	Day 7	69.1	67.8	<b>62.9</b>
NL203_R1	Day 1	80.4	<b>78.9</b>	<b>76.0</b>
	Day 2	80.1	<b>78.4</b>	<b>75.3</b>
	Day 3	79.9	<b>79.1</b>	<b>75.4</b>
	Day 4	79.1	<b>78.3</b>	<b>75.5</b>
	Day 5 (weekend)	<b>79.9</b>	<b>78.4</b>	<b>75.3</b>
	Day 6 (weekend)	<b>79.8</b>	<b>77.7</b>	<b>75.2</b>
	Day 7	79.9	<b>78.3</b>	<b>75.3</b>
<b>*Limit of Affected Residential Buildings Located Less Than 150m From Construction site where the noise is being emitted</b>	Sunday/Public Holiday	75	55	55
	Monday-Saturday	90	70	55

Remark: \* Maximum Permissible Noise Level (reckoned as equivalent continuous noise level over a period of 5 minutes)

NA denote Not Available

**BOLD** denote the noise level has exceeded the permissible limit

**Table 13: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL101\_R1 Day 1**

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 1	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	61.4	NA	NA
0800 – 0900	61.2		
0900 – 1000	60.7		
1000 – 1100	61.3		
1100 – 1200	60.4		
1200 – 1300	60.1		
1300 – 1400	60.1		
1400 – 1500	62.0		
1500 – 1600	70.0		
1600 – 1700	72.4		
1700 – 1800	65.6		
1800 – 1900	58.1		
1900 – 2000	61.4	NA	NA
2000 – 2100	60.3		
2100 – 2200	60.4		
2200 – 2300	60.1	NA	NA
2300 – 0000	59.3		
0000 – 0100	58.1		
0100 – 0200	56.4		
0200 – 0300	55.7		
0300 – 0400	55.6		
0400 – 0500	55.7		
0500 – 0600	57.9		
0600 – 0700	61.2		

Remark: \* Limit of Affected Hospitals, schools, institutions of higher learning, home for aged sick, etc where the noise is being emitted on Monday to Saturday.  
NA denote Not Available

**Table 14: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL101\_R1 Day 2**

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 2	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	61.8	NA	NA
0800 – 0900	61.7		
0900 – 1000	62.0		
1000 – 1100	61.0		
1100 – 1200	60.3		
1200 – 1300	60.1		
1300 – 1400	60.2		
1400 – 1500	60.3		
1500 – 1600	60.3		
1600 – 1700	60.5		
1700 – 1800	60.3		
1800 – 1900	60.3		
1900 – 2000	61.5	NA	NA
2000 – 2100	59.8		
2100 – 2200	59.5		
2200 – 2300	59.5	NA	NA
2300 – 0000	58.6		
0000 – 0100	57.4		
0100 – 0200	56.4		
0200 – 0300	55.5		
0300 – 0400	54.9		
0400 – 0500	55.6		
0500 – 0600	62.7		
0600 – 0700	62.5		

Remark: \* Limit of Affected Hospitals, schools, institutions of higher learning, home for aged sick, etc where the noise is being emitted on Monday to Saturday.  
NA denote Not Available



**Table 15: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL101\_R1 Day 3**

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 3	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	61.1	NA	NA
0800 – 0900	61.5		
0900 – 1000	61.2		
1000 – 1100	70.6		
1100 – 1200	70.6		
1200 – 1300	65.3		
1300 – 1400	66.1		
1400 – 1500	65.1		
1500 – 1600	66.5		
1600 – 1700	63.4		
1700 – 1800	58.9		
1800 – 1900	59.5		
1900 – 2000	62.1	NA	NA
2000 – 2100	60.6		
2100 – 2200	60.9		
2200 – 2300	61.0	NA	NA
2300 – 0000	60.3		
0000 – 0100	59.3		
0100 – 0200	58.5		
0200 – 0300	57.6		
0300 – 0400	56.8		
0400 – 0500	57.0		
0500 – 0600	58.2		
0600 – 0700	59.9		

Remark: \* Limit of Affected Hospitals, schools, institutions of higher learning, home for aged sick, etc where the noise is being emitted on Monday to Saturday.  
NA denote Not Available

**Table 16: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL101\_R1 Day 4**

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 4 (weekend)	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	58.7	NA	NA
0800 – 0900	59.5		
0900 – 1000	61.9		
1000 – 1100	61.4		
1100 – 1200	60.9		
1200 – 1300	60.7		
1300 – 1400	60.5		
1400 – 1500	60.6		
1500 – 1600	60.8		
1600 – 1700	67.4		
1700 – 1800	61.4		
1800 – 1900	60.8		
1900 – 2000	65.6	NA	NA
2000 – 2100	60.3		
2100 – 2200	60.1		
2200 – 2300	60.1	NA	NA
2300 – 0000	59.6		
0000 – 0100	58.5		
0100 – 0200	57.7		
0200 – 0300	57.0		
0300 – 0400	56.5		
0400 – 0500	56.8		
0500 – 0600	57.1		
0600 – 0700	58.1		

Remark: \* Limit of Affected Hospitals, schools, institutions of higher learning, home for aged sick, etc where the noise is being emitted on Monday to Saturday.  
NA denote Not Available

**Table 17: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL101\_R1 Day 5**

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 5 (weekend)	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	61.3	NA	NA
0800 – 0900	62.2		
0900 – 1000	60.1		
1000 – 1100	60.0		
1100 – 1200	59.8		
1200 – 1300	59.5		
1300 – 1400	59.6		
1400 – 1500	59.7		
1500 – 1600	59.2		
1600 – 1700	69.5		
1700 – 1800	61.7		
1800 – 1900	60.9		
1900 – 2000	61.7	NA	NA
2000 – 2100	60.2		
2100 – 2200	60.3		
2200 – 2300	60.3	NA	NA
2300 – 0000	59.6		
0000 – 0100	58.2		
0100 – 0200	56.9		
0200 – 0300	56.0		
0300 – 0400	55.5		
0400 – 0500	56.5		
0500 – 0600	58.6		
0600 – 0700	60.9		

Remark: \* Limit of Affected Hospitals, schools, institutions of higher learning, home for aged sick, etc where the noise is being emitted on Monday to Saturday.  
NA denote Not Available

**Table 18: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL101\_R1 Day 6**

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 6	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	61.0	NA	NA
0800 – 0900	60.5		
0900 – 1000	61.7		
1000 – 1100	63.9		
1100 – 1200	61.0		
1200 – 1300	60.8		
1300 – 1400	61.0		
1400 – 1500	62.5		
1500 – 1600	61.5		
1600 – 1700	61.4		
1700 – 1800	60.7		
1800 – 1900	59.7		
1900 – 2000	60.8	NA	NA
2000 – 2100	59.2		
2100 – 2200	59.2		
2200 – 2300	58.3	NA	NA
2300 – 0000	57.0		
0000 – 0100	51.2		
0100 – 0200	56.2		
0200 – 0300	54.9		
0300 – 0400	54.6		
0400 – 0500	55.3		
0500 – 0600	57.7		
0600 – 0700	60.4		

Remark: \* Limit of Affected Hospitals, schools, institutions of higher learning, home for aged sick, etc where the noise is being emitted on Monday to Saturday.  
NA denote Not Available



**Table 19: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL101\_R1 Day 7**

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 7	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	60.8	NA	NA
0800 – 0900	61.1		
0900 – 1000	61.0		
1000 – 1100	60.9		
1100 – 1200	60.4		
1200 – 1300	60.7		
1300 – 1400	60.6		
1400 – 1500	63.4		
1500 – 1600	62.2		
1600 – 1700	62.6		
1700 – 1800	61.1		
1800 – 1900	59.7		
1900 – 2000	60.4	NA	NA
2000 – 2100	60.3		
2100 – 2200	60.2		
2200 – 2300	60.2	NA	NA
2300 – 0000	59.6		
0000 – 0100	58.2		
0100 – 0200	56.9		
0200 – 0300	55.7		
0300 – 0400	55.7		
0400 – 0500	55.6		
0500 – 0600	57.4		
0600 – 0700	59.6		

Remark: \* Limit of Affected Hospitals, schools, institutions of higher learning, home for aged sick, etc where the noise is being emitted on Monday to Saturday.  
NA denote Not Available

**Table 20: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL102\_R1 Day 1**

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 1	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	45.1	NA	NA
0800 – 0900	52.2		
0900 – 1000	59.4		
1000 – 1100	50.7		
1100 – 1200	50.3		
1200 – 1300	50.1		
1300 – 1400	50.4		
1400 – 1500	56.5		
1500 – 1600	57.7		
1600 – 1700	65.1		
1700 – 1800	69.3		
1800 – 1900	50.2		
1900 – 2000	61.1	NA	NA
2000 – 2100	56.4		
2100 – 2200	54.7		
2200 – 2300	55.0	NA	NA
2300 – 0000	54.3		
0000 – 0100	52.6		
0100 – 0200	53.1		
0200 – 0300	51.4		
0300 – 0400	51.8		
0400 – 0500	49.6		
0500 – 0600	50.0		
0600 – 0700	49.2		

Remark: \* Limit of Affected Hospitals, schools, institutions of higher learning, home for aged sick, etc where the noise is being emitted on Monday to Saturday.  
NA denote Not Available

**Table 21: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL102\_R1 Day 2**

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 2	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	45.7	NA	NA
0800 – 0900	46.2		
0900 – 1000	55.9		
1000 – 1100	55.6		
1100 – 1200	53.7		
1200 – 1300	57.6		
1300 – 1400	55.8		
1400 – 1500	67.1		
1500 – 1600	69.6		
1600 – 1700	57.3		
1700 – 1800	44.1		
1800 – 1900	62.7		
1900 – 2000	67.2	NA	NA
2000 – 2100	55.8		
2100 – 2200	54.8		
2200 – 2300	54.4	NA	NA
2300 – 0000	53.4		
0000 – 0100	53.5		
0100 – 0200	52.1		
0200 – 0300	50.3		
0300 – 0400	49.3		
0400 – 0500	49.3		
0500 – 0600	49.5		
0600 – 0700	49.4		

Remark: \* Limit of Affected Hospitals, schools, institutions of higher learning, home for aged sick, etc where the noise is being emitted on Monday to Saturday.  
NA denote Not Available

**Table 22: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL102\_R1 Day 3**

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 3	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	45.3	NA	NA
0800 – 0900	44.6		
0900 – 1000	56.4		
1000 – 1100	56.2		
1100 – 1200	55.1		
1200 – 1300	52.3		
1300 – 1400	56.8		
1400 – 1500	56.2		
1500 – 1600	76.0		
1600 – 1700	81.5		
1700 – 1800	69.9		
1800 – 1900	55.6		
1900 – 2000	52.3	NA	NA
2000 – 2100	50.2		
2100 – 2200	51.5		
2200 – 2300	51.2	NA	NA
2300 – 0000	48.9		
0000 – 0100	50.4		
0100 – 0200	47.4		
0200 – 0300	48.8		
0300 – 0400	50.5		
0400 – 0500	45.8		
0500 – 0600	47.6		
0600 – 0700	49.0		

Remark: \* Limit of Affected Hospitals, schools, institutions of higher learning, home for aged sick, etc where the noise is being emitted on Monday to Saturday.  
NA denote Not Available



**Table 23: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL102\_R1 Day 4**

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 4	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	45.7	NA	NA
0800 – 0900	56.1		
0900 – 1000	51.3		
1000 – 1100	58.8		
1100 – 1200	51.2		
1200 – 1300	50.8		
1300 – 1400	62.7		
1400 – 1500	55.5		
1500 – 1600	52.7		
1600 – 1700	55.5		
1700 – 1800	45.3		
1800 – 1900	59.4		
1900 – 2000	63.0	NA	NA
2000 – 2100	55.0		
2100 – 2200	53.2		
2200 – 2300	52.1	NA	NA
2300 – 0000	52.3		
0000 – 0100	51.7		
0100 – 0200	49.3		
0200 – 0300	48.1		
0300 – 0400	47.4		
0400 – 0500	50.2		
0500 – 0600	50.1		
0600 – 0700	48.4		

Remark: \* Limit of Affected Hospitals, schools, institutions of higher learning, home for aged sick, etc where the noise is being emitted on Monday to Saturday.  
NA denote Not Available

**Table 24: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL102\_R1 Day 5**

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 5	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	48.0	NA	NA
0800 – 0900	48.0		
0900 – 1000	54.0		
1000 – 1100	55.7		
1100 – 1200	56.6		
1200 – 1300	51.6		
1300 – 1400	52.5		
1400 – 1500	62.2		
1500 – 1600	56.3		
1600 – 1700	50.7		
1700 – 1800	47.8		
1800 – 1900	45.8		
1900 – 2000	56.5	NA	NA
2000 – 2100	55.1		
2100 – 2200	53.8		
2200 – 2300	53.1	NA	NA
2300 – 0000	52.9		
0000 – 0100	52.4		
0100 – 0200	51.9		
0200 – 0300	50.9		
0300 – 0400	50.2		
0400 – 0500	48.6		
0500 – 0600	49.1		
0600 – 0700	47.1		

Remark: \* Limit of Affected Hospitals, schools, institutions of higher learning, home for aged sick, etc where the noise is being emitted on Monday to Saturday.  
NA denote Not Available

**Table 25: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL102\_R1 Day 6**

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 6 (weekend)	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	49.2	NA	NA
0800 – 0900	50.7		
0900 – 1000	56.1		
1000 – 1100	53.0		
1100 – 1200	54.1		
1200 – 1300	69.9		
1300 – 1400	72.1		
1400 – 1500	53.3		
1500 – 1600	51.1		
1600 – 1700	57.5		
1700 – 1800	50.9		
1800 – 1900	47.2		
1900 – 2000	55.5	NA	NA
2000 – 2100	52.8		
2100 – 2200	51.6		
2200 – 2300	50.8	NA	NA
2300 – 0000	50.8		
0000 – 0100	51.2		
0100 – 0200	50.9		
0200 – 0300	49.9		
0300 – 0400	49.5		
0400 – 0500	49.9		
0500 – 0600	49.6		
0600 – 0700	47.7		

Remark: \* Limit of Affected Hospitals, schools, institutions of higher learning, home for aged sick, etc where the noise is being emitted on Monday to Saturday.  
NA denote Not Available

**Table 26: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL102\_R1 Day 7**

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 7 (weekend)	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	60.7	NA	NA
0800 – 0900	62.2		
0900 – 1000	54.3		
1000 – 1100	49.5		
1100 – 1200	51.6		
1200 – 1300	49.2		
1300 – 1400	49.3		
1400 – 1500	55.5		
1500 – 1600	47.3		
1600 – 1700	47.3		
1700 – 1800	47.1		
1800 – 1900	49.1		
1900 – 2000	63.2	NA	NA
2000 – 2100	55.5		
2100 – 2200	54.3		
2200 – 2300	53.5	NA	NA
2300 – 0000	52.7		
0000 – 0100	51.9		
0100 – 0200	51.5		
0200 – 0300	50.3		
0300 – 0400	49.7		
0400 – 0500	57.0		
0500 – 0600	64.0		
0600 – 0700	49.9		

Remark: \* Limit of Affected Hospitals, schools, institutions of higher learning, home for aged sick, etc where the noise is being emitted on Monday to Saturday.  
NA denote Not Available



**Table 27: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL103\_R1 Day 1**

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 1	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	44.1	NA	NA
0800 – 0900	51.9		
0900 – 1000	48.3		
1000 – 1100	44.8		
1100 – 1200	53.3		
1200 – 1300	67.6		
1300 – 1400	53.7		
1400 – 1500	54.2		
1500 – 1600	59.6		
1600 – 1700	64.2		
1700 – 1800	66.0		
1800 – 1900	53.8		
1900 – 2000	60.0	NA	NA
2000 – 2100	52.2		
2100 – 2200	46.3		
2200 – 2300	46.1	NA	NA
2300 – 0000	46.0		
0000 – 0100	46.0		
0100 – 0200	47.1		
0200 – 0300	47.1		
0300 – 0400	47.0		
0400 – 0500	42.6		
0500 – 0600	41.9		
0600 – 0700	51.7		

Remark: \* Limit of Affected Hospitals, schools, institutions of higher learning, home for aged sick, etc where the noise is being emitted on Monday to Saturday.  
NA denote Not Available

**Table 28: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL103\_R1 Day 2**

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 2	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	41.2	NA	NA
0800 – 0900	43.3		
0900 – 1000	44.6		
1000 – 1100	43.5		
1100 – 1200	44.0		
1200 – 1300	47.7		
1300 – 1400	53.9		
1400 – 1500	63.4		
1500 – 1600	64.9		
1600 – 1700	56.2		
1700 – 1800	43.5		
1800 – 1900	63.8		
1900 – 2000	61.5	NA	NA
2000 – 2100	49.4		
2100 – 2200	47.5		
2200 – 2300	47.0	NA	NA
2300 – 0000	48.0		
0000 – 0100	45.9		
0100 – 0200	51.4		
0200 – 0300	50.9		
0300 – 0400	48.2		
0400 – 0500	45.0		
0500 – 0600	42.9		
0600 – 0700	51.0		

Remark: \* Limit of Affected Hospitals, schools, institutions of higher learning, home for aged sick, etc where the noise is being emitted on Monday to Saturday.  
NA denote Not Available

**Table 29: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL103\_R1 Day 3**

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 3	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	43.7	NA	NA
0800 – 0900	44.9		
0900 – 1000	46.6		
1000 – 1100	47.7		
1100 – 1200	44.3		
1200 – 1300	50.1		
1300 – 1400	53.7		
1400 – 1500	52.1		
1500 – 1600	73.3		
1600 – 1700	66.4		
1700 – 1800	58.8		
1800 – 1900	56.0		
1900 – 2000	50.3	NA	NA
2000 – 2100	48.0		
2100 – 2200	49.2		
2200 – 2300	50.1	NA	NA
2300 – 0000	47.0		
0000 – 0100	47.3		
0100 – 0200	47.6		
0200 – 0300	47.0		
0300 – 0400	46.2		
0400 – 0500	42.7		
0500 – 0600	42.5		
0600 – 0700	51.4		

Remark: \* Limit of Affected Hospitals, schools, institutions of higher learning, home for aged sick, etc where the noise is being emitted on Monday to Saturday.  
NA denote Not Available

**Table 30: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL103\_R1 Day 4**

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 4	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	48.2	NA	NA
0800 – 0900	48.7		
0900 – 1000	56.1		
1000 – 1100	49.3		
1100 – 1200	42.3		
1200 – 1300	51.1		
1300 – 1400	48.6		
1400 – 1500	43.5		
1500 – 1600	45.2		
1600 – 1700	46.4		
1700 – 1800	65.4		
1800 – 1900	59.7		
1900 – 2000	65.3	NA	NA
2000 – 2100	49.4		
2100 – 2200	46.4		
2200 – 2300	44.7	NA	NA
2300 – 0000	44.7		
0000 – 0100	44.0		
0100 – 0200	44.5		
0200 – 0300	44.8		
0300 – 0400	43.7		
0400 – 0500	42.1		
0500 – 0600	51.0		
0600 – 0700	47.0		

Remark: \* Limit of Affected Hospitals, schools, institutions of higher learning, home for aged sick, etc where the noise is being emitted on Monday to Saturday.  
NA denote Not Available



**Table 31: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL103\_R1 Day 5**

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 5	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	43.7	NA	NA
0800 – 0900	48.5		
0900 – 1000	43.1		
1000 – 1100	41.2		
1100 – 1200	50.6		
1200 – 1300	54.7		
1300 – 1400	57.2		
1400 – 1500	50.4		
1500 – 1600	41.4		
1600 – 1700	41.6		
1700 – 1800	57.9		
1800 – 1900	61.4		
1900 – 2000	61.9	NA	NA
2000 – 2100	55.8		
2100 – 2200	46.9		
2200 – 2300	45.9	NA	NA
2300 – 0000	46.4		
0000 – 0100	45.9		
0100 – 0200	45.4		
0200 – 0300	44.6		
0300 – 0400	43.6		
0400 – 0500	42.8		
0500 – 0600	49.6		
0600 – 0700	41.1		

Remark: \* Limit of Affected Hospitals, schools, institutions of higher learning, home for aged sick, etc where the noise is being emitted on Monday to Saturday.  
NA denote Not Available

**Table 32: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL103\_R1 Day 6**

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 6 (weekend)	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	42.1	NA	NA
0800 – 0900	45.5		
0900 – 1000	52.5		
1000 – 1100	46.2		
1100 – 1200	47.8		
1200 – 1300	67.5		
1300 – 1400	72.1		
1400 – 1500	52.8		
1500 – 1600	51.3		
1600 – 1700	55.0		
1700 – 1800	50.2		
1800 – 1900	54.7		
1900 – 2000	54.4	NA	NA
2000 – 2100	46.4		
2100 – 2200	47.0		
2200 – 2300	47.0	NA	NA
2300 – 0000	46.2		
0000 – 0100	46.6		
0100 – 0200	47.6		
0200 – 0300	46.3		
0300 – 0400	45.1		
0400 – 0500	46.3		
0500 – 0600	43.7		
0600 – 0700	50.9		

Remark: \* Limit of Affected Hospitals, schools, institutions of higher learning, home for aged sick, etc where the noise is being emitted on Monday to Saturday.  
NA denote Not Available

**Table 33: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL103\_R1 Day 7**

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 7 (weekend)	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	57.6	NA	NA
0800 – 0900	58.4		
0900 – 1000	52.0		
1000 – 1100	50.8		
1100 – 1200	46.4		
1200 – 1300	47.9		
1300 – 1400	49.8		
1400 – 1500	50.1		
1500 – 1600	39.4		
1600 – 1700	40.9		
1700 – 1800	40.6		
1800 – 1900	60.2		
1900 – 2000	65.9	NA	NA
2000 – 2100	58.4		
2100 – 2200	47.3		
2200 – 2300	47.0	NA	NA
2300 – 0000	46.8		
0000 – 0100	47.5		
0100 – 0200	48.5		
0200 – 0300	47.3		
0300 – 0400	47.3		
0400 – 0500	56.5		
0500 – 0600	60.2		
0600 – 0700	46.5		

Remark: \* Limit of Affected Hospitals, schools, institutions of higher learning, home for aged sick, etc where the noise is being emitted on Monday to Saturday.  
NA denote Not Available

**Table 34: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL104\_R1 Day 1**

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 1	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	61.3	NA	NA
0800 – 0900	59.6		
0900 – 1000	62.3		
1000 – 1100	61.2		
1100 – 1200	61.7		
1200 – 1300	60.5		
1300 – 1400	62.9		
1400 – 1500	62.3		
1500 – 1600	61.5		
1600 – 1700	66.2		
1700 – 1800	61.9		
1800 – 1900	59.7		
1900 – 2000	61.9	NA	NA
2000 – 2100	61.8		
2100 – 2200	59.0		
2200 – 2300	56.2	NA	NA
2300 – 0000	56.7		
0000 – 0100	53.9		
0100 – 0200	51.4		
0200 – 0300	49.1		
0300 – 0400	46.4		
0400 – 0500	46.1		
0500 – 0600	53.7		
0600 – 0700	59.4		

Remark: \* Limit of Affected Buildings (other than above)  
NA denote Not Available



**Table 35: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL104\_R1 Day 2**

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 2	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	60.3	NA	NA
0800 – 0900	60.6		
0900 – 1000	58.5		
1000 – 1100	58.8		
1100 – 1200	61.5		
1200 – 1300	60.4		
1300 – 1400	59.7		
1400 – 1500	60.0		
1500 – 1600	63.9		
1600 – 1700	67.6		
1700 – 1800	62.6		
1800 – 1900	61.1		
1900 – 2000	62.4	NA	NA
2000 – 2100	62.6		
2100 – 2200	61.0		
2200 – 2300	59.0	NA	NA
2300 – 0000	56.2		
0000 – 0100	53.0		
0100 – 0200	50.1		
0200 – 0300	51.7		
0300 – 0400	47.2		
0400 – 0500	46.8		
0500 – 0600	53.6		
0600 – 0700	59.5		

Remark: \* Limit of Affected Buildings (other than above)  
NA denote Not Available

**Table 36: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL104\_R1 Day 3**

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 3	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	58.9	NA	NA
0800 – 0900	62.3		
0900 – 1000	61.8		
1000 – 1100	64.0		
1100 – 1200	63.3		
1200 – 1300	61.8		
1300 – 1400	62.1		
1400 – 1500	62.9		
1500 – 1600	62.9		
1600 – 1700	61.9		
1700 – 1800	60.3		
1800 – 1900	60.5		
1900 – 2000	62.5	NA	NA
2000 – 2100	59.6		
2100 – 2200	60.8		
2200 – 2300	59.3	NA	NA
2300 – 0000	58.0		
0000 – 0100	55.2		
0100 – 0200	50.8		
0200 – 0300	48.6		
0300 – 0400	47.3		
0400 – 0500	48.3		
0500 – 0600	55.2		
0600 – 0700	59.3		

Remark: \* Limit of Affected Buildings (other than above)  
NA denote Not Available

**Table 37: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL104\_R1 Day 4**

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 4 (weekend)	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	60.2	NA	NA
0800 – 0900	60.0		
0900 – 1000	61.3		
1000 – 1100	60.4		
1100 – 1200	61.7		
1200 – 1300	60.9		
1300 – 1400	60.4		
1400 – 1500	62.2		
1500 – 1600	61.9		
1600 – 1700	61.6		
1700 – 1800	59.4		
1800 – 1900	56.9		
1900 – 2000	59.7	NA	NA
2000 – 2100	59.1		
2100 – 2200	59.3		
2200 – 2300	58.1	NA	NA
2300 – 0000	53.7		
0000 – 0100	53.1		
0100 – 0200	46.7		
0200 – 0300	50.5		
0300 – 0400	52.1		
0400 – 0500	52.9		
0500 – 0600	54.9		
0600 – 0700	57.1		

Remark: \* Limit of Affected Buildings (other than above)  
NA denote Not Available

**Table 38: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL104\_R1 Day 5**

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 5 (weekend)	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	59.8	NA	NA
0800 – 0900	62.9		
0900 – 1000	62.8		
1000 – 1100	62.6		
1100 – 1200	63.0		
1200 – 1300	63.6		
1300 – 1400	60.1		
1400 – 1500	62.9		
1500 – 1600	62.9		
1600 – 1700	61.9		
1700 – 1800	61.2		
1800 – 1900	63.8		
1900 – 2000	60.2	NA	NA
2000 – 2100	57.9		
2100 – 2200	59.8		
2200 – 2300	58.6	NA	NA
2300 – 0000	53.5		
0000 – 0100	52.8		
0100 – 0200	50.5		
0200 – 0300	48.1		
0300 – 0400	50.1		
0400 – 0500	50.1		
0500 – 0600	54.4		
0600 – 0700	57.8		

Remark: \* Limit of Affected Buildings (other than above)  
NA denote Not Available



**Table 39: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL104\_R1 Day 6**

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 6	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	58.2	NA	NA
0800 – 0900	59.1		
0900 – 1000	60.5		
1000 – 1100	59.1		
1100 – 1200	59.2		
1200 – 1300	59.6		
1300 – 1400	59.1		
1400 – 1500	58.7		
1500 – 1600	59.8		
1600 – 1700	58.3		
1700 – 1800	63.9		
1800 – 1900	65.8		
1900 – 2000	61.8	NA	NA
2000 – 2100	61.8		
2100 – 2200	61.0		
2200 – 2300	59.6	NA	NA
2300 – 0000	54.8		
0000 – 0100	54.7		
0100 – 0200	48.1		
0200 – 0300	49.3		
0300 – 0400	49.6		
0400 – 0500	44.9		
0500 – 0600	54.0		
0600 – 0700	58.4		

Remark: \* Limit of Affected Buildings (other than above)  
NA denote Not Available

**Table 40: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL104\_R1 Day 7**

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 7	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	63.2	NA	NA
0800 – 0900	65.8		
0900 – 1000	62.0		
1000 – 1100	66.0		
1100 – 1200	62.7		
1200 – 1300	62.4		
1300 – 1400	67.2		
1400 – 1500	70.9		
1500 – 1600	67.8		
1600 – 1700	66.4		
1700 – 1800	58.4		
1800 – 1900	58.6		
1900 – 2000	60.5	NA	NA
2000 – 2100	58.5		
2100 – 2200	58.4		
2200 – 2300	58.6	NA	NA
2300 – 0000	55.0		
0000 – 0100	53.0		
0100 – 0200	50.9		
0200 – 0300	49.8		
0300 – 0400	49.6		
0400 – 0500	53.0		
0500 – 0600	51.6		
0600 – 0700	59.9		

Remark: \* Limit of Affected Buildings (other than above)  
NA denote Not Available

**Table 41: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL201\_R1 Day 1**

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 1	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	75.1	NA	NA
0800 – 0900	76.5		
0900 – 1000	76.9		
1000 – 1100	76.1		
1100 – 1200	75.4		
1200 – 1300	75.1		
1300 – 1400	75.1		
1400 – 1500	74.9		
1500 – 1600	74.9		
1600 – 1700	77.2		
1700 – 1800	76.0		
1800 – 1900	75.7		
1900 – 2000	<b>74.6</b>	NA	65
2000 – 2100	<b>74.0</b>		
2100 – 2200	<b>73.7</b>		
2200 – 2300	<b>73.4</b>	NA	55
2300 – 0000	<b>73.2</b>		
0000 – 0100	<b>71.5</b>		
0100 – 0200	<b>69.4</b>		
0200 – 0300	<b>69.1</b>		
0300 – 0400	<b>67.6</b>		
0400 – 0500	<b>67.2</b>		
0500 – 0600	<b>68.8</b>		
0600 – 0700	<b>72.7</b>		

Remark: \* Limit of Affected Residential Buildings Located Less Than 150m From Construction site where the noise is being emitted on Monday to Saturday  
NA denote Not Available

**Table 42: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL201\_R1 Day 2**

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 2 (weekend)	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	72.7	NA	NA
0800 – 0900	73.8		
0900 – 1000	74.3		
1000 – 1100	74.3		
1100 – 1200	74.4		
1200 – 1300	73.8		
1300 – 1400	74.1		
1400 – 1500	73.6		
1500 – 1600	74.3		
1600 – 1700	77.2		
1700 – 1800	76.1		
1800 – 1900	75.9		
1900 – 2000	<b>74.9</b>	NA	65
2000 – 2100	<b>73.2</b>		
2100 – 2200	<b>72.8</b>		
2200 – 2300	<b>72.8</b>	NA	55
2300 – 0000	<b>72.1</b>		
0000 – 0100	<b>70.6</b>		
0100 – 0200	<b>69.9</b>		
0200 – 0300	<b>67.9</b>		
0300 – 0400	<b>67.2</b>		
0400 – 0500	<b>65.9</b>		
0500 – 0600	<b>67.4</b>		
0600 – 0700	<b>70.7</b>		

Remark: \* Limit of Affected Residential Buildings Located Less Than 150m From Construction site where the noise is being emitted on Monday to Saturday  
NA denote Not Available



**Table 43: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL201\_R1 Day 3**

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 3 (weekend)	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	76.4	NA	NA
0800 – 0900	76.5		
0900 – 1000	75.8		
1000 – 1100	76.2		
1100 – 1200	75.4		
1200 – 1300	75.1		
1300 – 1400	74.8		
1400 – 1500	75.2		
1500 – 1600	74.9		
1600 – 1700	75.1		
1700 – 1800	74.6		
1800 – 1900	74.1		
1900 – 2000	73.1	NA	65
2000 – 2100	72.7		
2100 – 2200	72.9		
2200 – 2300	72.6	NA	55
2300 – 0000	71.1		
0000 – 0100	70.2		
0100 – 0200	66.7		
0200 – 0300	66.1		
0300 – 0400	64.5		
0400 – 0500	64.6		
0500 – 0600	68.5		
0600 – 0700	73.3		

Remark: \* Limit of Affected Residential Buildings Located Less Than 150m From Construction site where the noise is being emitted on Monday to Saturday  
NA denote Not Available

**Table 44: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL201\_R1 Day 4**

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 4	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	75.8	NA	NA
0800 – 0900	76.2		
0900 – 1000	76.4		
1000 – 1100	75.4		
1100 – 1200	74.5		
1200 – 1300	75.4		
1300 – 1400	74.8		
1400 – 1500	75.0		
1500 – 1600	75.2		
1600 – 1700	74.4		
1700 – 1800	74.0		
1800 – 1900	74.2		
1900 – 2000	73.4	NA	65
2000 – 2100	73.6		
2100 – 2200	72.9		
2200 – 2300	72.5	NA	55
2300 – 0000	71.6		
0000 – 0100	68.7		
0100 – 0200	67.2		
0200 – 0300	66.9		
0300 – 0400	64.5		
0400 – 0500	65.1		
0500 – 0600	67.4		
0600 – 0700	73.0		

Remark: \* Limit of Affected Residential Buildings Located Less Than 150m From Construction site where the noise is being emitted on Monday to Saturday  
NA denote Not Available

**Table 45: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL201\_R1 Day 5**

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 5	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	76.0	NA	NA
0800 – 0900	76.0		
0900 – 1000	75.9		
1000 – 1100	75.7		
1100 – 1200	74.7		
1200 – 1300	75.1		
1300 – 1400	75.1		
1400 – 1500	74.7		
1500 – 1600	74.8		
1600 – 1700	74.7		
1700 – 1800	74.6		
1800 – 1900	74.5		
1900 – 2000	73.4	NA	65
2000 – 2100	73.0		
2100 – 2200	72.8		
2200 – 2300	72.3	NA	55
2300 – 0000	71.7		
0000 – 0100	69.9		
0100 – 0200	67.4		
0200 – 0300	66.4		
0300 – 0400	65.7		
0400 – 0500	64.8		
0500 – 0600	67.6		
0600 – 0700	72.4		

Remark: \* Limit of Affected Residential Buildings Located Less Than 150m From Construction site where the noise is being emitted on Monday to Saturday  
NA denote Not Available

**Table 46: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL201\_R1 Day 6**

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 6	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	71.2	NA	NA
0800 – 0900	72.8		
0900 – 1000	73.6		
1000 – 1100	73.8		
1100 – 1200	73.5		
1200 – 1300	74.0		
1300 – 1400	73.8		
1400 – 1500	73.1		
1500 – 1600	73.4		
1600 – 1700	74.5		
1700 – 1800	76.6		
1800 – 1900	77.7		
1900 – 2000	<b>74.9</b>	NA	65
2000 – 2100	<b>74.2</b>		
2100 – 2200	<b>73.1</b>		
2200 – 2300	<b>73.5</b>	NA	55
2300 – 0000	<b>72.9</b>		
0000 – 0100	<b>71.3</b>		
0100 – 0200	<b>70.3</b>		
0200 – 0300	<b>69.4</b>		
0300 – 0400	<b>67.8</b>		
0400 – 0500	<b>67.4</b>		
0500 – 0600	<b>67.4</b>		
0600 – 0700	<b>70.4</b>		

Remark: \* Limit of Affected Residential Buildings Located Less Than 150m From Construction site where the noise is being emitted on Monday to Saturday  
NA denote Not Available



**Table 47: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL201\_R1 Day 7**

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 7	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	78.4	NA	NA
0800 – 0900	79.4		
0900 – 1000	77.8		
1000 – 1100	77.7		
1100 – 1200	77.8		
1200 – 1300	76.8		
1300 – 1400	77.9		
1400 – 1500	80.2		
1500 – 1600	78.7		
1600 – 1700	76.3		
1700 – 1800	73.0		
1800 – 1900	73.4		
1900 – 2000	<b>72.5</b>	NA	65
2000 – 2100	<b>72.2</b>		
2100 – 2200	<b>72.5</b>		
2200 – 2300	<b>72.0</b>	NA	55
2300 – 0000	<b>72.2</b>		
0000 – 0100	<b>69.2</b>		
0100 – 0200	<b>67.5</b>		
0200 – 0300	<b>66.9</b>		
0300 – 0400	<b>65.8</b>		
0400 – 0500	<b>65.3</b>		
0500 – 0600	<b>67.2</b>		
0600 – 0700	<b>72.8</b>		

Remark: \* Limit of Affected Residential Buildings Located Less Than 150m From Construction site where the noise is being emitted on Monday to Saturday  
NA denote Not Available

**Table 48: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL202\_R1 Day 1**

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 1	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	72.6	NA	NA
0800 – 0900	76.6		
0900 – 1000	72.8		
1000 – 1100	72.2		
1100 – 1200	68.2		
1200 – 1300	68.0		
1300 – 1400	68.2		
1400 – 1500	68.6		
1500 – 1600	68.5		
1600 – 1700	68.8		
1700 – 1800	69.0		
1800 – 1900	68.7		
1900 – 2000	<b>67.7</b>	NA	65
2000 – 2100	<b>66.5</b>		
2100 – 2200	<b>66.3</b>		
2200 – 2300	<b>66.3</b>	NA	55
2300 – 0000	<b>65.3</b>		
0000 – 0100	<b>62.4</b>		
0100 – 0200	<b>58.4</b>		
0200 – 0300	<b>57.9</b>		
0300 – 0400	<b>56.4</b>		
0400 – 0500	<b>57.3</b>		
0500 – 0600	<b>59.9</b>		
0600 – 0700	<b>65.2</b>		

Remark: \* Limit of Affected Residential Buildings Located Less Than 150m From Construction site where the noise is being emitted on Monday to Saturday  
NA denote Not Available

**Table 49: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL202\_R1 Day 2**

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 2	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	71.2	NA	NA
0800 – 0900	71.9		
0900 – 1000	71.4		
1000 – 1100	71.4		
1100 – 1200	71.2		
1200 – 1300	71.5		
1300 – 1400	71.7		
1400 – 1500	72.3		
1500 – 1600	72.8		
1600 – 1700	72.7		
1700 – 1800	72.8		
1800 – 1900	73.0		
1900 – 2000	<b>72.3</b>	NA	65
2000 – 2100	<b>72.0</b>		
2100 – 2200	<b>71.2</b>		
2200 – 2300	<b>70.0</b>	NA	55
2300 – 0000	<b>69.7</b>		
0000 – 0100	<b>68.9</b>		
0100 – 0200	<b>68.3</b>		
0200 – 0300	<b>68.1</b>		
0300 – 0400	<b>68.0</b>		
0400 – 0500	<b>68.0</b>		
0500 – 0600	<b>68.3</b>		
0600 – 0700	<b>69.7</b>		

Remark: \* Limit of Affected Residential Buildings Located Less Than 150m From Construction site where the noise is being emitted on Monday to Saturday  
NA denote Not Available

**Table 50: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL202\_R1 Day 3**

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 3	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	67.2	NA	NA
0800 – 0900	68.0		
0900 – 1000	68.8		
1000 – 1100	68.6		
1100 – 1200	71.4		
1200 – 1300	71.6		
1300 – 1400	71.1		
1400 – 1500	71.6		
1500 – 1600	70.2		
1600 – 1700	71.2		
1700 – 1800	71.3		
1800 – 1900	72.1		
1900 – 2000	<b>70.7</b>	NA	65
2000 – 2100	<b>69.4</b>		
2100 – 2200	<b>66.3</b>		
2200 – 2300	<b>67.0</b>	NA	55
2300 – 0000	<b>66.2</b>		
0000 – 0100	<b>63.3</b>		
0100 – 0200	<b>62.1</b>		
0200 – 0300	<b>59.9</b>		
0300 – 0400	<b>58.8</b>		
0400 – 0500	<b>57.9</b>		
0500 – 0600	<b>60.9</b>		
0600 – 0700	<b>65.3</b>		

Remark: \* Limit of Affected Residential Buildings Located Less Than 150m From Construction site where the noise is being emitted on Monday to Saturday  
NA denote Not Available



**Table 51: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL202\_R1 Day 4**

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 4 (weekend)	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	64.7	NA	NA
0800 – 0900	66.0		
0900 – 1000	66.2		
1000 – 1100	66.7		
1100 – 1200	67.7		
1200 – 1300	68.0		
1300 – 1400	67.7		
1400 – 1500	67.9		
1500 – 1600	67.6		
1600 – 1700	67.7		
1700 – 1800	68.8		
1800 – 1900	67.3		
1900 – 2000	<b>66.3</b>	NA	65
2000 – 2100	<b>65.7</b>		
2100 – 2200	<b>66.2</b>		
2200 – 2300	<b>66.0</b>	NA	55
2300 – 0000	<b>65.7</b>		
0000 – 0100	<b>62.8</b>		
0100 – 0200	<b>60.3</b>		
0200 – 0300	<b>59.7</b>		
0300 – 0400	<b>57.6</b>		
0400 – 0500	<b>57.8</b>		
0500 – 0600	<b>58.9</b>		
0600 – 0700	<b>63.1</b>		

Remark: \* Limit of Affected Residential Buildings Located Less Than 150m From Construction site where the noise is being emitted on Monday to Saturday  
NA denote Not Available

**Table 52: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL202\_R1 Day 5**

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 5 (weekend)	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	69.0	NA	NA
0800 – 0900	69.7		
0900 – 1000	69.6		
1000 – 1100	70.9		
1100 – 1200	66.6		
1200 – 1300	66.5		
1300 – 1400	66.8		
1400 – 1500	67.1		
1500 – 1600	80.3		
1600 – 1700	72.4		
1700 – 1800	72.0		
1800 – 1900	73.0		
1900 – 2000	70.6	NA	65
2000 – 2100	66.7		
2100 – 2200	66.5		
2200 – 2300	66.3	NA	55
2300 – 0000	65.6		
0000 – 0100	63.3		
0100 – 0200	60.1		
0200 – 0300	57.9		
0300 – 0400	56.5		
0400 – 0500	56.8		
0500 – 0600	60.6		
0600 – 0700	66.1		

Remark: \* Limit of Affected Residential Buildings Located Less Than 150m From Construction site where the noise is being emitted on Monday to Saturday  
NA denote Not Available

**Table 53: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL202\_R1 Day 6**

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 6	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	68.4	NA	NA
0800 – 0900	69.9		
0900 – 1000	68.9		
1000 – 1100	68.7		
1100 – 1200	71.7		
1200 – 1300	70.7		
1300 – 1400	71.6		
1400 – 1500	71.1		
1500 – 1600	71.3		
1600 – 1700	72.5		
1700 – 1800	72.5		
1800 – 1900	71.3		
1900 – 2000	<b>70.8</b>	NA	65
2000 – 2100	<b>66.8</b>		
2100 – 2200	<b>66.2</b>		
2200 – 2300	<b>65.9</b>	NA	55
2300 – 0000	<b>65.4</b>		
0000 – 0100	<b>62.2</b>		
0100 – 0200	<b>62.1</b>		
0200 – 0300	<b>59.2</b>		
0300 – 0400	<b>56.8</b>		
0400 – 0500	<b>57.0</b>		
0500 – 0600	<b>60.5</b>		
0600 – 0700	<b>66.2</b>		

Remark: \* Limit of Affected Residential Buildings Located Less Than 150m From Construction site where the noise is being emitted on Monday to Saturday  
NA denote Not Available

**Table 54: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL202\_R1 Day 7**

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 7	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	68.7	NA	NA
0800 – 0900	69.9		
0900 – 1000	68.9		
1000 – 1100	69.1		
1100 – 1200	67.9		
1200 – 1300	67.3		
1300 – 1400	67.7		
1400 – 1500	67.7		
1500 – 1600	68.1		
1600 – 1700	69.2		
1700 – 1800	69.4		
1800 – 1900	72.7		
1900 – 2000	<b>69.1</b>	NA	65
2000 – 2100	<b>67.3</b>		
2100 – 2200	<b>66.5</b>		
2200 – 2300	<b>66.5</b>	NA	55
2300 – 0000	<b>65.5</b>		
0000 – 0100	<b>62.7</b>		
0100 – 0200	<b>66.0</b>		
0200 – 0300	<b>58.8</b>		
0300 – 0400	<b>56.9</b>		
0400 – 0500	<b>57.8</b>		
0500 – 0600	<b>60.3</b>		
0600 – 0700	<b>65.5</b>		

Remark: \* Limit of Affected Residential Buildings Located Less Than 150m From Construction site where the noise is being emitted on Monday to Saturday  
NA denote Not Available



**Table 55: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL203\_R1 Day 1**

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 1	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	80.2	NA	NA
0800 – 0900	80.1		
0900 – 1000	81.4		
1000 – 1100	80.6		
1100 – 1200	80.3		
1200 – 1300	79.7		
1300 – 1400	80.1		
1400 – 1500	80.3		
1500 – 1600	80.3		
1600 – 1700	80.1		
1700 – 1800	80.6		
1800 – 1900	80.3		
1900 – 2000	<b>79.2</b>	NA	65
2000 – 2100	<b>78.8</b>		
2100 – 2200	<b>78.7</b>		
2200 – 2300	<b>78.1</b>	NA	55
2300 – 0000	<b>77.4</b>		
0000 – 0100	<b>75.4</b>		
0100 – 0200	<b>73.0</b>		
0200 – 0300	<b>71.5</b>		
0300 – 0400	<b>71.2</b>		
0400 – 0500	<b>72.4</b>		
0500 – 0600	<b>75.6</b>		
0600 – 0700	<b>79.9</b>		

Remark: \* Limit of Affected Residential Buildings Located Less Than 150m From Construction site where the noise is being emitted on Monday to Saturday  
NA denote Not Available

**Table 56: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL203\_R1 Day 2**

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 2	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	81.6	NA	NA
0800 – 0900	81.7		
0900 – 1000	81.3		
1000 – 1100	78.2		
1100 – 1200	77.0		
1200 – 1300	80.1		
1300 – 1400	79.4		
1400 – 1500	79.8		
1500 – 1600	80.0		
1600 – 1700	80.1		
1700 – 1800	80.0		
1800 – 1900	79.2		
1900 – 2000	<b>78.9</b>	NA	65
2000 – 2100	<b>78.1</b>		
2100 – 2200	<b>78.2</b>		
2200 – 2300	<b>77.7</b>	NA	55
2300 – 0000	<b>76.6</b>		
0000 – 0100	<b>75.0</b>		
0100 – 0200	<b>73.4</b>		
0200 – 0300	<b>71.2</b>		
0300 – 0400	<b>71.5</b>		
0400 – 0500	<b>71.7</b>		
0500 – 0600	<b>74.5</b>		
0600 – 0700	<b>79.0</b>		

Remark: \* Limit of Affected Residential Buildings Located Less Than 150m From Construction site where the noise is being emitted on Monday to Saturday  
NA denote Not Available

**Table 57: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL203\_R1 Day 3**

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 3	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	81.8	NA	NA
0800 – 0900	81.5		
0900 – 1000	81.2		
1000 – 1100	77.1		
1100 – 1200	77.5		
1200 – 1300	76.0		
1300 – 1400	76.4		
1400 – 1500	77.0		
1500 – 1600	76.4		
1600 – 1700	77.7		
1700 – 1800	82.1		
1800 – 1900	83.5		
1900 – 2000	<b>79.9</b>	NA	65
2000 – 2100	<b>78.6</b>		
2100 – 2200	<b>78.6</b>		
2200 – 2300	<b>77.9</b>	NA	55
2300 – 0000	<b>76.8</b>		
0000 – 0100	<b>75.4</b>		
0100 – 0200	<b>73.2</b>		
0200 – 0300	<b>71.4</b>		
0300 – 0400	<b>70.9</b>		
0400 – 0500	<b>71.8</b>		
0500 – 0600	<b>74.7</b>		
0600 – 0700	<b>79.0</b>		

Remark: \* Limit of Affected Residential Buildings Located Less Than 150m From Construction site where the noise is being emitted on Monday to Saturday  
NA denote Not Available

**Table 58: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL203\_R1 Day 4**

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 4	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	80.1	NA	NA
0800 – 0900	80.5		
0900 – 1000	80.4		
1000 – 1100	80.2		
1100 – 1200	80.1		
1200 – 1300	76.7		
1300 – 1400	77.2		
1400 – 1500	77.7		
1500 – 1600	76.8		
1600 – 1700	77.2		
1700 – 1800	80.1		
1800 – 1900	79.9		
1900 – 2000	<b>78.6</b>	NA	65
2000 – 2100	<b>78.0</b>		
2100 – 2200	<b>78.1</b>		
2200 – 2300	<b>77.8</b>	NA	55
2300 – 0000	<b>77.0</b>		
0000 – 0100	<b>76.0</b>		
0100 – 0200	<b>74.1</b>		
0200 – 0300	<b>73.3</b>		
0300 – 0400	<b>72.2</b>		
0400 – 0500	<b>72.6</b>		
0500 – 0600	<b>74.3</b>		
0600 – 0700	<b>77.7</b>		

Remark: \* Limit of Affected Residential Buildings Located Less Than 150m From Construction site where the noise is being emitted on Monday to Saturday  
NA denote Not Available



**Table 59: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL203\_R1 Day 5**

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 5 (weekend)	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	77.8	NA	NA
0800 – 0900	78.7		
0900 – 1000	77.6		
1000 – 1100	78.9		
1100 – 1200	78.7		
1200 – 1300	79.9		
1300 – 1400	79.8		
1400 – 1500	80.1		
1500 – 1600	79.9		
1600 – 1700	79.7		
1700 – 1800	83.4		
1800 – 1900	81.0		
1900 – 2000	<b>79.0</b>	NA	65
2000 – 2100	<b>78.2</b>		
2100 – 2200	<b>77.7</b>		
2200 – 2300	<b>77.9</b>	NA	55
2300 – 0000	<b>77.5</b>		
0000 – 0100	<b>76.4</b>		
0100 – 0200	<b>74.9</b>		
0200 – 0300	<b>73.5</b>		
0300 – 0400	<b>72.4</b>		
0400 – 0500	<b>72.1</b>		
0500 – 0600	<b>72.8</b>		
0600 – 0700	<b>75.8</b>		

Remark: \* Limit of Affected Residential Buildings Located Less Than 150m From Construction site where the noise is being emitted on Monday to Saturday  
NA denote Not Available

**Table 60: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL203\_R1 Day 6**

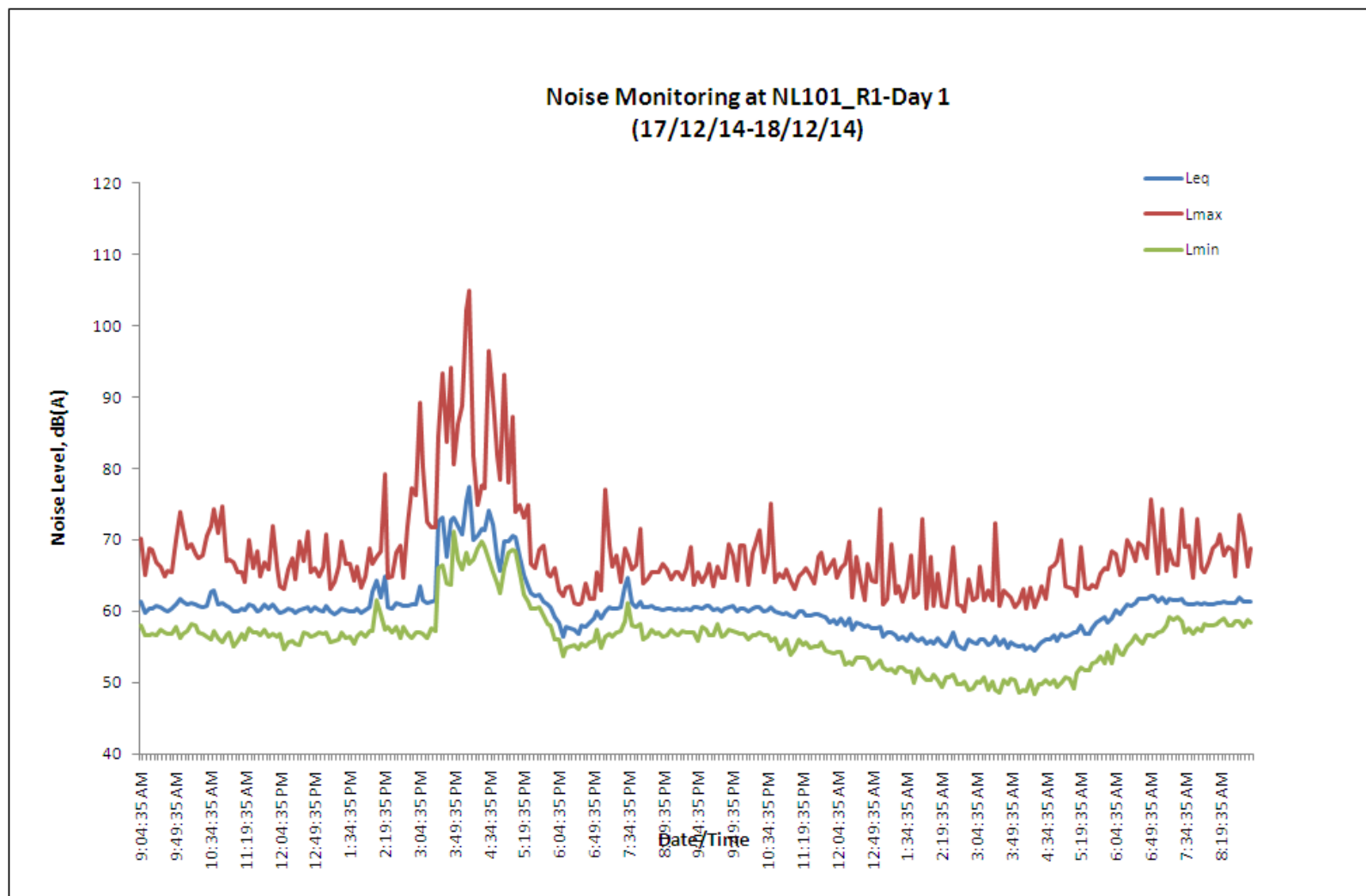
Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 6 (weekend)	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	81.8	NA	NA
0800 – 0900	82.0		
0900 – 1000	81.3		
1000 – 1100	79.1		
1100 – 1200	79.1		
1200 – 1300	78.7		
1300 – 1400	78.5		
1400 – 1500	79.4		
1500 – 1600	78.8		
1600 – 1700	78.9		
1700 – 1800	78.7		
1800 – 1900	78.8		
1900 – 2000	79.9	NA	65
2000 – 2100	77.5		
2100 – 2200	77.7		
2200 – 2300	77.4	NA	55
2300 – 0000	76.9		
0000 – 0100	75.1		
0100 – 0200	73.2		
0200 – 0300	70.5		
0300 – 0400	70.3		
0400 – 0500	71.1		
0500 – 0600	74.5		
0600 – 0700	79.3		

Remark: \* Limit of Affected Residential Buildings Located Less Than 150m From Construction site where the noise is being emitted on Monday to Saturday  
NA denote Not Available

**Table 61: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL203\_R1 Day 7**

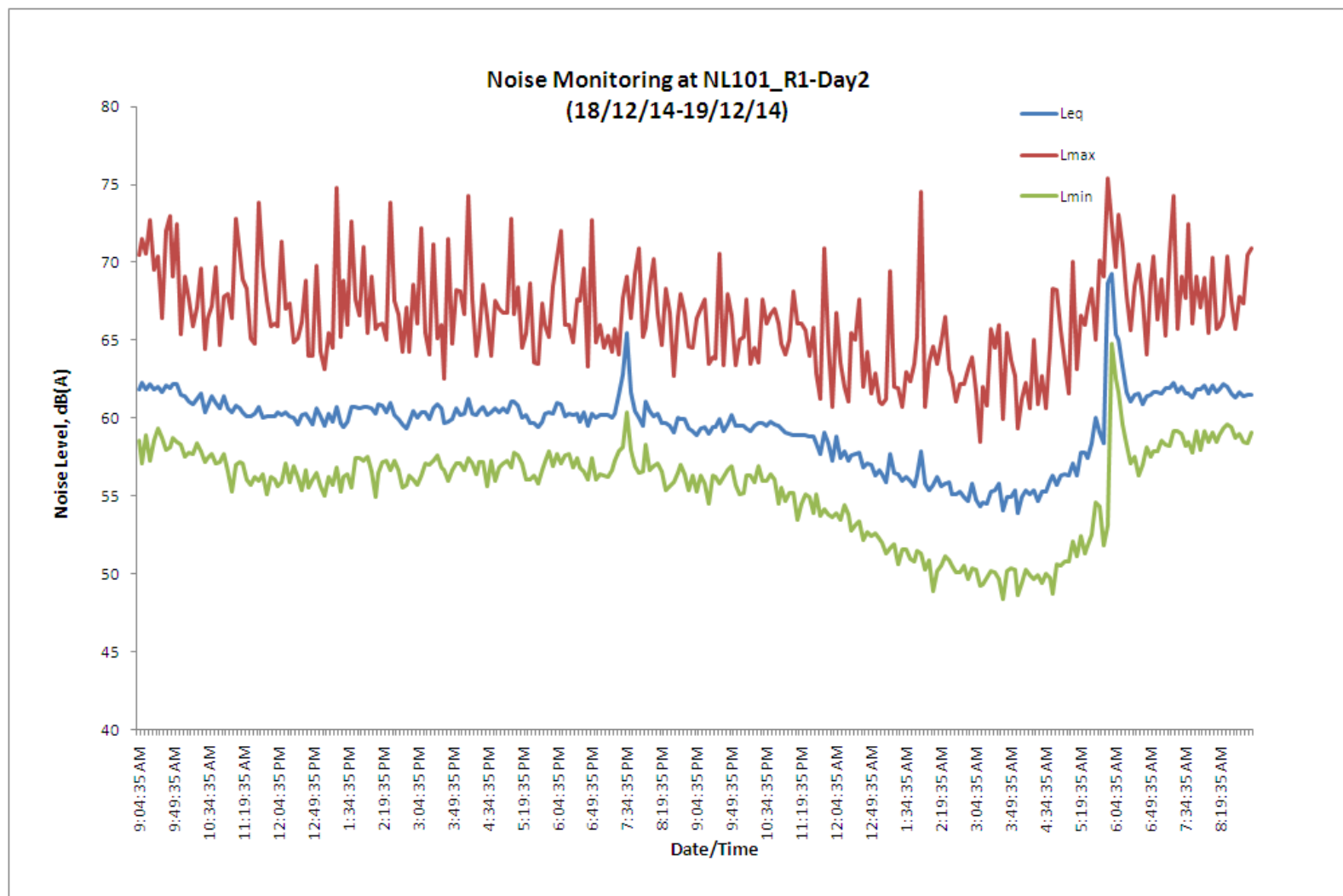
Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 7	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	81.8	NA	NA
0800 – 0900	82.1		
0900 – 1000	80.9		
1000 – 1100	79.6		
1100 – 1200	79.9		
1200 – 1300	79.0		
1300 – 1400	78.2		
1400 – 1500	78.2		
1500 – 1600	77.9		
1600 – 1700	79.0		
1700 – 1800	80.0		
1800 – 1900	80.0		
1900 – 2000	<b>78.9</b>	NA	65
2000 – 2100	<b>78.0</b>		
2100 – 2200	<b>77.8</b>		
2200 – 2300	<b>77.7</b>	NA	55
2300 – 0000	<b>76.4</b>		
0000 – 0100	<b>75.0</b>		
0100 – 0200	<b>72.7</b>		
0200 – 0300	<b>71.0</b>		
0300 – 0400	<b>70.4</b>		
0400 – 0500	<b>71.4</b>		
0500 – 0600	<b>74.5</b>		
0600 – 0700	<b>79.4</b>		

Remark: \* Limit of Affected Residential Buildings Located Less Than 150m From Construction site where the noise is being emitted on Monday to Saturday  
NA denote Not Available

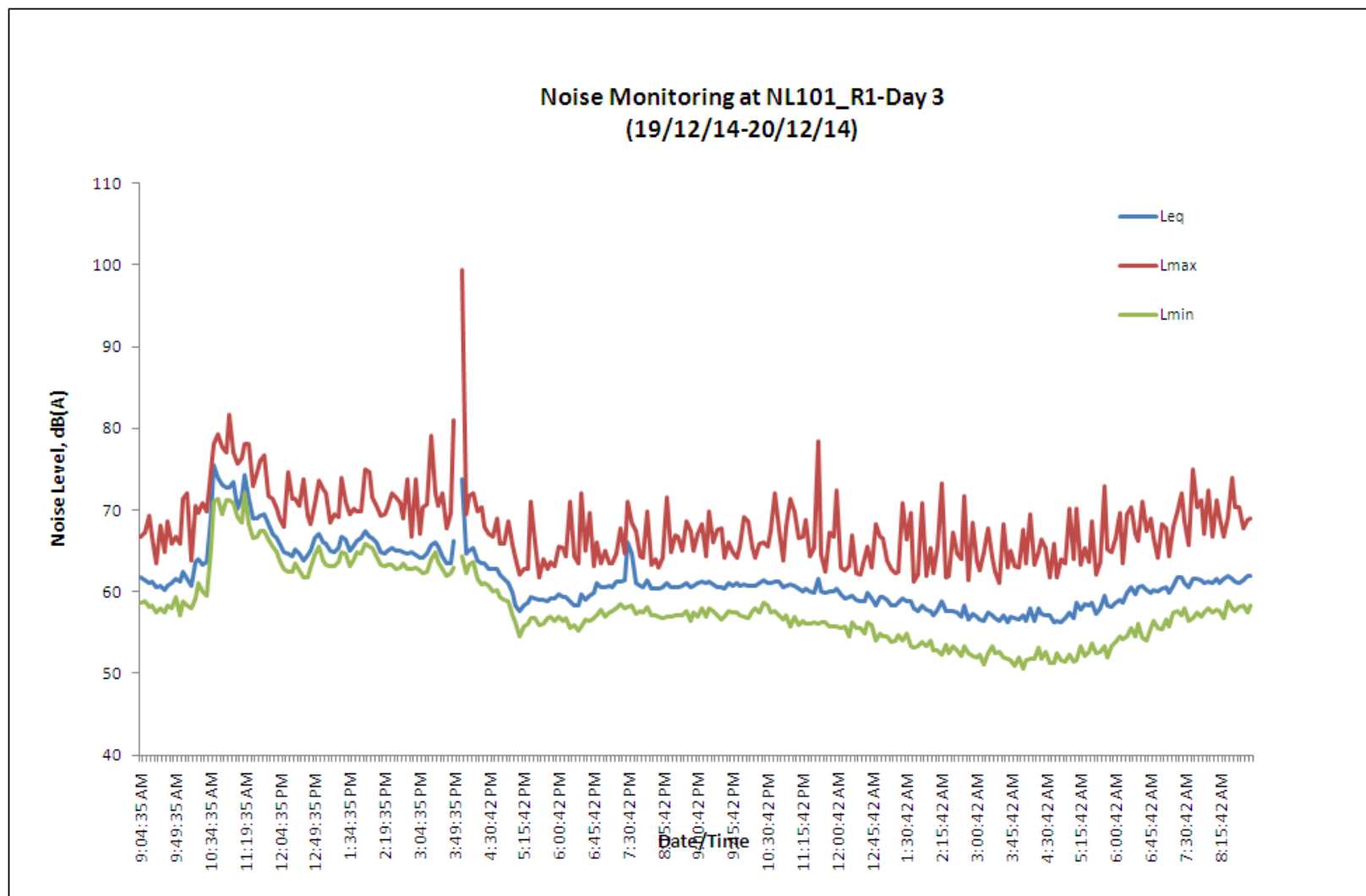


**Figure 4: Daily noise level measured at Point NL101\_R1 (Day 1)**

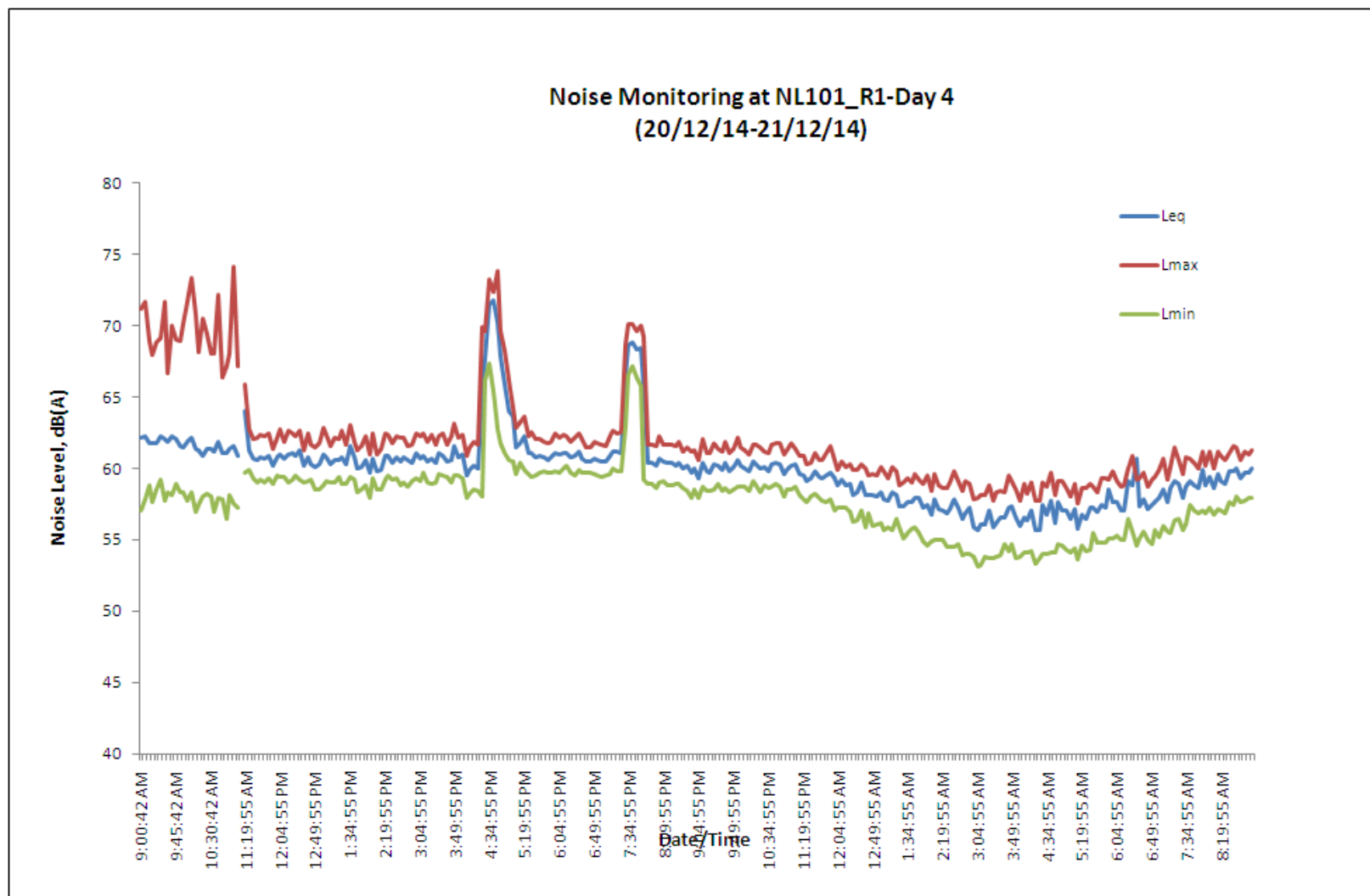




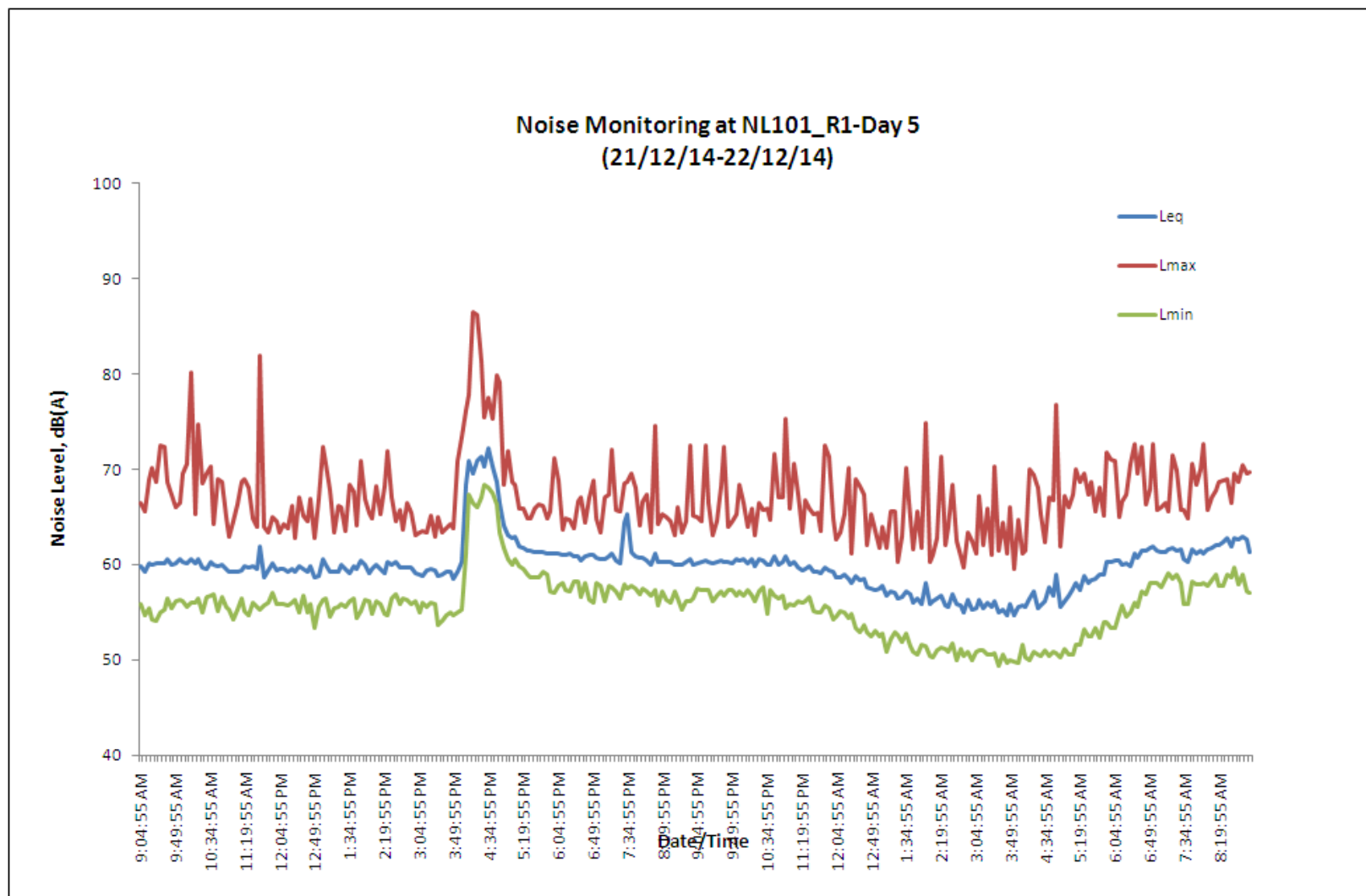
**Figure 5: Daily noise level measured at Point NL101\_R1 (Day 2)**



**Figure 6: Daily noise level measured at Point NL101\_R1 (Day 3)**

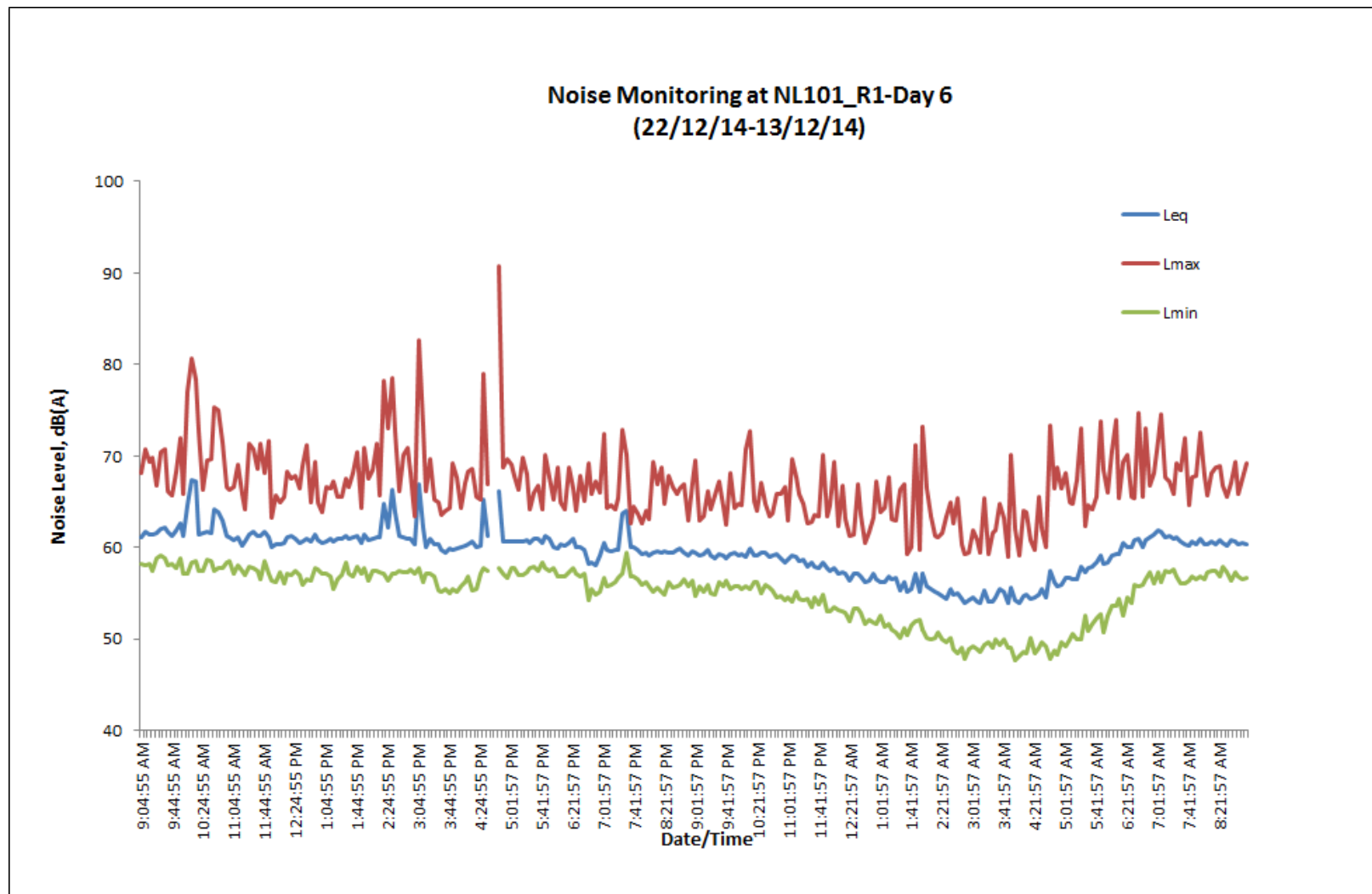


**Figure 7: Daily noise level measured at Point NL101\_R1 (Day 4)**

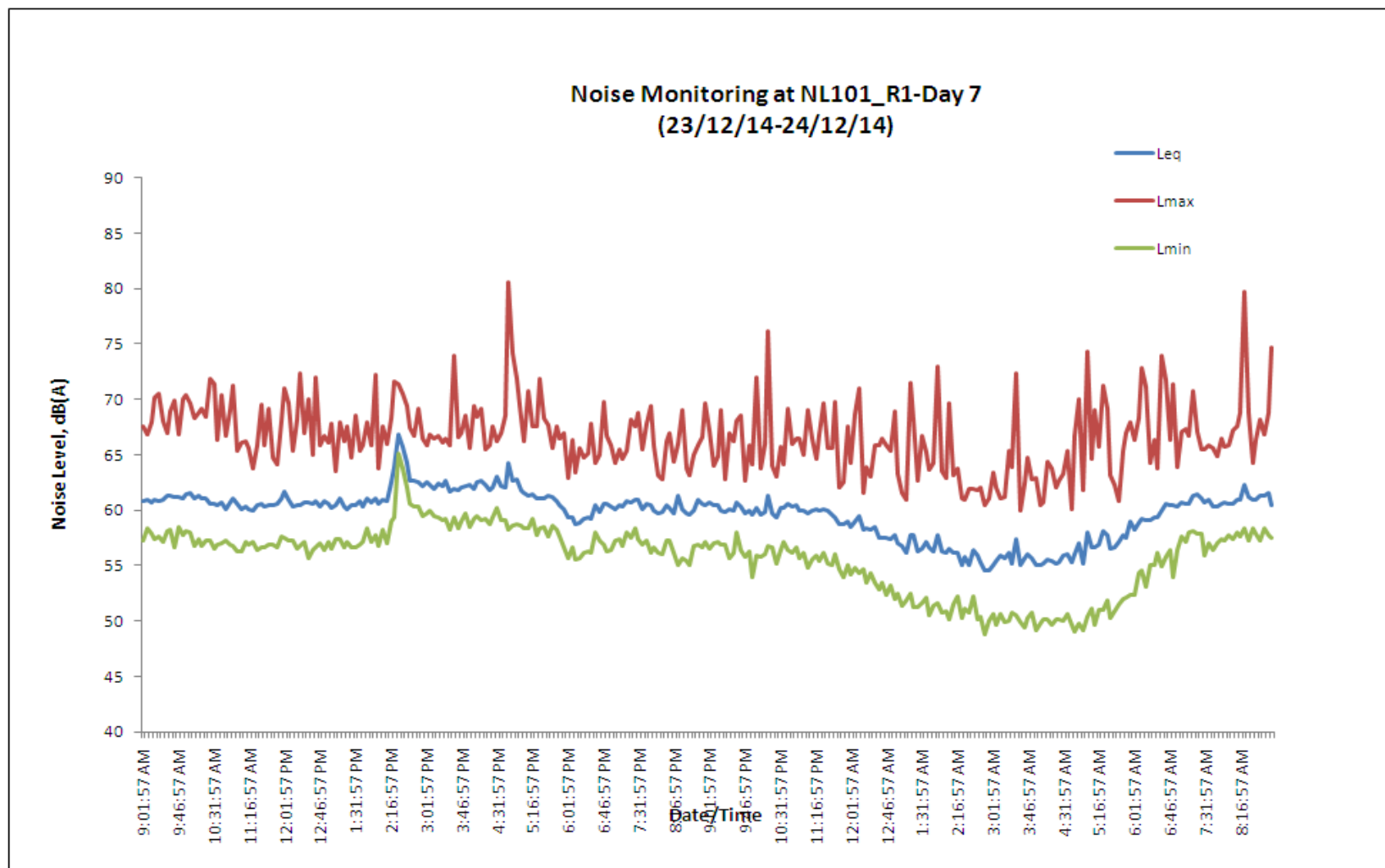


**Figure 8: Daily noise level measured at Point NL101\_R1 (Day 5)**

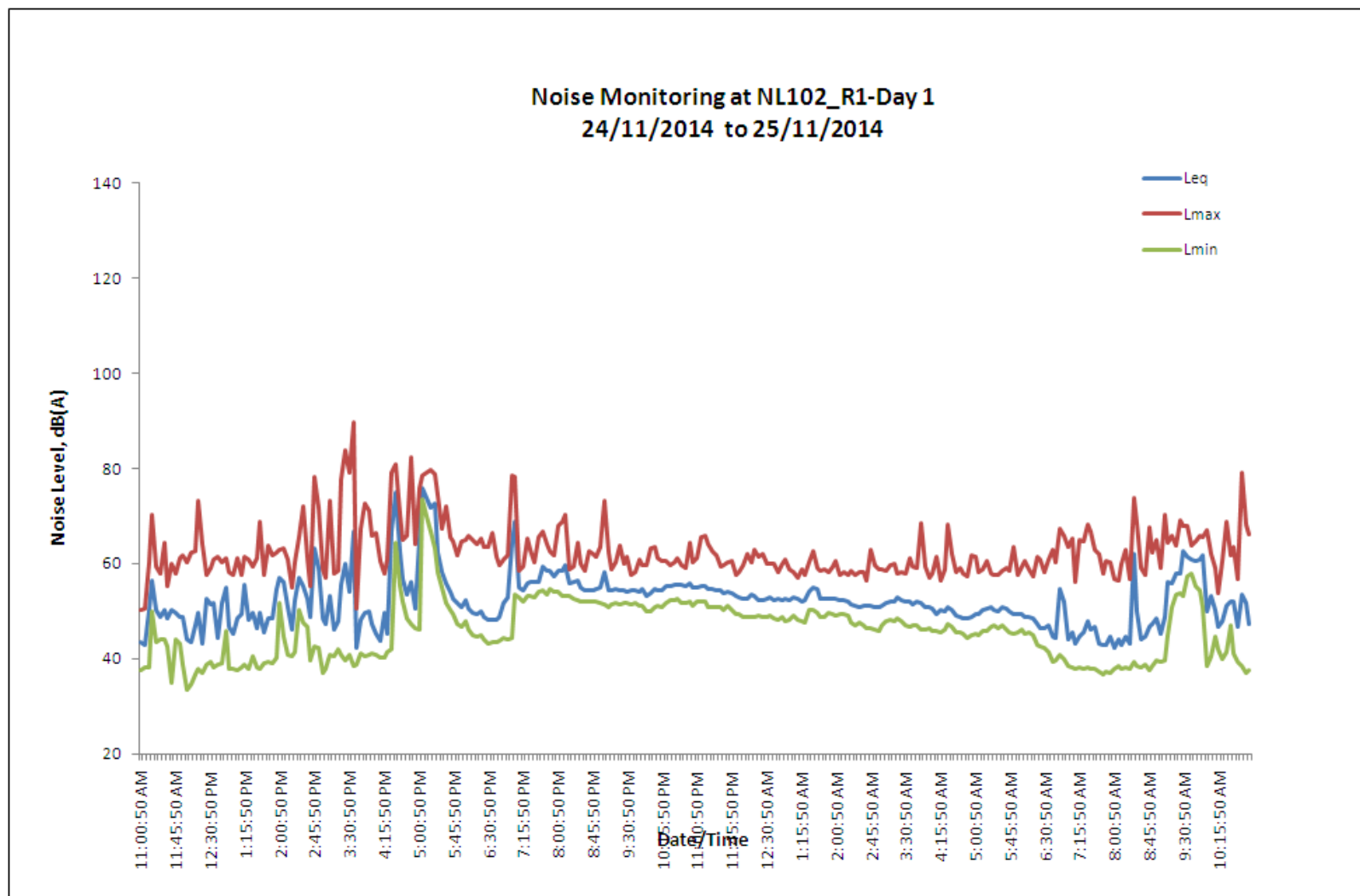




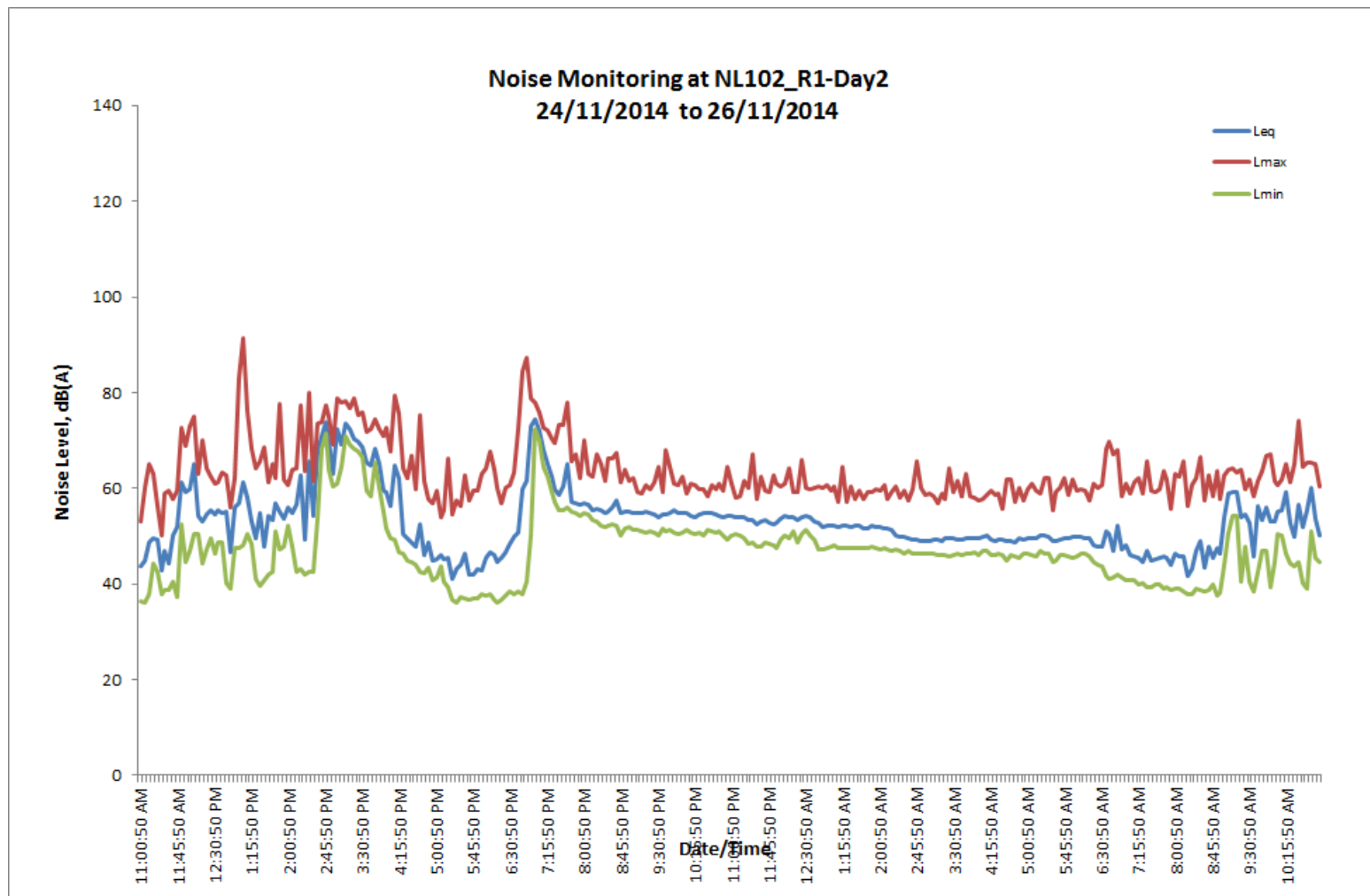
**Figure 9: Daily noise level measured at Point NL101\_R1 (Day 6)**



**Figure 10: Daily noise level measured at Point NL101\_R1 (Day 7)**

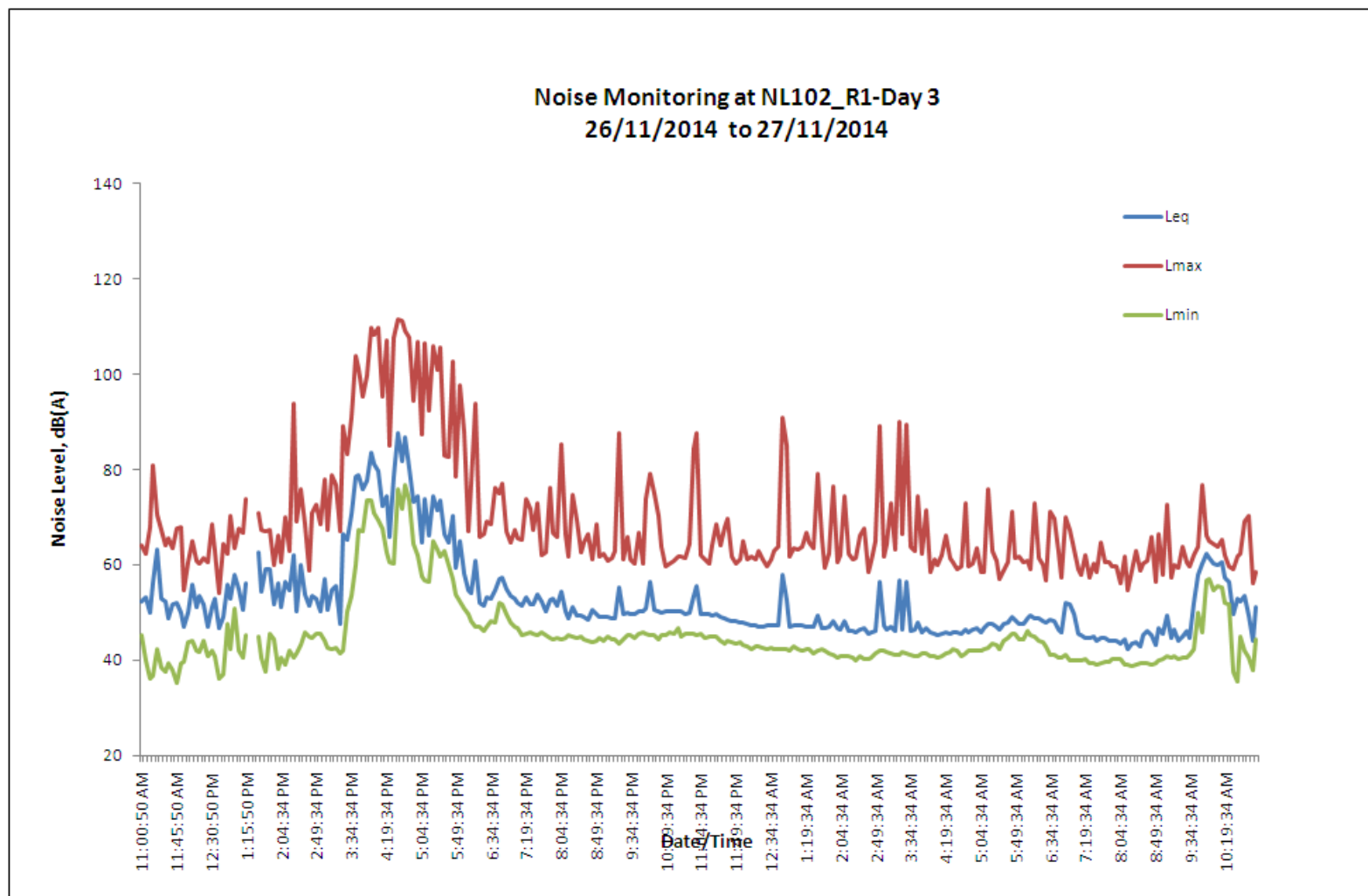


**Figure 11: Daily noise level measured at Point NL102\_R1 (Day 1)**

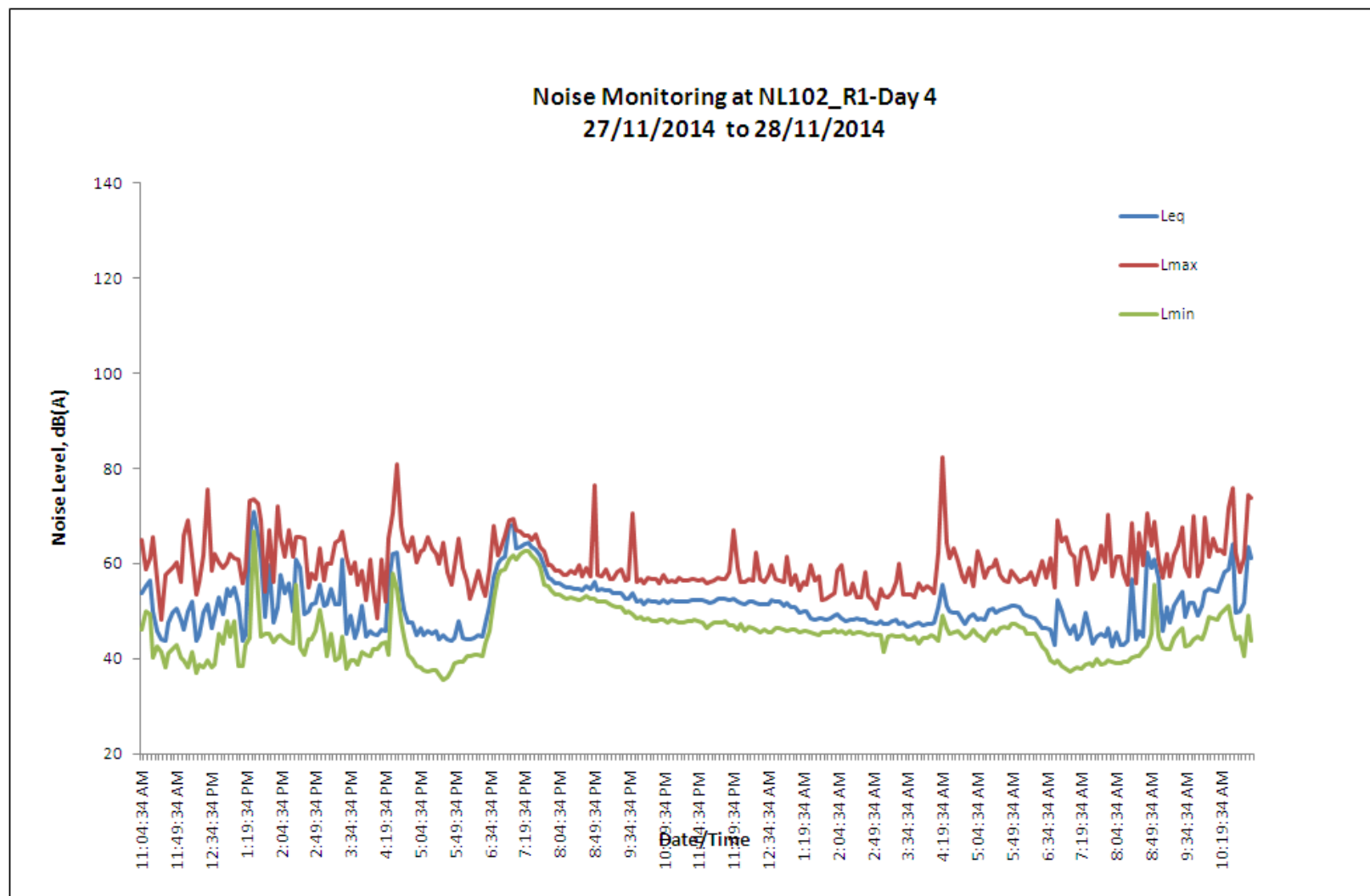


**Figure 12: Daily noise level measured at Point NL102\_R1 (Day 2)**

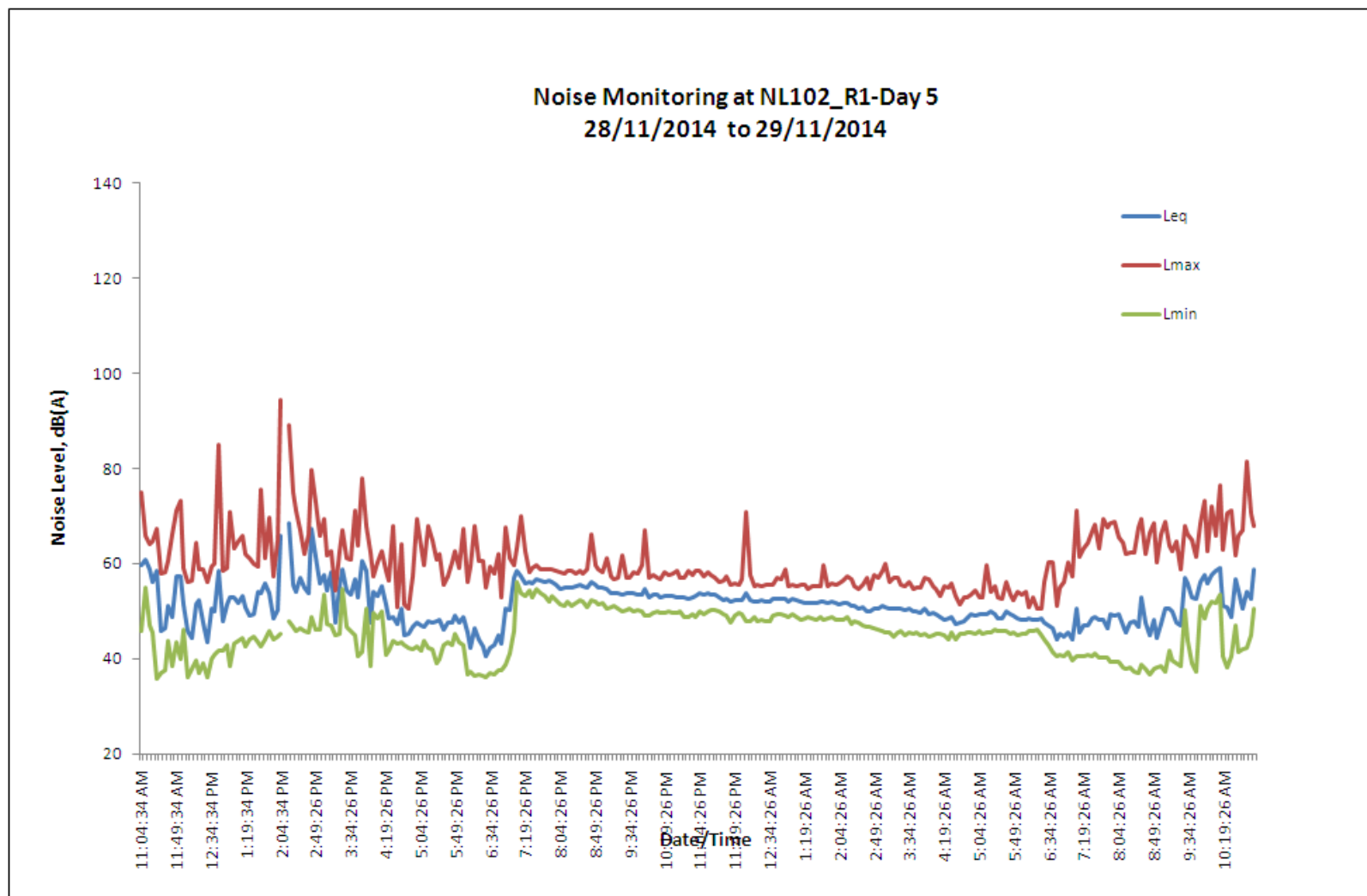




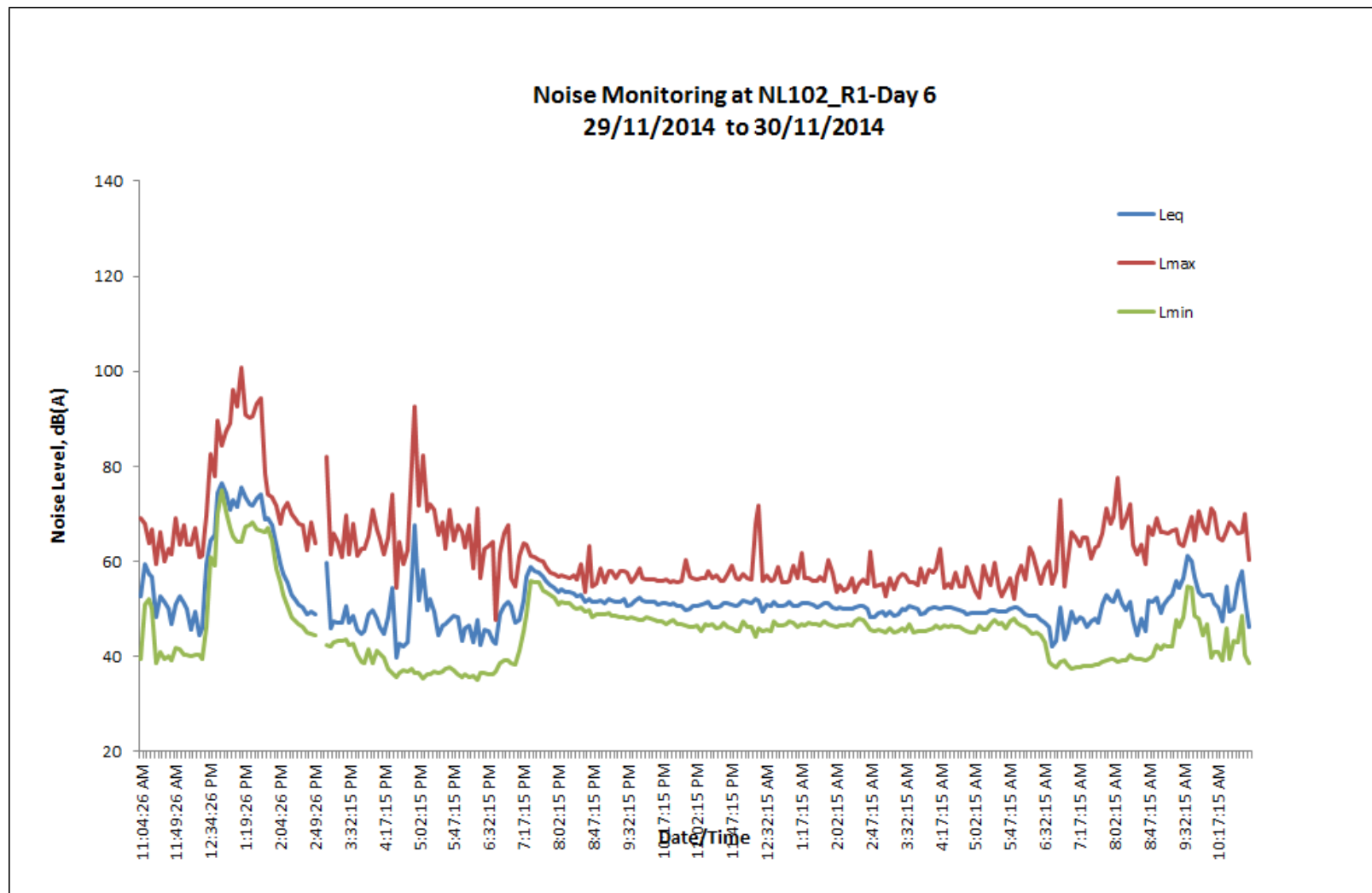
**Figure 13: Daily noise level measured at Point NL102\_R1 (Day 3)**



**Figure 14: Daily noise level measured at Point NL102\_R1 (Day 4)**

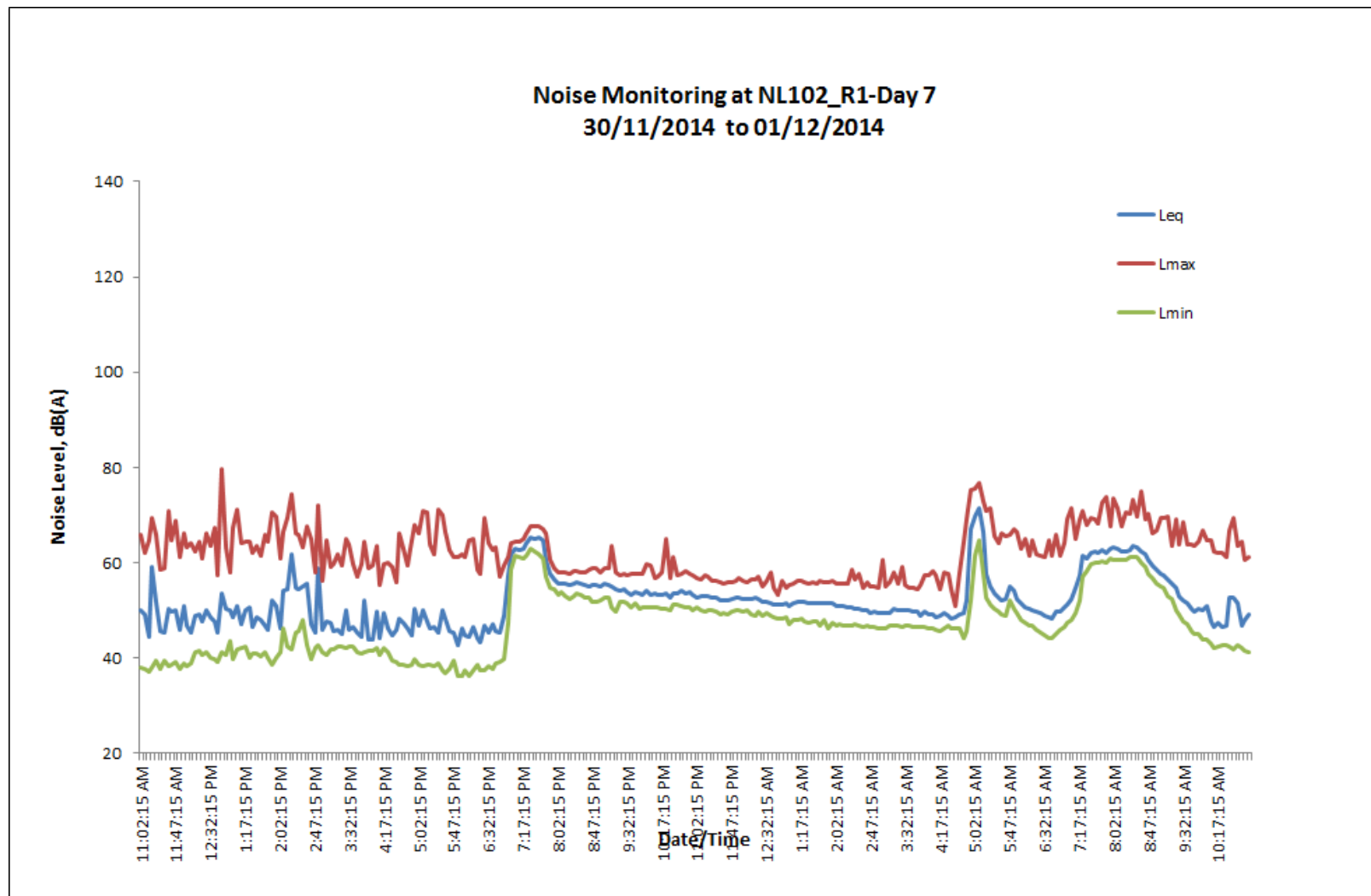


**Figure 15: Daily noise level measured at Point NL102\_R1 (Day 5)**

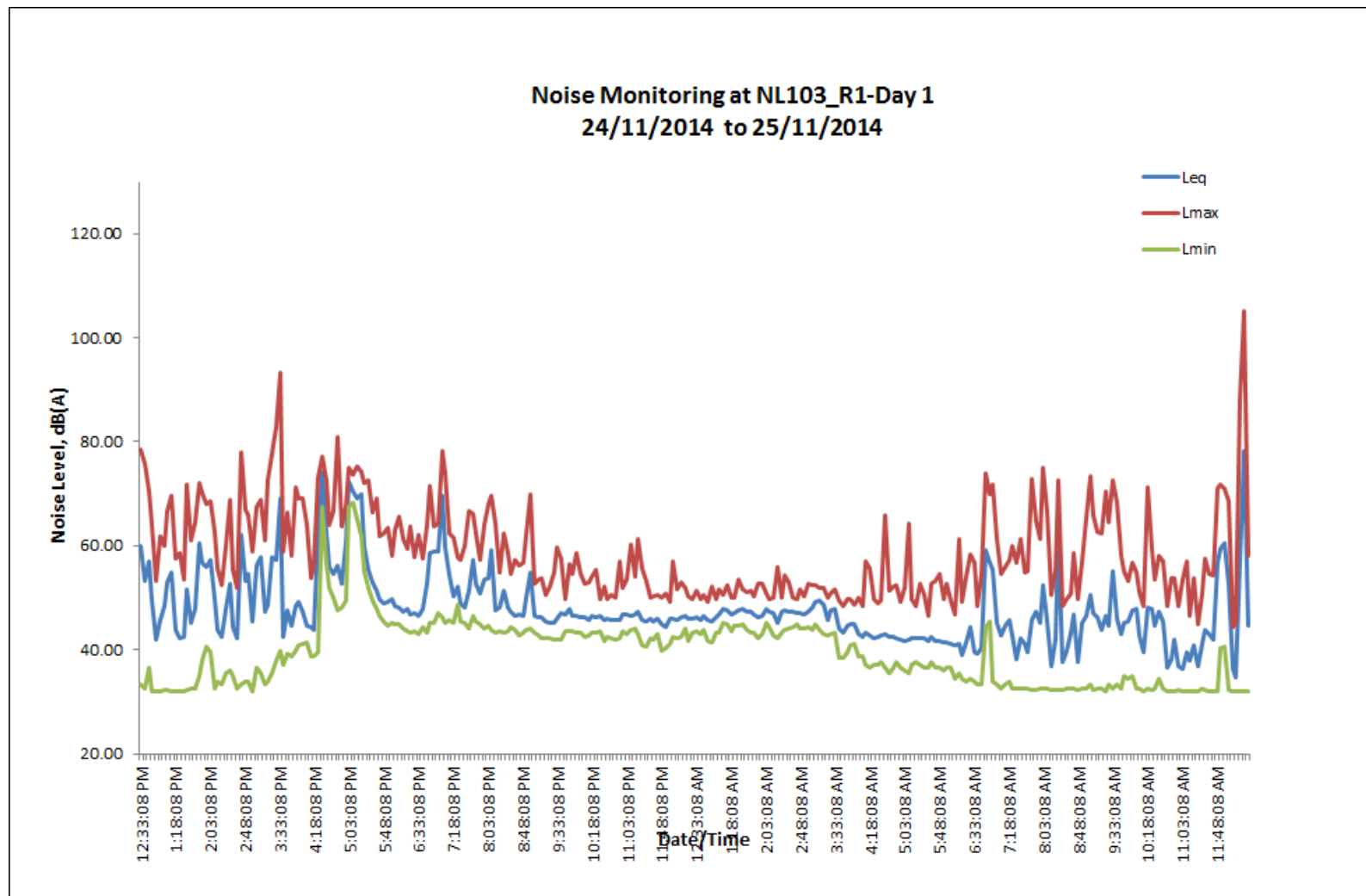


**Figure 16: Daily noise level measured at Point NL102\_R1 (Day 6)**

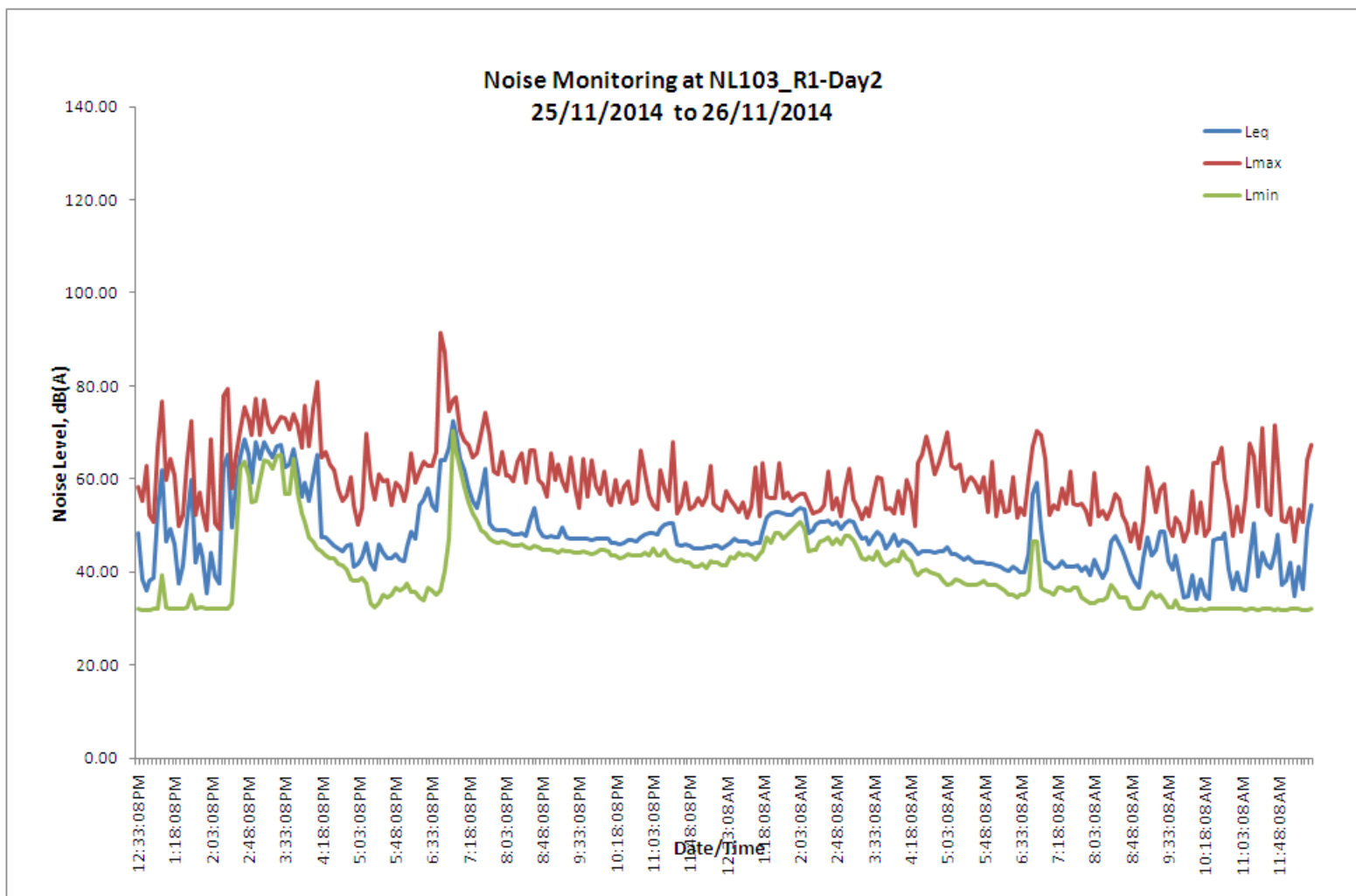




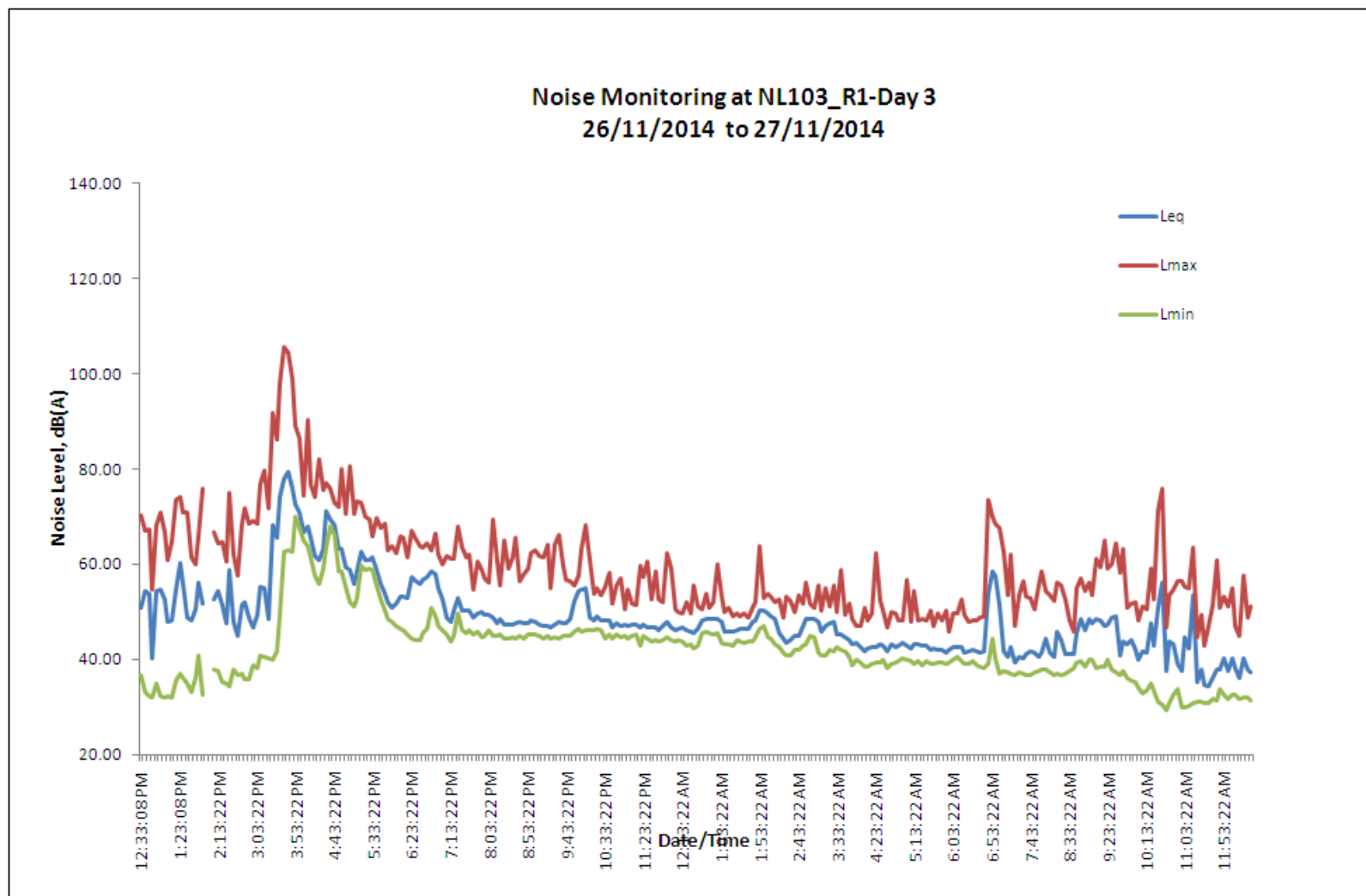
**Figure 17: Daily noise level measured at Point NL102\_R1 (Day 7)**



**Figure 18: Daily noise level measured at Point NL103\_R1 (Day 1)**

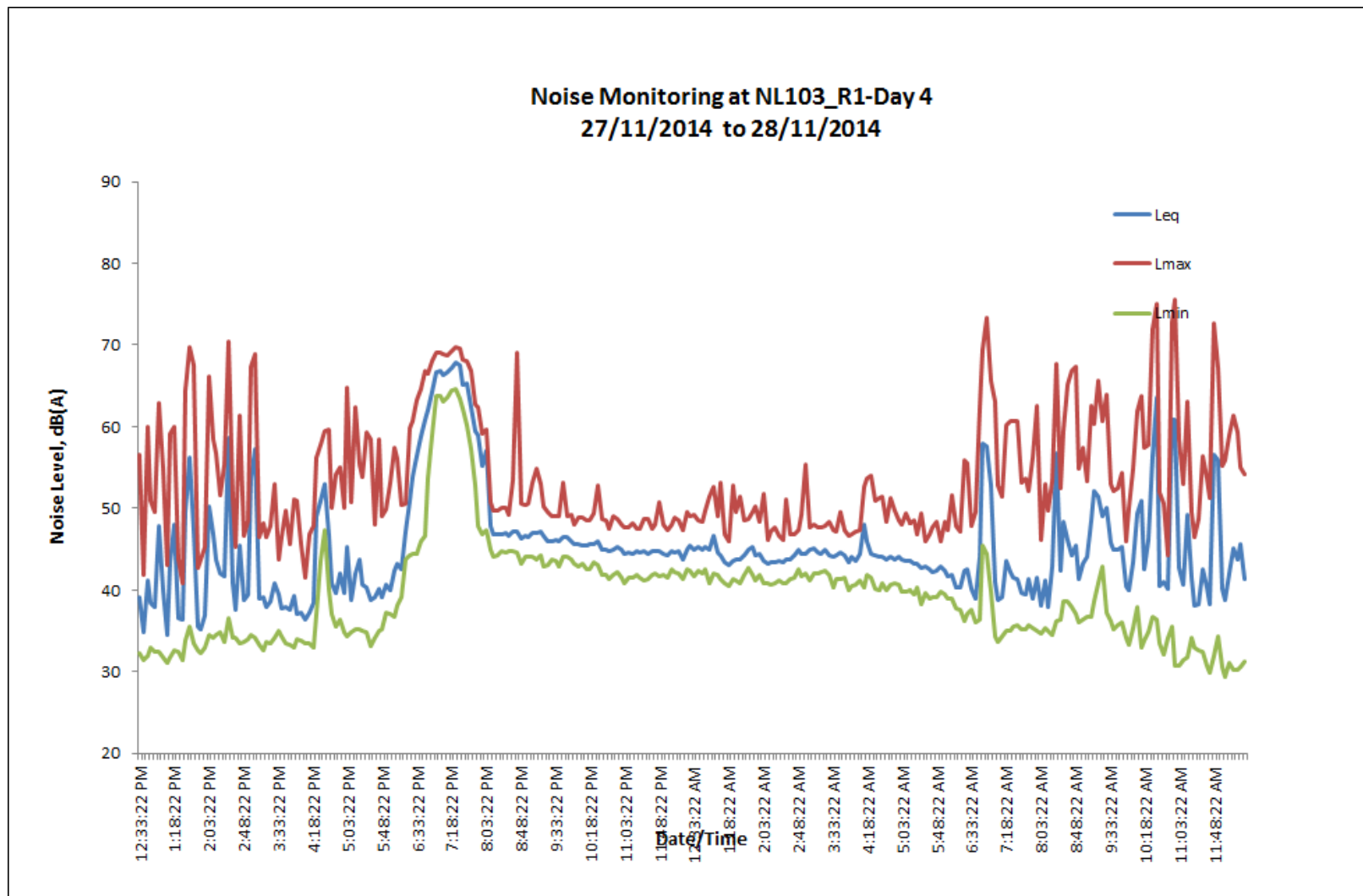


**Figure 19: Daily noise level measured at Point NL103\_R1 (Day 2)**

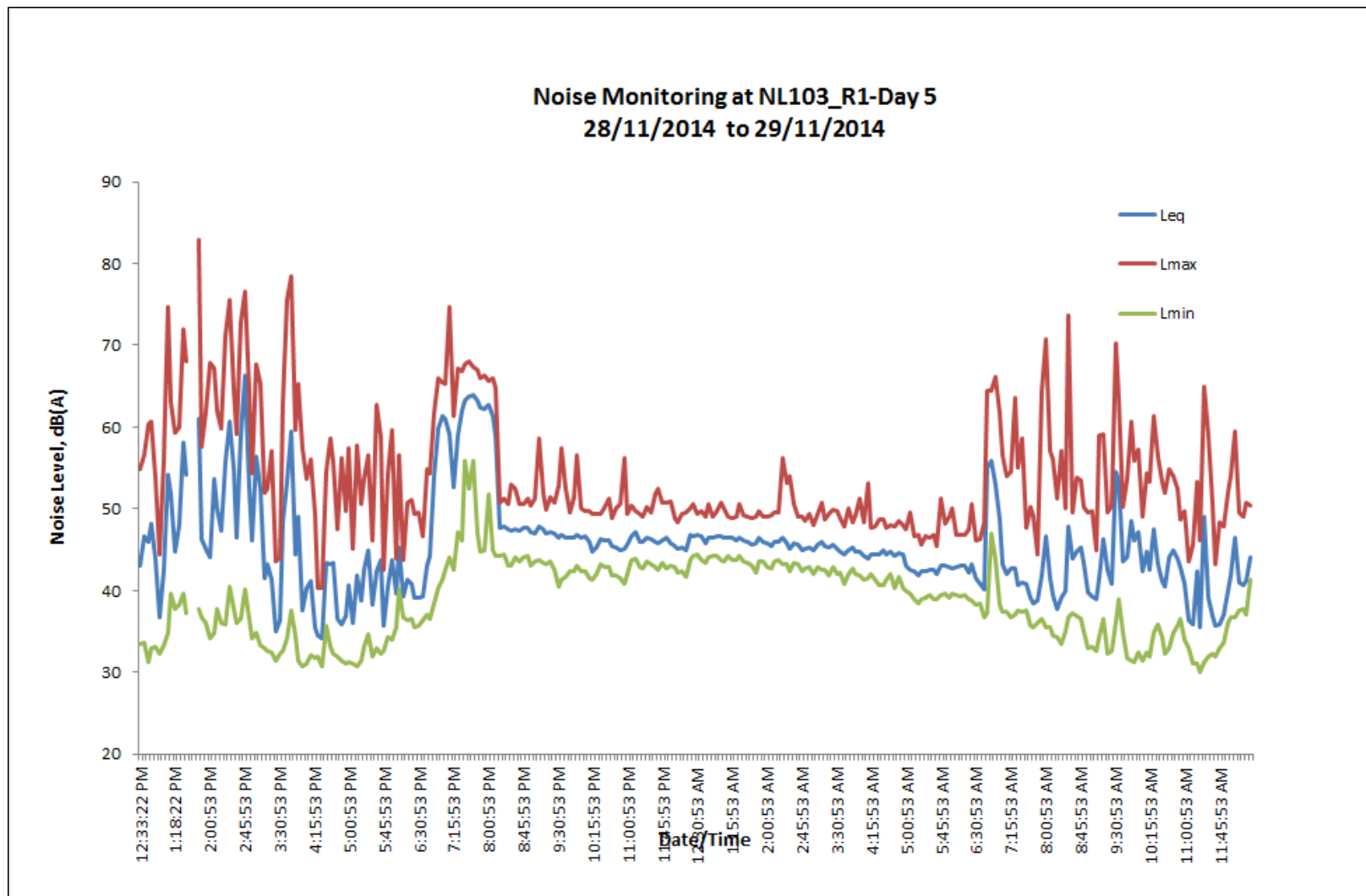


**Figure 20: Daily noise level measured at Point NL103\_R1 (Day 3)**

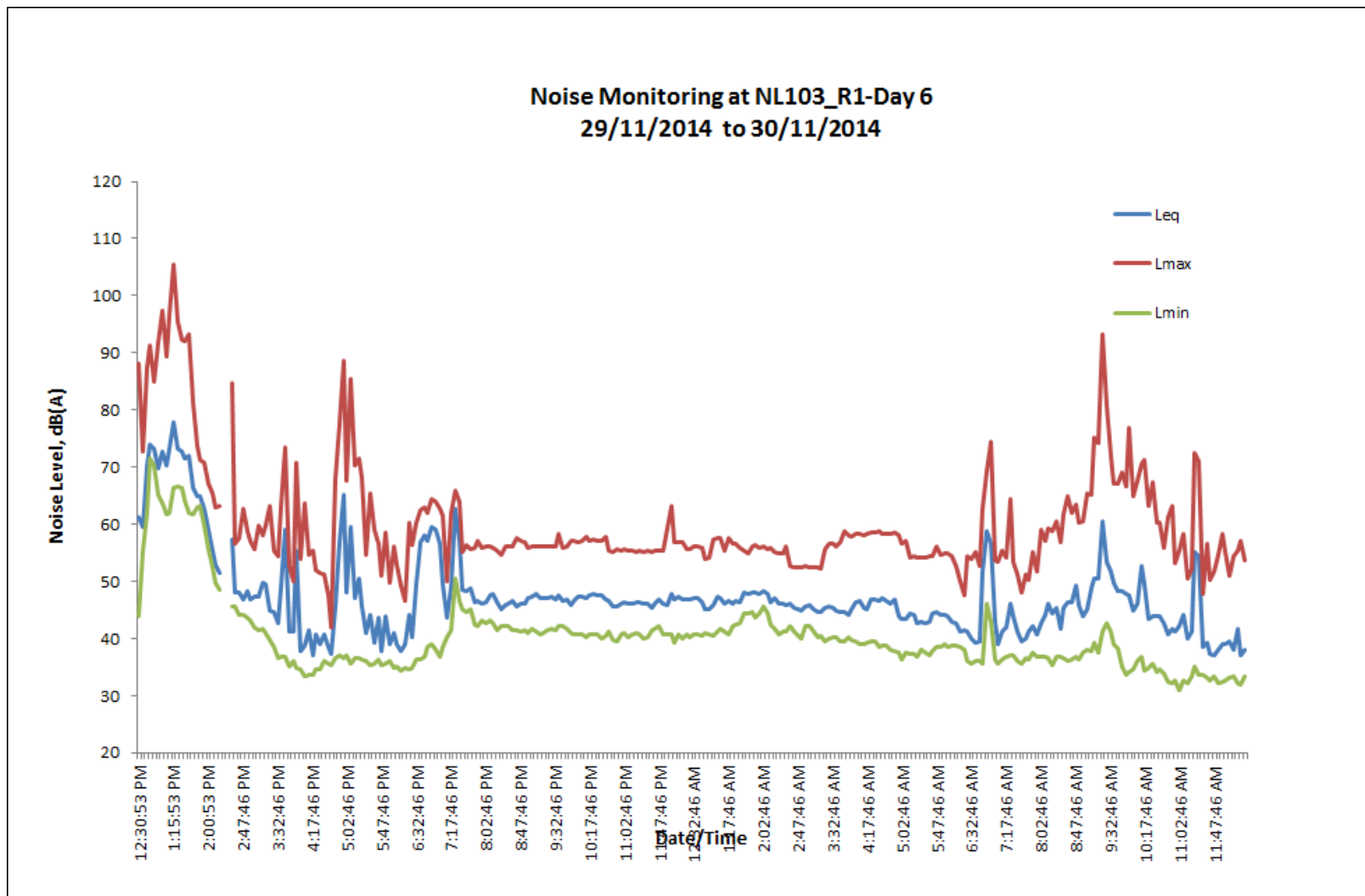




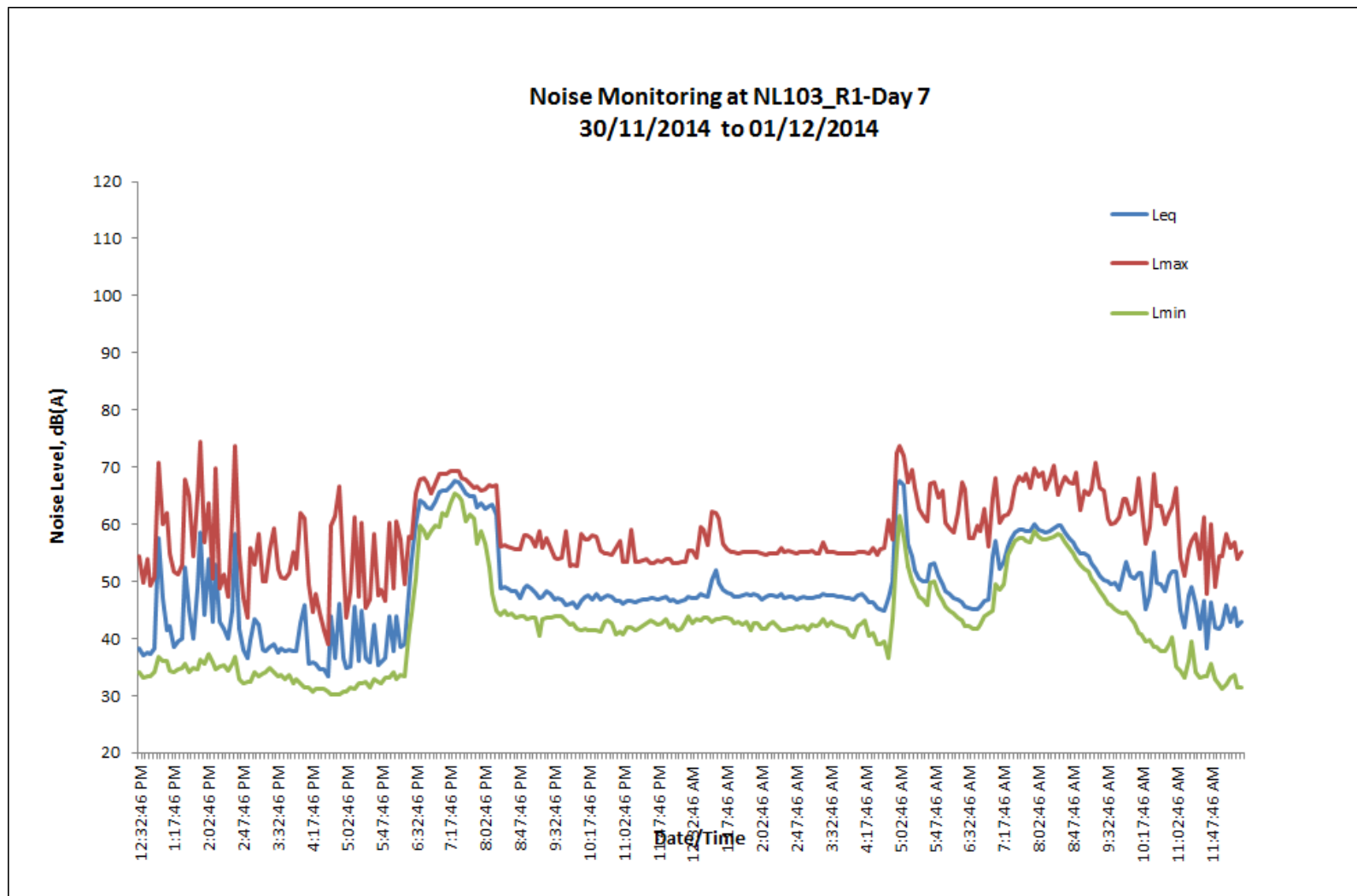
**Figure 21: Daily noise level measured at Point NL103\_R1 (Day 4)**



**Figure 22: Daily noise level measured at Point NL103\_R1 (Day 5)**

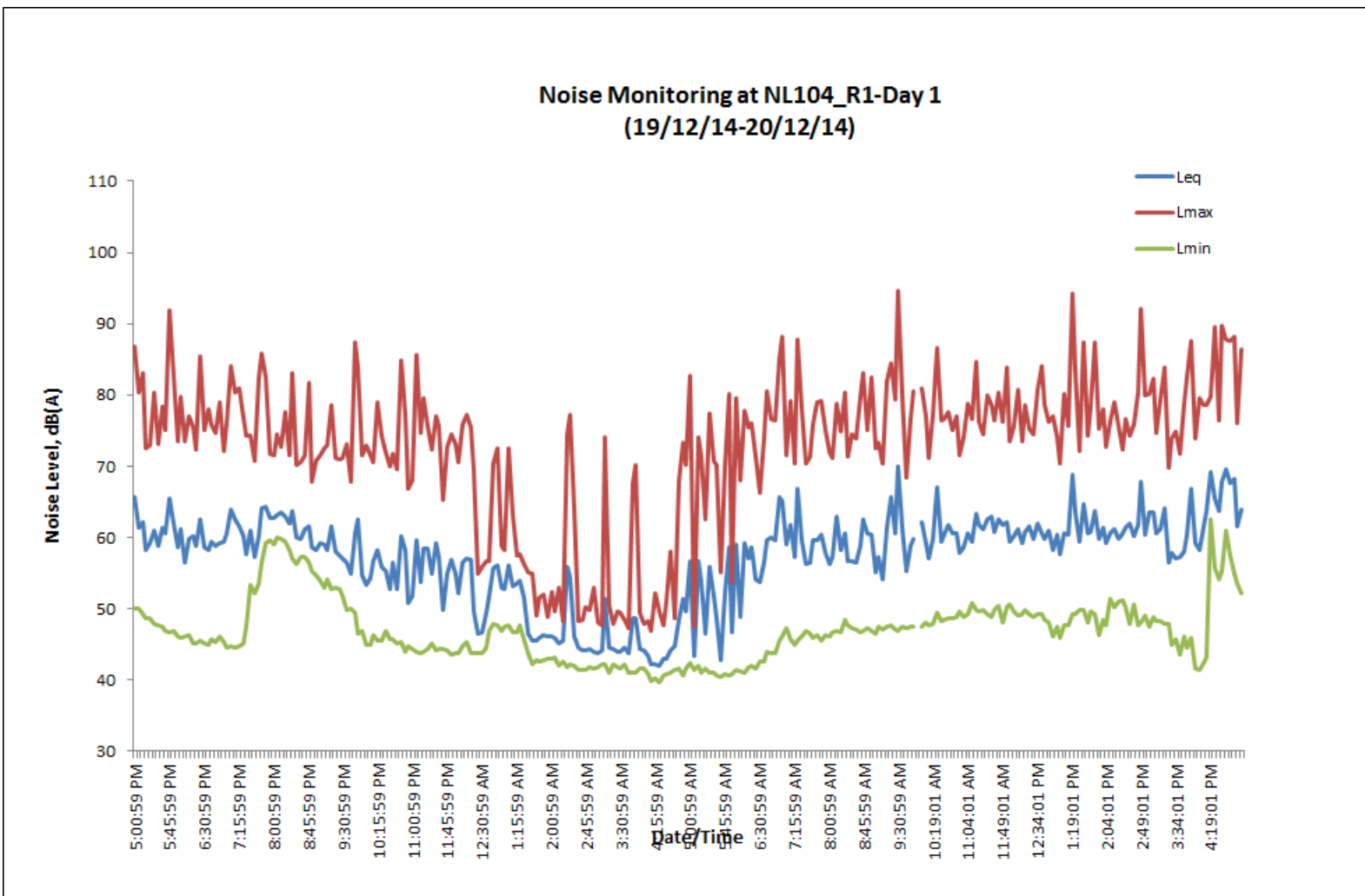


**Figure 23: Daily noise level measured at Point NL103\_R1 (Day 6)**

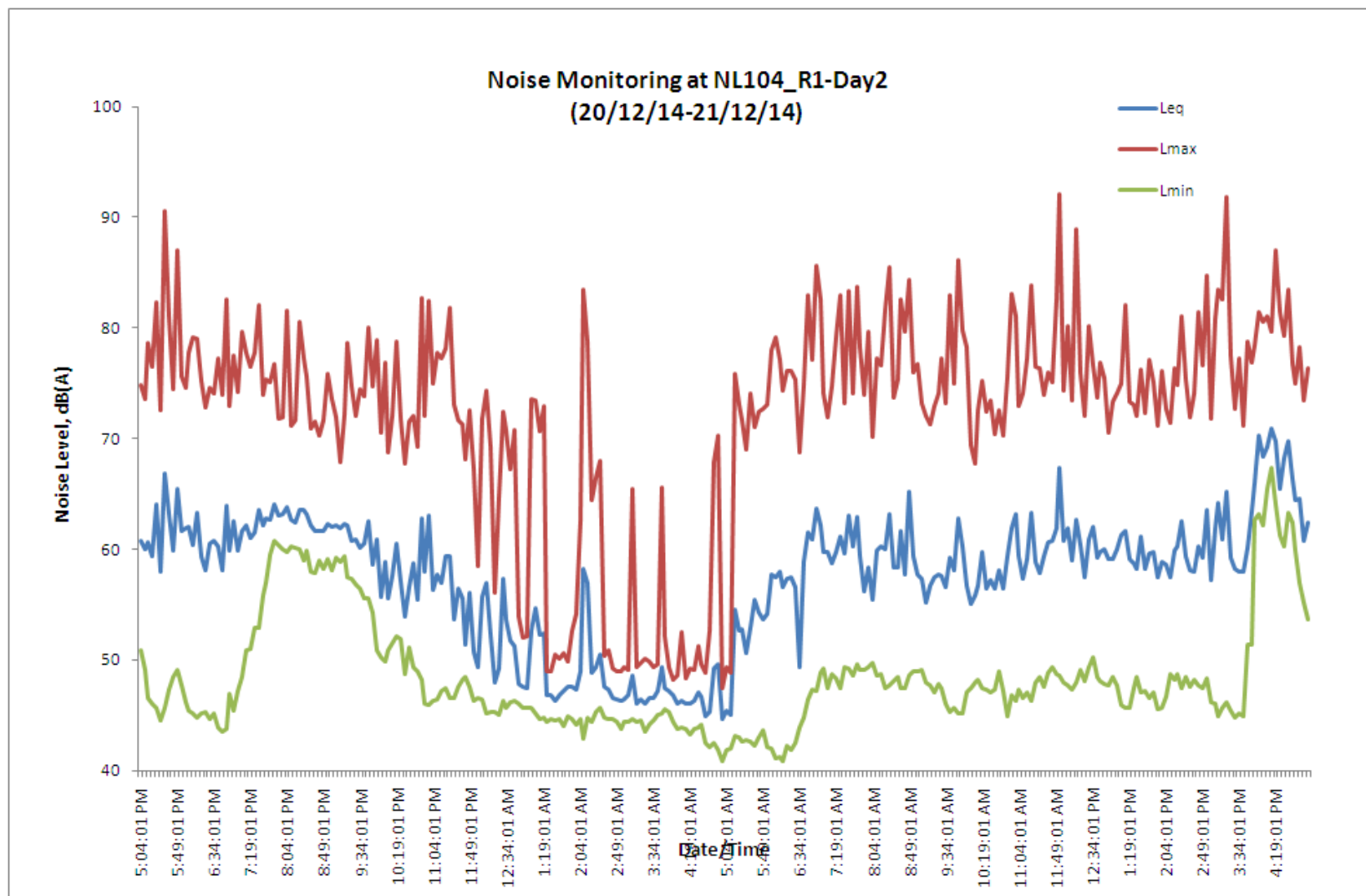


**Figure 24: Daily noise level measured at Point NL103\_R1 (Day 7)**

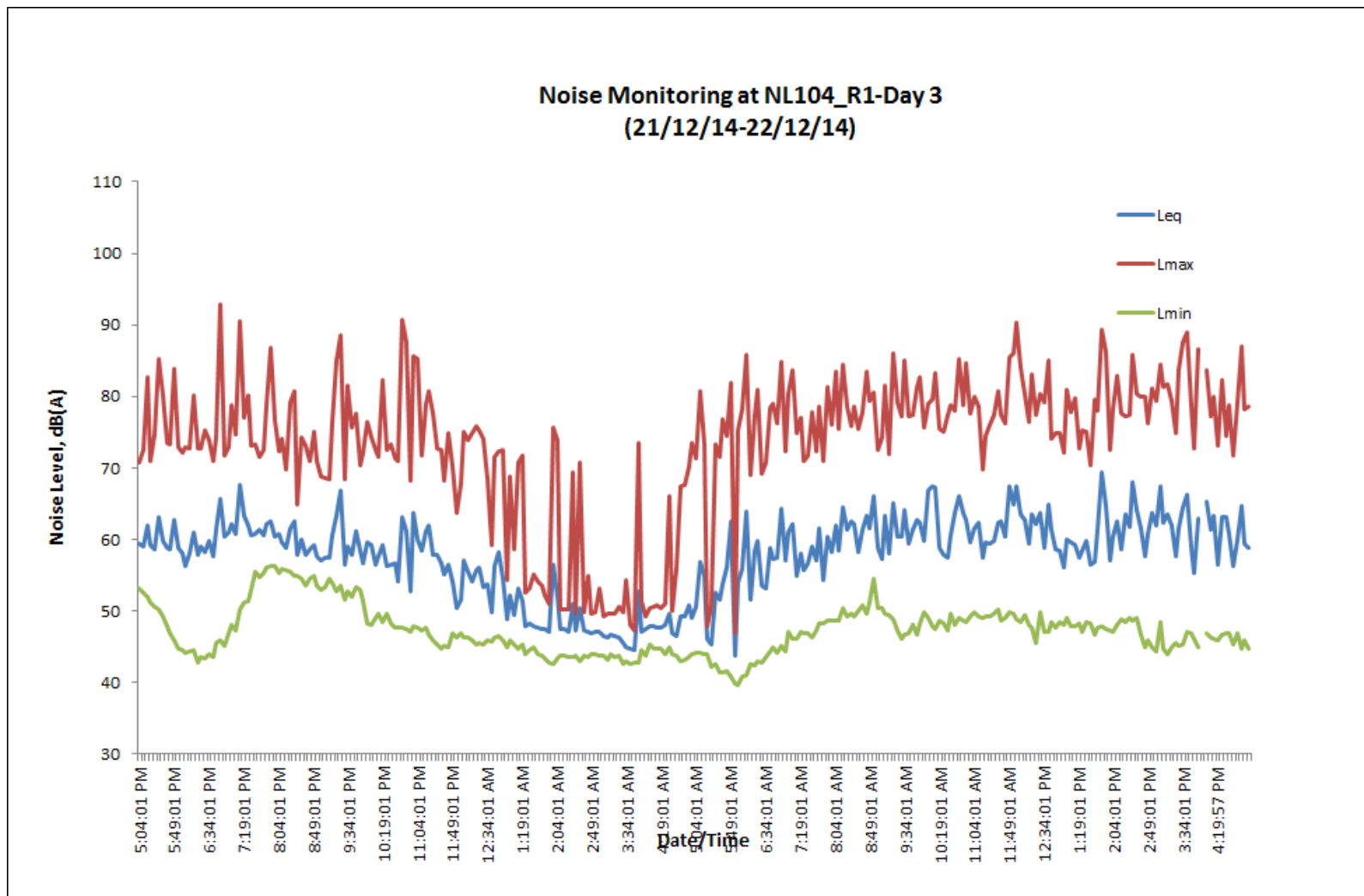




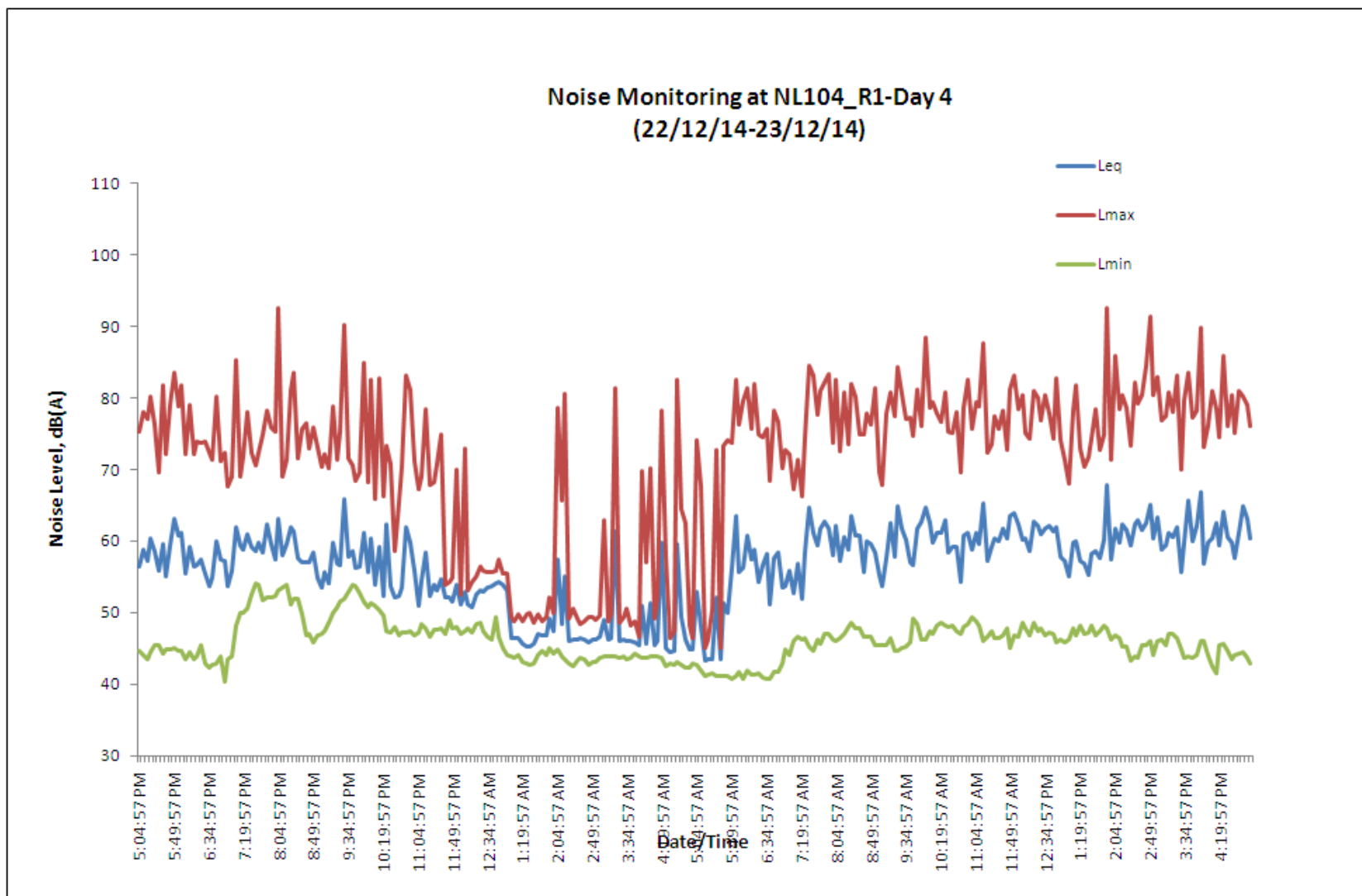
**Figure 25: Daily noise level measured at Point NL104\_R1 (Day 1)**



**Figure 26: Daily noise level measured at Point NL104\_R1 (Day 2)**

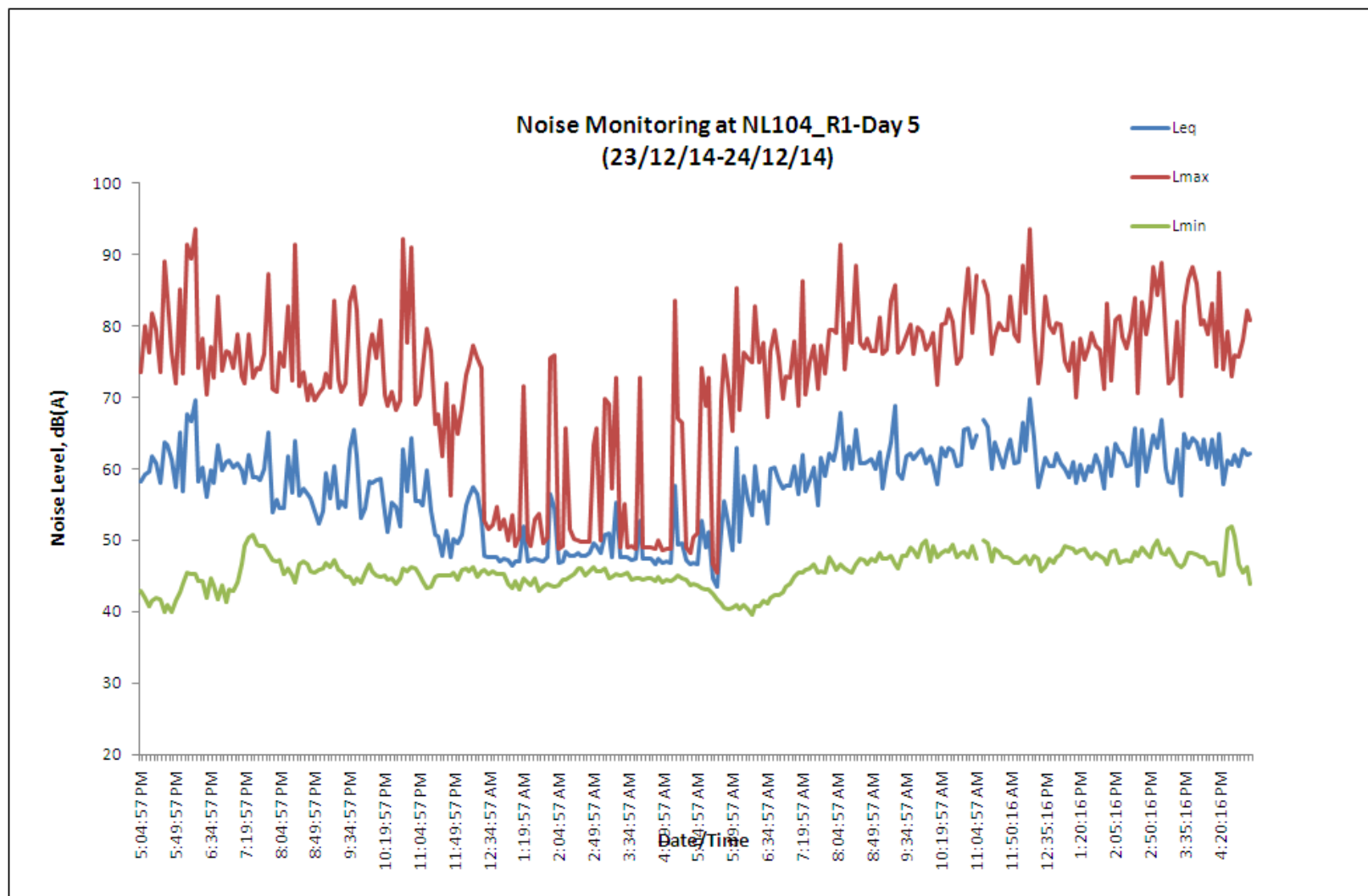


**Figure 27: Daily noise level measured at Point NL104\_R1 (Day 3)**

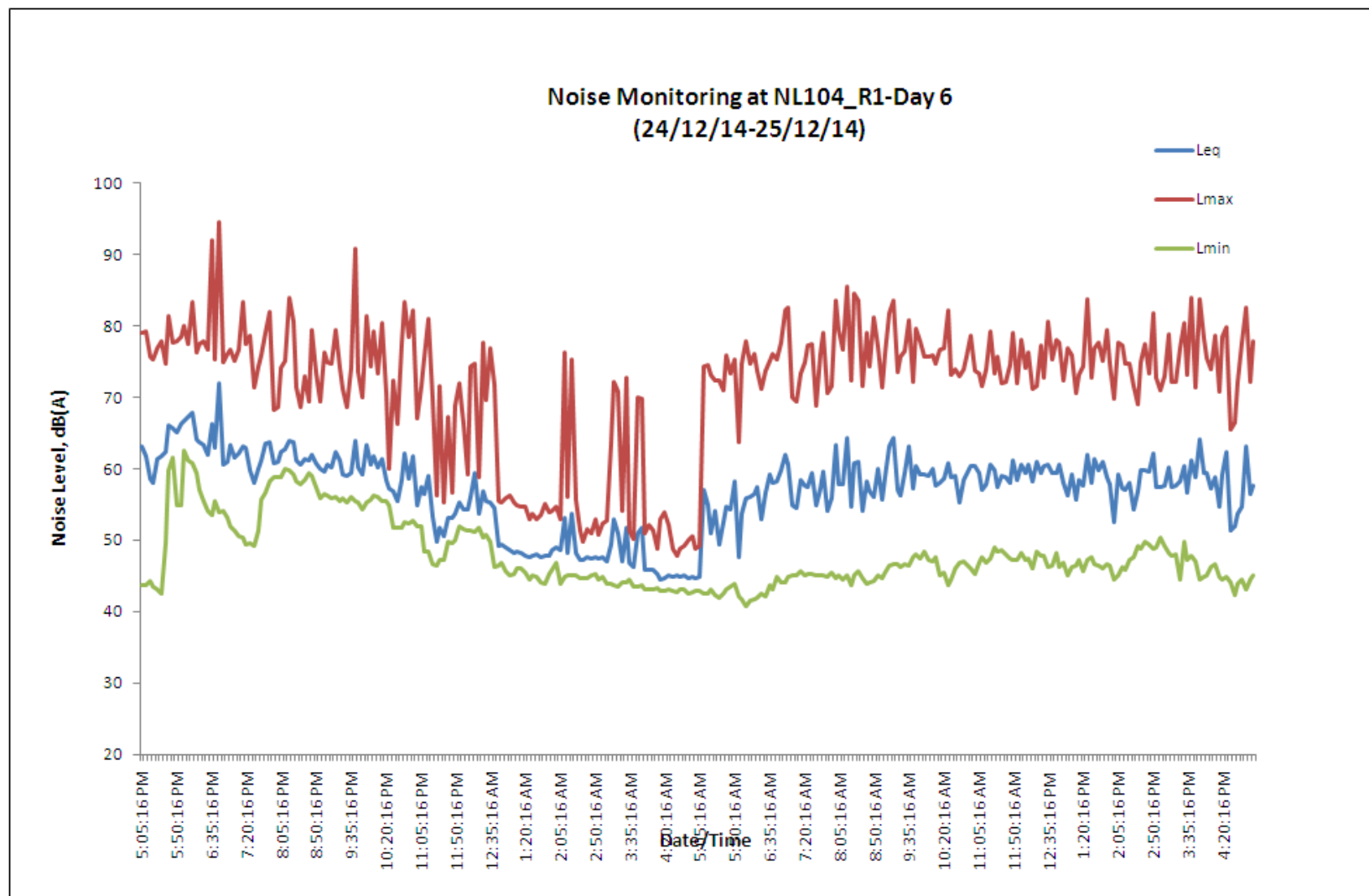


**Figure 28: Daily noise level measured at Point NL104\_R1 (Day 4)**

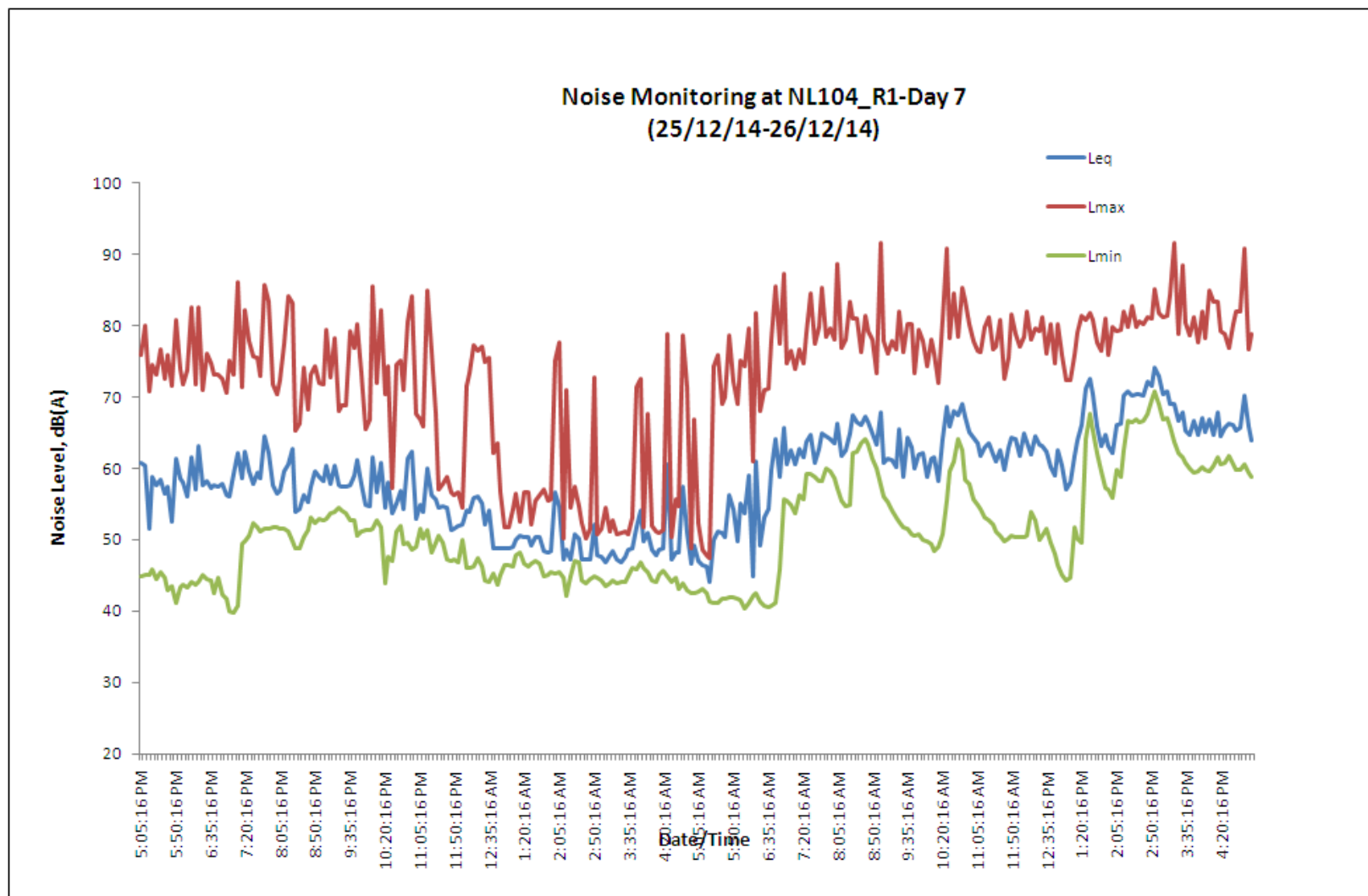




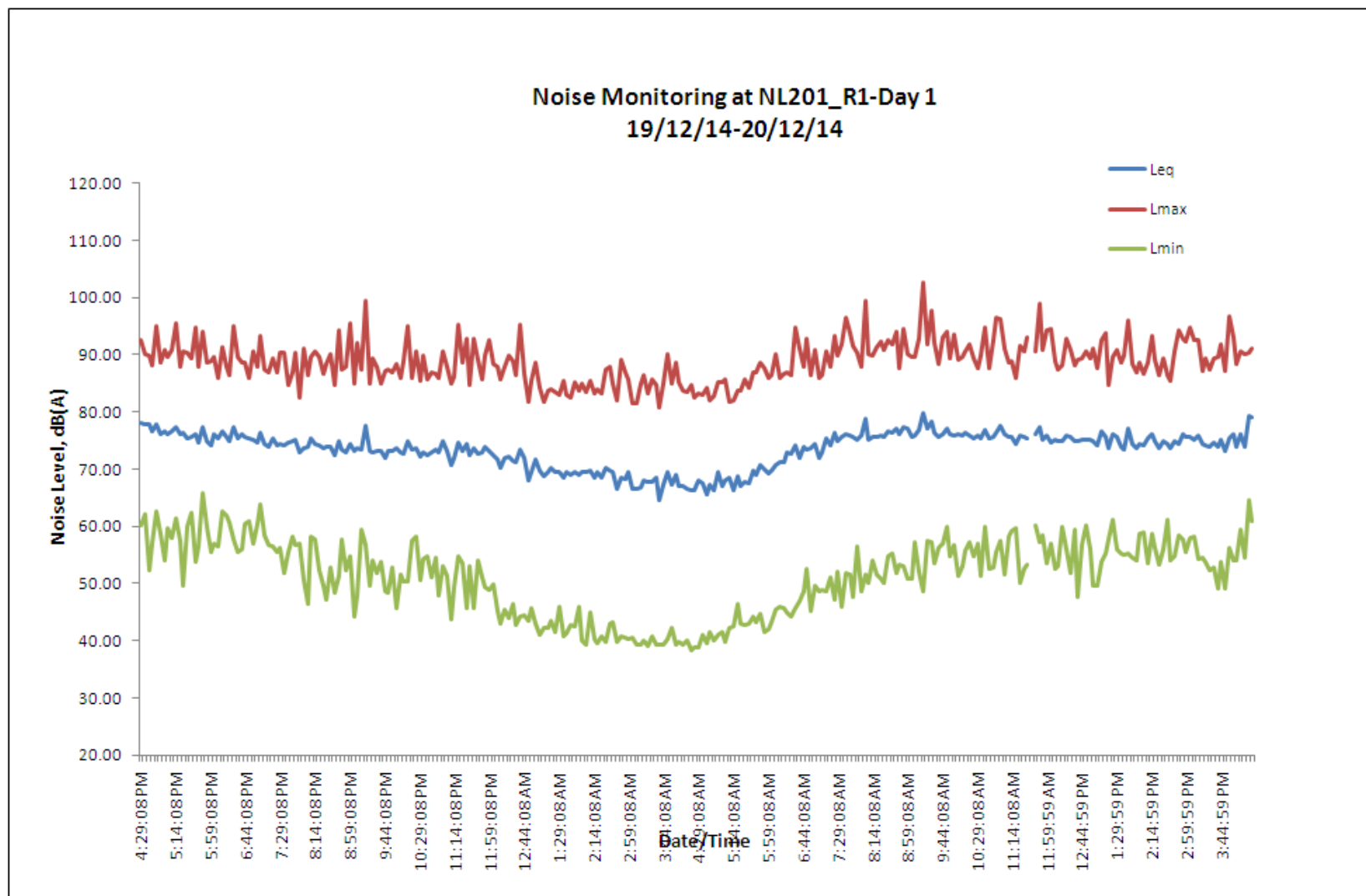
**Figure 29: Daily noise level measured at Point NL104\_R1 (Day 5)**



**Figure 30: Daily noise level measured at Point NL104\_R1 (Day 6)**

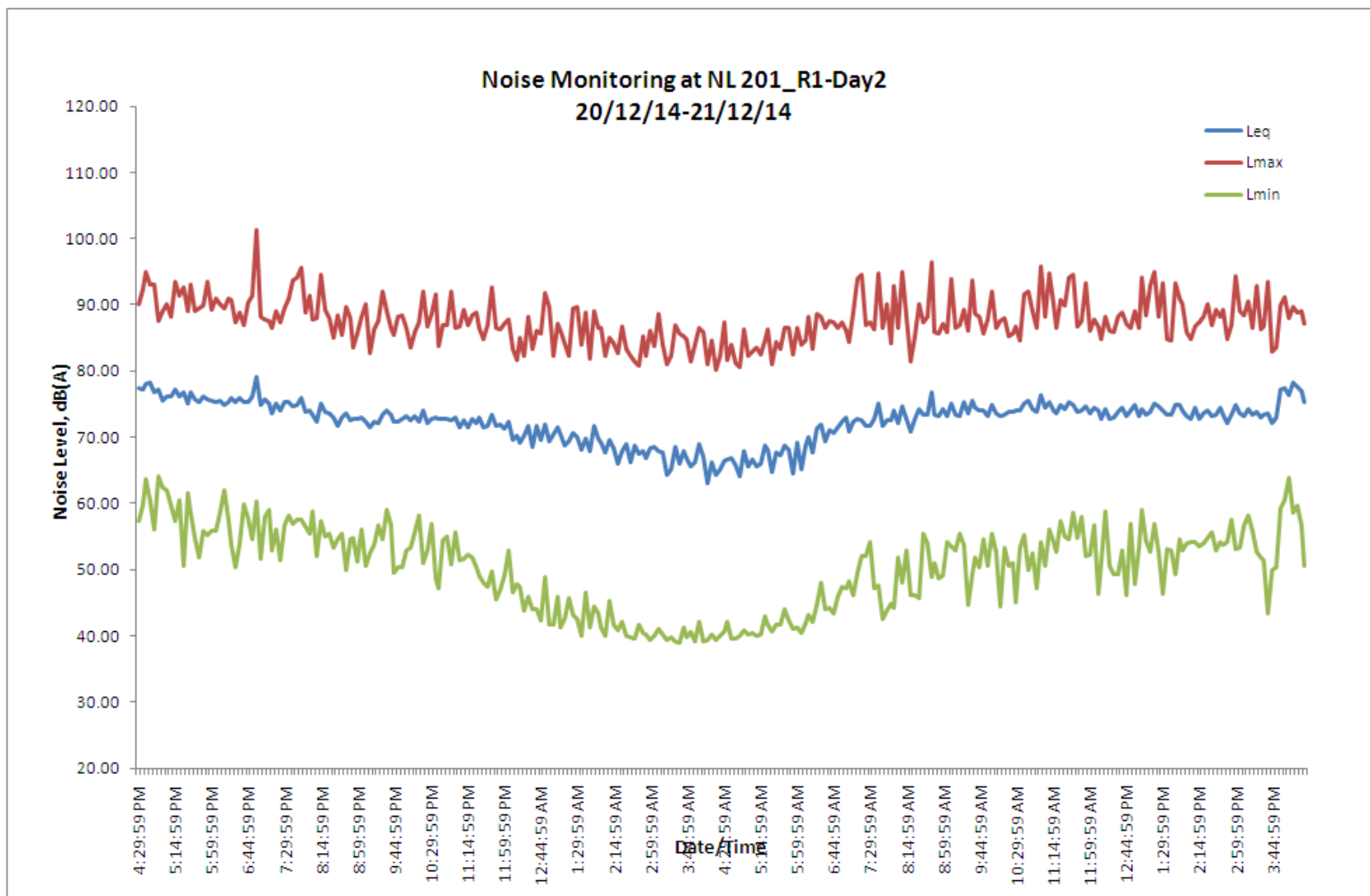


**Figure 31: Daily noise level measured at Point NL104\_R1 (Day 7)**

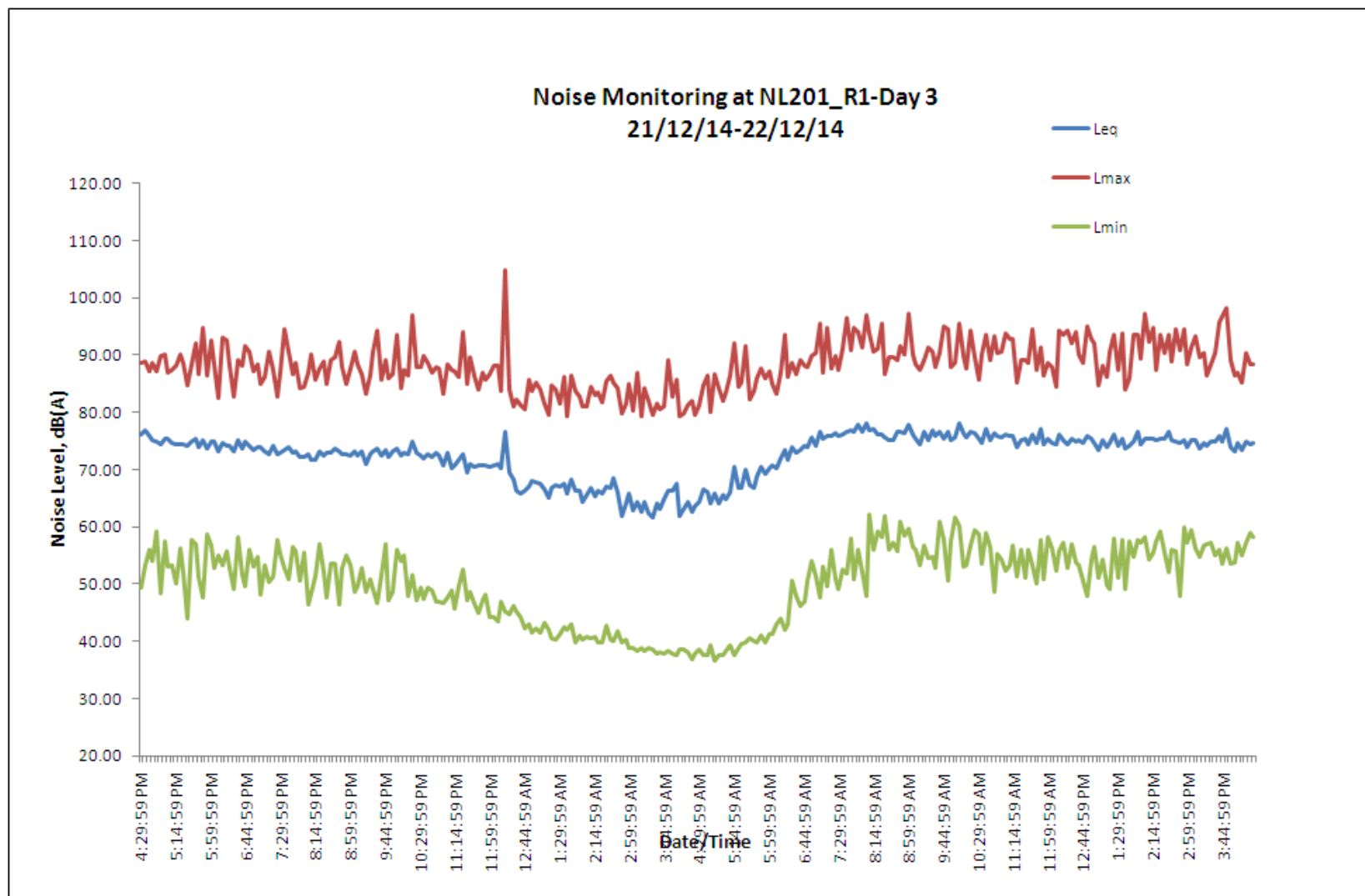


**Figure 32: Daily noise level measured at Point NL201\_R1 (Day 1)**

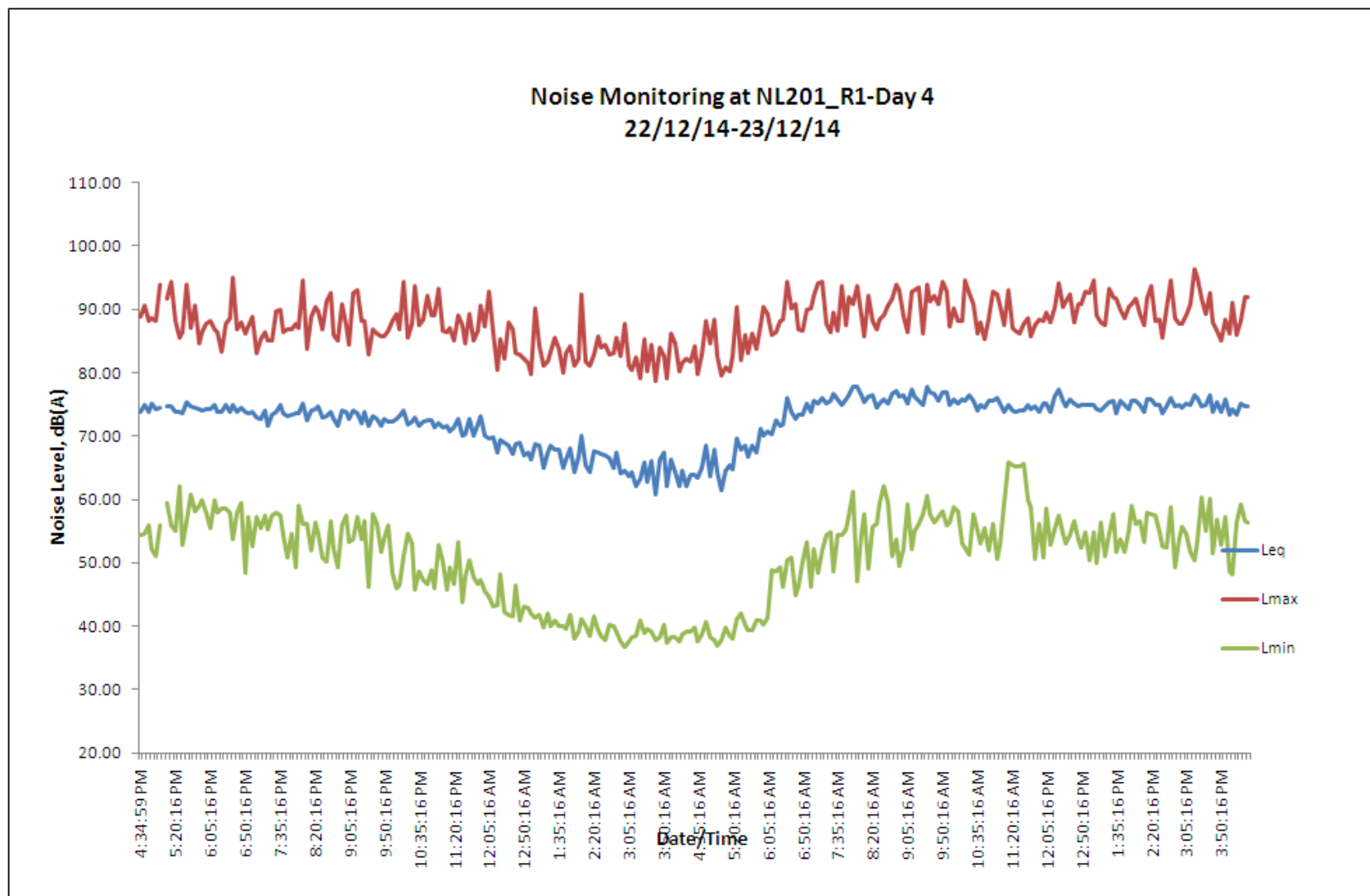




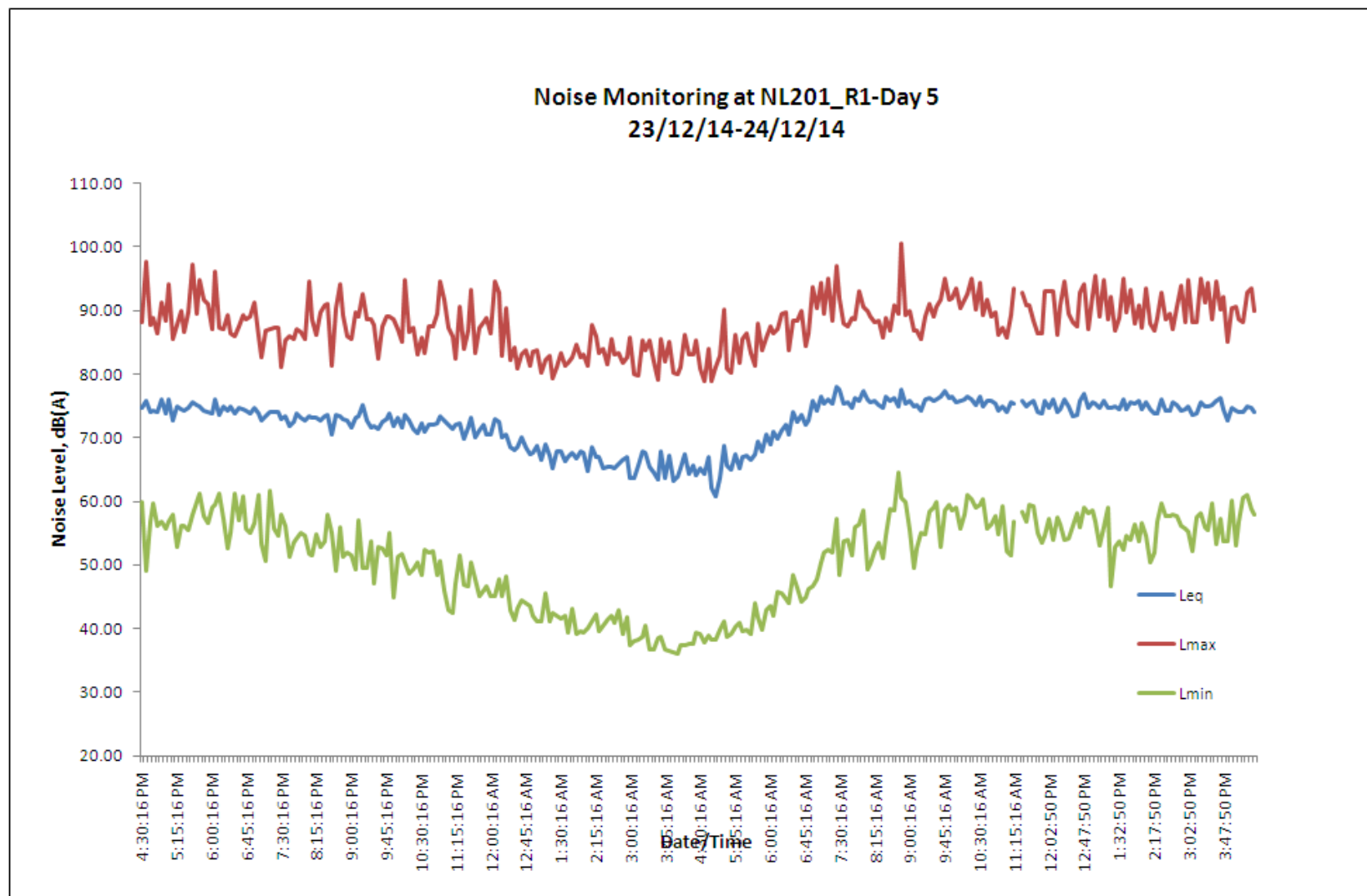
**Figure 33: Daily noise level measured at Point NL201\_R1 (Day 2)**



**Figure 34: Daily noise level measured at Point NL201\_R1 (Day 3)**

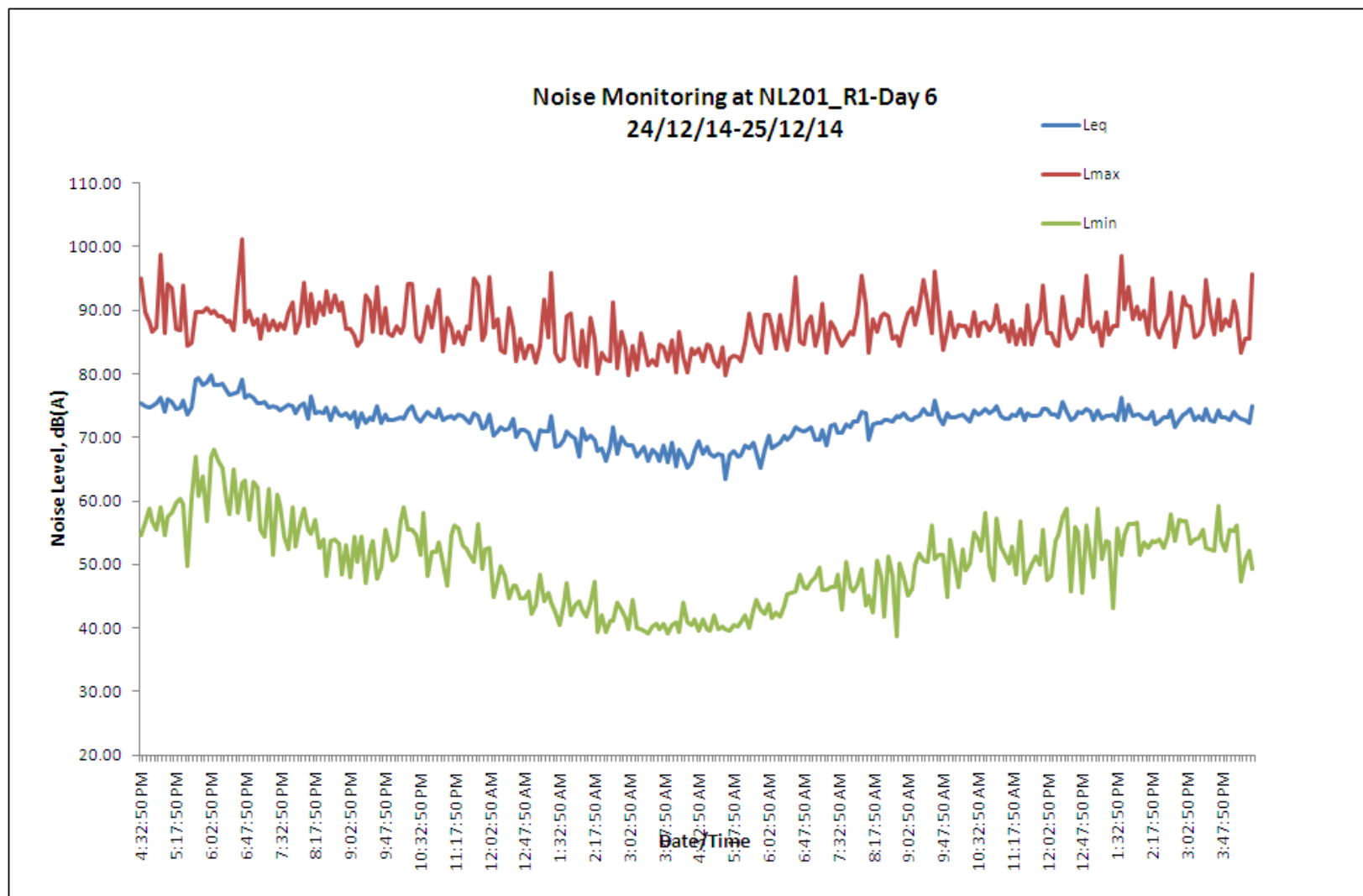


**Figure 35: Daily noise level measured at Point NL201\_R1 (Day 4)**

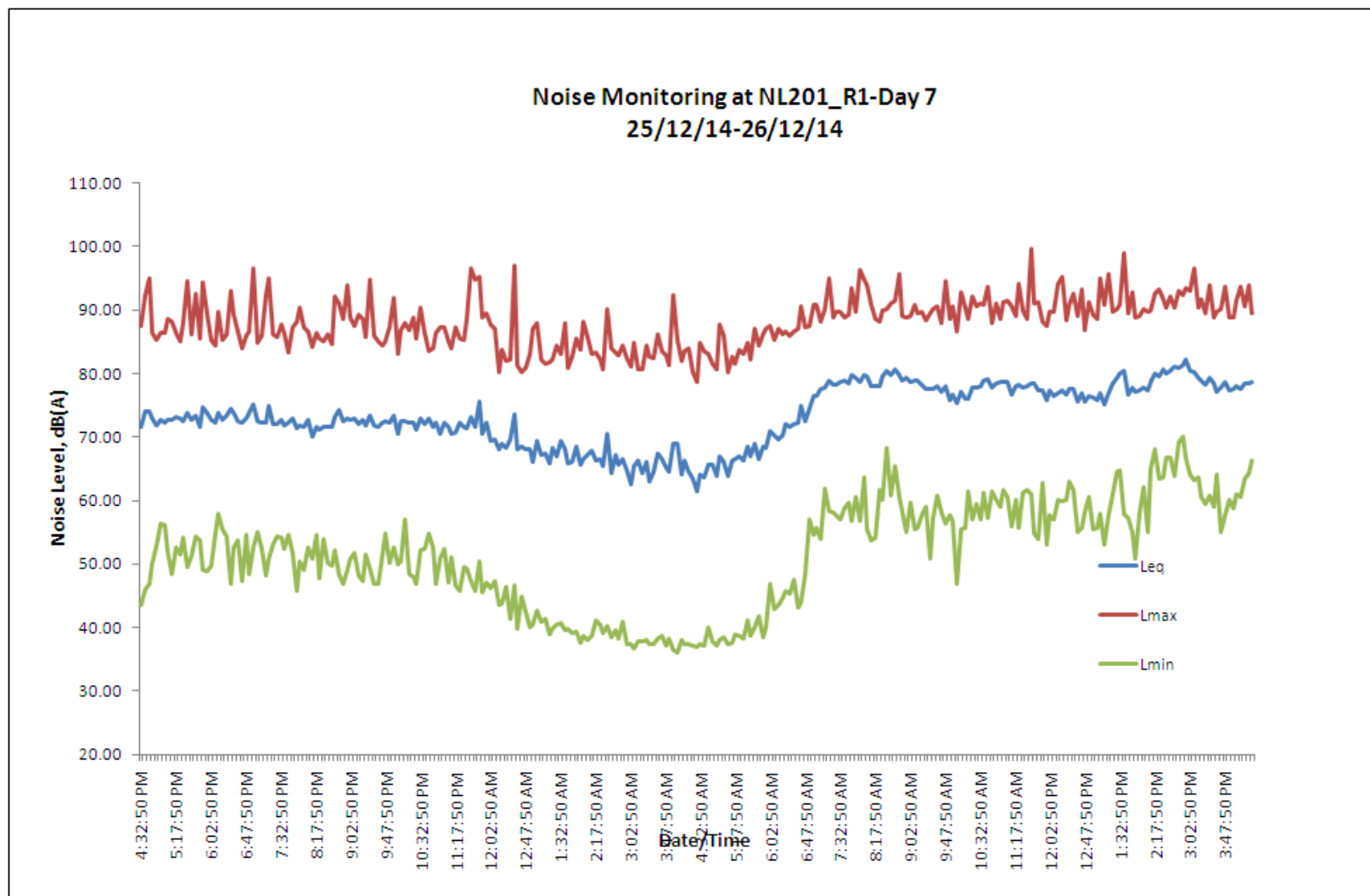


**Figure 36: Daily noise level measured at Point NL201\_R1 (Day 5)**

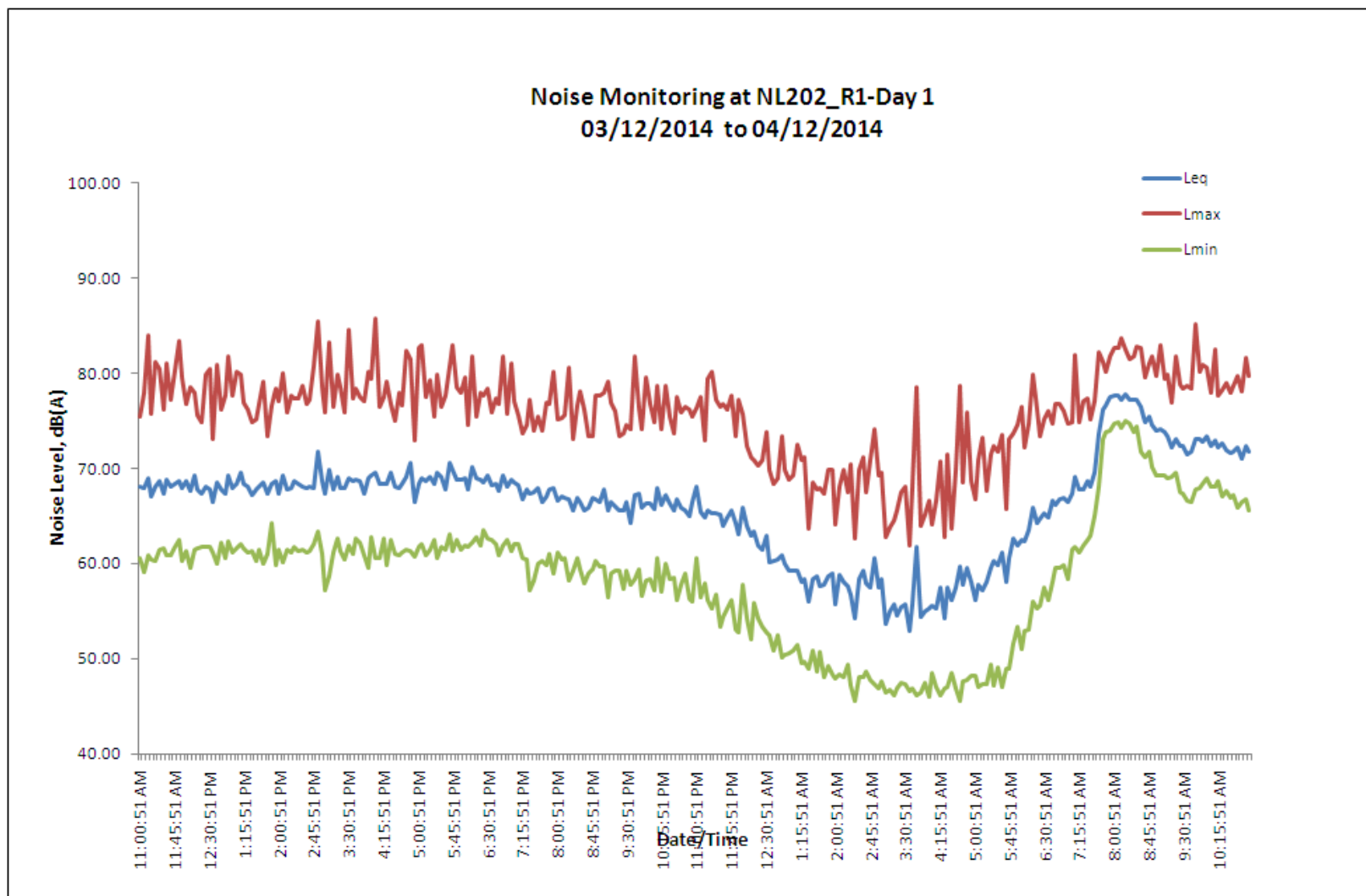




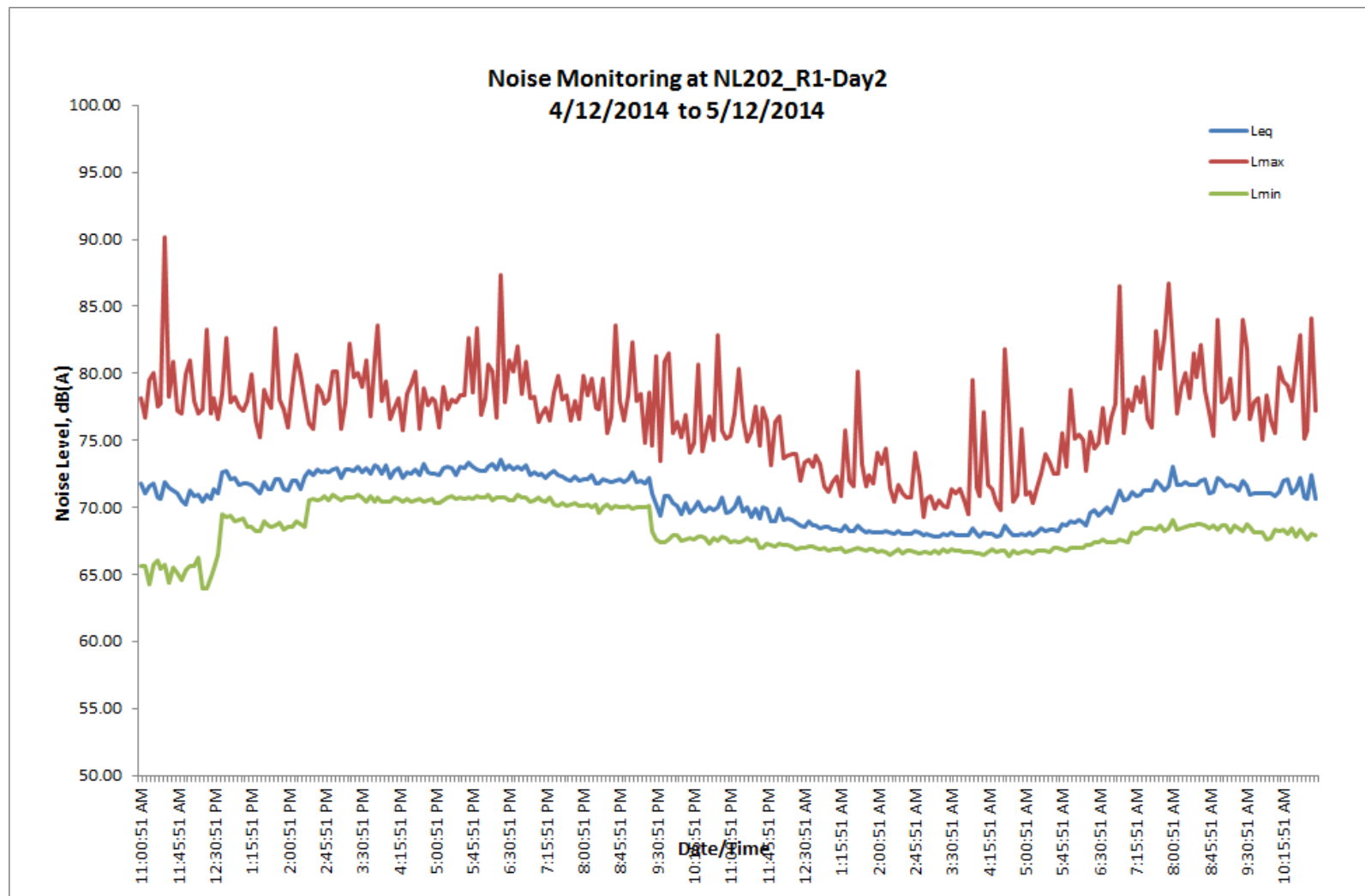
**Figure 37: Daily noise level measured at Point NL201\_R1 (Day 6)**



**Figure 38: Daily noise level measured at Point NL201\_R1 (Day 7)**

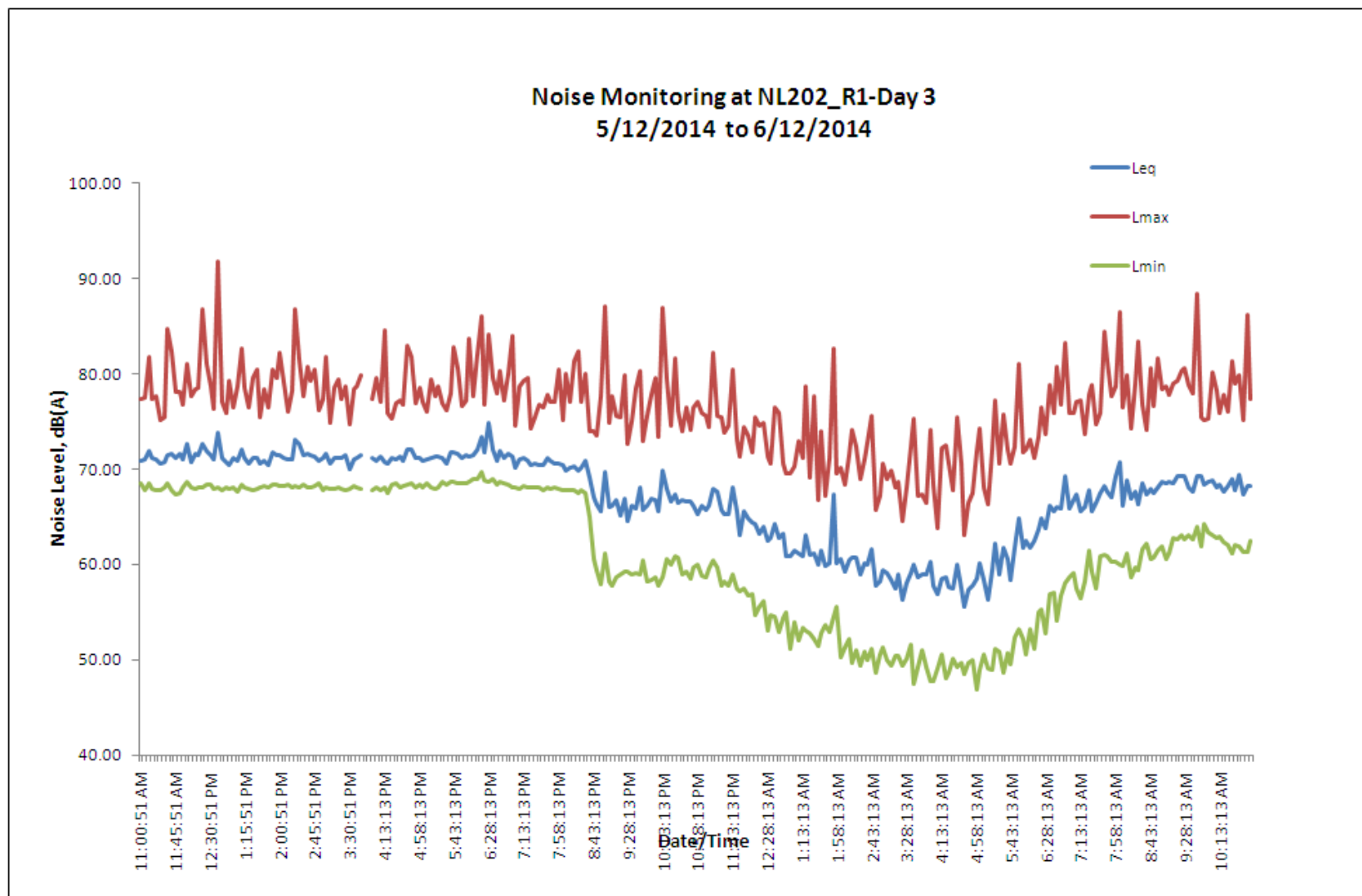


**Figure 39: Daily noise level measured at Point NL202\_R1 (Day 1)**

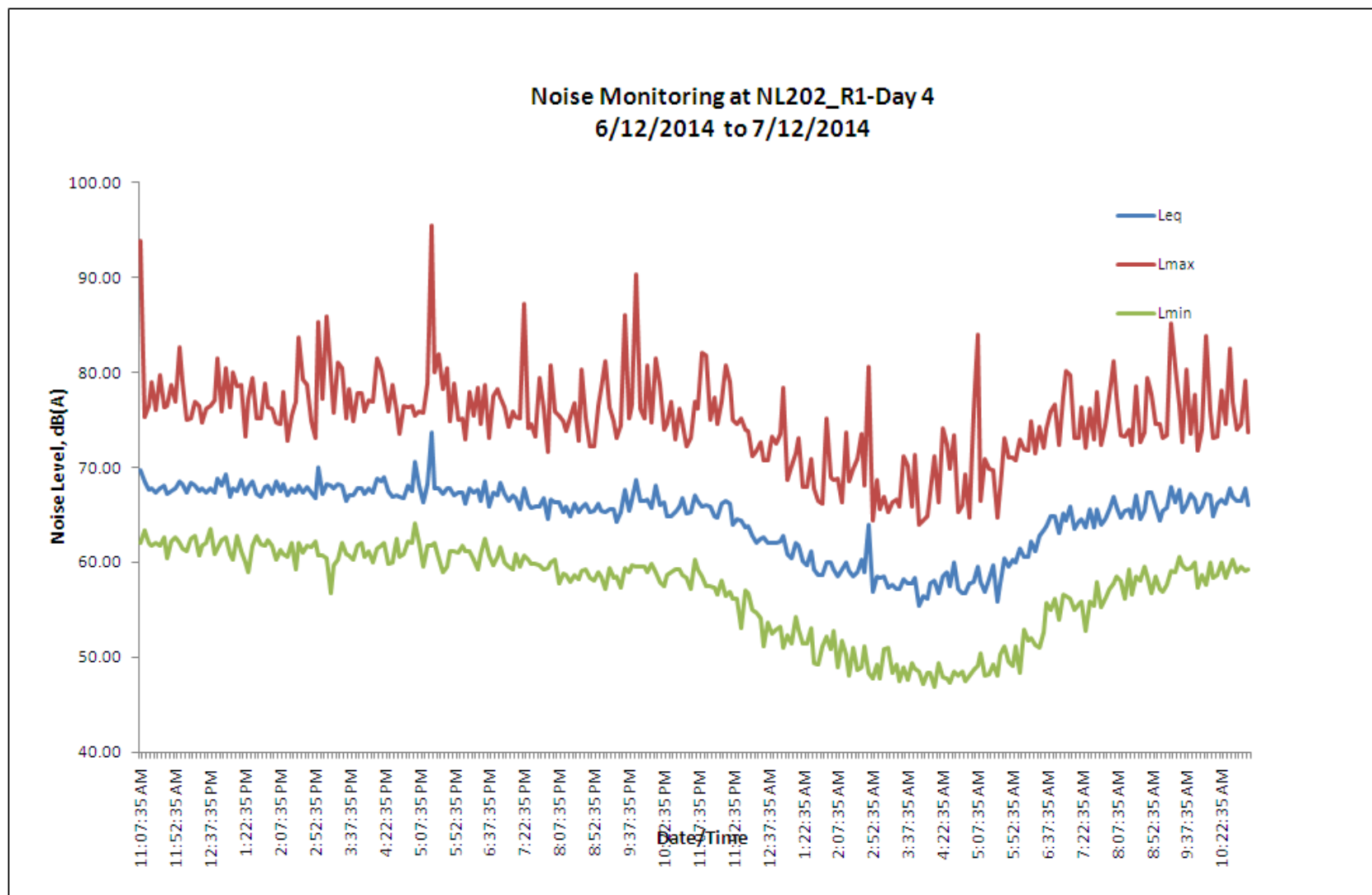


**Figure 40: Daily noise level measured at Point NL202\_R1 (Day 2)**

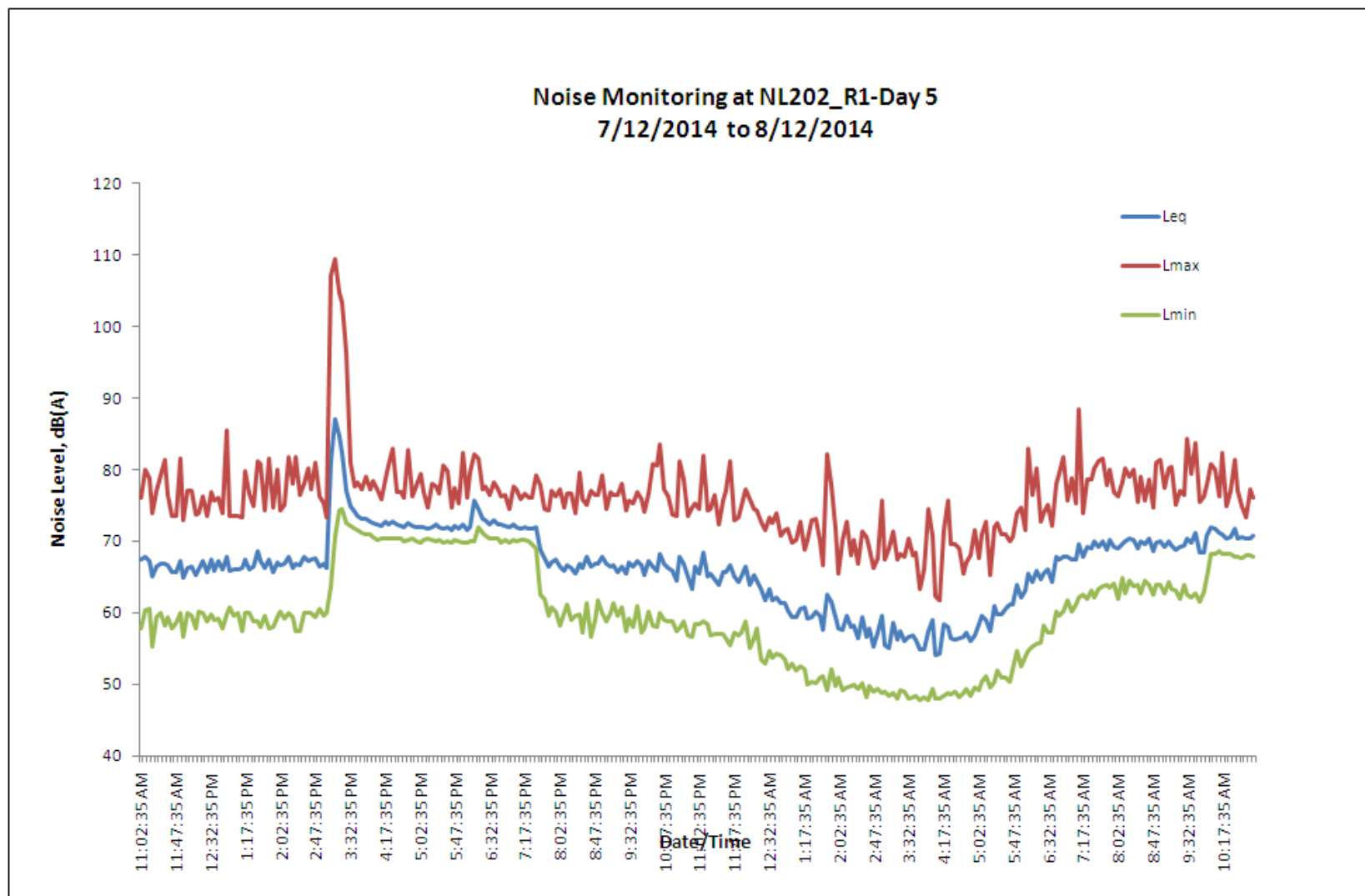




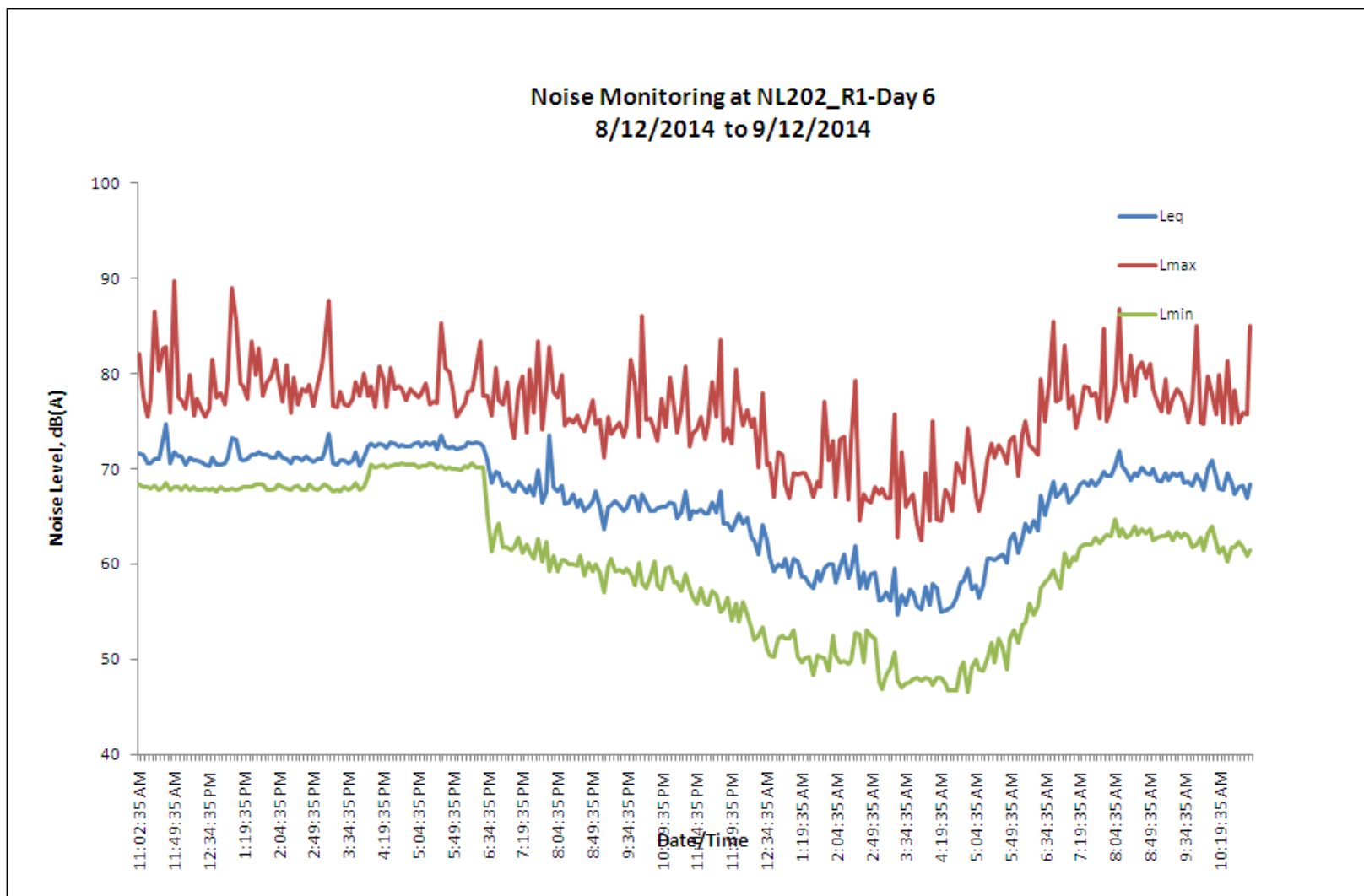
**Figure 41: Daily noise level measured at Point NL202\_R1 (Day 3)**



**Figure 42: Daily noise level measured at Point NL202\_R1 (Day 4)**

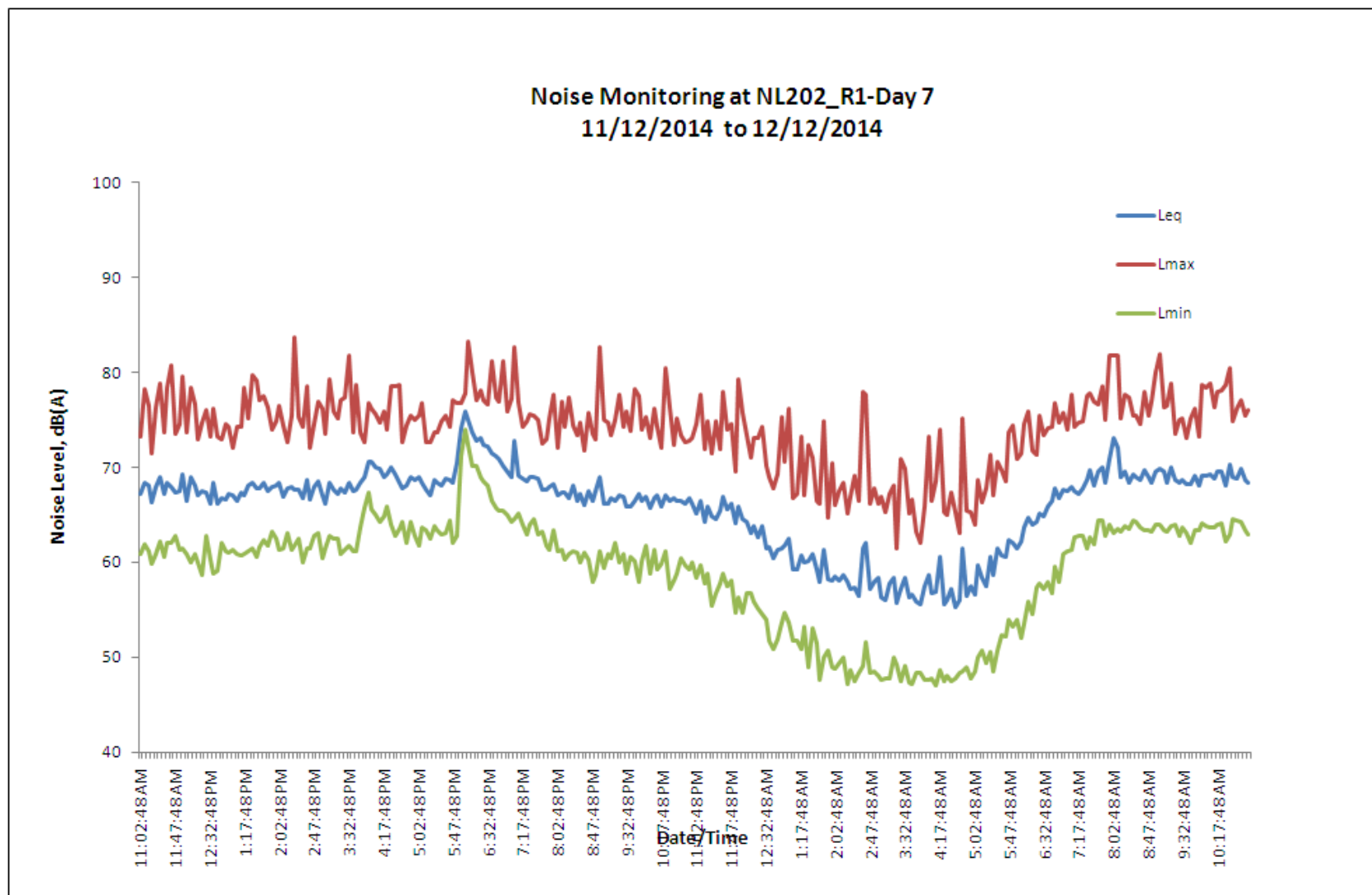


**Figure 43: Daily noise level measured at Point NL202\_R1 (Day 5)**

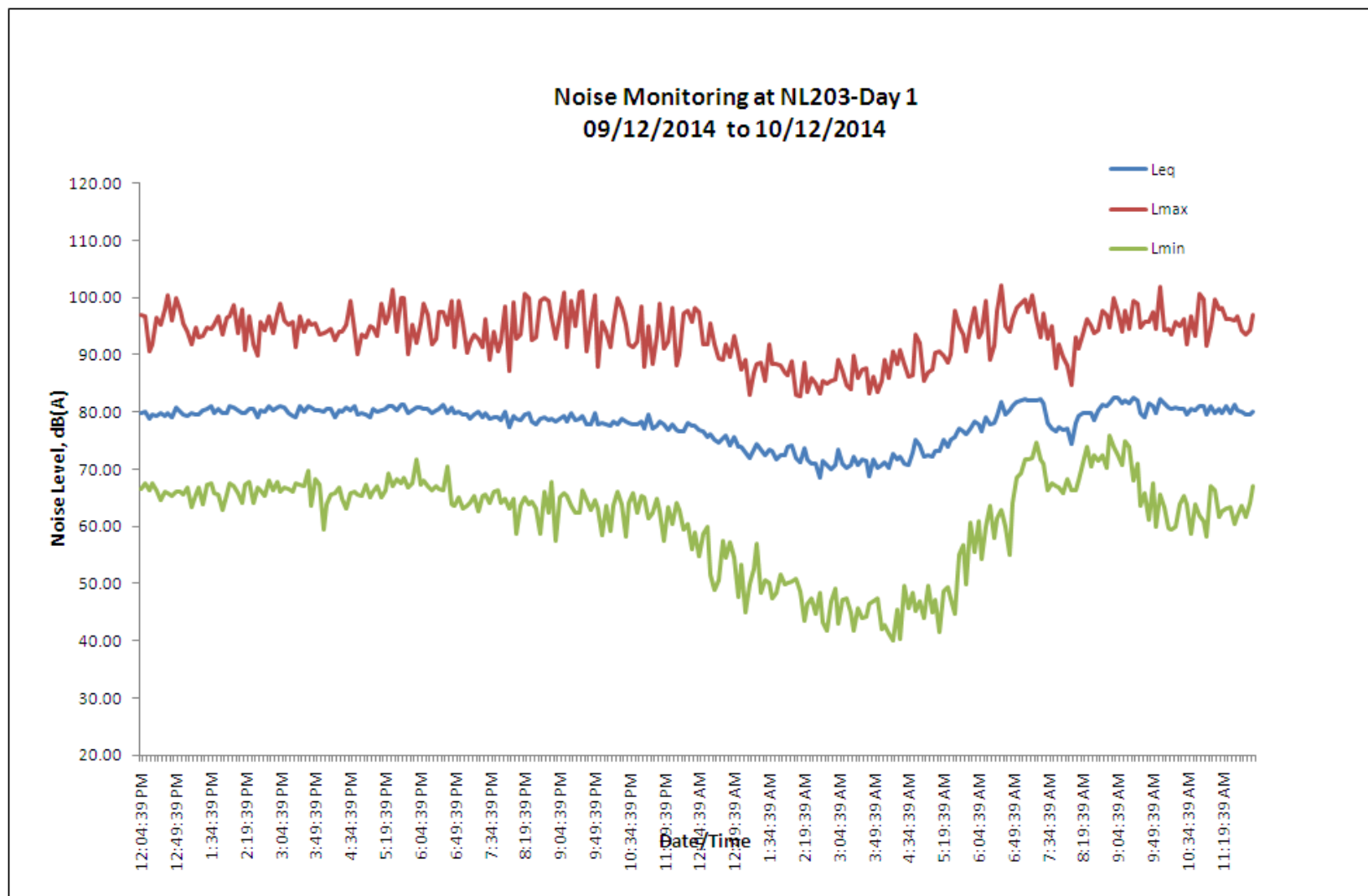


**Figure 44: Daily noise level measured at Point NL202\_R1 (Day 6)**

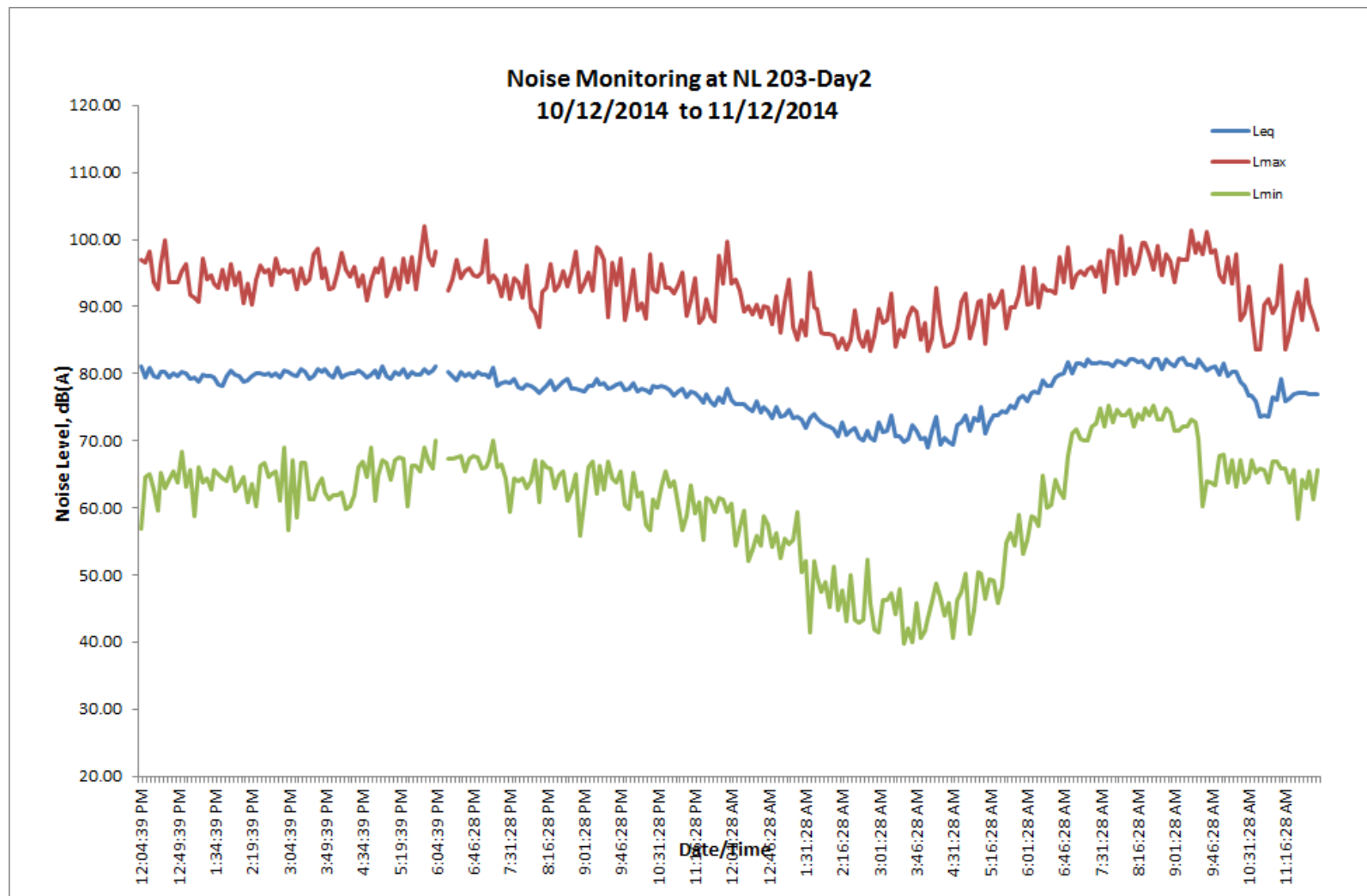




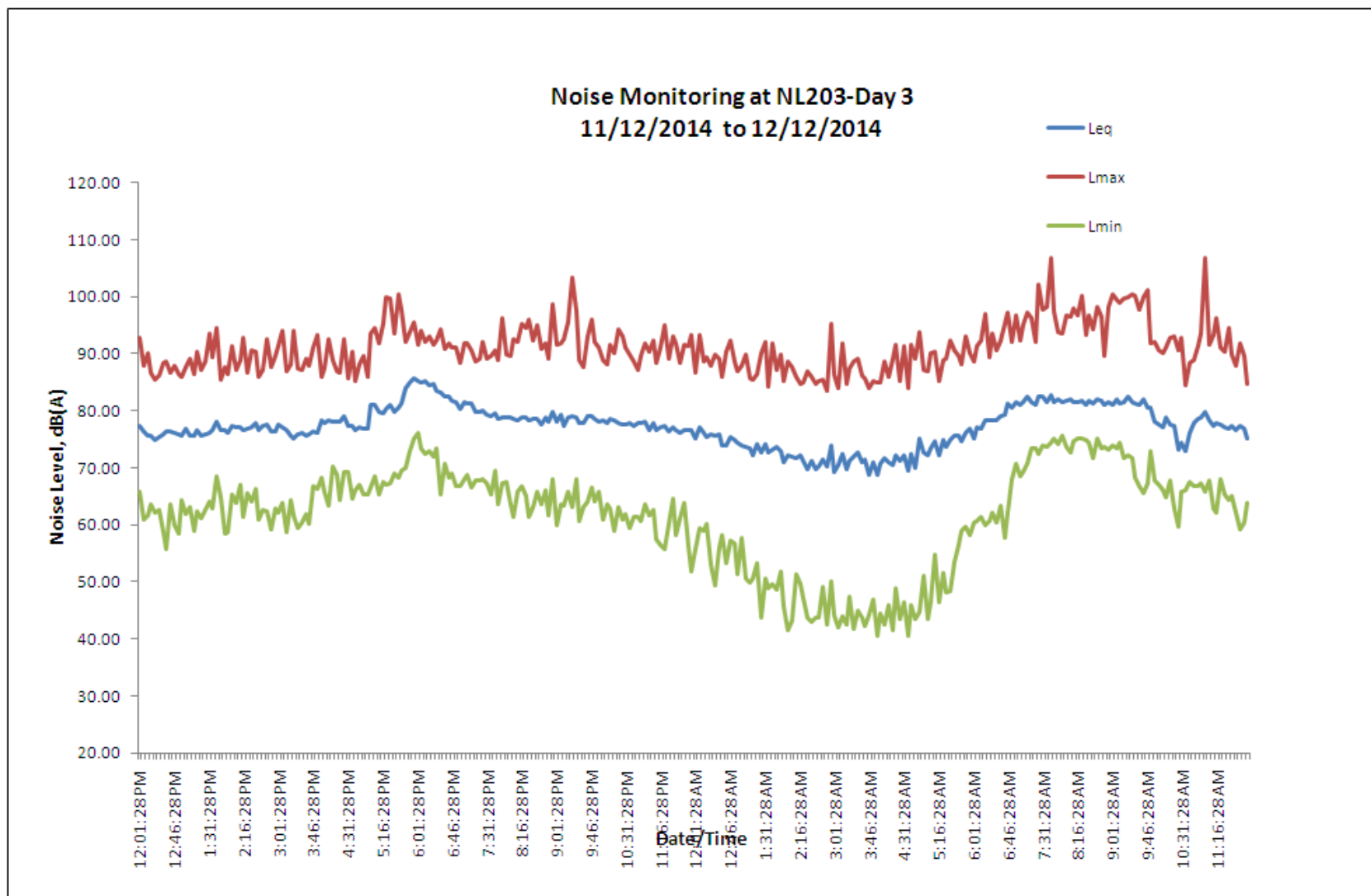
**Figure 45: Daily noise level measured at Point NL202\_R1 (Day 7)**



**Figure 46: Daily noise level measured at Point NL203\_R1 (Day 1)**

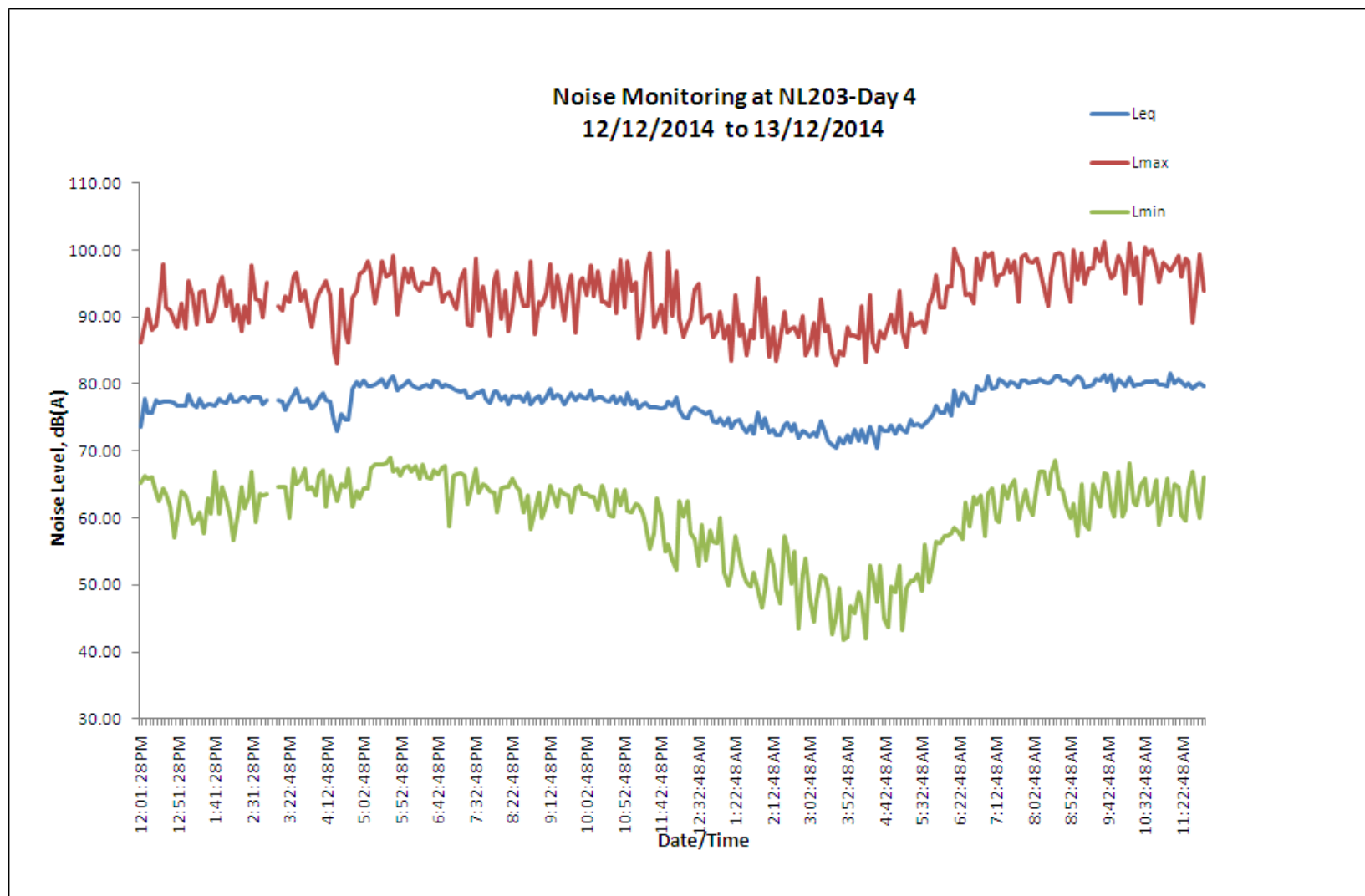


**Figure 47: Daily noise level measured at Point NL203\_R1 (Day 2)**

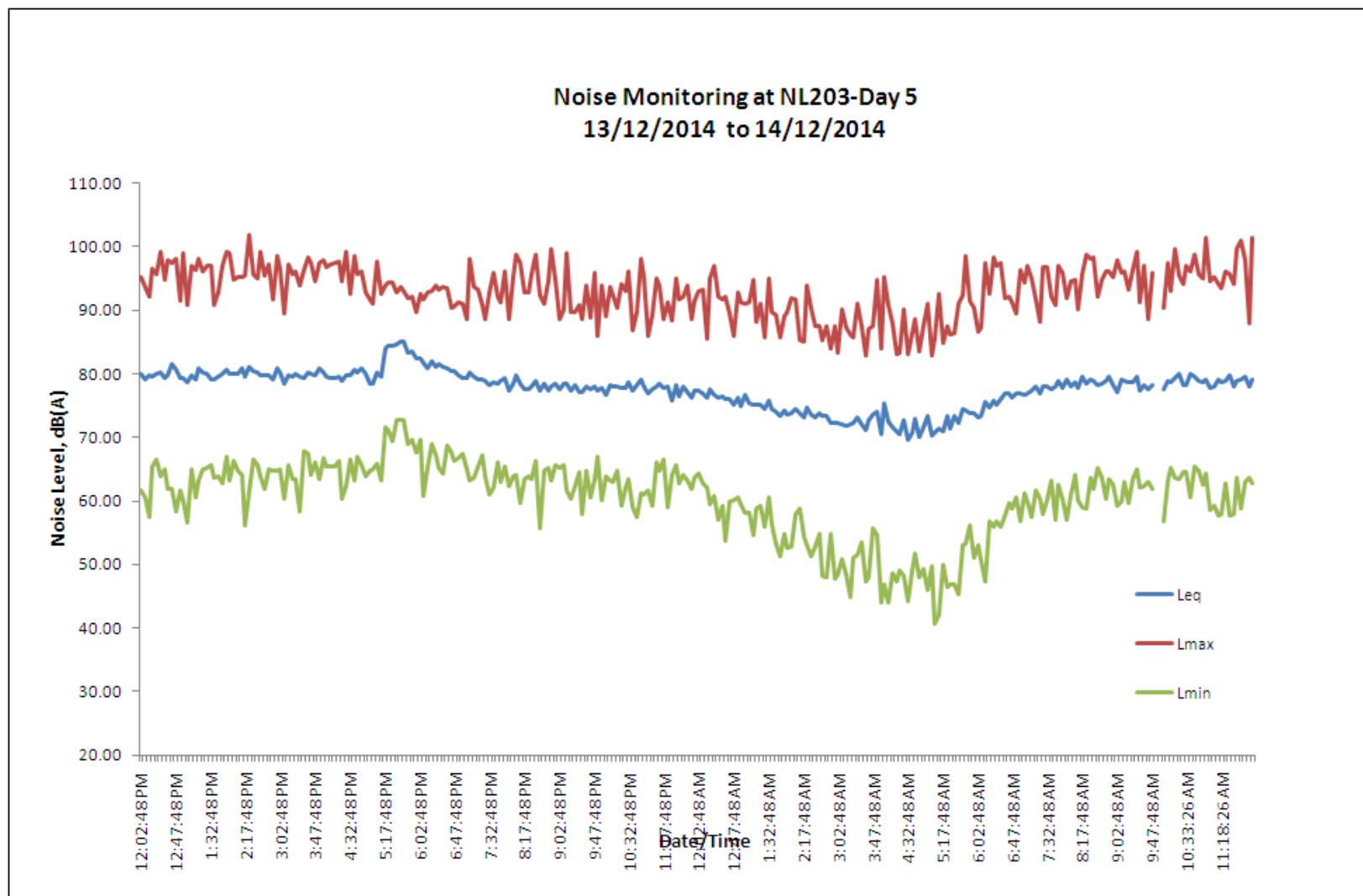


**Figure 48: Daily noise level measured at Point NL203\_R1 (Day 3)**

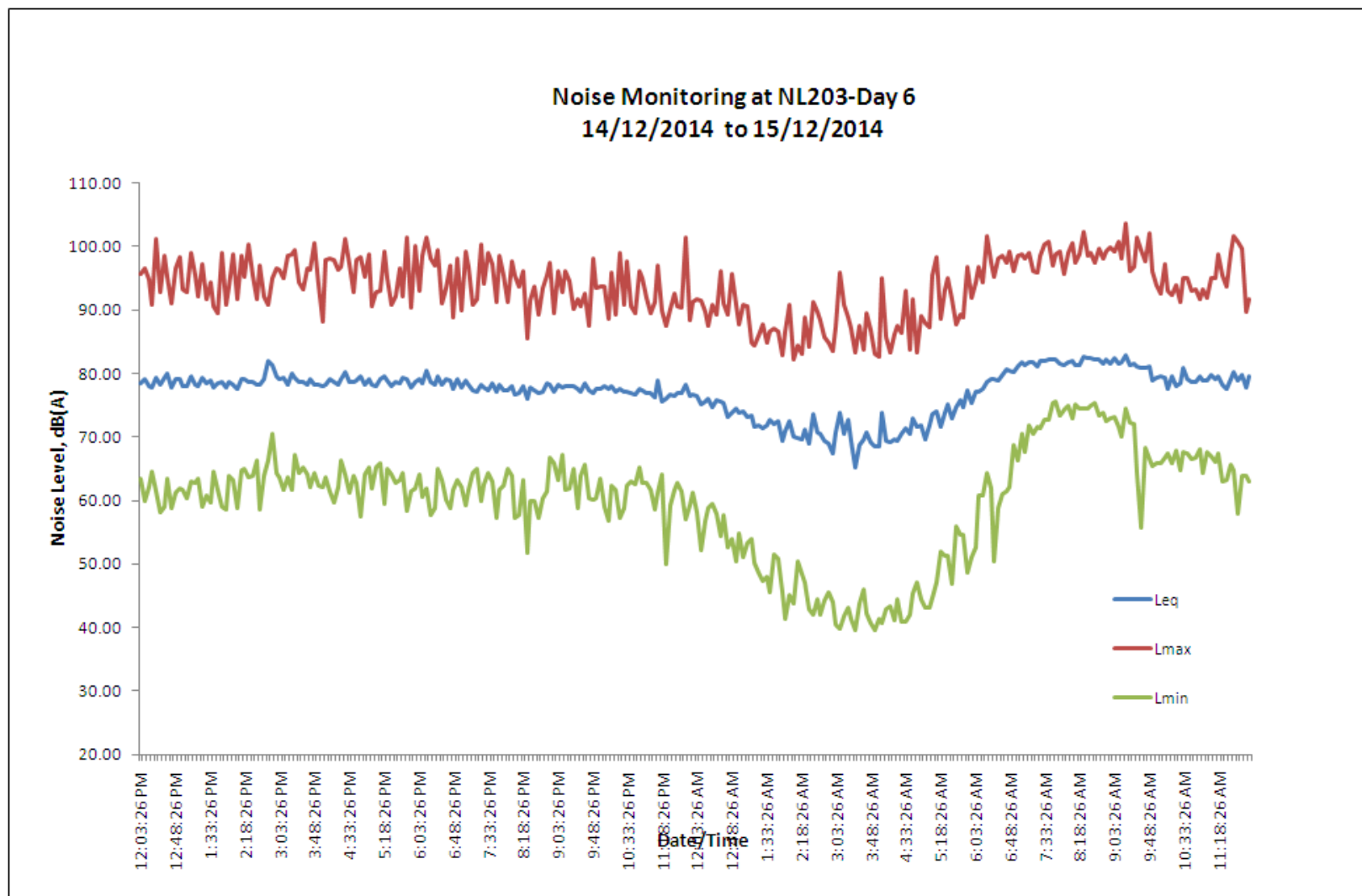




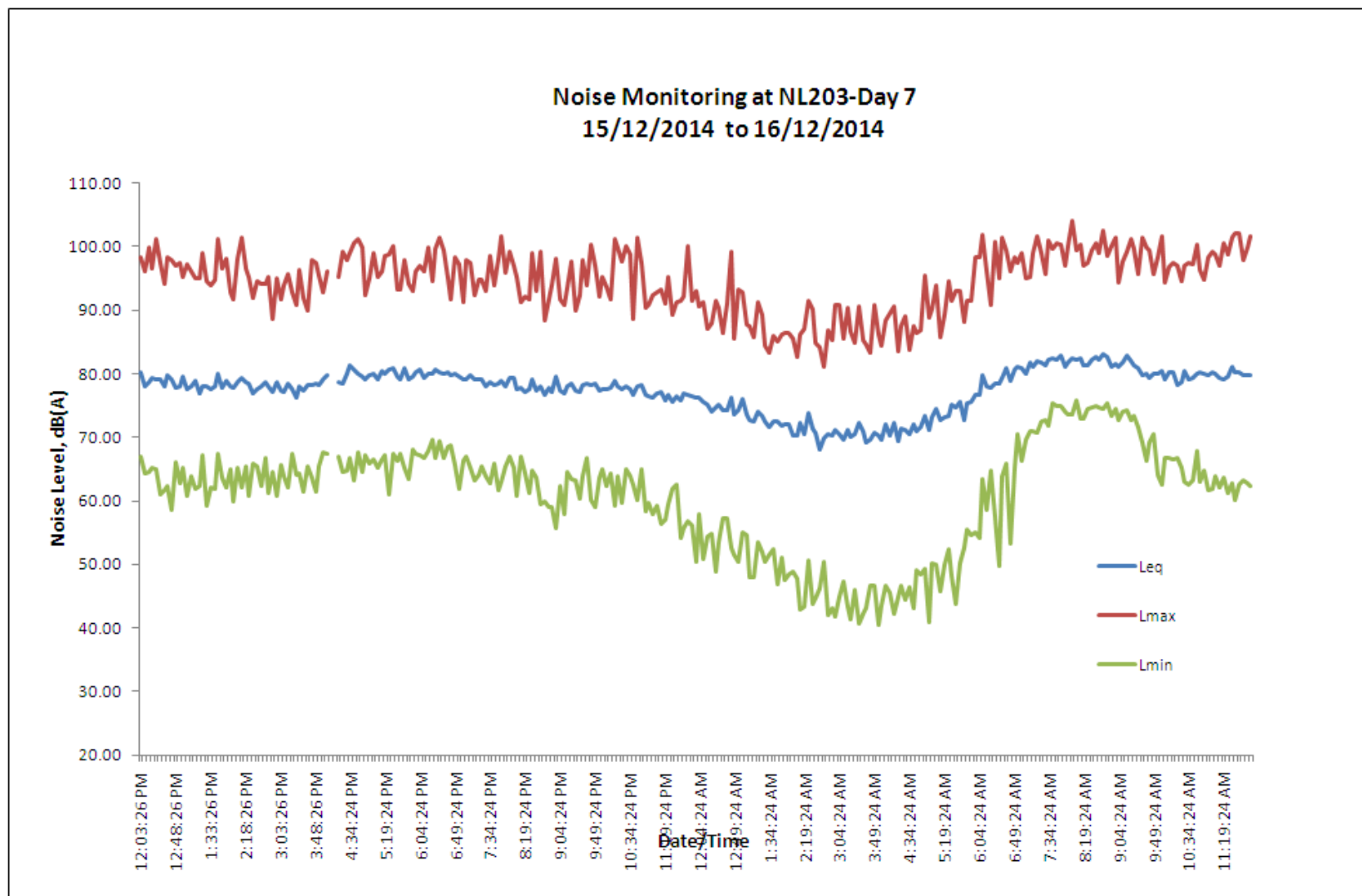
**Figure 49: Daily noise level measured at Point NL203\_R1 (Day 4)**



**Figure 50: Daily noise level measured at Point NL203\_R1 (Day 5)**



**Figure 51: Daily noise level measured at Point NL203\_R1 (Day 6)**



**Figure 52: Daily noise level measured at Point NL203\_R1 (Day 7)**



**Table 62: Summary of results for short term noise level measurement ( $L_{max}$ ,  $L_{Aeq}$  &  $L_{90}$ ) over 15 minutes**

Monitoring Point	Date	Weekend / Weekday	Peak Hour					Off-Peak Hour					Noise Source
			Time		Noise Level, dB(A)			Time		Noise Level, dB(A)			
			Start	Stop	L <sub>max</sub>	L <sub>Aeq</sub>	L <sub>90</sub>	Start	Stop	L <sub>max</sub>	L <sub>Aeq</sub>	L <sub>90</sub>	
NL102_R1	29/11/14	Weekend	1500	1515	62.1	47.6	44.7	1444	1459	70.1	47.5	44.0	Insect Noise, Human Activities
	26/11/14	Weekday	1500	1515	77.3	55.6	46.0	-	-	-	-	-	Army shooting training (Day3), Army aircraft passing overhead (Day 5), Insect Noise, Human Activities,
	28/11/14		-	-	-	-	-	1434	1449	80.5	59.5	46.9	
NL201_R1	20/12/14	Weekend	1206	1221	98.1	74.4	64.1	1140	1155	97.9	75.5	63.3	Traffic Noise From Upper Thomson Road, Human Activities
	22/12/14	Weekday	1703	1718	94.6	74.4	63.1	1643	1658	94.2	73.8	63.2	
NL202_R1	06/12/14	Weekend	1250	1305	78.8	68.0	64.1	1107	1122	74.5	67.5	64.0	Traffic noise (vehicles) from Thomson Road and Lornie road
	05/12/14	Weekday	1800	1815	80.4	71.4	69.6	1554	1609	77.1	69.8	67.6	Traffic noise (vehicles) from Thomson Road and Lornie road, Noise from water canal (After rainfall).
NL203_R1	13/12/14	Weekend	1218	1233	88.9	79.1	73.6	1140	1155	90.6	79.4	73.7	Traffic noise (vehicles) from Lornie road
	09/12/14	Weekday	1730	1745	88.0	78.3	73.3	1625	1640	83.9	76.7	72.1	

**Table 63: Summary of noise level (NL101\_R1)**

Category of Noise Regulated Period	Period	DAY 1	DAY 2	DAY 3	DAY 4 (weekend)	DAY 5 (weekend)	DAY 6	DAY 7
*12 hours	7am-7pm	X	X	X	X	X	X	X
	7pm-7am	X	X	X	X	X	X	X
*5 minutes	7am-7pm	√	√	√	√	√	√	√
	7pm-10pm	X	X	X	X	X	X	X
	10pm-7am	X	X	X	X	X	X	X
*1 hour	7am-7pm	NA	NA	NA	NA	NA	NA	NA
	7pm-8pm	NA	NA	NA	NA	NA	NA	NA
	8pm-9pm	NA	NA	NA	NA	NA	NA	NA
	9pm-10pm	NA	NA	NA	NA	NA	NA	NA
	10pm-11pm	NA	NA	NA	NA	NA	NA	NA
	11pm-12pm	NA	NA	NA	NA	NA	NA	NA
	12pm-1am	NA	NA	NA	NA	NA	NA	NA
	1am-2am	NA	NA	NA	NA	NA	NA	NA
	2am-3am	NA	NA	NA	NA	NA	NA	NA
	3am-4am	NA	NA	NA	NA	NA	NA	NA
	4am-5am	NA	NA	NA	NA	NA	NA	NA
	5am-6am	NA	NA	NA	NA	NA	NA	NA
	6am-7am	NA	NA	NA	NA	NA	NA	NA

**Note:** \*Environmental Protection & Management Act – Environmental Protection & Management (Control of Noise at Construction Sites) Regulations, 2011 Revised Ed

N/A denote Not Applicable

√ denote Within Limit

X denote Exceed Limit

**Table 64: Summary of noise level (NL102\_R1)**

Category of Noise Regulated Period	Period	DAY 1	DAY 2	DAY 3	DAY 4	DAY 5	DAY 6 (weekend)	DAY 7 (weekend)
*12 hours	7am-7pm	X	X	X	√	√	X	√
	7pm-7am	X	X	√	X	X	X	X
*5 minutes	7am-7pm	√	√	√	√	√	√	√
	7pm-10pm	X	X	√	X	X	√	X
	10pm-7am	√	√	√	√	√	√	X
*1 hour	7am-7pm	NA	NA	NA	NA	NA	NA	NA
	7pm-8pm	NA	NA	NA	NA	NA	NA	NA
	8pm-9pm	NA	NA	NA	NA	NA	NA	NA
	9pm-10pm	NA	NA	NA	NA	NA	NA	NA
	10pm-11pm	NA	NA	NA	NA	NA	NA	NA
	11pm-12pm	NA	NA	NA	NA	NA	NA	NA
	12pm-1am	NA	NA	NA	NA	NA	NA	NA
	1am-2am	NA	NA	NA	NA	NA	NA	NA
	2am-3am	NA	NA	NA	NA	NA	NA	NA
	3am-4am	NA	NA	NA	NA	NA	NA	NA
	4am-5am	NA	NA	NA	NA	NA	NA	NA
	5am-6am	NA	NA	NA	NA	NA	NA	NA
	6am-7am	NA	NA	NA	NA	NA	NA	NA

**Note:** \*Environmental Protection & Management Act – Environmental Protection & Management (Control of Noise at Construction Sites) Regulations, 2011 Revised Ed

N/A denote Not Applicable

√ denote Within Limit

X denote Exceed Limit

**Table 65: Summary of noise level (NL103\_R1)**

Category of Noise Regulated Period	Period	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6 (weekend)	Day 7 (weekend)
*12 hours	7am-7pm	X	√	X	√	√	X	√
	7pm-7am	X	X	√	√	√	√	X
*5 minutes	7am-7pm	√	√	√	√	√	√	√
	7pm-10pm	X	X	√	√	√	√	X
	10pm-7am	√	√	√	√	√	√	√
*1 hour	7am-7pm	NA	NA	NA	NA	NA	NA	NA
	7pm-8pm	NA	NA	NA	NA	NA	NA	NA
	8pm-9pm	NA	NA	NA	NA	NA	NA	NA
	9pm-10pm	NA	NA	NA	NA	NA	NA	NA
	10pm-11pm	NA	NA	NA	NA	NA	NA	NA
	11pm-12pm	NA	NA	NA	NA	NA	NA	NA
	12pm-1am	NA	NA	NA	NA	NA	NA	NA
	1am-2am	NA	NA	NA	NA	NA	NA	NA
	2am-3am	NA	NA	NA	NA	NA	NA	NA
	3am-4am	NA	NA	NA	NA	NA	NA	NA
	4am-5am	NA	NA	NA	NA	NA	NA	NA
	5am-6am	NA	NA	NA	NA	NA	NA	NA
	6am-7am	NA	NA	NA	NA	NA	NA	NA

**Note:** \*Environmental Protection & Management Act – Environmental Protection & Management (Control of Noise at Construction Sites) Regulations, 2011 Revised Ed

N/A denote Not Applicable

√ denote Within Limit

X denote Exceed Limit



**Table 66: Summary of noise level (NL104\_R1)**

Category of Noise Regulated Period	Period	Day 1	Day 2	Day 3	Day 4 (weekend)	Day 5 (weekend)	Day 6	Day 7
*12 hours	7am-7pm	√	√	√	√	√	√	√
	7pm-7am	√	√	√	√	√	√	√
*5 minutes	7am-7pm	√	√	√	√	√	√	√
	7pm-10pm	√	√	√	√	√	√	√
	10pm-7am	√	√	√	√	√	√	√
*1 hour	7am-7pm	NA	NA	NA	NA	NA	NA	NA
	7pm-8pm	NA	NA	NA	NA	NA	NA	NA
	8pm-9pm	NA	NA	NA	NA	NA	NA	NA
	9pm-10pm	NA	NA	NA	NA	NA	NA	NA
	10pm-11pm	NA	NA	NA	NA	NA	NA	NA
	11pm-12pm	NA	NA	NA	NA	NA	NA	NA
	12pm-1am	NA	NA	NA	NA	NA	NA	NA
	1am-2am	NA	NA	NA	NA	NA	NA	NA
	2am-3am	NA	NA	NA	NA	NA	NA	NA
	3am-4am	NA	NA	NA	NA	NA	NA	NA
	4am-5am	NA	NA	NA	NA	NA	NA	NA
	5am-6am	NA	NA	NA	NA	NA	NA	NA
	6am-7am	NA	NA	NA	NA	NA	NA	NA

**Note:** \*Environmental Protection & Management Act – Environmental Protection & Management (Control of Noise at Construction Sites) Regulations, 2011 Revised Ed

N/A denote Not Applicable

√ denote Within Limit

X denote Exceed Limit

**Table 67: Summary of noise level (NL201\_R1)**

Category of Noise Regulated Period	Period	Day 1	Day 2 (weekend)	Day 3 (weekend)	Day 4	Day 5	Day 6	Day 7
*12 hours	7am-7pm	X	√	X	X	X	√	X
	7pm-7am	NA	NA	NA	NA	NA	NA	NA
*5 minutes	7am-7pm	√	√	X	√	√	√	√
	7pm-10pm	X	X	X	X	X	X	X
	10pm-7am	X	X	X	X	X	X	X
*1 hour	7am-7pm	NA	NA	NA	NA	NA	NA	NA
	7pm-8pm	X	X	NA	X	X	X	X
	8pm-9pm	X	X	NA	X	X	X	X
	9pm-10pm	X	X	NA	X	X	X	X
	10pm-11pm	X	X	NA	X	X	X	X
	11pm-12pm	X	X	NA	X	X	X	X
	12pm-1am	X	X	NA	X	X	X	X
	1am-2am	X	X	NA	X	X	X	X
	2am-3am	X	X	NA	X	X	X	X
	3am-4am	X	X	NA	X	X	X	X
	4am-5am	X	X	NA	X	X	X	X
	5am-6am	X	X	NA	X	X	X	X
	6am-7am	X	X	NA	X	X	X	X

**Note:** \*Environmental Protection & Management Act – Environmental Protection & Management (Control of Noise at Construction Sites) Regulations, 2011 Revised Ed

N/A denote Not Applicable

√ denote Within Limit

X denote Exceed Limit

**Table 68: Summary of noise level (NL202\_R1)**

Category of Noise Regulated Period	Period	Day 1	Day 2	Day 3	Day 4 (weekend)	Day 5 (weekend)	Day 6	Day 7
*12 hours	7am-7pm	√	√	√	√	√	√	√
	7pm-7am	NA	NA	NA	NA	NA	NA	NA
*5 minutes	7am-7pm	√	√	√	√	√	√	√
	7pm-10pm	√	X	√	X	X	√	√
	10pm-7am	X	X	X	X	X	X	X
*1 hour	7am-7pm	NA	NA	NA	NA	NA	NA	NA
	7pm-8pm	X	X	X	X	NA	X	X
	8pm-9pm	X	X	X	X	NA	X	X
	9pm-10pm	X	X	X	X	NA	X	X
	10pm-11pm	X	X	X	X	NA	X	X
	11pm-12pm	X	X	X	X	NA	X	X
	12pm-1am	X	X	X	X	NA	X	X
	1am-2am	X	X	X	X	NA	X	X
	2am-3am	X	X	X	X	NA	X	X
	3am-4am	X	X	X	X	NA	X	X
	4am-5am	X	X	X	X	NA	X	X
	5am-6am	X	X	X	X	NA	X	X
	6am-7am	X	X	X	X	NA	X	X

**Note:** \*Environmental Protection & Management Act – Environmental Protection & Management (Control of Noise at Construction Sites) Regulations, 2011 Revised Ed

N/A denote Not Applicable

√ denote Within Limit

X denote Exceed Limit

**Table 69: Summary of noise level (NL203\_R1)**

Category of Noise Regulated Period	Period	Day 1	Day 2	Day 3	Day 4	Day 5 (weekend)	Day 6 (weekend)	Day 7
*12 hours	7am-7pm	X	X	X	X	X	X	X
	7pm-7am	NA	NA	NA	NA	NA	NA	NA
*5 minutes	7am-7pm	√	√	√	√	X	X	√
	7pm-10pm	X	X	X	X	X	X	X
	10pm-7am	X	X	X	X	X	X	X
*1 hour	7am-7pm	NA	NA	NA	NA	NA	NA	NA
	7pm-8pm	X	X	X	X	X	NA	X
	8pm-9pm	X	X	X	X	X	NA	X
	9pm-10pm	X	X	X	X	X	NA	X
	10pm-11pm	X	X	X	X	X	NA	X
	11pm-12pm	X	X	X	X	X	NA	X
	12pm-1am	X	X	X	X	X	NA	X
	1am-2am	X	X	X	X	X	NA	X
	2am-3am	X	X	X	X	X	NA	X
	3am-4am	X	X	X	X	X	NA	X
	4am-5am	X	X	X	X	X	NA	X
	5am-6am	X	X	X	X	X	NA	X
	6am-7am	X	X	X	X	X	NA	X

**Note:** \*Environmental Protection & Management Act – Environmental Protection & Management (Control of Noise at Construction Sites) Regulations, 2011 Revised Ed

N/A denote Not Applicable

√ denote Within Limit

X denote Exceed Limit



# **Noise Monitoring (Second Round of Survey)**

Date of Survey: 16<sup>th</sup> January to 2<sup>nd</sup> February 2015

## 5.0 Detail of Noise Monitoring Point

There were a total of seven noise monitoring points have been selected, namely NL 101\_R2-104\_R2 & NL 201\_R2-203\_R2. The monitoring points were dictated by ERM. During the noise measurement, it was noted a range of possible noise sources at the respective monitoring points that may contribute to the overall ambient noise levels. The detail of the monitoring points and identified noise sources near to the monitoring points are listed in Table 70 on the day of monitoring. In addition, Table 71 & 72 lists the number of vehicles and motorbikes which traveled along the respective areas of concerned during the 2 periods (peak and off peak hours) for each individual location on selected date is listed as below.

**Table 70: Identified noise sources near to the monitoring points**

Monitoring Point	Date		Time (hr)		Noise Sources
	Start	Stop	Start	Stop	
NL101_R2	16/01/15	23/01/15	0942	0943	Traffic noise (vehicles) from PIE, Insect Noise
NL102_R2	26/01/15	02/02/15	1900	1855	Human Activities (Jogging and jungle tracking) , Insect Noise, army aircraft passing overhead
NL103_R2	26/01/15	02/02/15	1904	1859	Insect noise, airplane noise
NL104_R2	19/01/15	26/01/15	1823	1821	Traffic noise (vehicles) from Island club road, Insect Noise
NL201_R2	16/01/15	23/01/15	1147	1143	Traffic noise (vehicles) from Upper Thomson road.
NL202_R2	16/01/15	23/01/15	1900	1855	Traffic noise (vehicles) from Thomson Road and Lornie road, Noise from water canal.
NL203_R2	16/01/15	23/01/15	1900	1855	Traffic noise (vehicles) from Lornie road

**Table 71: Human Traffic volume for peak and off peak hour**

Location	Weekend / Weekday	Peak Hour			Off Peak hour		
		Human	Heavy Vehicles	Motor-bikes	Human	Heavy Vehicles	Motor-bikes
NL102_R2	Weekend	29	NA	NA	18	NA	NA
	Weekday	7	NA	NA	5	NA	NA

Remarks:

- a) Peak Hour - (9am to 11am) & (3pm to 5pm) for weekend  
- After 3pm for weekday
- b) Non-peak Hour - Hours other than above

**Table 72: Vehicular Traffic volume for peak and off peak hour**

Location	Weekend / Weekday	Peak Hour			Off Peak hour		
		Vehicles	Heavy Vehicles	Motor-bikes	Vehicles	Heavy Vehicles	Motor-bikes
NL201_R2	Weekend	621	89	35	456	103	27
	Weekday	680	100	113	658	87	111
NL202_R2	Weekend	268	78	26	244	63	12
	Weekday	376	44	39	250	78	16
NL203_R2	Weekend	1052	256	158	761	183	31
	Weekday	1230	173	114	821	208	98

Remarks:

- a) Traffic volume was noted based on 15 minutes duration of each period;
- b) The heavy vehicles included trucks, vans, lorries and buses (involve in business).  
The vehicles included family car, four-wheel car and small vehicle which are non commercial.
- c) Peak Hour - (7.30am – 9.30am) & (5.00pm-8.00pm) for weekday  
- 12pm-2pm for weekend  
Non-Peak Hour - Hours other than above

## 6.0 LOCATION INDEX / SAMPLING SCHEDULE / TEST RESULTS

Location index, sampling schedule and their respective test results obtained were tabulated and reflected our findings on 16<sup>th</sup> January to 2<sup>nd</sup> February 2015.

Please refer to Table 73 to 128 and the daily noise level at all monitoring points were illustrated in Figure 53 to 101 and sampling locations at Figure 1 to 3.

**Table 73: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 12 hours**

Monitoring Point	Weekend / Weekday	Noise levels Leq in dB (A)	
		7am – 7pm	7pm – 7am
NL101_R2	Day 1	<b>60.5</b>	<b>58.4</b>
	Day 2 (weekend)	59.1	<b>57.7</b>
	Day 3 (weekend)	58.7	<b>57.0</b>
	Day 4	<b>60.1</b>	<b>57.0</b>
	Day 5	<b>60.9</b>	<b>59.4</b>
	Day 6	<b>63.9</b>	<b>59.5</b>
	Day 7	<b>61.2</b>	<b>59.9</b>
NL102_R2	Day 1	52.3	<b>50.6</b>
	Day 2	55.4	<b>51.2</b>
	Day 3	47.0	50.0
	Day 4	52.9	49.2
	Day 5 (weekend)	51.3	<b>50.5</b>
	Day 6 (weekend)	49.8	<b>50.3</b>
	Day 7	50.2	49.4
<b>*Limit of Affected Hospitals, schools, institutions of higher learning, homes for the aged sick, etc.</b>		60	50

Remark: \*Maximum Permissible Noise Level (reckoned as equivalent continuous noise level over a period of 12 hours)

**BOLD** denote the noise level has exceeded the respective permissible limit

**Table 14: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 12 hours**



Monitoring Point	Weekend / Weekday	Noise levels Leq in dB (A)	
		7am – 7pm	7pm – 7am
NL103_R2	Day 1	51.0	<b>50.9</b>
	Day 2	52.9	49.9
	Day 3	46.3	<b>50.4</b>
	Day 4	50.7	47.6
	Day 5 (weekend)	48.1	48.9
	Day 6 (weekend)	46.0	<b>50.1</b>
	Day 7	50.9	44.8
<b>*Limit of Affected Hospitals, schools, institutions of higher learning, homes for the aged sick, etc.</b>		60	50

Remark: \* Maximum Permissible Noise Level (reckoned as equivalent continuous noise level over a period of 5 minutes)

**BOLD** denote the noise level has exceeded the permissible limit

**Table 75: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 12 hours**

Monitoring Point	Weekend / Weekday	Noise levels Leq in dB (A)	
		7am – 7pm	7pm – 7am
NL104_R2	Day 1	61.8	55.8
	Day 2	64.7	58.2
	Day 3	62.2	61.6
	Day 4	62.6	58.4
	Day 5 (weekend)	62.2	59.4
	Day 6 (weekend)	61.6	57.9
	Day 7	62.4	56.5
<b>*Limit of Affected Buildings (other than those above)</b>		75	65

Remark: \* Maximum Permissible Noise Level (reckoned as equivalent continuous noise level over a period of 5 minutes)

**Table 76: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 12 hours**

Monitoring Point	Weekend / Weekday	Noise levels Leq in dB (A)	
		7am – 7pm	7pm – 7am
NL201_R2	Day 1	<b>75.5</b>	71.5
	Day 2 (weekend)	74.9	71.3
	Day 3 (weekend)	75.0	71.0
	Day 4	<b>75.5</b>	71.3
	Day 5	<b>75.5</b>	71.3
	Day 6	<b>76.8</b>	72.1
	Day 7	<b>75.5</b>	71.3
NL202_R2	Day 1	65.5	62.1
	Day 2 (weekend)	64.1	61.4
	Day 3 (weekend)	66.4	61.0
	Day 4	66.5	61.7
	Day 5	67.5	61.7
	Day 6	68.4	66.3
	Day 7	67.7	65.9
NL203_R2	Day 1	<b>80.7</b>	77.3
	Day 2	<b>79.1</b>	76.7
	Day 3	<b>81.0</b>	76.5
	Day 4	<b>81.1</b>	77.1
	Day 5 (weekend)	<b>81.6</b>	77.2
	Day 6 (weekend)	<b>80.9</b>	77.5
	Day 7	<b>81.0</b>	77.3
<b>*Limit of Affected Residential Buildings Located Less Than 150m From Construction site where the noise is being emitted</b>		75	NA

Remark: \*Maximum Permissible Noise Level (reckoned as equivalent continuous noise level over a period of 12 hours)

NA denote Not Available

**BOLD** denote the noise level has exceeded the respective permissible limit

**Table 2: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 5 minutes**

Monitoring Point	Day	Noise levels Leq in dB (A)		
		7am – 7pm	7pm – 10pm	10pm – 7am
NL101_R2	Day 1	60.5	<b>59.4</b>	<b>58.0</b>
	Day 2 (weekend)	59.1	<b>59.5</b>	<b>56.8</b>
	Day 3 (weekend)	58.7	<b>58.6</b>	<b>56.3</b>
	Day 4	60.1	<b>58.7</b>	<b>56.3</b>
	Day 5	60.9	<b>63.2</b>	<b>56.6</b>
	Day 6	63.9	<b>61.9</b>	<b>58.3</b>
	Day 7	61.2	<b>63.2</b>	<b>57.9</b>
NL102_R2	Day 1	52.3	54.5	47.7
	Day 2	55.4	<b>55.6</b>	48.1
	Day 3	47.0	53.5	49.0
	Day 4	52.9	51.2	48.3
	Day 5 (weekend)	51.3	52.8	49.3
	Day 6 (weekend)	49.8	53.4	48.3
	Day 7	50.2	51.2	48.6
NL103_R2	Day 1	51.0	<b>55.2</b>	47.4
	Day 2	52.9	54.5	45.7
	Day 3	46.3	54.8	46.4
	Day 4	50.7	50.4	46.0
	Day 5 (weekend)	48.1	50.9	47.9
	Day 6 (weekend)	46.0	54.7	45.5
	Day 7	50.9	45.9	44.3
<b>*Limit of Affected Hospitals, schools, institutions of higher learning, homes for the aged sick, etc.</b>		75	55	55

Remark: \* Maximum Permissible Noise Level (reckoned as equivalent continuous noise level over a period of 5 minutes)  
NA denote Not Available  
**BOLD** denote the noise level has exceeded the permissible limit

**Table 78: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 5 minutes**

Monitoring Point	Day	Noise levels Leq in dB (A)		
		7am – 7pm	7pm – 10pm	10pm – 7am
NL104_R2	Day 1	61.8	58.6	54.2
	Day 2	64.7	60.3	57.2
	Day 3	62.2	65.0	59.5
	Day 4	62.6	61.4	56.6
	Day 5 (weekend)	62.2	61.1	58.7
	Day 6 (weekend)	61.6	60.7	56.2
	Day 7	62.4	59.1	55.0
<b>*Limit of Affected Buildings (other than those above)</b>		90	70	70

Remark: \* Maximum Permissible Noise Level (reckoned as equivalent continuous noise level over a period of 5 minutes)  
NA denote Not Available  
**BOLD** denote the noise level has exceeded the permissible limit



**Table 79: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 5 minutes**

Monitoring Point	Day	Noise levels Leq in dB (A)		
		7am – 7pm	7pm – 10pm	10pm – 7am
NL201_R2	Day 1	75.5	<b>73.9</b>	<b>70.3</b>
	Day 2 (weekend)	74.9	<b>73.6</b>	<b>70.1</b>
	Day 3 (weekend)	75.0	<b>73.1</b>	<b>69.9</b>
	Day 4	75.5	<b>73.5</b>	<b>70.2</b>
	Day 5	75.5	<b>73.6</b>	<b>70.2</b>
	Day 6	76.8	<b>74.8</b>	<b>70.7</b>
	Day 7	75.5	<b>73.6</b>	<b>70.1</b>
NL202_R2	Day 1	65.5	64.6	<b>60.8</b>
	Day 2 (weekend)	64.1	<b>63.6</b>	<b>60.3</b>
	Day 3 (weekend)	66.4	<b>63.4</b>	<b>59.7</b>
	Day 4	66.5	64.7	<b>59.9</b>
	Day 5	67.5	65.8	<b>60.0</b>
	Day 6	68.4	68.3	<b>65.3</b>
	Day 7	67.7	67.8	<b>65.1</b>
NL203_R2	Day 1	80.7	<b>79.4</b>	<b>76.4</b>
	Day 2 (weekend)	79.1	<b>78.8</b>	<b>75.8</b>
	Day 3 (weekend)	<b>81.0</b>	<b>78.3</b>	<b>75.6</b>
	Day 4	81.1	<b>79.2</b>	<b>76.1</b>
	Day 5	81.6	<b>79.3</b>	<b>76.1</b>
	Day 6	80.9	<b>80.0</b>	<b>76.3</b>
	Day 7	81.0	<b>78.3</b>	<b>75.6</b>
<b>*Limit of Affected Residential Buildings Located Less Than 150m From Construction site where the noise is being emitted</b>	Sunday/Public Holiday	75	55	55
	Monday-Saturday	90	70	55

Remark: \* Maximum Permissible Noise Level (reckoned as equivalent continuous noise level over a period of 5 minutes)  
NA denote Not Available  
**BOLD** denote the noise level has exceeded the permissible limit

**Table 80: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL101\_R2 Day 1**

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 1	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	60.6	NA	NA
0800 – 0900	61.1		
0900 – 1000	60.9		
1000 – 1100	63.6		
1100 – 1200	61.0		
1200 – 1300	59.9		
1300 – 1400	59.9		
1400 – 1500	60.1		
1500 – 1600	59.6		
1600 – 1700	61.2		
1700 – 1800	58.5		
1800 – 1900	56.1		
1900 – 2000	58.2	NA	NA
2000 – 2100	60.3		
2100 – 2200	59.3		
2200 – 2300	60.2	NA	NA
2300 – 0000	58.8		
0000 – 0100	57.9		
0100 – 0200	59.5		
0200 – 0300	56.1		
0300 – 0400	55.5		
0400 – 0500	55.7		
0500 – 0600	56.9		
0600 – 0700	58.4		

Remark: \* Limit of Affected Hospitals, schools, institutions of higher learning, home for aged sick, etc where the noise is being emitted on Monday to Saturday.  
NA denote Not Available

**Table 81: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL101\_R2 Day 2**

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 2 (weekend)	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	58.4	NA	NA
0800 – 0900	59.2		
0900 – 1000	59.9		
1000 – 1100	61.4		
1100 – 1200	59.3		
1200 – 1300	55.5		
1300 – 1400	56.4		
1400 – 1500	59.0		
1500 – 1600	59.4		
1600 – 1700	59.5		
1700 – 1800	59.4		
1800 – 1900	59.4		
1900 – 2000	59.7	NA	NA
2000 – 2100	59.8		
2100 – 2200	59.1		
2200 – 2300	59.3	NA	NA
2300 – 0000	58.3		
0000 – 0100	57.3		
0100 – 0200	56.2		
0200 – 0300	55.5		
0300 – 0400	54.9		
0400 – 0500	54.9		
0500 – 0600	55.1		
0600 – 0700	57.3		

Remark: \* Limit of Affected Hospitals, schools, institutions of higher learning, home for aged sick, etc where the noise is being emitted on Monday to Saturday.  
NA denote Not Available

**Table 82: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL101\_R2 Day 3**

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 3 (weekend)	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	58.7	NA	NA
0800 – 0900	58.9		
0900 – 1000	59.8		
1000 – 1100	59.1		
1100 – 1200	58.7		
1200 – 1300	58.2		
1300 – 1400	58.1		
1400 – 1500	58.6		
1500 – 1600	58.4		
1600 – 1700	58.6		
1700 – 1800	58.8		
1800 – 1900	58.8		
1900 – 2000	58.9	NA	NA
2000 – 2100	58.4		
2100 – 2200	58.5		
2200 – 2300	58.6	NA	NA
2300 – 0000	57.6		
0000 – 0100	56.0		
0100 – 0200	54.3		
0200 – 0300	53.1		
0300 – 0400	52.7		
0400 – 0500	53.8		
0500 – 0600	56.3		
0600 – 0700	59.3		

Remark: \* Limit of Affected Hospitals, schools, institutions of higher learning, home for aged sick, etc where the noise is being emitted on Monday to Saturday.  
NA denote Not Available

**Table 83: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL101\_R2 Day 4**

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 4	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	61.4	NA	NA
0800 – 0900	59.6		
0900 – 1000	59.5		
1000 – 1100	61.3		
1100 – 1200	59.5		
1200 – 1300	60.2		
1300 – 1400	60.7		
1400 – 1500	60.8		
1500 – 1600	59.0		
1600 – 1700	59.9		
1700 – 1800	59.9		
1800 – 1900	59.1		
1900 – 2000	58.7	NA	NA
2000 – 2100	58.8		
2100 – 2200	58.6		
2200 – 2300	58.5	NA	NA
2300 – 0000	57.3		
0000 – 0100	55.5		
0100 – 0200	54.5		
0200 – 0300	53.2		
0300 – 0400	53.5		
0400 – 0500	53.9		
0500 – 0600	56.2		
0600 – 0700	59.2		

Remark: \* Limit of Affected Hospitals, schools, institutions of higher learning, home for aged sick, etc where the noise is being emitted on Monday to Saturday.  
NA denote Not Available



**Table 84: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL102\_R1 Day 5**

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 5	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	58.9	NA	NA
0800 – 0900	59.6		
0900 – 1000	60.0		
1000 – 1100	62.5		
1100 – 1200	61.8		
1200 – 1300	59.9		
1300 – 1400	61.7		
1400 – 1500	62.2		
1500 – 1600	59.5		
1600 – 1700	59.7		
1700 – 1800	61.0		
1800 – 1900	61.4		
1900 – 2000	65.6	NA	NA
2000 – 2100	62.5		
2100 – 2200	59.4		
2200 – 2300	59.6	NA	NA
2300 – 0000	57.5		
0000 – 0100	57.3		
0100 – 0200	54.5		
0200 – 0300	53.6		
0300 – 0400	53.1		
0400 – 0500	53.7		
0500 – 0600	56.2		
0600 – 0700	58.9		

Remark: \* Limit of Affected Hospitals, schools, institutions of higher learning, home for aged sick, etc where the noise is being emitted on Monday to Saturday.  
NA denote Not Available

**Table 85: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL101\_R2 Day 6**

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 6	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	61.0	NA	NA
0800 – 0900	60.9		
0900 – 1000	60.6		
1000 – 1100	61.7		
1100 – 1200	60.1		
1200 – 1300	58.9		
1300 – 1400	61.7		
1400 – 1500	59.2		
1500 – 1600	60.5		
1600 – 1700	59.4		
1700 – 1800	70.9		
1800 – 1900	67.7		
1900 – 2000	63.4	NA	NA
2000 – 2100	61.1		
2100 – 2200	60.8		
2200 – 2300	62.0	NA	NA
2300 – 0000	59.3		
0000 – 0100	57.5		
0100 – 0200	56.1		
0200 – 0300	54.8		
0300 – 0400	55.7		
0400 – 0500	55.4		
0500 – 0600	57.3		
0600 – 0700	60.4		

Remark: \* Limit of Affected Hospitals, schools, institutions of higher learning, home for aged sick, etc where the noise is being emitted on Monday to Saturday.  
NA denote Not Available

**Table 86: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL101\_R2 Day 7**

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 7	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	60.3	NA	NA
0800 – 0900	60.0		
0900 – 1000	59.7		
1000 – 1100	63.2		
1100 – 1200	61.6		
1200 – 1300	62.7		
1300 – 1400	60.1		
1400 – 1500	60.8		
1500 – 1600	62.2		
1600 – 1700	61.0		
1700 – 1800	60.2		
1800 – 1900	60.8		
1900 – 2000	65.5	NA	NA
2000 – 2100	62.5		
2100 – 2200	59.4		
2200 – 2300	59.3	NA	NA
2300 – 0000	62.2		
0000 – 0100	56.5		
0100 – 0200	55.0		
0200 – 0300	54.6		
0300 – 0400	53.5		
0400 – 0500	54.9		
0500 – 0600	56.8		
0600 – 0700	59.9		

Remark: \* Limit of Affected Hospitals, schools, institutions of higher learning, home for aged sick, etc where the noise is being emitted on Monday to Saturday.  
NA denote Not Available

**Table 87: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL102\_R2 Day 1**

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 1	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	45.9	NA	NA
0800 – 0900	44.6		
0900 – 1000	48.1		
1000 – 1100	53.2		
1100 – 1200	54.9		
1200 – 1300	53.6		
1300 – 1400	53.0		
1400 – 1500	51.5		
1500 – 1600	48.6		
1600 – 1700	58.1		
1700 – 1800	44.5		
1800 – 1900	48.9		
1900 – 2000	57.4	NA	NA
2000 – 2100	52.6		
2100 – 2200	51.0		
2200 – 2300	50.0	NA	NA
2300 – 0000	48.5		
0000 – 0100	48.0		
0100 – 0200	47.3		
0200 – 0300	47.4		
0300 – 0400	47.3		
0400 – 0500	46.5		
0500 – 0600	45.6		
0600 – 0700	46.7		

Remark: \* Limit of Affected Hospitals, schools, institutions of higher learning, home for aged sick, etc where the noise is being emitted on Monday to Saturday.  
NA denote Not Available

**Table 88: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL102\_R2 Day 2**

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 2	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	47.7	NA	NA
0800 – 0900	44.0		
0900 – 1000	45.4		
1000 – 1100	47.3		
1100 – 1200	43.8		
1200 – 1300	64.9		
1300 – 1400	42.2		
1400 – 1500	54.6		
1500 – 1600	50.1		
1600 – 1700	45.8		
1700 – 1800	46.4		
1800 – 1900	55.1		
1900 – 2000	58.7	NA	NA
2000 – 2100	52.0		
2100 – 2200	50.6		
2200 – 2300	49.3	NA	NA
2300 – 0000	49.0		
0000 – 0100	48.2		
0100 – 0200	48.0		
0200 – 0300	48.2		
0300 – 0400	47.6		
0400 – 0500	48.2		
0500 – 0600	46.6		
0600 – 0700	46.7		

Remark: \* Limit of Affected Hospitals, schools, institutions of higher learning, home for aged sick, etc where the noise is being emitted on Monday to Saturday.  
NA denote Not Available



**Table 89: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL102\_R2 Day 3**

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 3	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	48.1	NA	NA
0800 – 0900	44.6		
0900 – 1000	46.0		
1000 – 1100	45.6		
1100 – 1200	44.9		
1200 – 1300	45.2		
1300 – 1400	44.2		
1400 – 1500	44.7		
1500 – 1600	48.7		
1600 – 1700	47.5		
1700 – 1800	52.1		
1800 – 1900	42.3		
1900 – 2000	51.3	NA	NA
2000 – 2100	53.7		
2100 – 2200	50.6		
2200 – 2300	49.8	NA	NA
2300 – 0000	50.2		
0000 – 0100	50.1		
0100 – 0200	49.2		
0200 – 0300	48.3		
0300 – 0400	48.2		
0400 – 0500	48.0		
0500 – 0600	47.4		
0600 – 0700	48.6		

Remark: \* Limit of Affected Hospitals, schools, institutions of higher learning, home for aged sick, etc where the noise is being emitted on Monday to Saturday.  
NA denote Not Available

**Table 90: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL102\_R2 Day 4**

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 4	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	47.0	NA	NA
0800 – 0900	53.2		
0900 – 1000	55.6		
1000 – 1100	50.5		
1100 – 1200	48.2		
1200 – 1300	53.2		
1300 – 1400	46.8		
1400 – 1500	60.2		
1500 – 1600	50.1		
1600 – 1700	47.1		
1700 – 1800	45.4		
1800 – 1900	43.6		
1900 – 2000	50.6	NA	NA
2000 – 2100	52.3		
2100 – 2200	50.7		
2200 – 2300	50.0	NA	NA
2300 – 0000	49.4		
0000 – 0100	48.5		
0100 – 0200	48.3		
0200 – 0300	47.6		
0300 – 0400	47.4		
0400 – 0500	46.8		
0500 – 0600	46.9		
0600 – 0700	48.1		

Remark: \* Limit of Affected Hospitals, schools, institutions of higher learning, home for aged sick, etc where the noise is being emitted on Monday to Saturday.  
NA denote Not Available

**Table 91: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL102\_R2 Day 5**

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 5 (weekend)	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	51.0	NA	NA
0800 – 0900	50.2		
0900 – 1000	50.2		
1000 – 1100	50.4		
1100 – 1200	59.0		
1200 – 1300	47.5		
1300 – 1400	47.4		
1400 – 1500	46.5		
1500 – 1600	45.9		
1600 – 1700	47.1		
1700 – 1800	49.9		
1800 – 1900	44.8		
1900 – 2000	52.0	NA	NA
2000 – 2100	54.0		
2100 – 2200	52.3		
2200 – 2300	49.4	NA	NA
2300 – 0000	49.1		
0000 – 0100	49.4		
0100 – 0200	50.8		
0200 – 0300	49.2		
0300 – 0400	49.5		
0400 – 0500	48.7		
0500 – 0600	48.5		
0600 – 0700	48.6		

Remark: \* Limit of Affected Hospitals, schools, institutions of higher learning, home for aged sick, etc where the noise is being emitted on Monday to Saturday.  
NA denote Not Available

**Table 92: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL102\_R2 Day 6**

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 6 (weekend)	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	50.6	NA	NA
0800 – 0900	49.7		
0900 – 1000	49.6		
1000 – 1100	53.8		
1100 – 1200	51.5		
1200 – 1300	48.8		
1300 – 1400	48.0		
1400 – 1500	49.8		
1500 – 1600	48.4		
1600 – 1700	47.5		
1700 – 1800	49.2		
1800 – 1900	45.3		
1900 – 2000	52.5	NA	NA
2000 – 2100	55.0		
2100 – 2200	52.2		
2200 – 2300	51.2	NA	NA
2300 – 0000	47.4		
0000 – 0100	49.6		
0100 – 0200	46.7		
0200 – 0300	48.6		
0300 – 0400	49.8		
0400 – 0500	46.8		
0500 – 0600	44.6		
0600 – 0700	46.8		

Remark: \* Limit of Affected Hospitals, schools, institutions of higher learning, home for aged sick, etc where the noise is being emitted on Monday to Saturday.  
NA denote Not Available

**Table 93: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL102\_R2 Day 7**

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 7	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	50.4	NA	NA
0800 – 0900	47.2		
0900 – 1000	46.3		
1000 – 1100	44.8		
1100 – 1200	47.0		
1200 – 1300	44.4		
1300 – 1400	42.8		
1400 – 1500	54.5		
1500 – 1600	57.2		
1600 – 1700	46.8		
1700 – 1800	45.1		
1800 – 1900	44.2		
1900 – 2000	49.3	NA	NA
2000 – 2100	53.2		
2100 – 2200	50.2		
2200 – 2300	48.4	NA	NA
2300 – 0000	50.1		
0000 – 0100	48.0		
0100 – 0200	47.5		
0200 – 0300	47.9		
0300 – 0400	48.0		
0400 – 0500	48.1		
0500 – 0600	48.3		
0600 – 0700	50.1		

Remark: \* Limit of Affected Hospitals, schools, institutions of higher learning, home for aged sick, etc where the noise is being emitted on Monday to Saturday.  
NA denote Not Available



**Table 94: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL103\_R2 Day 1**

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 1	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	45.9	NA	NA
0800 – 0900	42.5		
0900 – 1000	48.6		
1000 – 1100	52.3		
1100 – 1200	55.5		
1200 – 1300	53.1		
1300 – 1400	42.2		
1400 – 1500	48.1		
1500 – 1600	50.0		
1600 – 1700	55.8		
1700 – 1800	40.9		
1800 – 1900	49.4		
1900 – 2000	58.8	NA	NA
2000 – 2100	50.8		
2100 – 2200	50.4		
2200 – 2300	48.6	NA	NA
2300 – 0000	47.7		
0000 – 0100	47.8		
0100 – 0200	48.0		
0200 – 0300	47.8		
0300 – 0400	47.6		
0400 – 0500	47.9		
0500 – 0600	45.0		
0600 – 0700	45.3		

Remark: \* Limit of Affected Hospitals, schools, institutions of higher learning, home for aged sick, etc where the noise is being emitted on Monday to Saturday.  
NA denote Not Available

**Table 95: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL103\_R2 Day 2**

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 2	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	45.6	NA	NA
0800 – 0900	42.0		
0900 – 1000	50.5		
1000 – 1100	48.2		
1100 – 1200	50.5		
1200 – 1300	54.8		
1300 – 1400	59.4		
1400 – 1500	55.2		
1500 – 1600	50.2		
1600 – 1700	44.4		
1700 – 1800	42.0		
1800 – 1900	55.3		
1900 – 2000	58.5	NA	NA
2000 – 2100	48.3		
2100 – 2200	47.9		
2200 – 2300	46.4	NA	NA
2300 – 0000	45.5		
0000 – 0100	45.9		
0100 – 0200	45.7		
0200 – 0300	47.3		
0300 – 0400	46.2		
0400 – 0500	45.1		
0500 – 0600	44.4		
0600 – 0700	44.1		

Remark: \* Limit of Affected Hospitals, schools, institutions of higher learning, home for aged sick, etc where the noise is being emitted on Monday to Saturday.  
NA denote Not Available

**Table 96: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL103\_R2 Day 3**

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 3	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	47.1	NA	NA
0800 – 0900	43.9		
0900 – 1000	44.1		
1000 – 1100	46.9		
1100 – 1200	45.7		
1200 – 1300	41.2		
1300 – 1400	40.2		
1400 – 1500	46.9		
1500 – 1600	48.9		
1600 – 1700	43.7		
1700 – 1800	51.4		
1800 – 1900	40.8		
1900 – 2000	58.4	NA	NA
2000 – 2100	51.6		
2100 – 2200	48.2		
2200 – 2300	47.2	NA	NA
2300 – 0000	46.9		
0000 – 0100	47.3		
0100 – 0200	47.1		
0200 – 0300	46.3		
0300 – 0400	45.3		
0400 – 0500	45.5		
0500 – 0600	47.0		
0600 – 0700	44.4		

Remark: \* Limit of Affected Hospitals, schools, institutions of higher learning, home for aged sick, etc where the noise is being emitted on Monday to Saturday.  
NA denote Not Available

**Table 97: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL103\_R2 Day 4**

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 4	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	47.7	NA	NA
0800 – 0900	52.4		
0900 – 1000	56.4		
1000 – 1100	47.6		
1100 – 1200	46.2		
1200 – 1300	52.9		
1300 – 1400	45.0		
1400 – 1500	54.6		
1500 – 1600	49.5		
1600 – 1700	43.6		
1700 – 1800	42.0		
1800 – 1900	39.0		
1900 – 2000	53.7	NA	NA
2000 – 2100	46.9		
2100 – 2200	46.7		
2200 – 2300	45.7	NA	NA
2300 – 0000	46.0		
0000 – 0100	46.2		
0100 – 0200	47.6		
0200 – 0300	46.4		
0300 – 0400	45.9		
0400 – 0500	46.5		
0500 – 0600	44.3		
0600 – 0700	44.8		

Remark: \* Limit of Affected Hospitals, schools, institutions of higher learning, home for aged sick, etc where the noise is being emitted on Monday to Saturday.  
NA denote Not Available

**Table 98: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL103\_R2 Day 5**

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 5 (weekend)	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	45.3	NA	NA
0800 – 0900	43.3		
0900 – 1000	48.1		
1000 – 1100	48.1		
1100 – 1200	55.7		
1200 – 1300	43.2		
1300 – 1400	41.5		
1400 – 1500	49.0		
1500 – 1600	45.8		
1600 – 1700	43.2		
1700 – 1800	43.9		
1800 – 1900	42.7		
1900 – 2000	53.6	NA	NA
2000 – 2100	48.6		
2100 – 2200	48.2		
2200 – 2300	49.0	NA	NA
2300 – 0000	49.4		
0000 – 0100	49.3		
0100 – 0200	47.7		
0200 – 0300	47.4		
0300 – 0400	47.5		
0400 – 0500	47.5		
0500 – 0600	46.2		
0600 – 0700	45.6		

Remark: \* Limit of Affected Hospitals, schools, institutions of higher learning, home for aged sick, etc where the noise is being emitted on Monday to Saturday.  
NA denote Not Available



**Table 99: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL103\_R2 Day 6**

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 6 (weekend)	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	43.1	NA	NA
0800 – 0900	42.1		
0900 – 1000	46.2		
1000 – 1100	47.6		
1100 – 1200	46.8		
1200 – 1300	44.6		
1300 – 1400	44.0		
1400 – 1500	48.3		
1500 – 1600	48.9		
1600 – 1700	46.6		
1700 – 1800	45.7		
1800 – 1900	42.1		
1900 – 2000	58.7	NA	NA
2000 – 2100	48.3		
2100 – 2200	49.0		
2200 – 2300	47.4	NA	NA
2300 – 0000	47.9		
0000 – 0100	45.9		
0100 – 0200	45.6		
0200 – 0300	44.1		
0300 – 0400	44.9		
0400 – 0500	44.5		
0500 – 0600	44.0		
0600 – 0700	43.3		

Remark: \* Limit of Affected Hospitals, schools, institutions of higher learning, home for aged sick, etc where the noise is being emitted on Monday to Saturday.  
NA denote Not Available

**Table 100: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL103\_R2 Day 7**

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 7	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	45.4	NA	NA
0800 – 0900	43.6		
0900 – 1000	44.7		
1000 – 1100	43.3		
1100 – 1200	44.0		
1200 – 1300	45.0		
1300 – 1400	43.4		
1400 – 1500	56.0		
1500 – 1600	59.1		
1600 – 1700	46.7		
1700 – 1800	42.1		
1800 – 1900	41.8		
1900 – 2000	43.3	NA	NA
2000 – 2100	46.9		
2100 – 2200	46.7		
2200 – 2300	45.7	NA	NA
2300 – 0000	44.5		
0000 – 0100	43.7		
0100 – 0200	44.7		
0200 – 0300	43.7		
0300 – 0400	44.3		
0400 – 0500	44.8		
0500 – 0600	43.8		
0600 – 0700	43.2		

Remark: \* Limit of Affected Hospitals, schools, institutions of higher learning, home for aged sick, etc where the noise is being emitted on Monday to Saturday.  
NA denote Not Available

**Table 101: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL104\_R2 Day 1**

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 1	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	60.1	NA	NA
0800 – 0900	61.5		
0900 – 1000	59.8		
1000 – 1100	63.1		
1100 – 1200	61.2		
1200 – 1300	60.5		
1300 – 1400	61.8		
1400 – 1500	62.1		
1500 – 1600	63.7		
1600 – 1700	61.8		
1700 – 1800	63.0		
1800 – 1900	61.5		
1900 – 2000	61.2	NA	NA
2000 – 2100	57.6		
2100 – 2200	54.5		
2200 – 2300	55.6	NA	NA
2300 – 0000	53.2		
0000 – 0100	47.9		
0100 – 0200	47.6		
0200 – 0300	54.5		
0300 – 0400	48.2		
0400 – 0500	48.2		
0500 – 0600	54.2		
0600 – 0700	60.0		

Remark: \* Limit of Affected Buildings (other than above)  
NA denote Not Available

**Table 102: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL104\_R2 Day 2**

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 2	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	58.6	NA	NA
0800 – 0900	61.0		
0900 – 1000	61.6		
1000 – 1100	64.0		
1100 – 1200	62.0		
1200 – 1300	61.7		
1300 – 1400	61.6		
1400 – 1500	63.8		
1500 – 1600	62.5		
1600 – 1700	63.3		
1700 – 1800	71.9		
1800 – 1900	65.2		
1900 – 2000	63.4	NA	NA
2000 – 2100	57.2		
2100 – 2200	57.0		
2200 – 2300	58.1	NA	NA
2300 – 0000	55.6		
0000 – 0100	56.7		
0100 – 0200	51.8		
0200 – 0300	51.2		
0300 – 0400	62.1		
0400 – 0500	49.1		
0500 – 0600	52.0		
0600 – 0700	60.5		

Remark: \* Limit of Affected Buildings (other than above)  
NA denote Not Available

**Table 103: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL104\_R2 Day 3**

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 3	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	61.1	NA	NA
0800 – 0900	62.9		
0900 – 1000	62.2		
1000 – 1100	63.0		
1100 – 1200	62.9		
1200 – 1300	61.4		
1300 – 1400	60.8		
1400 – 1500	62.6		
1500 – 1600	62.6		
1600 – 1700	61.2		
1700 – 1800	62.7		
1800 – 1900	62.4		
1900 – 2000	65.4	NA	NA
2000 – 2100	65.5		
2100 – 2200	63.9		
2200 – 2300	63.2	NA	NA
2300 – 0000	62.9		
0000 – 0100	55.5		
0100 – 0200	61.1		
0200 – 0300	59.3		
0300 – 0400	55.4		
0400 – 0500	49.6		
0500 – 0600	53.6		
0600 – 0700	59.3		

Remark: \* Limit of Affected Buildings (other than above)  
NA denote Not Available



**Table 104: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL104\_R2 Day 4**

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 4	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	60.8	NA	NA
0800 – 0900	63.1		
0900 – 1000	62.9		
1000 – 1100	62.9		
1100 – 1200	61.8		
1200 – 1300	62.4		
1300 – 1400	62.8		
1400 – 1500	64.4		
1500 – 1600	62.6		
1600 – 1700	61.4		
1700 – 1800	63.9		
1800 – 1900	60.7		
1900 – 2000	62.8	NA	NA
2000 – 2100	59.9		
2100 – 2200	61.2		
2200 – 2300	59.4	NA	NA
2300 – 0000	60.2		
0000 – 0100	56.4		
0100 – 0200	50.7		
0200 – 0300	52.4		
0300 – 0400	53.0		
0400 – 0500	48.3		
0500 – 0600	52.8		
0600 – 0700	59.9		

Remark: \* Limit of Affected Buildings (other than above)  
NA denote Not Available

**Table 105: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL104\_R2 Day 5**

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 5 (weekend)	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	61.6	NA	NA
0800 – 0900	61.4		
0900 – 1000	62.5		
1000 – 1100	63.2		
1100 – 1200	62.4		
1200 – 1300	62.5		
1300 – 1400	63.4		
1400 – 1500	62.6		
1500 – 1600	62.1		
1600 – 1700	62.3		
1700 – 1800	60.9		
1800 – 1900	61.1		
1900 – 2000	61.5	NA	NA
2000 – 2100	61.8		
2100 – 2200	59.6		
2200 – 2300	63.2	NA	NA
2300 – 0000	57.5		
0000 – 0100	55.8		
0100 – 0200	54.8		
0200 – 0300	52.4		
0300 – 0400	56.7		
0400 – 0500	52.3		
0500 – 0600	52.5		
0600 – 0700	63.6		

Remark: \* Limit of Affected Buildings (other than above)  
NA denote Not Available

**Table 106: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL104\_R2 Day 6**

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 6 (weekend)	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	61.3	NA	NA
0800 – 0900	60.5		
0900 – 1000	60.3		
1000 – 1100	62.0		
1100 – 1200	60.9		
1200 – 1300	62.9		
1300 – 1400	61.8		
1400 – 1500	62.5		
1500 – 1600	62.2		
1600 – 1700	61.3		
1700 – 1800	61.1		
1800 – 1900	61.1		
1900 – 2000	62.3	NA	NA
2000 – 2100	59.3		
2100 – 2200	60.0		
2200 – 2300	58.9	NA	NA
2300 – 0000	56.7		
0000 – 0100	53.0		
0100 – 0200	50.6		
0200 – 0300	59.3		
0300 – 0400	50.5		
0400 – 0500	50.5		
0500 – 0600	56.6		
0600 – 0700	58.3		

Remark: \* Limit of Affected Buildings (other than above)  
NA denote Not Available

**Table 107: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL104\_R2 Day 7**

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 7	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	61.4	NA	NA
0800 – 0900	61.1		
0900 – 1000	62.1		
1000 – 1100	62.6		
1100 – 1200	64.2		
1200 – 1300	61.8		
1300 – 1400	60.6		
1400 – 1500	61.8		
1500 – 1600	62.6		
1600 – 1700	64.6		
1700 – 1800	62.7		
1800 – 1900	60.5		
1900 – 2000	61.4	NA	NA
2000 – 2100	57.9		
2100 – 2200	56.7		
2200 – 2300	59.1	NA	NA
2300 – 0000	55.2		
0000 – 0100	51.3		
0100 – 0200	52.8		
0200 – 0300	55.6		
0300 – 0400	52.0		
0400 – 0500	47.4		
0500 – 0600	51.6		
0600 – 0700	58.2		

Remark: \* Limit of Affected Buildings (other than above)  
NA denote Not Available

**Table 108: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL201\_R2 Day 1**

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 1	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	75.2	NA	NA
0800 – 0900	76.5		
0900 – 1000	76.6		
1000 – 1100	76.1		
1100 – 1200	75.2		
1200 – 1300	75.3		
1300 – 1400	75.4		
1400 – 1500	75.3		
1500 – 1600	75.3		
1600 – 1700	75.4		
1700 – 1800	75.0		
1800 – 1900	74.7		
1900 – 2000	74.1	NA	65
2000 – 2100	73.7		
2100 – 2200	73.8		
2200 – 2300	72.9	NA	55
2300 – 0000	72.5		
0000 – 0100	70.3		
0100 – 0200	69.0		
0200 – 0300	68.3		
0300 – 0400	67.0		
0400 – 0500	67.2		
0500 – 0600	68.0		
0600 – 0700	72.4		

Remark: \* Limit of Affected Residential Buildings Located Less Than 150m From Construction site where the noise is being emitted on Monday to Saturday  
NA denote Not Available



**Table 109: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL201\_R2 Day 2**

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 2 (weekend)	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	72.9	NA	NA
0800 – 0900	74.5		
0900 – 1000	74.2		
1000 – 1100	75.1		
1100 – 1200	74.7		
1200 – 1300	75.5		
1300 – 1400	75.5		
1400 – 1500	75.9		
1500 – 1600	74.9		
1600 – 1700	75.0		
1700 – 1800	74.8		
1800 – 1900	75.1		
1900 – 2000	<b>73.9</b>	NA	65
2000 – 2100	<b>73.8</b>		
2100 – 2200	<b>72.9</b>		
2200 – 2300	<b>72.9</b>	NA	55
2300 – 0000	<b>72.7</b>		
0000 – 0100	<b>70.5</b>		
0100 – 0200	<b>69.1</b>		
0200 – 0300	<b>68.0</b>		
0300 – 0400	<b>67.5</b>		
0400 – 0500	<b>66.3</b>		
0500 – 0600	<b>67.9</b>		
0600 – 0700	<b>70.8</b>		

Remark: \* Limit of Affected Residential Buildings Located Less Than 150m From Construction site where the noise is being emitted on Monday to Saturday  
NA denote Not Available

**Table 110: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL201\_R2 Day 3**

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 3 (weekend)	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	75.5	NA	NA
0800 – 0900	76.0		
0900 – 1000	76.8		
1000 – 1100	75.9		
1100 – 1200	75.6		
1200 – 1300	74.5		
1300 – 1400	74.2		
1400 – 1500	74.2		
1500 – 1600	74.1		
1600 – 1700	73.6		
1700 – 1800	74.5		
1800 – 1900	74.0		
1900 – 2000	73.5	NA	65
2000 – 2100	72.8		
2100 – 2200	73.1		
2200 – 2300	72.3	NA	55
2300 – 0000	70.8		
0000 – 0100	68.4		
0100 – 0200	66.9		
0200 – 0300	65.0		
0300 – 0400	64.8		
0400 – 0500	65.9		
0500 – 0600	68.9		
0600 – 0700	74.8		

Remark: \* Limit of Affected Residential Buildings Located Less Than 150m From Construction site where the noise is being emitted on Monday to Saturday  
NA denote Not Available

**Table 111: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL201\_R2 Day 4**

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 4	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	75.7	NA	NA
0800 – 0900	76.3		
0900 – 1000	77.1		
1000 – 1100	76.1		
1100 – 1200	75.7		
1200 – 1300	75.2		
1300 – 1400	75.1		
1400 – 1500	75.6		
1500 – 1600	75.1		
1600 – 1700	75.1		
1700 – 1800	74.0		
1800 – 1900	74.6		
1900 – 2000	73.7	NA	65
2000 – 2100	72.8		
2100 – 2200	73.8		
2200 – 2300	72.2	NA	55
2300 – 0000	71.1		
0000 – 0100	68.0		
0100 – 0200	66.8		
0200 – 0300	66.9		
0300 – 0400	65.4		
0400 – 0500	66.5		
0500 – 0600	68.8		
0600 – 0700	75.2		

Remark: \* Limit of Affected Residential Buildings Located Less Than 150m From Construction site where the noise is being emitted on Monday to Saturday  
NA denote Not Available

**Table 112: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL201\_R2 Day 5**

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 5	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	75.9	NA	NA
0800 – 0900	75.9		
0900 – 1000	76.7		
1000 – 1100	76.6		
1100 – 1200	75.1		
1200 – 1300	74.9		
1300 – 1400	75.2		
1400 – 1500	75.4		
1500 – 1600	75.5		
1600 – 1700	74.7		
1700 – 1800	74.5		
1800 – 1900	74.9		
1900 – 2000	74.1	NA	65
2000 – 2100	73.3		
2100 – 2200	73.5		
2200 – 2300	72.5	NA	55
2300 – 0000	71.0		
0000 – 0100	69.7		
0100 – 0200	67.0		
0200 – 0300	66.2		
0300 – 0400	65.2		
0400 – 0500	66.3		
0500 – 0600	68.7		
0600 – 0700	74.8		

Remark: \* Limit of Affected Residential Buildings Located Less Than 150m From Construction site where the noise is being emitted on Monday to Saturday  
NA denote Not Available

**Table 113: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL201\_R2 Day 6**

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 6	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	76.1	NA	NA
0800 – 0900	77.2		
0900 – 1000	76.6		
1000 – 1100	76.3		
1100 – 1200	75.7		
1200 – 1300	74.8		
1300 – 1400	75.8		
1400 – 1500	75.6		
1500 – 1600	75.4		
1600 – 1700	76.5		
1700 – 1800	80.2		
1800 – 1900	78.1		
1900 – 2000	<b>75.6</b>	NA	65
2000 – 2100	<b>74.6</b>		
2100 – 2200	<b>74.1</b>		
2200 – 2300	<b>73.0</b>	NA	55
2300 – 0000	<b>71.8</b>		
0000 – 0100	<b>68.0</b>		
0100 – 0200	<b>67.1</b>		
0200 – 0300	<b>67.5</b>		
0300 – 0400	<b>65.9</b>		
0400 – 0500	<b>69.9</b>		
0500 – 0600	<b>68.5</b>		
0600 – 0700	<b>75.1</b>		

Remark: \* Limit of Affected Residential Buildings Located Less Than 150m From Construction site where the noise is being emitted on Monday to Saturday  
NA denote Not Available



**Table 114: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL201\_R2 Day 7**

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 7	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	75.5	NA	NA
0800 – 0900	76.4		
0900 – 1000	76.4		
1000 – 1100	76.3		
1100 – 1200	75.7		
1200 – 1300	75.0		
1300 – 1400	75.5		
1400 – 1500	75.3		
1500 – 1600	75.0		
1600 – 1700	74.7		
1700 – 1800	74.5		
1800 – 1900	74.9		
1900 – 2000	74.1	NA	65
2000 – 2100	73.6		
2100 – 2200	73.1		
2200 – 2300	72.9	NA	55
2300 – 0000	71.6		
0000 – 0100	69.1		
0100 – 0200	67.5		
0200 – 0300	65.6		
0300 – 0400	65.2		
0400 – 0500	64.8		
0500 – 0600	68.2		
0600 – 0700	74.5		

Remark: \* Limit of Affected Residential Buildings Located Less Than 150m From Construction site where the noise is being emitted on Monday to Saturday  
NA denote Not Available

**Table 115: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL202\_R2 Day 1**

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 1	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	64.8	NA	NA
0800 – 0900	64.8		
0900 – 1000	65.4		
1000 – 1100	65.5		
1100 – 1200	66.5		
1200 – 1300	65.3		
1300 – 1400	65.9		
1400 – 1500	65.3		
1500 – 1600	66.2		
1600 – 1700	65.3		
1700 – 1800	65.1		
1800 – 1900	64.8		
1900 – 2000	<b>65.4</b>	NA	65
2000 – 2100	64.6		
2100 – 2200	63.9		
2200 – 2300	<b>64.5</b>	NA	55
2300 – 0000	<b>63.2</b>		
0000 – 0100	<b>60.8</b>		
0100 – 0200	<b>59.9</b>		
0200 – 0300	<b>57.1</b>		
0300 – 0400	<b>56.2</b>		
0400 – 0500	<b>55.5</b>		
0500 – 0600	<b>58.1</b>		
0600 – 0700	<b>62.5</b>		

Remark: \* Limit of Affected Residential Buildings Located Less Than 150m From Construction site where the noise is being emitted on Monday to Saturday  
NA denote Not Available

**Table 116: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL202\_R2 Day 2**

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 2 (weekend)	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	62.6	NA	NA
0800 – 0900	63.0		
0900 – 1000	63.8		
1000 – 1100	63.8		
1100 – 1200	64.4		
1200 – 1300	64.5		
1300 – 1400	64.5		
1400 – 1500	64.1		
1500 – 1600	64.4		
1600 – 1700	64.6		
1700 – 1800	64.5		
1800 – 1900	64.8		
1900 – 2000	63.9	NA	65
2000 – 2100	63.5		
2100 – 2200	63.1		
2200 – 2300	<b>63.3</b>	NA	55
2300 – 0000	<b>63.8</b>		
0000 – 0100	<b>60.2</b>		
0100 – 0200	<b>57.9</b>		
0200 – 0300	<b>56.8</b>		
0300 – 0400	<b>58.0</b>		
0400 – 0500	<b>56.4</b>		
0500 – 0600	<b>57.4</b>		
0600 – 0700	<b>61.4</b>		

Remark: \* Limit of Affected Residential Buildings Located Less Than 150m From Construction site where the noise is being emitted on Monday to Saturday  
NA denote Not Available

**Table 117: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL202\_R2 Day 3**

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 3 (weekend)	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	66.0	NA	NA
0800 – 0900	65.9		
0900 – 1000	65.8		
1000 – 1100	67.1		
1100 – 1200	65.3		
1200 – 1300	65.7		
1300 – 1400	67.5		
1400 – 1500	67.5		
1500 – 1600	65.5		
1600 – 1700	66.0		
1700 – 1800	66.3		
1800 – 1900	67.4		
1900 – 2000	63.6	NA	65
2000 – 2100	63.5		
2100 – 2200	63.0		
2200 – 2300	63.2	NA	55
2300 – 0000	61.9		
0000 – 0100	58.7		
0100 – 0200	55.3		
0200 – 0300	54.6		
0300 – 0400	54.1		
0400 – 0500	54.4		
0500 – 0600	58.0		
0600 – 0700	63.8		

Remark: \* Limit of Affected Residential Buildings Located Less Than 150m From Construction site where the noise is being emitted on Monday to Saturday  
NA denote Not Available

**Table 118: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL202\_R2 Day 4**

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 4	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	66.2	NA	NA
0800 – 0900	65.4		
0900 – 1000	66.5		
1000 – 1100	66.7		
1100 – 1200	65.7		
1200 – 1300	65.7		
1300 – 1400	67.4		
1400 – 1500	67.2		
1500 – 1600	65.9		
1600 – 1700	66.1		
1700 – 1800	66.0		
1800 – 1900	68.2		
1900 – 2000	<b>65.7</b>	NA	65
2000 – 2100	64.4		
2100 – 2200	63.5		
2200 – 2300	<b>63.4</b>	NA	55
2300 – 0000	<b>62.2</b>		
0000 – 0100	<b>59.3</b>		
0100 – 0200	<b>56.5</b>		
0200 – 0300	<b>55.5</b>		
0300 – 0400	<b>55.9</b>		
0400 – 0500	54.6		
0500 – 0600	<b>57.7</b>		
0600 – 0700	<b>63.5</b>		

Remark: \* Limit of Affected Residential Buildings Located Less Than 150m From Construction site where the noise is being emitted on Monday to Saturday  
NA denote Not Available



**Table 119: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL202\_R2 Day 5**

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 5	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	66.5	NA	NA
0800 – 0900	65.5		
0900 – 1000	66.1		
1000 – 1100	67.1		
1100 – 1200	65.6		
1200 – 1300	65.2		
1300 – 1400	66.1		
1400 – 1500	66.4		
1500 – 1600	66.9		
1600 – 1700	67.9		
1700 – 1800	70.4		
1800 – 1900	71.2		
1900 – 2000	<b>66.1</b>	NA	65
2000 – 2100	64.3		
2100 – 2200	63.5		
2200 – 2300	<b>63.6</b>	NA	55
2300 – 0000	<b>61.9</b>		
0000 – 0100	<b>59.2</b>		
0100 – 0200	<b>56.4</b>		
0200 – 0300	<b>55.4</b>		
0300 – 0400	54.0		
0400 – 0500	54.7		
0500 – 0600	<b>57.6</b>		
0600 – 0700	<b>63.6</b>		

Remark: \* Limit of Affected Residential Buildings Located Less Than 150m From Construction site where the noise is being emitted on Monday to Saturday  
NA denote Not Available

**Table 120: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL202\_R2 Day 6**

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 6	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	68.3	NA	NA
0800 – 0900	67.8		
0900 – 1000	67.9		
1000 – 1100	69.5		
1100 – 1200	67.7		
1200 – 1300	67.4		
1300 – 1400	67.7		
1400 – 1500	68.3		
1500 – 1600	68.8		
1600 – 1700	70.3		
1700 – 1800	68.0		
1800 – 1900	68.1		
1900 – 2000	<b>70.0</b>	NA	65
2000 – 2100	<b>67.2</b>		
2100 – 2200	<b>66.7</b>		
2200 – 2300	<b>67.0</b>	NA	55
2300 – 0000	<b>66.2</b>		
0000 – 0100	<b>65.1</b>		
0100 – 0200	<b>64.4</b>		
0200 – 0300	<b>64.2</b>		
0300 – 0400	<b>64.1</b>		
0400 – 0500	<b>64.2</b>		
0500 – 0600	<b>64.6</b>		
0600 – 0700	<b>66.8</b>		

Remark: \* Limit of Affected Residential Buildings Located Less Than 150m From Construction site where the noise is being emitted on Monday to Saturday  
NA denote Not Available

**Table 121: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL202\_R2 Day 7**

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 7	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	68.2	NA	NA
0800 – 0900	67.7		
0900 – 1000	68.2		
1000 – 1100	68.7		
1100 – 1200	67.7		
1200 – 1300	67.5		
1300 – 1400	68.2		
1400 – 1500	68.7		
1500 – 1600	67.9		
1600 – 1700	65.8		
1700 – 1800	66.4		
1800 – 1900	66.1		
1900 – 2000	<b>69.0</b>	NA	65
2000 – 2100	<b>67.4</b>		
2100 – 2200	<b>66.4</b>		
2200 – 2300	<b>66.5</b>	NA	55
2300 – 0000	<b>66.1</b>		
0000 – 0100	<b>65.0</b>		
0100 – 0200	<b>64.3</b>		
0200 – 0300	<b>64.0</b>		
0300 – 0400	<b>64.0</b>		
0400 – 0500	<b>64.0</b>		
0500 – 0600	<b>64.5</b>		
0600 – 0700	<b>66.6</b>		

Remark: \* Limit of Affected Residential Buildings Located Less Than 150m From Construction site where the noise is being emitted on Monday to Saturday  
NA denote Not Available

**Table 122: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL203\_R2 Day 1**

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 1	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	80.9	NA	NA
0800 – 0900	81.2		
0900 – 1000	81.0		
1000 – 1100	80.9		
1100 – 1200	80.9		
1200 – 1300	80.6		
1300 – 1400	80.7		
1400 – 1500	80.5		
1500 – 1600	80.8		
1600 – 1700	80.3		
1700 – 1800	80.1		
1800 – 1900	79.7		
1900 – 2000	<b>79.9</b>	NA	65
2000 – 2100	<b>79.1</b>		
2100 – 2200	<b>79.0</b>		
2200 – 2300	<b>78.6</b>	NA	55
2300 – 0000	<b>77.8</b>		
0000 – 0100	<b>76.8</b>		
0100 – 0200	<b>75.4</b>		
0200 – 0300	<b>74.3</b>		
0300 – 0400	<b>74.0</b>		
0400 – 0500	<b>72.8</b>		
0500 – 0600	<b>75.7</b>		
0600 – 0700	<b>78.4</b>		

Remark: \* Limit of Affected Residential Buildings Located Less Than 150m From Construction site where the noise is being emitted on Monday to Saturday  
NA denote Not Available

**Table 123: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL203\_R2 Day 2**

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 2 (weekend)	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	78.4	NA	NA
0800 – 0900	79.1		
0900 – 1000	78.4		
1000 – 1100	79.4		
1100 – 1200	79.6		
1200 – 1300	79.4		
1300 – 1400	79.4		
1400 – 1500	79.1		
1500 – 1600	79.1		
1600 – 1700	79.1		
1700 – 1800	78.9		
1800 – 1900	78.7		
1900 – 2000	<b>79.2</b>	NA	65
2000 – 2100	<b>78.9</b>		
2100 – 2200	<b>78.3</b>		
2200 – 2300	<b>78.5</b>	NA	55
2300 – 0000	<b>77.9</b>		
0000 – 0100	<b>76.7</b>		
0100 – 0200	<b>75.1</b>		
0200 – 0300	<b>73.8</b>		
0300 – 0400	<b>72.3</b>		
0400 – 0500	<b>72.6</b>		
0500 – 0600	<b>73.6</b>		
0600 – 0700	<b>76.4</b>		

Remark: \* Limit of Affected Residential Buildings Located Less Than 150m From Construction site where the noise is being emitted on Monday to Saturday  
NA denote Not Available



**Table 124: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL203\_R2 Day 3**

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 3 (weekend)	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	81.0	NA	NA
0800 – 0900	80.8		
0900 – 1000	81.8		
1000 – 1100	81.0		
1100 – 1200	81.3		
1200 – 1300	80.6		
1300 – 1400	80.9		
1400 – 1500	81.1		
1500 – 1600	81.0		
1600 – 1700	80.6		
1700 – 1800	80.8		
1800 – 1900	80.7		
1900 – 2000	78.4	NA	65
2000 – 2100	78.2		
2100 – 2200	78.4		
2200 – 2300	78.0	NA	55
2300 – 0000	76.9		
0000 – 0100	74.9		
0100 – 0200	72.4		
0200 – 0300	70.5		
0300 – 0400	70.1		
0400 – 0500	71.5		
0500 – 0600	75.7		
0600 – 0700	79.9		

Remark: \* Limit of Affected Residential Buildings Located Less Than 150m From Construction site where the noise is being emitted on Monday to Saturday  
NA denote Not Available

**Table 125: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL203\_R2 Day 4**

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 4	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	80.8	NA	NA
0800 – 0900	81.1		
0900 – 1000	82.0		
1000 – 1100	81.6		
1100 – 1200	81.1		
1200 – 1300	80.7		
1300 – 1400	80.9		
1400 – 1500	80.8		
1500 – 1600	81.2		
1600 – 1700	81.0		
1700 – 1800	80.8		
1800 – 1900	80.8		
1900 – 2000	<b>79.9</b>	NA	65
2000 – 2100	<b>78.6</b>		
2100 – 2200	<b>78.8</b>		
2200 – 2300	<b>78.1</b>	NA	55
2300 – 0000	<b>77.4</b>		
0000 – 0100	<b>75.7</b>		
0100 – 0200	<b>73.6</b>		
0200 – 0300	<b>72.7</b>		
0300 – 0400	<b>71.0</b>		
0400 – 0500	<b>72.2</b>		
0500 – 0600	<b>76.1</b>		
0600 – 0700	<b>80.3</b>		

Remark: \* Limit of Affected Residential Buildings Located Less Than 150m From Construction site where the noise is being emitted on Monday to Saturday  
NA denote Not Available

**Table 126: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL203\_R2 Day 5**

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 5	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	81.0	NA	NA
0800 – 0900	80.2		
0900 – 1000	81.7		
1000 – 1100	81.3		
1100 – 1200	81.1		
1200 – 1300	80.9		
1300 – 1400	81.0		
1400 – 1500	80.7		
1500 – 1600	81.1		
1600 – 1700	81.2		
1700 – 1800	83.7		
1800 – 1900	83.6		
1900 – 2000	<b>80.1</b>	NA	65
2000 – 2100	<b>78.7</b>		
2100 – 2200	<b>78.8</b>		
2200 – 2300	<b>78.3</b>	NA	55
2300 – 0000	<b>77.2</b>		
0000 – 0100	<b>75.7</b>		
0100 – 0200	<b>74.1</b>		
0200 – 0300	<b>71.8</b>		
0300 – 0400	<b>71.2</b>		
0400 – 0500	<b>72.5</b>		
0500 – 0600	<b>75.8</b>		
0600 – 0700	<b>80.3</b>		

Remark: \* Limit of Affected Residential Buildings Located Less Than 150m From Construction site where the noise is being emitted on Monday to Saturday  
NA denote Not Available

**Table 127: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL203\_R2 Day 6**

Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 6	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	81.4	NA	NA
0800 – 0900	80.7		
0900 – 1000	81.5		
1000 – 1100	81.1		
1100 – 1200	81.0		
1200 – 1300	80.5		
1300 – 1400	80.8		
1400 – 1500	81.0		
1500 – 1600	80.7		
1600 – 1700	80.7		
1700 – 1800	80.8		
1800 – 1900	80.5		
1900 – 2000	<b>80.6</b>	NA	65
2000 – 2100	<b>79.4</b>		
2100 – 2200	<b>79.3</b>		
2200 – 2300	<b>78.6</b>	NA	55
2300 – 0000	<b>77.6</b>		
0000 – 0100	<b>76.4</b>		
0100 – 0200	<b>74.0</b>		
0200 – 0300	<b>72.1</b>		
0300 – 0400	<b>71.8</b>		
0400 – 0500	<b>71.9</b>		
0500 – 0600	<b>76.0</b>		
0600 – 0700	<b>80.3</b>		

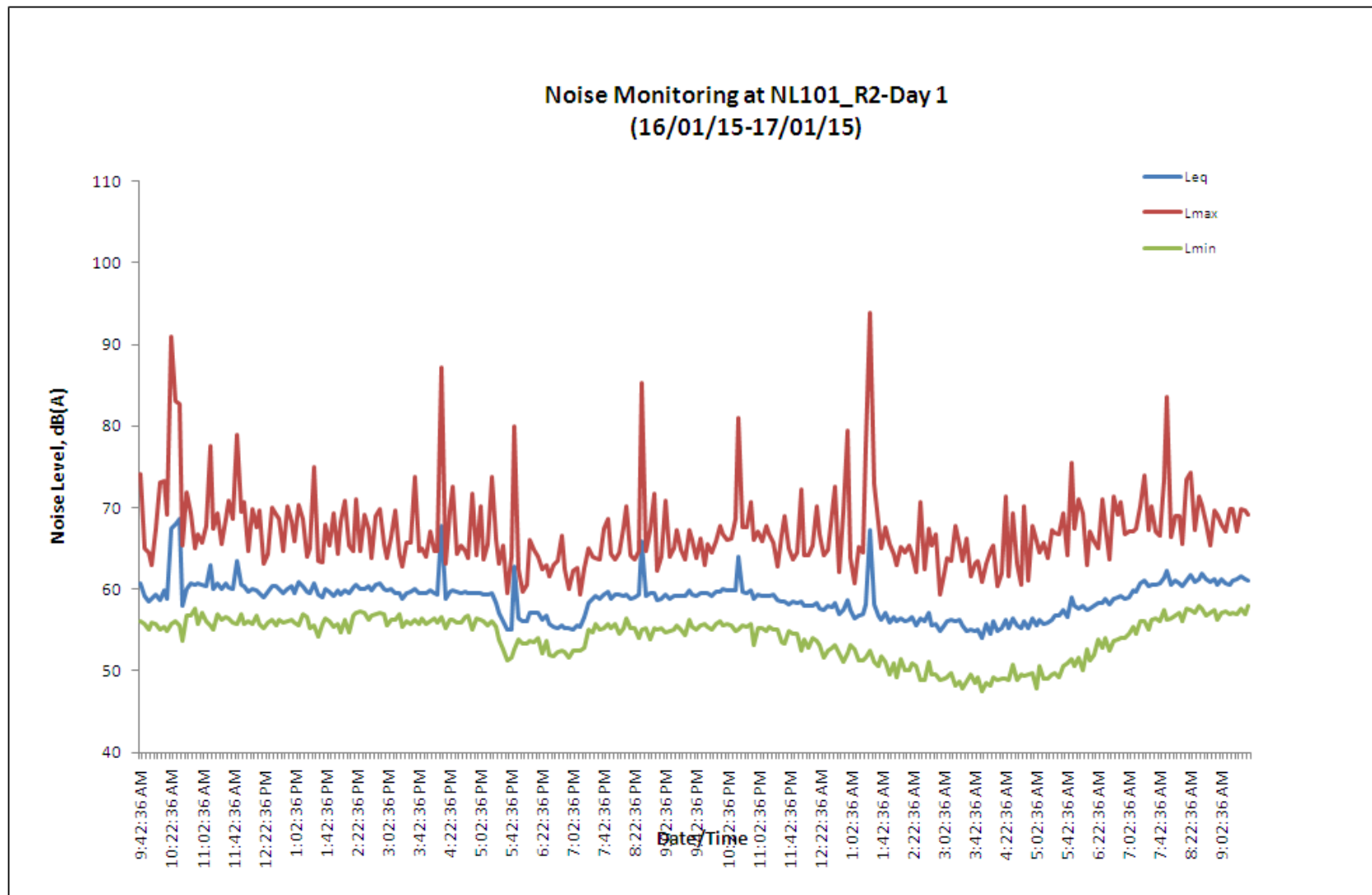
Remark: \* Limit of Affected Residential Buildings Located Less Than 150m From Construction site where the noise is being emitted on Monday to Saturday  
NA denote Not Available

**Table 128: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at NL203\_R2 Day 7**

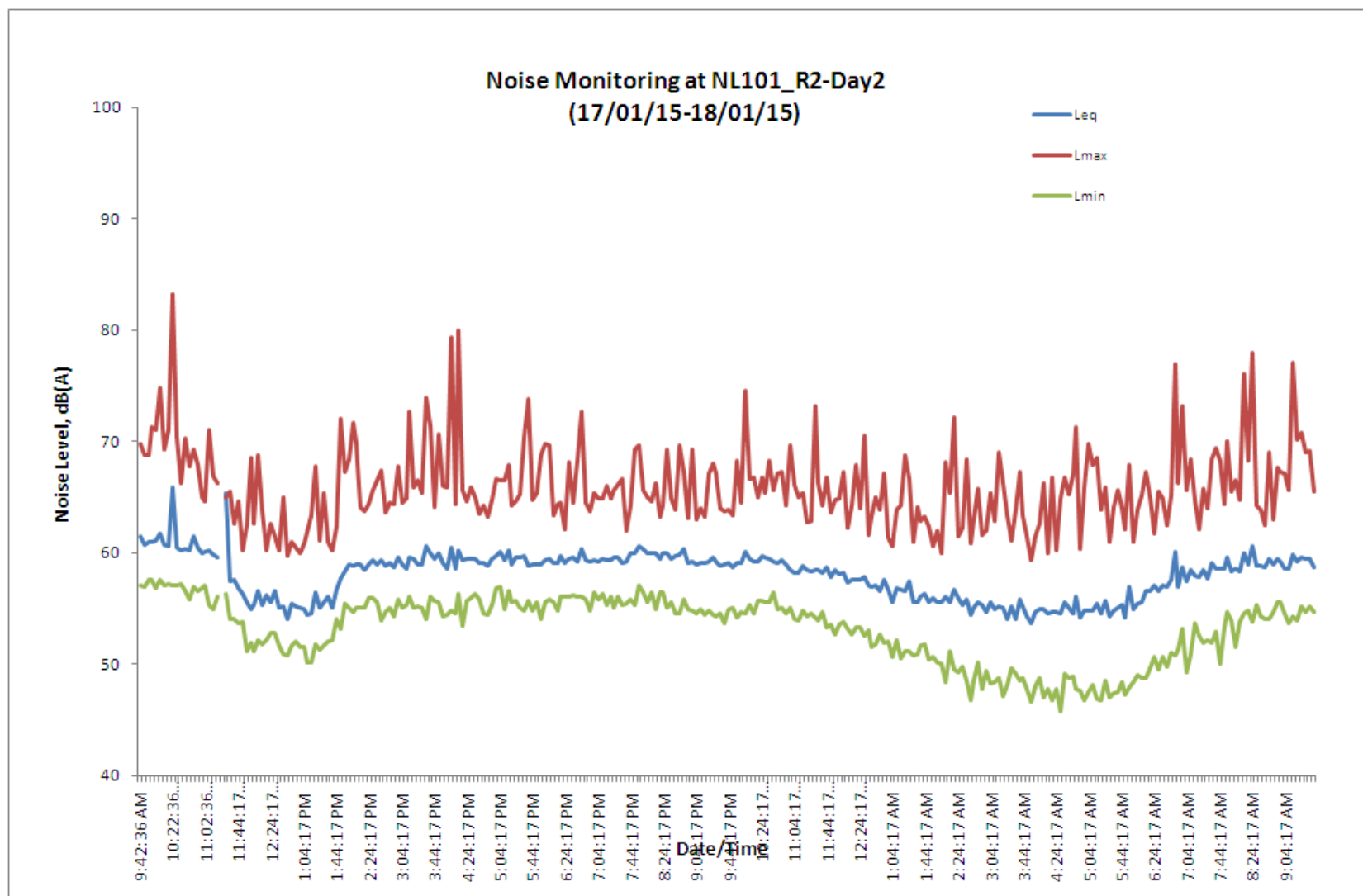
Duration (hr)	Noise levels Leq in dB (A)	*Limit	
	Day 7	Sunday/ Public Holiday	Monday to Saturday
0700 – 0800	81.2	NA	NA
0800 – 0900	80.6		
0900 – 1000	81.5		
1000 – 1100	81.0		
1100 – 1200	81.0		
1200 – 1300	80.6		
1300 – 1400	80.6		
1400 – 1500	81.1		
1500 – 1600	80.9		
1600 – 1700	80.6		
1700 – 1800	80.6		
1800 – 1900	80.5		
1900 – 2000	<b>80.0</b>	NA	65
2000 – 2100	<b>79.1</b>		
2100 – 2200	<b>78.8</b>		
2200 – 2300	<b>78.4</b>	NA	55
2300 – 0000	<b>77.5</b>		
0000 – 0100	<b>75.7</b>		
0100 – 0200	<b>74.3</b>		
0200 – 0300	<b>72.1</b>		
0300 – 0400	<b>72.4</b>		
0400 – 0500	<b>72.5</b>		
0500 – 0600	<b>76.1</b>		
0600 – 0700	<b>80.3</b>		

Remark: \* Limit of Affected Residential Buildings Located Less Than 150m From Construction site where the noise is being emitted on Monday to Saturday  
NA denote Not Available

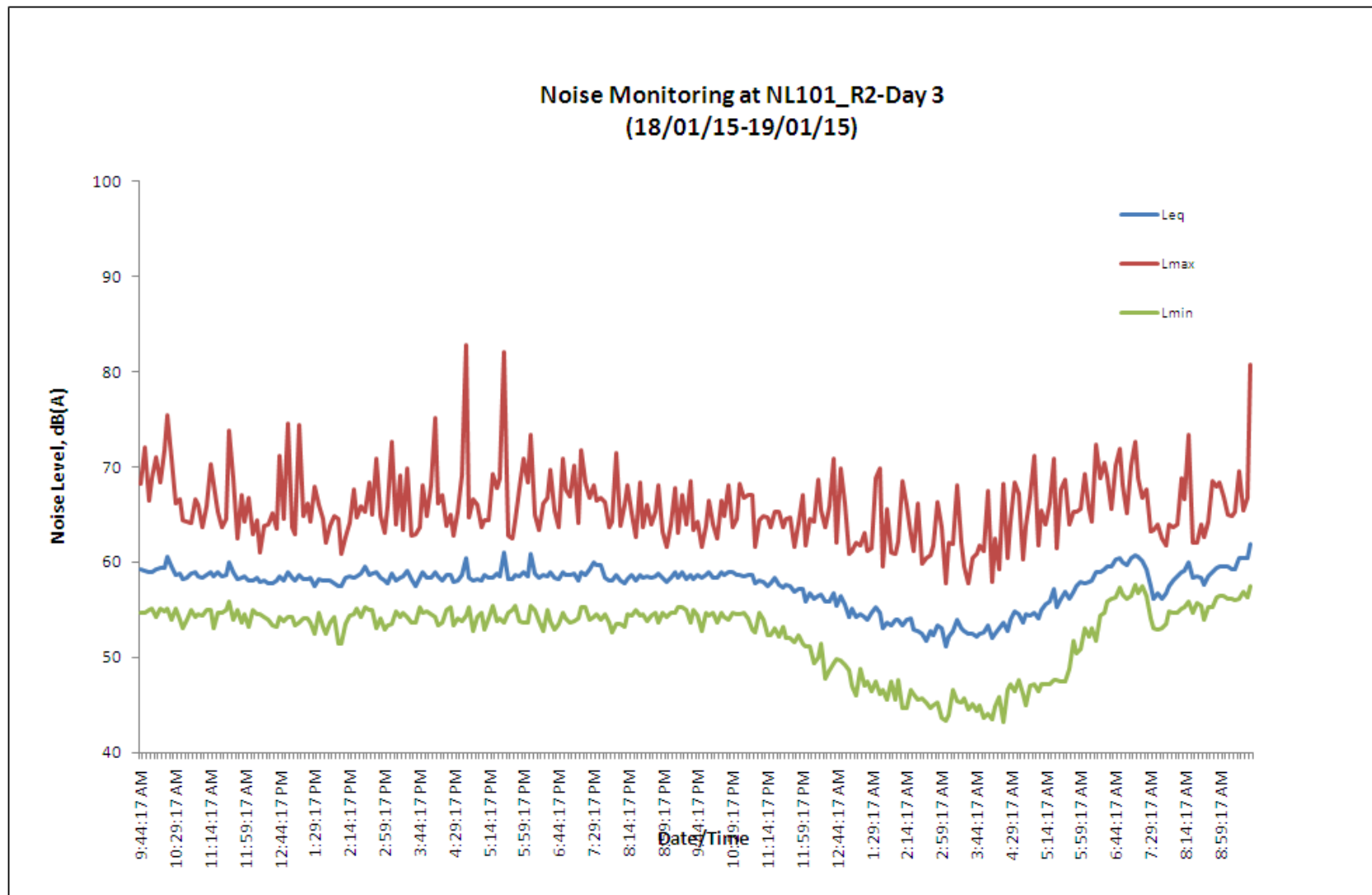




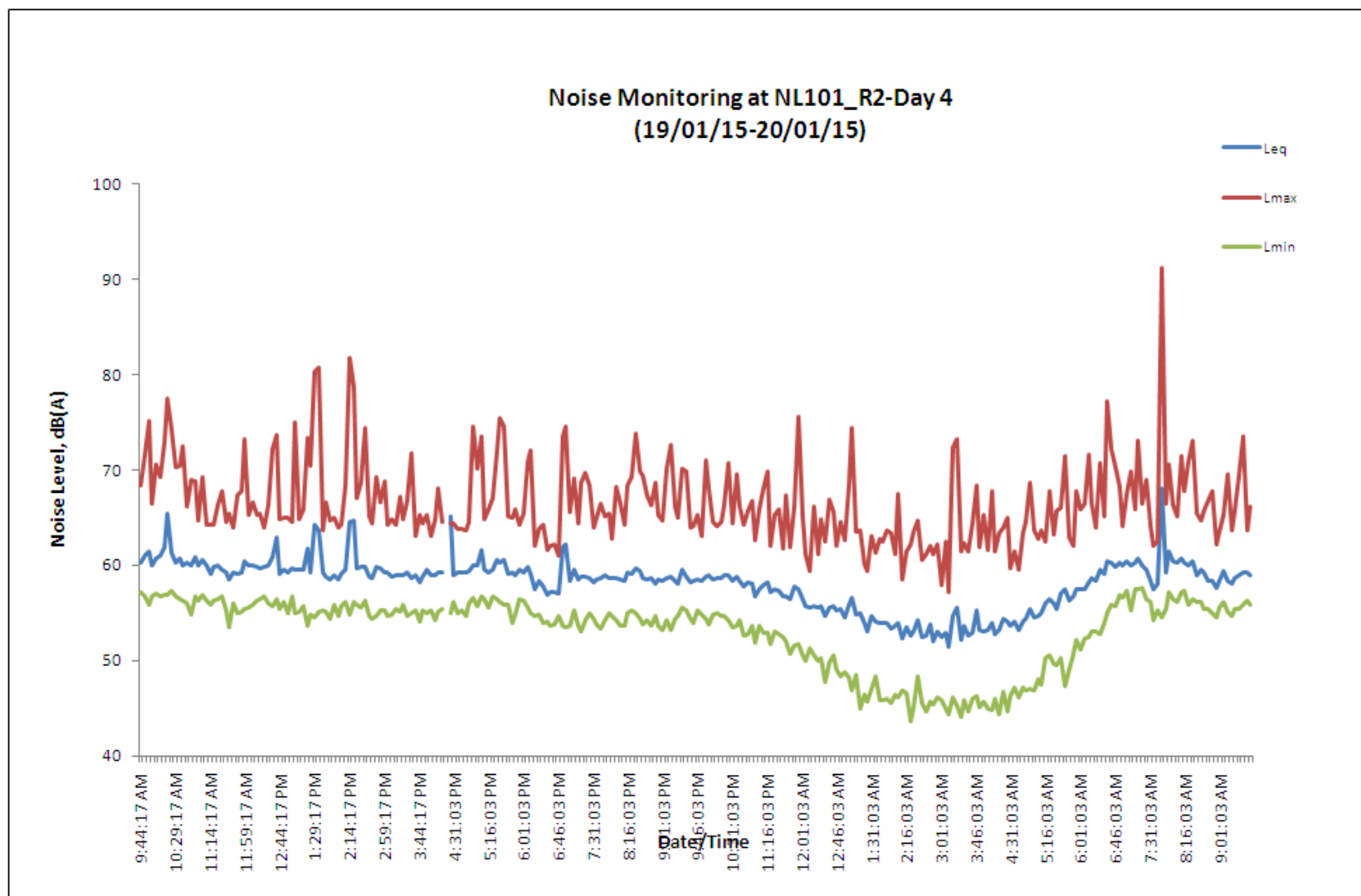
**Figure 53: Daily noise level measured at Point NL101\_R2 (Day 1)**



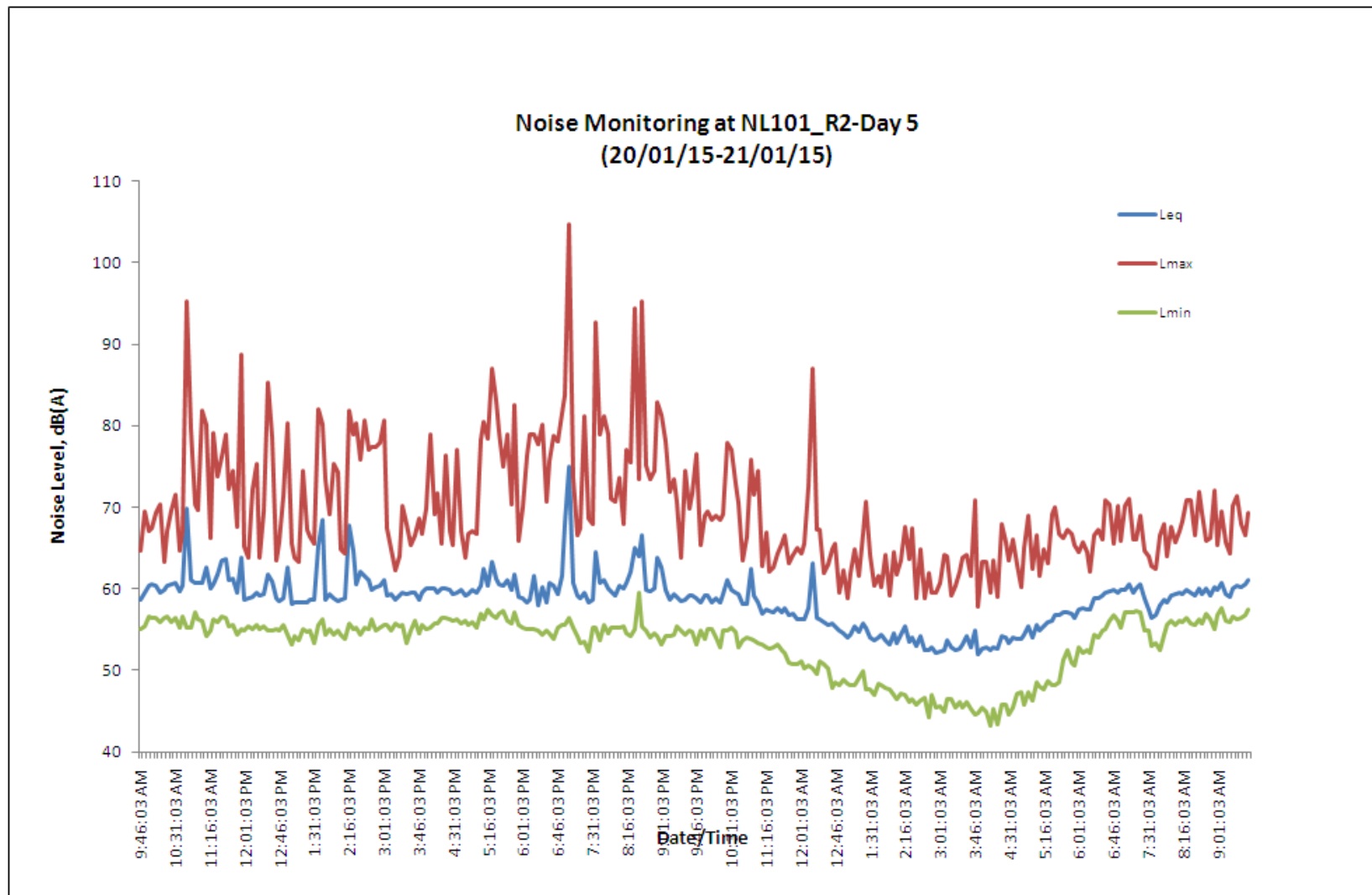
**Figure 54: Daily noise level measured at Point NL101\_R2 (Day 2)**



**Figure 55: Daily noise level measured at Point NL101\_R2 (Day 3)**

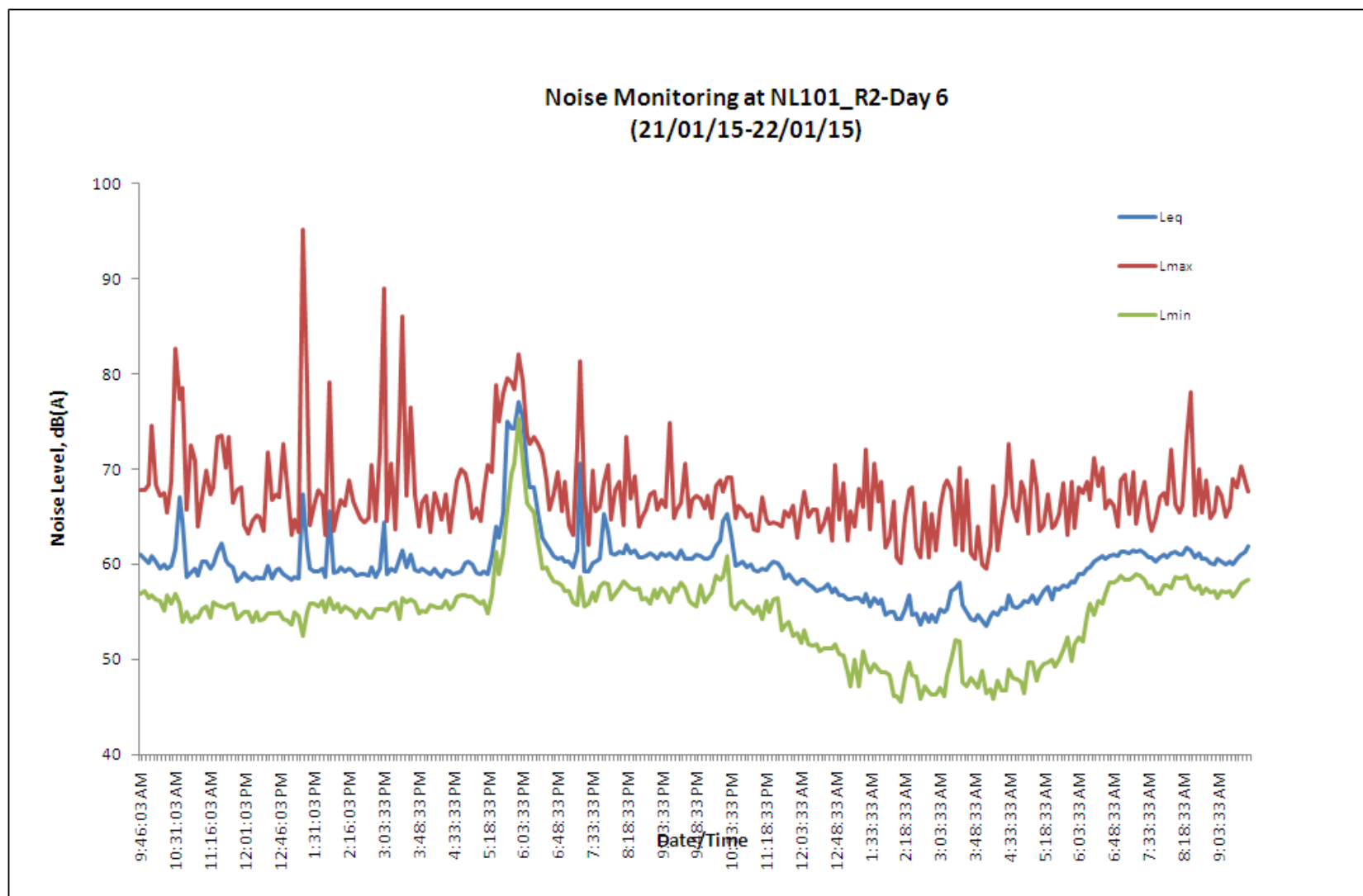


**Figure 56: Daily noise level measured at Point NL101\_R2 (Day 4)**

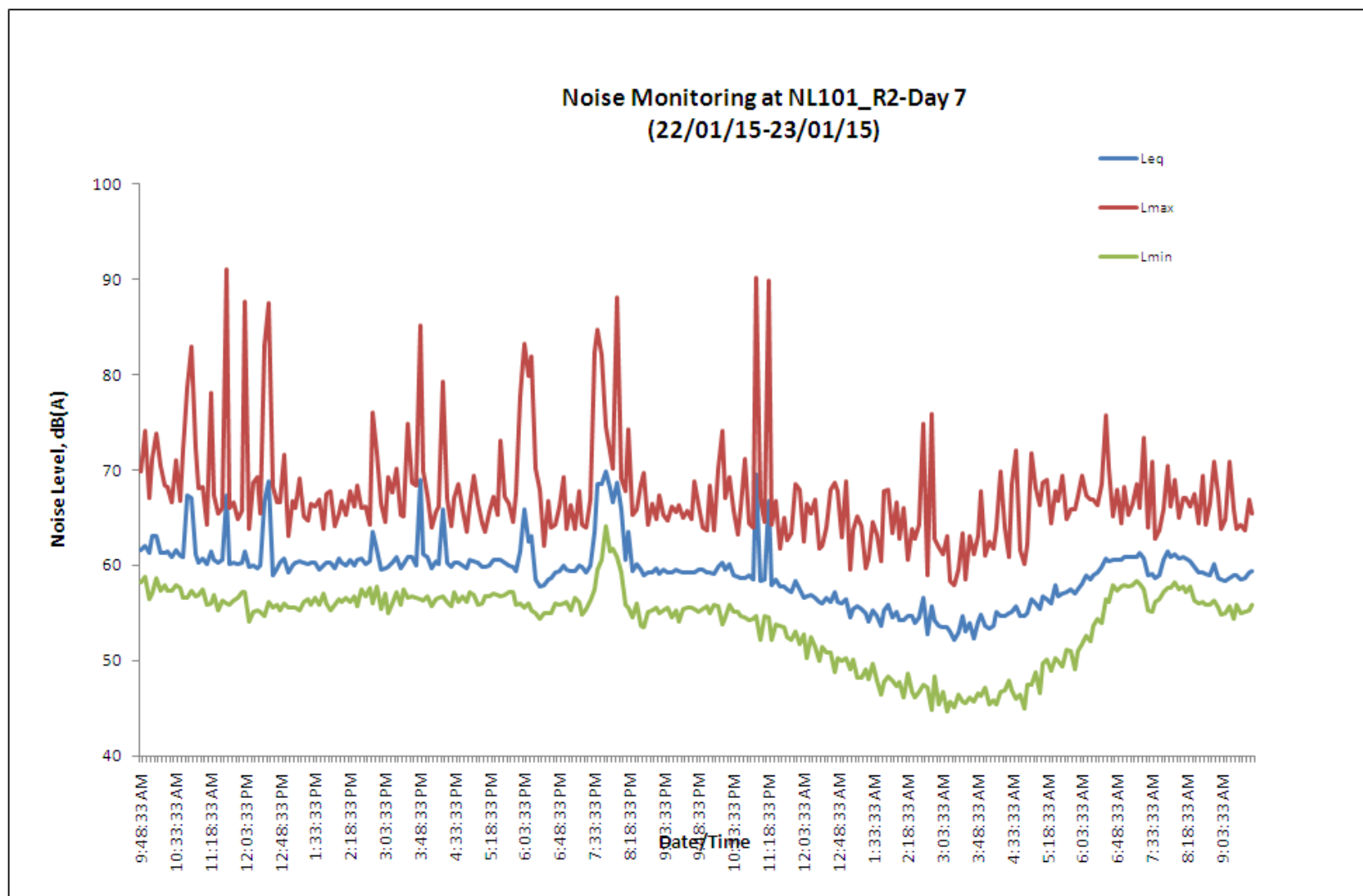


**Figure 57: Daily noise level measured at Point NL101\_R2 (Day 5)**

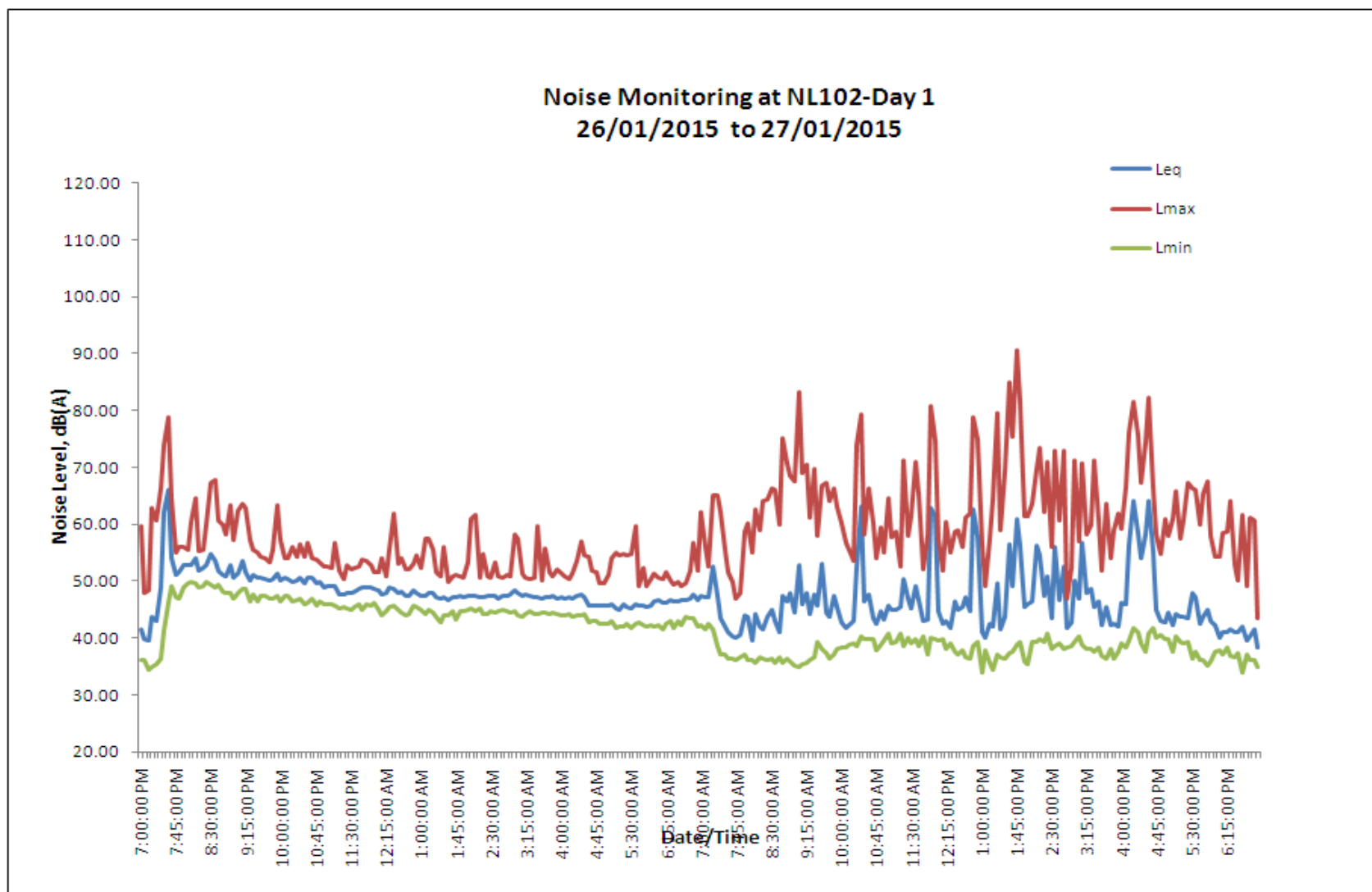




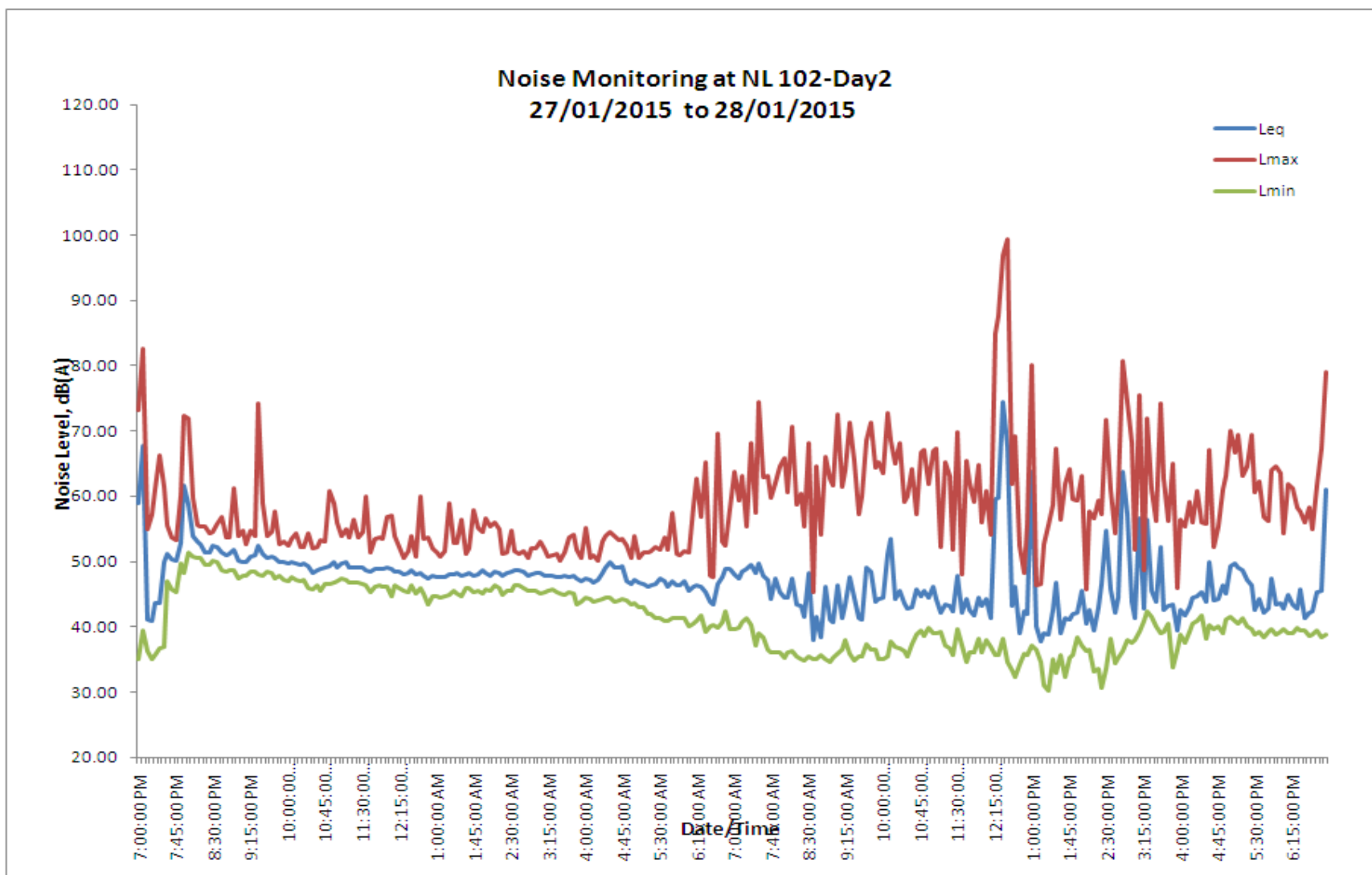
**Figure 58: Daily noise level measured at Point NL101\_R2 (Day 6)**



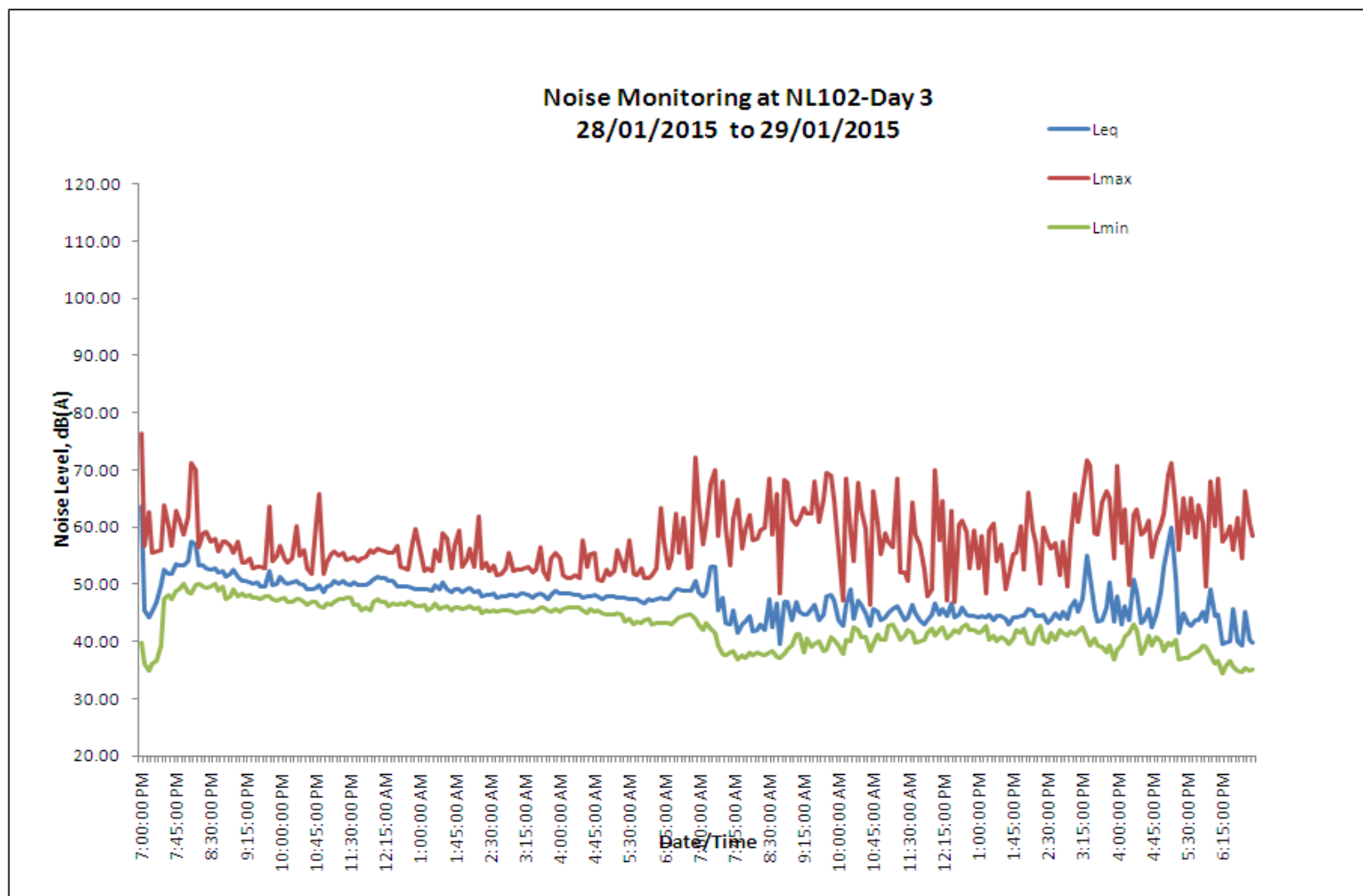
**Figure 59: Daily noise level measured at Point NL101\_R1 (Day 7)**



**Figure 60: Daily noise level measured at Point NL102\_R2 (Day 1)**

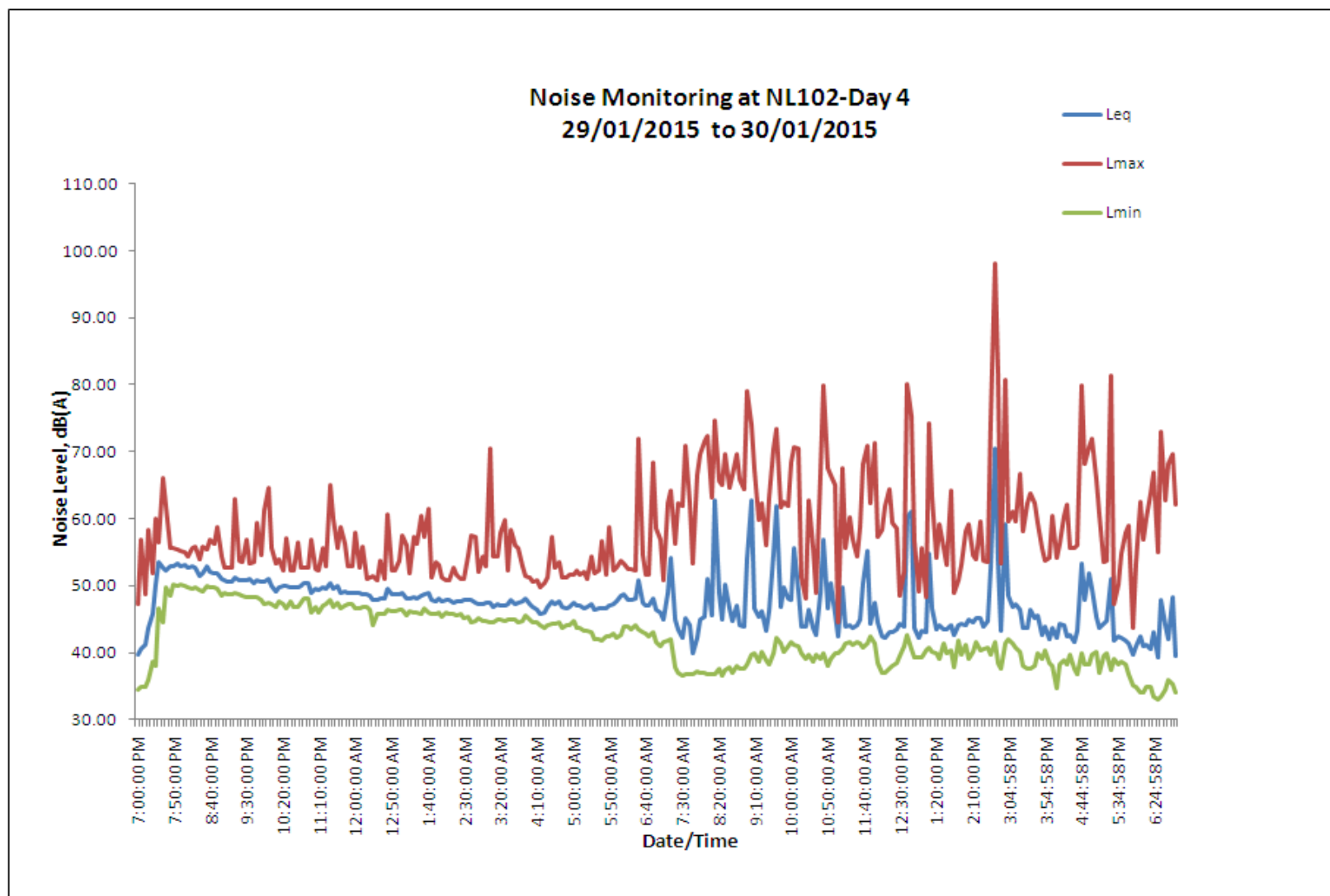


**Figure 61: Daily noise level measured at Point NL102\_R2 (Day 2)**

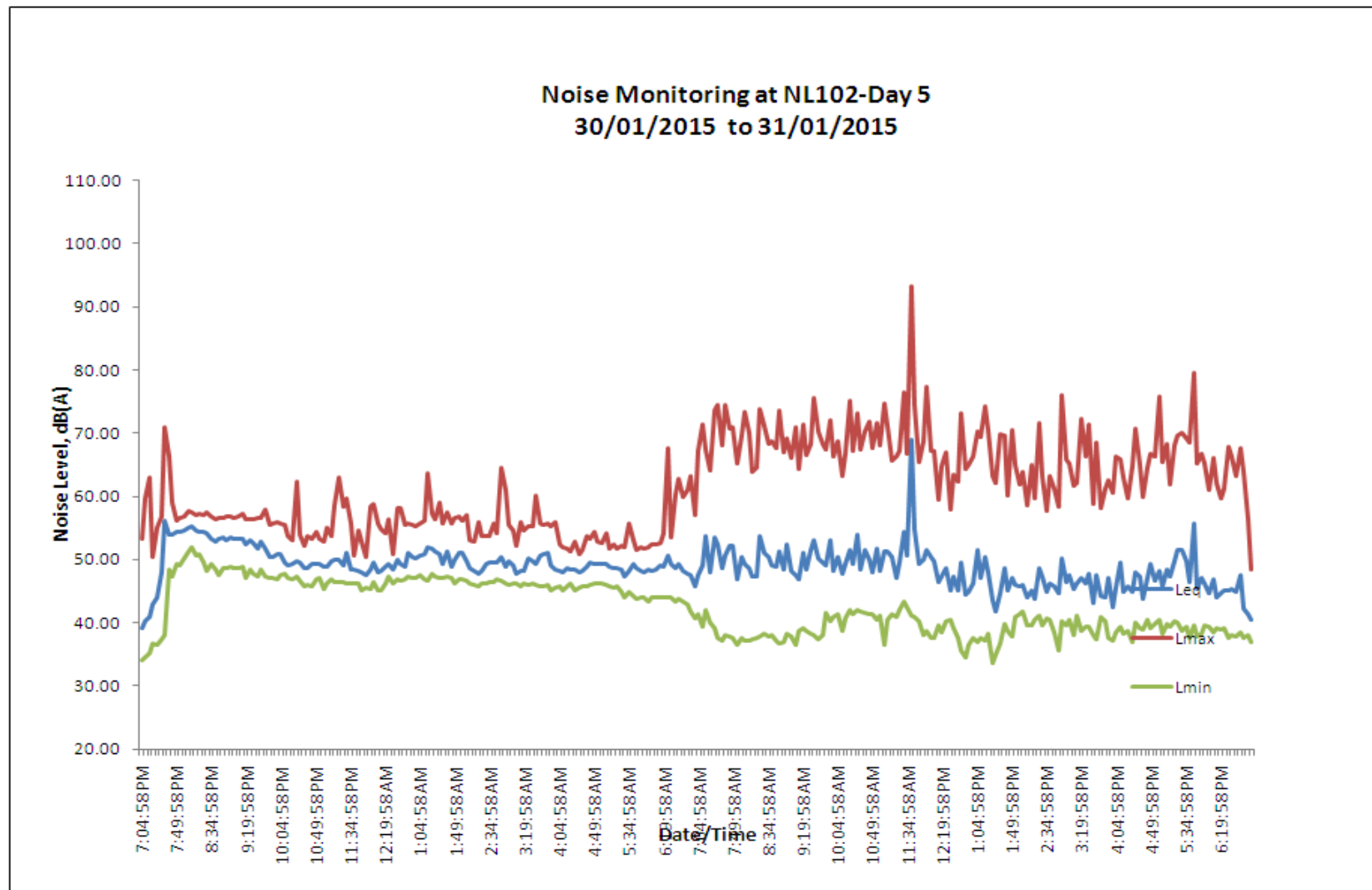


**Figure 62: Daily noise level measured at Point NL102\_R2 (Day 3)**

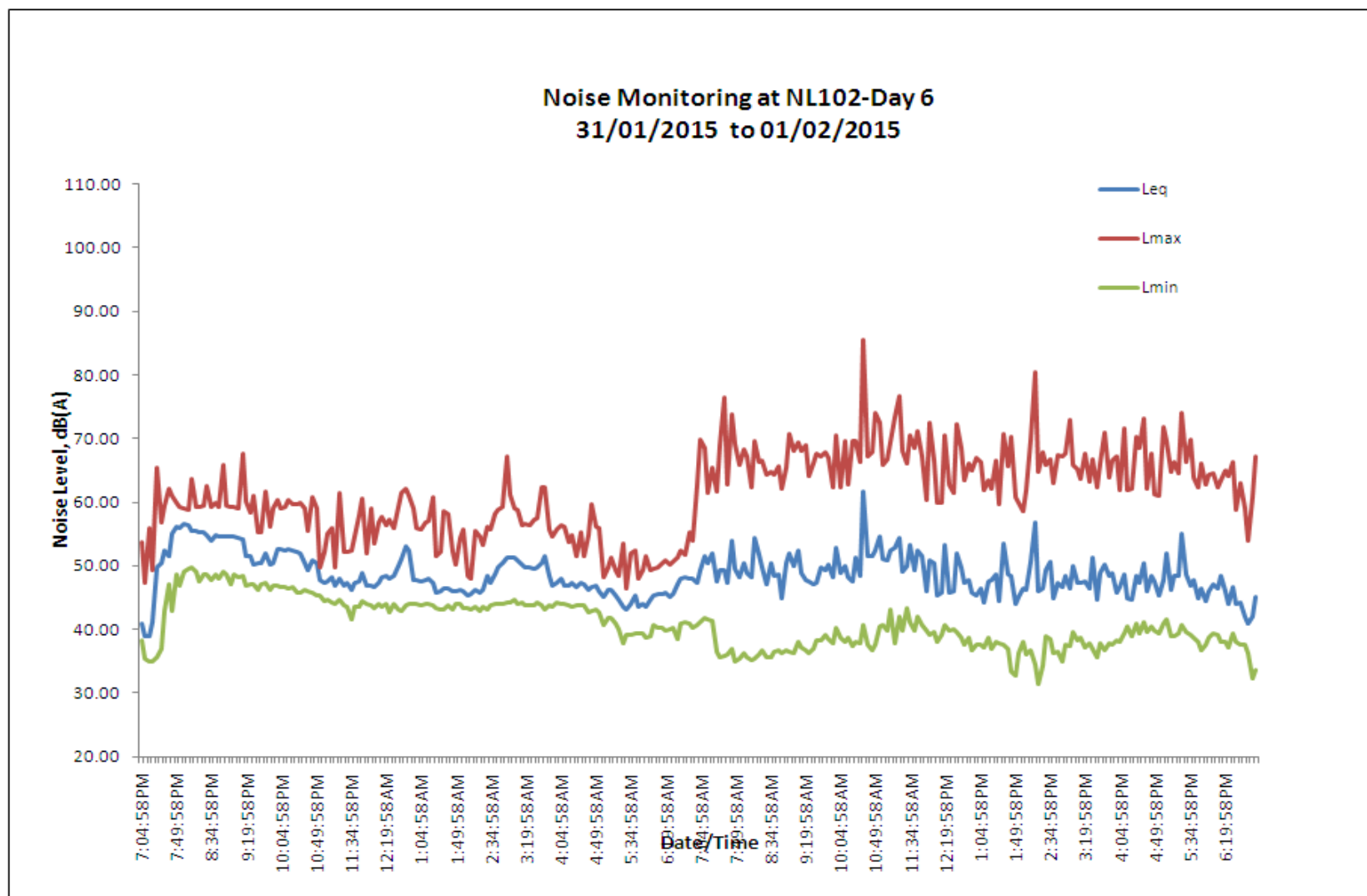




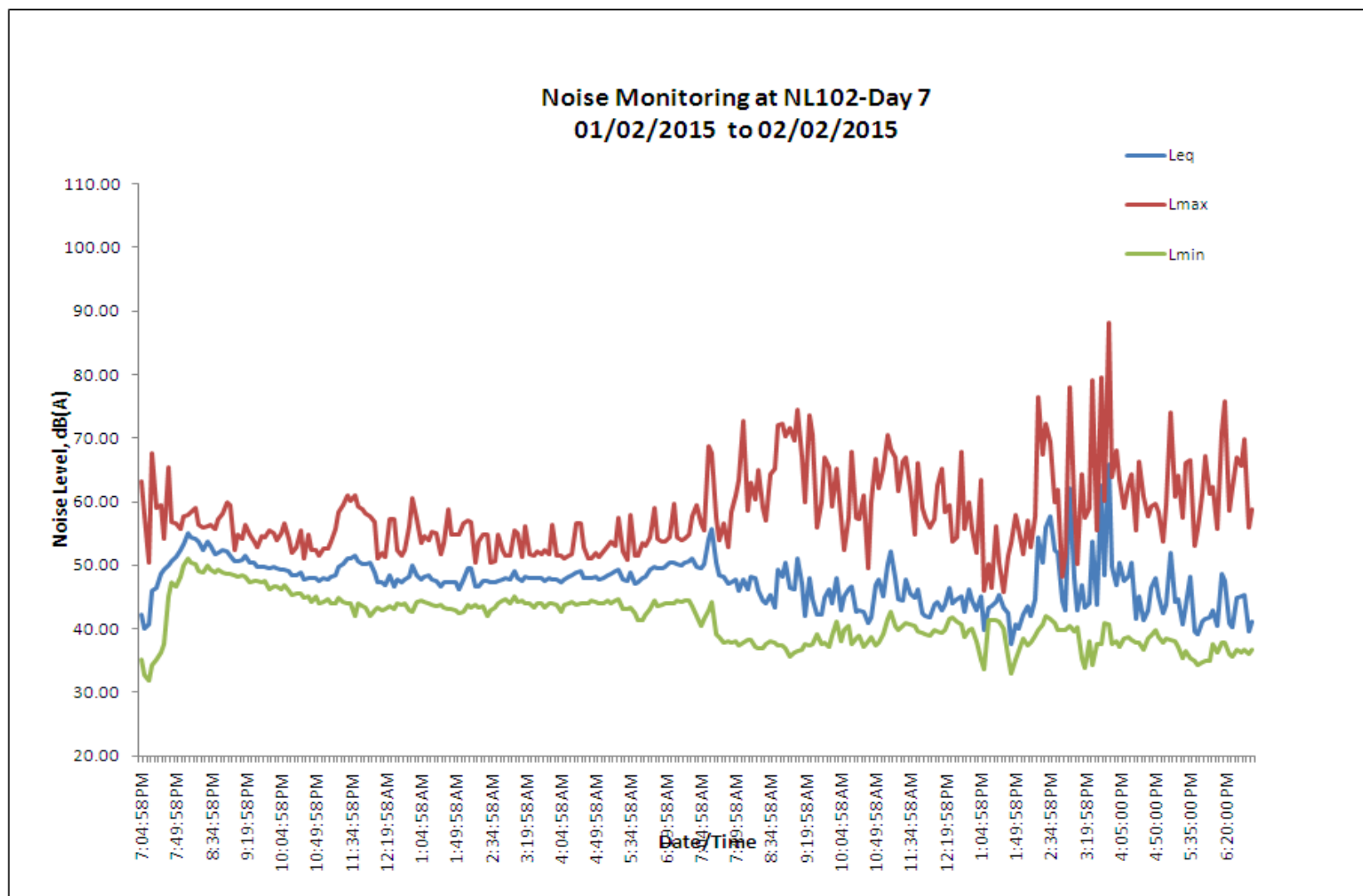
**Figure 63: Daily noise level measured at Point NL102\_R2 (Day 4)**



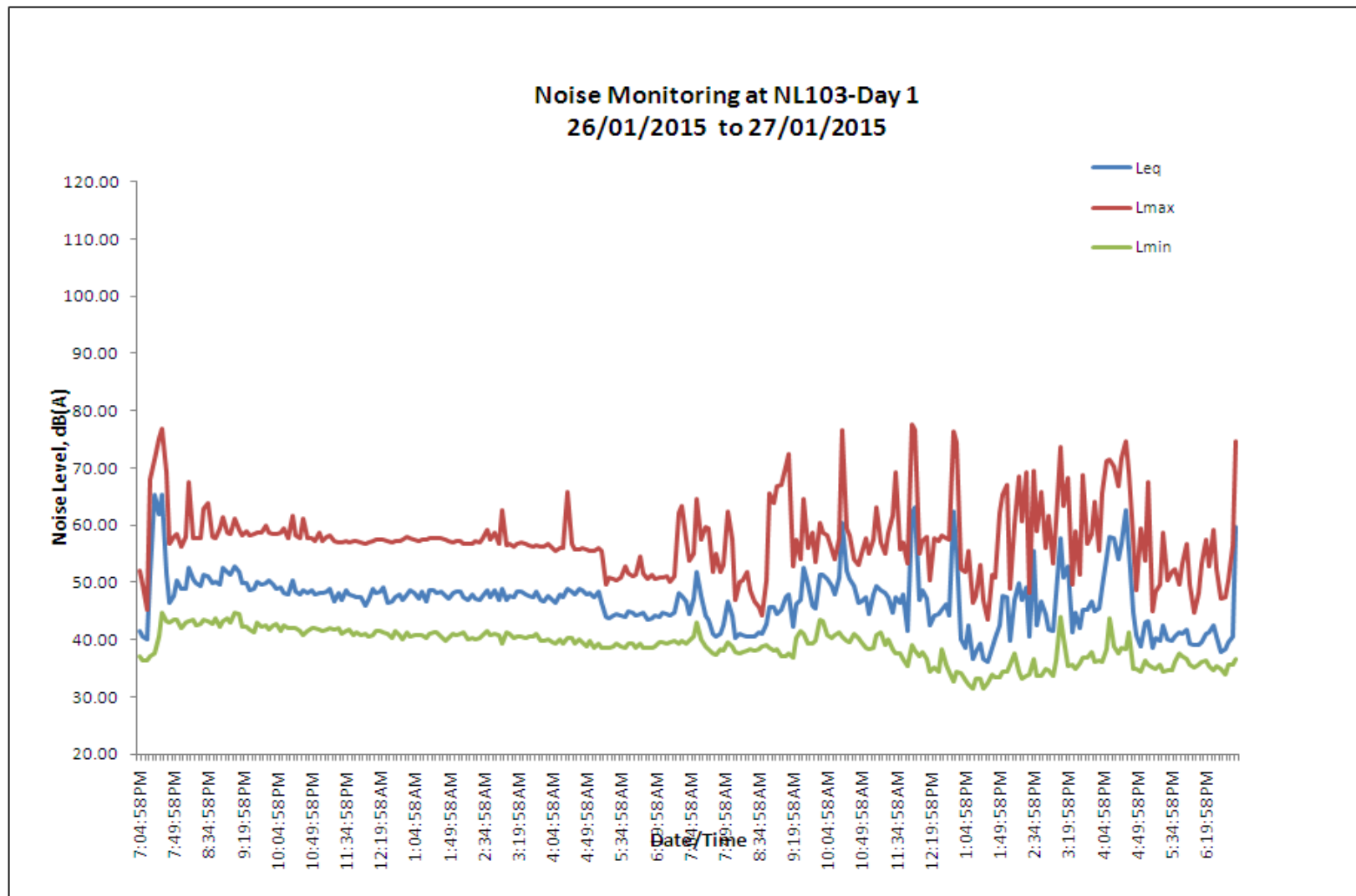
**Figure 64: Daily noise level measured at Point NL102\_R2 (Day 5)**



**Figure 65: Daily noise level measured at Point NL102\_R2 (Day 6)**

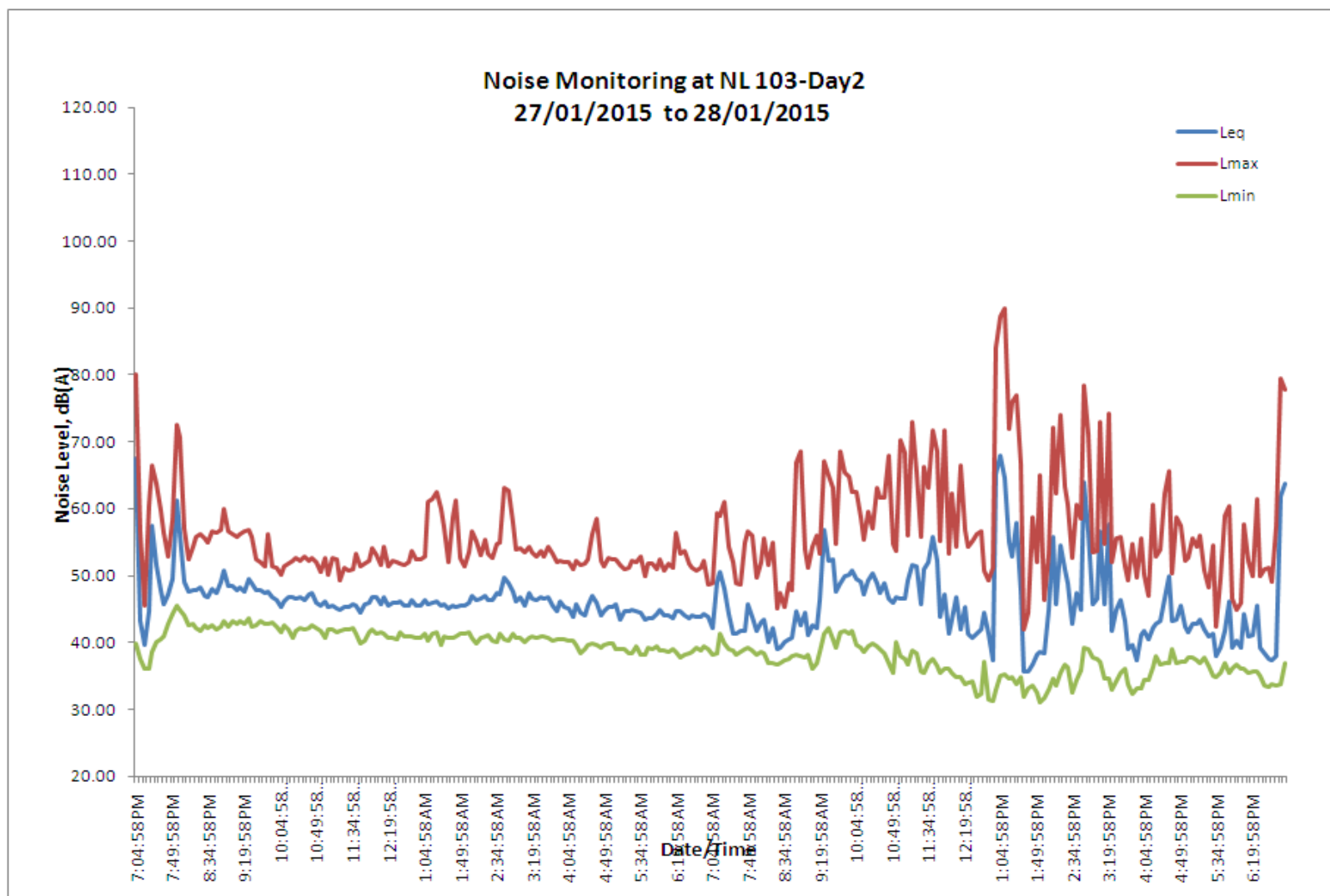


**Figure 66: Daily noise level measured at Point NL102\_R2 (Day 7)**

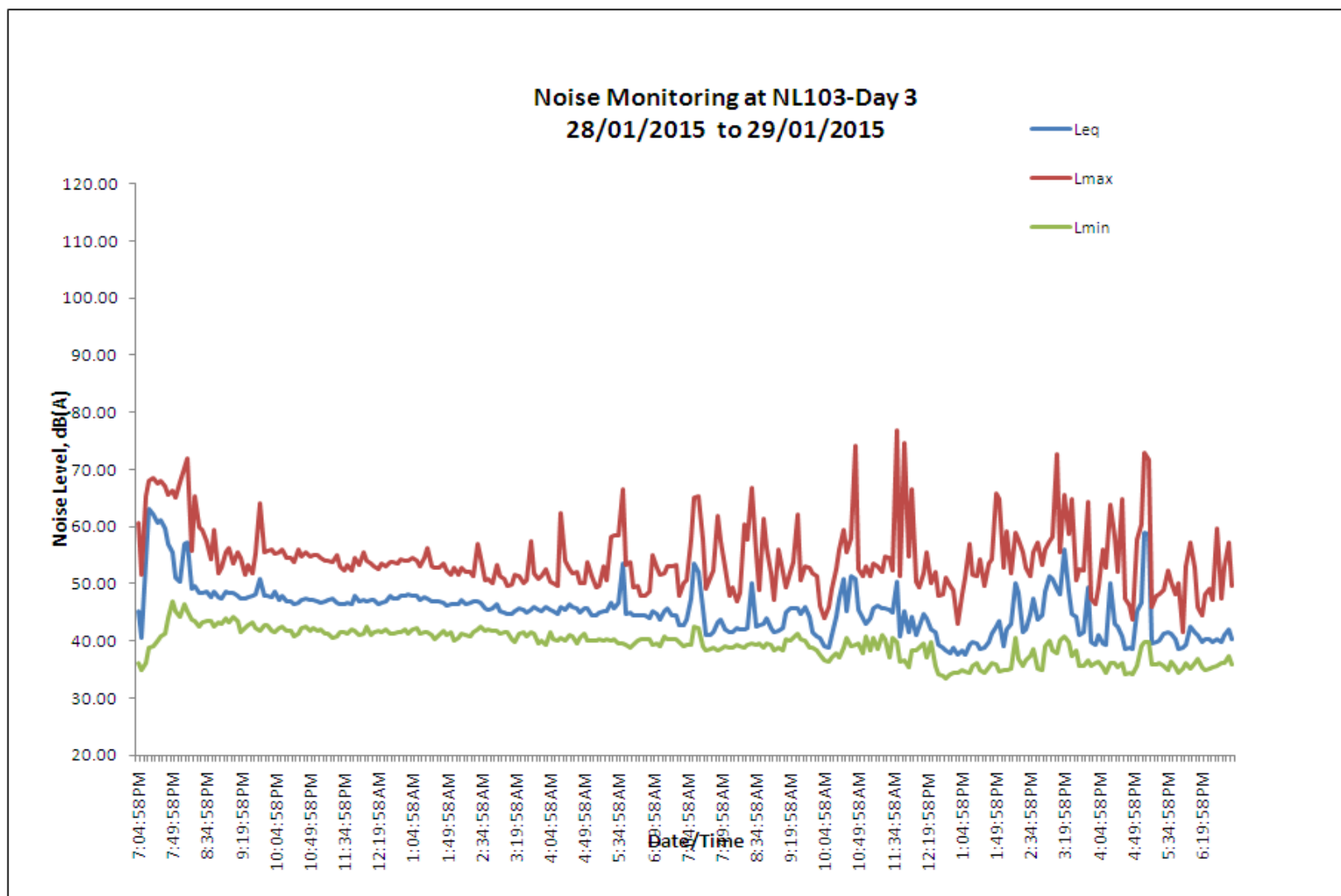


**Figure 67: Daily noise level measured at Point NL103\_R2 (Day 1)**

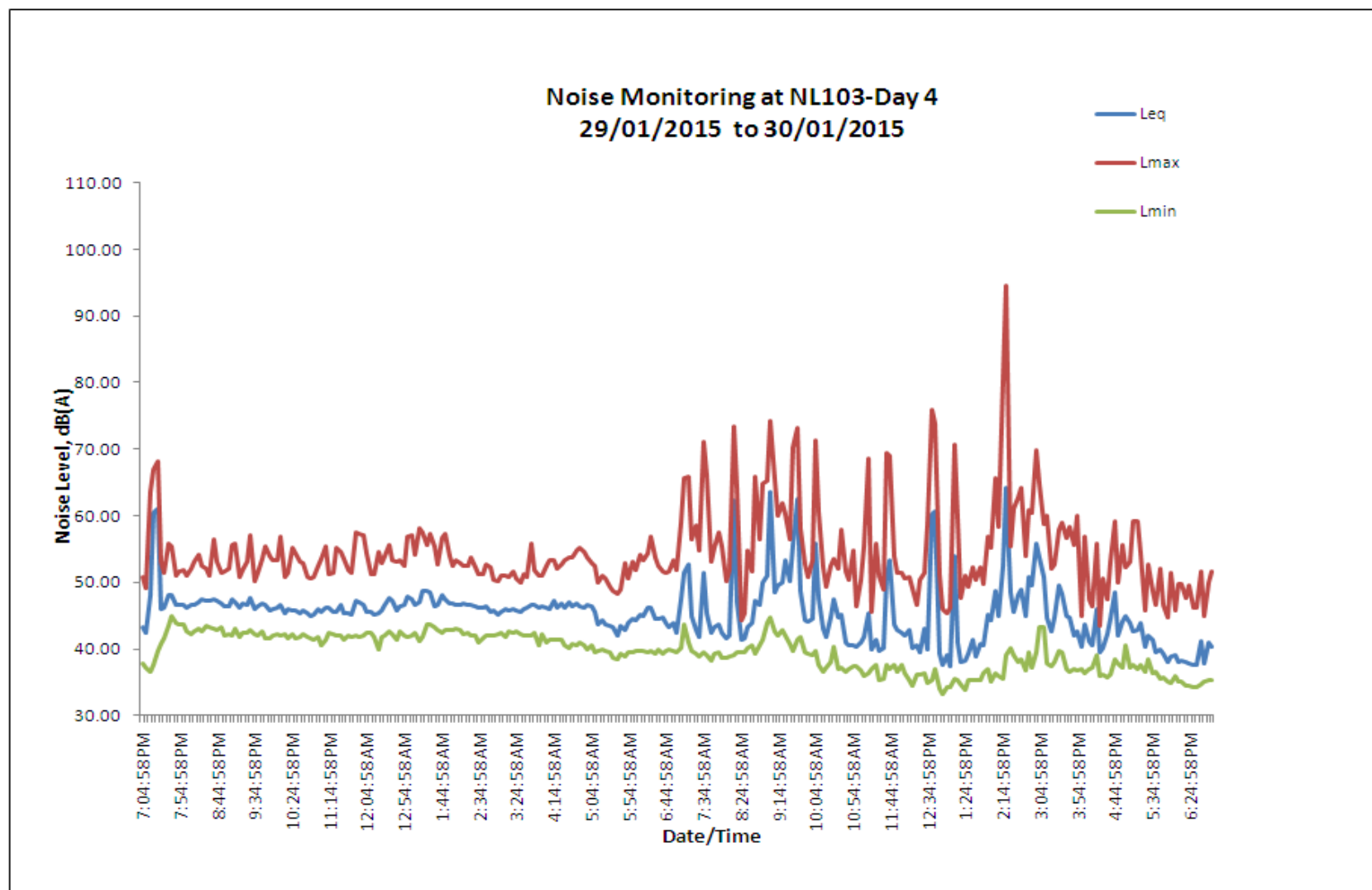




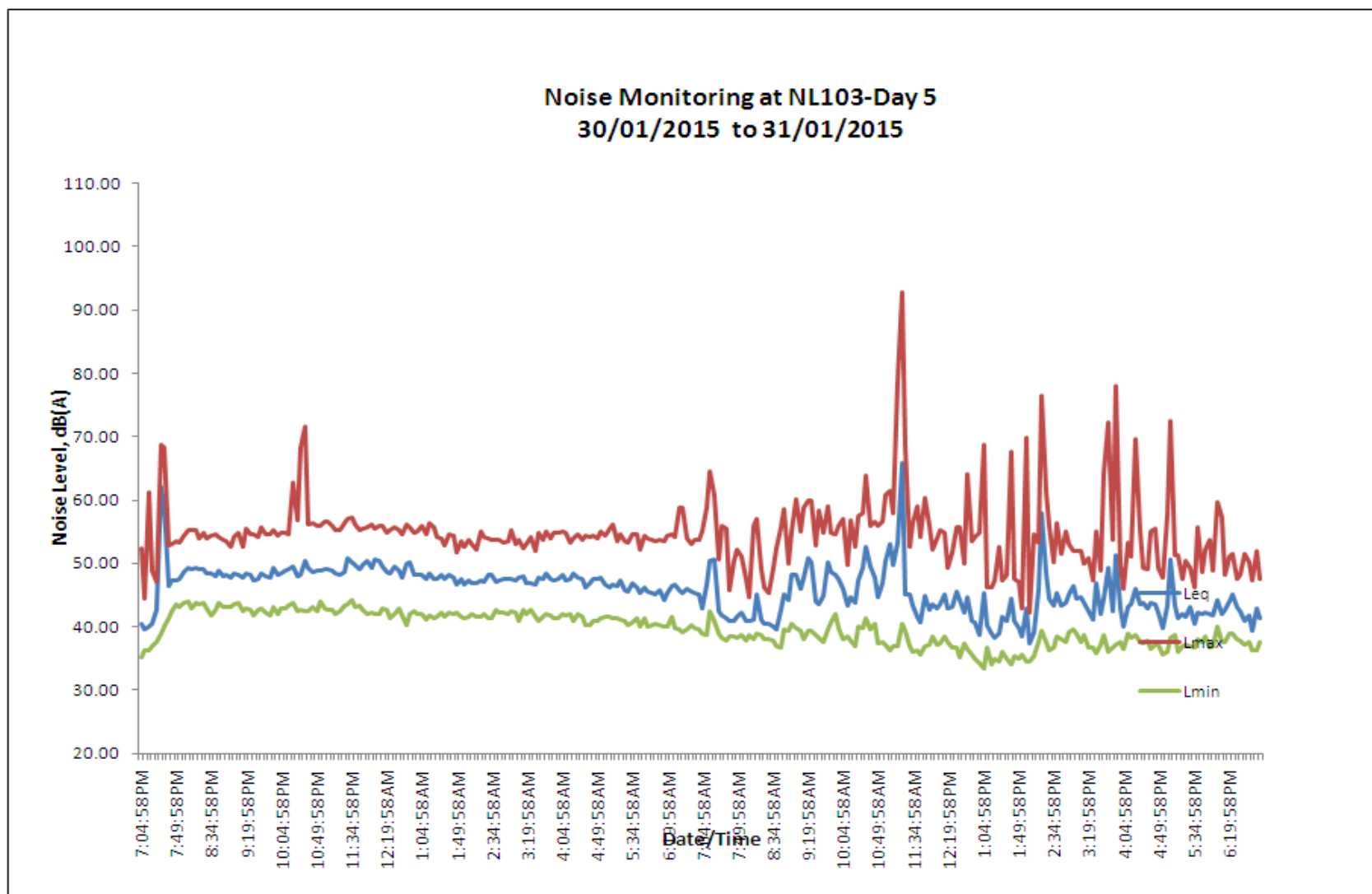
**Figure 68: Daily noise level measured at Point NL103\_R2 (Day 2)**



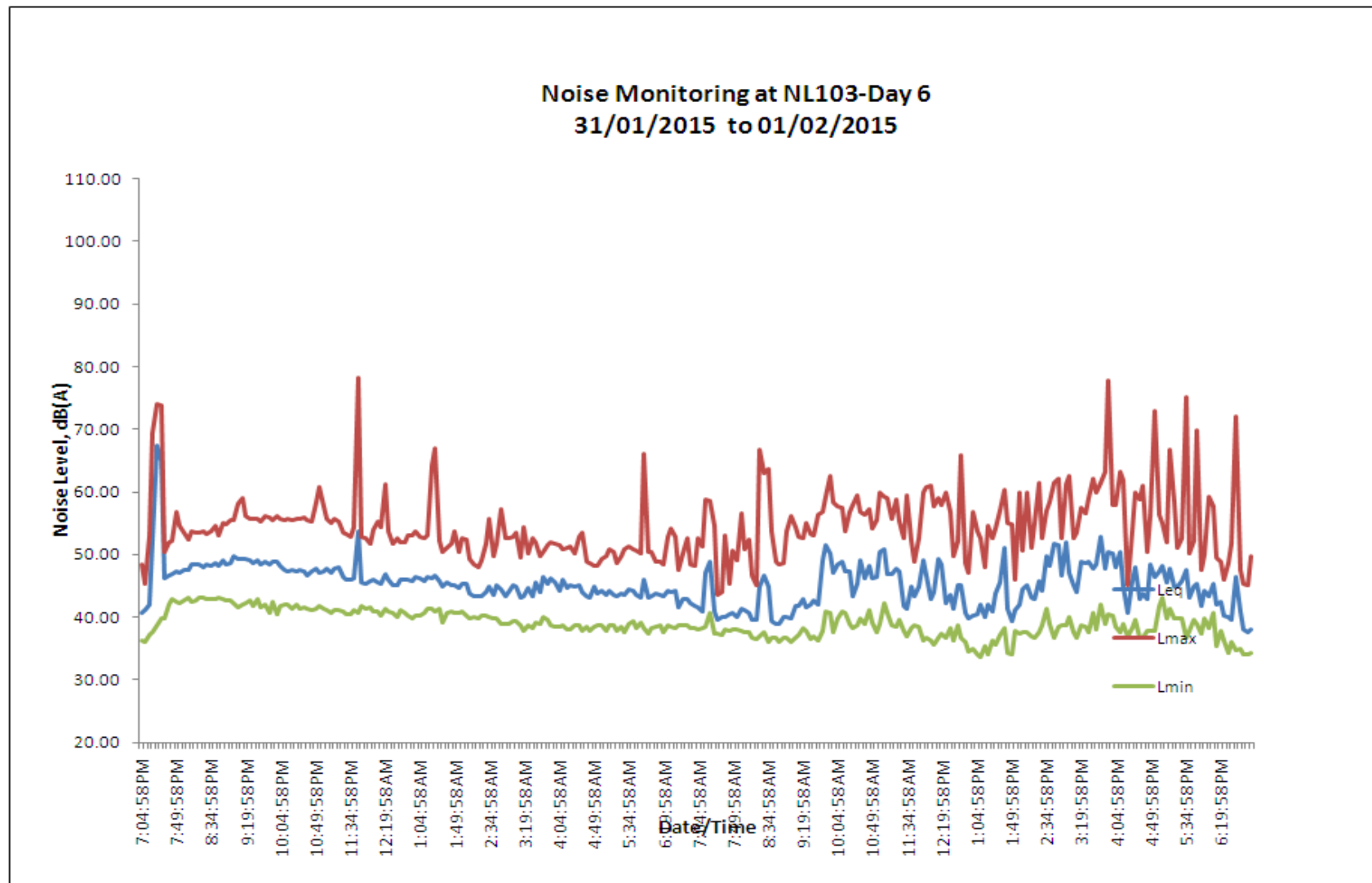
**Figure 69: Daily noise level measured at Point NL103\_R2 (Day 3)**



**Figure 70: Daily noise level measured at Point NL103\_R2 (Day 4)**

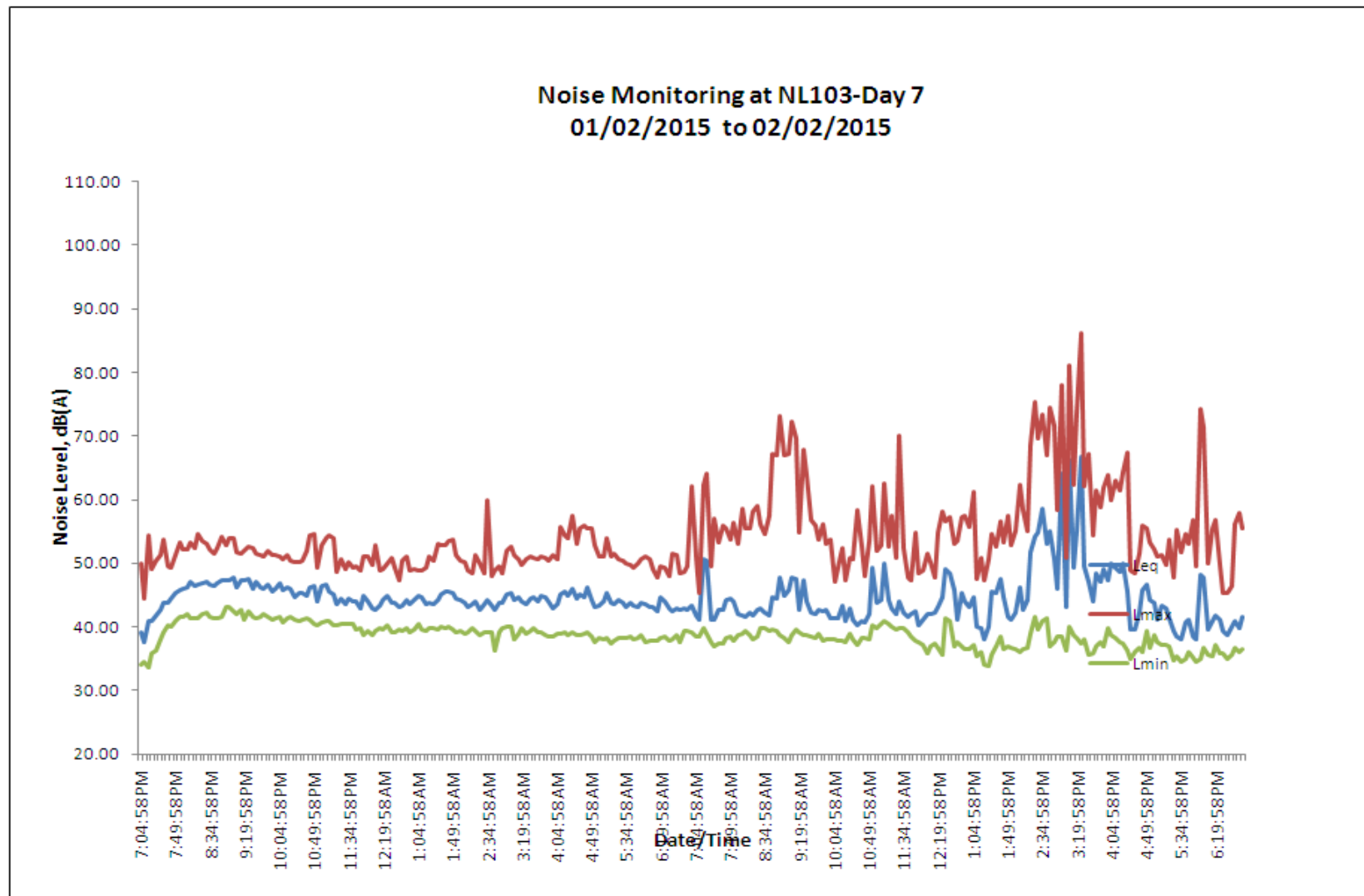


**Figure 71: Daily noise level measured at Point NL103\_R2 (Day 5)**

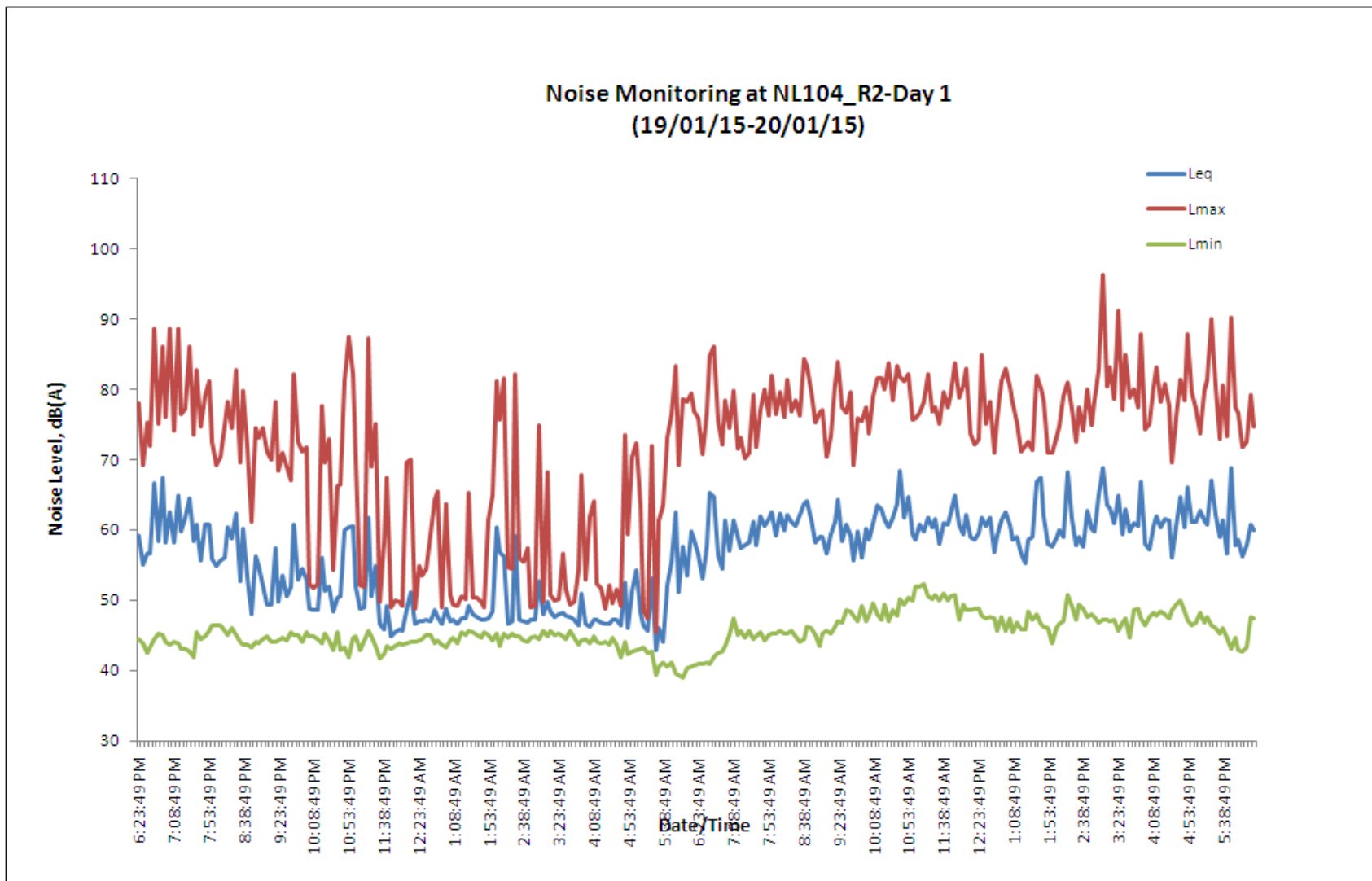


**Figure 72: Daily noise level measured at Point NL103\_R2 (Day 6)**

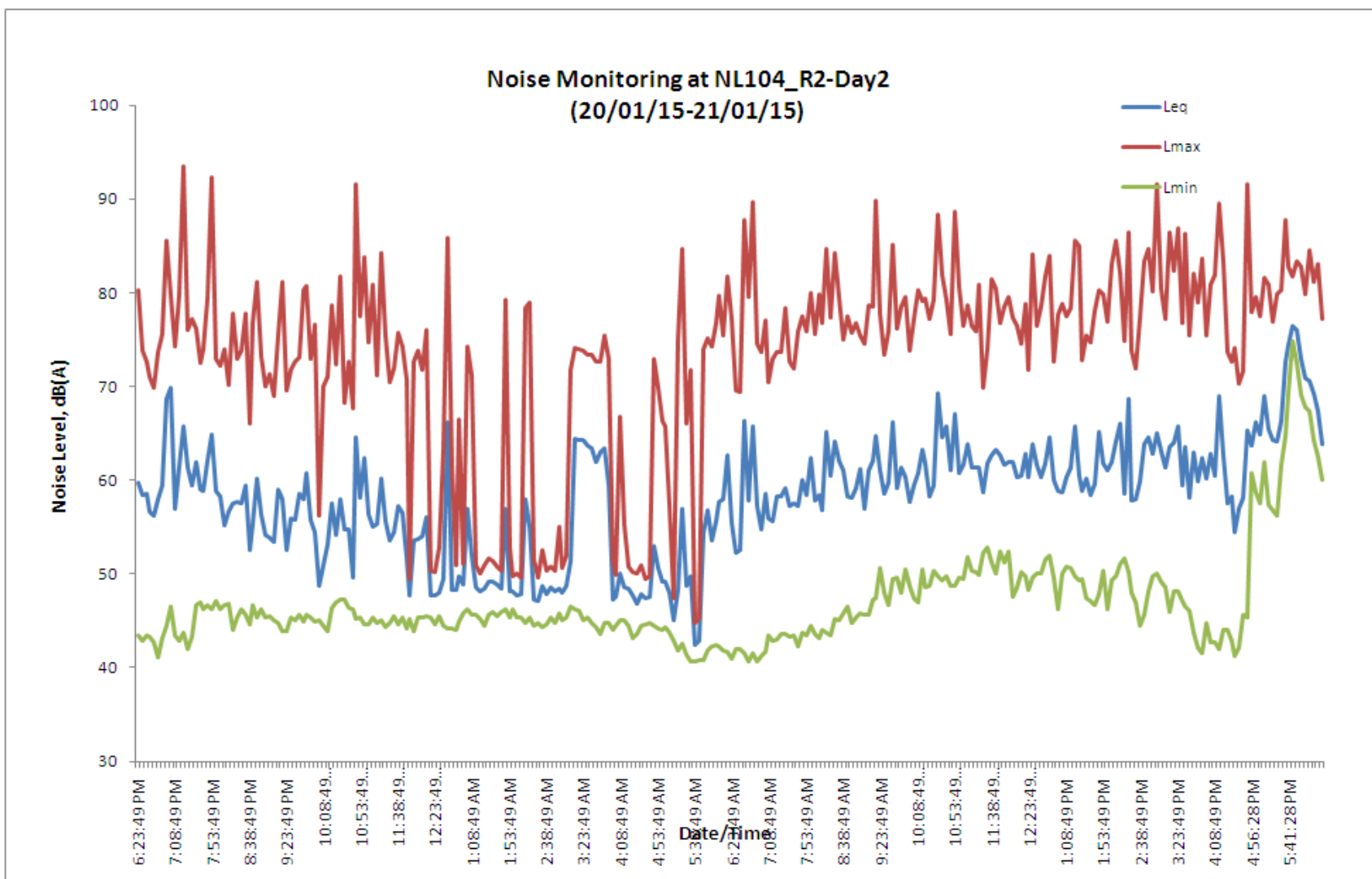




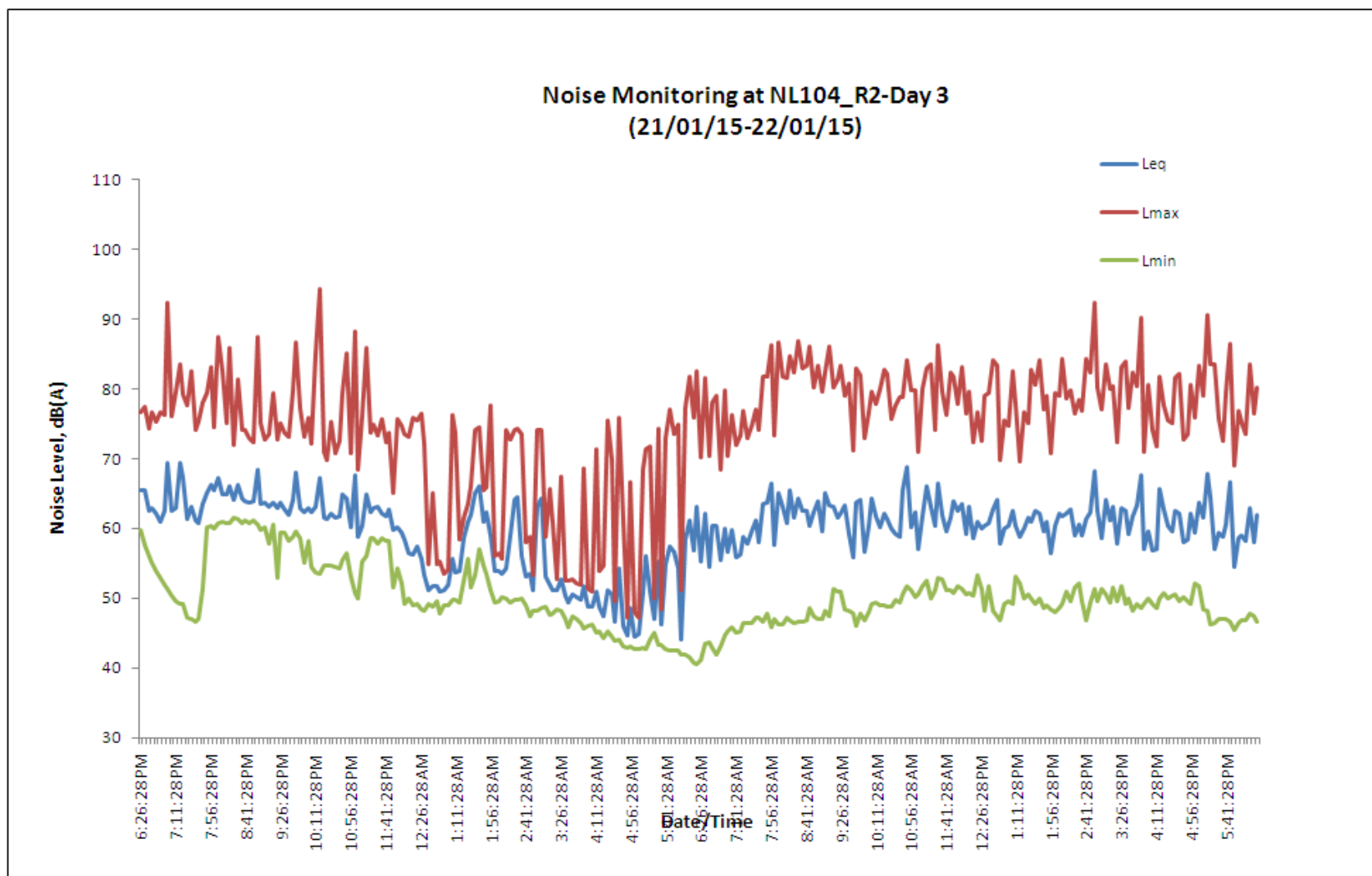
**Figure 73: Daily noise level measured at Point NL103\_R2 (Day 7)**



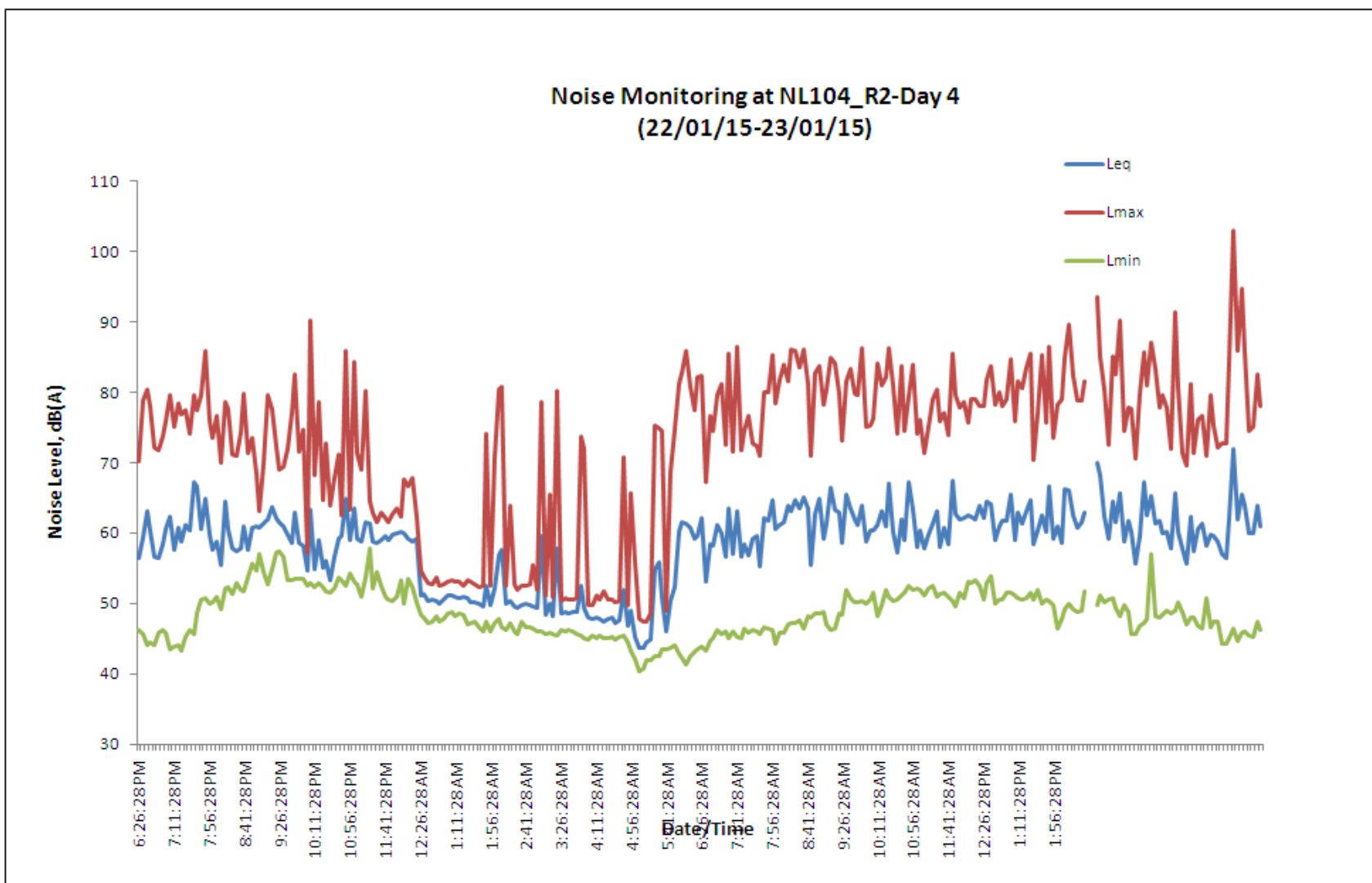
**Figure 74: Daily noise level measured at Point NL104\_R2 (Day 1)**



**Figure 75: Daily noise level measured at Point NL104\_R2 (Day 2)**

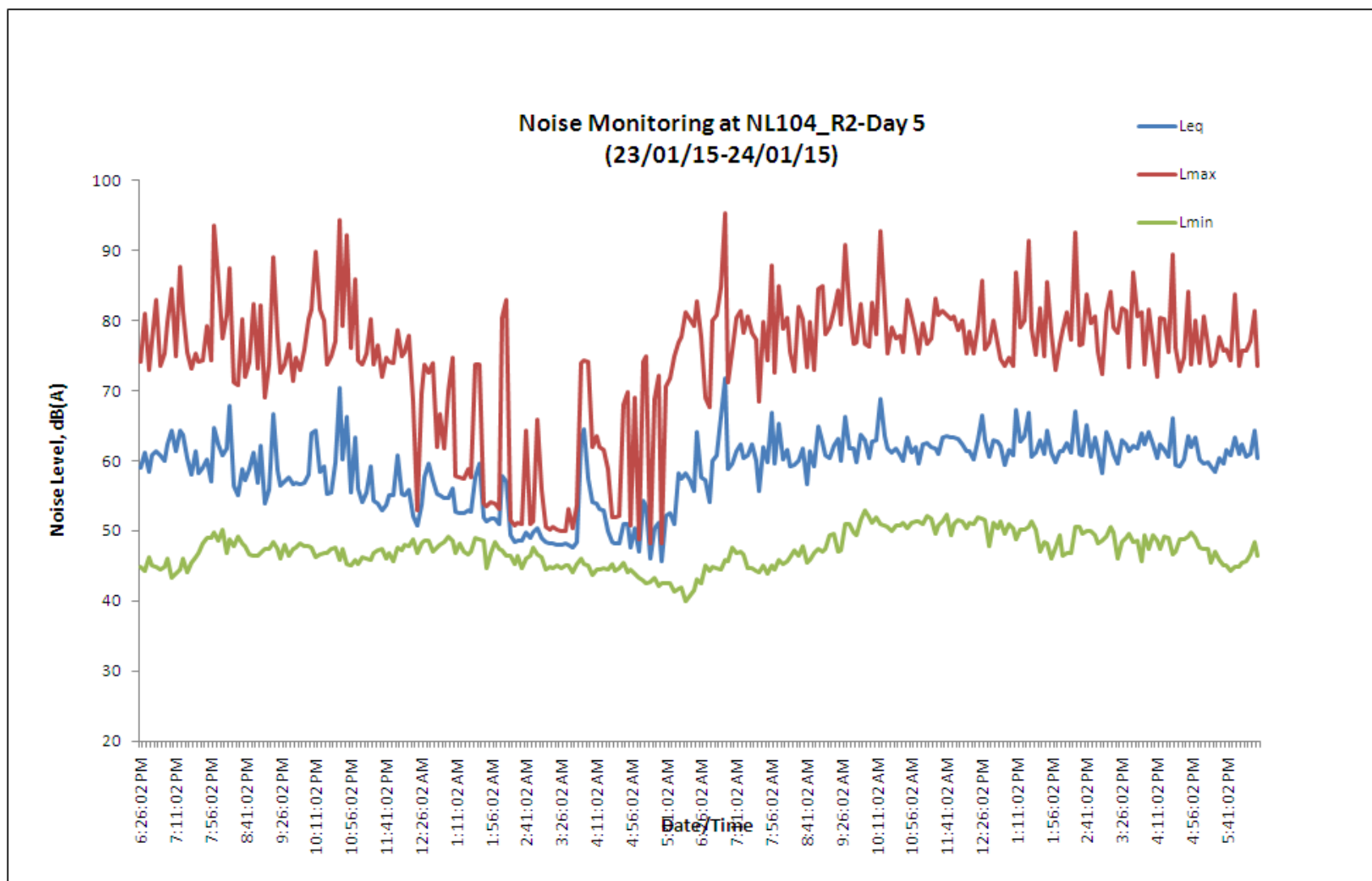


**Figure 76: Daily noise level measured at Point NL104\_R2 (Day 3)**

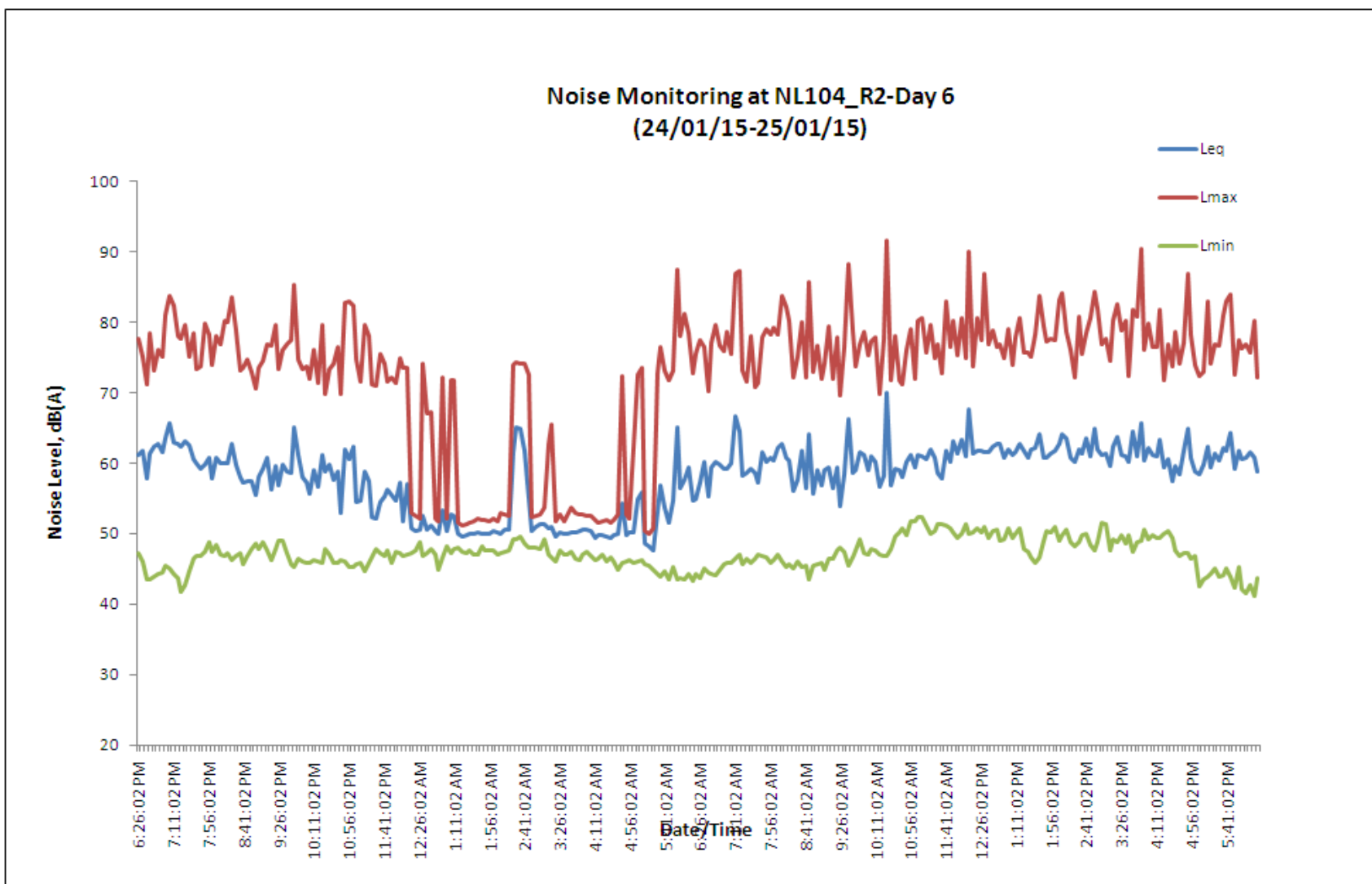


**Figure 77: Daily noise level measured at Point NL104\_R2 (Day 4)**

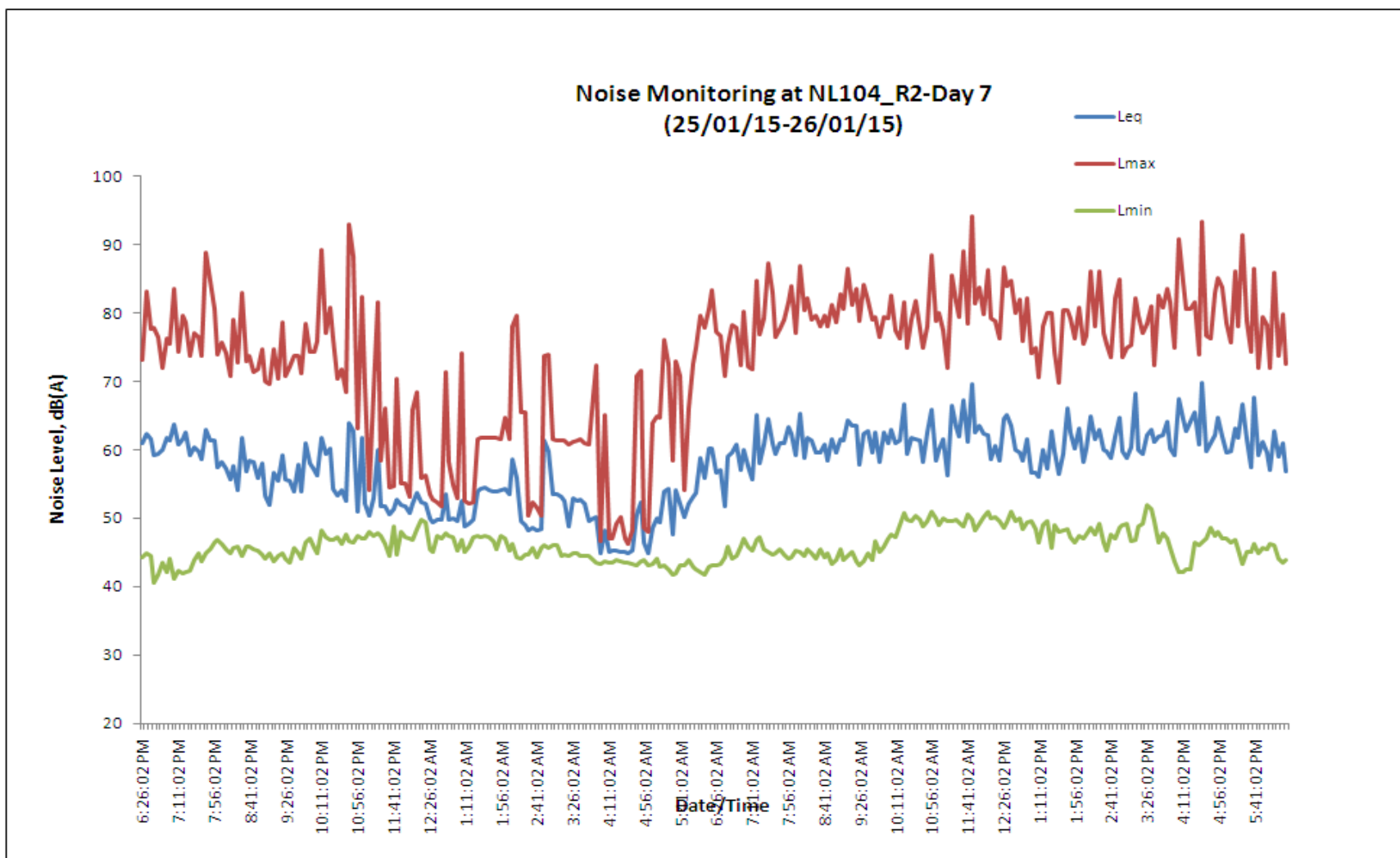




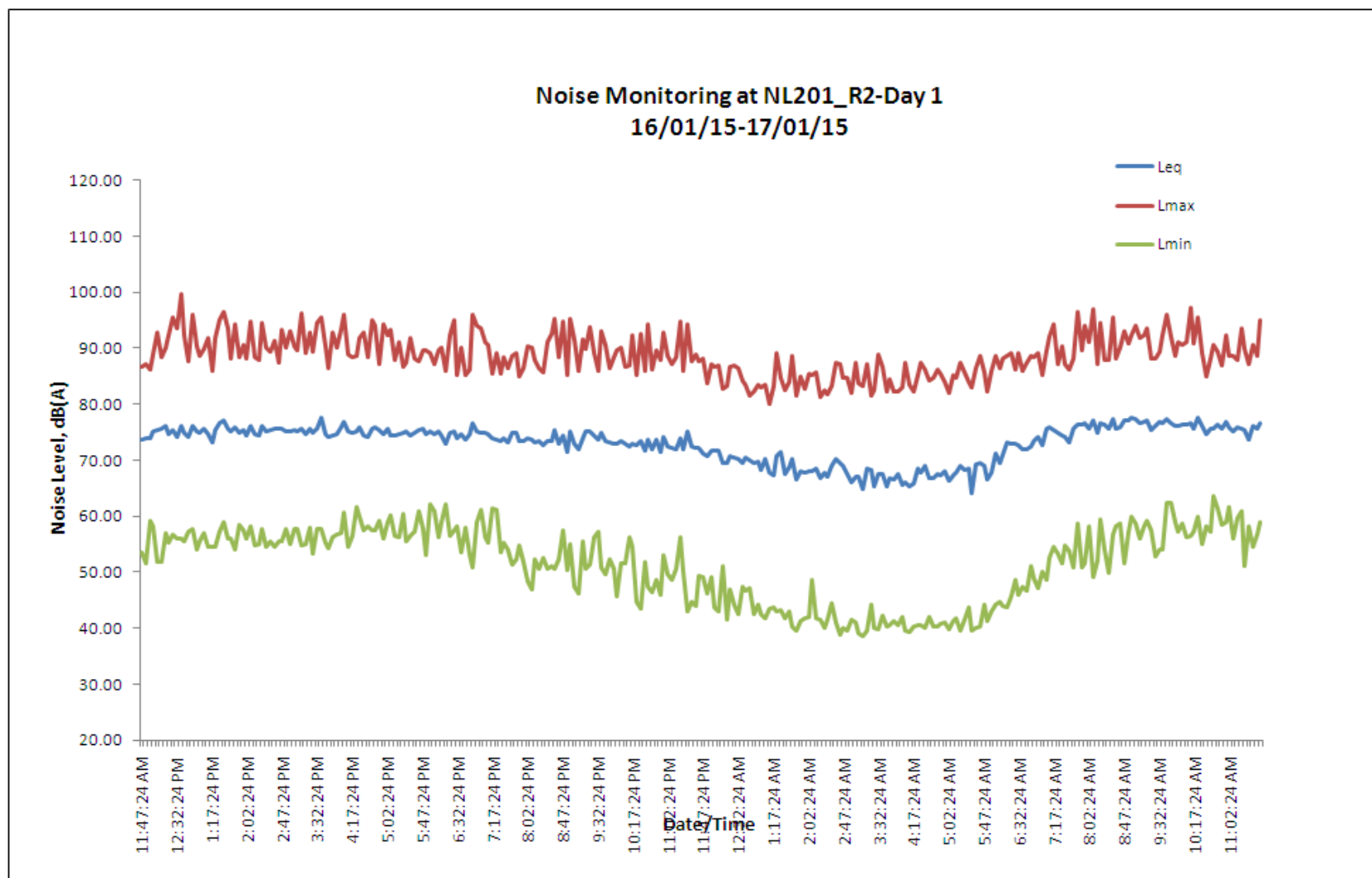
**Figure 78: Daily noise level measured at Point NL104\_R2 (Day 5)**



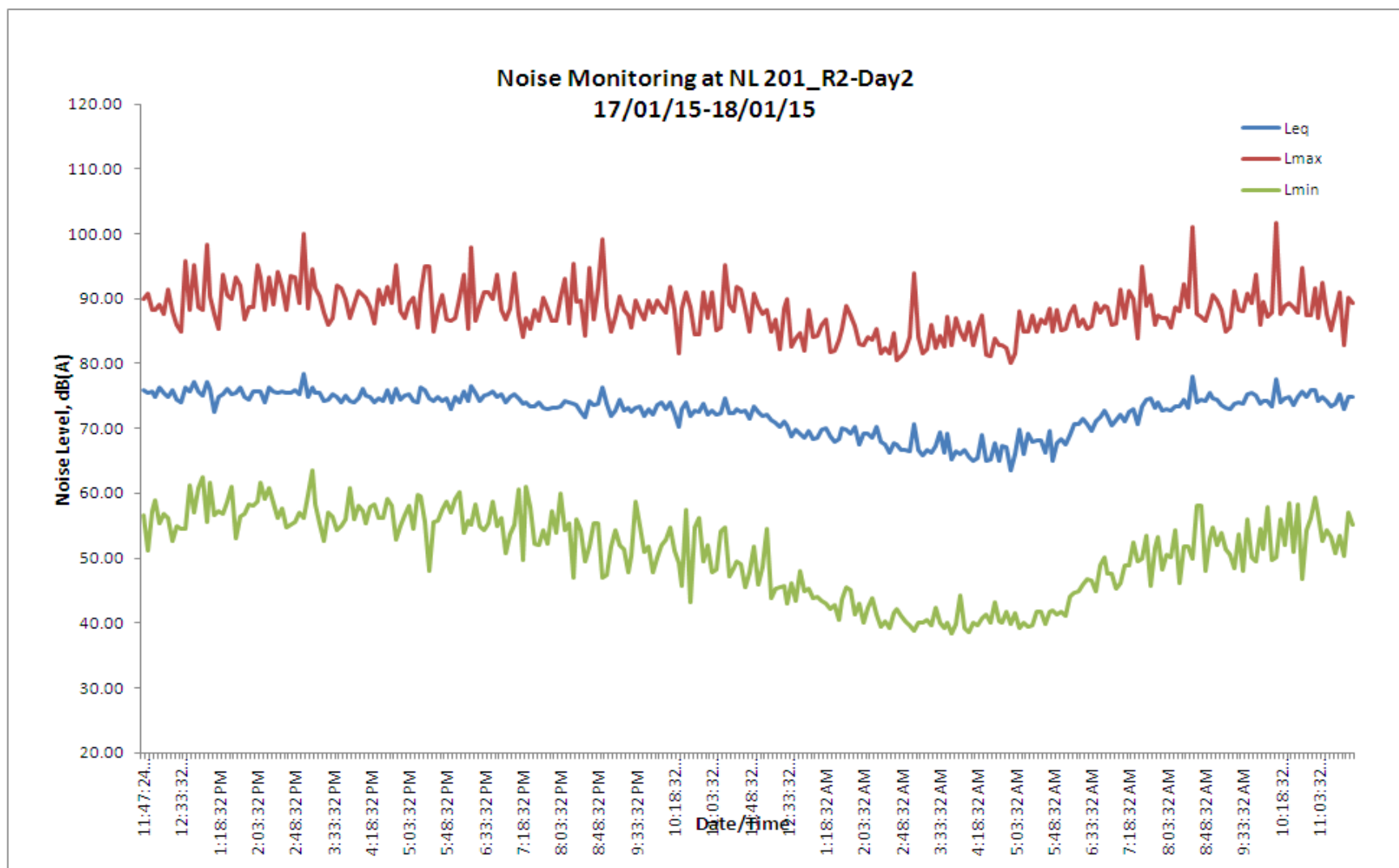
**Figure 79: Daily noise level measured at Point NL104\_R2 (Day 6)**



**Figure 80: Daily noise level measured at Point NL104\_R2 (Day 7)**

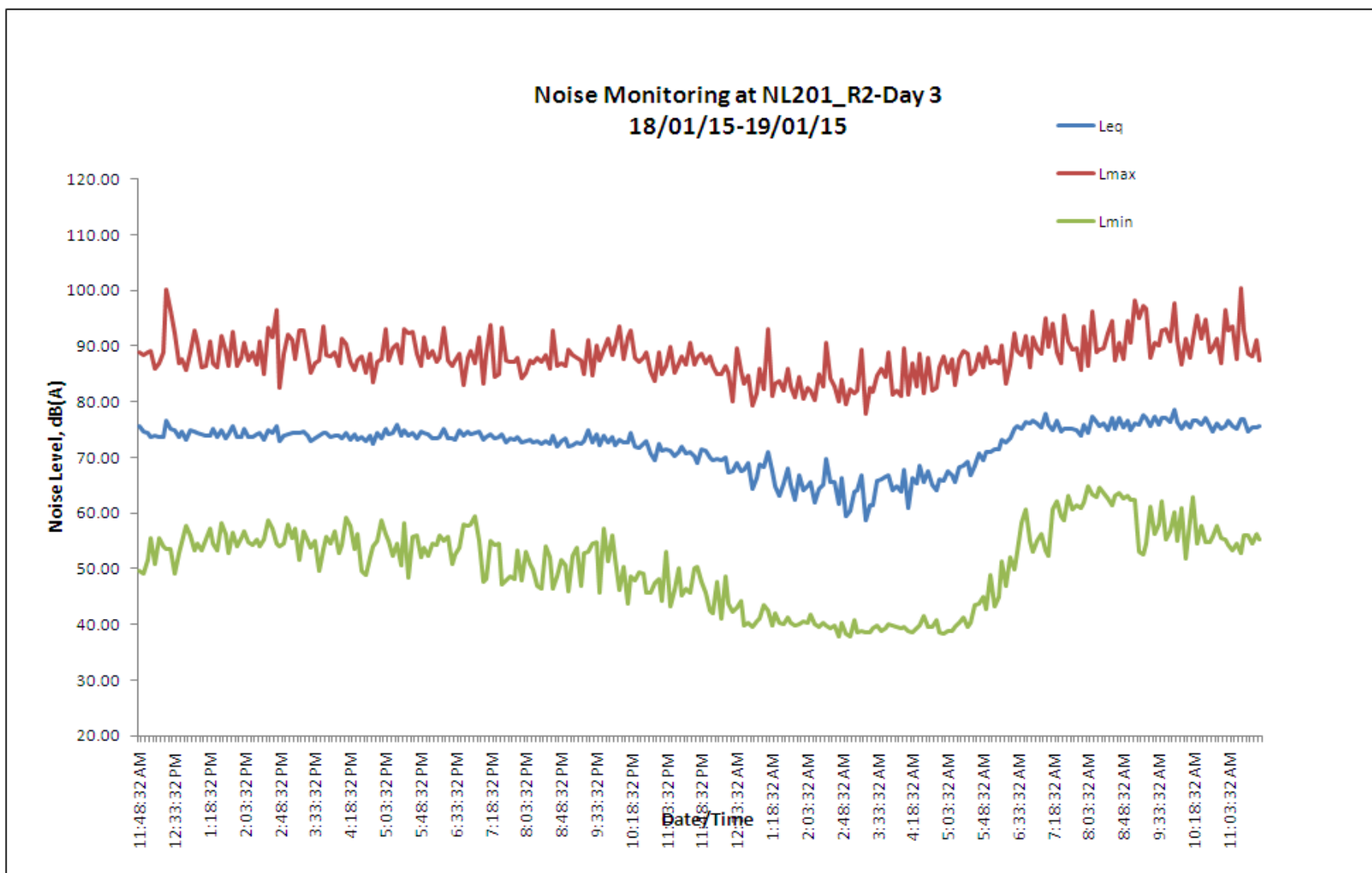


**Figure 81: Daily noise level measured at Point NL201\_R2 (Day 1)**

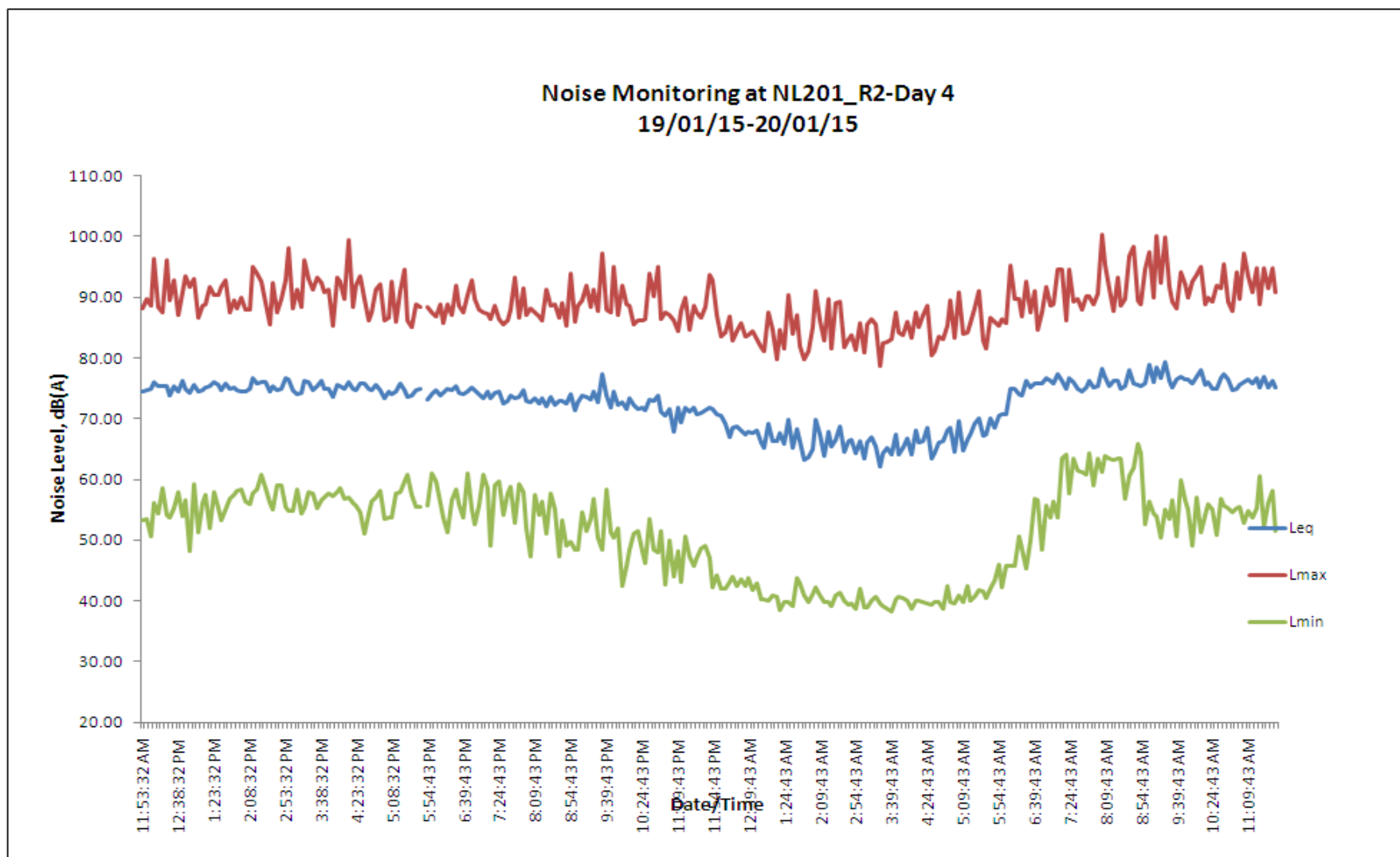


**Figure 82: Daily noise level measured at Point NL201\_R2 (Day 2)**

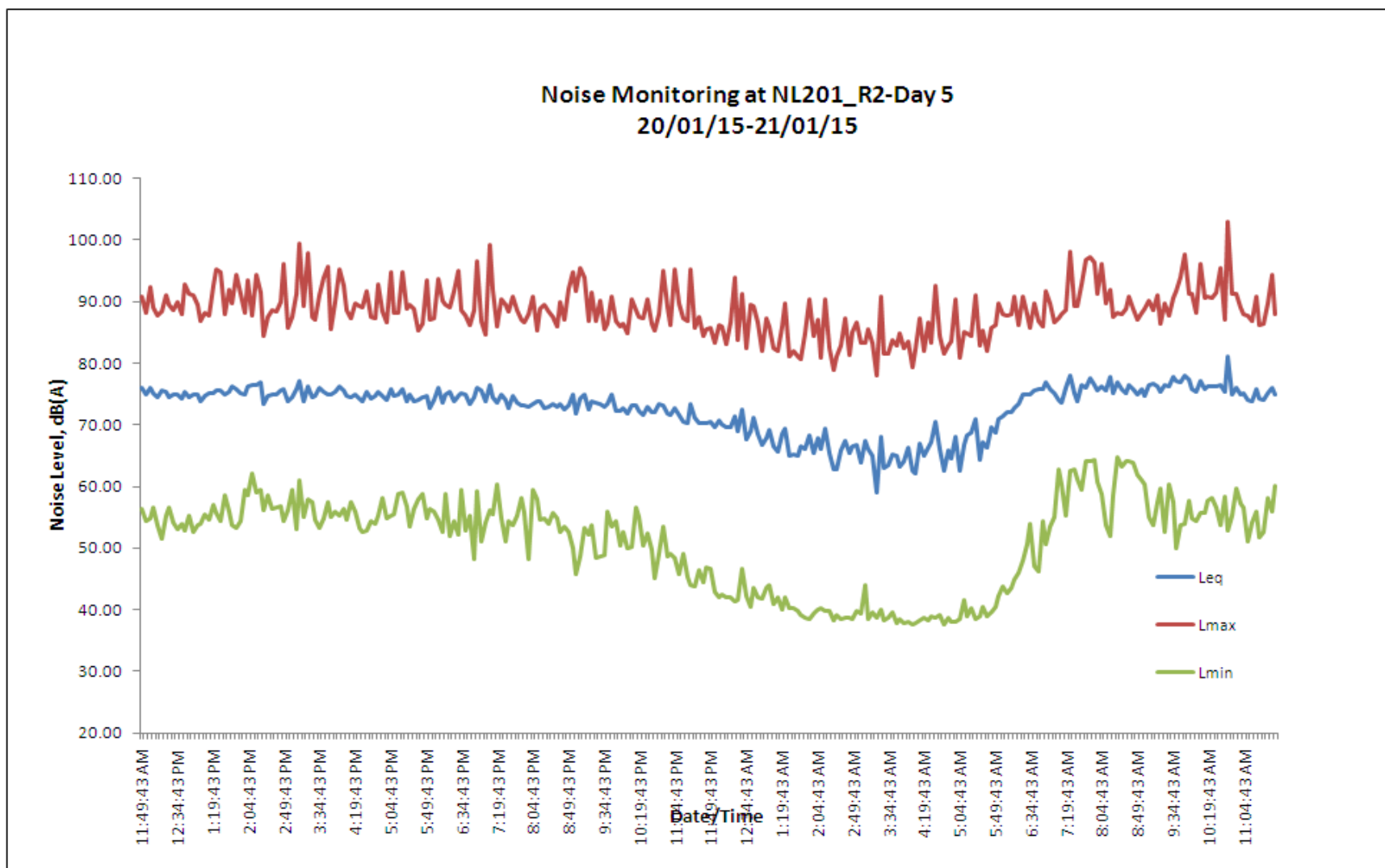




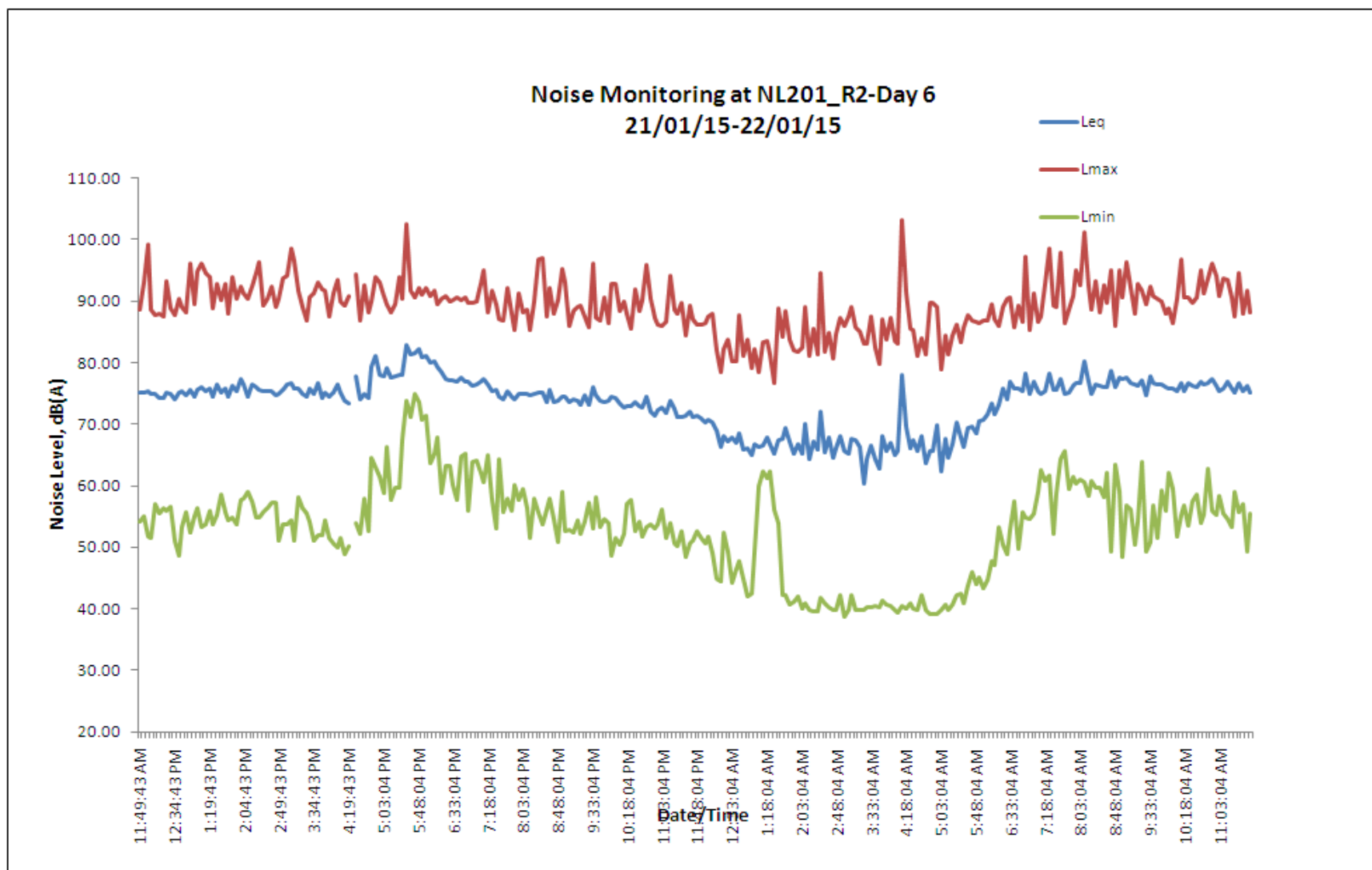
**Figure 83: Daily noise level measured at Point NL201\_R2 (Day 3)**



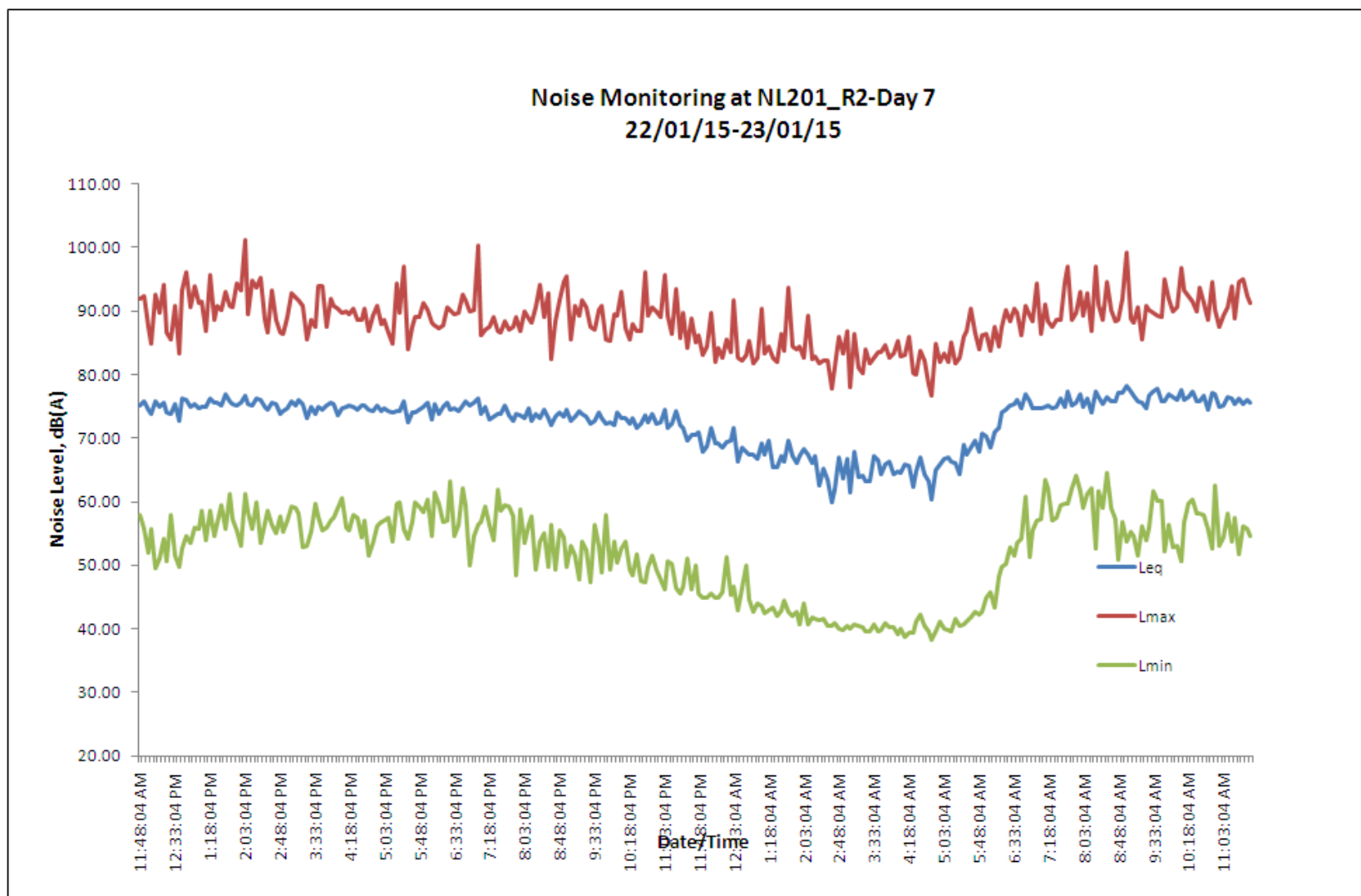
**Figure 84: Daily noise level measured at Point NL201\_R2 (Day 4)**



**Figure 85: Daily noise level measured at Point NL201\_R2 (Day 5)**

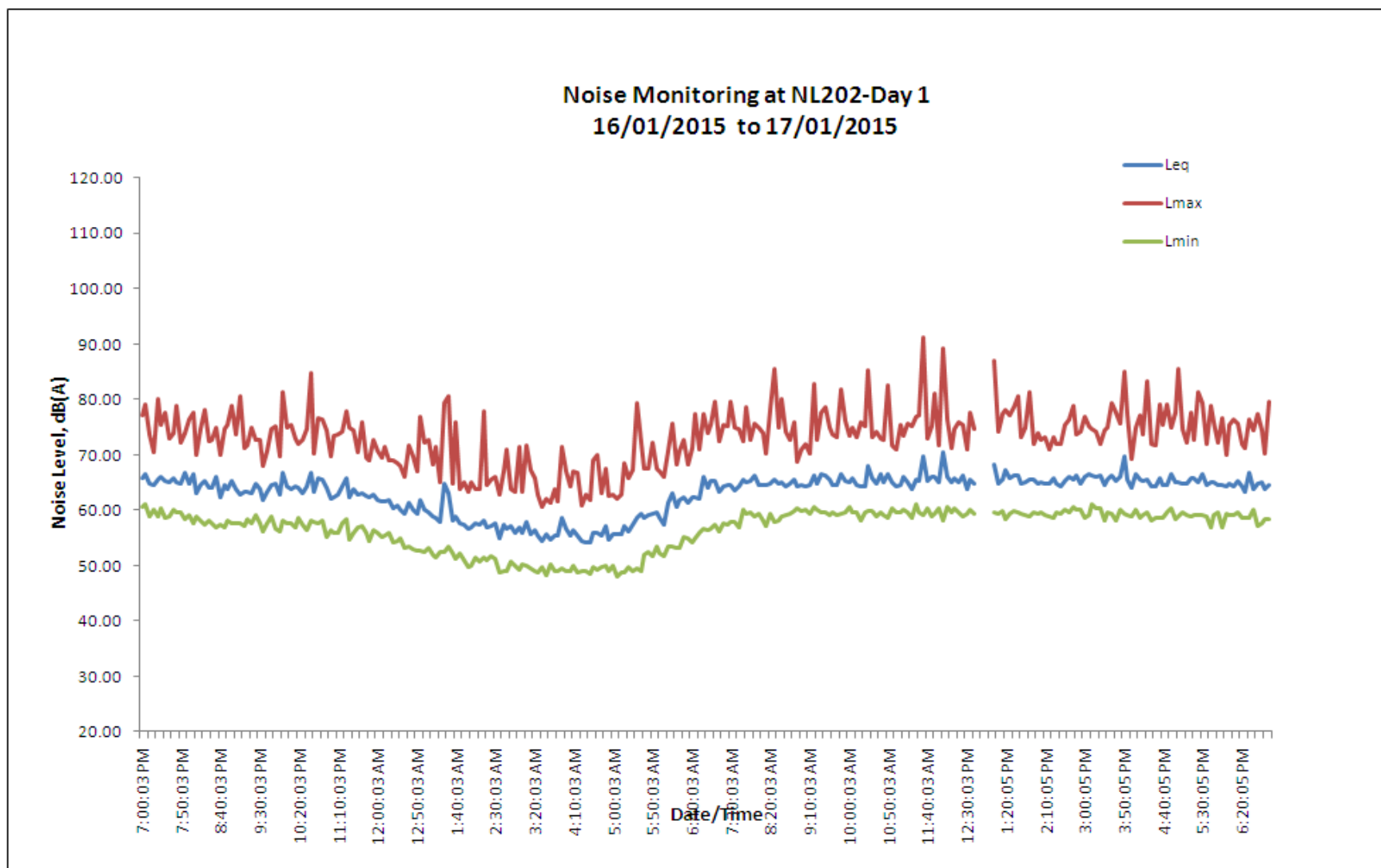


**Figure 86: Daily noise level measured at Point NL201\_R2 (Day 6)**

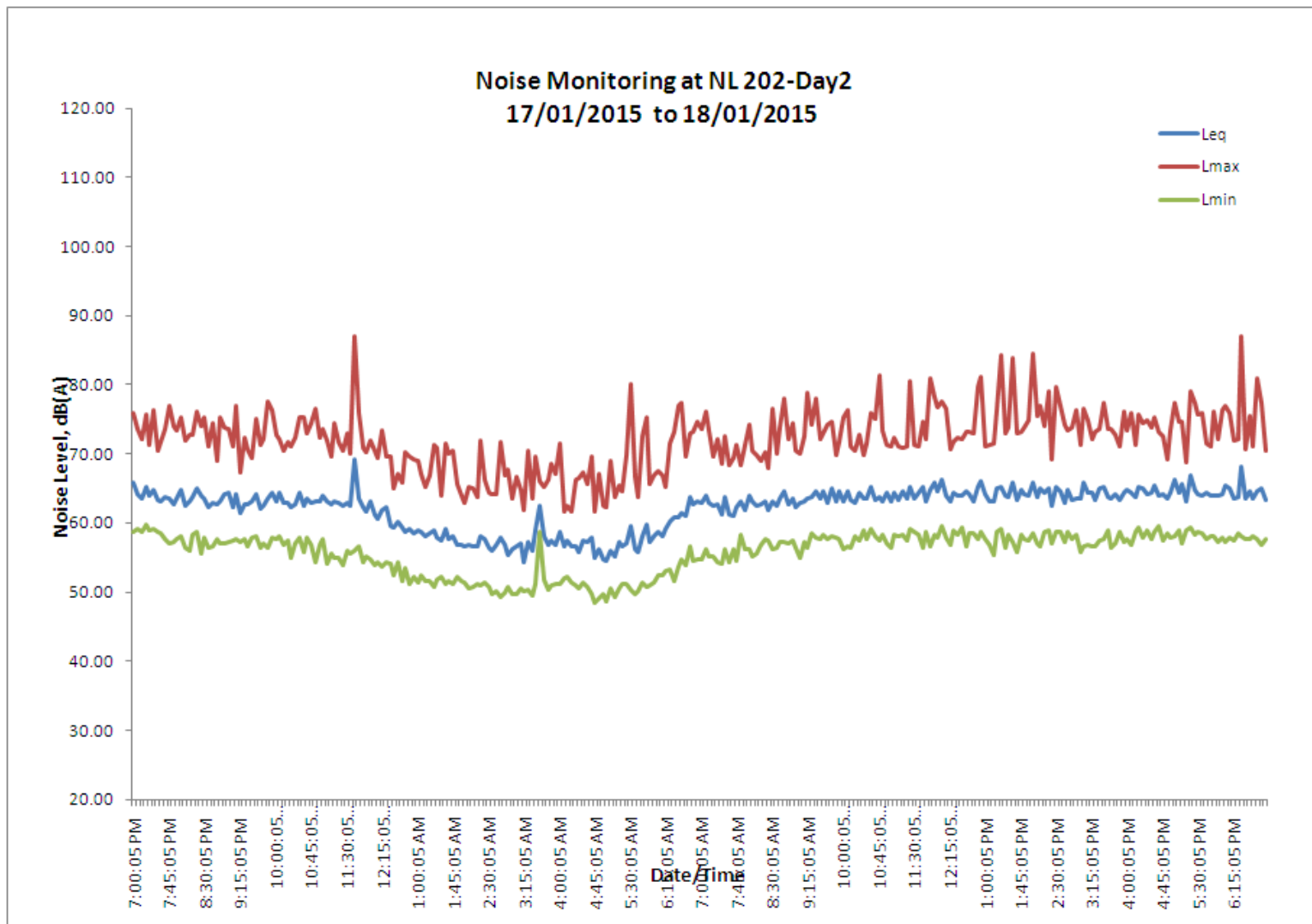


**Figure 87: Daily noise level measured at Point NL201\_R2 (Day 7)**

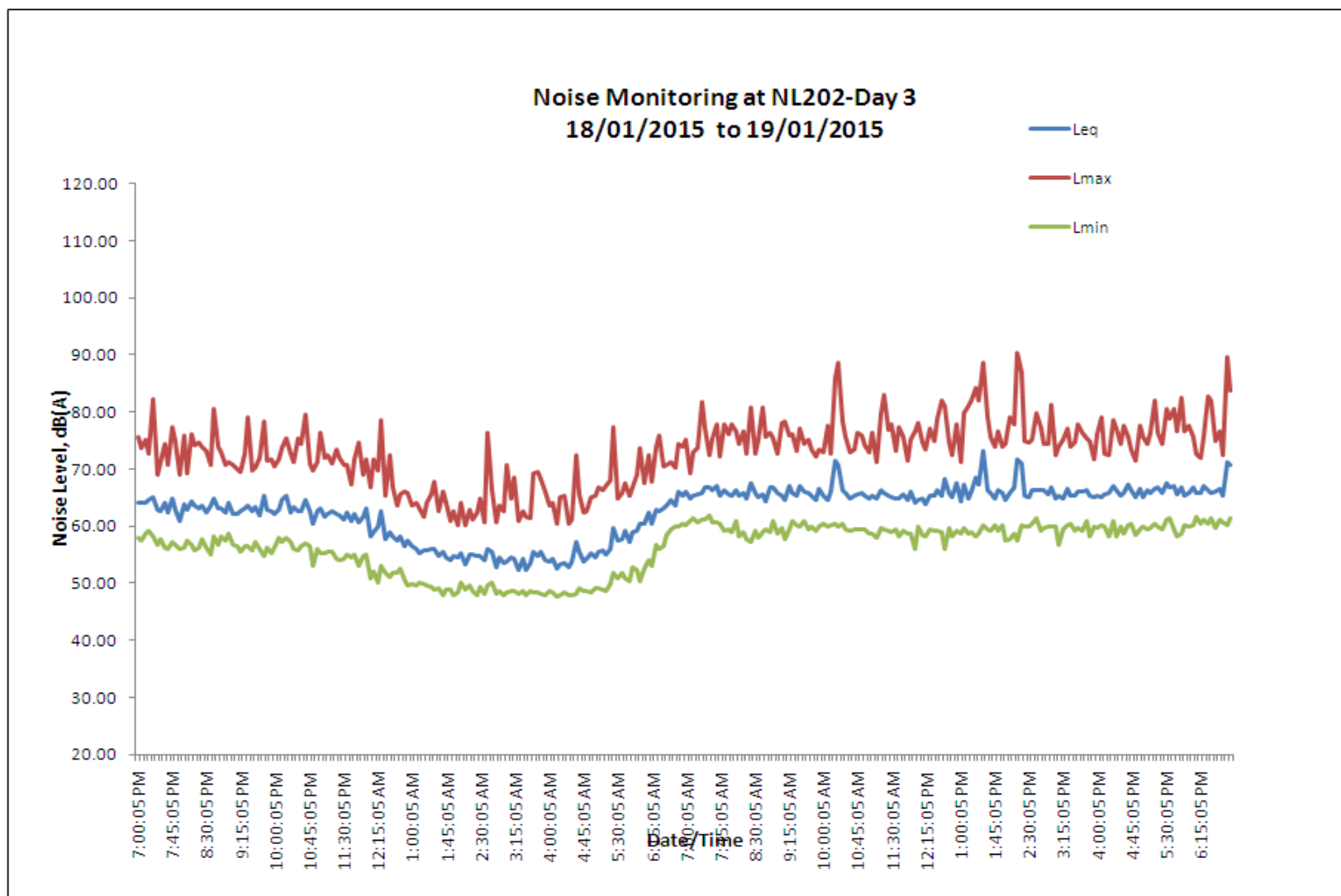




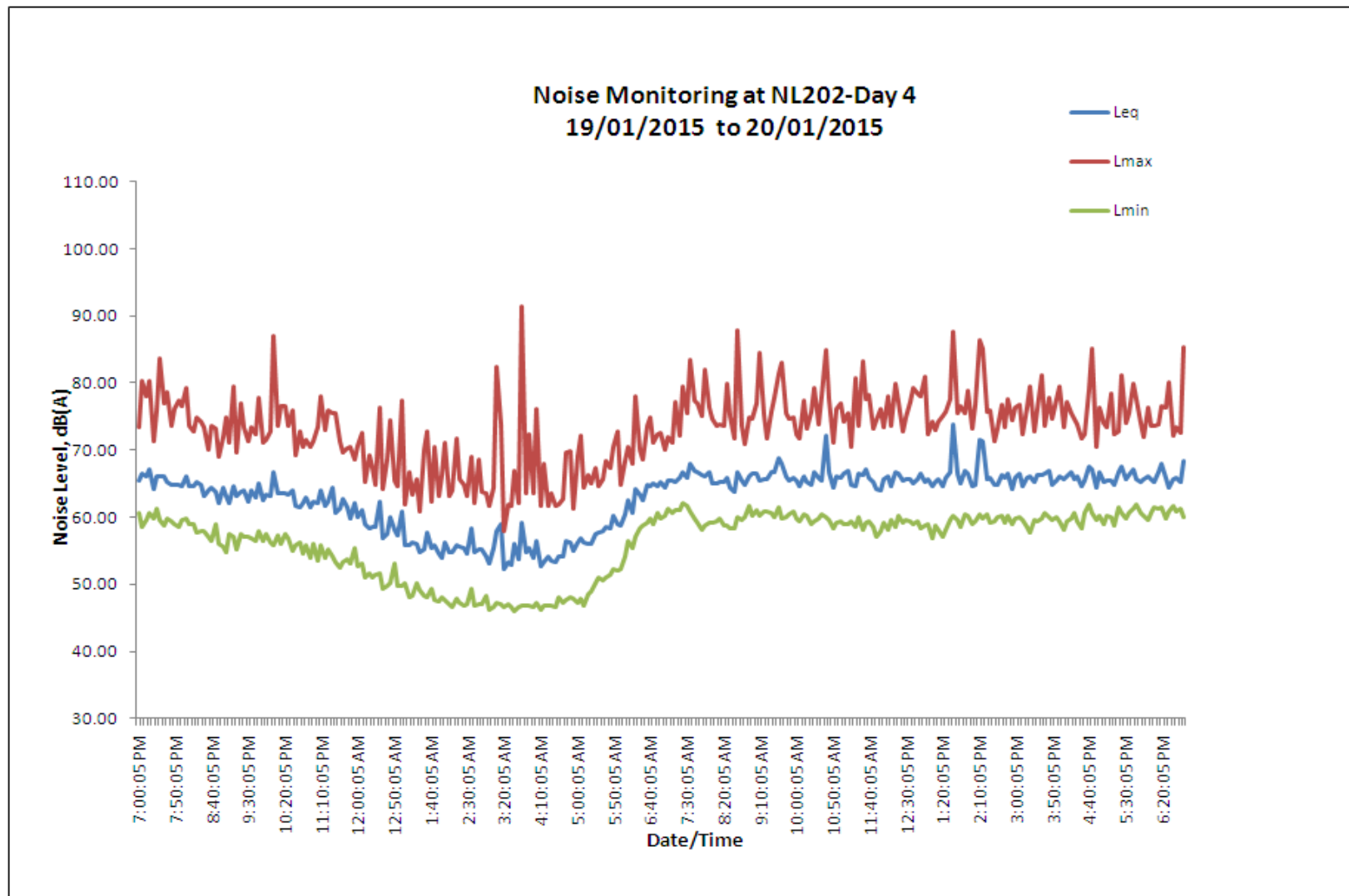
**Figure 88: Daily noise level measured at Point NL202\_R2 (Day 1)**



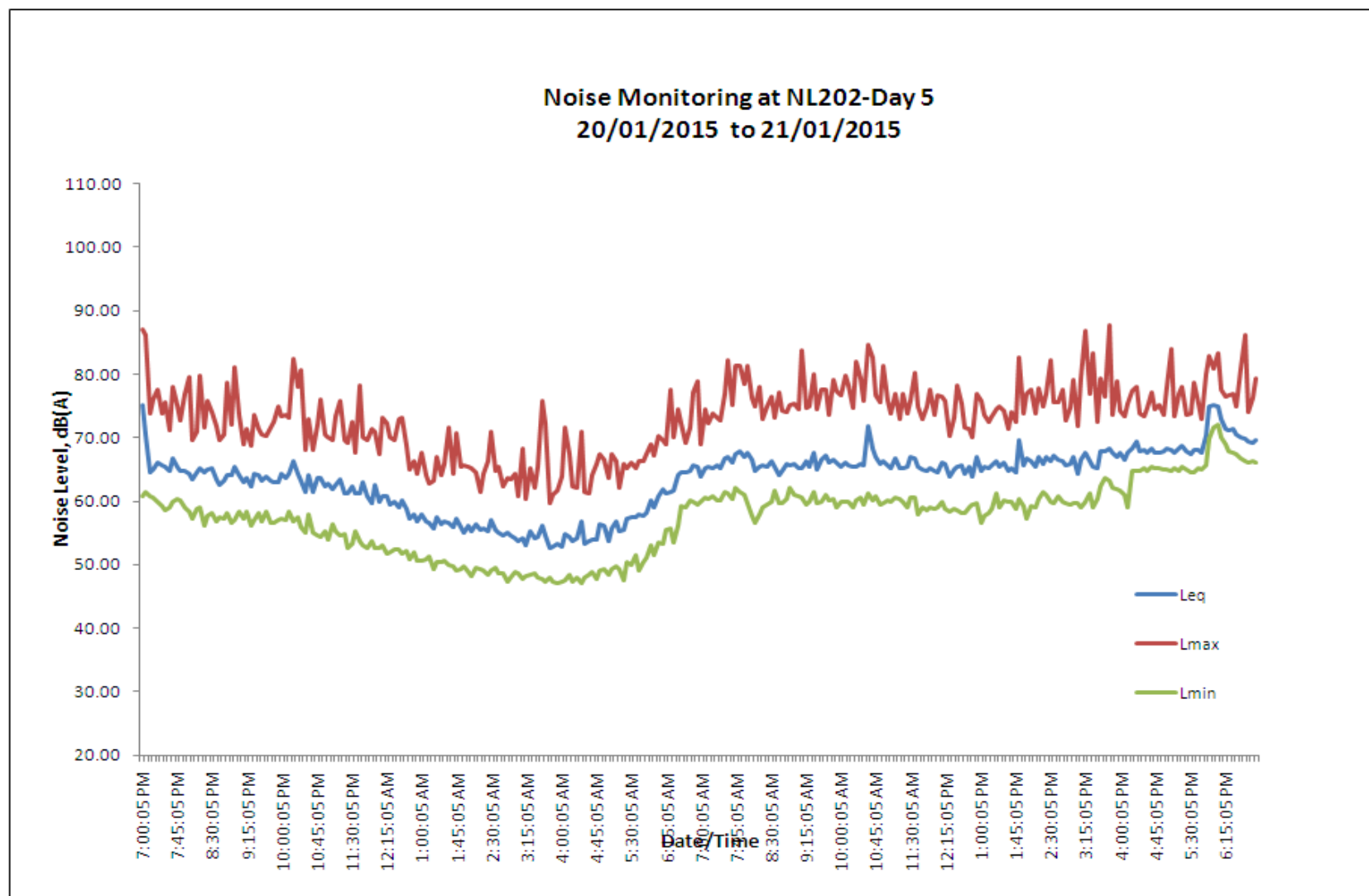
**Figure 89: Daily noise level measured at Point NL202\_R2 (Day 2)**



**Figure 90: Daily noise level measured at Point NL202\_R2 (Day 3)**

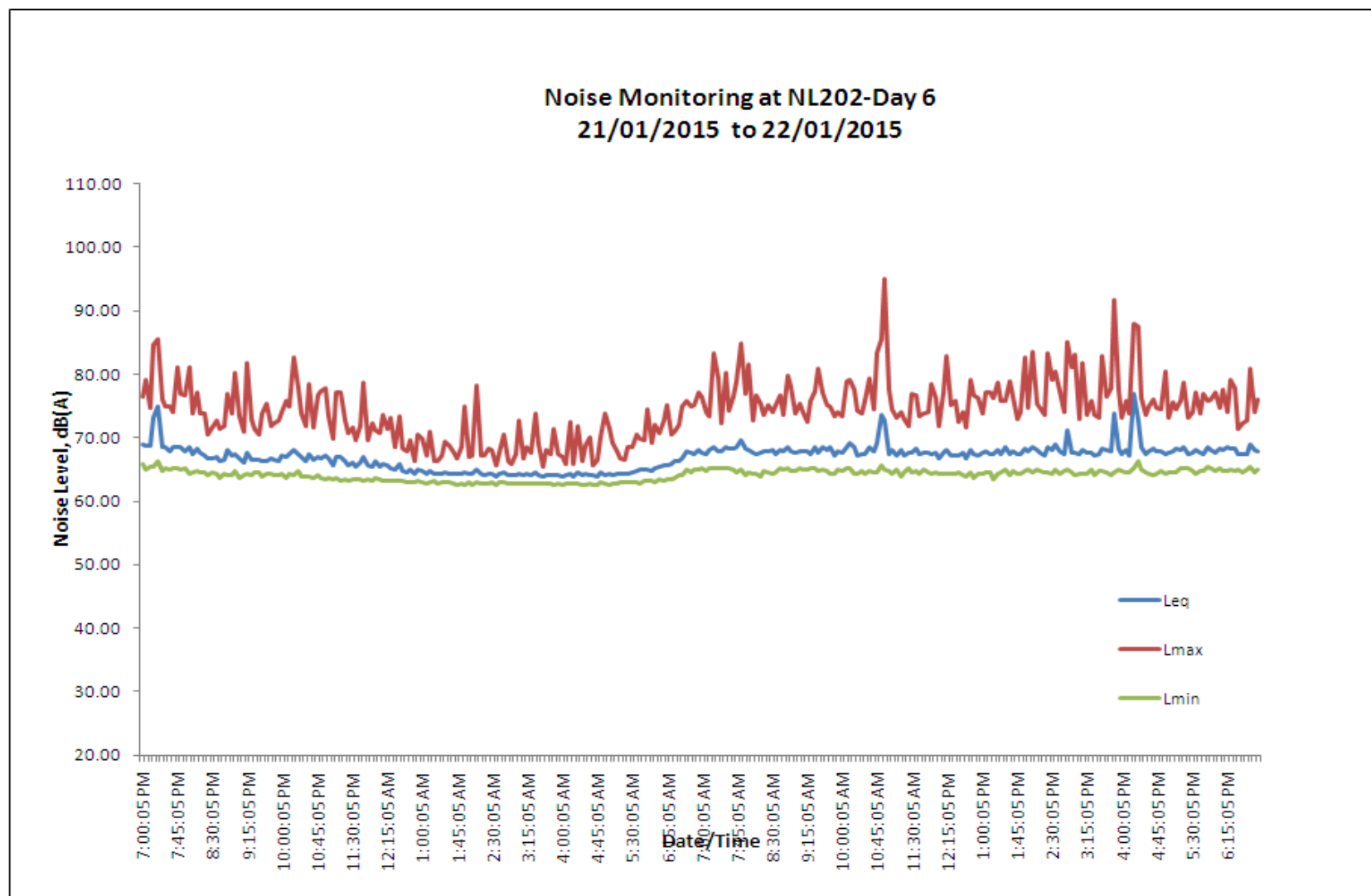


**Figure 91: Daily noise level measured at Point NL202\_R2 (Day 4)**

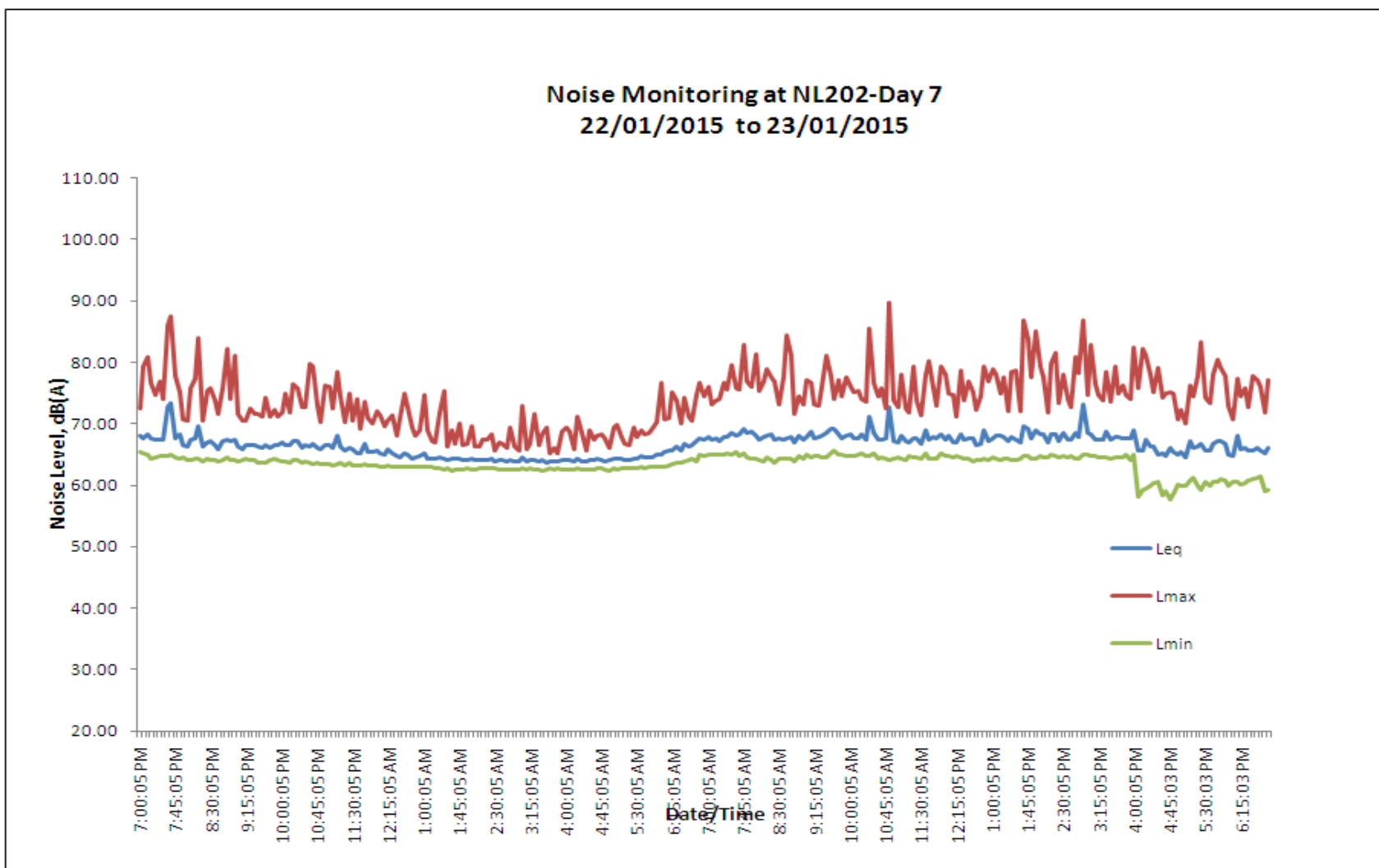


**Figure 92: Daily noise level measured at Point NL202\_R2 (Day 5)**

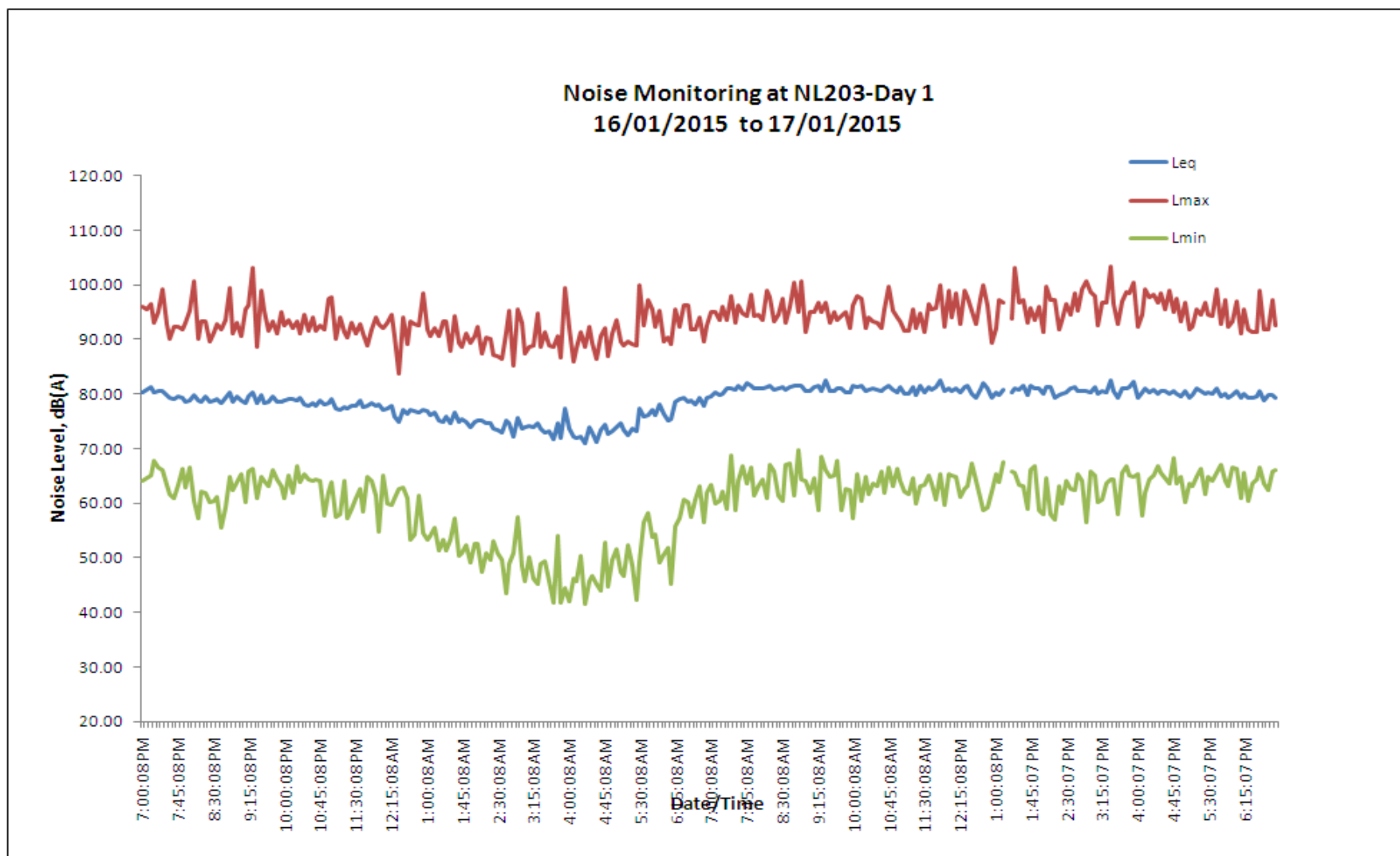




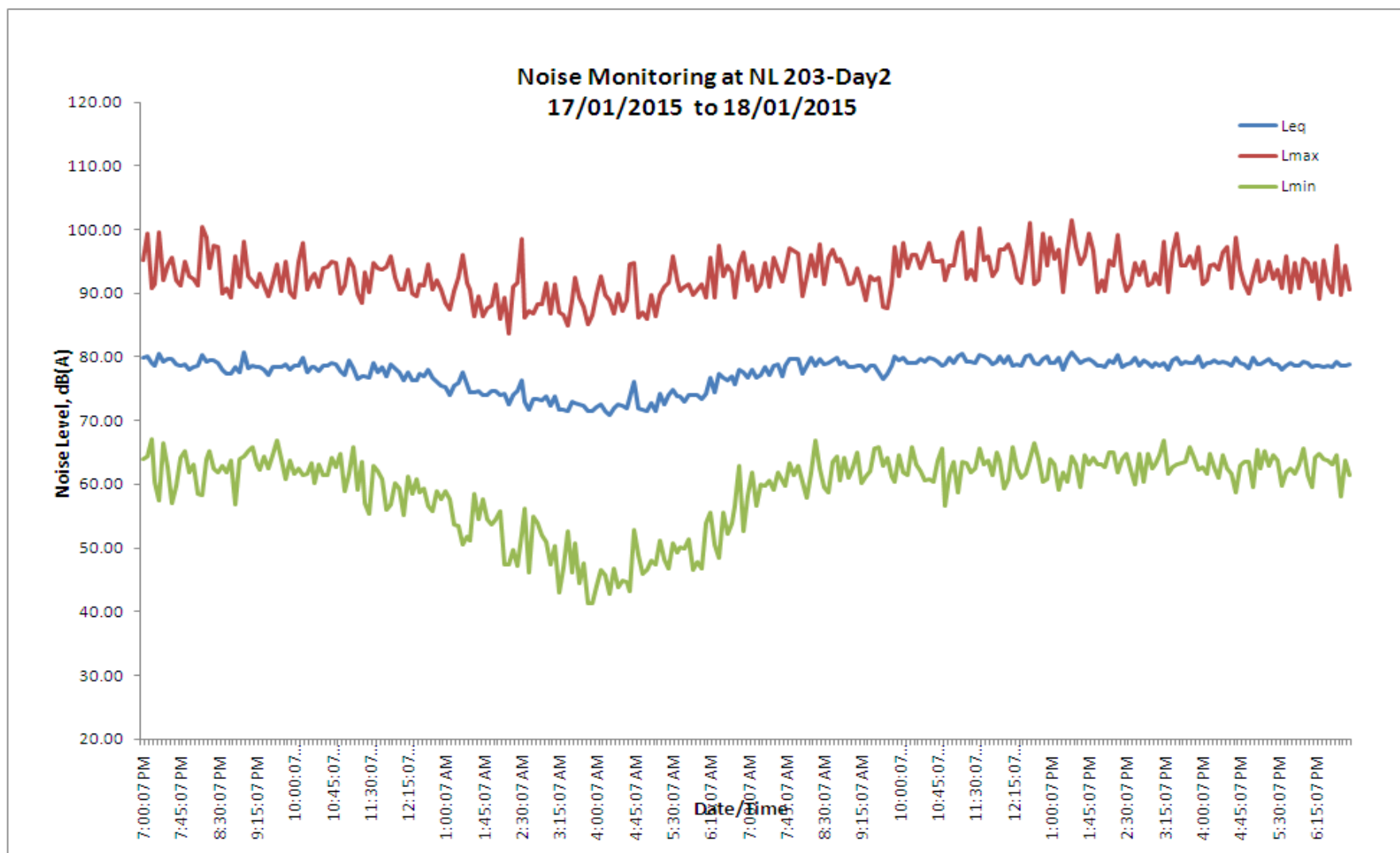
**Figure 93: Daily noise level measured at Point NL202\_R2 (Day 6)**



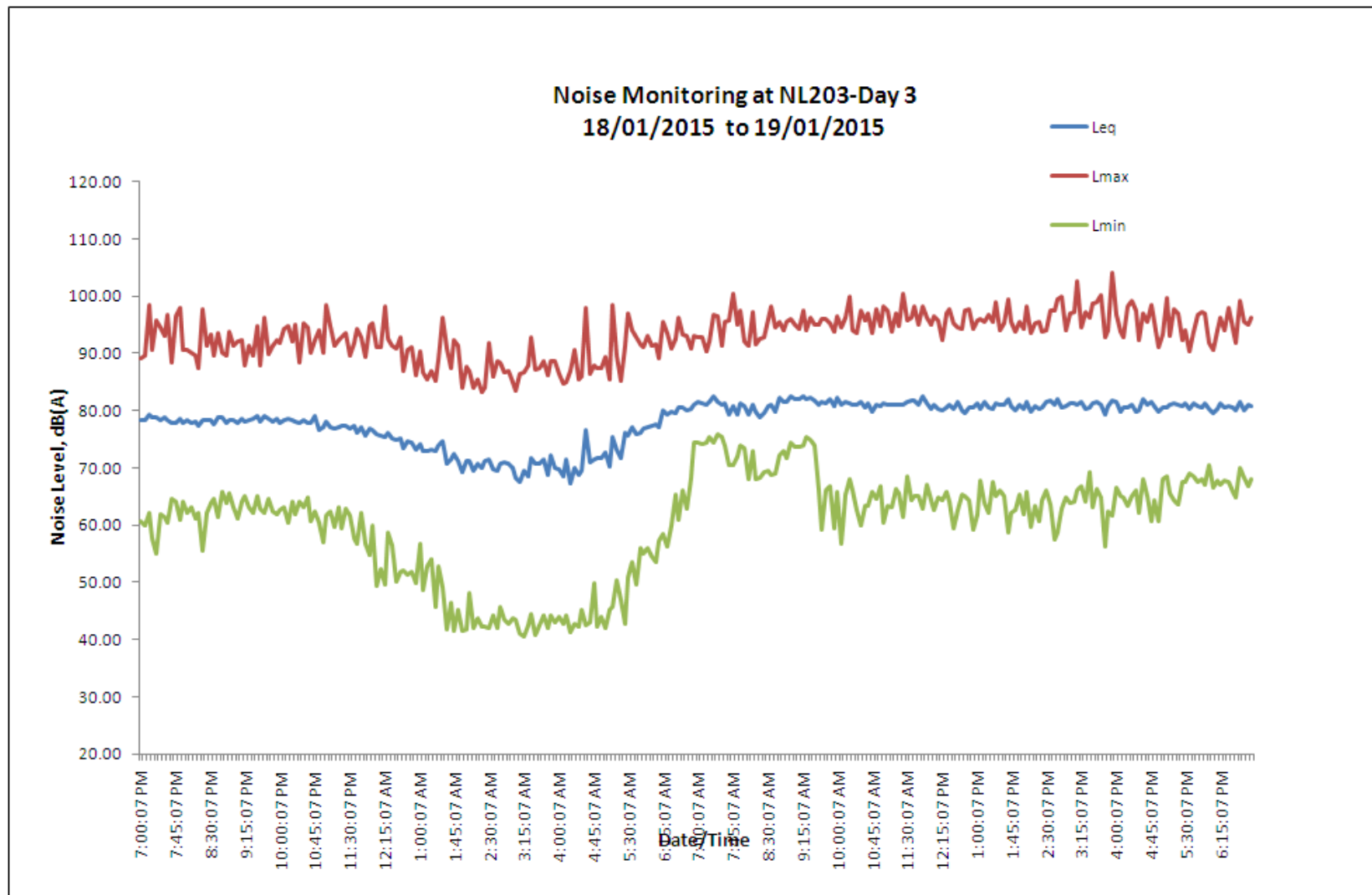
**Figure 94: Daily noise level measured at Point NL202\_R2 (Day 7)**



**Figure 95: Daily noise level measured at Point NL203\_R2 (Day 1)**

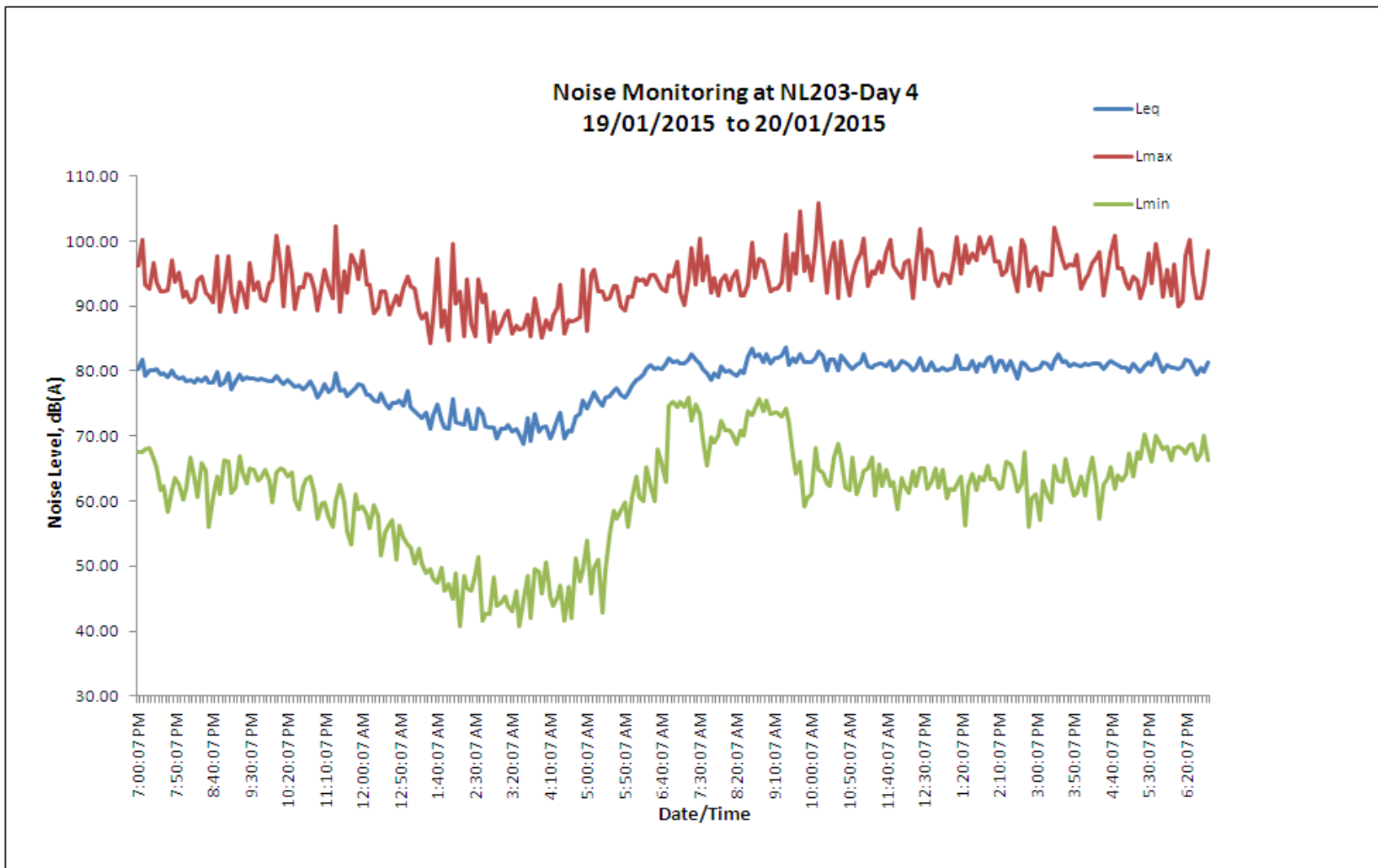


**Figure 96: Daily noise level measured at Point NL203\_R2 (Day 2)**

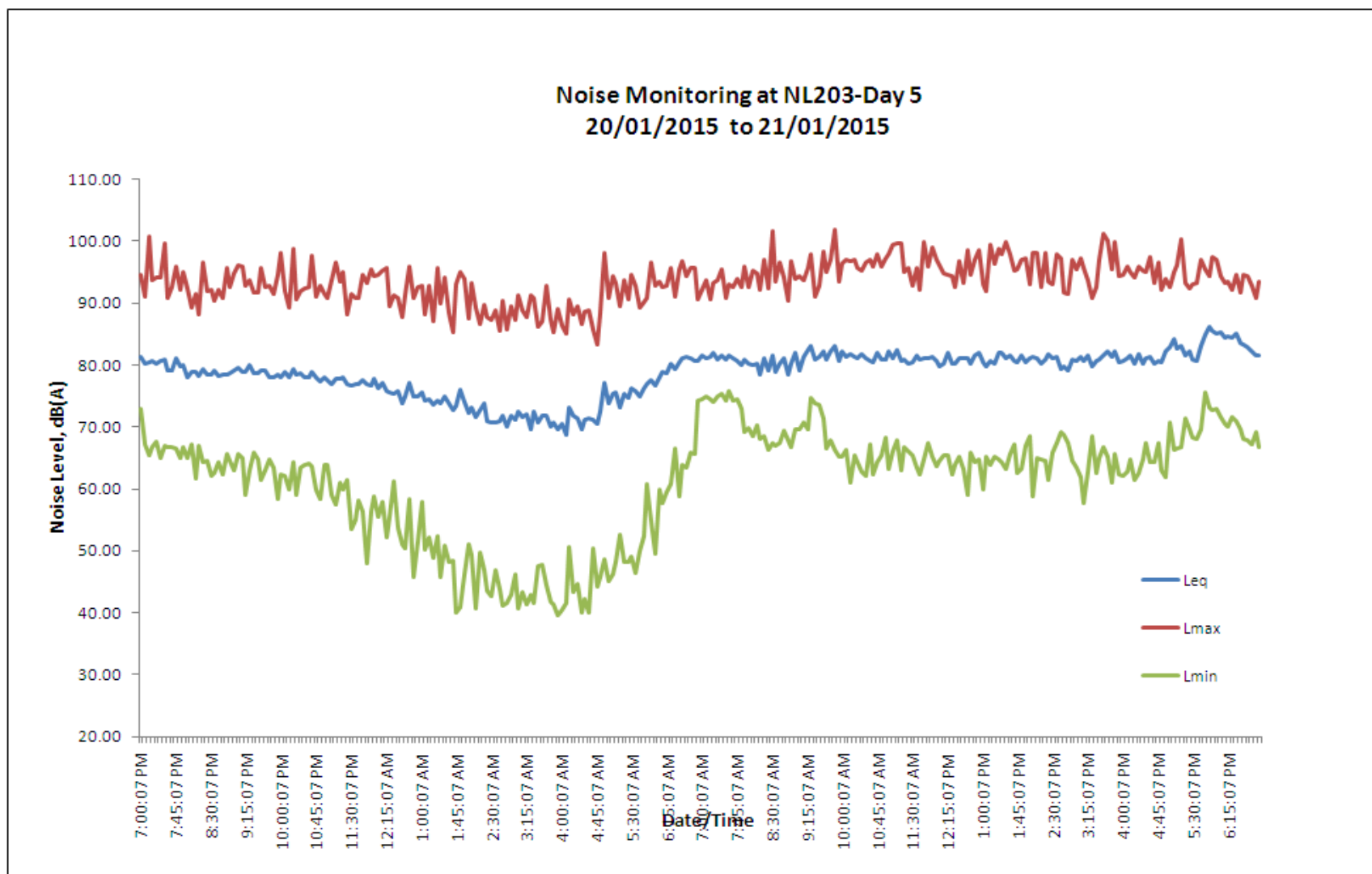


**Figure 97: Daily noise level measured at Point NL203\_R2 (Day 3)**

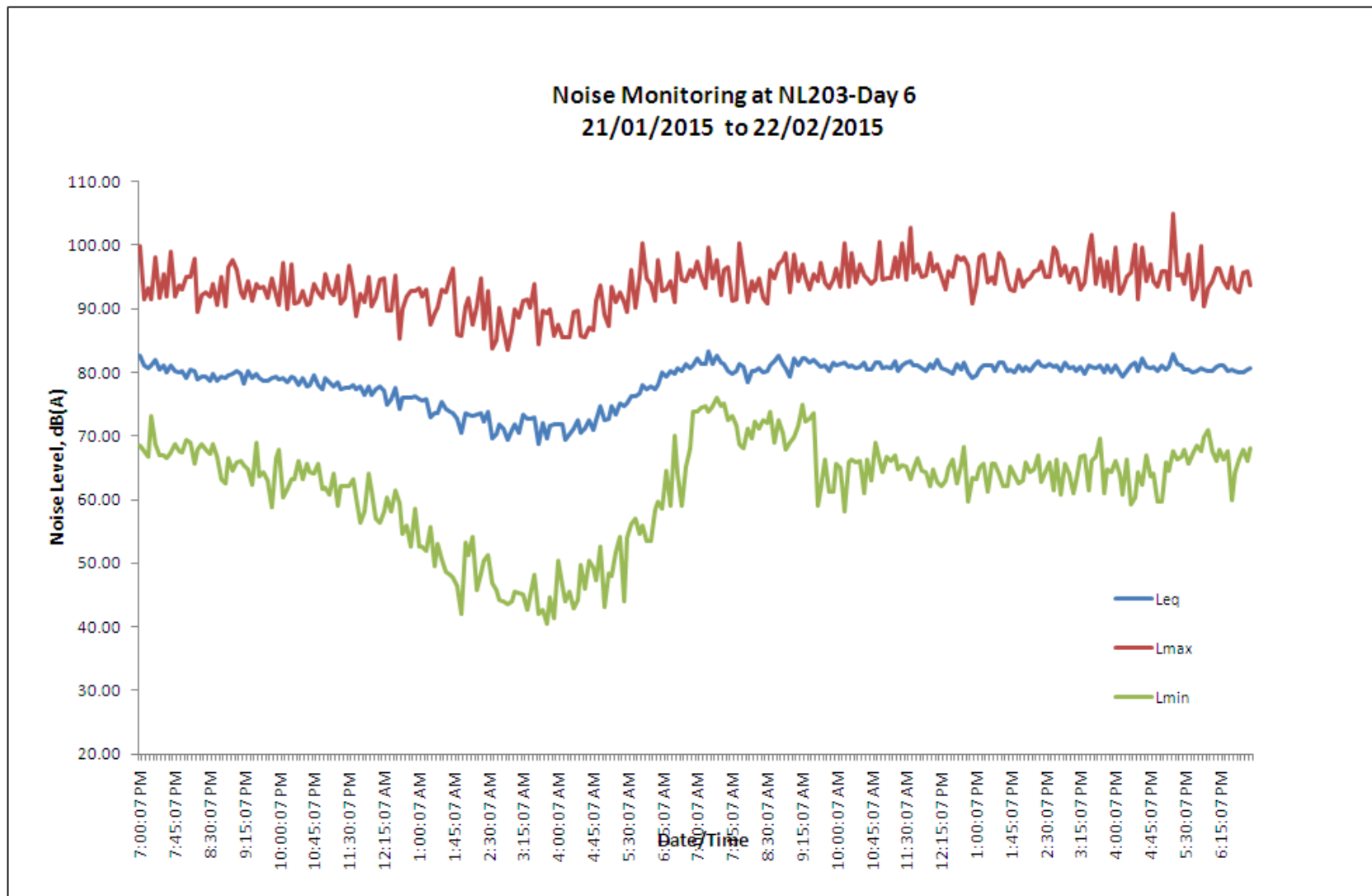




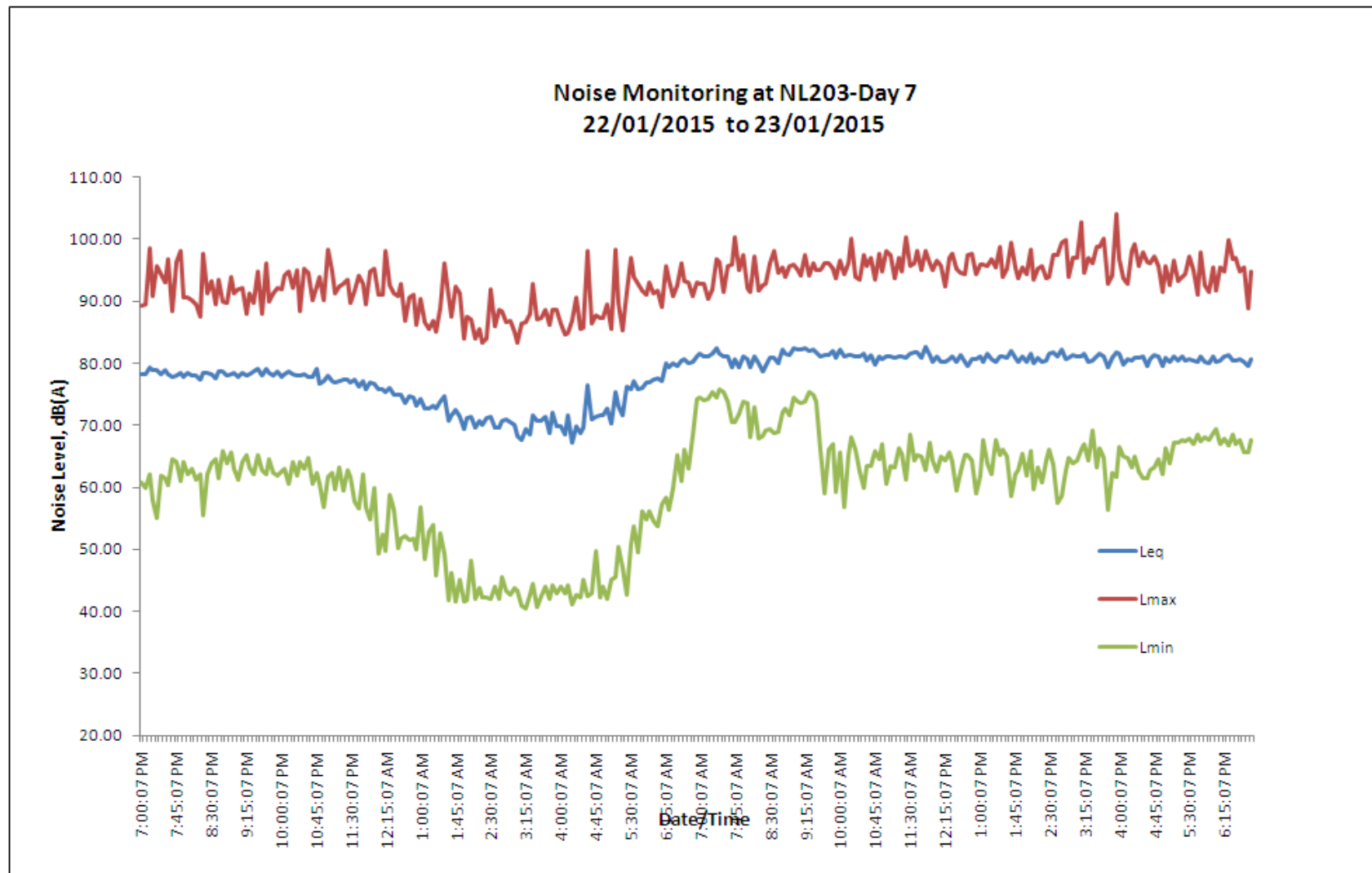
**Figure 98: Daily noise level measured at Point NL203\_R2 (Day 4)**



**Figure 99: Daily noise level measured at Point NL203\_R2 (Day 5)**



**Figure 100: Daily noise level measured at Point NL203\_R2 (Day 6)**



**Figure 101: Daily noise level measured at Point NL203\_R2 (Day 7)**

**Table 129: Summary of results for short term noise level measurement ( $L_{max}$ ,  $L_{Aeq}$  &  $L_{90}$ ) over 15 minutes**

Monitoring Point	Date	Weekend / Weekday	Peak Hour						Off-Peak Hour						Noise Source
			Time		Noise Level, dB(A)			Time		Noise Level, dB(A)					
			Start	Stop	L <sub>max</sub>	L <sub>Aeq</sub>	L <sub>90</sub>	Start	Stop	L <sub>max</sub>	L <sub>Aeq</sub>	L <sub>90</sub>			
NL102_R2	31/01/15	Weekend	1044	1100	81.5	56.4	43.3	1205	1220	65.5	48.9	40.7	Insect Noise, Human Activities (jogging and jungle tracking, Day 6)		
	30/01/15	Weekday	1500	1515	83.9	54.0	40.4	-	-	-	-	-	Army aircraft passing overhead(Day 5) , Insect Noise, Human Activities		
	28/01/15		-	-	-	-	-	1410	1425	76.7	49.9	45.4			
NL201_R2	17/01/15	Weekend	1205	1220	90.2	74.9	63.2	1140	1155	88.7	74.7	64.2	Traffic Noise From Upper Thomson Road, Human Activities		
	19/01/15	Weekday	1800	1815	87.1	73.0	62.9	1744	1759	85.9	72.1	63.0			
NL202_R2	17/01/15	Weekend	1250	1305	73.2	65.3	62.4	1030	1045	76.5	64.8	60.9	Traffic noise (vehicles) from Thomson Road and Lornie road		
	19/01/15	Weekday	1825	1840	80.5	65.5	62.2	1520	1535	75.3	64.4	61.1	Traffic noise (vehicles) from Thomson Road and Lornie road.		
NL203_R2	17/01/15	Weekend	1325	1340	94.6	78.6	71.1	1100	1115	90.3	78.3	70.7	Traffic noise (vehicles) from Lornie road		
	19/01/15	Weekday	1842	1858	97.8	78.5	73.3	1545	1600	96.9	77.5	69.9			



**Table 130: Summary of noise level (NL101\_R2)**

Category of Noise Regulated Period	Period	DAY 1	DAY 2 (weekend)	DAY 3 (weekend)	DAY 4	DAY 5	DAY 6	DAY 7
*12 hours	7am-7pm	X	√	√	X	X	X	X
	7pm-7am	X	X	X	X	X	X	X
*5 minutes	7am-7pm	√	√	√	√	√	√	√
	7pm-10pm	X	X	X	X	X	X	X
	10pm-7am	X	X	X	X	X	X	X
*1 hour	7am-7pm	NA	NA	NA	NA	NA	NA	NA
	7pm-8pm	NA	NA	NA	NA	NA	NA	NA
	8pm-9pm	NA	NA	NA	NA	NA	NA	NA
	9pm-10pm	NA	NA	NA	NA	NA	NA	NA
	10pm-11pm	NA	NA	NA	NA	NA	NA	NA
	11pm-12pm	NA	NA	NA	NA	NA	NA	NA
	12pm-1am	NA	NA	NA	NA	NA	NA	NA
	1am-2am	NA	NA	NA	NA	NA	NA	NA
	2am-3am	NA	NA	NA	NA	NA	NA	NA
	3am-4am	NA	NA	NA	NA	NA	NA	NA
	4am-5am	NA	NA	NA	NA	NA	NA	NA
	5am-6am	NA	NA	NA	NA	NA	NA	NA
	6am-7am	NA	NA	NA	NA	NA	NA	NA

**Note:** \*Environmental Protection & Management Act – Environmental Protection & Management (Control of Noise at Construction Sites) Regulations, 2011 Revised Ed

N/A denote Not Applicable

√ denote Within Limit

X denote Exceed Limit

**Table 131: Summary of noise level (NL102\_R2)**

Category of Noise Regulated Period	Period	DAY 1	DAY 2	DAY 3	DAY 4	DAY 5 (weekend)	DAY 6 (weekend)	DAY 7
*12 hours	7am-7pm	√	√	√	√	√	√	√
	7pm-7am	X	X	√	√	X	X	√
*5 minutes	7am-7pm	√	√	√	√	√	√	√
	7pm-10pm	√	X	√	√	√	√	√
	10pm-7am	√	√	√	√	√	√	√
*1 hour	7am-7pm	NA	NA	NA	NA	NA	NA	NA
	7pm-8pm	NA	NA	NA	NA	NA	NA	NA
	8pm-9pm	NA	NA	NA	NA	NA	NA	NA
	9pm-10pm	NA	NA	NA	NA	NA	NA	NA
	10pm-11pm	NA	NA	NA	NA	NA	NA	NA
	11pm-12pm	NA	NA	NA	NA	NA	NA	NA
	12pm-1am	NA	NA	NA	NA	NA	NA	NA
	1am-2am	NA	NA	NA	NA	NA	NA	NA
	2am-3am	NA	NA	NA	NA	NA	NA	NA
	3am-4am	NA	NA	NA	NA	NA	NA	NA
	4am-5am	NA	NA	NA	NA	NA	NA	NA
	5am-6am	NA	NA	NA	NA	NA	NA	NA
	6am-7am	NA	NA	NA	NA	NA	NA	NA

**Note:** \*Environmental Protection & Management Act – Environmental Protection & Management (Control of Noise at Construction Sites) Regulations, 2011 Revised Ed

N/A denote Not Applicable

√ denote Within Limit

X denote Exceed Limit

**Table 132: Summary of noise level (NL103\_R2)**

Category of Noise Regulated Period	Period	DAY 1	DAY 2	DAY 3	DAY 4	DAY 5 (weekend)	DAY 6 (weekend)	DAY 7
*12 hours	7am-7pm	√	√	√	√	√	√	√
	7pm-7am	X	√	X	√	√	X	√
*5 minutes	7am-7pm	√	√	√	√	√	√	√
	7pm-10pm	X	√	√	√	√	√	√
	10pm-7am	√	√	√	√	√	√	√
*1 hour	7am-7pm	NA	NA	NA	NA	NA	NA	NA
	7pm-8pm	NA	NA	NA	NA	NA	NA	NA
	8pm-9pm	NA	NA	NA	NA	NA	NA	NA
	9pm-10pm	NA	NA	NA	NA	NA	NA	NA
	10pm-11pm	NA	NA	NA	NA	NA	NA	NA
	11pm-12pm	NA	NA	NA	NA	NA	NA	NA
	12pm-1am	NA	NA	NA	NA	NA	NA	NA
	1am-2am	NA	NA	NA	NA	NA	NA	NA
	2am-3am	NA	NA	NA	NA	NA	NA	NA
	3am-4am	NA	NA	NA	NA	NA	NA	NA
	4am-5am	NA	NA	NA	NA	NA	NA	NA
	5am-6am	NA	NA	NA	NA	NA	NA	NA
	6am-7am	NA	NA	NA	NA	NA	NA	NA

**Note:** \*Environmental Protection & Management Act – Environmental Protection & Management (Control of Noise at Construction Sites) Regulations, 2011 Revised Ed

N/A denote Not Applicable

√ denote Within Limit

X denote Exceed Limit

**Table 133: Summary of noise level (NL104\_R2)**

Category of Noise Regulated Period	Period	DAY 1	DAY 2	DAY 3	DAY 4	DAY 5 (weekend)	DAY 6 (weekend)	DAY 7
*12 hours	7am-7pm	√	√	√	√	√	√	√
	7pm-7am	√	√	√	√	√	√	√
*5 minutes	7am-7pm	√	√	√	√	√	√	√
	7pm-10pm	√	√	√	√	√	√	√
	10pm-7am	√	√	√	√	√	√	√
*1 hour	7am-7pm	NA	NA	NA	NA	NA	NA	NA
	7pm-8pm	NA	NA	NA	NA	NA	NA	NA
	8pm-9pm	NA	NA	NA	NA	NA	NA	NA
	9pm-10pm	NA	NA	NA	NA	NA	NA	NA
	10pm-11pm	NA	NA	NA	NA	NA	NA	NA
	11pm-12pm	NA	NA	NA	NA	NA	NA	NA
	12pm-1am	NA	NA	NA	NA	NA	NA	NA
	1am-2am	NA	NA	NA	NA	NA	NA	NA
	2am-3am	NA	NA	NA	NA	NA	NA	NA
	3am-4am	NA	NA	NA	NA	NA	NA	NA
	4am-5am	NA	NA	NA	NA	NA	NA	NA
	5am-6am	NA	NA	NA	NA	NA	NA	NA
	6am-7am	NA	NA	NA	NA	NA	NA	NA

**Note:** \*Environmental Protection & Management Act – Environmental Protection & Management (Control of Noise at Construction Sites) Regulations, 2011 Revised Ed

N/A denote Not Applicable

√ denote Within Limit

X denote Exceed Limit

**Table 134: Summary of noise level (NL201\_R2)**

Category of Noise Regulated Period	Period	DAY 1	DAY 2 (weekend)	DAY 3 (weekend)	DAY 4	DAY 5	DAY 6	DAY 7
*12 hours	7am-7pm	X	√	√	X	X	X	X
	7pm-7am	NA	NA	NA	NA	NA	NA	NA
*5 minutes	7am-7pm	√	√	√	√	√	√	√
	7pm-10pm	X	X	X	X	X	X	X
	10pm-7am	X	X	X	X	X	X	X
*1 hour	7am-7pm	NA	NA	NA	NA	NA	NA	NA
	7pm-8pm	X	X	NA	X	X	X	X
	8pm-9pm	X	X	NA	X	X	X	X
	9pm-10pm	X	X	NA	X	X	X	X
	10pm-11pm	X	X	NA	X	X	X	X
	11pm-12pm	X	X	NA	X	X	X	X
	12pm-1am	X	X	NA	X	X	X	X
	1am-2am	X	X	NA	X	X	X	X
	2am-3am	X	X	NA	X	X	X	X
	3am-4am	X	X	NA	X	X	X	X
	4am-5am	X	X	NA	X	X	X	X
	5am-6am	X	X	NA	X	X	X	X
	6am-7am	X	X	NA	X	X	X	X

**Note:** \*Environmental Protection & Management Act – Environmental Protection & Management (Control of Noise at Construction Sites) Regulations, 2011 Revised Ed

N/A denote Not Applicable

√ denote Within Limit

X denote Exceed Limit



**Table 135: Summary of noise level (NL202\_R2)**

Category of Noise Regulated Period	Period	DAY 1	DAY 2 (weekend)	DAY 3 (weekend)	DAY 4	DAY 5	DAY 6	DAY 7
*12 hours	7am-7pm	√	√	√	√	√	√	√
	7pm-7am	NA	NA	NA	NA	NA	NA	NA
*5 minutes	7am-7pm	√	√	√	√	√	√	√
	7pm-10pm	√	X	X	√	√	√	√
	10pm-7am	X	X	X	X	X	X	X
*1 hour	7am-7pm	NA	NA	NA	NA	NA	NA	NA
	7pm-8pm	X	√	NA	X	X	X	X
	8pm-9pm	√	√	NA	√	√	X	X
	9pm-10pm	√	√	NA	√	√	X	X
	10pm-11pm	X	X	NA	X	X	X	X
	11pm-12pm	X	X	NA	X	X	X	X
	12pm-1am	X	X	NA	X	X	X	X
	1am-2am	X	X	NA	X	X	X	X
	2am-3am	X	X	NA	X	X	X	X
	3am-4am	X	X	NA	X	√	X	X
	4am-5am	X	X	NA	√	√	X	X
	5am-6am	X	X	NA	X	X	X	X
	6am-7am	X	X	NA	X	X	X	X

**Note:** \*Environmental Protection & Management Act – Environmental Protection & Management (Control of Noise at Construction Sites) Regulations, 2011 Revised Ed

N/A denote Not Applicable

√ denote Within Limit

X denote Exceed Limit

**Table 136: Summary of noise level (NL203\_R2)**

Category of Noise Regulated Period	Period	DAY 1	DAY 2 (weekend)	DAY 3 (weekend)	DAY 4	DAY 5	DAY 6	DAY 7
*12 hours	7am-7pm	X	X	X	X	X	X	X
	7pm-7am	NA	NA	NA	NA	NA	NA	NA
*5 minutes	7am-7pm	√	√	X	√	√	√	√
	7pm-10pm	X	X	X	X	X	X	X
	10pm-7am	X	X	X	X	X	X	X
*1 hour	7am-7pm	NA	NA	NA	NA	NA	NA	NA
	7pm-8pm	X	X	NA	X	X	X	X
	8pm-9pm	X	X	NA	X	X	X	X
	9pm-10pm	X	X	NA	X	X	X	X
	10pm-11pm	X	X	NA	X	X	X	X
	11pm-12pm	X	X	NA	X	X	X	X
	12pm-1am	X	X	NA	X	X	X	X
	1am-2am	X	X	NA	X	X	X	X
	2am-3am	X	X	NA	X	X	X	X
	3am-4am	X	X	NA	X	X	X	X
	4am-5am	X	X	NA	X	X	X	X
	5am-6am	X	X	NA	X	X	X	X
	6am-7am	X	X	NA	X	X	X	X

**Note:** \*Environmental Protection & Management Act – Environmental Protection & Management (Control of Noise at Construction Sites) Regulations, 2011 Revised Ed

N/A denote Not Applicable

√ denote Within Limit

X denote Exceed Limit

## 7.0 EVALUATION & DISCUSSION

In general, the results obtained were in compliance with the National Environment Agency's (NEA) Environmental Protection & Management Act – Environmental Protection & Management (Control of Noise at Construction Sites) Regulations, 2011 Revised Ed except periods listed in the tables below:

No. of Rounds	Category of Noise Regulated Period	Period	NL101	NL102	NL103
<b>First round of survey (R1)</b>	*12 hours	7am-7pm	Day 1 - 7	Day 1,2,3 & 6	Day 1,3 & 6
		7pm-7am	Day 1 - 7	Day 1,2,4,5,6 & 7	Day 1,2 & 7
	*5 Minutes	7am-7pm	-	-	-
		7pm-10pm	Day 1 - 7	Day 1,2,4,5 & 7	Day 1,2 & 7
		10pm-7am	Day 1 - 7	Day 7	-
	*1 hour	7am-7pm	N.A	N.A	N.A
		7pm-7am	N.A	N.A	N.A
<b>Second round of survey (R2)</b>	*12 hours	7am-7pm	Day 1,4,5,6 & 7	-	-
		7pm-7am	Day 1 - 7	Day 1,2,5 & 6	Day 1,3 & 6
	*5 Minutes	7am-7pm	-	-	-
		7pm-10pm	Day 1 - 7	Day 2	Day 1
		10pm-7am	Day 1 - 7	-	-
	*1 hour	7am-7pm	N.A	N.A	N.A
		7pm-7am	N.A	N.A	N.A
<b>*Limit of Affected Hospitals, schools, institutions of higher learning, homes for the aged sick, etc.</b>					

Category of Noise Regulated Period	Period	Round 1 of Survey	Round 2 of Survey
		NL104_R1	NL104_R2
*12 hours	7am-7pm	-	-
	7pm-7am	-	-
*5 Minutes	7am-7pm	-	-
	7pm-10pm	-	-
	10pm-7am	-	-
*1 hour	7am-7pm	N.A	N.A
	7pm-7am	N.A	N.A
<b>*Limit of Affected Buildings (other than those above)</b>			

No. of Rounds	Category of Noise Regulated Period	Period	NL201	NL202	NL203
<b>First round of survey (R1)</b>	*12 hours	7am-7pm	Day 1,3,4,5 & 7	-	Day 1-7
		7pm-7am	N.A	N.A	N.A
	*5 Minutes	7am-7pm	Day 3	-	Day 5 & 6
		7pm-10pm	Day 1-7	Day 2, 4 & 5	Day 1-7
		10pm-7am	Day 1-7	Day 1-7	Day 1-7
	*1 hour	7am-7pm	N.A	N.A	N.A
		7pm-7am	Day 1,2,4,5,6 & 7	Day 1,2,3,4, 6 & 7	Day 1,2,3,4,5 & 7
<b>Second round of survey (R2)</b>	*12 hours	7am-7pm	Day 1,4,5,6 & 7	-	Day 1-7
		7pm-7am	N.A	N.A	N.A
	*5 Minutes	7am-7pm	-	-	Day 2 (7am-7pm) & 3
		7pm-10pm	Day 1-7	Day 2 & 3	Day 1-7
		10pm-7am	Day 1-7	Day 1-7	Day 1-7
	*1 hour	7am-7pm	N.A	N.A	N.A
		7pm-7am	Day 1,2,4,5,6 & 7	Day 1(except 2000-2200), Day 2 (except 1900-2200), Day4(except 2000-2200)& (0400-0500), Day5(except 2000-2200)& (0300-0500) Day6 & Day 7	Day 1,2,4,5,6 & 7

**\*Limit of Affected Residential Buildings Located Less Than 150m From Construction site where the noise is being emitted**

From the graphs we can observe the daily noise pattern of 7 days continuous of monitoring at all points. As NL101, NL201, NL202 and NL203 are located near to the major roadside/expressway hence the major noise source for these locations is mainly from vehicular noise. Therefore, similar graph patterns are observed from these four locations. And among the four locations, NL201 and NL203 have shown higher noise level and this is probably due to high traffic volume from these major roads (as per tabulated in Table 4 and Table 62).

On another note, NL102 & NL103 (which are located inside the Central Catchment Nature Reserve) and NL104 (which is located at Island Club Road) have shown fluctuation of noise pattern at the period of 7am-7pm. And this is probably due to human activities (jogging and jungle tracking). Other activities such as army shooting training and army aircraft passing over head have also been observed during site checking for NL102 and NL103. In addition, the predominant noise source for NL104 would probably be the vehicular noise along the Island Club Road. Insect noise is probably the main noise source during the period of 7pm-7am and a quite constant of noise pattern was observed during this period of time for these three locations.

In general, noise level obtained from Round 1 (monitoring period: Nov 14-Dec 14) is slightly higher than Round 2 (monitoring period: Jan 15-Feb 15) at most locations. In our opinion, this is probably due to the rainfall season during December period.

In conclusion, monitoring of the baseline noise level of these points is recommended when the construction work is commenced. This exercise will help to determine the presence of any nuisance noise contribution on their daily operations and activities to their immediate neighbouring occupants on site.

It should be noted that this study is based upon relevant information gathered during the execution of this project and reflected our findings at the date/time and locations sampled.

## **8.0 REFERENCES**

**National Environment Agency's (NEA) Environmental Protection & Management Act –** Environmental Protection & Management (Control of Noise at Construction Sites) Regulations, 2011 Revised Ed.


**Quest Technologies** SoundPro Models SE/DL User Manual



# APPENDIX 1

## CALIBRATION CERTIFICATION OF FIELD EQUIPMENT

ATS - ENV - 421 Q



**LEE HUNG TEST SERVICES PTE LTD**  
(Sister company of Lee Hung Scientific Pte Ltd)  
Business Reg. No. 200207853M

**Certificate of Calibration**

Page 1 of 3

Certificate No. : 14/03/136  
Submitted by : ALS TECHNICHEM (S) PTE LTD  
121 GENTING LANE,  
#04-01 ALS BUILDING,  
SINGAPORE 349572

Date Submitted : 18 Mar 2014  
Date of Calibration : 27 Mar 2014

**Description of Equipment :**

Subject : SOUND LEVEL METER TYPE 1  
Brand : QUEST  
Model No. : SOUNDPRO DL-1-1/1  
Serial No. : BKM030003  
Sub-Assemblies : B & K 4936 2752680

**Ambient conditions :**

Ambient Temp. : (23 ± 3) °C  
Relative Humidity : (50 ± 10) %R.H.  
Pressure : (1006.0 ± 4.0) hPa

The above-mentioned product/equipment has been calibrated at LHTS Lab under the ambient conditions stated above for conformity with certain specifications as laid down in the calibration procedure.

**Method of Calibration**

The method of calibration is Calibration Procedure : LHT-WI-CAL-S11 REV 7, generally as recommended by manufacturer. The calibration was carried out with reference to the following calibration and measurement standards which are traceable to the following below:


Instrument	Serial Number	Cal. Report	Due Date
1. QUEST-CAL	S/N KZE040001	AL000410	NMC(SG) 12 Dec 14
2. 9004 GLOBAL MULTI TESTER	S/N 0229007	RL000425	NMC (SG) 07 May 14
3. HEWLETT PACKARD ATTENUATOR	S/N 1250J01894	RL000424	NMC(SG) 06 May 14


**Results of Calibration**

The results of the calibration are given on the Calibration Report as per attached.  
The expanded uncertainties of measurement stated in this report are estimated at a level of confidence of approximately 95% with a coverage factor k=2.

The results of the above-mentioned instrument shown in the Calibration Report does not cover the full parameters of the Sound Level Meter. The user should determine the suitability of this instrument for its intended use.


\* Recommended Next Calibration Date: 26 Mar 2015  
\* This is only a suggested date, the recalibration interval should be determined based on the user's requirements.

Calibrated By,   
Ryan Zhou Ran  
Calibration Officer

Reviewed By,   
Gavino delos Reyes  
Senior Service Engineer

This report must not be reproduced except in full, without the written approval of Lee Hung Test Services Pte Ltd.  
This set of Certificate is not a Certificate of Quality. It only applies to the specific product/ equipment given at the time of its testing/ calibration. The results shall not be used to indicate or imply that they are applicable to other similar terms.

50 Bukit Batok Street 23 #05-10/11/12/13/14 Midview Building Singapore 659578  
Tel: +65 6560 6903 Fax: +65 6567 6909  
E-mail: service@leehung.com Website: http://www.leehung.com





# LEE HUNG TEST SERVICES PTE LTD

(Sister company of Lee Hung Scientific Pte Ltd)

Business Reg. No. 200207853M

## Certificate of Calibration

Page 1 of 3

Certificate No. : 14/03/048  
Submitted by : ALS TECHNICHEM (S) PTE LTD  
121 GENTING LANE,  
#04-01 ALS BUILDING,  
SINGAPORE 349572

Date Submitted : 10 Mar 2014  
Date of Calibration : 14 Mar 2014

### Description of Equipment :

Subject : SOUND LEVEL METER TYPE 1  
Brand : QUEST  
Model No. : SOUNDPRO DL-1  
Serial No. : BJL080024  
Sub-Assemblies : B & K 4936 2785695

### Ambient conditions :

Ambient Temp. : (23 ± 3) °C  
Relative Humidity : (50 ± 10) %R.H.  
Pressure : (1006.0 ± 4.0) hPa

The above-mentioned product/equipment has been calibrated at LHTS Lab under the ambient conditions stated above for conformity with certain specifications as laid down in the calibration procedure.

### Method of Calibration

The method of calibration is Calibration Procedure : LHT-WI-CAL-S11 REV 7, generally as recommended by manufacturer. The calibration was carried out with reference to the following calibration and measurement standards which are traceable to the following below:

Instrument	Serial Number	Cal. Report		Due Date
1. QUEST-CAL	S/N KZE040001	AL000410	NMC(SG)	12 Dec 14
2. 9004 GLOBAL MULTI TESTER	S/N 0229007	RL000425	NMC (SG)	07 Apr 14
3. HEWLETT PACKARD ATTENUATOR	S/N 1250J01894	RL000424	NMC(SG)	06 May 14

### Results of Calibration

The results of the calibration are given on the Calibration Report as per attached.

The expanded uncertainties of measurement stated in this report are estimated at a level of confidence of approximately 95% with a coverage factor k=2.

The results of the above-mentioned instrument shown in the Calibration Report does not cover the full parameters of the Sound Level Meter. The user should determine the suitability of this instrument for its intended use.

\* Recommended Next Calibration Date: 13 Mar 2015

\* This is only a suggested date, the recalibration interval should be determined based on the user's requirements.

Calibrated By,

Ryan Zhou Ran  
Calibration Officer

Reviewed By,

Gavino delos Reyes  
Senior Service Engineer

This report must not be reproduced except in full, without the written approval of Lee Hung Test Services Pte Ltd.  
This set of Certificate is not a Certificate of Quality. It only applies to the specific product/ equipment given at the time of its testing/ calibration. The results shall not be used to indicate or imply that they are applicable to other similar terms.

50 Bukit Batok Street 23 #05-10/11/12/13/14 Midview Building Singapore 659578  
Tel: +65 6560 6903 Fax: +65 6567 6909  
E-mail: service@leehung.com Website: http://www.leehung.com





# LEE HUNG TEST SERVICES PTE LTD

(Sister company of Lee Hung Scientific Pte Ltd)

Business Reg. No. 200207853M

## Certificate of Calibration

Page 1 of 3

Certificate No. : 14/03/137  
Submitted by : ALS TECHNICHEM (S) PTE LTD  
121 GENTING LANE,  
#04-01 ALS BUILDING,  
SINGAPORE 349572

Date Submitted : 18 Mar 2014  
Date of Calibration : 27 Mar 2014

### Description of Equipment :

Subject : SOUND LEVEL METER TYPE 1  
Brand : QUEST  
Model No. : SOUNDPRO DL-1  
Serial No. : BJM030015  
Sub-Assemblies : B & K 4936 2785930

### Ambient conditions :

Ambient Temp. : (23 ± 3) °C  
Relative Humidity : (50 ± 10) %R.H.  
Pressure : (1006.0 ± 4.0) hPa

The above-mentioned product/equipment has been calibrated at LHTS Lab under the ambient conditions stated above for conformity with certain specifications as laid down in the calibration procedure.

### Method of Calibration

The method of calibration is Calibration Procedure : LHT-WI-CAL-S11 REV 7, generally as recommended by manufacturer. The calibration was carried out with reference to the following calibration and measurement standards which are traceable to the following below:

Instrument	Serial Number	Cal. Report	Due Date
1. QUEST-CAL	S/N KZE040001	AL000410	NMC(SG) 12 Dec 14
2. 9004 GLOBAL MULTI TESTER	S/N 0229007	RL000425	NMC (SG) 07 May 14
3. HEWLETT PACKARD ATTENUATOR	S/N 1250J01894	RL000424	NMC(SG) 06 May 14


### Results of Calibration

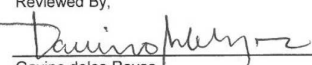
The results of the calibration are given on the Calibration Report as per attached.  
The expanded uncertainties of measurement stated in this report are estimated at a level of confidence of approximately 95% with a coverage factor k=2.

The results of the above-mentioned instrument shown in the Calibration Report does not cover the full parameters of the Sound Level Meter. The user should determine the suitability of this instrument for its intended use.

\* Recommended Next Calibration Date: 26 Mar 2015

\* This is only a suggested date, the recalibration interval should be determined based on the user's requirements.

Calibrated By  
  
Ryan Zhou Ran  
Calibration Officer

Reviewed By  
  
Gavino delos Reyes  
Senior Service Engineer

This report must not be reproduced except in full, without the written approval of Lee Hung Test Services Pte Ltd.  
This set of Certificate is not a Certificate of Quality. It only applies to the specific product/ equipment given at the time of its testing/ calibration. The results shall not be used to indicate or imply that they are applicable to other similar terms.

50 Bukit Batok Street 23 #05-10/11/12/13/14 Midview Building Singapore 659578  
Tel: +65 6560 6903 Fax: +65 6567 6909  
E-mail: service@leehung.com Website: http://www.leehung.com





# LEE HUNG TEST SERVICES PTE LTD

(Sister company of Lee Hung Scientific Pte Ltd)

Business Reg. No. 200207853M

## Certificate of Calibration

Page 1 of 4

Certificate No. : 14/03/049  
Submitted by : ALS TECHNICHEM (S) PTE LTD  
121 GENTING LANE,  
#04-01 ALS BUILDING,  
SINGAPORE 349572

Date Submitted : 10 Mar 2014  
Date of Calibration : 14 Mar 2014

### Description of Equipment :

Subject : SOUND LEVEL METER TYPE 1  
Brand : QUEST  
Model No. : SOUNDPRO DL-1-1/3  
Serial No. : BLK030008  
Sub-Assemblies : B & K 4936 2819034

### Ambient conditions :

Ambient Temp. : (23 ± 3) °C  
Relative Humidity : (50 ± 10) %R.H.  
Pressure : (1006.0 ± 4.0) hPa

The above-mentioned product/equipment has been calibrated at LHTS Lab under the ambient conditions stated above for conformity with certain specifications as laid down in the calibration procedure.

### Method of Calibration

The method of calibration is Calibration Procedure : LHT-WI-CAL-S11 REV 7, generally as recommended by manufacturer. The calibration was carried out with reference to the following calibration and measurement standards which are traceable to the following below:

Instrument	Serial Number	Cal. Report		Due Date
1. QUEST-CAL	S/N KZE040001	AL000410	NMC(SG)	12 Dec 14
2. 9004 GLOBAL MULTI TESTER	S/N 0229007	RL000425	NMC (SG)	07 Apr 14
3. HEWLETT PACKARD ATTENUATOR	S/N 1250J01894	RL000424	NMC(SG)	06 May 14

### Results of Calibration

The results of the calibration are given on the Calibration Report as per attached.

The expanded uncertainties of measurement stated in this report are estimated at a level of confidence of approximately 95% with a coverage factor k=2.

The results of the above-mentioned instrument shown in the Calibration Report does not cover the full parameters of the Sound Level Meter. The user should determine the suitability of this instrument for its intended use.

\* Recommended Next Calibration Date: 13 Mar 2015

\* This is only a suggested date, the recalibration interval should be determined based on the user's requirements.

Calibrated By,

Ryan Zhou Ran  
Calibration Officer

Reviewed By,

Gavino delos Reyes  
Senior Service Engineer

This report must not be reproduced except in full, without the written approval of Lee Hung Test Services Pte Ltd. This set of Certificate is not a Certificate of Quality. It only applies to the specific product/ equipment given at the time of its testing/ calibration. The results shall not be used to indicate or imply that they are applicable to other similar terms.



50 Bukit Batok Street 23 #05-10/11/12/13/14 Midview Building Singapore 659578  
Tel: +65 6560 6903 Fax: +65 6567 6909  
E-mail: service@leehung.com Website: http://www.leehung.com

3M Oconomowoc  
Personal Safety Division

3M Detection Solutions  
1060 Corporate Center Drive  
Oconomowoc, WI 53066-4828  
www.3M.com/detection  
262 567 9157 800 245 0779  
262 567 4047 Fax

An ISO 9001  
Registered Company

ATD-BAY-494Q



## Certificate of Calibration

Certificate Number: 1410271124BJN100031

Model: SoundPro SP DL-1

Date Issued: 27-Oct-2014

S/N: BJN100031

On this day of manufacture and calibration, 3M certifies that the above listed product meets or exceeds the performance requirements of the following acoustic standard(s):

ANSI S1.4 1983 (R 2006) - Specification for Sound Level Meters / Type 1  
ANSI S1.43 1997 (R 2007) - Specification for Integrating - Averaging Sound Level Meters / Type 1  
IEC 61672-1 (2002) - Electro acoustics - Sound Level Meters - Part 1: Specifications / Class 1

Test Conditions: Temp: 18-25°C Humidity: 20-80% R.H. Barometric Pressure: 950-1050 mBar

Test Procedure: S053-899

### Subassemblies:

B&K 4936	2861247
SPro Preamp	10140083

### Reference Standard(s):

Device	Ref Standard Cal Due	Uncertainty - Estimated at 95% Confidence Level (k=2)
B&K Ensemble	1/23/2015	+/- 2.2% Acoustic (0.19dB)
Fluke 45	2/20/2015	+/- 1.4% AC Voltage, +/- 0.1% DC Voltage

Calibrated By:

  
Janet Pompe - Assembler

In order to maintain best instrument performance over time, and in the event of inspection, audit or litigation, we recommend the instrument be recalibrated annually. Any number of factors may cause the calibration to drift before the recommended interval has expired.  
See user manual for more information.

All equipment used in the test and calibration of this instrument is traceable to NIST, and applies only to the unit identified above.  
This report must not be reproduced, except in its entirety, without the written approval of 3M.



3M Oconomowoc  
Personal Safety Division

3M Detection Solutions  
1060 Corporate Center Drive  
Oconomowoc, WI 53066-4828  
www.3M.com/detection  
262 567 9157 800 245 0779  
262 567 4047 Fax

An ISO 9001  
Registered Company

ATS-ENV-4950



## Certificate of Calibration

Certificate Number: 1410271125BJN100032

Model: SoundPro SP DL-1

Date Issued: 27-Oct-2014

S/N: BJN100032

On this day of manufacture and calibration, 3M certifies that the above listed product meets or exceeds the performance requirements of the following acoustic standard(s):

ANSI S1.4 1983 (R 2006) - Specification for Sound Level Meters / Type 1

ANSI S1.43 1997 (R 2007) - Specification for Integrating - Averaging Sound Level Meters / Type 1

IEC 61672-1 (2002) - Electro acoustics - Sound Level Meters - Part 1: Specifications / Class 1

Test Conditions: Temp: 18-25°C Humidity: 20-80% R.H. Barometric Pressure: 950-1050 mBar

Test Procedure: S053-899

### Subassemblies:

B&K 4936	2861257
SPro Preamp	10140088

### Reference Standard(s):

Device	Ref Standard Cal Due	Uncertainty - Estimated at 95% Confidence Level (k=2)
B&K Ensemble	1/23/2015	+/- 2.2% Acoustic (0.19dB)
Fluke 45	2/20/2015	+/- 1.4% AC Voltage, +/- 0.1% DC Voltage

Calibrated By:

  
Janet Pompe - Assembler

In order to maintain best instrument performance over time, and in the event of inspection, audit or litigation, we recommend the instrument be recalibrated annually. Any number of factors may cause the calibration to drift before the recommended interval has expired.  
See user manual for more information.

All equipment used in the test and calibration of this instrument is traceable to NIST, and applies only to the unit identified above.  
This report must not be reproduced, except in its entirety, without the written approval of 3M.



# LEE HUNG TEST SERVICES PTE LTD

(Sister company of Lee Hung Scientific Pte Ltd)  
Business Reg. No. 200207853M

ATS-ENV-2630

## Certificate of Calibration

Page 1 of 3

Certificate No. : 14/09/065  
Submitted by : ALS TECHNICHEM (S) PTE LTD  
121 GENTING LANE,  
#04-01 ALS BUILDING,  
SINGAPORE 349572

Date Submitted : 11 Sep 2014  
Date of Calibration : 18 Sep 2014

### Description of Equipment :

Subject : SOUND LEVEL METER TYPE 1  
Brand : QUEST  
Model No. : SOUNDPRO DL-1  
Serial No. : BJH050018  
Sub-Assemblies : B & K 4936 2819041

### Ambient conditions :

Ambient Temp. :  $(23 \pm 3) ^\circ\text{C}$   
Relative Humidity :  $(50 \pm 10) \% \text{R.H.}$   
Pressure :  $(1006.0 \pm 4.0) \text{ hPa}$

The above-mentioned product/equipment has been calibrated at LHTS Lab under the ambient conditions stated above for conformity with certain specifications as laid down in the calibration procedure.

### Method of Calibration

The method of calibration is Calibration Procedure : LHT-WI-CAL-S11 REV 7, generally as recommended by manufacturer. The calibration was carried out with reference to the following calibration and measurement standards which are traceable to the following below:

Instrument	Serial Number	Cal. Report	Due Date
1. QUEST-CAL	S/N KZE040001	AL000410	NMC(SG) 12-Dec-14
2. 9004 GLOBAL MULTI TESTER	S/N 0229007	RL000749	NMC (SG) 25-May-15
3. HEWLETT PACKARD ATTENUATOR	S/N 1250J01894	RL000748	NMC(SG) 22-May-15

### Results of Calibration

The results of the calibration are given on the Calibration Report as per attached.  
The expanded uncertainties of measurement stated in this report are estimated at a level of confidence of approximately 95% with a coverage factor  $k=2$ .

The results of the above-mentioned instrument shown in the Calibration Report does not cover the full parameters of the Sound Level Meter. The user should determine the suitability of this instrument for its intended use.

\* Recommended Next Calibration Date: 17 Sep 2015

\* This is only a suggested date, the recalibration interval should be determined based on the user's requirements.

Calibrated By,

Ryan Zhou Ran  
Calibration Officer

Reviewed By,

Gavino delos Reyes  
Senior Service Engineer

This report must not be reproduced except in full, without the written approval of Lee Hung Test Services Pte Ltd.  
This set of Certificate is not a Certificate of Quality. It only applies to the specific product/ equipment given at the time of its testing/ calibration. The results shall not be used to indicate or imply that they are applicable to other similar terms.



50 Bukit Batok Street 23 #05-10/11/12/13/14 Midview Building Singapore 659578

Tel: +65 6560 6903 Fax: +65 6567 6909

E-mail: service@leehung.com Website: http://www.leehung.com

19 Sep 2014

ATS-ENV-345Q



# LEE HUNG TEST SERVICES PTE LTD

(Sister company of Lee Hung Scientific Pte Ltd)

Business Reg. No. 200207853M

## Certificate of Calibration

Page 1 of 4

Certificate No. : 14/03/049  
Submitted by : ALS TECHNICHEM (S) PTE LTD  
121 GENTING LANE,  
#04-01 ALS BUILDING,  
SINGAPORE 349572

Date Submitted : 10 Mar 2014  
Date of Calibration : 14 Mar 2014

### Description of Equipment :

Subject : SOUND LEVEL METER TYPE 1  
Brand : QUEST  
Model No. : SOUNDPRO DL-1-1/3  
Serial No. : BLK030008  
Sub-Assemblies : B & K 4936 2819034

### Ambient conditions :

Ambient Temp. : (23 ± 3) °C  
Relative Humidity : (50 ± 10) %R.H.  
Pressure : (1006.0 ± 4.0) hPa

The above-mentioned product/equipment has been calibrated at LHTS Lab under the ambient conditions stated above for conformity with certain specifications as laid down in the calibration procedure.

### Method of Calibration

The method of calibration is Calibration Procedure : LHT-WI-CAL-S11 REV 7, generally as recommended by manufacturer. The calibration was carried out with reference to the following calibration and measurement standards which are traceable to the following below:

Instrument	Serial Number	Cal. Report		Due Date
1. QUEST-CAL	S/N KZE040001	AL000410	NMC(SG)	12 Dec 14
2. 9004 GLOBAL MULTI TESTER	S/N 0229007	RL000425	NMC (SG)	07 Apr 14
3. HEWLETT PACKARD ATTENUATOR	S/N 1250J01894	RL000424	NMC(SG)	06 May 14


### Results of Calibration


The results of the calibration are given on the Calibration Report as per attached.  
The expanded uncertainties of measurement stated in this report are estimated at a level of confidence of approximately 95% with a coverage factor k=2.

The results of the above-mentioned instrument shown in the Calibration Report does not cover the full parameters of the Sound Level Meter. The user should determine the suitability of this instrument for its intended use.

\* Recommended Next Calibration Date: 13 Mar 2015

\* This is only a suggested date, the recalibration interval should be determined based on the user's requirements.

Calibrated By,   
Ryan Zhou Ran  
Calibration Officer

Reviewed By,   
Gavino delos Reyes  
Senior Service Engineer

This report must not be reproduced except in full, without the written approval of Lee Hung Test Services Pte Ltd.  
This set of Certificate is not a Certificate of Quality. It only applies to the specific product/ equipment given at the time of its testing/ calibration. The results shall not be used to indicate or imply that they are applicable to other similar terms.



50 Bukit Batok Street 23 #05-10/11/12/13/14 Midview Building Singapore 659578  
Tel: +65 6560 6903 Fax: +65 6567 6909  
E-mail: service@leehung.com Website: http://www.leehung.com



## APPENDIX 2

### SITE PHOTO (ROUND 1)



NL101\_R1



NL102\_R1





NL103\_R1



NL104\_R1





NL201\_R1



NL202\_R1



NL203\_R1



## SITE PHOTO (ROUND 2)



NL101\_R2



NL102\_R2





NL103\_R2



NL104\_R2





NL201\_R2



NL202\_R2





NL203\_R2

Vibration



## **GROUND VIBRATION MONITORING**

**Report Prepared by:**

**SETSCO SERVICES PTE LTD  
18, TEBAN GARDENS CRESCENT  
SINGAPORE 608925  
TEL : 65667777  
FAX : 65667718**

**(Business Reg. No. : 196900269D)**

**For:**

**ERM SINGAPORE  
120 Robinson Road  
#10-01  
Singapore 068913**

**ATTN: Ms Rosalind Finney**

### **Terms & Conditions:**

- (1) The Report is prepared for the sole use of the Client and is prepared based upon the item submitted, the Services required by the Client and the conditions under which the Services are performed by SETSCO. The Report is not intended to be representative of similar or equivalent Services on similar equivalent items. The Report does not constitute an endorsement by SETSCO of the item.
- (2) SETSCO agrees to use reasonable diligence in the performance of the Services but no warranties are given and none may be implied directly or indirectly relating to the Services, the Report or the facilities of SETSCO.
- (3) The Report may not be used in any publicity material without the written consent of SETSCO.
- (4) The Report may not be reproduced in part or in full unless approval in writing has been given by SETSCO.
- (5) SETSCO shall under no circumstances be liable to the Client or its agents, servants or representatives, in contract, tort (including negligence or breach of statutory duty) or otherwise for any direct or indirect loss or damage suffered by the client, its agents, servants or representative howsoever arising or whether connected with the Services provided by SETSCO herein.



<b>CONTENT</b>	<b>PAGE NO.</b>
<b>1 Introduction</b>	<b>3</b>
<b>2 Project</b>	<b>3</b>
<b>3 Scope of Measurement</b>	<b>3</b>
<b>4 Objective of Measurement</b>	<b>3</b>
<b>5 Measurement Equipment Specification</b>	<b>3</b>
<b>6 Date of Measurement and Test Locations</b>	<b>3</b>
<b>7 Observation</b>	<b>3</b>
<b>8 Results &amp; Conclusion</b>	<b>4</b>
<b>9 Vibration Data Histogram (Figure 1)</b>	<b>5</b>

**APPENDIX**

**APPENDIX 1 – Vibration Meter Calibration Certificate**

**APPENDIX 2 – Site Photos**



## 1 INTRODUCTION

SETSCO SERVICES PTE LTD was appointed by ERM SINGAPORE to carry out Ambient Ground Vibration Monitoring for VL 101: Jelutong Tower, Central Catchment Nature Reserve.

## 2 PROJECT

Environmental Baseline Survey

## 3 SCOPE OF MEASUREMENT

In this monitoring the evaluation of the ambient ground vibration is based on the maximum values of the three components of the vibration velocity that is Vertical, Longitudinal and Transverse direction {V (z-axis), L (y-axis) and T (x-axis)}. The measurement in three directions would be monitored at location specified in Figure 1. The measurement would be in frequency range of 1Hz to 100Hz, velocity-time domain with a minimum trigger level set at 0.5 mm/s for the Location. The vibration meter was set on continuous and histogram monitoring with readings taken every 5 minutes interval.

## 4 OBJECTIVE OF MEASUREMENT

The objective of this monitoring for VL 101: Jelutong Tower, Central Catchment Nature Reserve was to determine the level of the vibration for environmental baseline survey.

## 5 MEASUREMENT EQUIPMENT SPECIFICATION

The measurement equipment for the vibration test measurements are as follows:-

- INSTANTEL INC Ground Vibration Monitoring Equipment (Vibration Sensor Tri-axial)

## 6 DATE OF MEASUREMENT AND TEST LOCATIONS

The measurements were from 25<sup>th</sup> February 2015 to 26<sup>th</sup> February 2015 for VL 101: Jelutong Tower, Central Catchment Nature Reserve.

## 7 OBSERVATION

Sources of ground vibration observed at this location include people jogging and hiking in this area. Military training was also seen during the set up of the meter. There were also some painting works at the Jelutong Tower.





## 8 RESULTS & CONCLUSION

For the results of the measurement, refer to the vibration measurement data in figure 1. The details of the measurement show the frequency with the corresponding peak particle velocity in Vertical, Longitudinal and Transverse direction. The readings gathered during this monitoring show a very minimum vibration reading.



Figure 1: Location and Direction of measurement



**Figure 1**  
**Vibration Data (Histogram)**

**Event Report**

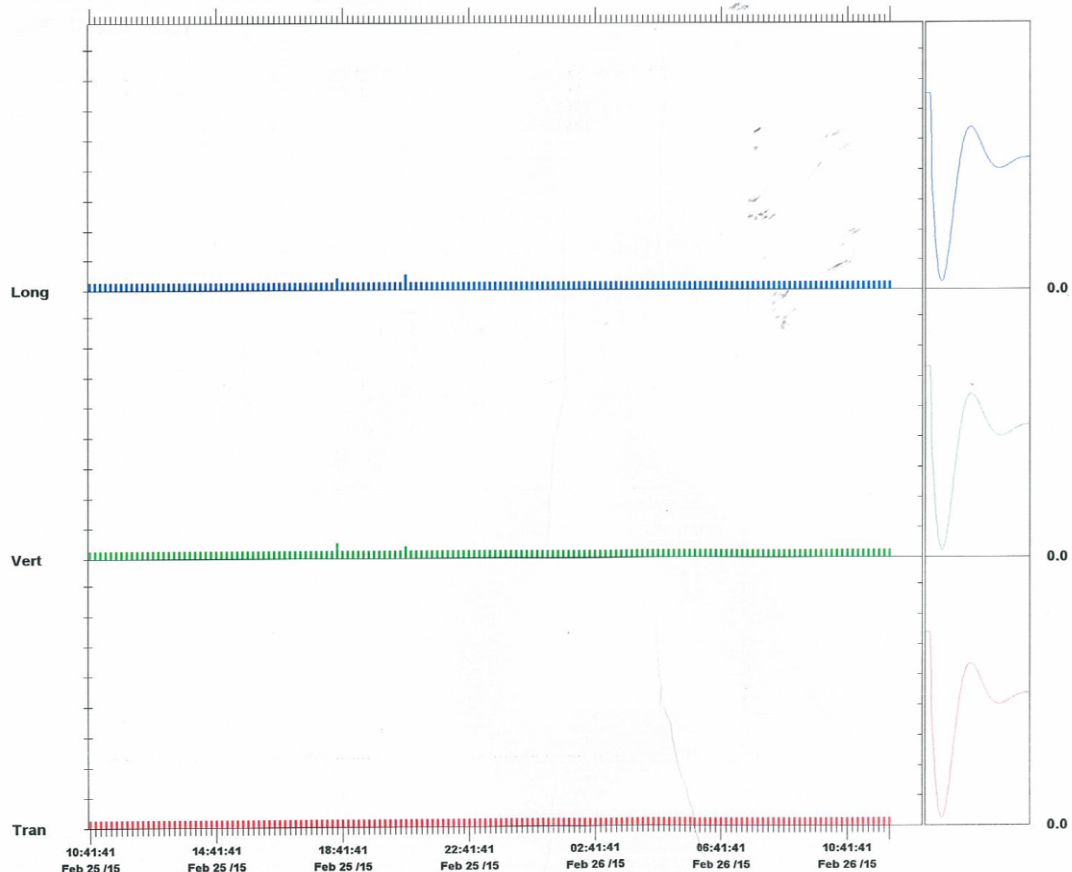
Histogram Start Time 10:31:41 February 25, 2015  
Histogram Finish Time 12:02:22 February 26, 2015  
Number of Intervals 306 at 5 minutes  
Range Geo:254 mm/s  
Sample Rate 1024sps  
Job Number: 1  
Notes  
Location:  
Client:  
User Name:  
General:

Serial Number BE16768 V 10.72-8.17 MiniMate Plus  
Battery Level 6.1 Volts  
Unit Calibration November 20, 2014 by Absolute Instrument Systems  
File Name R768FQHE.KTO

**Extended Notes**

	Tran	Vert	Long	
PPV	0.254	0.508	0.508	mm/s
ZC Freq	>100	>100	85	Hz
Date	Feb 25 /15	Feb 25 /15	Feb 25 /15	
Time	10:36:41	18:31:41	20:41:41	
Sensor Check	Passed	Passed	Passed	
Frequency	7.4	7.3	7.5	Hz
Overswing Ratio	3.9	3.7	3.8	

Peak Vector Sum 0.539 mm/s on February 25, 2015 at 18:31:41



Time Scale: 10 minutes /div Amplitude Scale: Geo: 1.000 mm/s/div

Sensor Check

Printed: March 5, 2015 (V 10.10 - 10.10)

Format (c) 2006-2010 Instantel, a division of Xmark Corporation

Note: The minimum trigger was set at 0.5 mm/s. Data was collected every 5 mins for the duration of test. (See Figure 1)



## Appendix 1

### Vibration Meter Calibration Certificate



### Calibration Certificate

Certificate Number: 141100531727

Customer Name : Seteco Services Pte Ltd  
Customer Address : 18 Teban Gardens Crescent  
Singapore 608925  
Manufacturer : Instanetel Inc.  
Item Description : Vibration Monitor  
Model Number : Minimate Plus  
Serial Number : BE16768  
Sub-Assemblies S/N : BG15775

Calibration Date : 20 Nov 2014

**Test Conditions :**

Ambient Temperature : 21 °C  
Relative Humidity : 57 % R.H.  
Pressure : 100.9 kPa

Absolute Laboratories Pte. Ltd. certifies that the above product listed was calibrated in compliance with a quality management system using the applicable and approved Absolute Laboratories Pte. Ltd. calibration procedures as specified.

The equipments used in the test and calibration of this instrument are traceable to the National Metrology Centre (NMC) Singapore and National Institute of Standards and Technology (NIST) U.S.

**Calibration Method:**

The instrument was calibrated following AL calibration procedure WI-26.

Calibration Equipment(s) Used			
Apparatus	Serial Number	Cal Due Date	Certificate Number
Digital Multimeter	MY45034436	29 October 2015	1-6281896095-1
DC Power Supply	740622	17 February 2015	EL001982
Auto Zero/ Gain Test Jig	718A1501-15	19 March 2015	140300270284

Calibrated By:

S.K. Raja

Calibration Officer

Reviewed/Approved By:

Rodrigo Manansala

Approving Officer

This calibration document shall not be reproduced except in full, without written approval of Absolute Laboratories Pte. Ltd.

Absolute Laboratories Pte. Ltd. is an affiliated company of Absolute Instrument Systems (Pte.) Ltd.

WI-26-CR-1

1 of 2

Absolute Laboratories Pte. Ltd.  
11 Kallang Place #06-02 Singapore 339155  
Tel: 65 6296 8012 Fax: 65 6296 3242



## Appendix 1 (Cont'd)

### Vibration Meter Calibration Certificate

#### Calibration Report

Item Description : Vibration Monitor  
Brand : Instantel  
Model : MM+  
Serial Number : BE16768  
Sub-assembly : BG15775  
Calibration Date : 20-Nov-14

Job No.: 14110053  
Temperature: 21 °C  
Humidity: 57 % RH  
Pressure: 100.9 kPa  
WI No.: 26

#### 1. BATTERY CURRENT TESTS:

Test Condition	Reading Result		Tolerance Range	Expanded Uncertainty (%)
	Before Adjustment	After Adjustment		
Unit On	71.36 mA	71.36 mA	≤100mA	3.29
Unit Off	0.84 mA	0.84 mA	≤1.5mA	16.63
Monitoring Mode (LCD Off) - MM+ (4Ch.)	6.56 mA	6.56 mA	≤8.7mA	4.65
Monitoring Mode (LCD Off) - MM+ (8Ch.)	NA mA	NA mA	≤11.0mA	NA

#### 2. LCD and BACKLIGHT TESTS:

2.1 LCD Control Test	Pass / Fail
2.2 Backlight Test	Pass / Fail

#### 3. UNIT OPERATING SYSTEM CHECK:

3.1 Unit Operating System	Rel. 10.72	Ver. 8.17
3.2 Disk Operating System	Rel. 10.72	Ver. 8.17
3.3 Library Components Report Type	DIN4150	

#### 4. AUTO-ZEROING TEST: Nominal Range: 2027 - 2069

	X1	X8
Channel 1	2044	2045
Channel 2	2045	2046
Channel 3	2044	2042
Channel 4	2044	2042
Channel 5	2048	2048
Channel 6	2048	2048
Channel 7	2048	2048
Channel 8	2048	2048

  
CALIBRATION OFFICER

2 of 2

Absolute Laboratories Pte. Ltd.  
11 Kallang Place #06-02 Singapore 339155 | TEL: 6296 8012, FAX: 6296 3242 | www.aisys.com.sg





## Appendix 2 (Site Photos for VL 101)



Photo 1



Photo 2

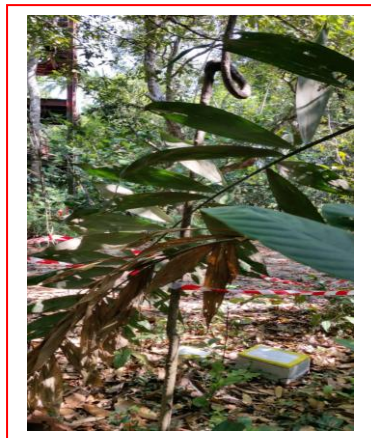


Photo 3





## **GROUND VIBRATION MONITORING**

**Report Prepared by:**

**SETSCO SERVICES PTE LTD  
18, TEBAN GARDENS CRESCENT  
SINGAPORE 608925  
TEL : 65667777  
FAX : 65667718**

**(Business Reg. No. : 196900269D)**

**For:**

**ERM SINGAPORE  
120 Robinson Road  
#10-01  
Singapore 068913**

**ATTN: Ms Rosalind Finney**

### **Terms & Conditions:**

- (1) The Report is prepared for the sole use of the Client and is prepared based upon the item submitted, the Services required by the Client and the conditions under which the Services are performed by SETSCO. The Report is not intended to be representative of similar or equivalent Services on similar equivalent items. The Report does not constitute an endorsement by SETSCO of the item.
- (2) SETSCO agrees to use reasonable diligence in the performance of the Services but no warranties are given and none may be implied directly or indirectly relating to the Services, the Report or the facilities of SETSCO.
- (3) The Report may not be used in any publicity material without the written consent of SETSCO.
- (4) The Report may not be reproduced in part or in full unless approval in writing has been given by SETSCO.
- (5) SETSCO shall under no circumstances be liable to the Client or its agents, servants or representatives, in contract, tort (including negligence or breach of statutory duty) or otherwise for any direct or indirect loss or damage suffered by the client, its agents, servants or representative howsoever arising or whether connected with the Services provided by SETSCO herein.



<b>CONTENT</b>	<b>PAGE NO.</b>
<b>1 Introduction</b>	<b>3</b>
<b>2 Project</b>	<b>3</b>
<b>3 Scope of Measurement</b>	<b>3</b>
<b>4 Objective of Measurement</b>	<b>3</b>
<b>5 Measurement Equipment Specification</b>	<b>3</b>
<b>6 Date of Measurement and Test Locations</b>	<b>3</b>
<b>7 Observation</b>	<b>3</b>
<b>8 Results &amp; Conclusion</b>	<b>4</b>
<b>9 Vibration Data Histogram (Figure 1)</b>	<b>5</b>

**APPENDIX**

**APPENDIX 1 – Vibration Meter Calibration Certificate**

**APPENDIX 2 – Site Photos**



## 1 INTRODUCTION

SETSCO SERVICES PTE LTD was appointed by ERM SINGAPORE to carry out Ambient Ground Vibration Monitoring for VL 102: Near Kallang Service Reservoir, Central Catchment Nature Reserve.

## 2 PROJECT

Environmental Baseline Survey

## 3 SCOPE OF MEASUREMENT

In this monitoring the evaluation of the ambient ground vibration is based on the maximum values of the three components of the vibration velocity that is Vertical, Longitudinal and Transverse direction {V (z-axis), L (y-axis) and T (x-axis)}. The measurement in three directions would be monitored at location specified in Figure 1. The measurement would be in frequency range of 1Hz to 100Hz, velocity-time domain with a minimum trigger level set at 0.5 mm/s for the Location. The vibration meter was set on continuous and histogram monitoring with readings taken every 5 minutes interval.

## 4 OBJECTIVE OF MEASUREMENT

The objective of this monitoring for VL 102: Near Kallang Service Reservoir, Central Catchment Nature Reserve was to determine the level of the vibration for environmental baseline survey.

## 5 MEASUREMENT EQUIPMENT SPECIFICATION

The measurement equipment for the vibration test measurements are as follows:-

- INSTANTEL INC Ground Vibration Monitoring Equipment  
(Vibration Sensor Tri-axial)

## 6 DATE OF MEASUREMENT AND TEST LOCATIONS

The measurements were from 25<sup>th</sup> February 2015 to 26<sup>th</sup> February 2015 for VL 102: Near Kallang Service Reservoir, Central Catchment Nature Reserve.

## 7 OBSERVATION

Sources of ground vibration observed at this location include people jogging and vehicular movements along the road.



## 7 RESULTS & CONCLUSION

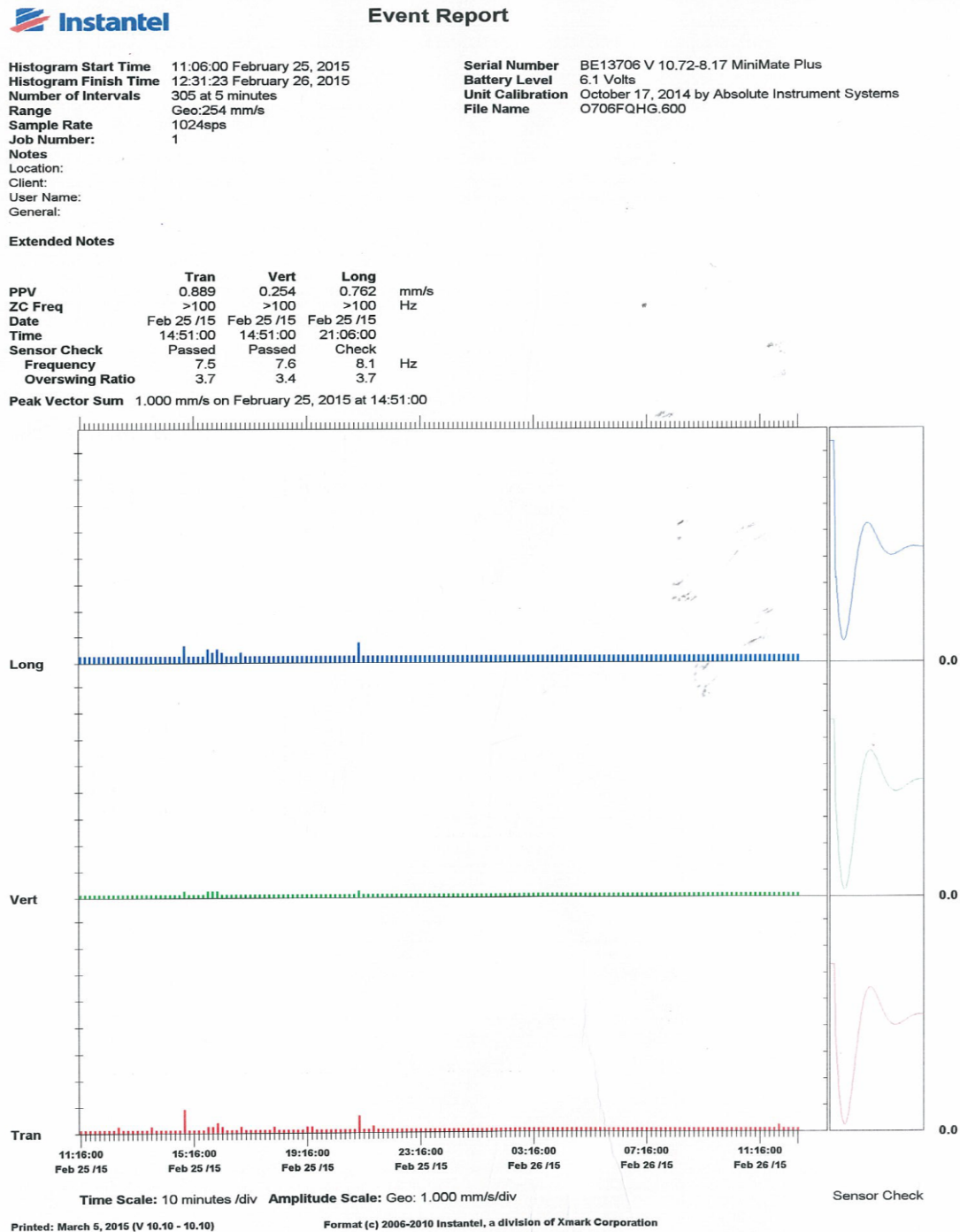
For the results of the measurement, refer to the vibration measurement data in figure 1. The details of the measurement show the frequency with the corresponding peak particle velocity in Vertical, Longitudinal and Transverse direction. The readings gathered during this monitoring show a very minimum vibration reading.



Figure 1: Location and Direction of measurement



**Figure 1**  
**Vibration Data (Histogram)**



Note: The minimum trigger was set at 0.5 mm/s. Data was collected every 5 mins for the duration of test. (See Figure 1)





## Appendix 1

### Vibration Meter Calibration Certificate



### Calibration Certificate

Certificate Number: 141000411538

**Customer Name** : Setesco Services Pte Ltd  
**Customer Address** : 18 Teban Gardens Crescent  
Singapore 608925  
**Manufacturer** : Instanetel Inc.  
**Item Description** : Vibration Monitor  
**Model Number** : Minimate Plus  
**Serial Number** : BE13706  
**Sub-Assemblies S/N** : BG12625

**Calibration Date** : 17 Oct 2014**Test Conditions** :

**Ambient Temperature** : 22 °C  
**Relative Humidity** : 55 % R.H.  
**Pressure** : 101.0 kPa

Absolute Laboratories Pte. Ltd. certifies that the above product listed was calibrated in compliance with a quality management system using the applicable and approved Absolute Laboratories Pte. Ltd. calibration procedures as specified.


The equipments used in the test and calibration of this instrument are traceable to the National Metrology Centre (NMC) Singapore and National Institute of Standards and Technology (NIST) U.S.

**Calibration Method:**

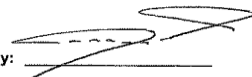
The instrument was calibrated following AL calibration procedure WI-26.

Calibration Equipment(s) Used			
Apparatus	Serial Number	Cal Due Date	Certificate Number
Digital Multimeter	MY47031724	14 Nov 2014	1-5507172071-1
DC Power Supply	740622	17 February 2015	EL001982
Auto Zero/ Gain Test Jig	718A1501-15	19 March 2015	140300270284

Calibrated By:

  
S.K. Raja  
Calibration Officer

Reviewed/Approved By:

  
Rodrigo Manansala  
Approving Officer

This calibration document shall not be reproduced except in full, without written approval of Absolute Laboratories Pte. Ltd.  
Absolute Laboratories Pte. Ltd. is an affiliated company of Absolute Instrument Systems (Pte.) Ltd.

WI-26-CR-1

1 of 2

Absolute Laboratories Pte. Ltd.  
11 Kallang Place #06-02 Singapore 339155  
Tel: 65 6296 8012 Fax: 65 6296 3242

4



## Appendix 1 (Cont'd)

### Vibration Meter Calibration Certificate

#### Calibration Report

Item Description : Vibration Monitor  
Brand : InstanTel  
Model : MM+  
Serial Number : BE13706  
Sub-assembly : BG12625  
Calibration Date : 17-Oct-14

Job No.: 14100041  
Temperature: 22 °C  
Humidity: 55 % RH  
Pressure: 101.0 kPa  
WI No.: 26

#### 1. BATTERY CURRENT TESTS:

Test Condition	Reading Result		Tolerance Range	Expanded Uncertainty (%)
	Before Adjustment	After Adjustment		
Unit On	70.91 mA	70.91 mA	≤100mA	3.29
Unit Off	0.76 mA	0.76 mA	≤1.5mA	18.08
Monitoring Mode (LCD Off) - MM+ (4Ch.)	6.87 mA	6.87 mA	≤8.7mA	4.57
Monitoring Mode (LCD Off) - MM+ (8Ch.)	NA mA	NA mA	≤11.0mA	NA

#### 2. LCD and BACKLIGHT TESTS:

2.1 LCD Control Test	Pass / Fail
2.2 Backlight Test	Pass / Fail

#### 3. UNIT OPERATING SYSTEM CHECK:

3.1 Unit Operating System	Rel. 10.72	Ver. 8.17
3.2 Disk Operating System	Rel. 10.72	Ver. 8.17
3.3 Library Components	DIN4150	
Report Type		

#### 4. AUTO-ZEROING TEST: Nominal Range: 2027 - 2069

	X1	X8
Channel 1	2043	2043
Channel 2	2043	2038
Channel 3	2043	2041
Channel 4	2042	2037
Channel 5	2048	2048
Channel 6	2048	2048
Channel 7	2048	2048
Channel 8	2048	2048

  
CALIBRATION OFFICER

2 of 2

Absolute Laboratories Pte. Ltd.  
11 Kallang Place #06-02 Singapore 339155 | TEL: 6296 8012, FAX: 6296 3242 | www.aisys.com.sg



## Appendix 2 (Site Photos for VL 102)



Photo 1

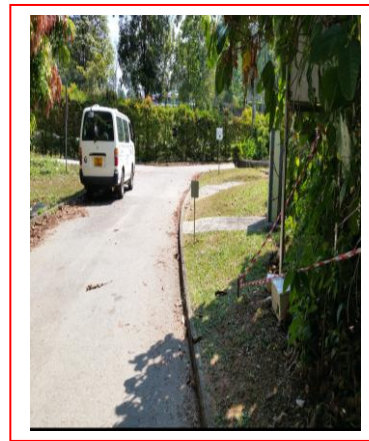


Photo 2



Photo 3



Photo 4



## **GROUND VIBRATION MONITORING**

**Report Prepared by:**

**SETSCO SERVICES PTE LTD  
18, TEBAN GARDENS CRESCENT  
SINGAPORE 608925  
TEL : 65667777  
FAX : 65667718**

**(Business Reg. No. : 196900269D)**

**For:**

**ERM SINGAPORE  
120 Robinson Road  
#10-01  
Singapore 068913**

**ATTN: Ms Rosalind Finney**

### **Terms & Conditions:**

- (1) The Report is prepared for the sole use of the Client and is prepared based upon the item submitted, the Services required by the Client and the conditions under which the Services are performed by SETSCO. The Report is not intended to be representative of similar or equivalent Services on similar equivalent items. The Report does not constitute an endorsement by SETSCO of the item.
- (2) SETSCO agrees to use reasonable diligence in the performance of the Services but no warranties are given and none may be implied directly or indirectly relating to the Services, the Report or the facilities of SETSCO.
- (3) The Report may not be used in any publicity material without the written consent of SETSCO.
- (4) The Report may not be reproduced in part or in full unless approval in writing has been given by SETSCO.
- (5) SETSCO shall under no circumstances be liable to the Client or its agents, servants or representatives, in contract, tort (including negligence or breach of statutory duty) or otherwise for any direct or indirect loss or damage suffered by the client, its agents, servants or representative howsoever arising or whether connected with the Services provided by SETSCO herein.



<b>CONTENT</b>	<b>PAGE NO.</b>
<b>1 Introduction</b>	<b>3</b>
<b>2 Project</b>	<b>3</b>
<b>3 Scope of Measurement</b>	<b>3</b>
<b>4 Objective of Measurement</b>	<b>3</b>
<b>5 Measurement Equipment Specification</b>	<b>3</b>
<b>6 Date of Measurement and Test Locations</b>	<b>3</b>
<b>7 Observation</b>	<b>3</b>
<b>8 Results &amp; Conclusion</b>	<b>4</b>
<b>9 Vibration Data Histogram (Figure 1)</b>	<b>5</b>

**APPENDIX**

**APPENDIX 1 – Vibration Meter Calibration Certificate**

**APPENDIX 2 – Site Photos**





## 1 INTRODUCTION

SETSCO SERVICES PTE LTD was appointed by ERM SINGAPORE to carry out Ambient Ground Vibration Monitoring for VL 201: Venus Drive.

## 2 PROJECT

Environmental Baseline Survey

## 3 SCOPE OF MEASUREMENT

In this monitoring the evaluation of the ambient ground vibration is based on the maximum values of the three components of the vibration velocity that is Vertical, Longitudinal and Transverse direction {V (z-axis), L (y-axis) and T (x-axis)}. The measurement in three directions would be monitored at location specified in Figure 1. The measurement would be in frequency range of 1Hz to 100Hz, velocity-time domain with a minimum trigger level set at 0.5 mm/s for the Location. The vibration meter was set on continuous and histogram monitoring with readings taken every 5 minutes interval.

## 4 OBJECTIVE OF MEASUREMENT

The objective of this monitoring for VL 201: Venus Drive was to determine the level of the vibration for environmental baseline survey.

## 5 MEASUREMENT EQUIPMENT SPECIFICATION

The measurement equipment for the vibration test measurements are as follows:-

- INSTANTEL INC Ground Vibration Monitoring Equipment (Vibration Sensor Tri-axial)

## 6 DATE OF MEASUREMENT AND TEST LOCATIONS

The measurements were from 18<sup>th</sup> March 2015 to 20<sup>th</sup> March 2015 for VL 201: Venus Drive

## 7 OBSERVATION

Sources of ground vibration observed at this location include people walking, jogging and vehicular movements along the road.



## 8 RESULTS & CONCLUSION

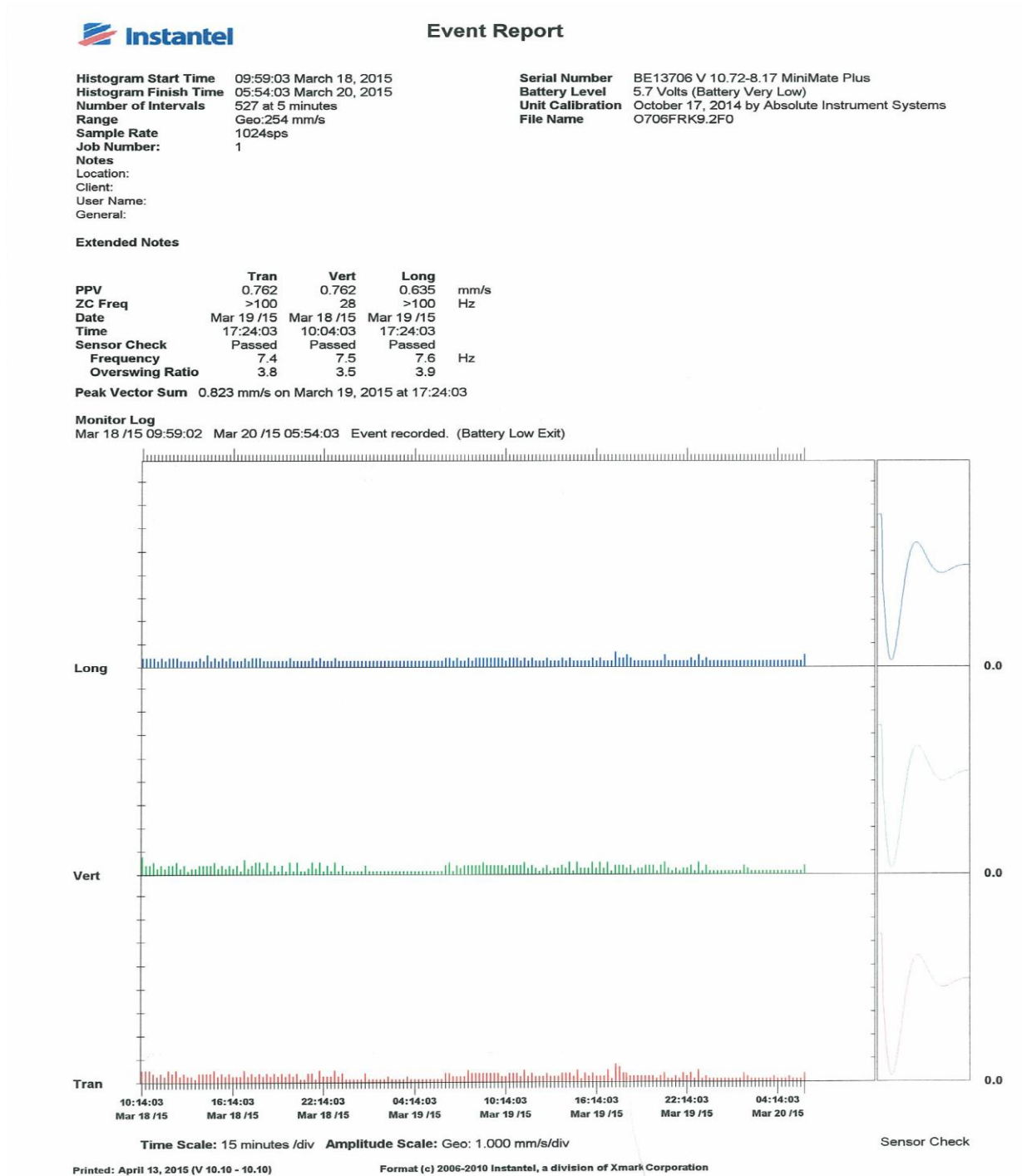
For the results of the measurement, refer to the vibration measurement data in figure 1. The details of the measurement show the frequency with the corresponding peak particle velocity in Vertical, Longitudinal and Transverse direction. The readings gathered during this monitoring show a very minimum vibration reading.



Figure 1: Location and Direction of measurement



**Figure 1**  
**Vibration Data (Histogram)**



Note: The minimum trigger was set at 0.5 mm/s. Data was collected every 5 mins for the duration of test. (See Figure 1)



## Appendix 1

### Vibration Meter Calibration Certificate



### Calibration Certificate

Certificate Number: 141000411538

**Customer Name** : Setesco Services Pte Ltd  
**Customer Address** : 18 Teban Gardens Crescent  
Singapore 608925  
**Manufacturer** : InstanTel Inc.  
**Item Description** : Vibration Monitor  
**Model Number** : Minimate Plus  
**Serial Number** : BE13706  
**Sub-Assemblies S/N** : BG12625

**Calibration Date** : 17 Oct 2014**Test Conditions** :

**Ambient Temperature** : 22 °C  
**Relative Humidity** : 55 % R.H.  
**Pressure** : 101.0 kPa

Absolute Laboratories Pte. Ltd. certifies that the above product listed was calibrated in compliance with a quality management system using the applicable and approved Absolute Laboratories Pte. Ltd. calibration procedures as specified.


The equipments used in the test and calibration of this instrument are traceable to the National Metrology Centre (NMC) Singapore and National Institute of Standards and Technology (NIST) U.S.

**Calibration Method:**

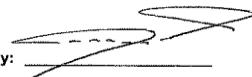
The instrument was calibrated following AL calibration procedure WI-26.

Calibration Equipment(s) Used			
Apparatus	Serial Number	Cal Due Date	Certificate Number
Digital Multimeter	MY47031724	14 Nov 2014	1-5507172071-1
DC Power Supply	740622	17 February 2015	EL001982
Auto Zero/ Gain Test Jig	718A1501-15	19 March 2015	140300270284

Calibrated By:

  
S.K. Raja  
Calibration Officer

Reviewed/Approved By:

  
Rodrigo Manansala  
Approving Officer

This calibration document shall not be reproduced except in full, without written approval of Absolute Laboratories Pte. Ltd.  
Absolute Laboratories Pte. Ltd. is an affiliated company of Absolute Instrument Systems (Pte.) Ltd.

WI-26-CR-1

1 of 2

Absolute Laboratories Pte. Ltd.  
11 Kallang Place #06-02 Singapore 339155  
Tel: 65 6296 8012 Fax: 65 6296 3242

4





## Appendix 1 (Cont'd)

### Vibration Meter Calibration Certificate

#### Calibration Report

Item Description : Vibration Monitor  
Brand : InstanTel  
Model : MM+  
Serial Number : BE13706  
Sub-assembly : BG12625  
Calibration Date : 17-Oct-14

Job No.: 14100041  
Temperature: 22 °C  
Humidity: 55 % RH  
Pressure: 101.0 kPa  
WI No.: 26

#### 1. BATTERY CURRENT TESTS:

Test Condition	Reading Result		Tolerance Range	Expanded Uncertainty (%)
	Before Adjustment	After Adjustment		
Unit On	70.91 mA	70.91 mA	≤100mA	3.29
Unit Off	0.76 mA	0.76 mA	≤1.5mA	18.08
Monitoring Mode (LCD Off) - MM+ (4Ch.)	6.87 mA	6.87 mA	≤8.7mA	4.57
Monitoring Mode (LCD Off) - MM+ (8Ch.)	NA mA	NA mA	≤11.0mA	NA

#### 2. LCD and BACKLIGHT TESTS:

2.1 LCD Control Test	Pass / Fail
2.2 Backlight Test	Pass / Fail

#### 3. UNIT OPERATING SYSTEM CHECK:

3.1 Unit Operating System	Rel. 10.72	Ver. 8.17
3.2 Disk Operating System	Rel. 10.72	Ver. 8.17
3.3 Library Components	DIN4150	
Report Type		

#### 4. AUTO-ZEROING TEST: Nominal Range: 2027 - 2069

	X1	X8
Channel 1	2043	2043
Channel 2	2043	2038
Channel 3	2043	2041
Channel 4	2042	2037
Channel 5	2048	2048
Channel 6	2048	2048
Channel 7	2048	2048
Channel 8	2048	2048

  
CALIBRATION OFFICER

2 of 2

Absolute Laboratories Pte. Ltd.  
11 Kallang Place #06-02 Singapore 339155 | TEL: 6296 8012, FAX: 6296 3242 | www.aisys.com.sg





## Appendix 2 (Site Photos for VL 201)

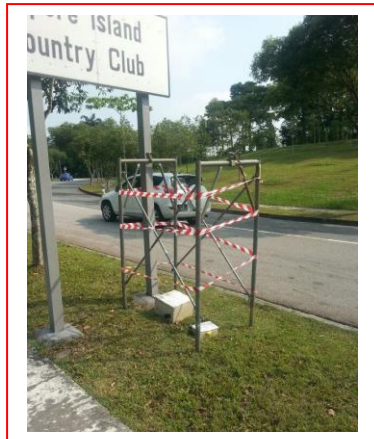


Photo 1



Photo 2



Photo 3



Photo 4



## **GROUND VIBRATION MONITORING**

**Report Prepared by:**

**SETSCO SERVICES PTE LTD  
18, TEBAN GARDENS CRESCENT  
SINGAPORE 608925  
TEL : 65667777  
FAX : 65667718**

**(Business Reg. No. : 196900269D)**

**For:**

**ERM SINGAPORE  
120 Robinson Road  
#10-01  
Singapore 068913**

**ATTN: Ms Rosalind Finney**

### **Terms & Conditions:**

- (1) The Report is prepared for the sole use of the Client and is prepared based upon the item submitted, the Services required by the Client and the conditions under which the Services are performed by SETSCO. The Report is not intended to be representative of similar or equivalent Services on similar equivalent items. The Report does not constitute an endorsement by SETSCO of the item.
- (2) SETSCO agrees to use reasonable diligence in the performance of the Services but no warranties are given and none may be implied directly or indirectly relating to the Services, the Report or the facilities of SETSCO.
- (3) The Report may not be used in any publicity material without the written consent of SETSCO.
- (4) The Report may not be reproduced in part or in full unless approval in writing has been given by SETSCO.
- (5) SETSCO shall under no circumstances be liable to the Client or its agents, servants or representatives, in contract, tort (including negligence or breach of statutory duty) or otherwise for any direct or indirect loss or damage suffered by the client, its agents, servants or representative howsoever arising or whether connected with the Services provided by SETSCO herein.



<b>CONTENT</b>	<b>PAGE NO.</b>
<b>1 Introduction</b>	<b>3</b>
<b>2 Project</b>	<b>3</b>
<b>3 Scope of Measurement</b>	<b>3</b>
<b>4 Objective of Measurement</b>	<b>3</b>
<b>5 Measurement Equipment Specification</b>	<b>3</b>
<b>6 Date of Measurement and Test Locations</b>	<b>3</b>
<b>7 Observation</b>	<b>3</b>
<b>8 Results &amp; Conclusion</b>	<b>4</b>
<b>9 Vibration Data Histogram (Figure 1)</b>	<b>5</b>

**APPENDIX**

**APPENDIX 1 – Vibration Meter Calibration Certificate**

**APPENDIX 2 – Site Photos**



## 1 INTRODUCTION

SETSCO SERVICES PTE LTD was appointed by ERM SINGAPORE to carry out Ambient Ground Vibration Monitoring for VL 202: Mt Alvernia Hospital & along Lornie Road.

## 2 PROJECT

Environmental Baseline Survey

## 3 SCOPE OF MEASUREMENT

In this monitoring the evaluation of the ambient ground vibration is based on the maximum values of the three components of the vibration velocity that is Vertical, Longitudinal and Transverse direction {V (z-axis), L (y-axis) and T (x-axis)}. The measurement in three directions would be monitored at location specified in Figure 1. The measurement would be in frequency range of 1Hz to 100Hz, velocity-time domain with a minimum trigger level set at 0.5 mm/s for the Location. The vibration meter was set on continuous and histogram monitoring with readings taken every 5 minutes interval.

## 4 OBJECTIVE OF MEASUREMENT

The objective of this monitoring for VL 202: Mt Alvernia Hospital & along Lornie Road was to determine the level of the vibration for environmental baseline survey.

## 5 MEASUREMENT EQUIPMENT SPECIFICATION

The measurement equipment for the vibration test measurements are as follows:-

- INSTANTEL INC Ground Vibration Monitoring Equipment (Vibration Sensor Tri-axial)

## 6 DATE OF MEASUREMENT AND TEST LOCATIONS

The measurements were from 18<sup>th</sup> March 2015 to 20<sup>th</sup> March 2015 for VL 202: Mt Alvernia Hospital & along Lornie Road.

## 7 OBSERVATION

Sources of ground vibration observed at this location include the vehicular movements along the slip road from Mt. Alvernia Hospital & along Lornie Road.



## 8 RESULTS & CONCLUSION

For the results of the measurement, refer to the vibration measurement data in figure 1. The details of the measurement show the frequency with the corresponding peak particle velocity in Vertical, Longitudinal and Transverse direction. The readings gathered during this monitoring show a very minimum vibration reading.



Figure 1: Location and Direction of measurement





**Figure 1**  
**Vibration Data (Histogram)**

**Event Report**

Histogram Start Time 11:12:49 March 18, 2015  
Histogram Finish Time 05:47:49 March 20, 2015  
Number of Intervals 511 at 5 minutes  
Range Geo:254 mm/s  
Sample Rate 1024sps  
Job Number: 1  
Notes  
Location:  
Client:  
User Name:  
General:

Serial Number BE16768 V 10.72-8.17 MiniMate Plus  
Battery Level 5.7 Volts (Battery Very Low)  
Unit Calibration November 20, 2014 by Absolute Instrument Systems  
File Name R768FRKC.HD0

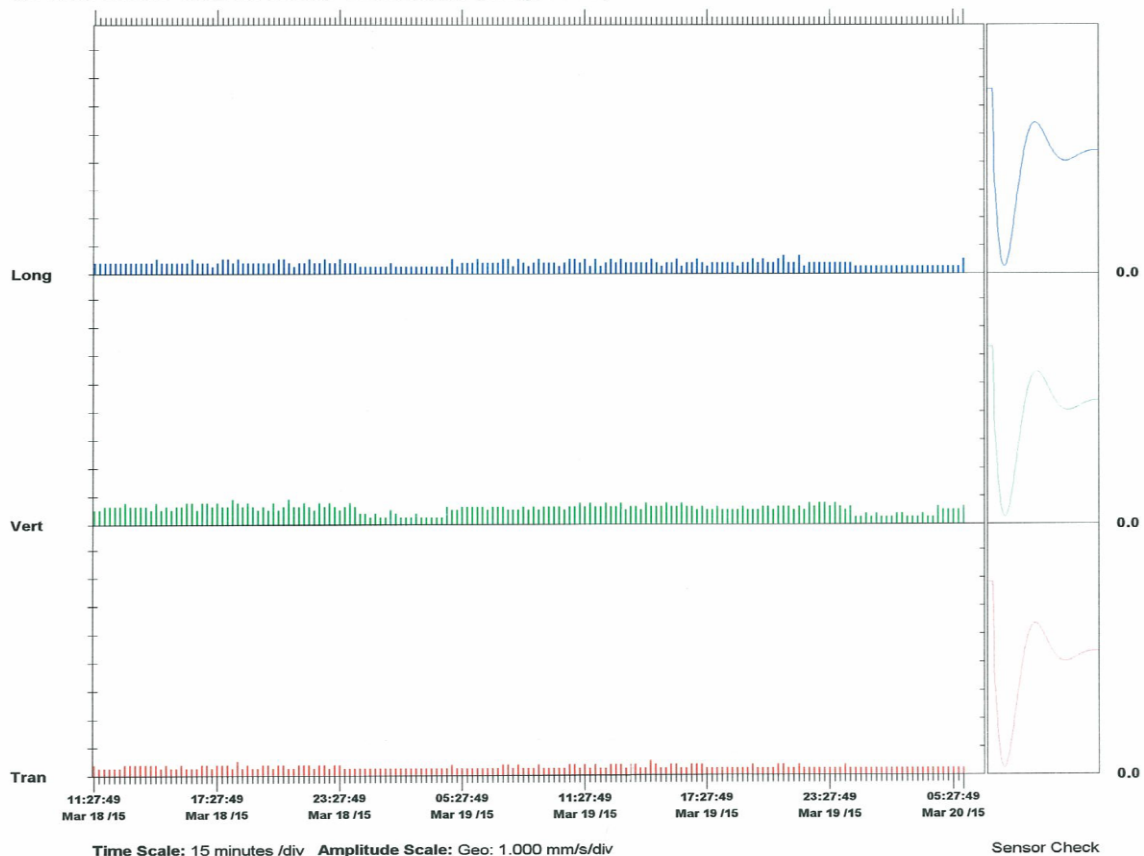
**Extended Notes**

	Tran	Vert	Long	
PPV	0.508	0.889	0.635	mm/s
ZC Freq	>100	21	>100	Hz
Date	Mar 18 /15	Mar 18 /15	Mar 19 /15	
Time	18:22:49	18:07:49	21:02:49	
Sensor Check	Passed	Passed	Passed	
Frequency	7.6	7.3	7.6	Hz
Overswing Ratio	3.9	3.8	3.8	

Peak Vector Sum 0.959 mm/s on March 18, 2015 at 20:52:49

**Monitor Log**

Mar 18 /15 11:12:48 Mar 20 /15 05:47:49 Event recorded. (Battery Low Exit)



Printed: April 13, 2015 (V 10.10 - 10.10)

Format (c) 2006-2010 Instantel, a division of Xmark Corporation

Note: The minimum trigger was set at 0.5 mm/s. Data was collected every 5 mins for the duration of test. (See Figure 1)



## Appendix 1

### Vibration Meter Calibration Certificate



### Calibration Certificate

Certificate Number: 141100531727

**Customer Name** : Seteco Services Pte Ltd  
**Customer Address** : 18 Teban Gardens Crescent  
Singapore 608925  
**Manufacturer** : InstanTel Inc.  
**Item Description** : Vibration Monitor  
**Model Number** : Minimate Plus  
**Serial Number** : BE16768  
**Sub-Assemblies S/N** : BG15775

**Calibration Date** : 20 Nov 2014**Test Conditions** :

**Ambient Temperature** : 21 °C  
**Relative Humidity** : 57 % R.H.  
**Pressure** : 100.9 kPa

Absolute Laboratories Pte. Ltd. certifies that the above product listed was calibrated in compliance with a quality management system using the applicable and approved Absolute Laboratories Pte. Ltd. calibration procedures as specified.

The equipments used in the test and calibration of this instrument are traceable to the National Metrology Centre (NMC) Singapore and National Institute of Standards and Technology (NIST) U.S.

**Calibration Method:**

The instrument was calibrated following AL calibration procedure WI-26.

Calibration Equipment(s) Used			
Apparatus	Serial Number	Cal Due Date	Certificate Number
Digital Multimeter	MY45034436	29 October 2015	1-6281896095-1
DC Power Supply	740622	17 February 2015	EL001982
Auto Zero/ Gain Test Jig	718A1501-15	19 March 2015	140300270284

Calibrated By:

S.K. Raja

Calibration Officer

Reviewed/Approved By:

Rodrigo Manansala

Approving Officer

This calibration document shall not be reproduced except in full, without written approval of Absolute Laboratories Pte. Ltd.  
Absolute Laboratories Pte. Ltd. is an affiliated company of Absolute Instrument Systems (Pte.) Ltd.

WI-26-CR-1

1 of 2

Absolute Laboratories Pte. Ltd.  
11 Kallang Place #06-02 Singapore 339155  
Tel: 65 6296 8012 Fax: 65 6296 3242



## Appendix 1 (Cont'd)

### Vibration Meter Calibration Certificate

#### Calibration Report

Item Description : Vibration Monitor  
Brand : Instantel  
Model : MM+  
Serial Number : BE16768  
Sub-assembly : BG15775  
Calibration Date : 20-Nov-14

Job No.: 14110053  
Temperature: 21 °C  
Humidity: 57 % RH  
Pressure: 100.9 kPa  
WI No.: 26

#### 1. BATTERY CURRENT TESTS:

Test Condition	Reading Result		Tolerance Range	Expanded Uncertainty (%)
	Before Adjustment	After Adjustment		
Unit On	71.36 mA	71.36 mA	≤100mA	3.29
Unit Off	0.84 mA	0.84 mA	≤1.5mA	16.63
Monitoring Mode (LCD Off) - MM+ (4Ch.)	6.56 mA	6.56 mA	≤8.7mA	4.65
Monitoring Mode (LCD Off) - MM+ (8Ch.)	NA mA	NA mA	≤11.0mA	NA

#### 2. LCD and BACKLIGHT TESTS:

2.1 LCD Control Test	Pass / Fail
2.2 Backlight Test	Pass / Fail

#### 3. UNIT OPERATING SYSTEM CHECK:

3.1 Unit Operating System	Rel. 10.72	Ver. 8.17
3.2 Disk Operating System	Rel. 10.72	Ver. 8.17
3.3 Library Components Report Type	DIN4150	

#### 4. AUTO-ZEROING TEST: Nominal Range: 2027 - 2069

	X1	X8
Channel 1	2044	2045
Channel 2	2045	2046
Channel 3	2044	2042
Channel 4	2044	2042
Channel 5	2048	2048
Channel 6	2048	2048
Channel 7	2048	2048
Channel 8	2048	2048

  
CALIBRATION OFFICER

2 of 2

Absolute Laboratories Pte. Ltd.  
11 Kallang Place #06-02 Singapore 339155 | TEL: 6296 8012, FAX: 6296 3242 | www.aisys.com.sg



## Appendix 2 (Site Photos for VL 202)



Photo 1



Photo 2



Photo 3



Photo 4



Photo 5



**AD-HOC  
GROUND VIBRATION MONITORING**

**Report Prepared by:**

**SETSCO SERVICES PTE LTD  
18, TEBAN GARDENS CRESCENT  
SINGAPORE 608925  
TEL : 65667777  
FAX : 65667718**

**(Business Reg. No. : 196900269D)**

**For:**

**ERM SINGAPORE  
120 Robinson Road  
#10-01  
Singapore 068913**

**ATTN: Ms Rosalind Finney**

**Terms & Conditions:**

- (1) The Report is prepared for the sole use of the Client and is prepared based upon the item submitted, the Services required by the Client and the conditions under which the Services are performed by SETSCO. The Report is not intended to be representative of similar or equivalent Services on similar equivalent items. The Report does not constitute an endorsement by SETSCO of the item.
- (2) SETSCO agrees to use reasonable diligence in the performance of the Services but no warranties are given and none may be implied directly or indirectly relating to the Services, the Report or the facilities of SETSCO.
- (3) The Report may not be used in any publicity material without the written consent of SETSCO.
- (4) The Report may not be reproduced in part or in full unless approval in writing has been given by SETSCO.
- (5) SETSCO shall under no circumstances be liable to the Client or its agents, servants or representatives, in contract, tort (including negligence or breach of statutory duty) or otherwise for any direct or indirect loss or damage suffered by the client, its agents, servants or representative howsoever arising or whether connected with the Services provided by SETSCO herein.





## 1. Background

- 1.1 Setsco Services Pte Ltd was engaged by ERM Singapore for provision of measurement services to undertake ground vibration measurements at Pierce Secondary School, along Sin Min Walk – see Figure 1.1 below. The location of the A-frame drilling machine is marked by



below.



Figure 1.1: Location of measurement.

- 1.2 This document presents the results of the vibration measurement conducted at the site on the 20<sup>th</sup> April 2015 between 1430 and 1630.
- 1.3 The measurements were performed with an A-frame borehole drilling machine in operation and ground vibration levels were recorded at defined distances away from the drilling machine.
- 1.4 The objective of the measurement is to establish the typical ground vibration response at various distances from an operational A-frame rotary borehole drilling machine.

## 2. Site Condition and Measurement

- 2.1 It was observed that there was also ongoing construction at the Bright Hill MRT Station and tunnels located along Sin Ming Avenue. About 400m southeast of the measurement site. See Figures 2.1 and 2.2 below.



Figure 2.1: Nearby construction site.



Figure 2.2: Nearby construction site.

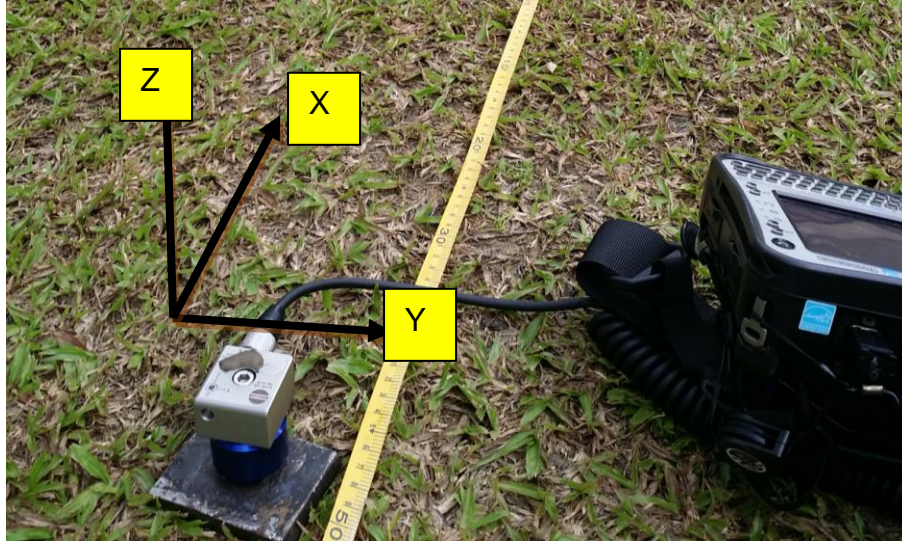
2.2 Six location points were selected for the measurements – namely Point A, Point B, Point C, Point D, Point E, Point F and point G referenced to the A-frame drilling machine.

- Point A – 2m away
- Point B – 3m away
- Point C – 5m away
- Point D – 15m away
- Point E – 11m away
- Point F – 20m away
- Point G – Baseline

Measurement was taken on the grass patch.



- 2.3 Vibration measurements were performed using a tri-axial accelerometer (for the X, Y and Z-axis representing the three orthogonal directions) attached to a steel rod embedded 1 meter into the ground as shown in Figure 2.3 below.



**Figure 2.3:** Measurement setup and measurement axis.

- 2.4 For each measurement point, vibration levels were recorded over a time period of approximately 5 minutes.
- 2.5 Table 2.1 below details the instrumentation used for the vibration measurements. All instrumentation has been verified to traceable standards by the manufacturer within the least 2 years. A copy of the equipment calibration certificate is attached in Appendix A.

**Table 2.1:** Instrument used during survey.

Item	Manufacturer	Type	Description	S/No.
1	Adash	SAB	Signal Analyser Box	624127
2	Adash	Tri-axial Accelerometer	Accelerometer with sensitivity of 100mV/g	

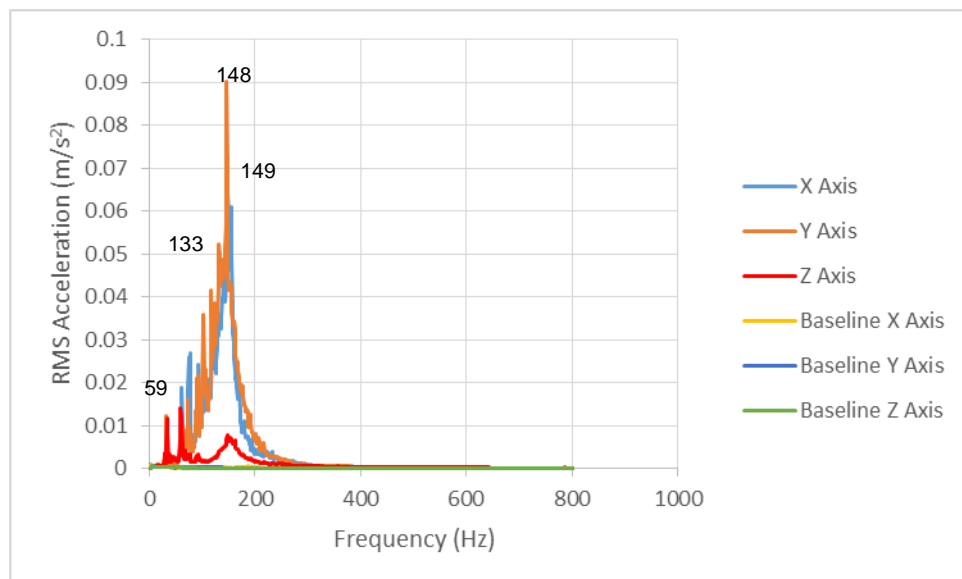
- 2.6 The external environmental condition during the attended survey period was dry with low wind. The external temperature was around 32-35 Degree Celsius during the attended measurements.





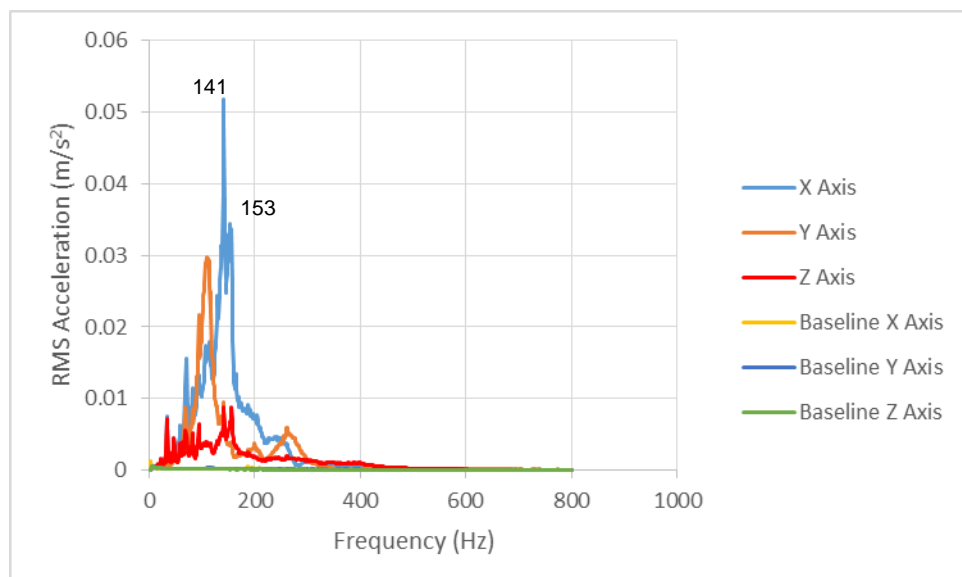
### 3. Results

- 3.1 The following section presents the results of the measurement.
- 3.2 Figures 3.1 presents RMS vibration acceleration frequency spectrums (X, Y and Z axis) between 1 and 1000 Hz measured at Location A.
- 3.3 Results presented in Figures 3.1 below shows that higher vibration was measured in the transverse direction compared to the vertical direction and the highest vibration level was measured at 148 Hz.



**Figure 3.1:** RMS vibration acceleration frequency spectrums measured at Location A.

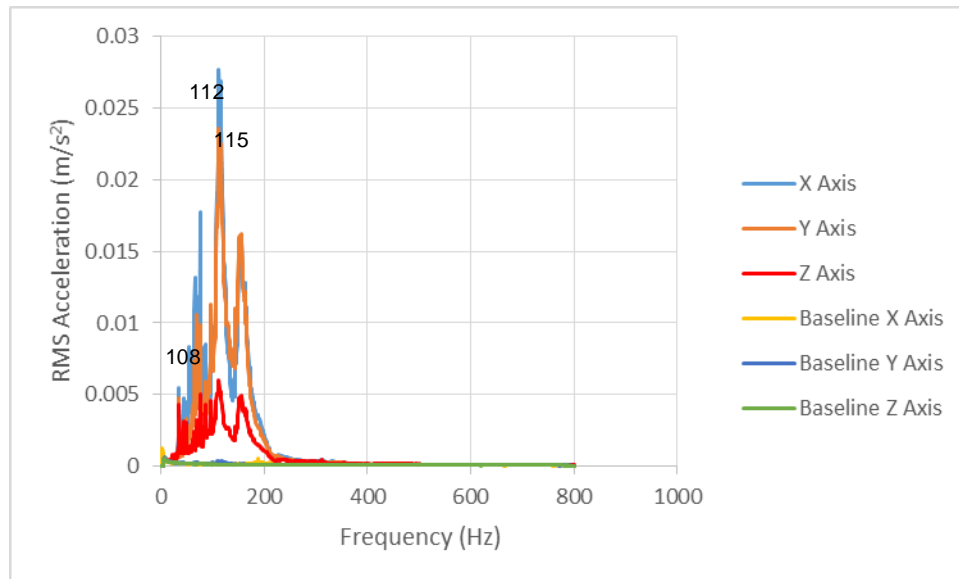
- 3.4 Figures 3.2 presents RMS vibration acceleration frequency spectrums (X, Y and Z axis) between 1 and 1000 Hz measured at Location B.
- 3.5 Results presented in Figures 3.2 below shows higher vibration levels measured in the transverse direction compared to the vibration measured in the vertical direction. The highest vibration level was measured at 141 Hz in the X-axis.



**Figure 3.2:** RMS vibration acceleration frequency spectrums measured at Location B.

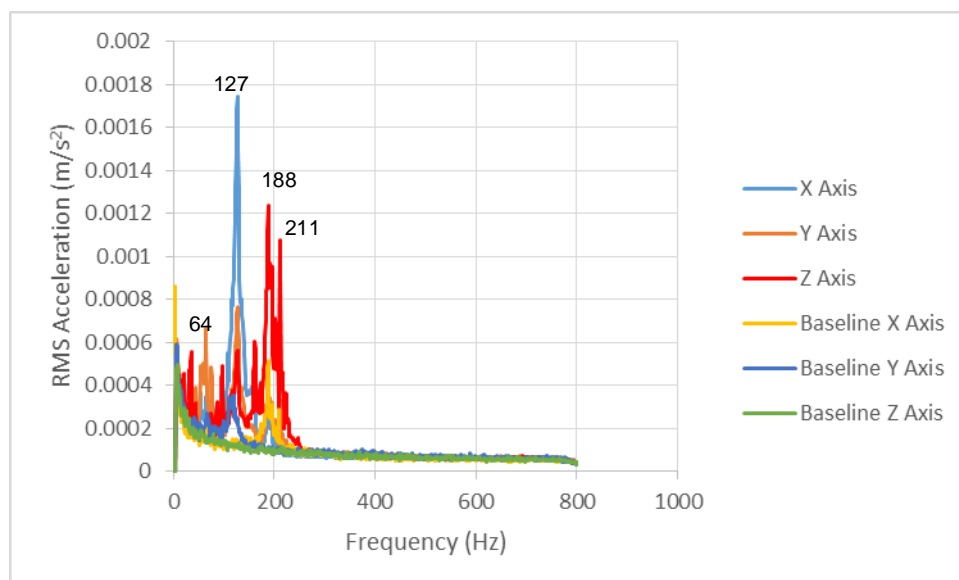


- 3.6 Figures 3.3 below presents RMS vibration acceleration frequency spectrums (X, Y and Z axis) between 1 and 1000 Hz measured at Location C.
- 3.7 Results presented in Figures 3.3 below shows that the highest vibration level was measured at 112 Hz in the X-axis. Higher vibration levels measured in the X and Y axis compared to those measured in the Z axis.



**Figure 3.3:** RMS vibration acceleration frequency spectrums measured at Location C.

- 3.8 Figures 3.4 presents RMS vibration acceleration frequency spectrums (X, Y and Z axis) between 1 and 1000 Hz measured at Location D.
- 3.9 Results presented in Figures 3.4 below shows that the highest vibration level was measured at 127 Hz in the X-axis.

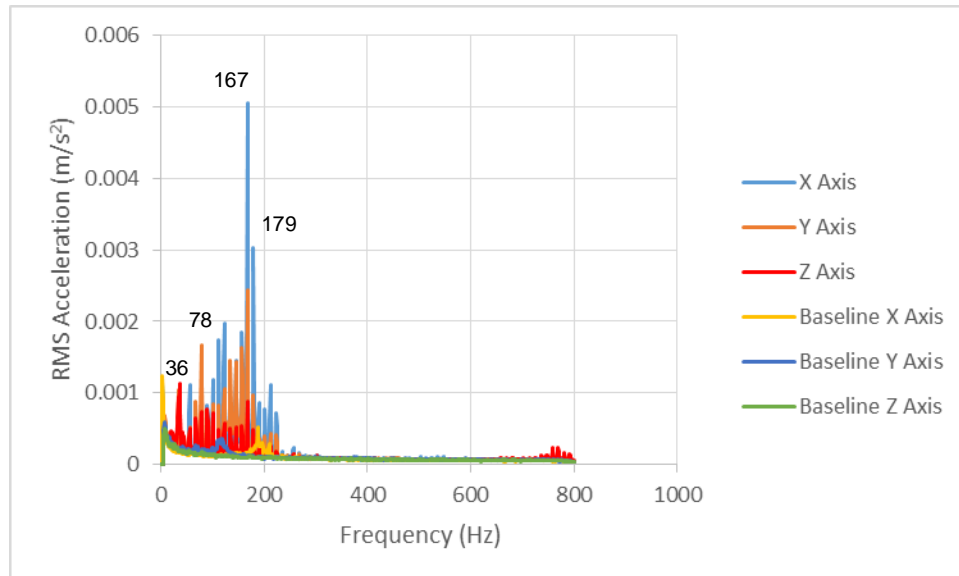


**Figure 3.4:** RMS vibration acceleration frequency spectrums measured at Location D.



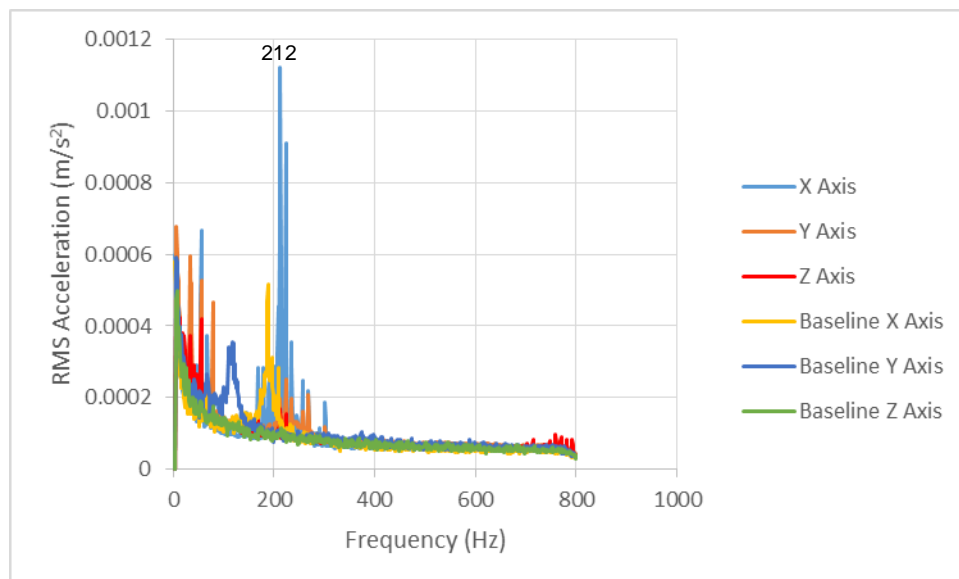


- 3.10 Figures 3.5 presents RMS vibration acceleration frequency spectrums (X, Y and Z axis) between 1 and 1000 Hz measured at Location E.
- 3.11 Results presented in Figures 3.5 below shows that the highest vibration level was measured at 167 Hz in the X-axis.



**Figure 3.5:** RMS vibration acceleration frequency spectrums measured at Location E.

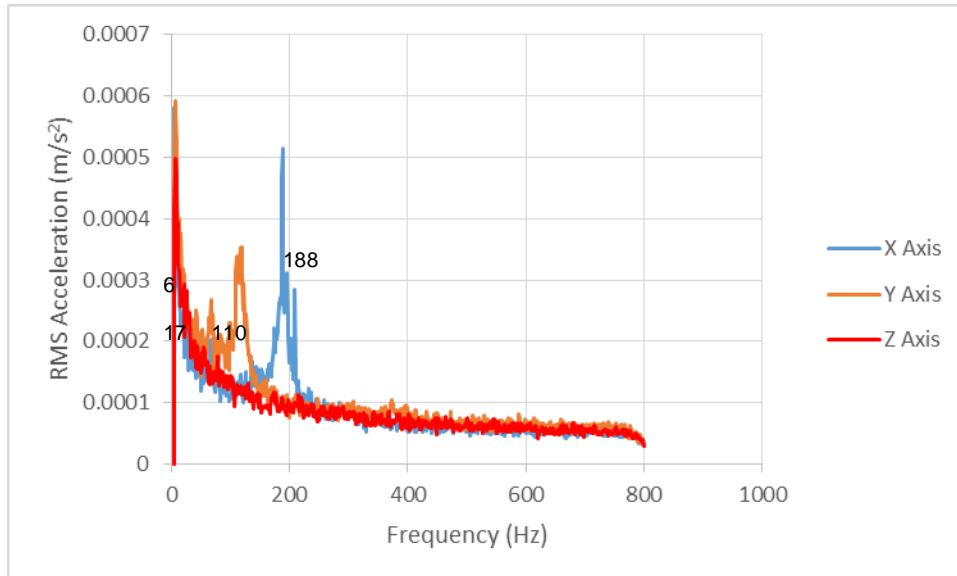
- 3.12 Figures 3.6 presents RMS vibration acceleration frequency spectrums (X, Y and Z axis) between 1 and 1000 Hz measured at Location F.
- 3.13 Results presented in Figures 3.6 below shows that the highest vibration level was measured at 212 Hz in the X-axis.



**Figure 3.6:** RMS vibration acceleration frequency spectrums measured at Location F.



- 3.14 Figures 3.7 presents RMS vibration acceleration frequency spectrums (X, Y and Z axis) between 1 and 1000 Hz measured at Location G which is used as the baseline noise levels without the A-frame machine in operation.



**Figure 3.7:** RMS vibration acceleration frequency spectrums measured at Location G.

- 3.15 The results presented in Figures 3.1 to 3.6 above show higher vibration levels measured in the transverse direction than the vibration levels measured in the vertical direction.
- 3.16 Table 3.1 summarises the dominant frequency components measured at the various measurement locations. The dominant vibration levels measured were generally in the low frequency range up to 220 Hz.

**Table 3.1:** Summary of dominant frequency components measured at the various measurement locations.

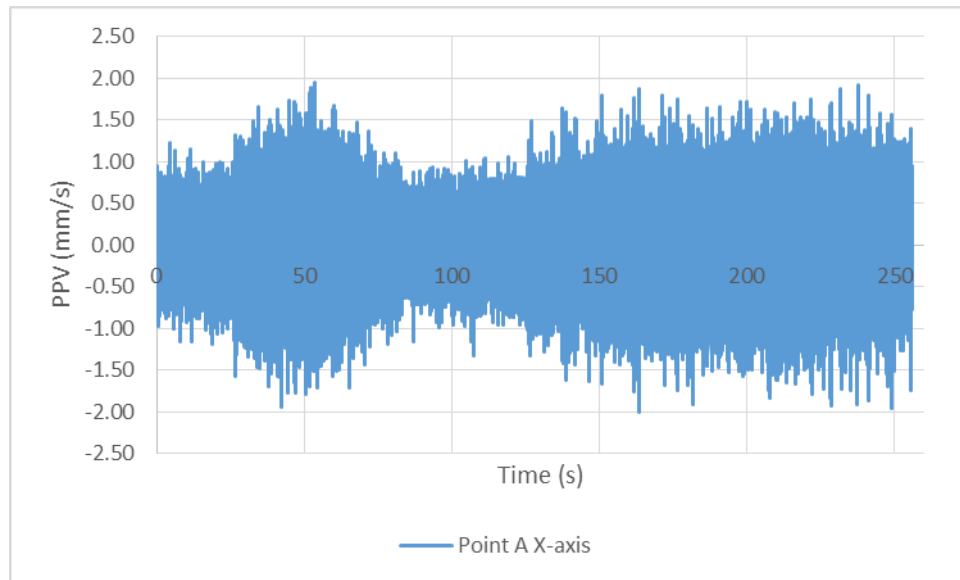
Location Point	Dominant Frequency Component (Hz)
A	34, 59, 133, 148, 149
B	109, 112, 141, 153, 156
C	108, 112, 115
D	64, 127, 188, 211
E	33, 36, 78, 167, 179
F	6, 12, 33, 212
G	6, 17, 110, 188



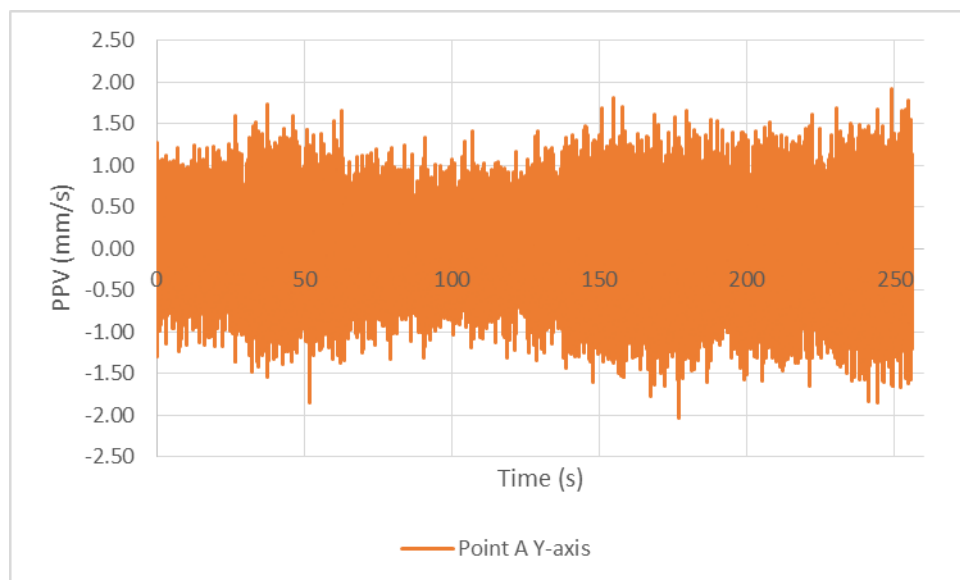
#### 4. Results (Peak Particle Velocity)

4.1 Figures 4.1 to 4.3 present the peak particle velocity (PPV) for X, Y and Z axis respectively, between 1 and 256 seconds measured at Location A. Figure 4.4 presents the resultant PPV, between 1 and 256 seconds measured at Location A.

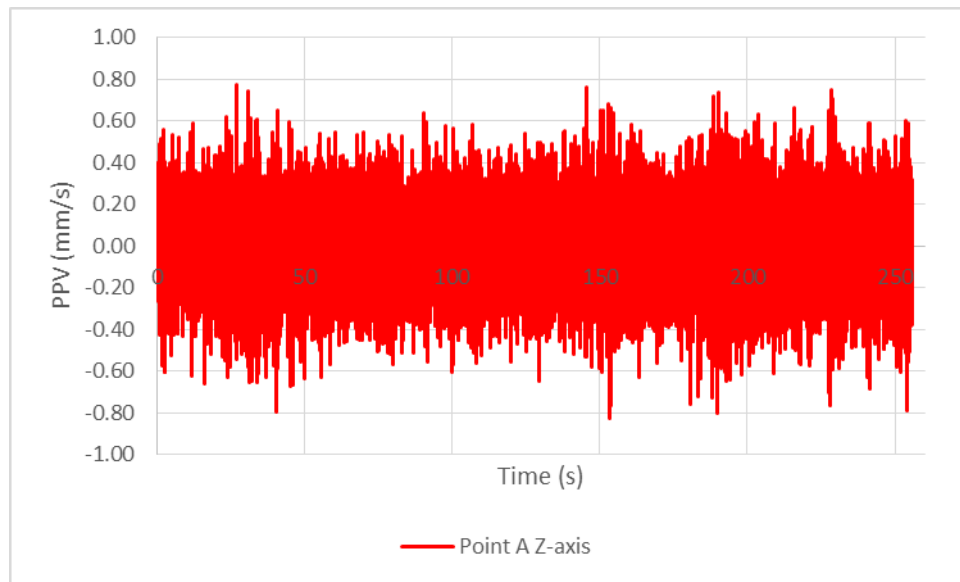
4.2 The maximum and minimum PPVs of each axis at Location A are identified and presented in table 4.1.



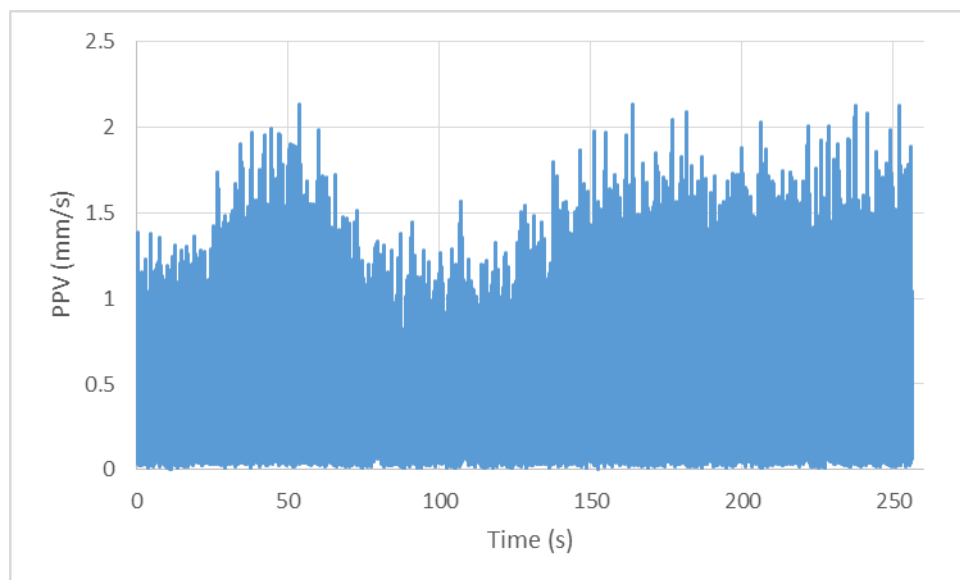
**Figure 4.1:** X-axis PPV measured at Location A.



**Figure 4.2:** Y-axis PPV measured at Location A.



**Figure 4.3:** Z-axis PPV measured at Location A.



**Figure 4.4:** Resultant PPV measured at Location A.

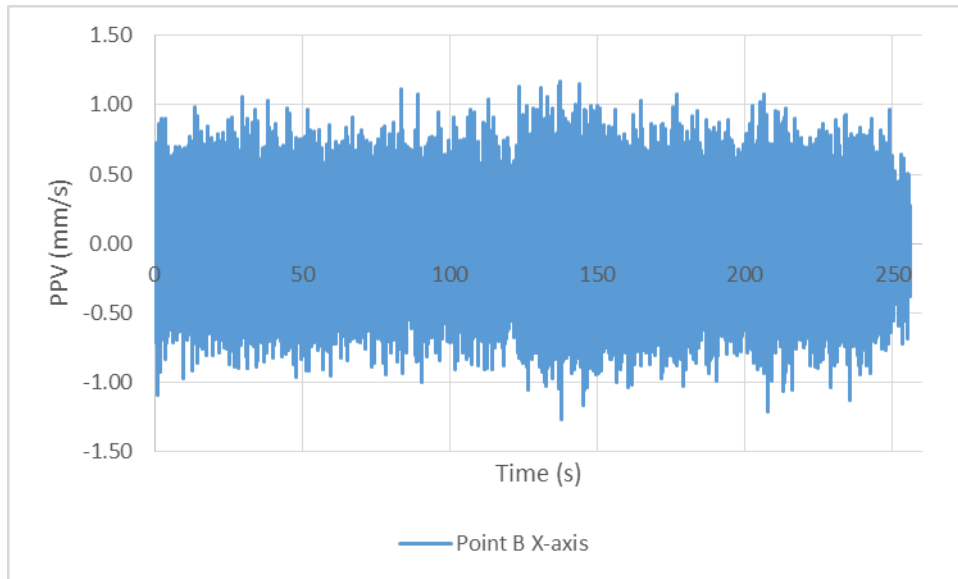
Max X (mm/s)	Max Y (mm/s)	Max Z (mm/s)
1.96E+00	1.92E+00	7.75E-01
Min X (mm/s)	Min Y (mm/s)	Min Z (mm/s)
-2.00E+00	-2.03E+00	-8.25E-01

**Table 4.1:** Maximum and minimum PPV at Location A.

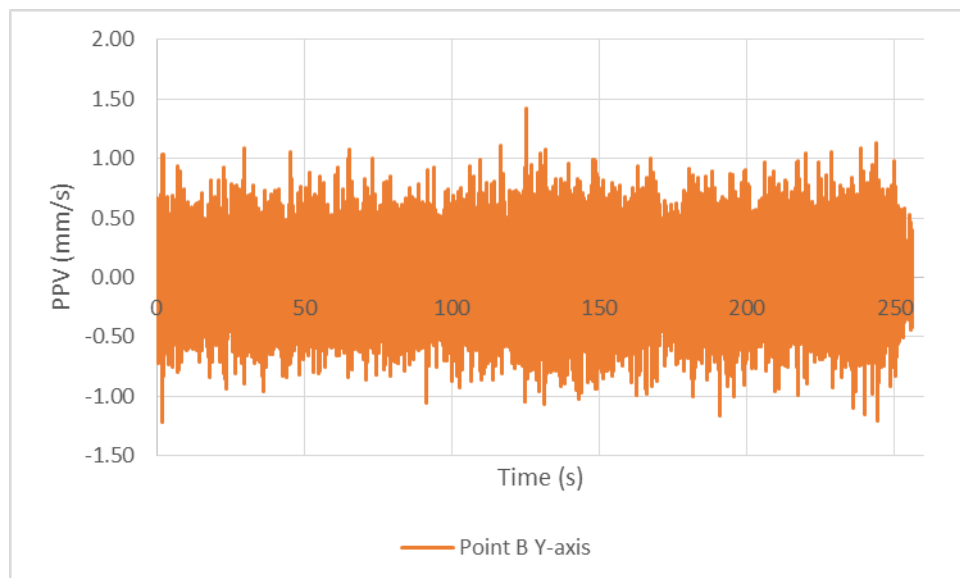


4.3 Figures 4.5 to 4.7 present the peak particle velocity (PPV) for X, Y and Z axis respectively, between 1 and 256 seconds measured at Location B. Figure 4.8 presents the resultant PPV, between 1 and 256 seconds measured at Location B.

4.4 The maximum and minimum PPVs of each axis at Location B are identified and presented in Table 4.2.

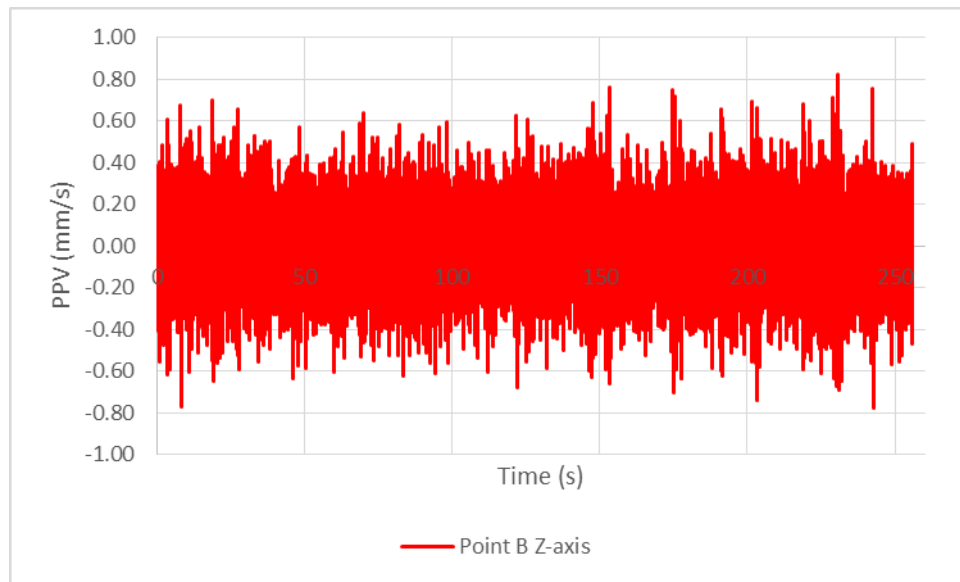


**Figure 4.5:** X-axis PPV measured at Location B.

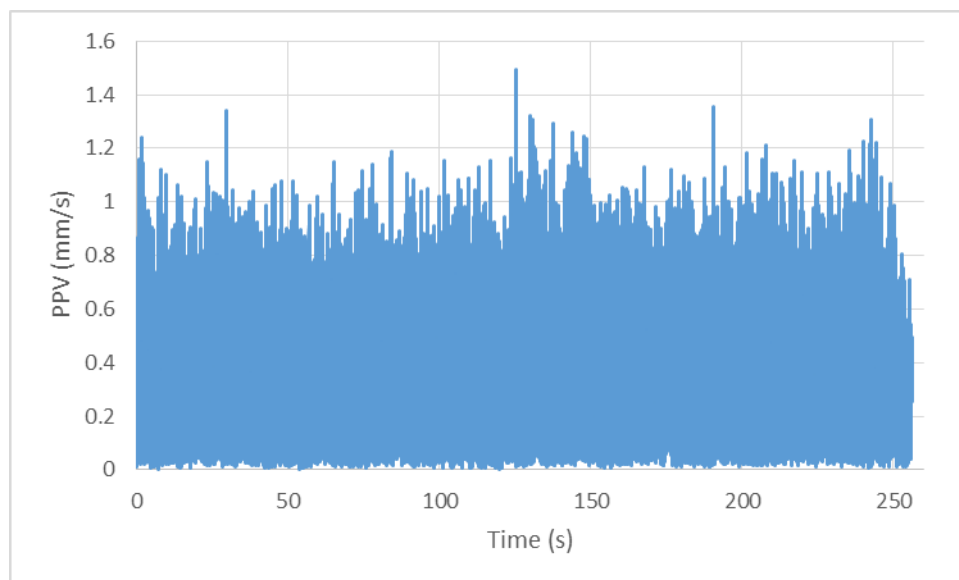


**Figure 4.6:** Y-axis PPV measured at Location B.





**Figure 4.7:** Z-axis PPV measured at Location B.



**Figure 4.8:** PPV measured at Location B.

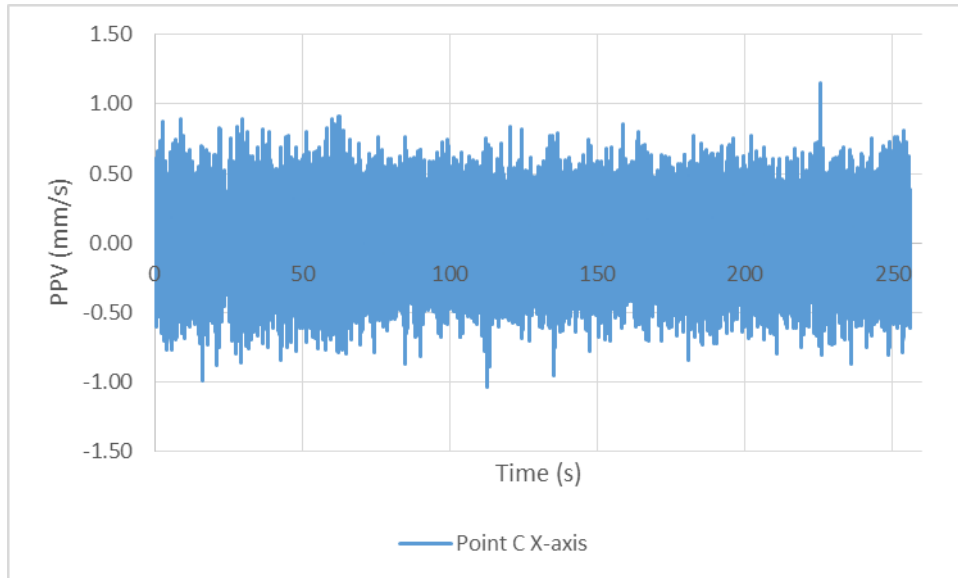
Max X (mm/s)	Max Y (mm/s)	Max Z (mm/s)
1.17E+00	1.42E+00	8.25E-01
Min X (mm/s)	Min Y (mm/s)	Min Z (mm/s)
-1.27E+00	-1.22E+00	-7.77E-01

**Table 4.2:** Maximum and minimum PPV at Location B.

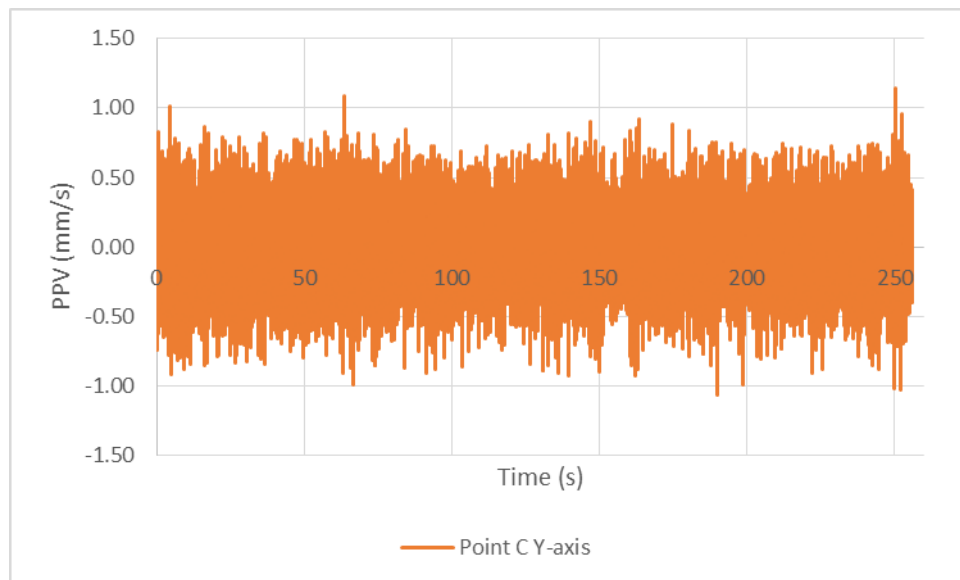


4.5 Figures 3.9 to 3.11 present the peak particle velocity (PPV) for X, Y and Z axis respectively, between 1 and 256 seconds measured at Location C. Figure 3.12 presents the resultant PPV, between 1 and 256 seconds measured at Location C.

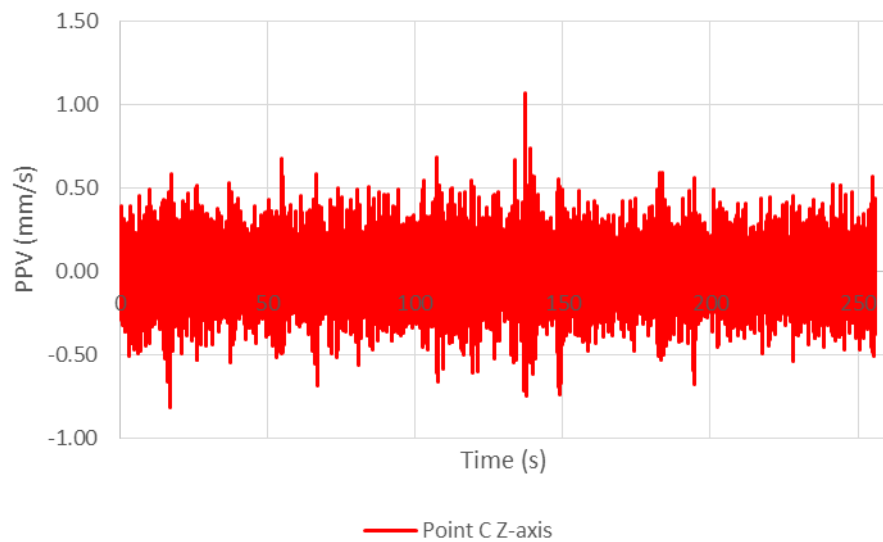
4.6 The maximum and minimum PPVs of each axis at Location C are identified and presented in Table 3.3.



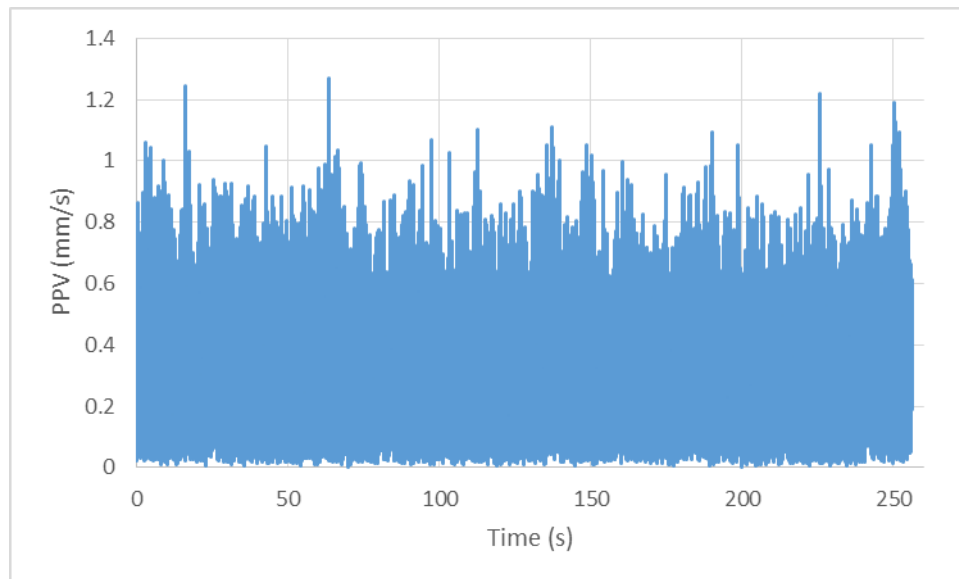
**Figure 4.9:** X-axis PPV measured at Location C.



**Figure 4.10:** Y-axis PPV measured at Location C.



**Figure 4.11: Z-axis PPV measured at Location C.**



**Figure 4.12: PPV measured at Location C.**

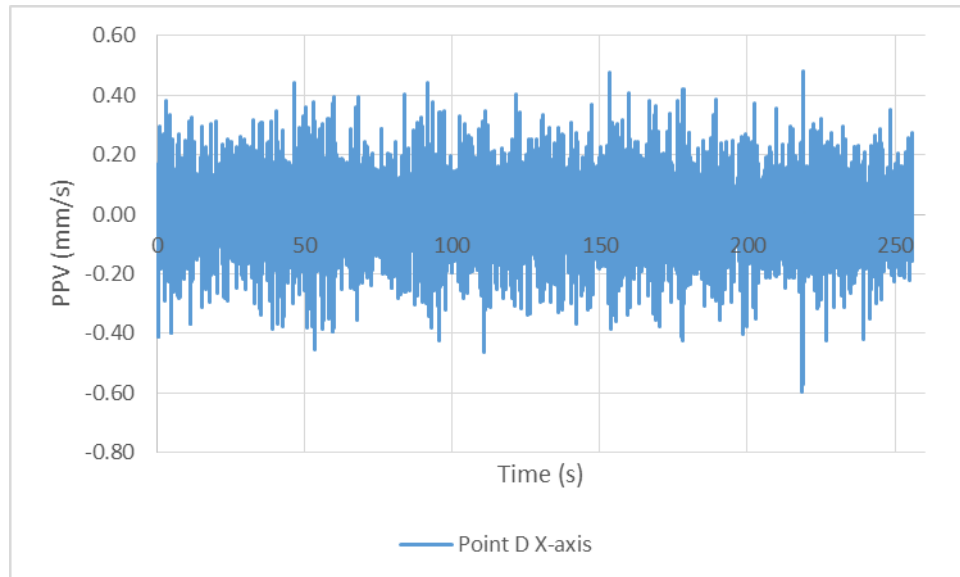
Max X (mm/s)	Max Y (mm/s)	Max Z (mm/s)
1.15E+00	1.14E+00	1.07E+00
Min X (mm/s)	Min Y (mm/s)	Min Z (mm/s)
-1.04E+00	-1.07E+00	-8.14E-01

**Table 4.3: Maximum and minimum PPV at Location C.**

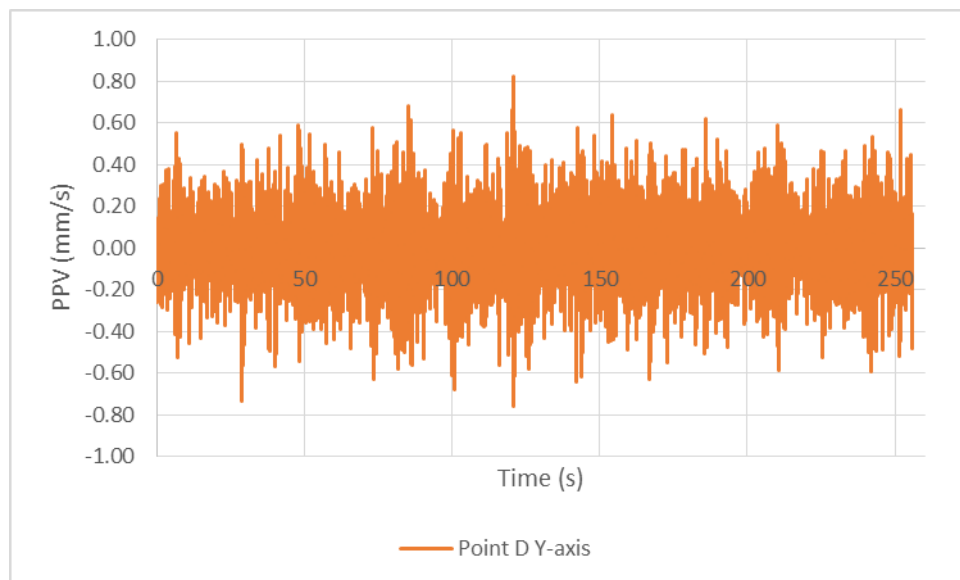


4.7 Figures 3.13 to 3.15 present the peak particle velocity (PPV) for X, Y and Z axis respectively, between 1 and 256 seconds measured at Location D. Figure 3.16 presents the resultant PPV, between 1 and 256 seconds measured at Location D.

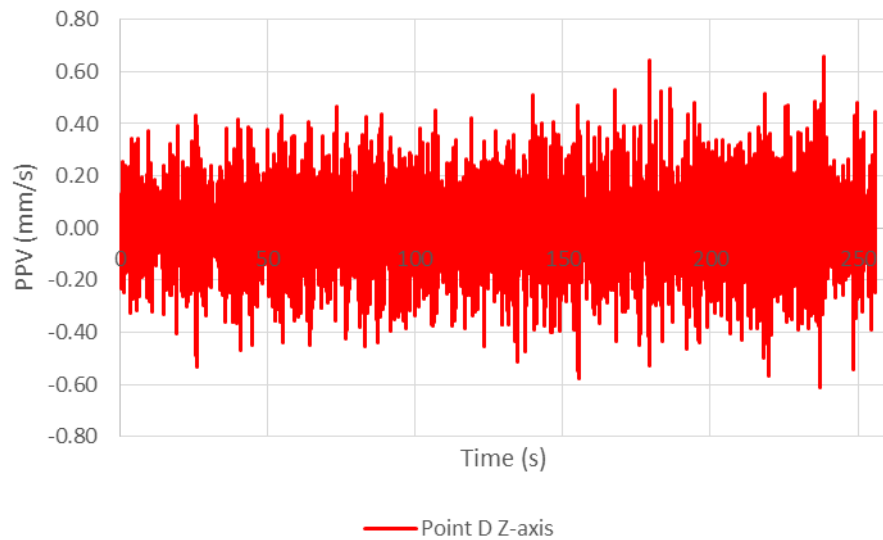
4.8 The maximum and minimum PPVs of each axis at Location D are identified and presented in Table 3.4.



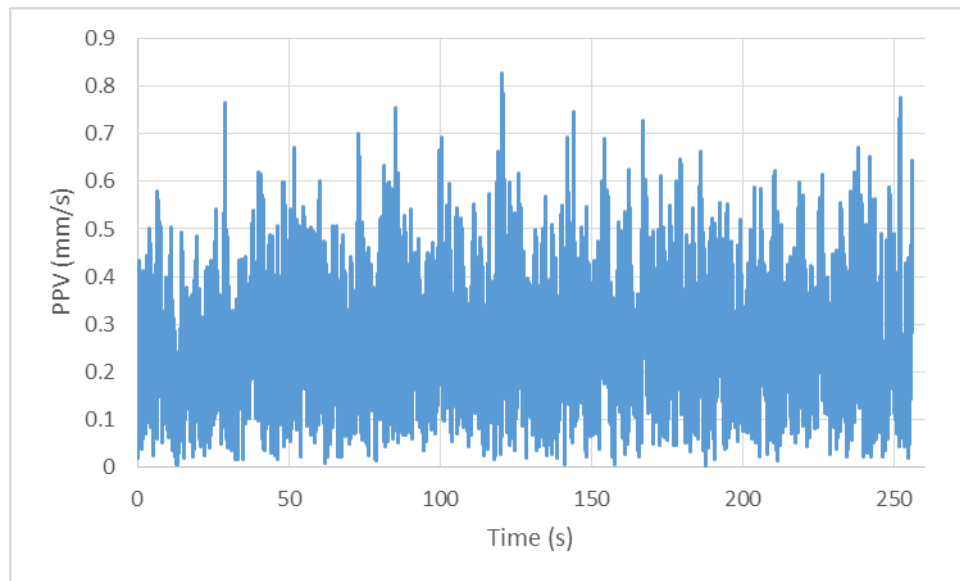
**Figure 4.13:** X-axis PPV measured at Location D.



**Figure 4.14:** Y-axis PPV measured at Location D.



**Figure 4.15:** Z-axis PPV measured at Location D.



**Figure 4.16:** PPV measured at Location D.

Max X (mm/s)	Max Y (mm/s)	Max Z (mm/s)
4.81E-01	8.24E-01	6.60E-01
Min X (mm/s)	Min Y (mm/s)	Min Z (mm/s)
-5.97E-01	-7.58E-01	-6.14E-01

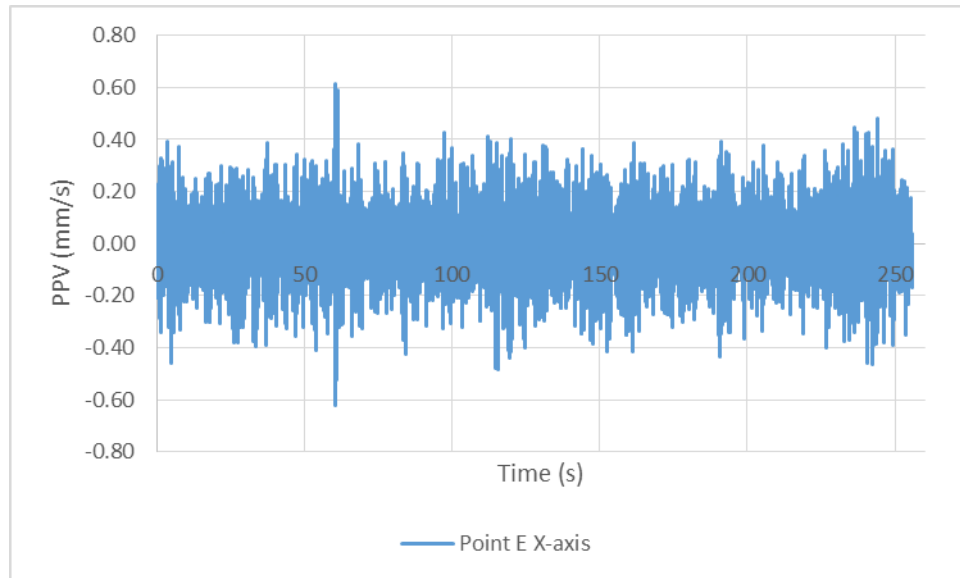
**Table 4.4:** Maximum and minimum PPV at Location D.



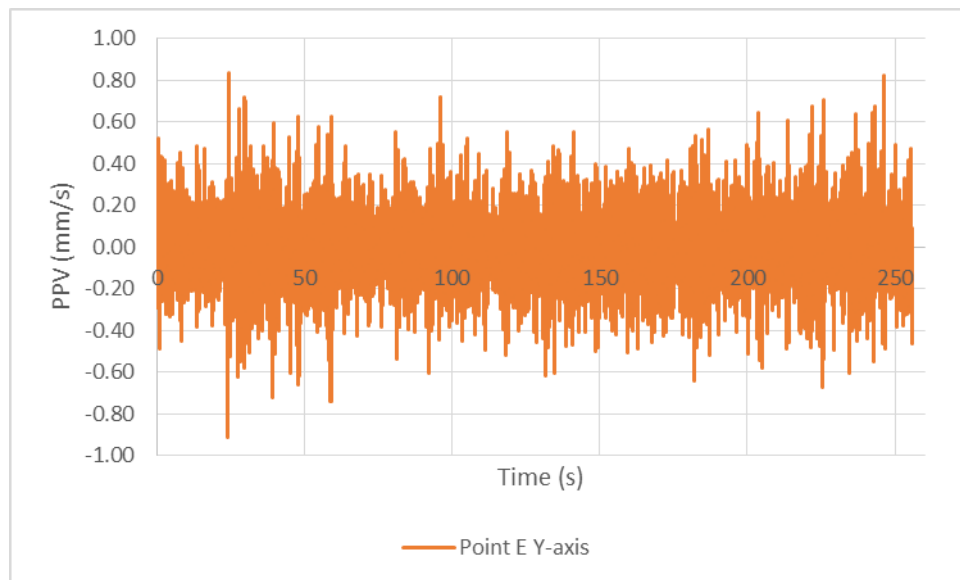


4.9 Figures 4.17 to 4.19 present the peak particle velocity (PPV) for X, Y and Z axis respectively, between 1 and 256 seconds measured at Location E. Figure 4.20 presents the resultant PPV, between 1 and 256 seconds measured at Location E.

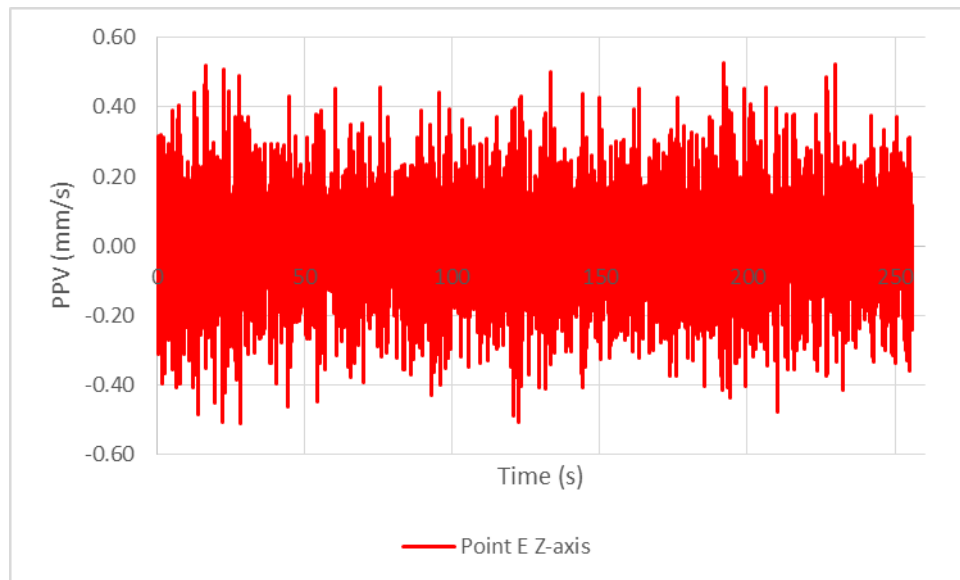
4.10 The maximum and minimum PPVs of each axis at Location E are identified and presented in Table 4.5.



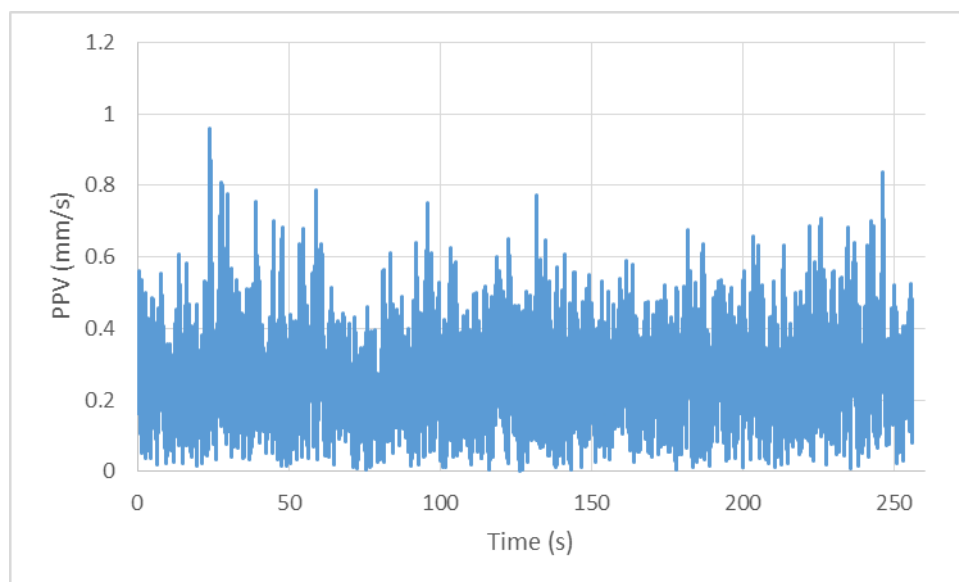
**Figure 4.17: X-axis PPV measured at Location E.**



**Figure 4.18: Y-axis PPV measured at Location E.**



**Figure 4.19:** Z-axis PPV measured at Location E.



**Figure 4.20:** PPV measured at Location E.

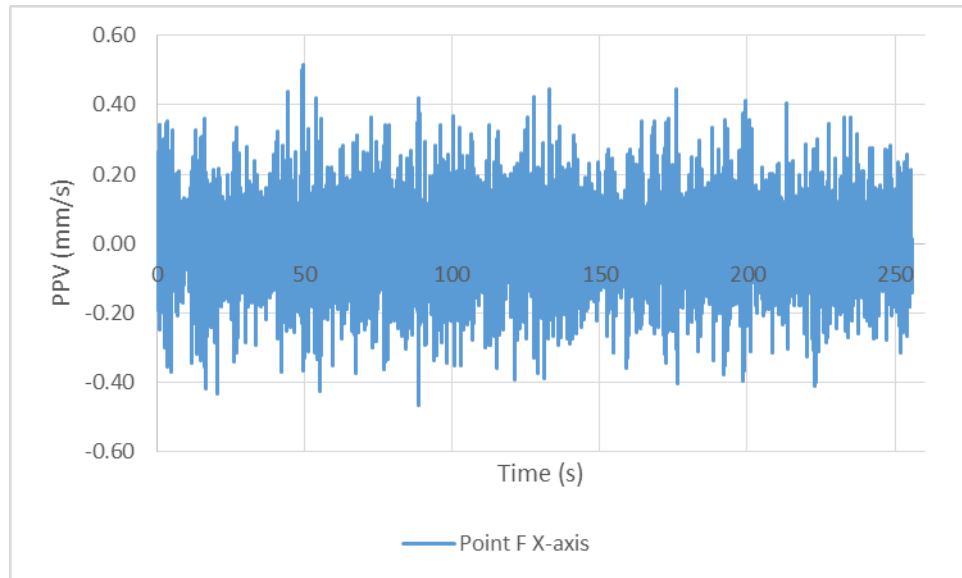
Max X (mm/s)	Max Y (mm/s)	Max Z (mm/s)
6.15E-01	8.33E-01	5.29E-01
Min X (mm/s)	Min Y (mm/s)	Min Z (mm/s)
-6.21E-01	-9.11E-01	-5.10E-01

**Table 4.5:** Maximum and minimum PPV at Location E.

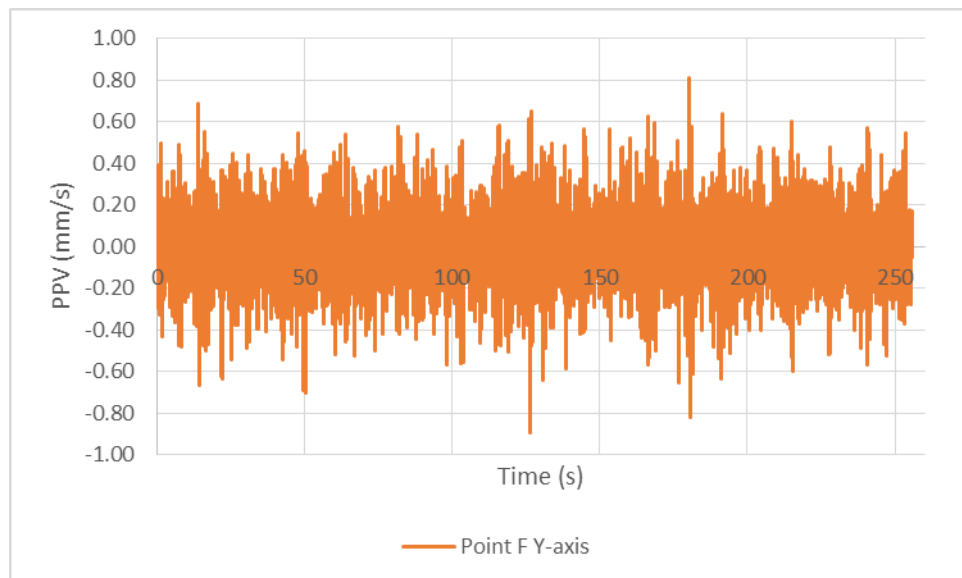


4.11 Figures 4.21 to 4.23 present the peak particle velocity (PPV) for X, Y and Z axis respectively, between 1 and 256 seconds measured at Location F. Figure 4.24 presents the resultant PPV, between 1 and 256 seconds measured at Location F.

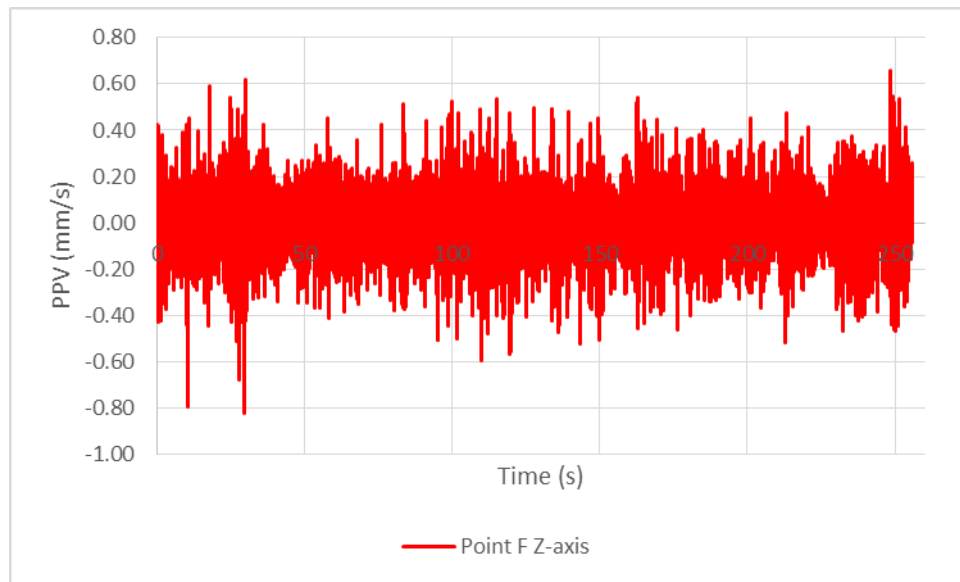
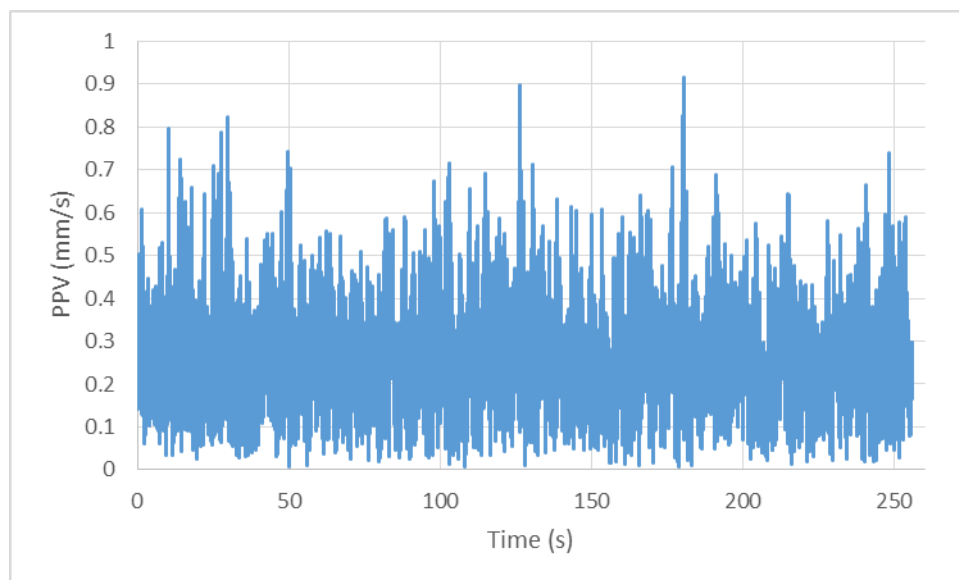
4.12 The maximum and minimum PPVs of each axis at Location F are identified and presented in Table 4.6.



**Figure 4.21:** X-axis PPV measured at Location F.



**Figure 4.22:** Y-axis PPV measured at Location F.

**Figure 4.23:** Z-axis PPV measured at Location F.**Figure 4.24:** PPV measured at Location F.

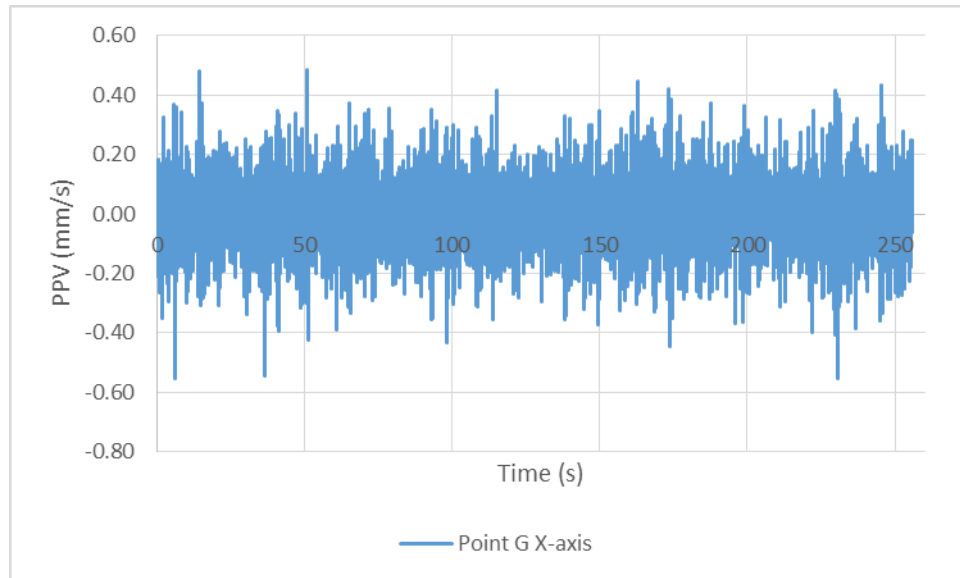
Max X (mm/s)	Max Y (mm/s)	Max Z (mm/s)
5.15E-01	8.10E-01	6.55E-01
Min X (mm/s)	Min Y (mm/s)	Min Z (mm/s)
-4.67E-01	-8.96E-01	-8.20E-01

**Table 4.6:** Maximum and minimum PPV at Location F.

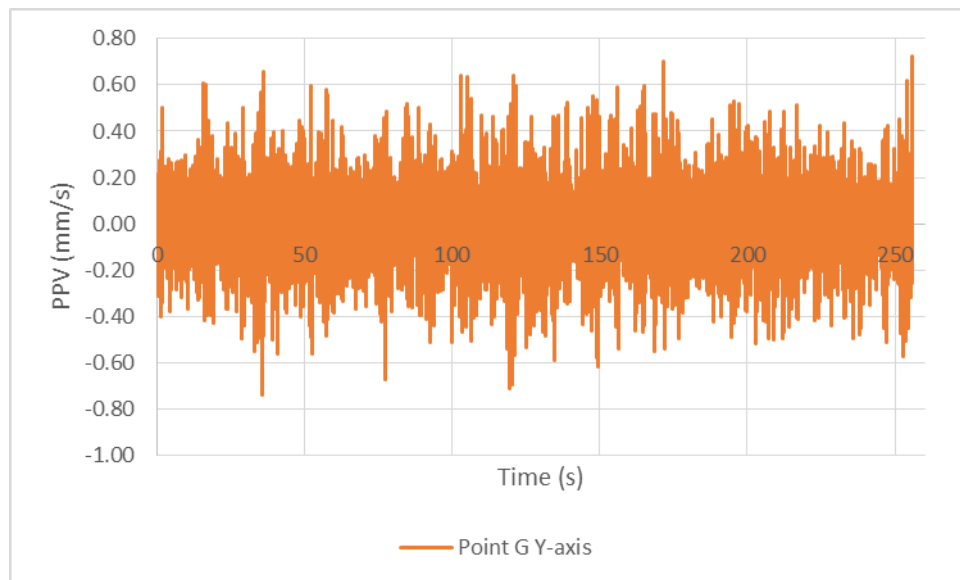


4.13 Figures 4.25 to 4.27 present the peak particle velocity (PPV) for X, Y and Z axis respectively, between 1 and 256 seconds measured at Location G. Figure 4.28 presents the resultant PPV, between 1 and 256 seconds measured at Location G.

4.14 The maximum and minimum PPVs of each axis at Location G are identified and presented in Table 4.7.

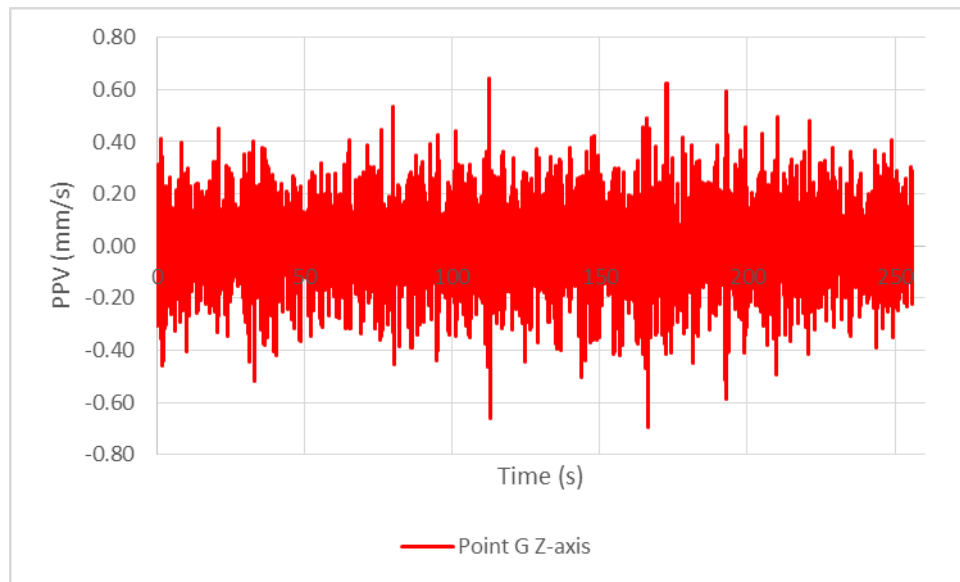


**Figure 4.25:** X-axis PPV measured at Location G.

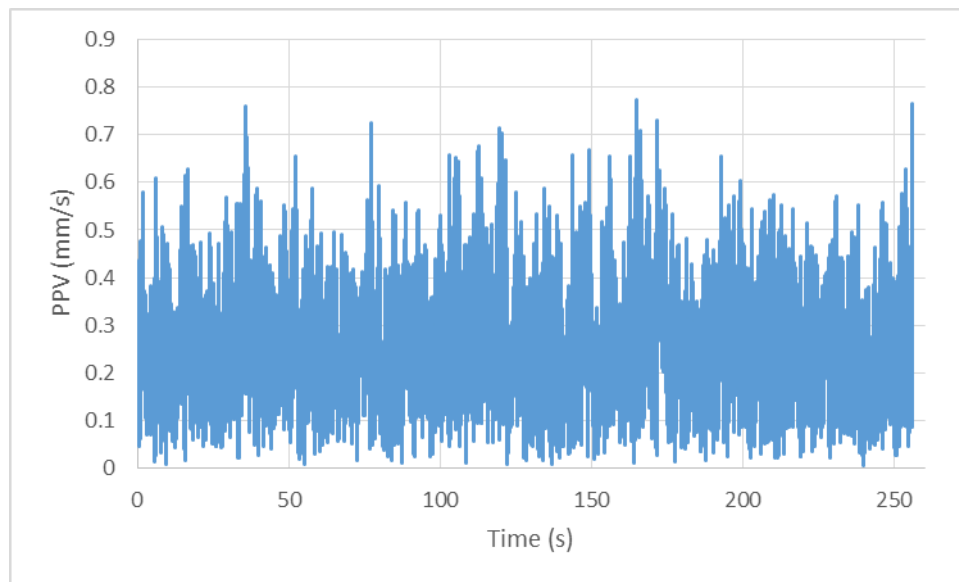


**Figure 4.26:** Y-axis PPV measured at Location G.





**Figure 4.27:** Z-axis PPV measured at Location G.



**Figure 4.28:** PPV measured at Location G.

Max X (mm/s)	Max Y (mm/s)	Max Z (mm/s)
4.85E-01	7.26E-01	6.42E-01
Min X (mm/s)	Min Y (mm/s)	Min Z (mm/s)
-5.55E-01	-7.40E-01	-6.98E-01

**Table 4.7:** Maximum and minimum PPV at Location G



**Appendix A**

Calibration Certificate

**VIBRATION & SOUND SERVICES & SALES PTE LTD**

59 Ubi Avenue 1, Bizlink Centre #04-17, Singapore 408938

Tel : 65-68440190 Fax : 65-65121903

**CERTIFICATE OF CALIBRATION**

REFERENCE : MCR\_ARS\_1206\_2015\_624498  
CUSTOMER : Affinity Engineering Consultancy Pte Ltd  
ADDRESS : 10 Bukit Batok Crescent, The Spire #08-05  
Singapore 658079  
DESCRIPTION : 4-Channel Signal Analyser Box  
MODEL : A4404  
MANUFACTURER : Adash  
SERIAL NO. : 624498  
DATE CALIBRATED : 24.12.2014  
NEXT DUE DATE : 24.12.2015  
TEMPERATURE : 25+/- 1 Celsius  
HUMIDITY : 47%

The test results have been verified to be generally within specification UNLESS indicated otherwise. The Laboratory's organisation and practices are derived from ISO/IEC 17025.

The instrument used for this calibration is traceable to National Institute of Standards and Technology (NIST) and Singapore Productivity and Standards Board (PSB). Compliance to ISO/IEC 17025:Ref. No. VSS/S & Ref. No. VSS/4.

**Calibration Equipment Used:**

<u>Model / Type</u>	<u>S / No</u>	<u>Next Due</u>
1. Function Generator	08090836	17/07/2015
2. Digital Multi-meter Fluke 77III	709606133X	29/07/2015

The analyser was set to the frequency span from 10 Hz to 1600 Hz with 1600 lines.  
Sensor sensitivity set to 100mV/g  
Input signal: 159.2 Hz, 100 mV AC, 5V DC offset

**Calibration Data**

Channel	Reading	Velocity	Reading	Acceleration
		Settings		Settings
Channel 1	9.82	9.81 ± 0.29 mm/s RMS	9.80	9.81 ± 0.29 m/s <sup>2</sup> RMS
Channel 2	9.81	9.81 ± 0.29 mm/s RMS	9.80	9.81 ± 0.29 m/s <sup>2</sup> RMS
Channel 3	9.81	9.81 ± 0.29 mm/s RMS	9.80	9.81 ± 0.29 m/s <sup>2</sup> RMS
Channel 4	9.81	9.81 ± 0.29 mm/s RMS	9.80	9.81 ± 0.29 m/s <sup>2</sup> RMS

**Comments:**

All calibration measurement reading is within the accuracy tolerances of ±3%.

**Test & Calibrated By:**

Raymond Lee  
Vibration Engineer

**VIBRATION & SOUND SERVICES & SALES PTE LTD**

59 Ubi Avenue 1, Bizlink Centre #04-17, Singapore 408938

Tel : 65-68440190 Fax : 65-65121903

**CERTIFICATE OF CALIBRATION**

REFERENCE : MCR\_ARS\_1103\_2015\_1015  
CUSTOMER : Affinity Engineering Consultancy Pte Ltd  
ADDRESS : 10 Bukit Batok Crescent, The Spire #08-05  
Singapore 658079  
DESCRIPTION : Triaxial Accelerometer  
MODEL : A115-1A  
MANUFACTURER : Adash,  
SERIAL NO. : 1015  
DATE CALIBRATED : 30.12.2014  
NEXT DUE DATE : 30.12.2015  
TEMPERATURE : 25+/- 1 Celsius  
HUMIDITY : 47%

The test results have been verified to be generally within specification UNLESS indicated otherwise. The Laboratory's organisation and practices are derived from ISO/IEC 17025.

The instrument used for this calibration is traceable to National Institute of Standards and Technology (NIST) and Singapore Productivity and Standards Board (PSB). Compliance to ISO/IEC 17025-Ref. No. VSS/5 & Ref. No. VSS/4.

**Calibration Equipment Used:**

Type	S / No	Next Due
1. Shaker System	CM4153	14/03/2015
2. Vibration Analyser	623274	24/12/2015

**Procedure:**

1. The unit under test is placed on the shaker-table. The shaker is excited by the internal function generator to generate vibrations from pre-determined frequencies and amplitudes.
2. By utilizing the transfer function the sensitivity and the deviation is recorded at different frequencies by the vibration analyser.
3. Test result is shown on calibration data.

**Comments:**

1. The tests show that the dB variation was within the  $\pm 3$  dB for the range 25-2000 Hz for all the 3 axes.

**Test & Calibrated By:**

Raymond Lee  
Vibration Engineer

MCR\_ARS\_1103\_2015\_1015

Page 1 of 3

**VIBRATION & SOUND SERVICES & SALES PTE LTD**

59 Ubi Avenue 1, Bizlink Centre #04-17, Singapore 408938

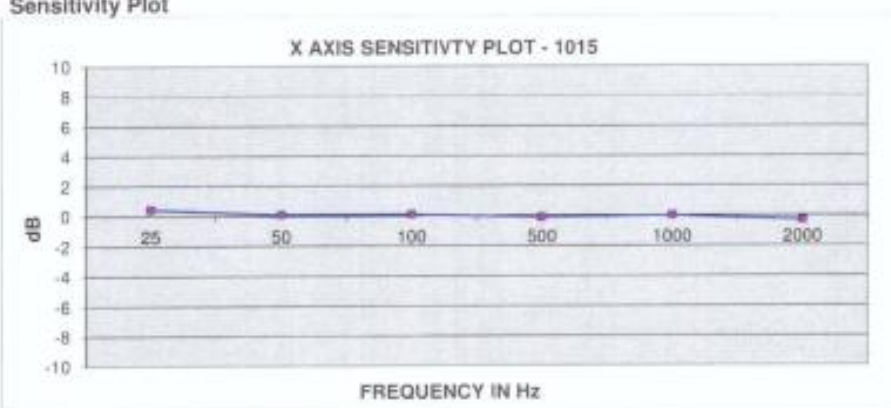
Tel : 65-68440190 Fax : 65-65121903

**CALIBRATION DATA**

Axis : X Direction  
Sensitivity @ 100 Hz : 96 mV/g

**Data Points**

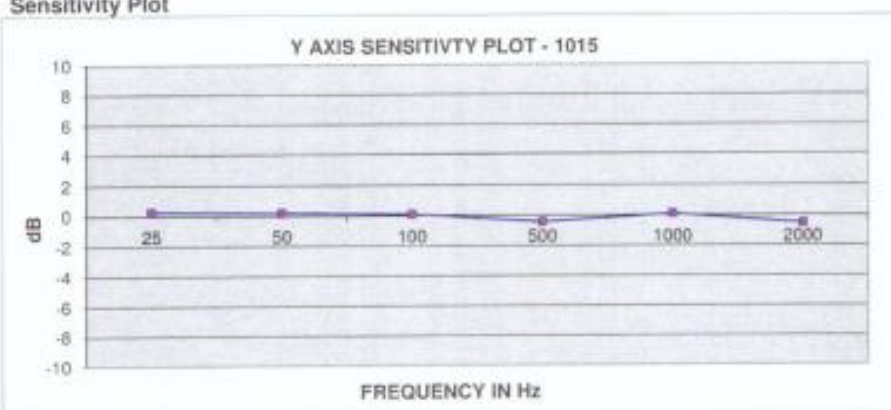
Freq. (Hz)	25	50	100	500	1,000	2,000
Sensitivity	100.8	97.0	97.0	94.7	96.0	92.6
Deviation %	0.05	0.01	0.01	-0.01	0.00	-0.04
dB	0.42	0.09	0.09	-0.12	0.00	-0.31

**Sensitivity Plot**

Axis : Y Direction  
Sensitivity @ 100 Hz : 96 mV/g

**Data Points**

Freq. (Hz)	25	50	100	500	1,000	2,000
Sensitivity	98.9	97.9	97.0	91.2	97.0	90.2
Deviation %	0.03	0.02	0.01	-0.05	0.01	-0.06
dB	0.26	0.17	0.09	-0.45	0.09	-0.54

**Sensitivity Plot**



**VIBRATION & SOUND SERVICES & SALES PTE LTD**

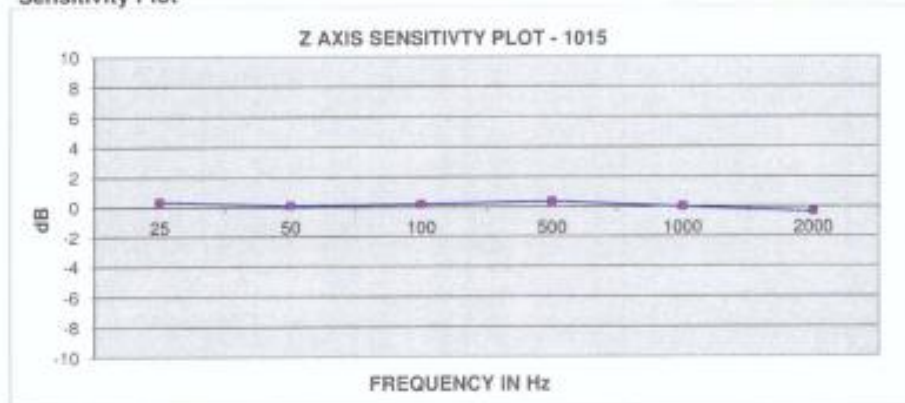
59 Ubi Avenue 1, Bizlink Centre #04-17, Singapore 408938

Tel : 65-68440190 Fax : 65-65121903

Axis : Z Direction  
Sensitivity @ 100 Hz : 100 mV/g

**Data Points**

Freq. (Hz)	25	50	100	500	1,000	2,000
Sensitivity	104.0	101.0	102.0	104.0	100.0	96.0
Deviation %	0.04	0.01	0.02	0.04	0.00	-0.04
dB	0.34	0.09	0.17	0.34	0.00	-0.35

**Sensitivity Plot**

Annex 6.0

## Air Quality Survey Results



**ALS Technichem (S) Pte Ltd**

121 Genting Lane #04-01, Singapore 349572  
Tel: (65) 6589 0118 Fax : (65) 6283 9689 E-mail: [alssg@alsglobal.com](mailto:alssg@alsglobal.com)  
Co. Reg No. 198403076R

Our Ref: ATS/IH/23a/15TTH

Date: 11 March 2015

**AMBIENT AIR MONITORING REPORT**  
**FOR**  
**ENVIRONMENTAL RESOURCES MANAGEMENT (S) PTE LTD**  
**120 ROBINSON ROAD #10-01,**  
**SINGAPORE 068913**

---

Chai Wai Hang  
Senior Field Chemist

---

Tan Teong Huat  
Senior Manager  
BSc, MSc (SHE Tech.), MSNIC

*This Report shall not be reproduced except in full without prior approval of Management*  
*This Report may not be used for advertising purposes*

## EXECUTIVE SUMMARY

ALS Technichem (S) Pte Ltd has carried out two rounds of air monitoring around Central Catchment Nature Reserve (MacRitchie) Singapore. The first round of monitoring started on 24<sup>th</sup> November to 26<sup>th</sup> December 2014 with a total of four ambient air monitoring points, namely AQ101\_R1, AQ102\_R1, AQ201\_R1 and AQ202\_R1 and followed by the second round of monitoring from 16<sup>th</sup> January to 2<sup>nd</sup> February 2015 with a total of five monitoring points have been setup, namely AQ101\_R2, AQ102\_R2, AQ201\_R2, AQ202\_R2 and AQ203\_R2. This exercise was undertaken to establish a baseline ambient air quality assessment of Particulate Matter (PM<sub>10</sub> & PM<sub>2.5</sub>) on the selected locations. The obtained results were also used to determine whether the ambient air quality is in compliance to the Singapore Ambient Air Quality Targets by 2020 of National Environmental Agency (NEA).

In general, all the PM<sub>2.5</sub> and PM<sub>10</sub> monitored at all sampling points were found to be within the limit stated in the Singapore Ambient Air Quality Targets by 2020 except periods listed in the following tables:

No. of Rounds	Monitoring Points	Parameters	
		Particulate Matter (PM <sub>2.5</sub> ) in ug m <sup>-3</sup>	Particulate Matter (PM <sub>10</sub> ) in ug m <sup>-3</sup>
First round of survey (R1)	AQ101	-	Day 1-4
	AQ102	-	Day 1,2,3 & 6
	AQ201	-	-
	AQ202	-	Day 1,2,3,5 & 7
Second round of survey (R2)	AQ101	-	Day 1,3,4,5 & 6
	AQ102	-	Day 3 & 4
	AQ201	-	Day 5
	AQ202	Day 5 & 6	Day 1-7
	AQ203 (16/01/15-22/01/15)	Day 3,4,5 & 6	Day 1-6
	AQ203 (02/02/15-09/02/15)	Day 1,3,5 & 6	Day 1-7
*Limit		37.5	50

In our opinion, as AQ202 is near to the roadway, hence the notably particulate level may associate to the engine exhaust emission from the vehicular traffic. On another note, the sources of particulate emission from AQ101 & AQ102 are likely from natural source mainly unpaved road (trail) and wind erosion within the park.

In conclusion, baseline monitoring of ambient air quality at the selected location is recommended during the enhancement work around the Central Catchment Nature Reserve (MacRitchie) Singapore. This exercise will help to determine the presence of air contaminants if any based on their daily operations and activities which will have any potential health hazard effect to the occupants on site. In addition, this will assists in reviewing the air quality of the selected location in relation to their local or any international regulatory deem applicable.



## LIST OF CONTENT

### Table of Contents

EXECUTIVE SUMMARY .....	0-2
LIST OF CONTENT .....	3
LIST OF TABLE .....	4
LIST OF FIGURE .....	4
LIST OF ABBREVIATION .....	4
1.0 INTRODUCTION .....	5
1.1 Objectives.....	5
1.2 Scope of Work.....	5
1.2.1 Monitoring Requirement .....	6
2.0 SAMPLING AND FIELD MONITORING .....	6
2.1 Sampling Equipment .....	6
2.2 Sampling Locations .....	7-8
3.0 SAMPLING AND ANALYSIS METHODOLOGIES .....	9
3.1 Quality Assurance / Quality Control .....	9
3.1.1 Calibration of Field Equipment .....	9
4.0 Detail of Ambient Air Monitoring Point (Round 1) .....	11
5.0 RESULTS (Round 1) .....	12
6.0 Detail of Ambient Air Monitoring Point (Round 2).....	43
7.0 RESULTS (Round 2) .....	44
8.0 CONCLUSION .....	87
7.0 REFERENCES.....	87

APPENDIX 1: Calibration Certificate of Field Equipment

APPENDIX 2: Site Photo

## LIST OF TABLE

Table 1 : Summary of test parameters and limits for ambient air monitoring.....	6
Table 2 : Summary of methodologies and limit of reporting (LOR).....	9
Table 3: Details of monitoring point (Round 1) .....	11
Table 4-5: Summary of results for Particulate Matter (PM <sub>2.5</sub> & PM <sub>10</sub> ) based on 24 hours average (Round 1).....	12-13
Table 6: Details of monitoring point (Round 2) .....	43
Table 7-8: Table 4-5: Summary of results for Particulate Matter (PM <sub>2.5</sub> & PM <sub>10</sub> ) based on 24 hours average (Round 2).....	12-13

## LIST OF FIGURE

	Page
Figure 1-3: Sampling Locations	6-7
Figure 4-31: Daily particulate concentration measured at Point AQ101,AQ102, AQ201 & AQ202 (Round 1)	14-41
Figure32-72: Daily particulate concentration measured at Point AQ101,AQ102, AQ201,AQ202 & AQ203 (Round 2)	46-86

## LIST OF ABBREVIATION

PM <sub>10</sub>	Particulate matter with aerodynamic diameter 10um or smaller
PM <sub>2.5</sub>	Particulate matter with aerodynamic diameter 2.5um or smaller
LOR	Limit of Reporting

## **1.0 INTRODUCTION**

ALS TECHNICHEM (S) PTE LTD (hereafter as “ALS”) has been appointed as the contractor to perform the Ambient Air Monitoring around the Central Catchment Nature Reserve (MacRitchie) Singapore as request by Environmental Resources Management (S) Pte Ltd (hereafter as “ERM”).

### **1.1 Objectives**

The ambient air monitoring is aimed to provide air quality baseline information on the state around the Central Catchment Nature Reserve (MacRitchie) environment. It helps the company management in evaluating environmental contamination if any, from present activities and also assists in reviewing the quality of the air monitoring point's environment in relation to regulatory and/or company requirements, if available.

### **1.2 Scope of Work**

The scope of works for the ambient air quality monitoring includes:

1. Preparation of an Ambient Air Monitoring Plan;
2. Ambient air monitoring station setup and sampling at selected five sampling points, namely AQ101-AQ102, AQ201-AQ203 (sampling point was dictated by ERM);
3. Collected air samples were analyzed for Particulate Matter (PM<sub>10</sub> & PM<sub>2.5</sub>)
4. Assessing the analytical results against Singapore Ambient Air Quality Targets by 2020 of National Environmental Agency (NEA) and;
5. Providing a report outlining the findings and results of the study.

### 1.2.1 Monitoring Requirement

Ambient air monitoring covers five sampling points, namely AQ101, AQ102, AQ201, AQ202 and AQ203. Particulate Matter (PM<sub>10</sub> & PM<sub>2.5</sub>) was monitored at all sampling points as required. Monitored parameters were dictated by ERM and compare with the Singapore Ambient Air Quality Targets by 2020. Table 1 lists the details of the limits of each parameter in this study.

**Table 1: Summary of test parameters and limits for ambient air monitoring**

Parameters	Limits (µgm <sup>-3</sup> or as indicated)	Guidelines
PM <sub>10</sub>	50 (24-hour averaging period)	Singapore Ambient Air Quality Targets by 2020
PM <sub>2.5</sub>	37.5 (24-hour averaging period)	

## 2.0 SAMPLING AND FIELD MONITORING

ALS has performed all the required sampling for ambient air monitoring at selected locations.

### 2.1 Sampling Equipment

The following equipment was mobilized and used during the environmental monitoring activities.

Parameter	Sampling Device
Particulate matter (PM <sub>10</sub> & PM <sub>2.5</sub> )	Met One (AEROCET 531)

## 2.2 Sampling Locations

Figure 1-3 illustrates the sampling locations for this monitoring program.

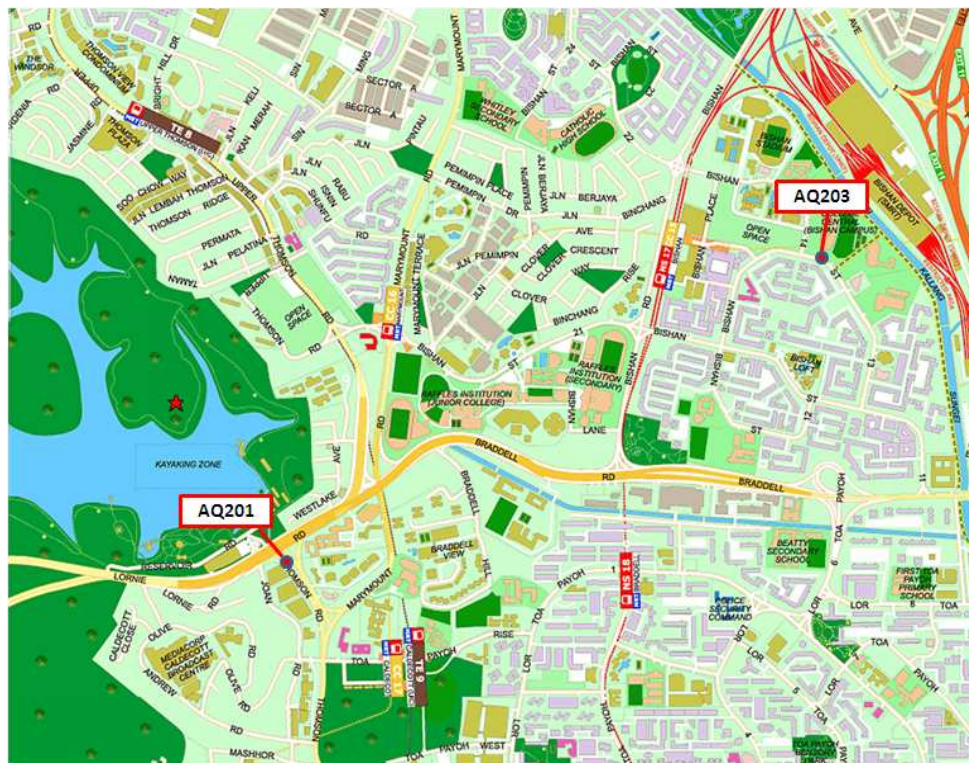


Figure 1: Sampling Locations





**Figure 2: Sampling Locations**



**Figure 3: Sampling Locations**

### 3.0 SAMPLING AND ANALYSIS METHODOLOGIES

Brief method description, method reference and reporting limit of the analytical methods are provided in Table 2.

**Table 2: Summary of methodologies and limit of reporting (LOR)**

No.	Parameter	Referenced Analytical Method	Description of Method	LOR
1.	Particulate matter (PM <sub>10</sub> & PM <sub>2.5</sub> )	Met One AEROCET 531 Operation Manual	Concentrations of PM <sub>10</sub> & PM <sub>2.5</sub> were measured by laser diffraction technology using a portable Met one Aerosol Monitor for 5 -minute interval data log over a 7 days sampling period.	1 µgm <sup>-3</sup>

### 3.1 Quality Assurance / Quality Control

#### 3.1.1 Calibration of Field Equipment

All field equipments were pre and post calibrated to ensure it falls within the ALS Laboratory Group's criteria. The certificates of field equipments calibrations were also attached in Appendix 1.

# **Air Monitoring (First Round of Survey)**

Date of Survey: 24<sup>th</sup> November to 30<sup>th</sup> December 2014

#### 4.0 Detail of Ambient Air Monitoring Point (Round 1)

There were a total of four air monitoring points have been setup during first round of survey, namely AQ101\_R1-AQ102\_R1 and AQ201\_R1-AQ202\_R1. The monitoring point was dictated by ERM. The detail of the monitoring point is listed in Table 3.

**Table 3: Details of monitoring point**

Sampling ID	Parameter	Sampling Start		Sampling Stop	
		Date	Time (hr)	Date	Time (hr)
AQ101_R1	PM <sub>10</sub> & PM <sub>2.5</sub>	24/11/14	1103	01/12/14	1058
AQ102_R1		19/12/14	1722	30/12/14	1541
AQ201_R1		03/12/14	1103	10/12/14	1057
AQ202_R1		18/12/14	0501	30/12/14	1615

## 5.0 RESULTS (Round 1)

Results obtained for all sampling points were presented in Table 4 and 5. The daily particulate concentration at all monitoring points were illustrated in Figure 4 to 31.

**Table 4: Summary of results for Particulate Matter (PM<sub>2.5</sub> & PM<sub>10</sub>) based on 24 hours average**

Sampling Point	Duration, hr (Period)	Particulate Matter (PM <sub>2.5</sub> ) in ug m <sup>-3</sup> (24hrs)	Particulate Matter (PM <sub>10</sub> ) in ug m <sup>-3</sup> (24hr)
<b>AQ101_R1</b>	Day 1 (1103-1058) (24/11/14-25/11/14)	11.6	<b>54.6</b>
	Day 2 (1103-1058) (25/11/14-26/11/14)	19.6	<b>74.0</b>
	Day 3 (1103-1057) (26/11/14-27/11/14)	29.2	<b>76.0</b>
	Day 4 (1102-1057) (27/11/14-28/11/14)	17.2	<b>62.7</b>
	Day 5 (1102-1057) (28/11/14-29/11/14)	3.7	31.4
	Day 6 (1102-1059) (29/11/14-30/11/14)	7.4	46.2
	Day 7 (1104-1057) (30/11/14-01/12/14)	9.5	46.3
<b>AQ102_R1</b>	Day 1 (1722 -1720) (19/12/14-20/12/14)	17.0	<b>87.7</b>
	Day 2 (1723 -1720) (20/12/14-21/12/14)	20.7	<b>83.7</b>
	Day 3 (1723-1722) (21/12/14-22/12/14)	10.7	<b>55.0</b>
	Day 4 (1725 -1722) (22/12/14-23/12/14)	4.7	29.2
	Day 5 (1725 -1722) (23/12/14-24/12/14)	8.0	39.0
	Day 6 (1725-1722) (24/12/14-25/12/14)	7.8	<b>52.1</b>
	Day 7 (1546 -1541) (29/12/14-30/12/14)	7.3	43.8
<b>*Limit</b>		37.5	50

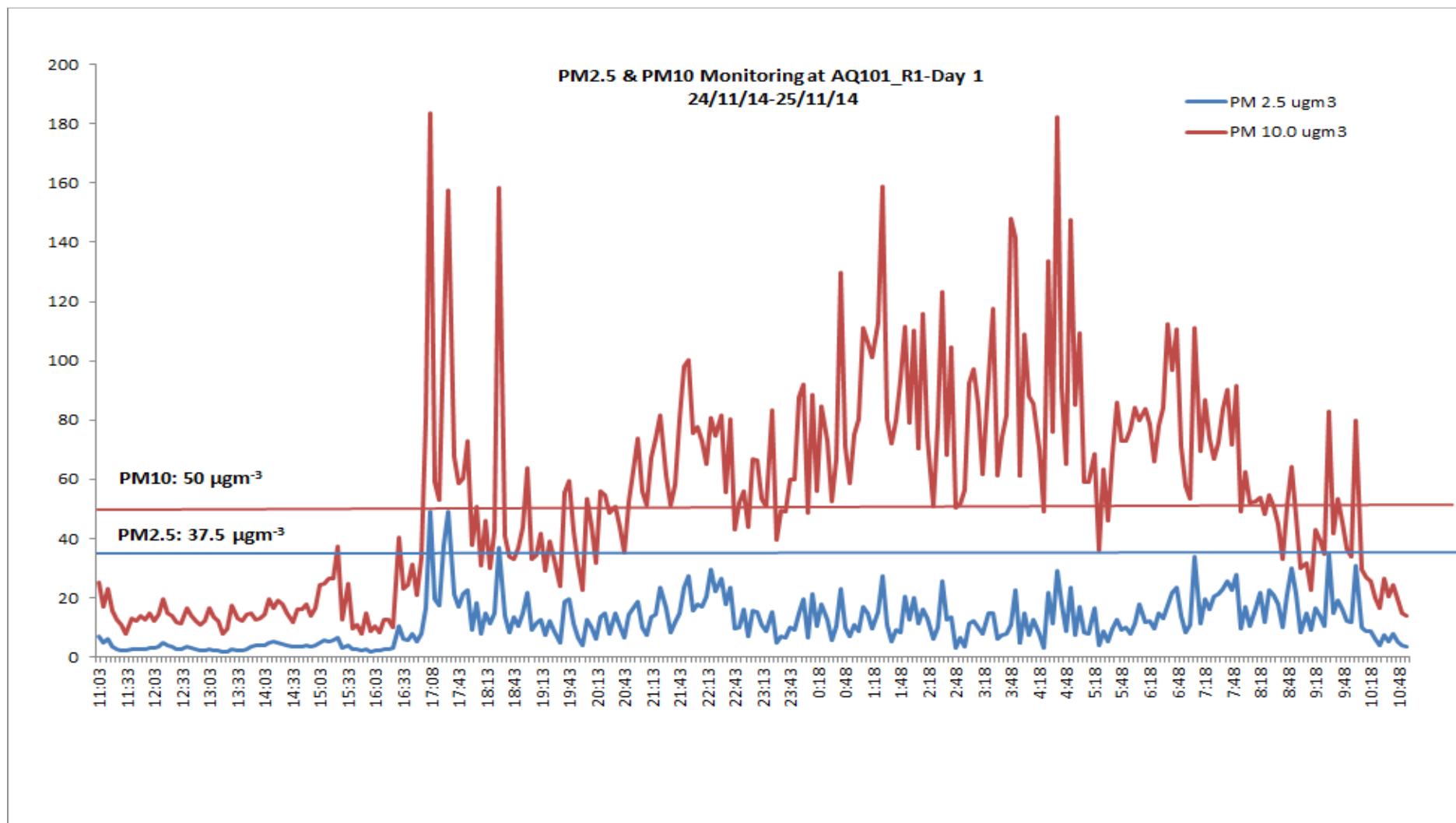
Remark: \* Singapore Ambient Air Quality Targets by 2020



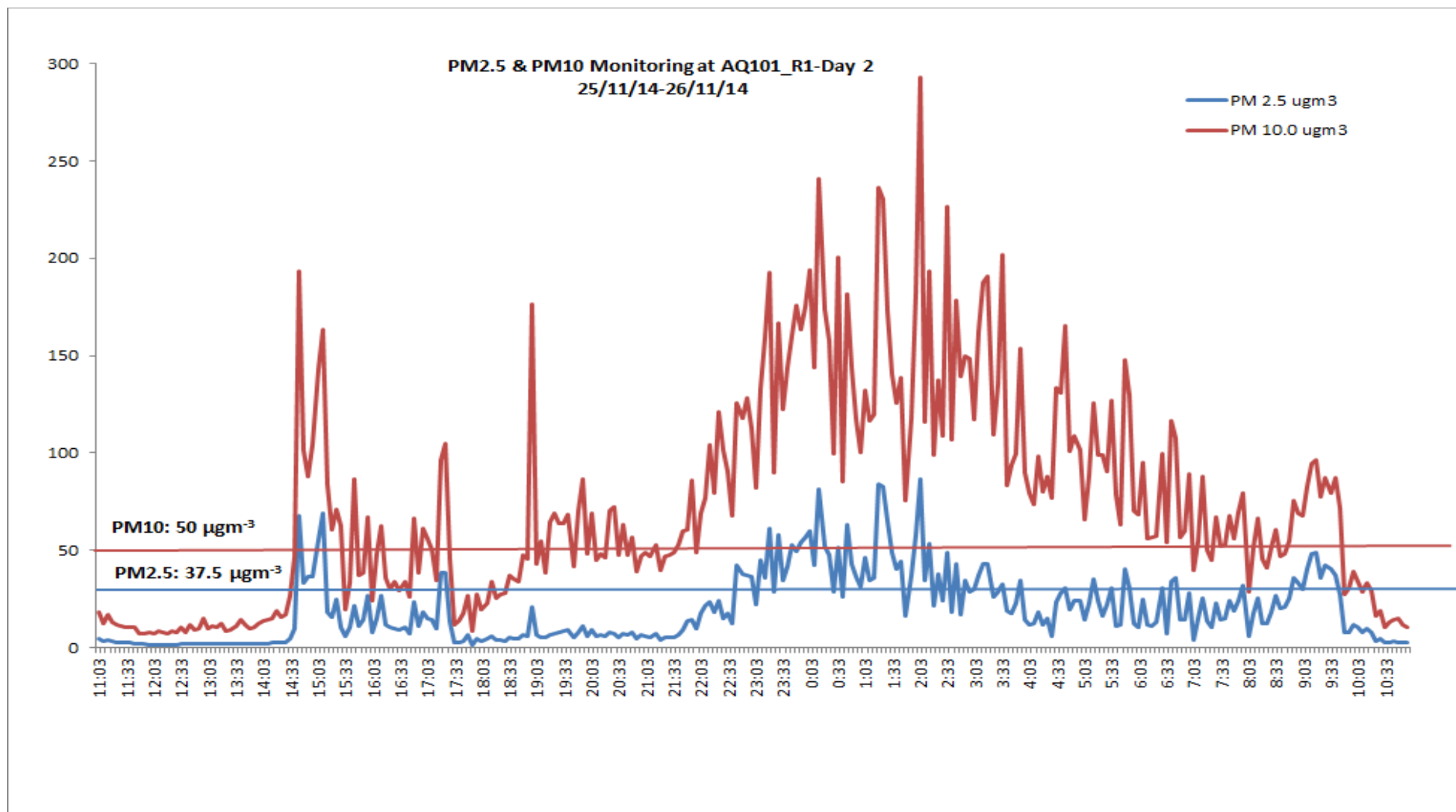
**Table 5: Summary of results for Particulate Matter (PM<sub>2.5</sub> & PM<sub>10</sub>) based on 24 hours average**

Sampling Point	Duration, hr (Period)	Particulate Matter (PM <sub>2.5</sub> ) in ug m <sup>-3</sup> (24hrs)	Particulate Matter (PM <sub>10</sub> ) in ug m <sup>-3</sup> (24hr)
<b>AQ201_R1</b>	Day 1 (1103-1058) (03/12/14-04/12/14)	4.3	21.7
	Day 2 (1103-1058) (04/12/14-05/12/14)	6.0	24.9
	Day 3 (1103-1057) (05/11/14-06/11/14)	3.1	13.0
	Day 4 (1102-1057) (06/12/14-07/12/14)	3.6	16.1
	Day 5 (1102-1057) (07/12/14-08/12/14)	5.9	19.1
	Day 6 (1102-1059) (08/12/14-09/11/14)	6.2	22.2
	Day 7 (1104-1057) (09/12/14-10/12/14)	8.5	32.4
<b>AQ202_R1</b>	Day 1 (0501 - 0459) (18/12/14-19/12/14)	12.5	<b>52.1</b>
	Day 2 (0501-0459) (19/12/14-20/12/14)	20.6	<b>78.7</b>
	Day 3 (0502-0500) (20/11/14-21/11/14)	12.1	<b>53.4</b>
	Day 4 (0503-0500) (21/12/14-22/12/14)	9.8	48.6
	Day 5 (1428-1423) (24/12/14-25/12/14)	14.8	<b>63.5</b>
	Day 6 (1617-1614) (29/12/14-30/12/14)	10.2	41.1
	Day 7 (1617-1615) (30/12/14-31/12/14)	25.3	<b>81.2</b>
<b>*Limit</b>		37.5	50

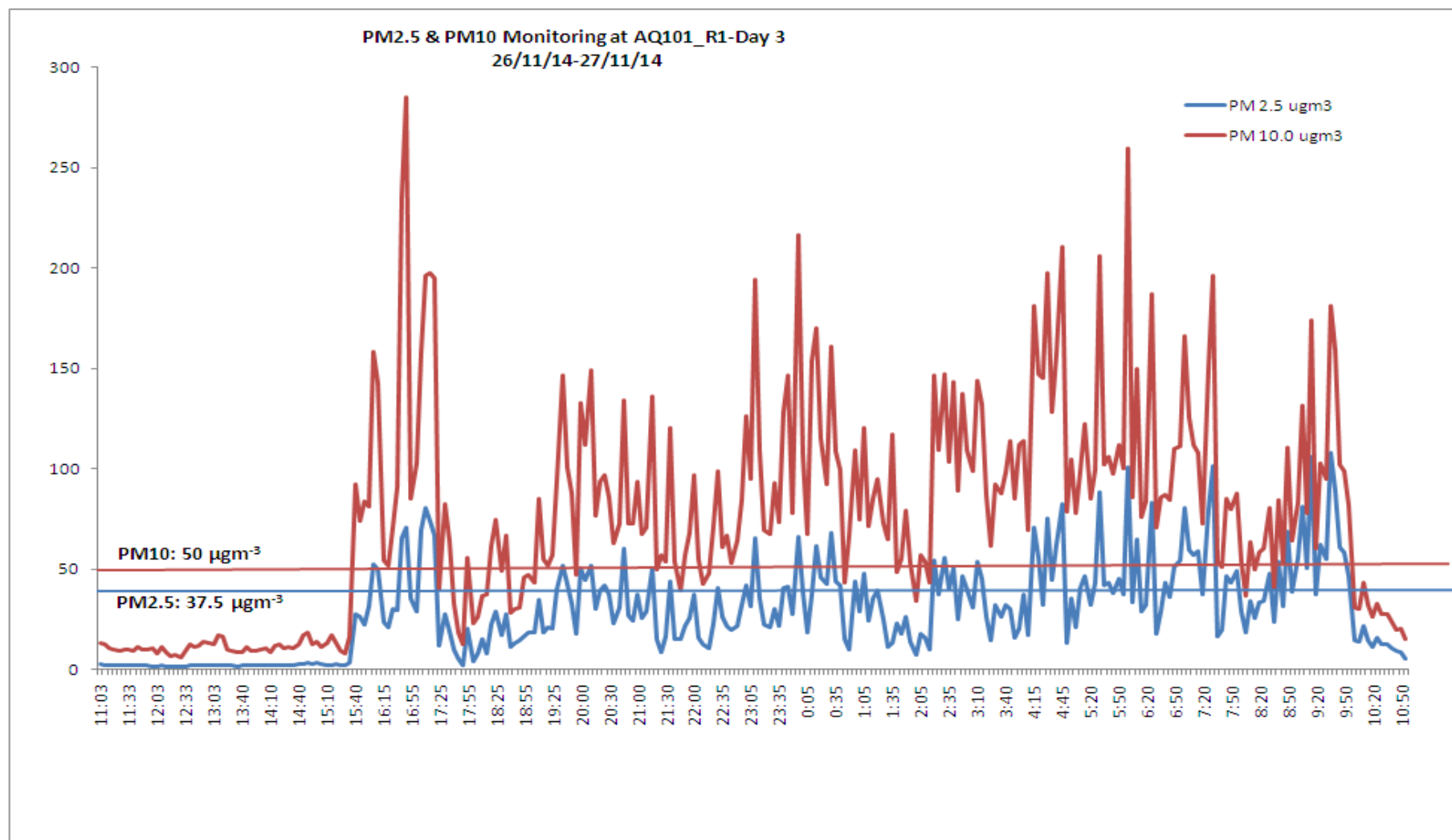
Remark:\* Singapore Ambient Air Quality Targets by 2020



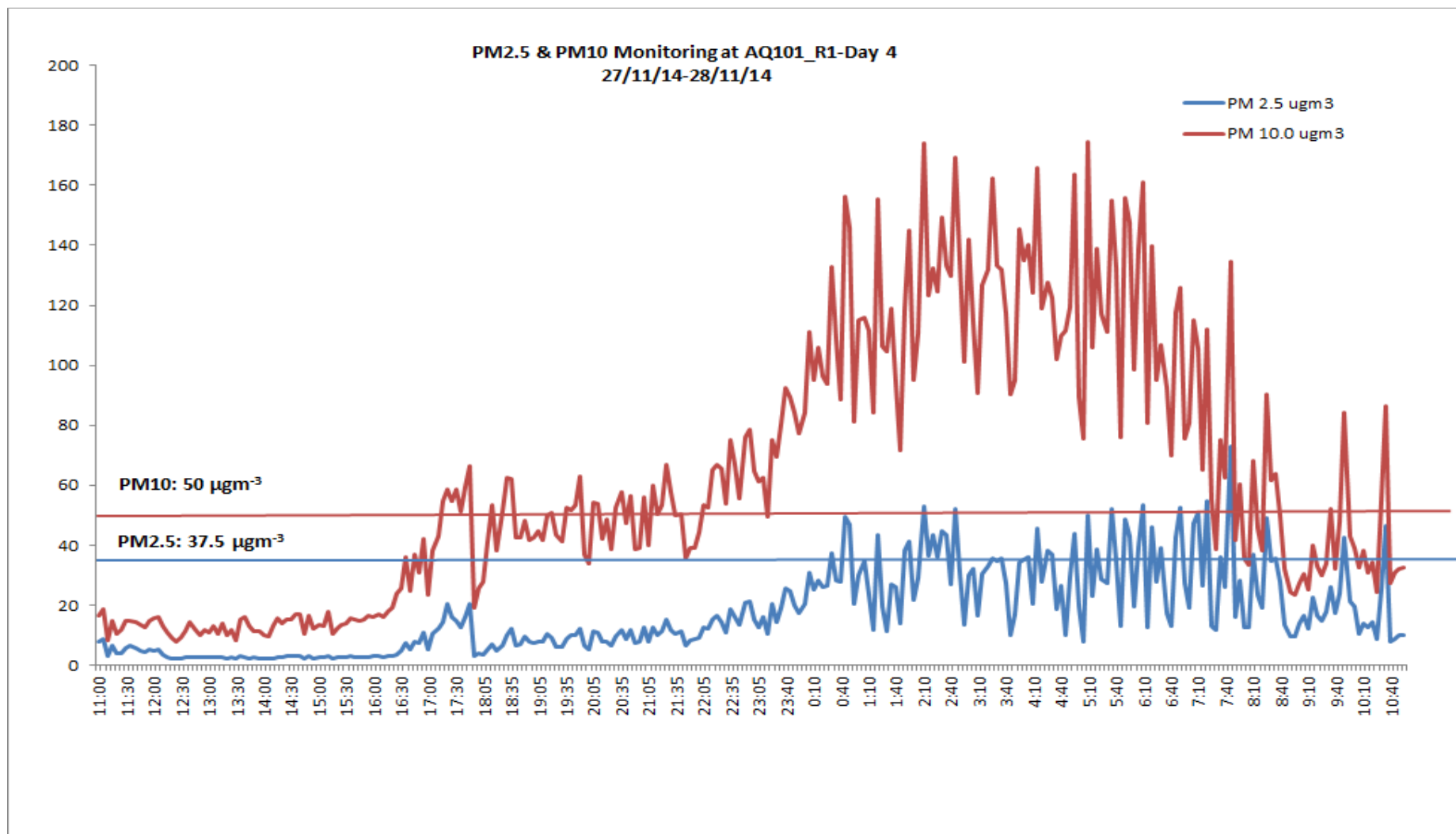
**Figure 4: Particulate concentration measured at Point AQ101\_R1 (Day 1)**



**Figure 5: Particulate concentration measured at Point AQ101\_R1 (Day 2)**

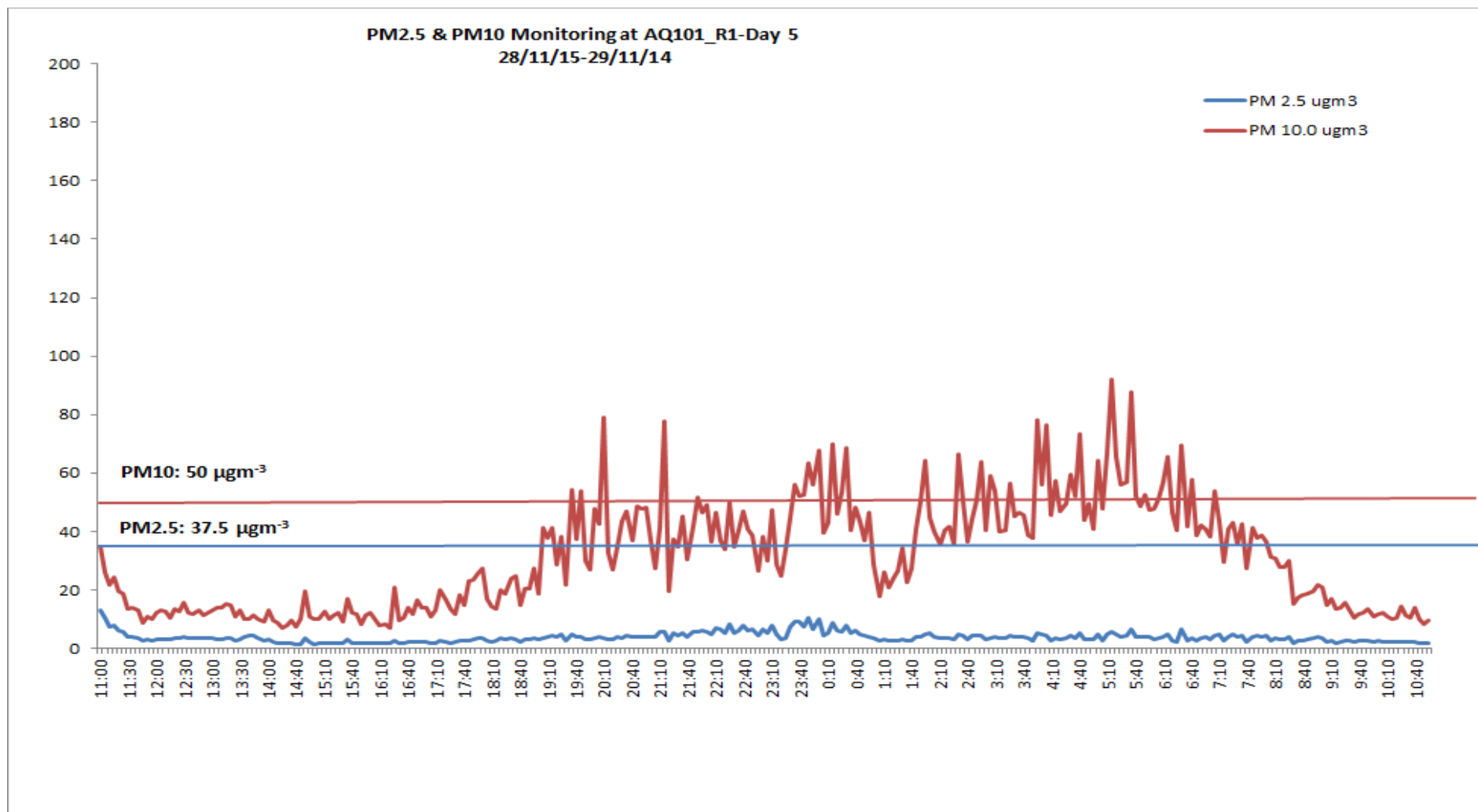


**Figure 6: Particulate concentration measured at Point AQ101\_R1 (Day 3)**

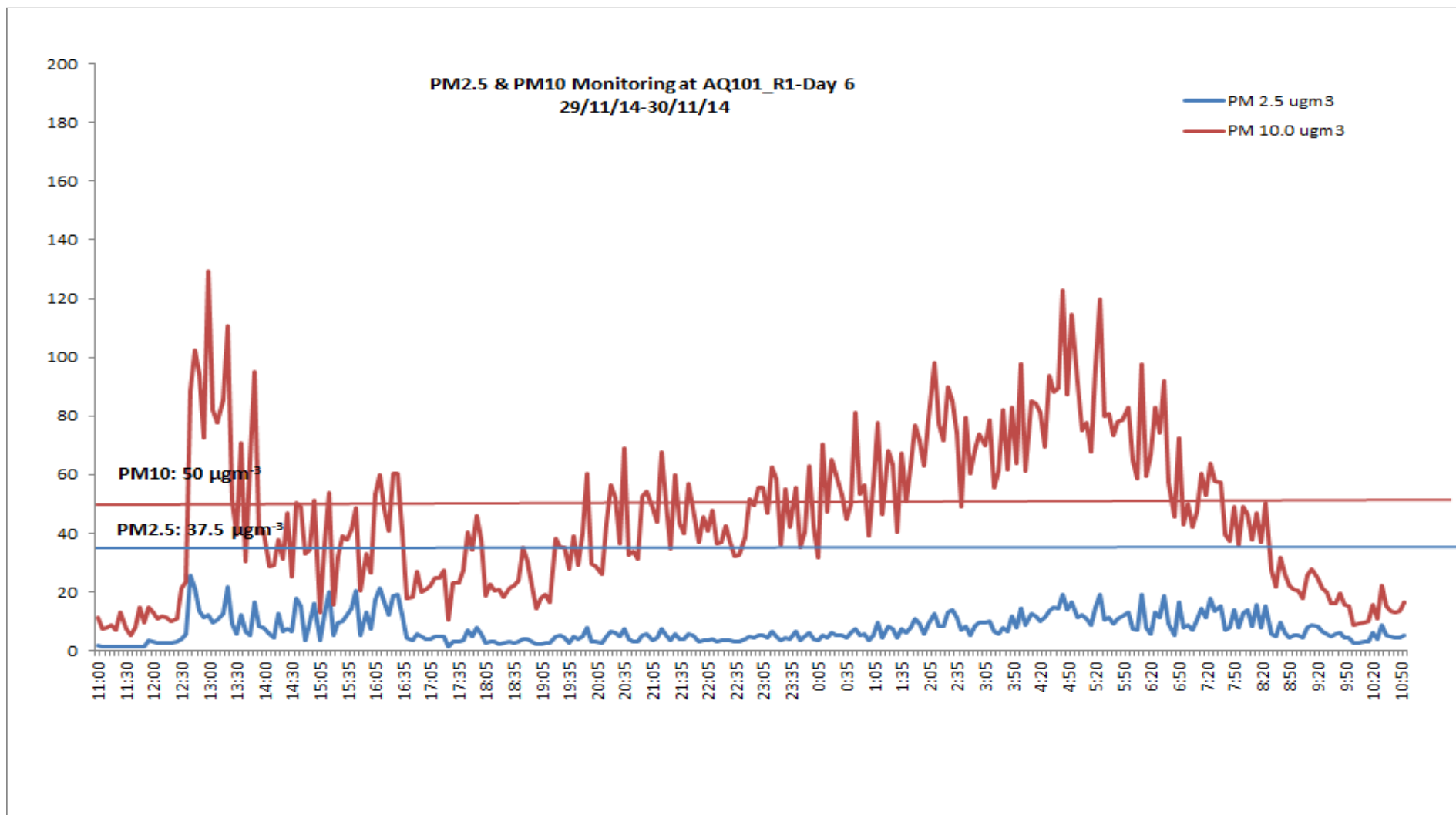


**Figure 7: Particulate concentration measured at Point AQ101\_R1 (Day 4)**

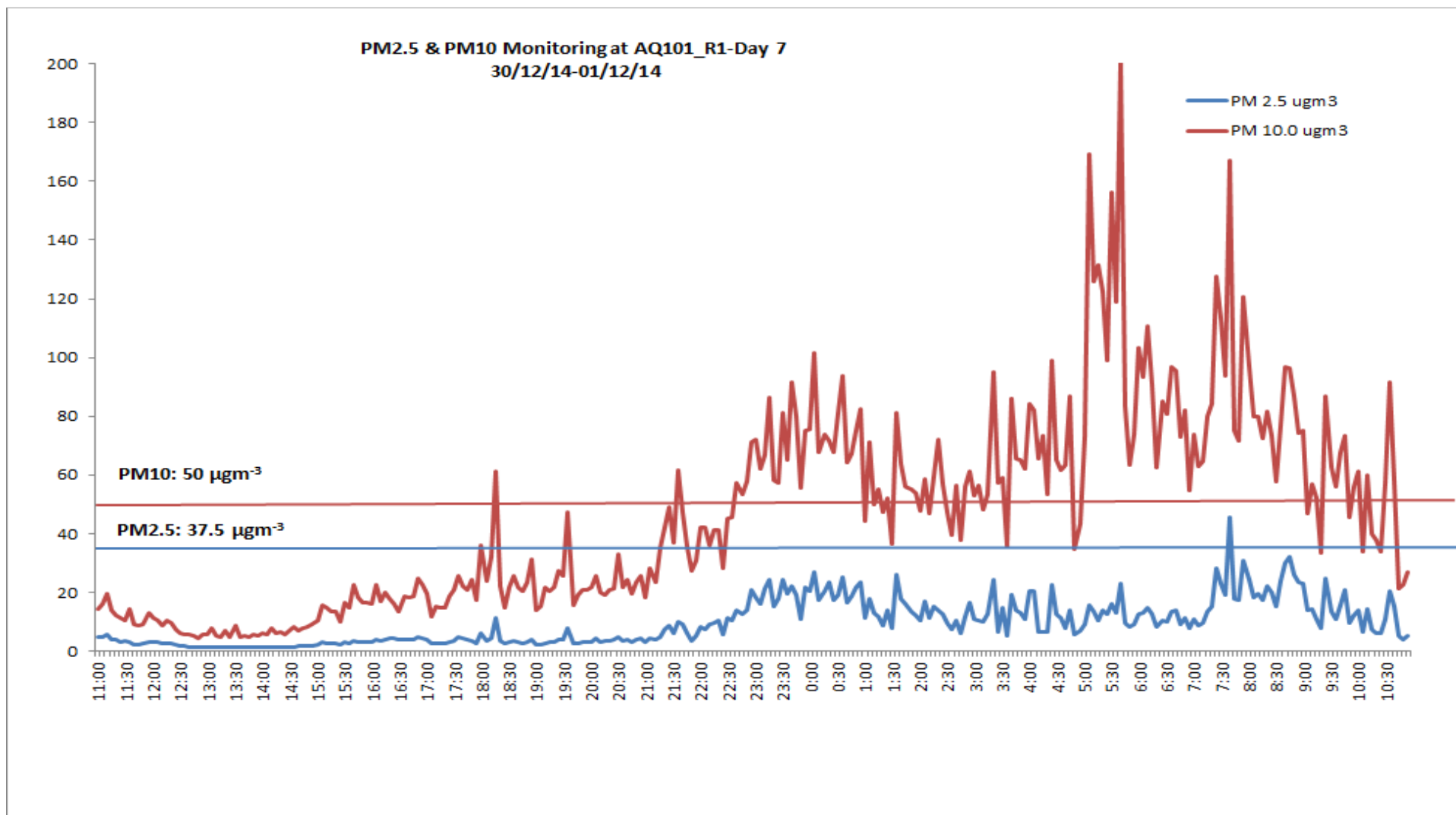




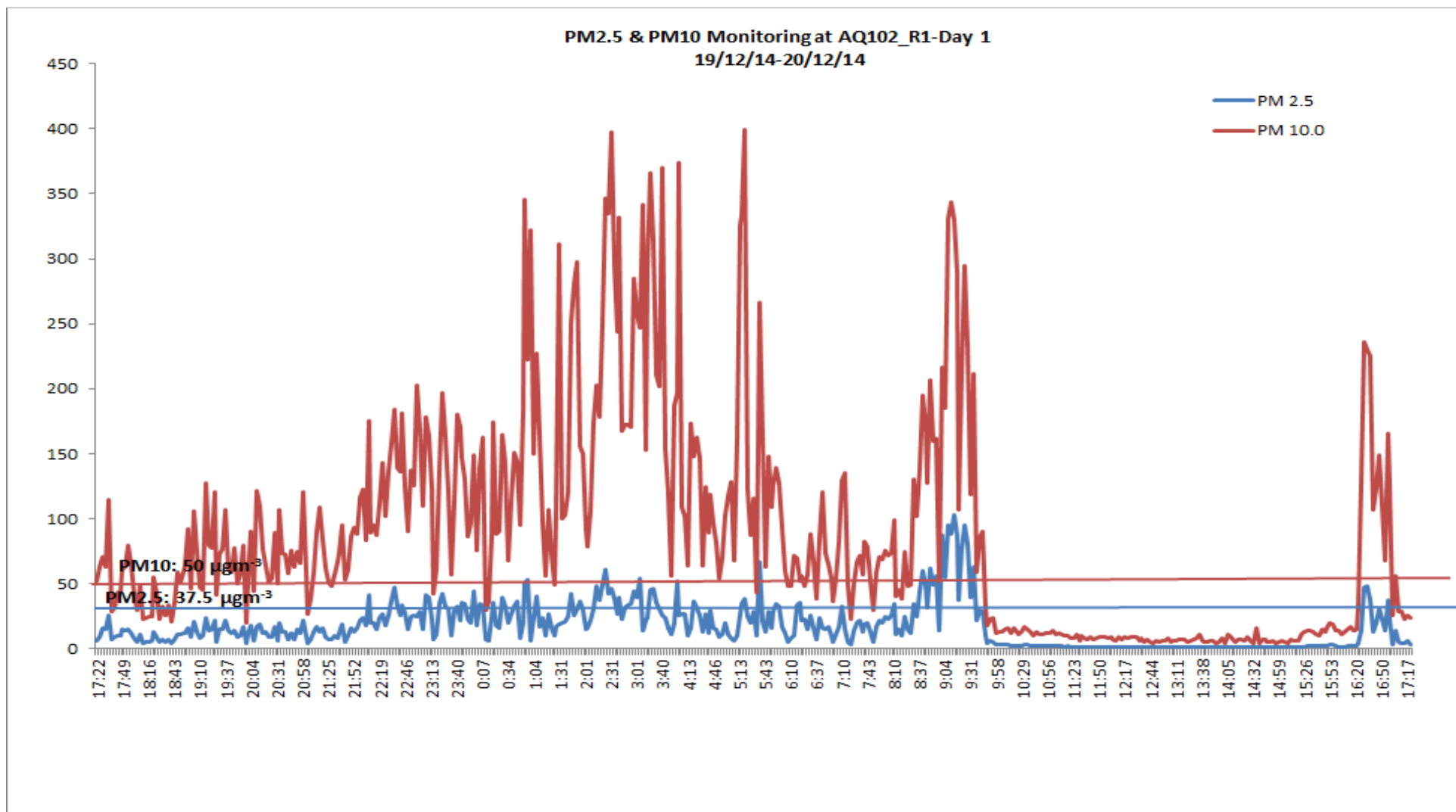
**Figure 8: Particulate concentration measured at Point AQ101\_R1 (Day 5)**



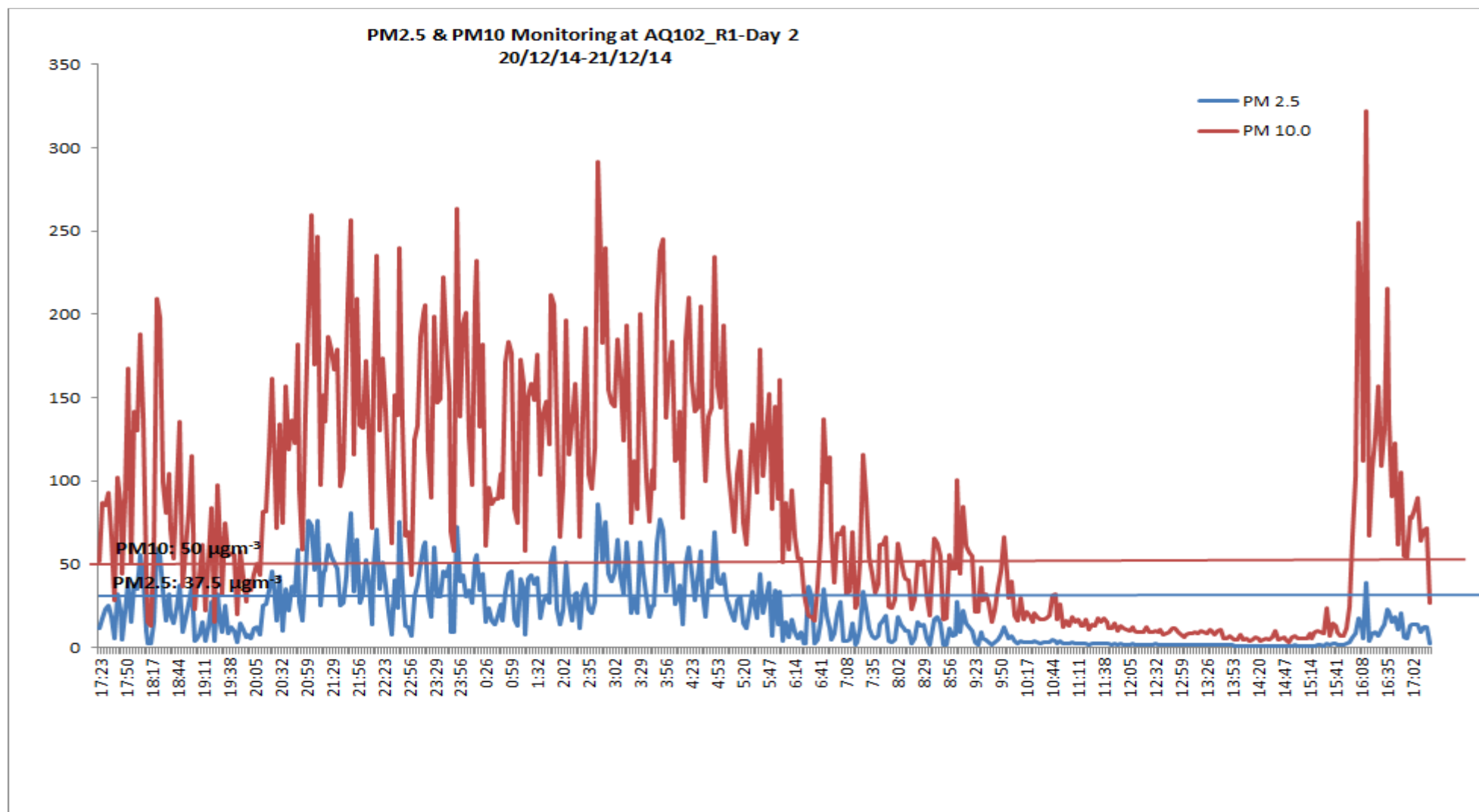
**Figure 9: Particulate concentration measured at Point AQ101\_R1 (Day 6)**



**Figure 10: Particulate concentration measured at Point AQ101\_R1 (Day 7)**



**Figure 11: Particulate concentration measured at Point AQ102\_R1 (Day 1)**



**Figure 12: Particulate concentration measured at Point AQ102\_R1 (Day 2)**



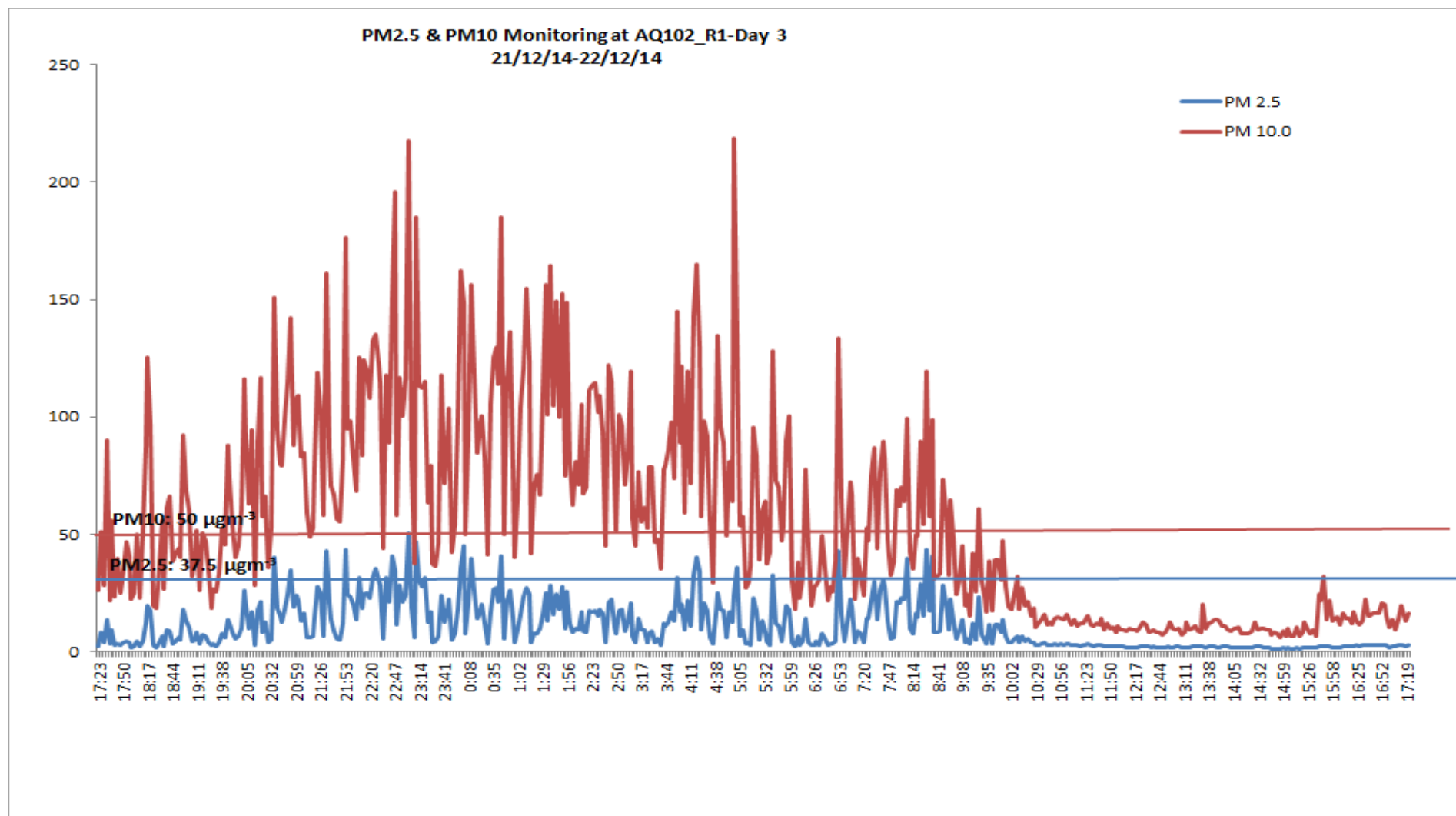
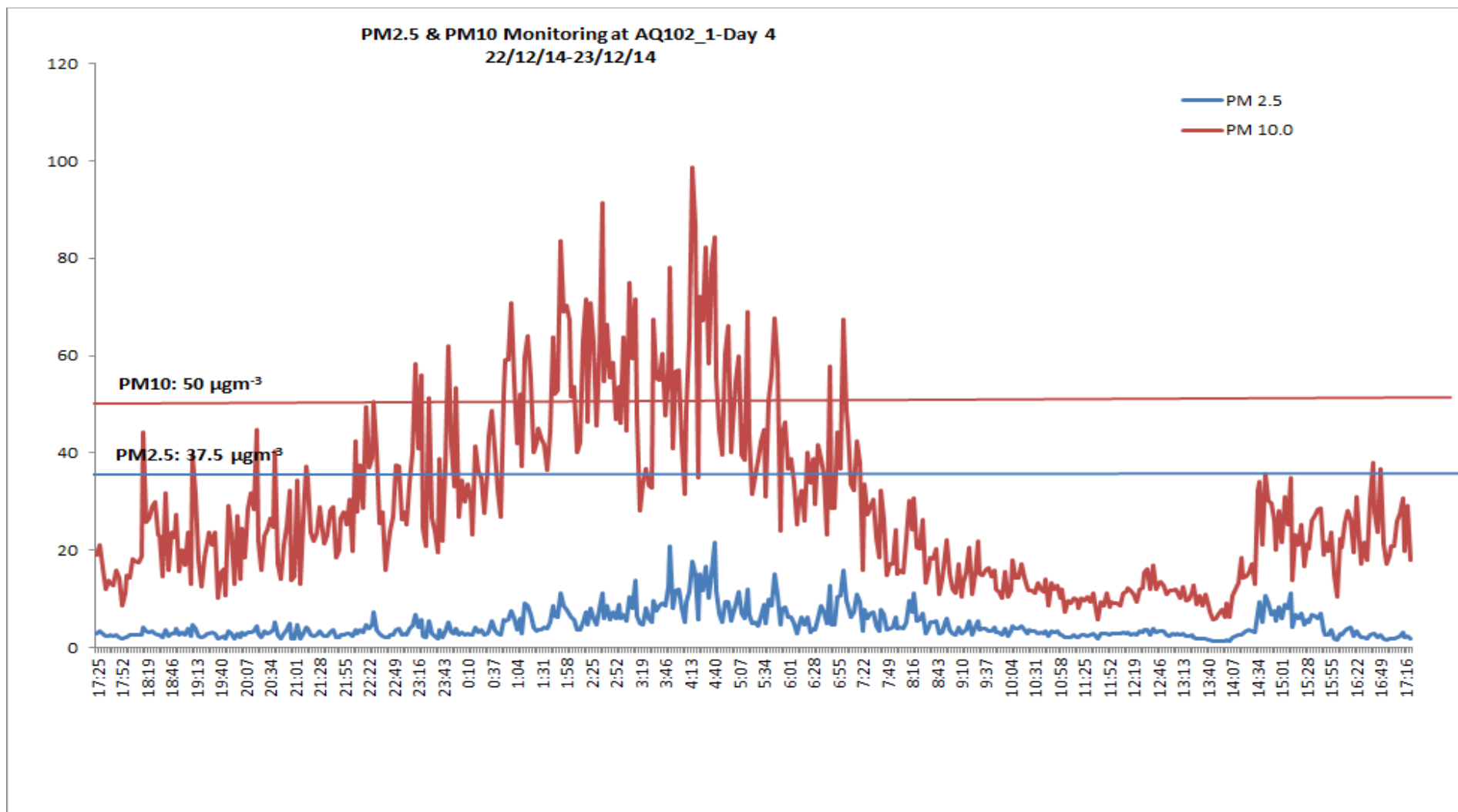
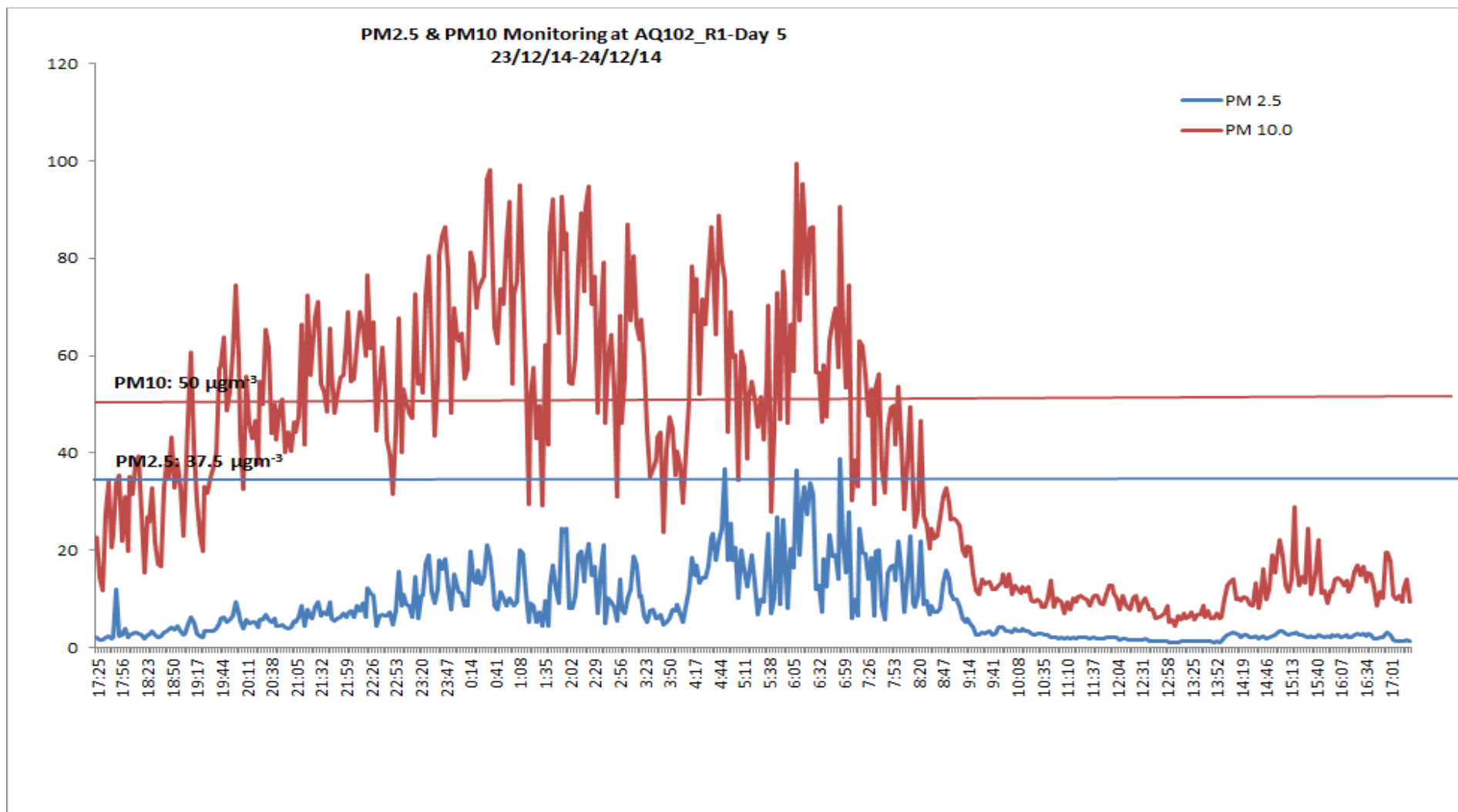


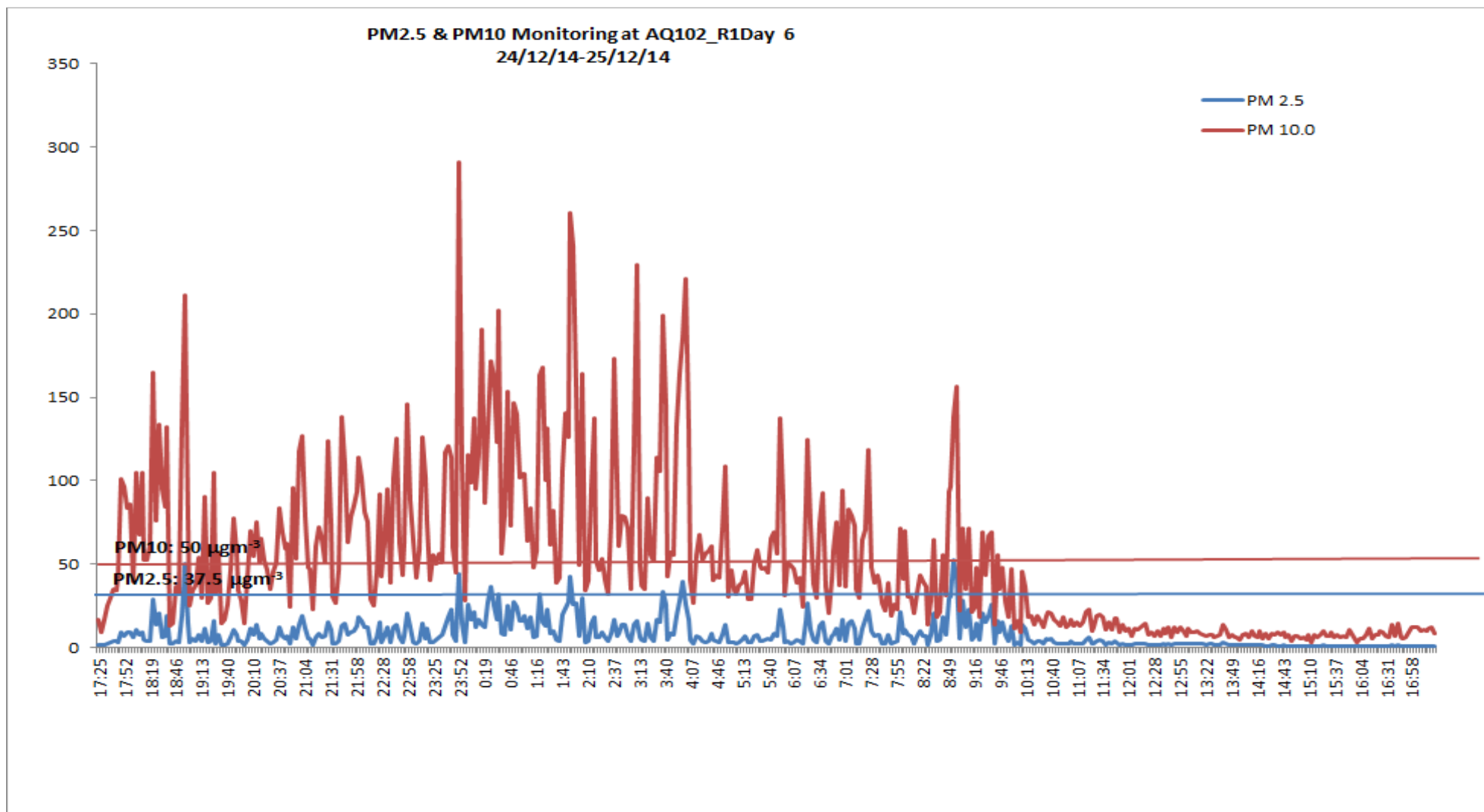
Figure 13: Particulate concentration measured at Point AQ102\_R1 (Day 3)



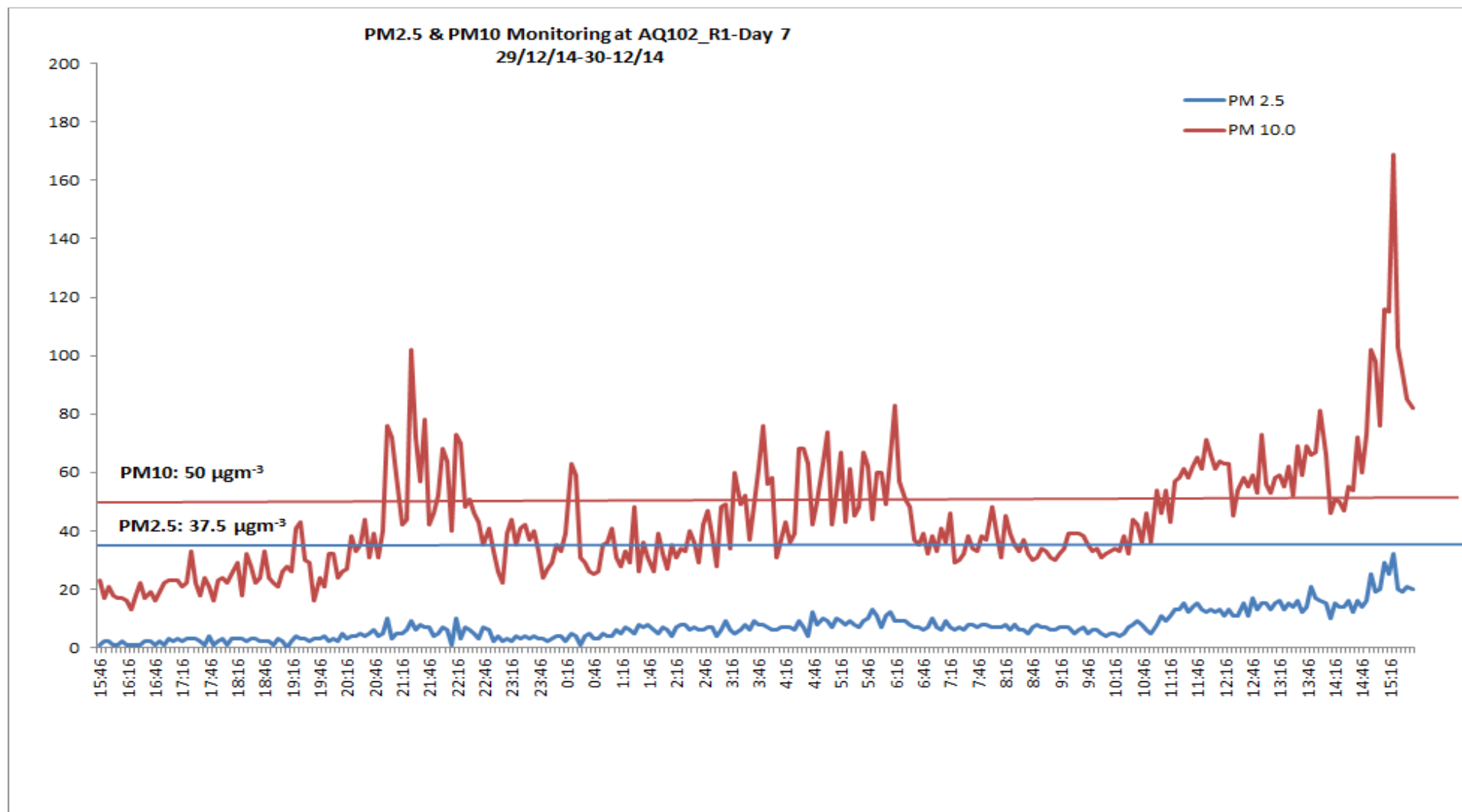
**Figure 14: Particulate concentration measured at Point AQ102\_R1 (Day 4)**



**Figure 15: Particulate concentration measured at Point AQ102\_R1 (Day 5)**

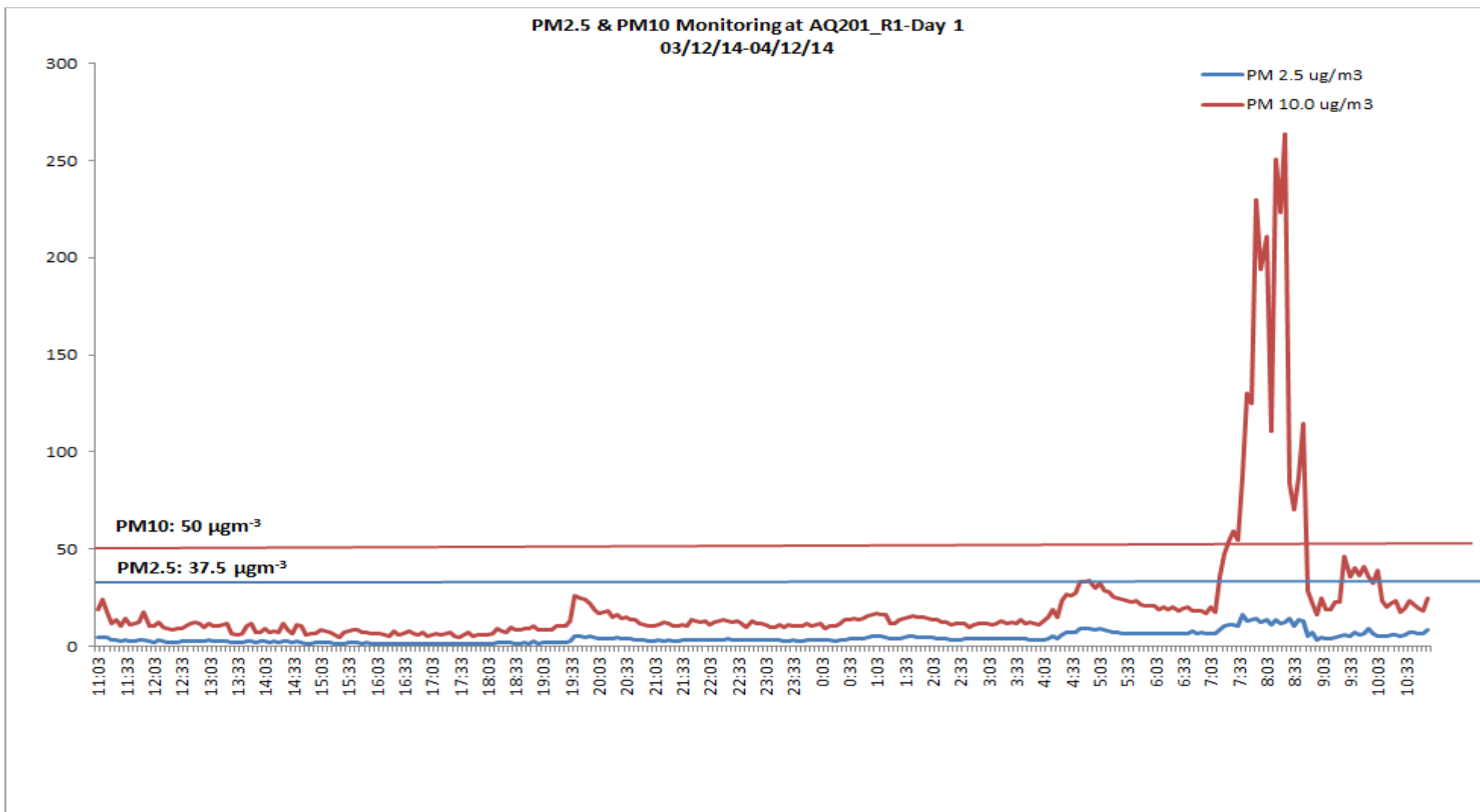


**Figure 16: Particulate concentration measured at Point AQ102\_R1 (Day 6)**

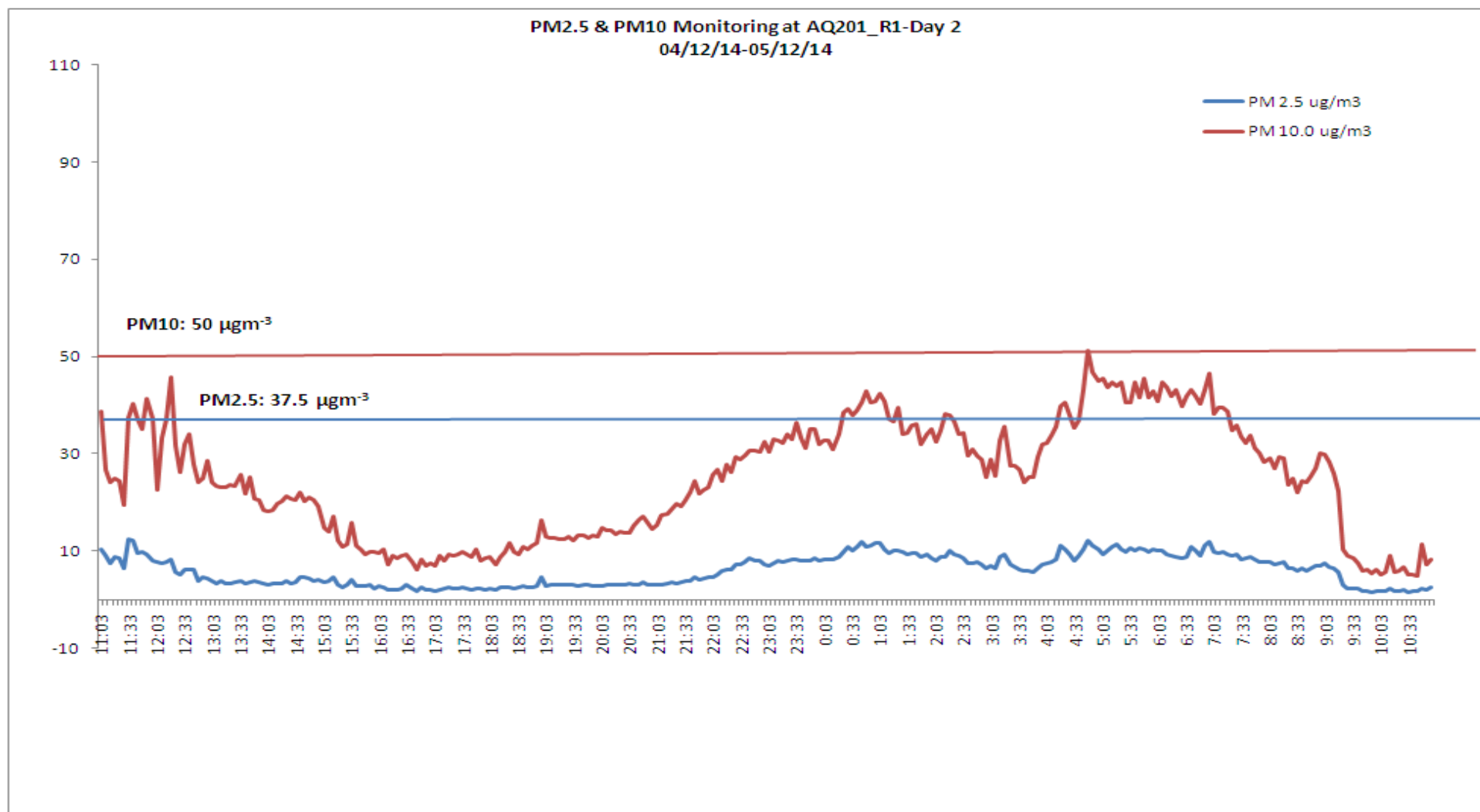


**Figure 17: Particulate concentration measured at Point AQ102\_R1 (Day 7)**

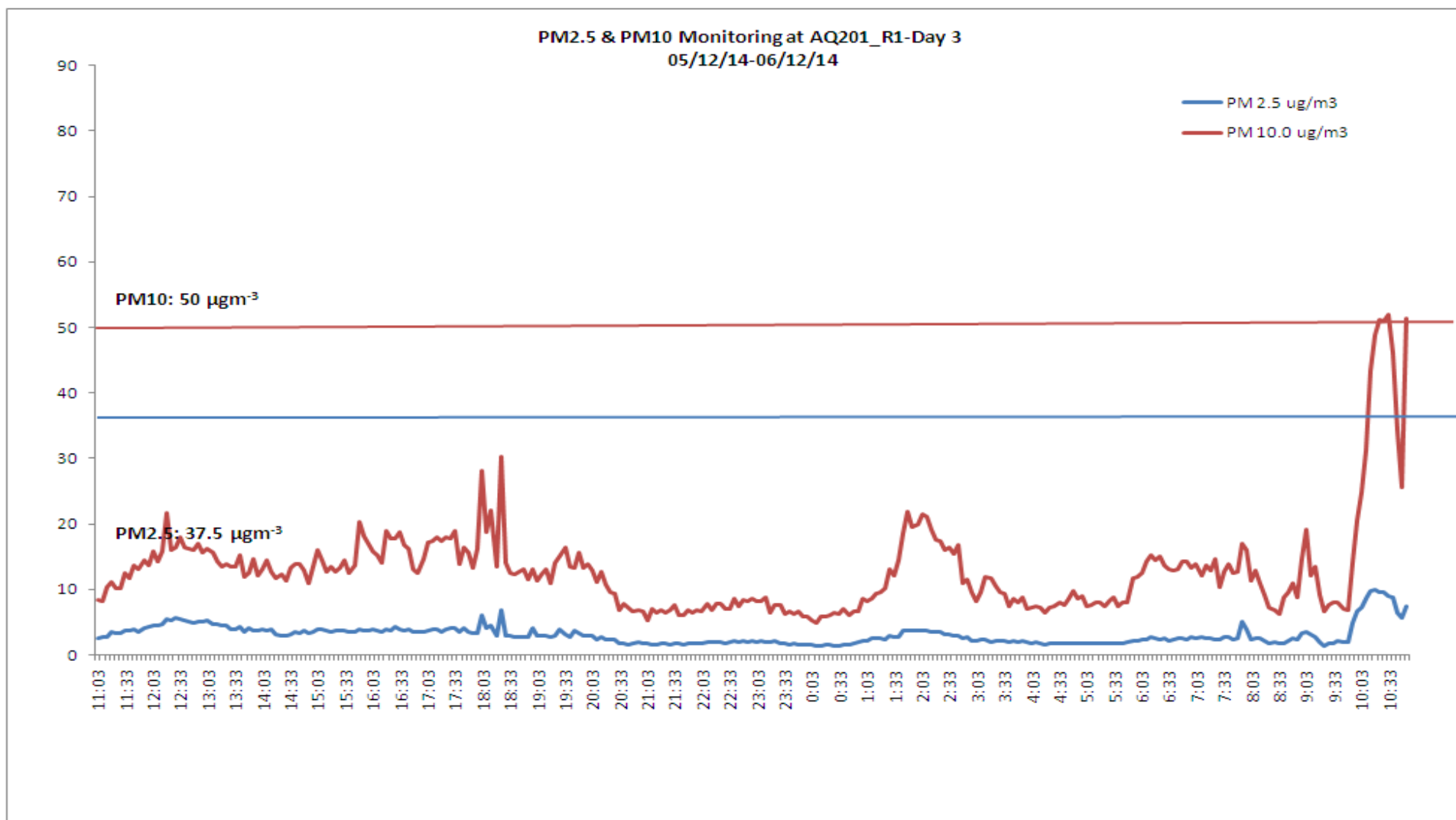




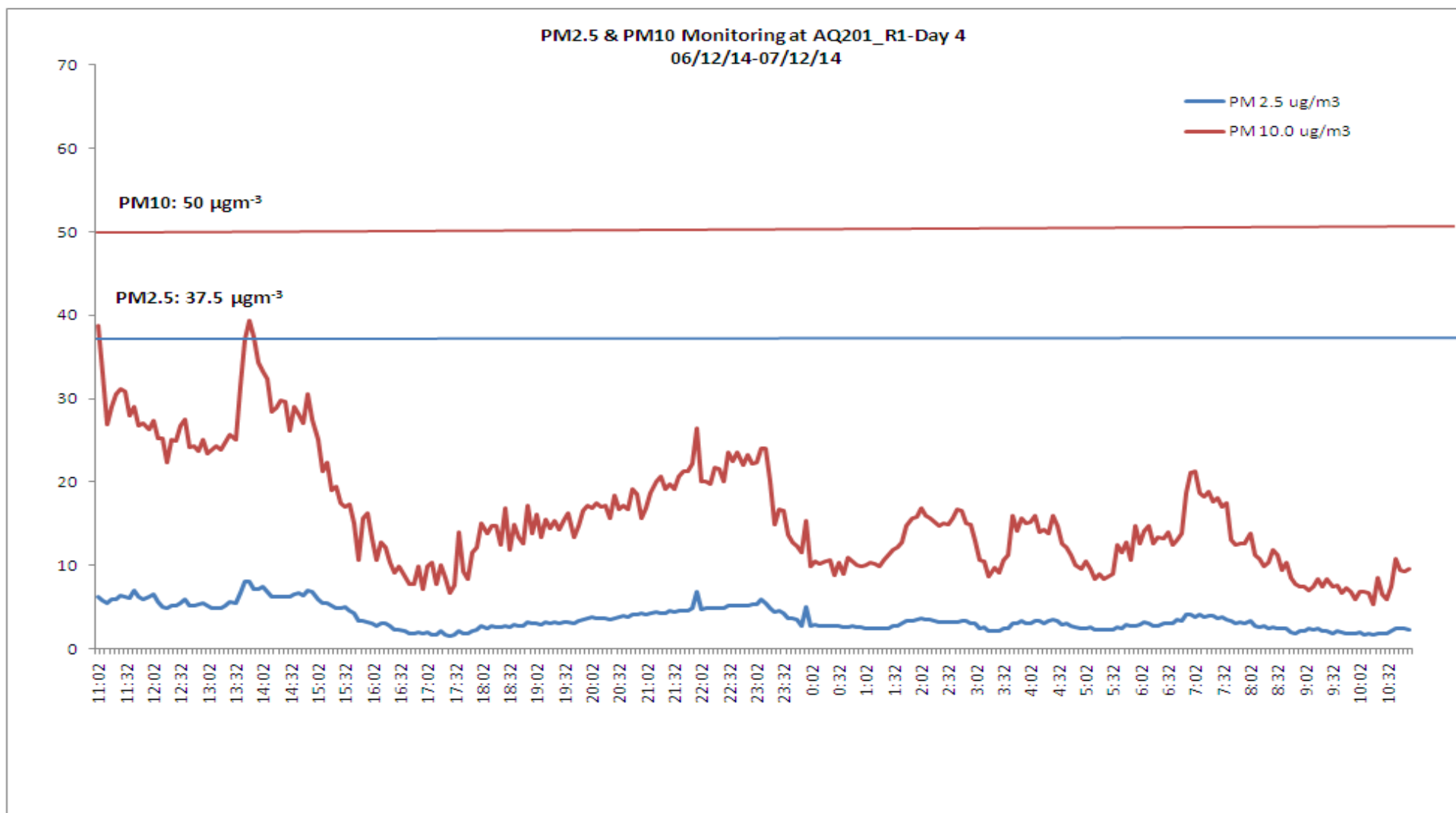
**Figure 18: Particulate concentration measured at Point AQ201\_R1 (Day 1)**



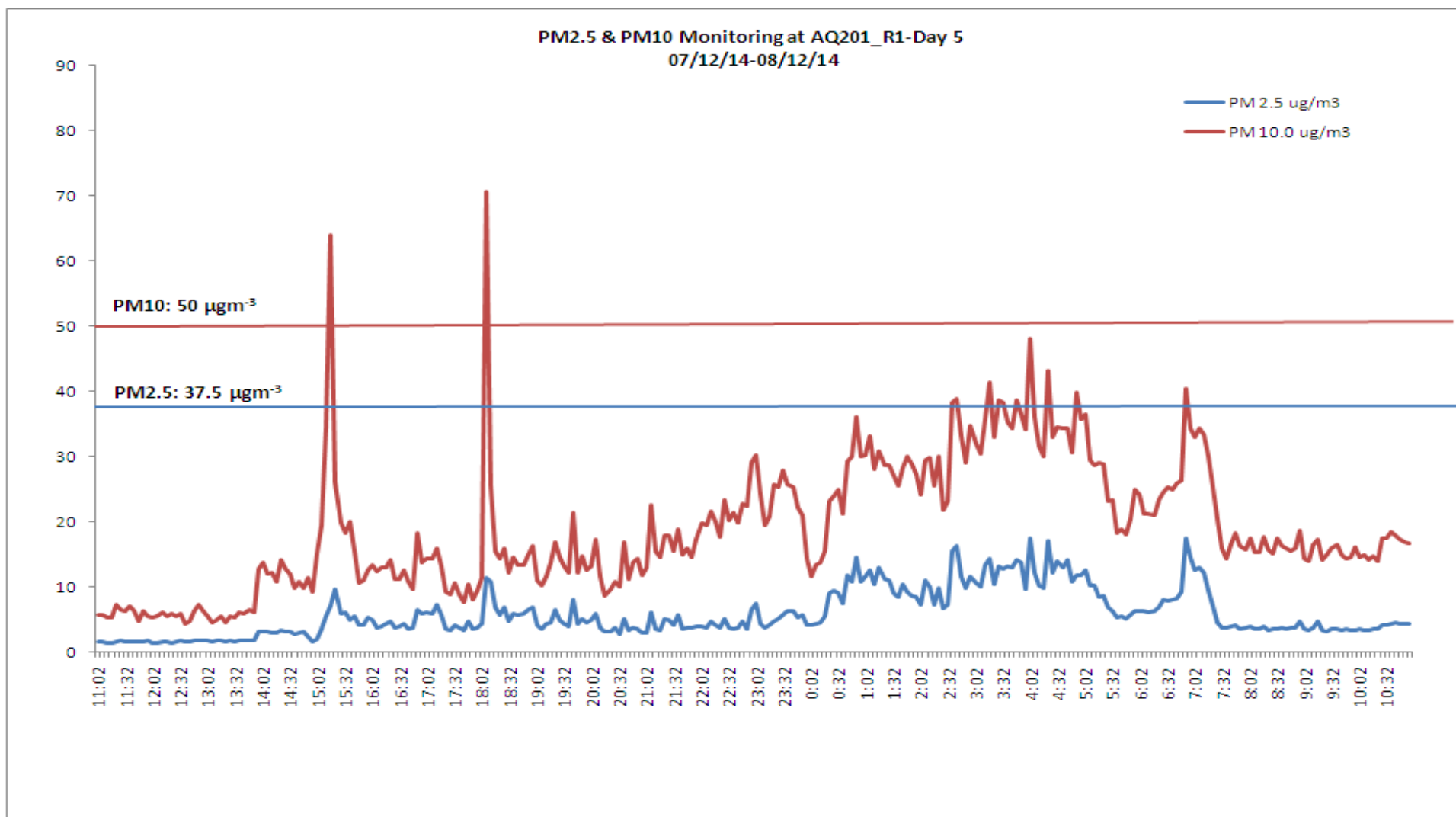
**Figure 19: Particulate concentration measured at Point AQ201\_R1 (Day 2)**



**Figure 20: Particulate concentration measured at Point AQ201\_R1 (Day 3)**

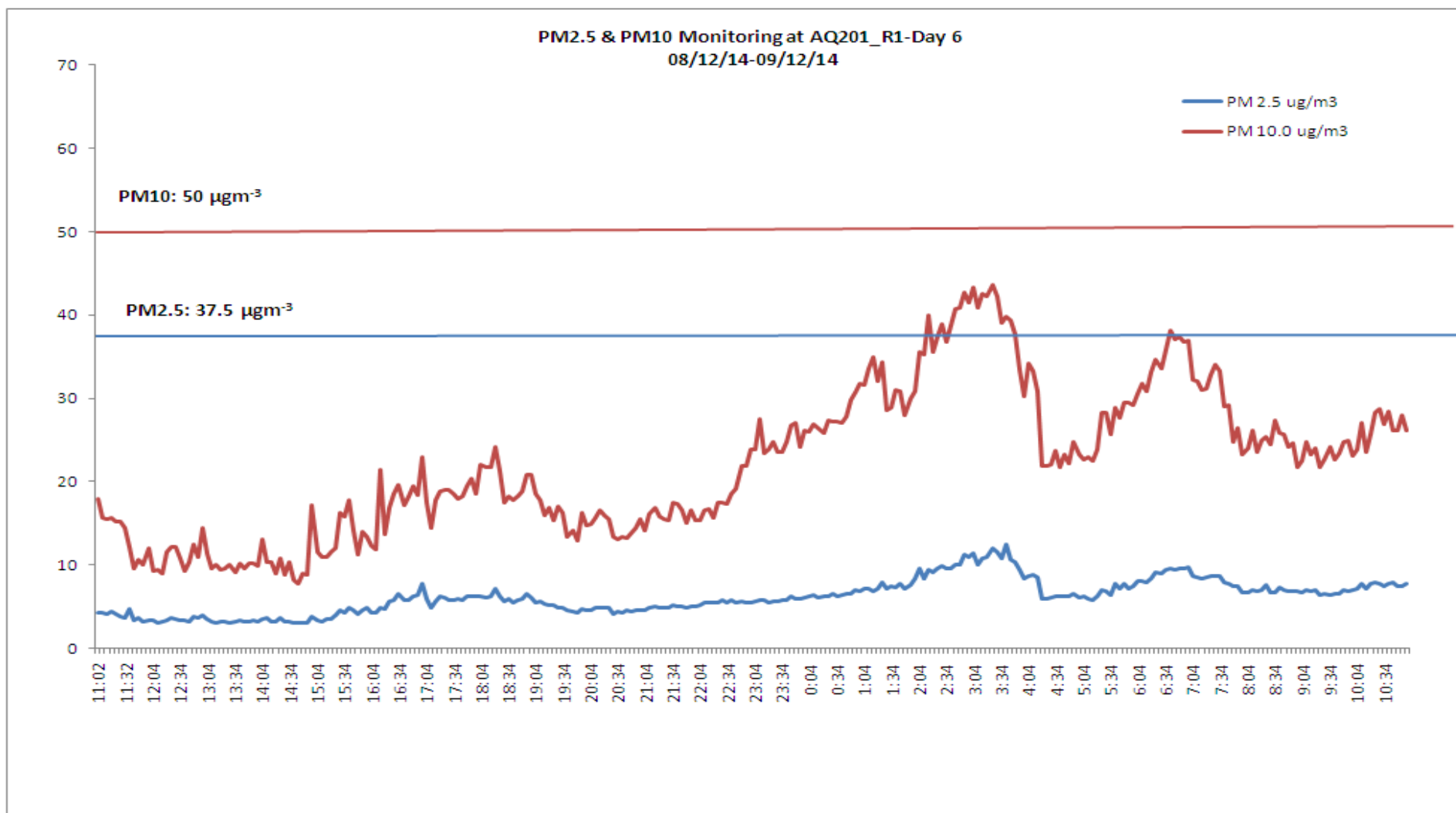


**Figure 21: Particulate concentration measured at Point AQ201\_R1 (Day 4)**

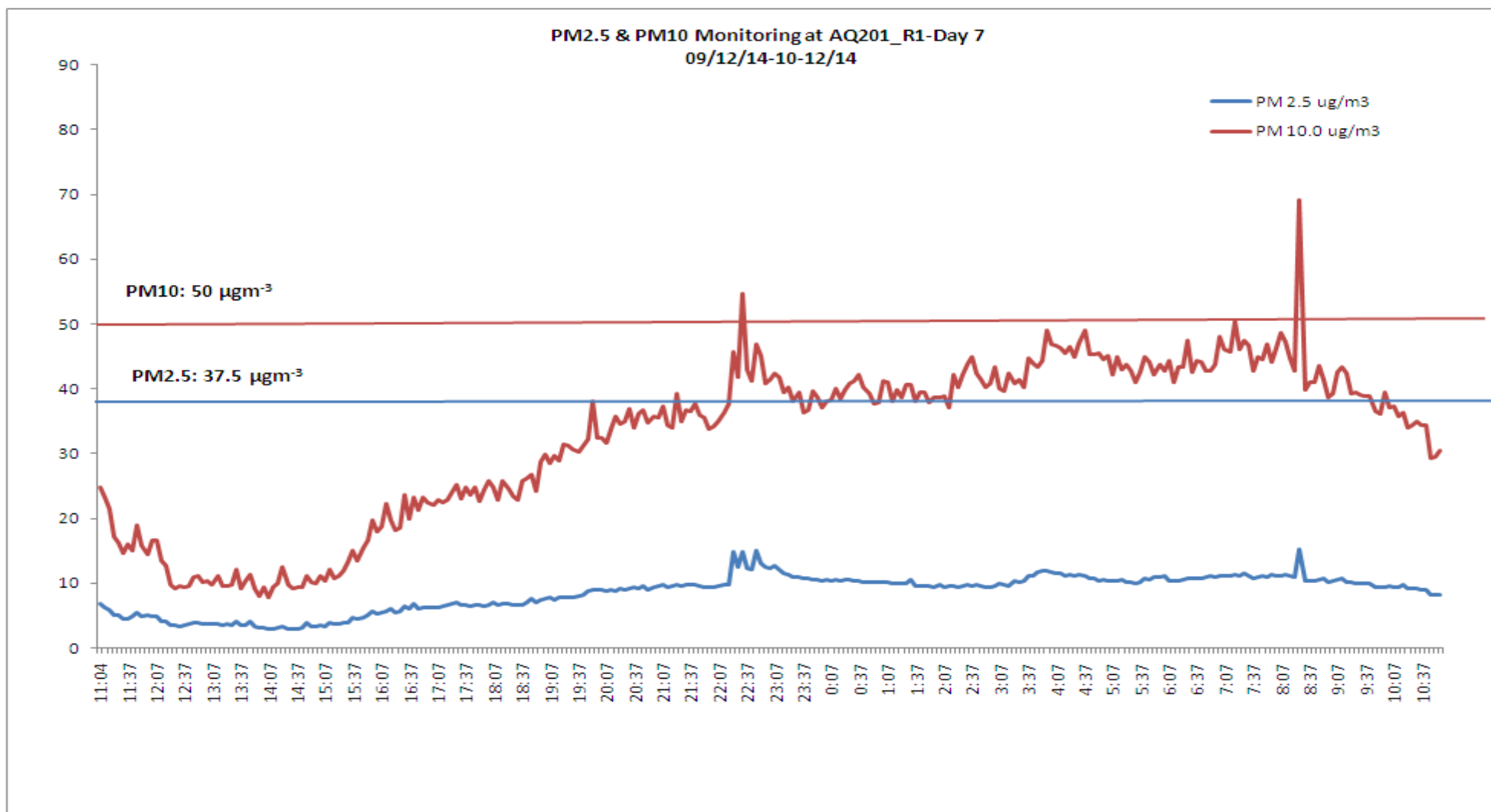


**Figure 22: Particulate concentration measured at Point AQ201\_R1 (Day 5)**

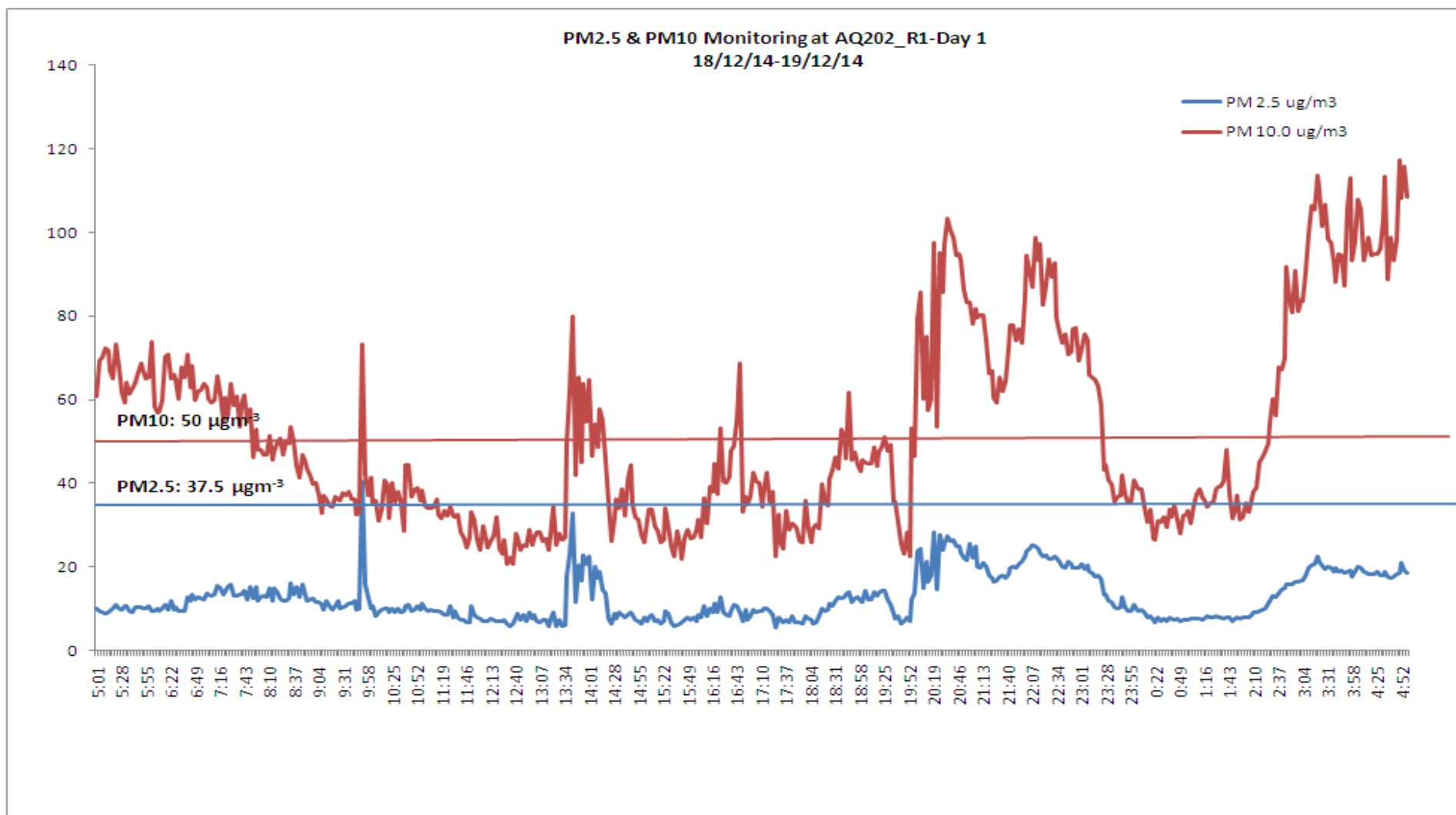




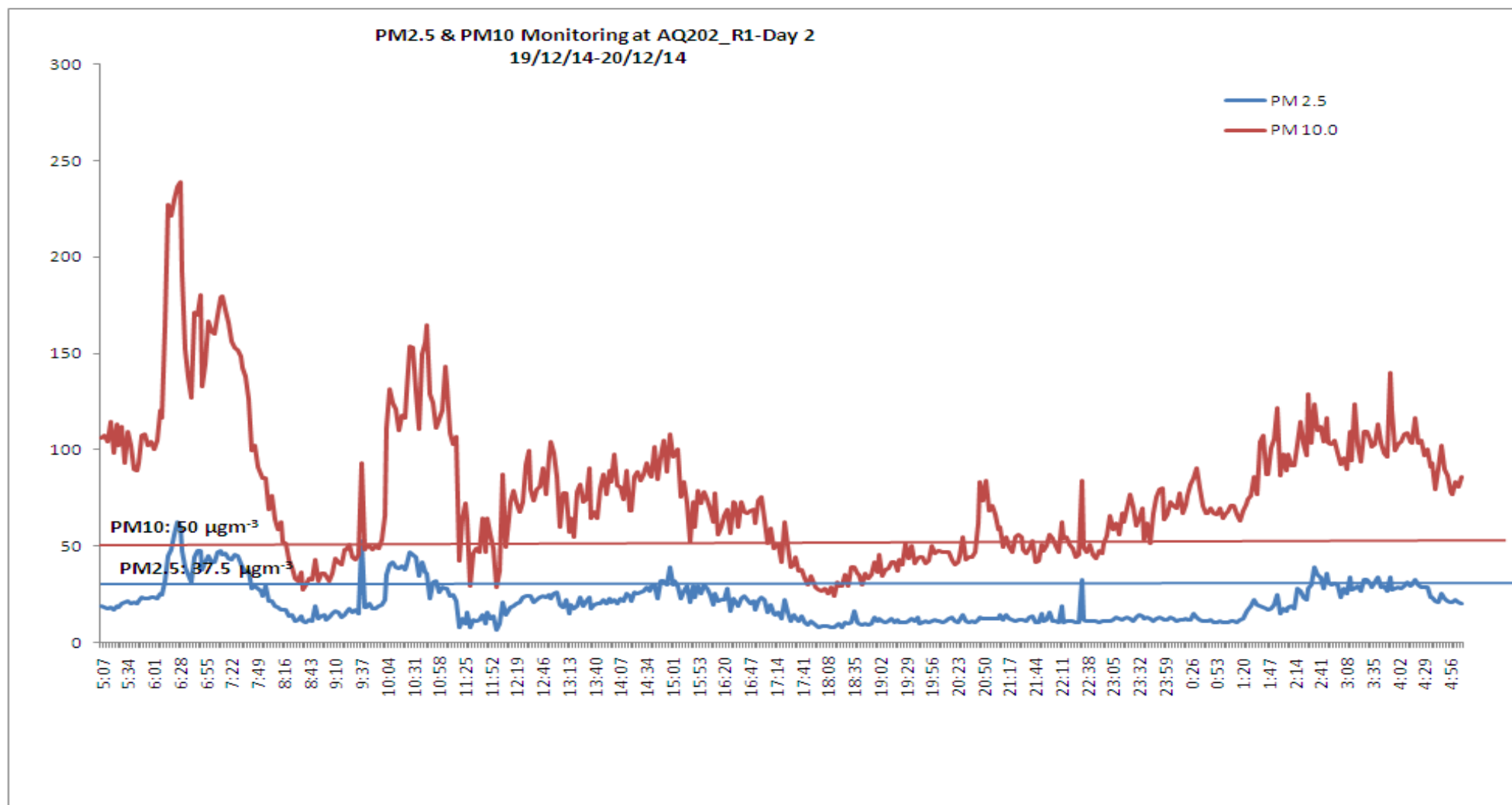
**Figure 23: Particulate concentration measured at Point AQ201\_R1 (Day 6)**



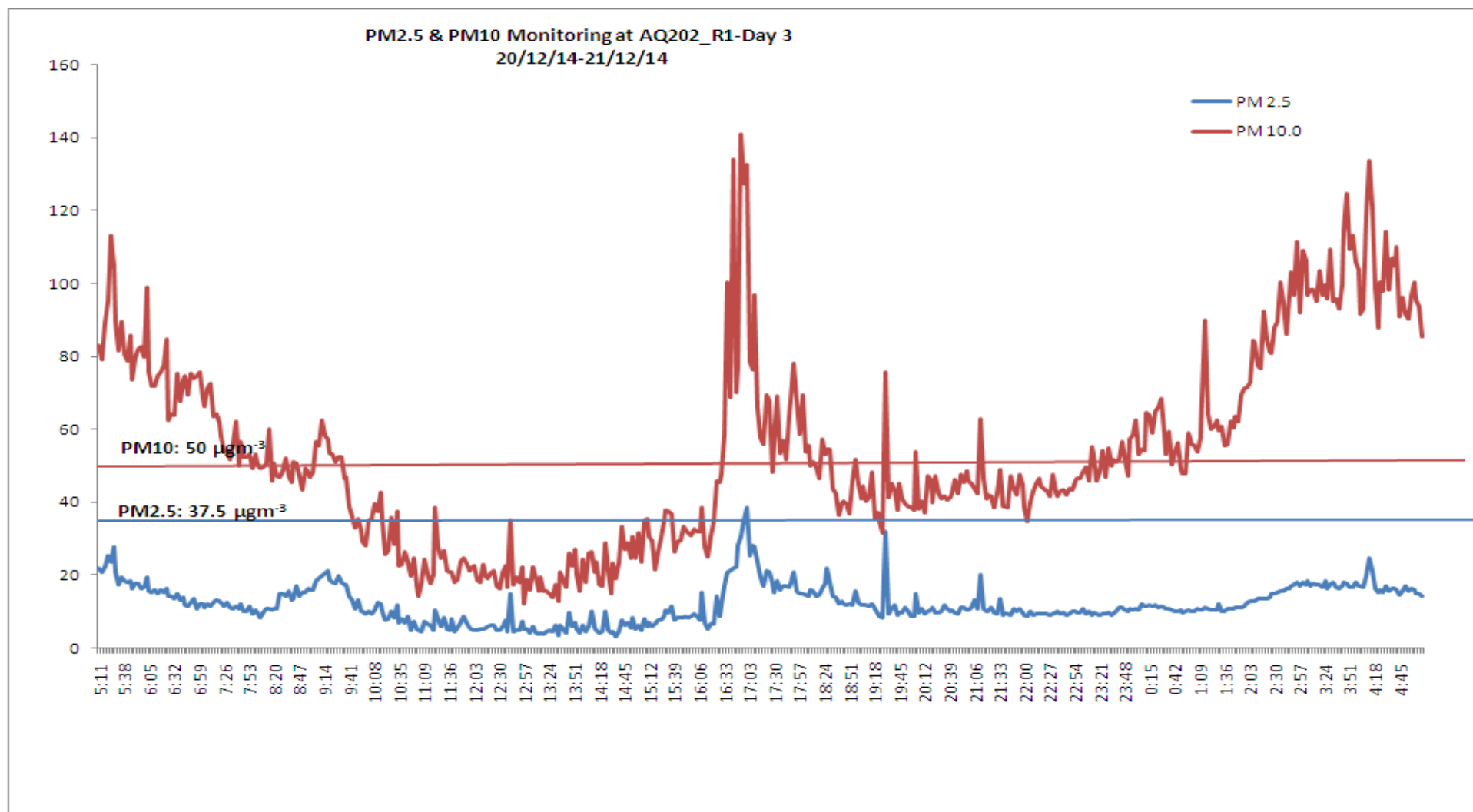
**Figure 24: Particulate concentration measured at Point AQ201\_R1 (Day 7)**



**Figure 25: Particulate concentration measured at Point AQ202\_R1 (Day 1)**

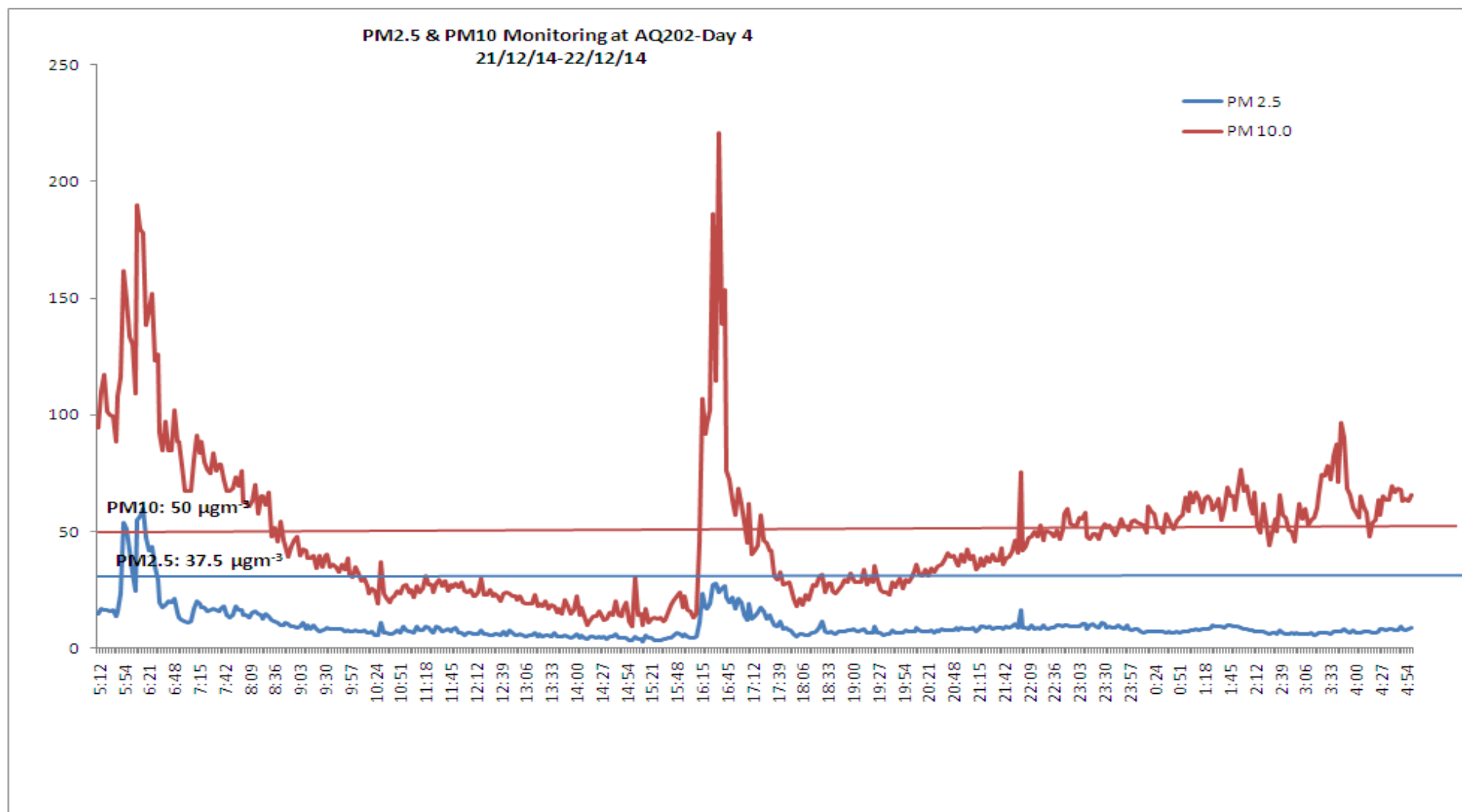


**Figure 26: Particulate concentration measured at Point AQ202\_R1 (Day 2)**

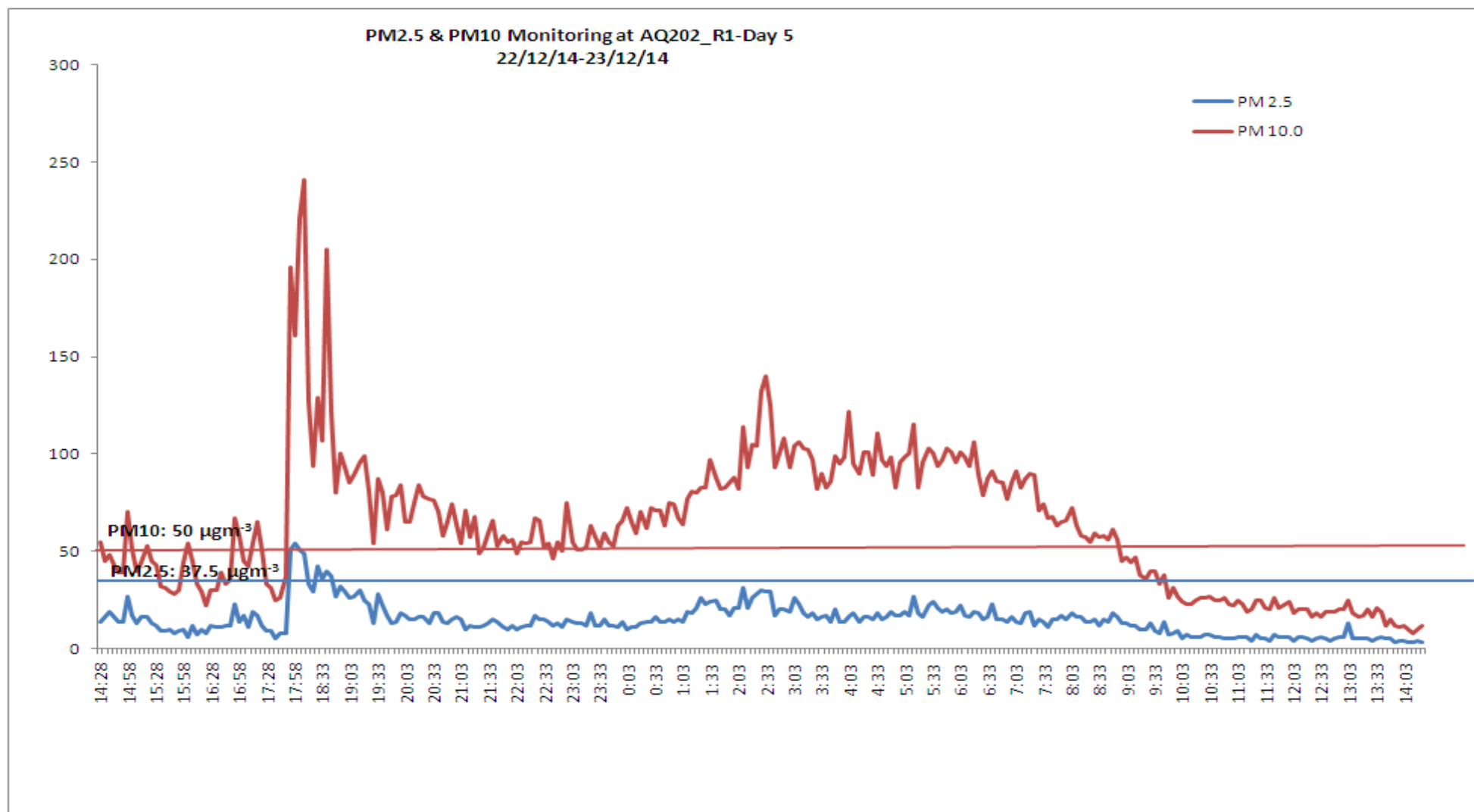


**Figure 27: Particulate concentration measured at Point AQ202\_R1 (Day 3)**

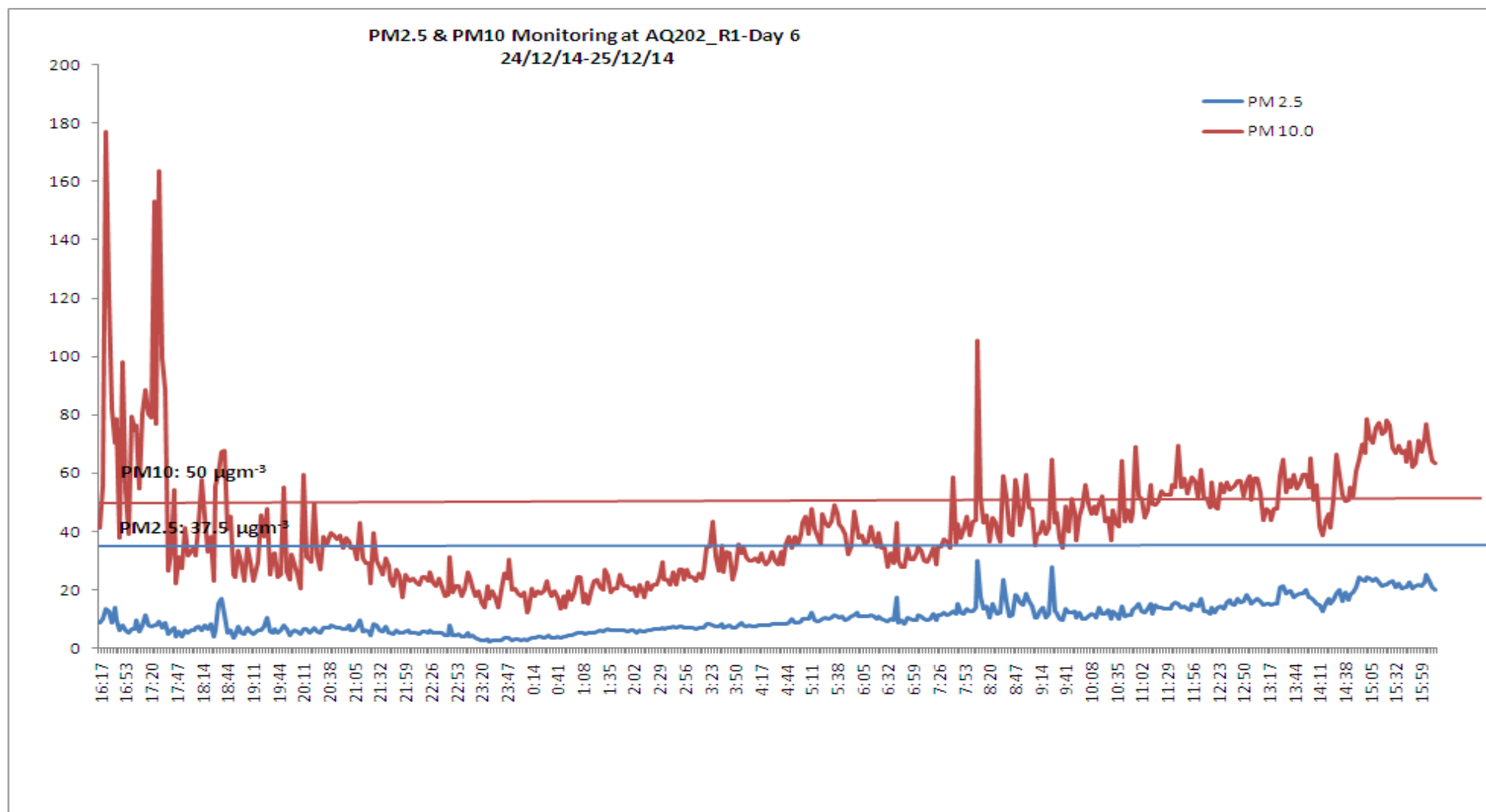




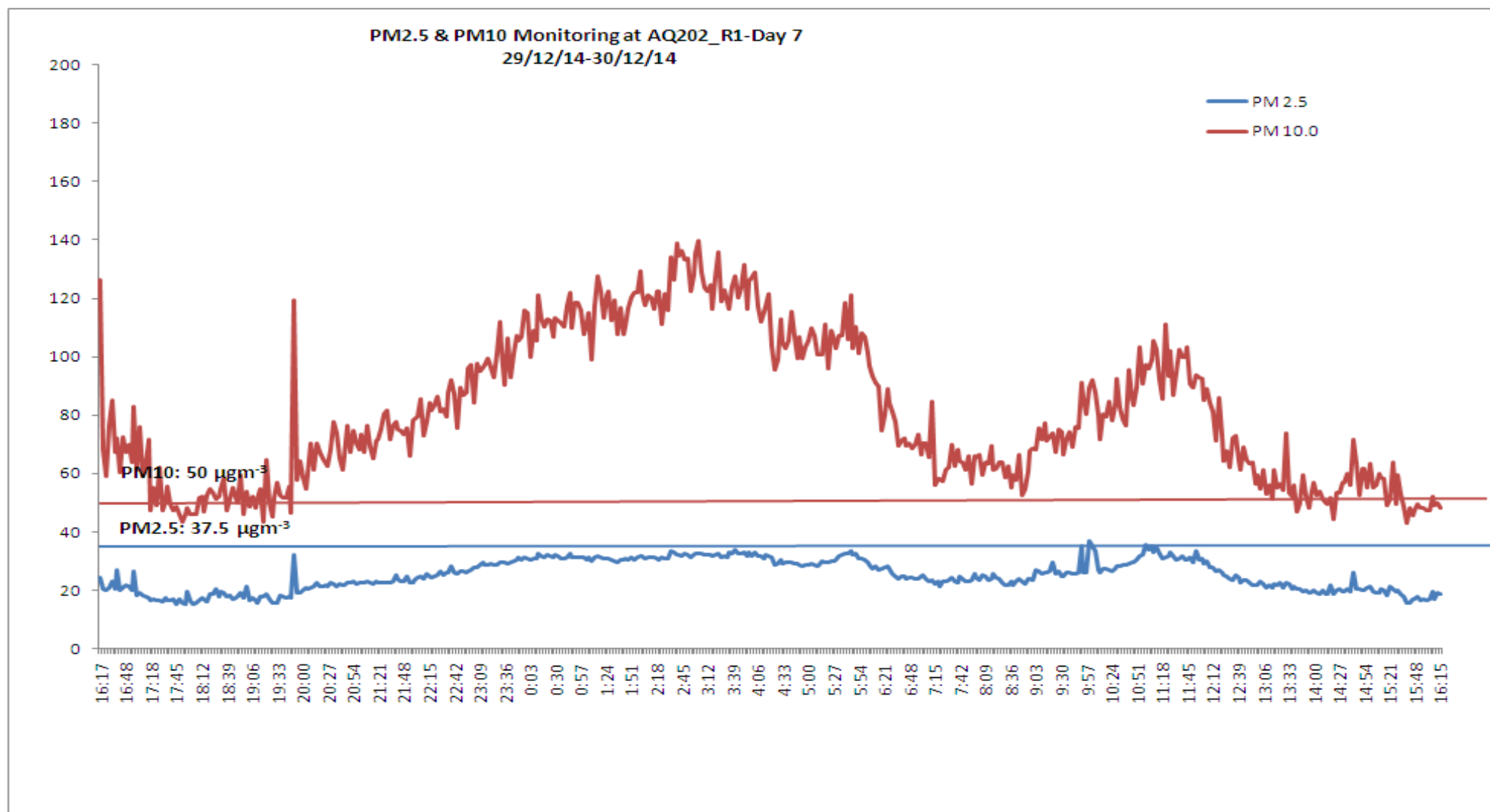
**Figure 28: Particulate concentration measured at Point AQ202\_R1 (Day 4)**



**Figure 29: Particulate concentration measured at Point AQ202\_R1 (Day 5)**



**Figure 30: Particulate concentration measured at Point AQ202\_R1 (Day 6)**



**Figure 31: Particulate concentration measured at Point AQ202\_R1 (Day 7)**

# **Air Monitoring (Second Round of Survey)**

Date of Survey: 16<sup>th</sup> January to 09<sup>th</sup> February 2015



## 6.0 Detail of Ambient Air Monitoring Point (Round 2)

There were a total of five air monitoring points have been setup during second round of survey, namely AQ101\_R2-AQ102\_R2 and AQ201\_R2-AQ203\_R2. The monitoring points were dictated by ERM. The details of the monitoring point are listed in Table 6.

**Table 6: Details of monitoring point**

Sampling ID	Parameter	Sampling Start		Sampling Stop	
		Date	Time (hr)	Date	Time (hr)
AQ101_R2	PM <sub>10</sub> & PM <sub>2.5</sub>	02/02/15	1550	09/02/15	1545
AQ102_R2		02/02/15	1508	09/02/15	1508
AQ203_R2		02/02/15	1446	09/02/15	1441
AQ201_R2		16/01/15	1319	23/01/15	1322
AQ202_R2		16/01/15	1401	23/01/15	1406
*AQ203_R2		16/01/15	1317	22/01/15	0028

Remark: \* Presented data only for around 6 days due to the meter shutdown.

## 7.0 RESULTS (Round 2)

Results obtained for all sampling points were presented in Table 7 and 8. The daily particulate concentration at all monitoring points were illustrated in Figure 32 to 72.

**Table 7: Summary of results for Particulate Matter (PM<sub>2.5</sub> & PM<sub>10</sub>) based on 24 hours average**

Sampling Point	Duration, hr (Period)	Particulate Matter (PM <sub>2.5</sub> ) in ug m <sup>-3</sup> (24hrs)	Particulate Matter (PM <sub>10</sub> ) in ug m <sup>-3</sup> (24hr)
<b>AQ101_R2</b>	Day 1 (1550-1545) (02/02/15-03/02/15)	13.7	<b>55.6</b>
	Day 2 (1550-1545) (03/04/15-04/02/15)	10.4	38.4
	Day 3 (1550-1545) (04/02/15-05/02/15)	18.4	<b>96.8</b>
	Day 4 (1550-1548) (05/02/15-06/02/15)	24.1	<b>85.6</b>
	Day 5 (1553-1548) (06/02/15-07/02/15)	15.1	<b>69.1</b>
	Day 6 (1553-1548) (07/02/15-08/02/15)	17.1	<b>62.2</b>
	Day 7 (1553-1548) (08/02/15-09/02/15)	13.5	42.4
<b>AQ102_R2</b>	Day 1 (1508 -1503) (02/02/15-03/02/15)	10.7	38.6
	Day 2 (1508 -1503) (03/02/15-04/02/15)	10.4	41.5
	Day 3 (1508 -1505) (04/02/15-05/02/15)	15.4	<b>76.5</b>
	Day 4 (1510 -1505) (05/02/15-06/02/15)	32.3	<b>115</b>
	Day 5 (1510 -1508) (06/02/15-07/02/15)	12.1	49.1
	Day 6 (1513-1508) (07/02/15-08/02/15)	12.4	40.8
	Day 7 (1513-1508) (08/02/15-09/02/15)	10.8	33.2
<b>AQ203_R2</b>	Day 1 (1446-1441) (02/02/15-03/02/15)	<b>40.5</b>	<b>150</b>
	Day 2 (1446-1441) (03/02/15-04/02/15)	25.3	<b>67.3</b>
	Day 3 (1446-1441) (04/02/15-05/02/15)	<b>46.1</b>	<b>172</b>
	Day 4 (1446-1441) (05/02/15-06/02/15)	34.7	<b>118</b>
	Day 5 (1446-1441) (06/02/15-07/02/15)	<b>44.3</b>	<b>162</b>
	Day 6 (1446-1441) (07/02/15-08/02/15)	<b>44.1</b>	<b>150</b>
	Day 7 (1446-1441) (08/02/15-09/02/15)	<b>39.9</b>	<b>128</b>
<b>*Limit</b>		37.5	50

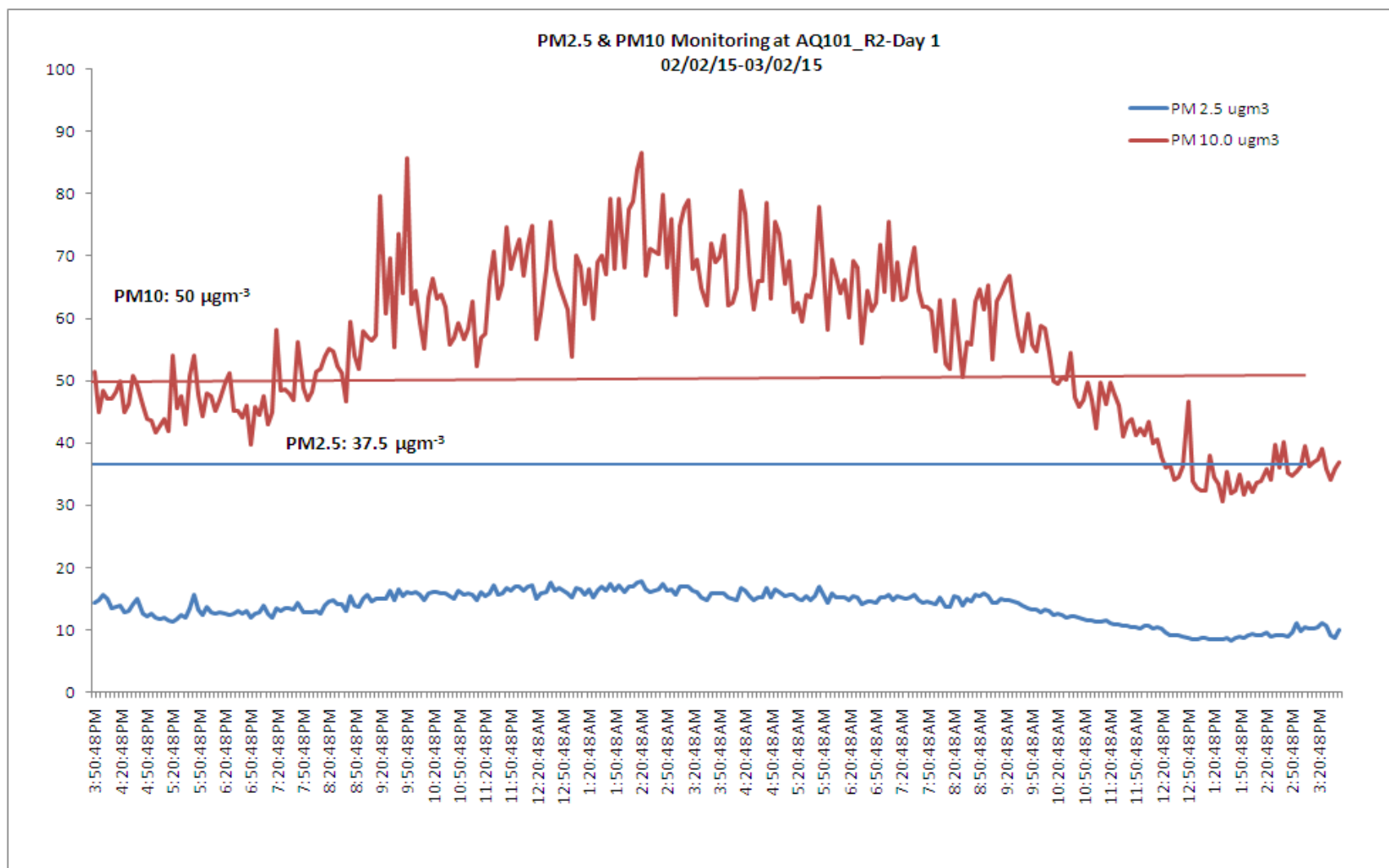
Remark: \* Singapore Ambient Air Quality Targets by 2020

**Table 8: Summary of results for Particulate Matter (PM<sub>2.5</sub> & PM<sub>10</sub>) based on 24 hours average**

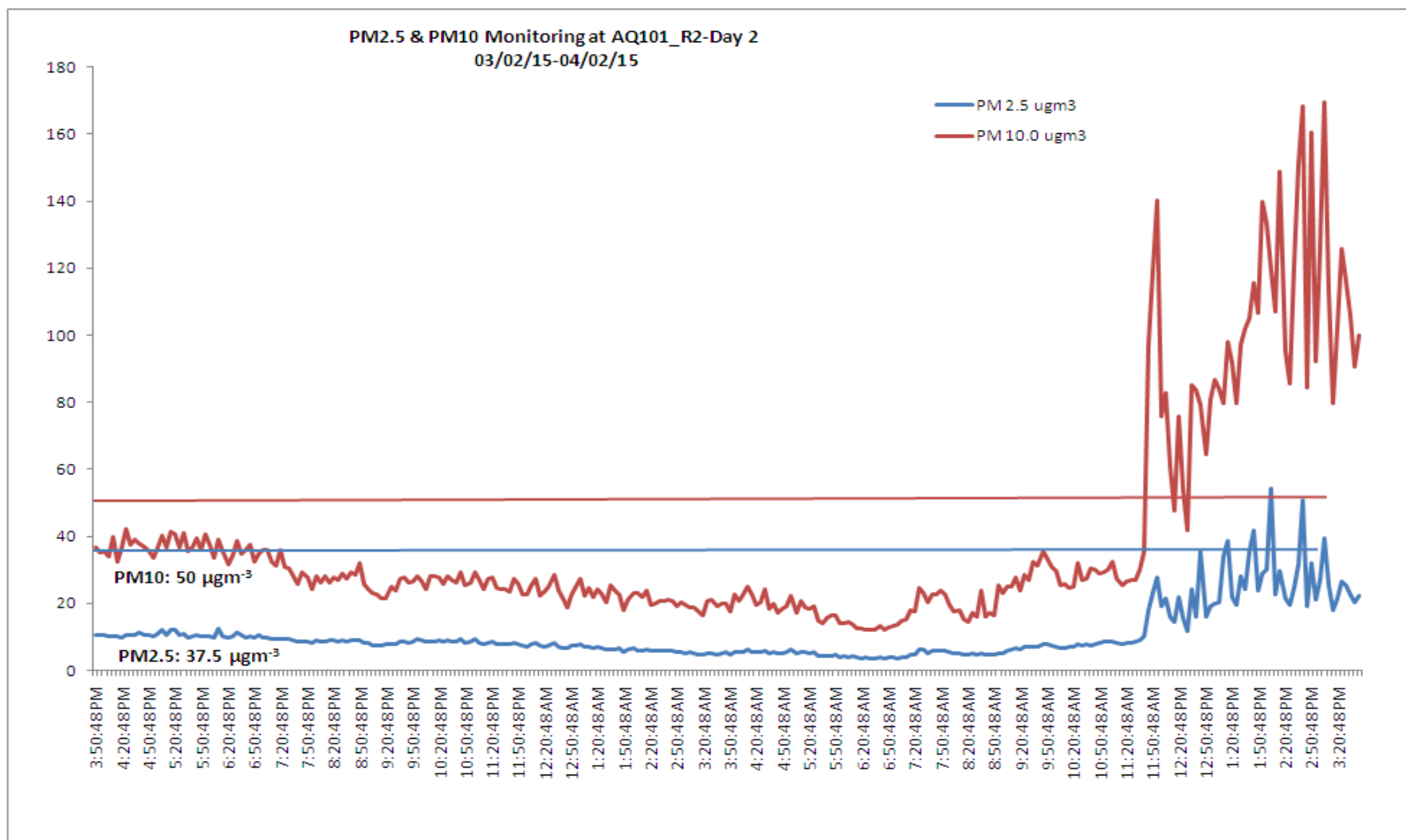
Sampling Point	Duration, hr (Period)	Particulate Matter (PM <sub>2.5</sub> ) in ug m <sup>-3</sup> (24hrs)	Particulate Matter (PM <sub>10</sub> ) in ug m <sup>-3</sup> (24hr)
<b>AQ201_R2</b>	Day 1 (1319-1316) (16/01/15-17/01/15)	6.5	25.9
	Day 2 (1321-1316) (17/01/15-18/01/15)	7.0	29.0
	Day 3 (1321-1316) (18/01/15-19/01/15)	11.3	45.7
	Day 4 (1321-1319) (19/01/15-20/01/15)	11.5	46.1
	Day 5 (1324-1319) (20/01/15-21/01/15)	16.5	<b>53.5</b>
	Day 6 (1324-1322) (21/01/15-22/01/15)	16.5	48.0
	Day 7 (1327-1322) (22/01/15-23/01/15)	11.8	36.0
<b>AQ202_R2</b>	Day 1 (1401-1358) (16/01/15-17/01/15)	19.4	<b>60.9</b>
	Day 2 (1403-1358) (17/01/15-18/01/15)	20.0	<b>67.8</b>
	Day 3 (1403-1358) (18/01/15-19/01/15)	31.3	<b>102</b>
	Day 4 (1403-1402) (19/01/15-20/01/15)	30.3	<b>96.9</b>
	Day 5 (1407-1402) (20/01/15-21/01/15)	<b>45.4</b>	<b>121</b>
	Day 6 (1407-1406) (21/01/15-22/01/15)	<b>45.6</b>	<b>111</b>
	Day 7 (1411-1406) (22/01/15-23/01/15)	32.8	<b>81.3</b>
<b>^ AQ203_R2</b>	Day 1 (1317-1312) (16/01/15-17/01/15)	22.1	<b>74.4</b>
	Day 2 (1317-1312) (17/01/15-18/01/15)	24.8	<b>85.1</b>
	Day 3 (1317-1312) (18/01/15-19/01/15)	<b>41.7</b>	<b>136</b>
	Day 4 (1317-1313) (19/01/15-20/01/15)	<b>42.4</b>	<b>145</b>
	Day 5 (1318-1313) (20/01/15-21/01/15)	<b>57.9</b>	<b>171</b>
	Day 6 (1318-0028) (21/01/15-22/01/15)	<b>63.9</b>	<b>192</b>
	-	-	-
<b>*Limit</b>		37.5	50

Remark: \* Singapore Ambient Air Quality Targets by 2020

^ Presented data only for around 6 days due to the meter shutdown

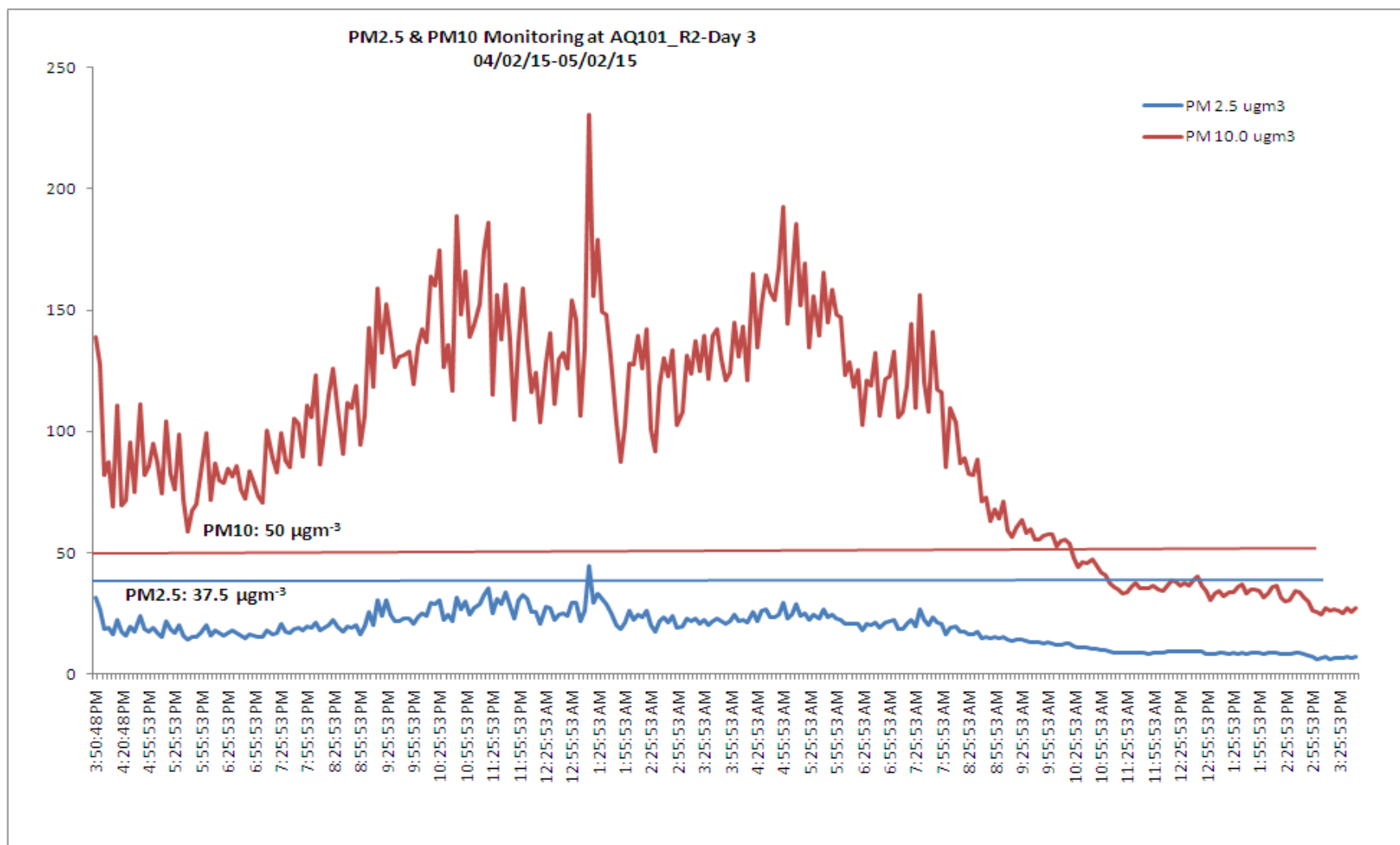


**Figure 32: Particulate concentration measured at Point AQ101\_R2 (Day 1)**

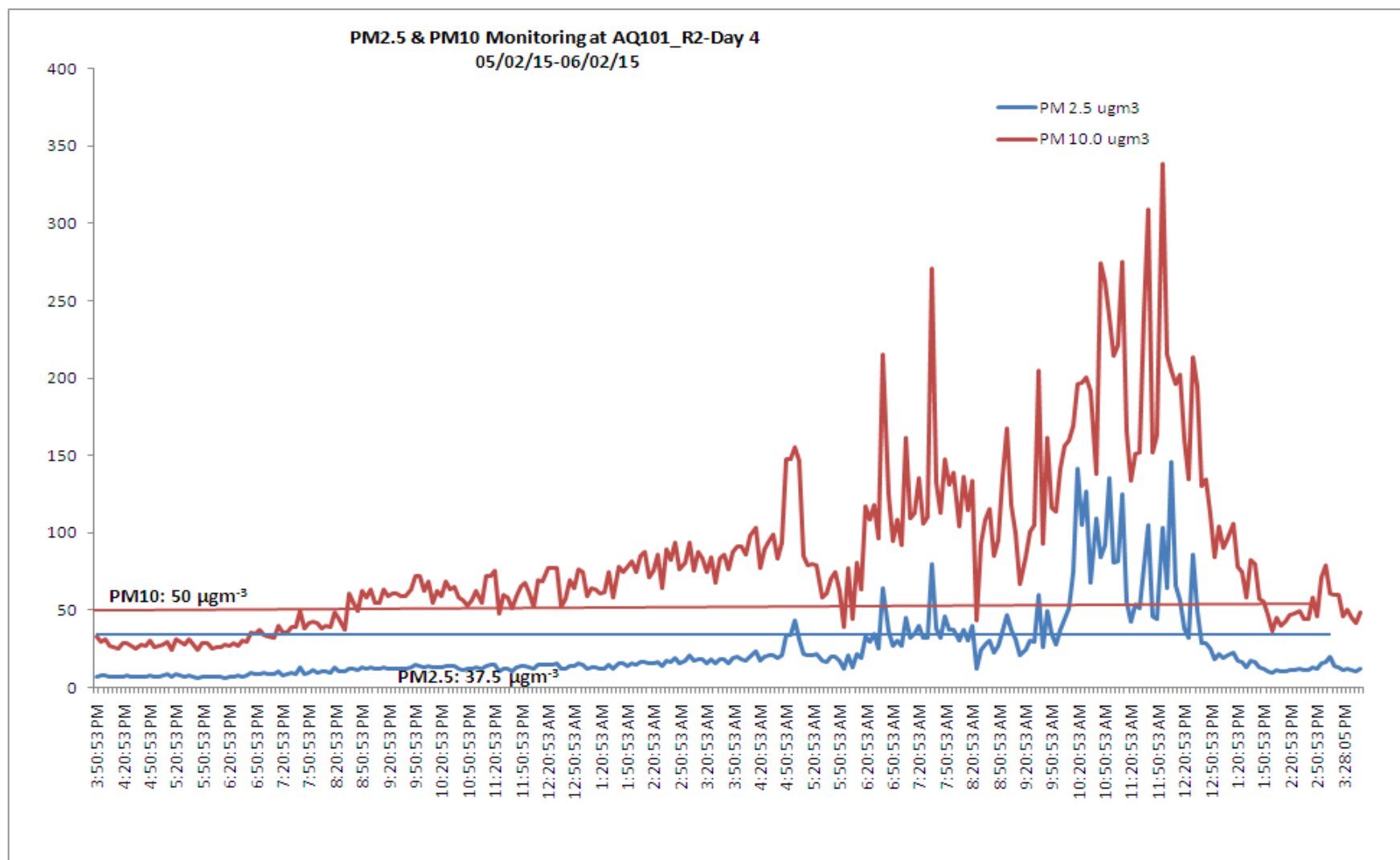


**Figure 33: Particulate concentration measured at Point AQ101\_R2 (Day 2)**

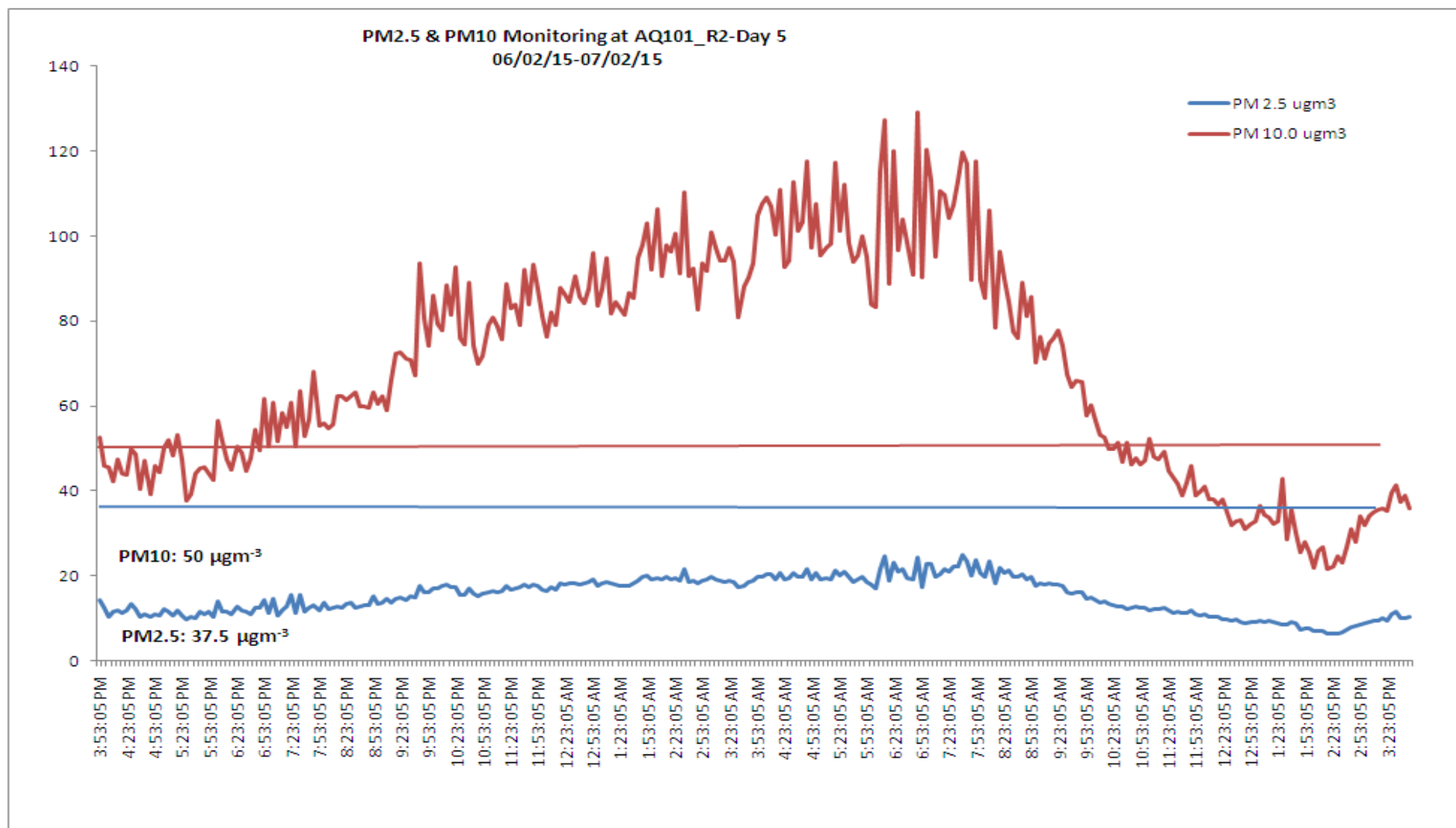




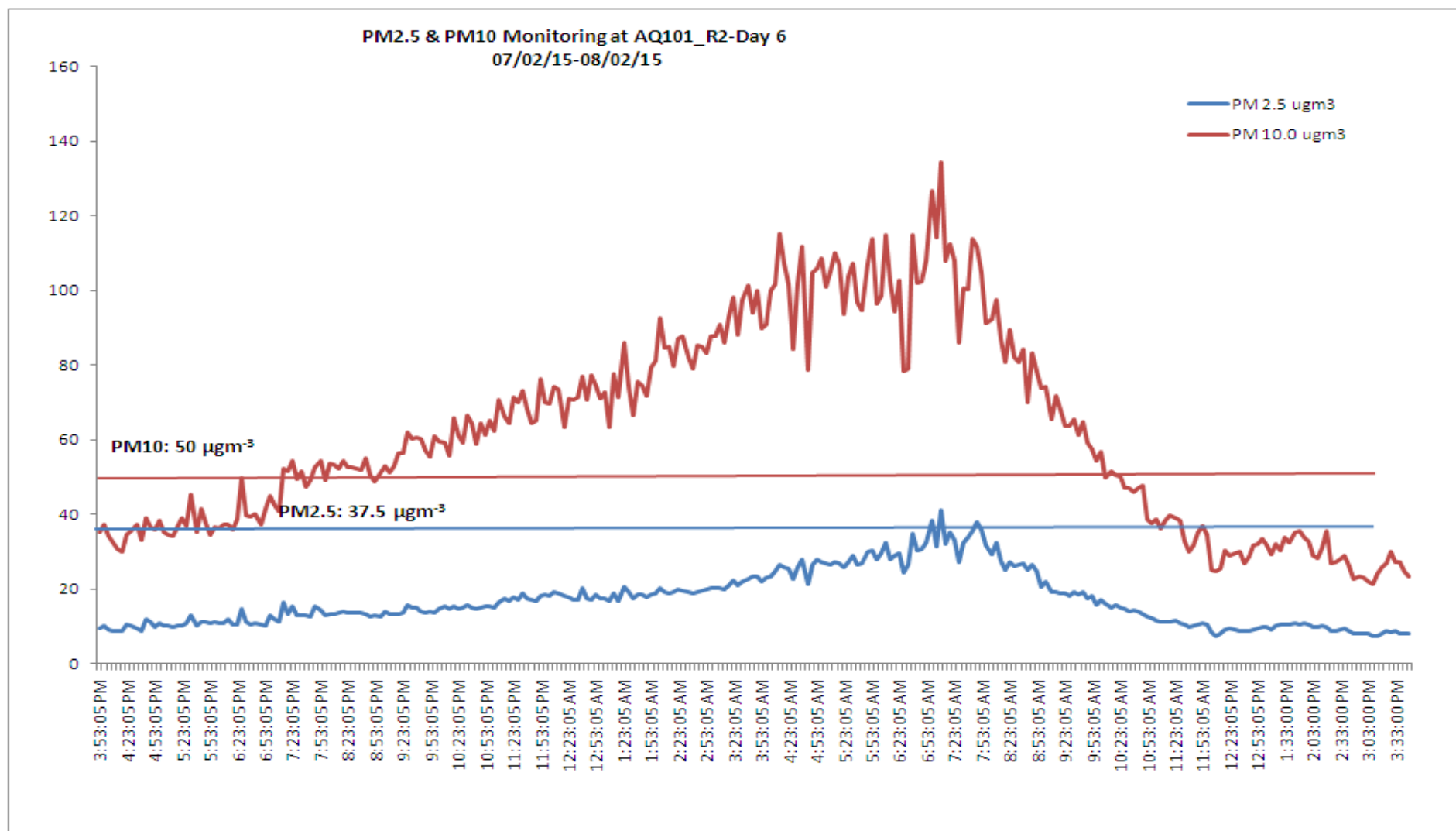
**Figure 34: Particulate concentration measured at Point AQ101\_R2 (Day 3)**



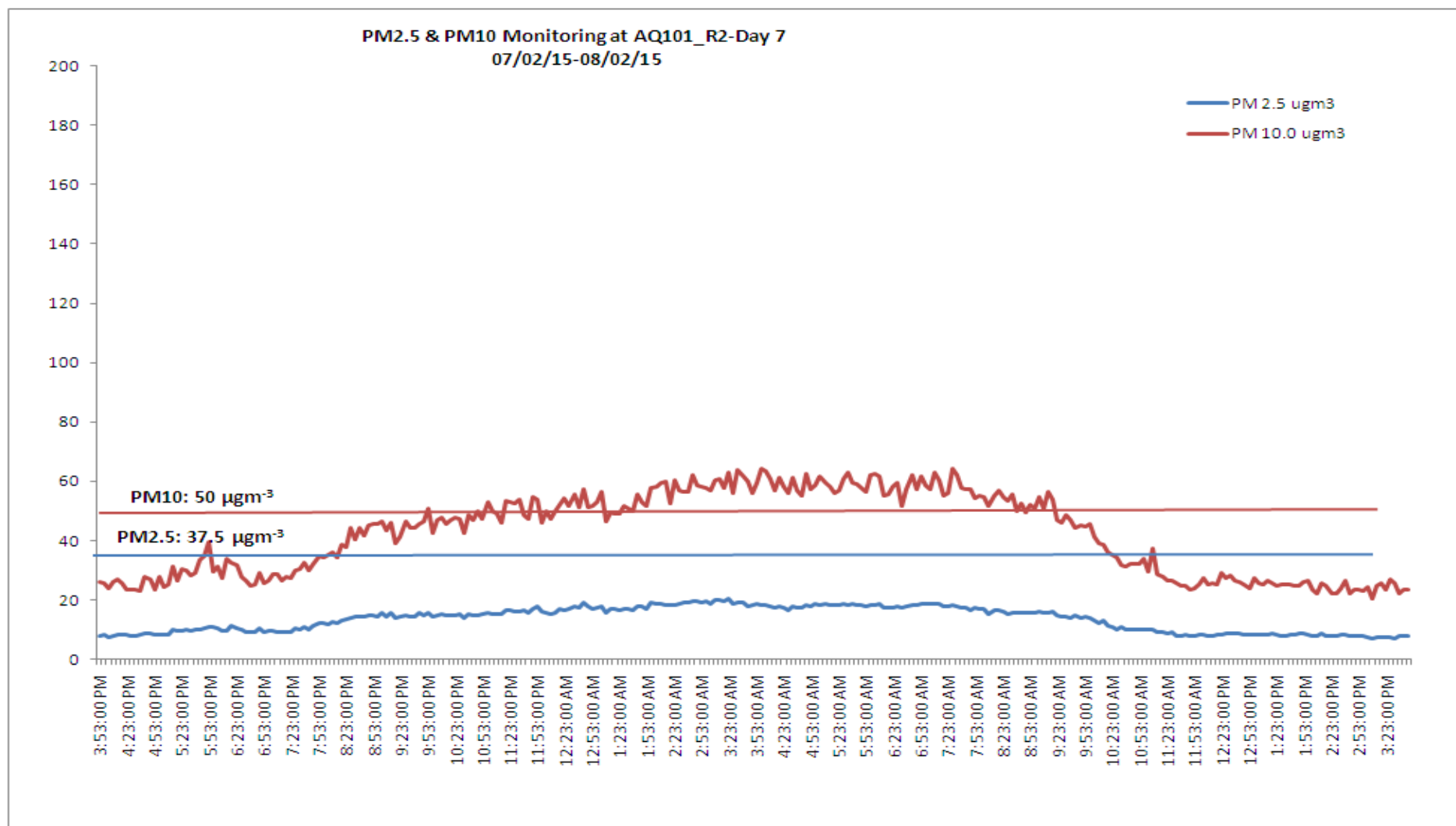
**Figure 35: Particulate concentration measured at Point AQ101\_R2 (Day 4)**



**Figure 36: Particulate concentration measured at Point AQ101\_R2 (Day 5)**

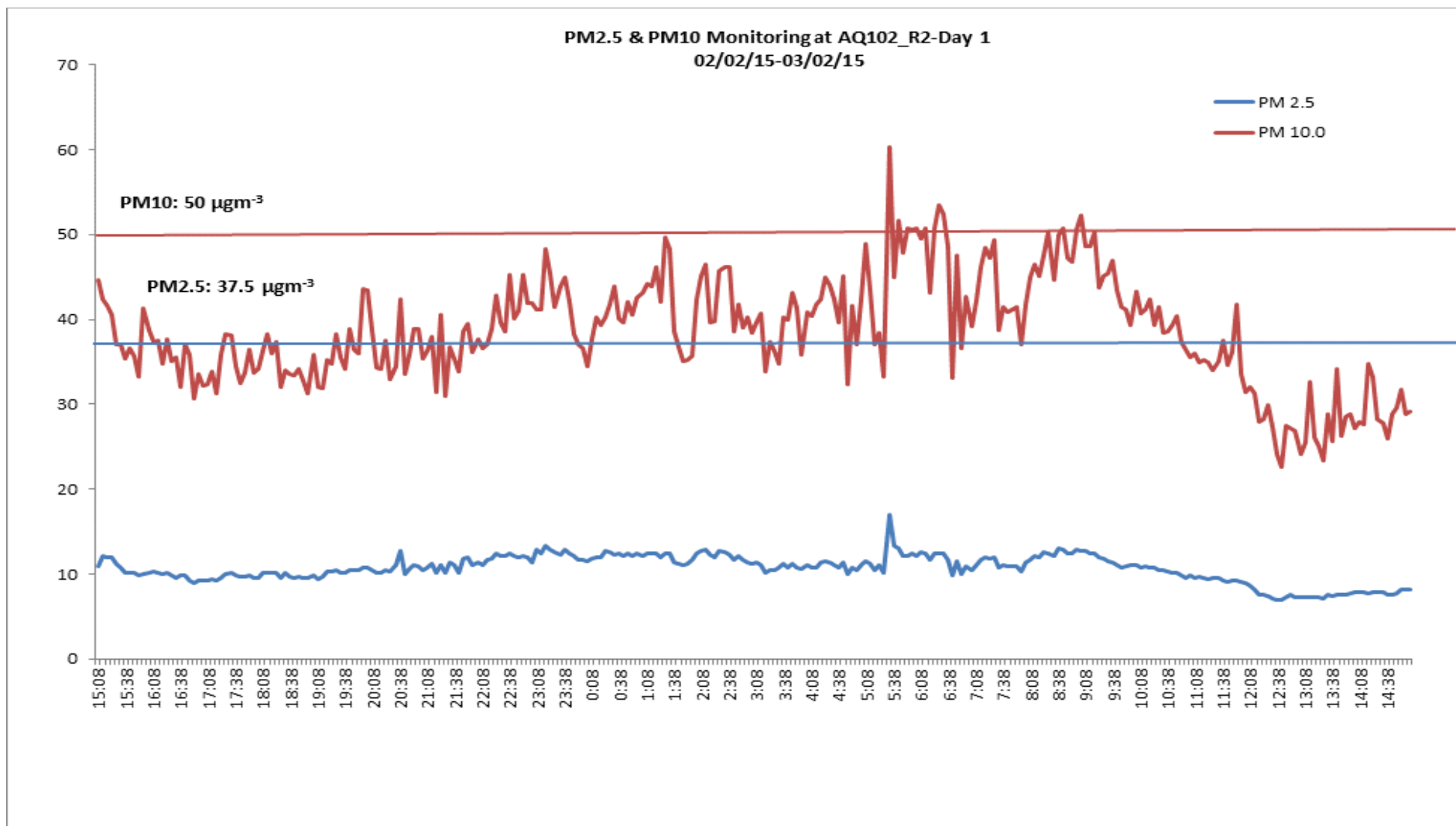


**Figure 37: Particulate concentration measured at Point AQ101\_R2 (Day 6)**

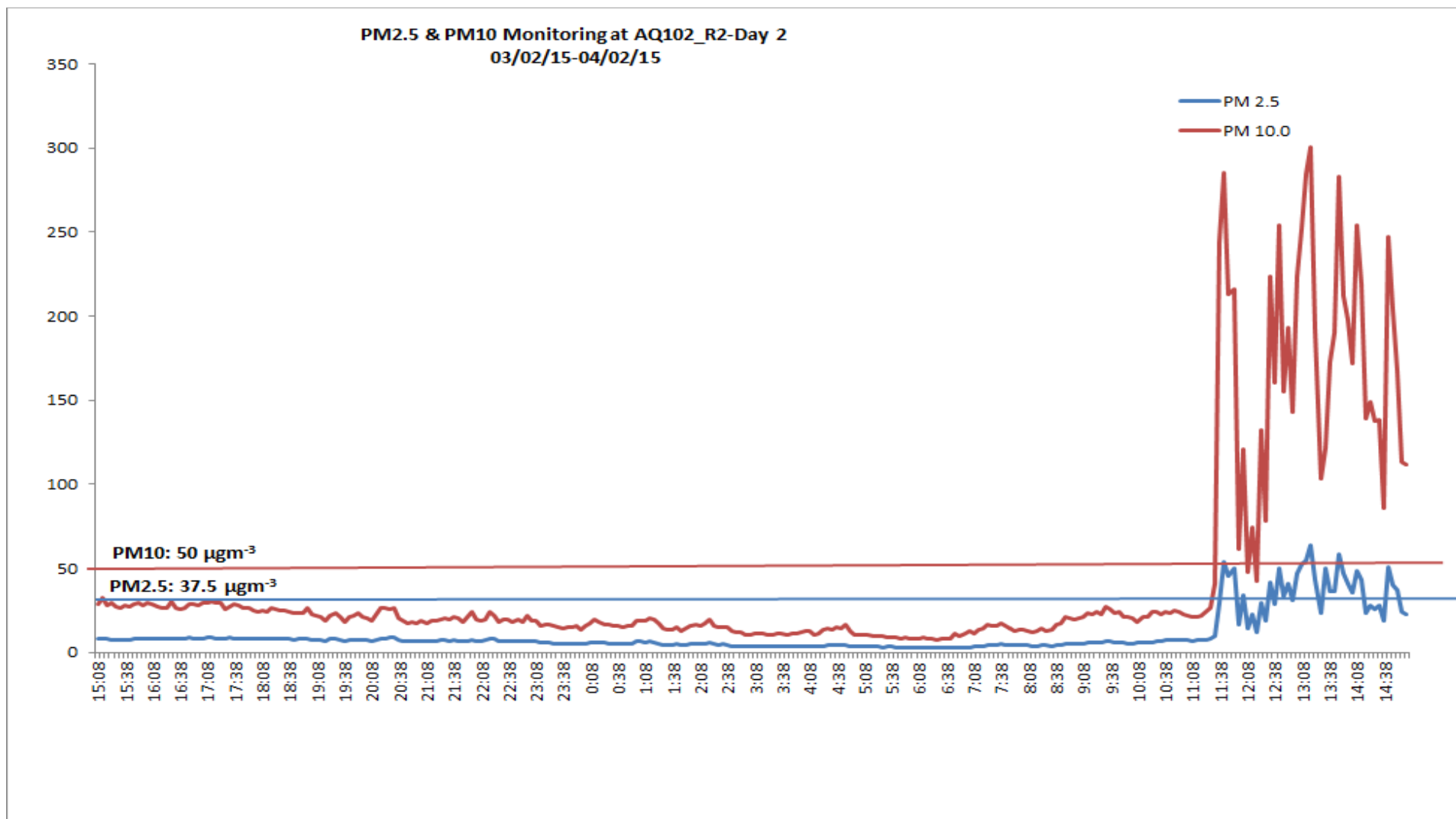


**Figure 38: Particulate concentration measured at Point AQ101\_R2 (Day 7)**

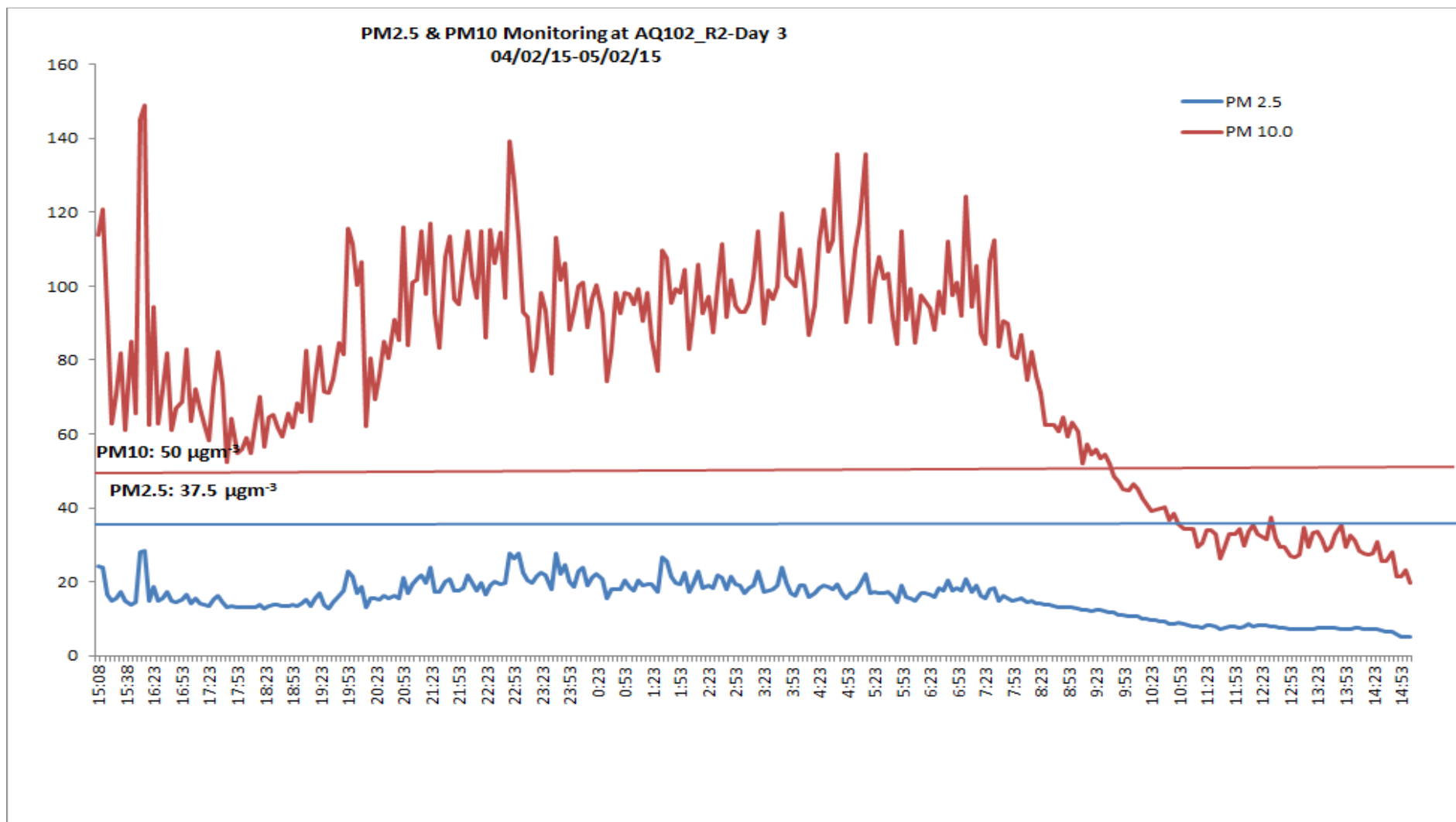




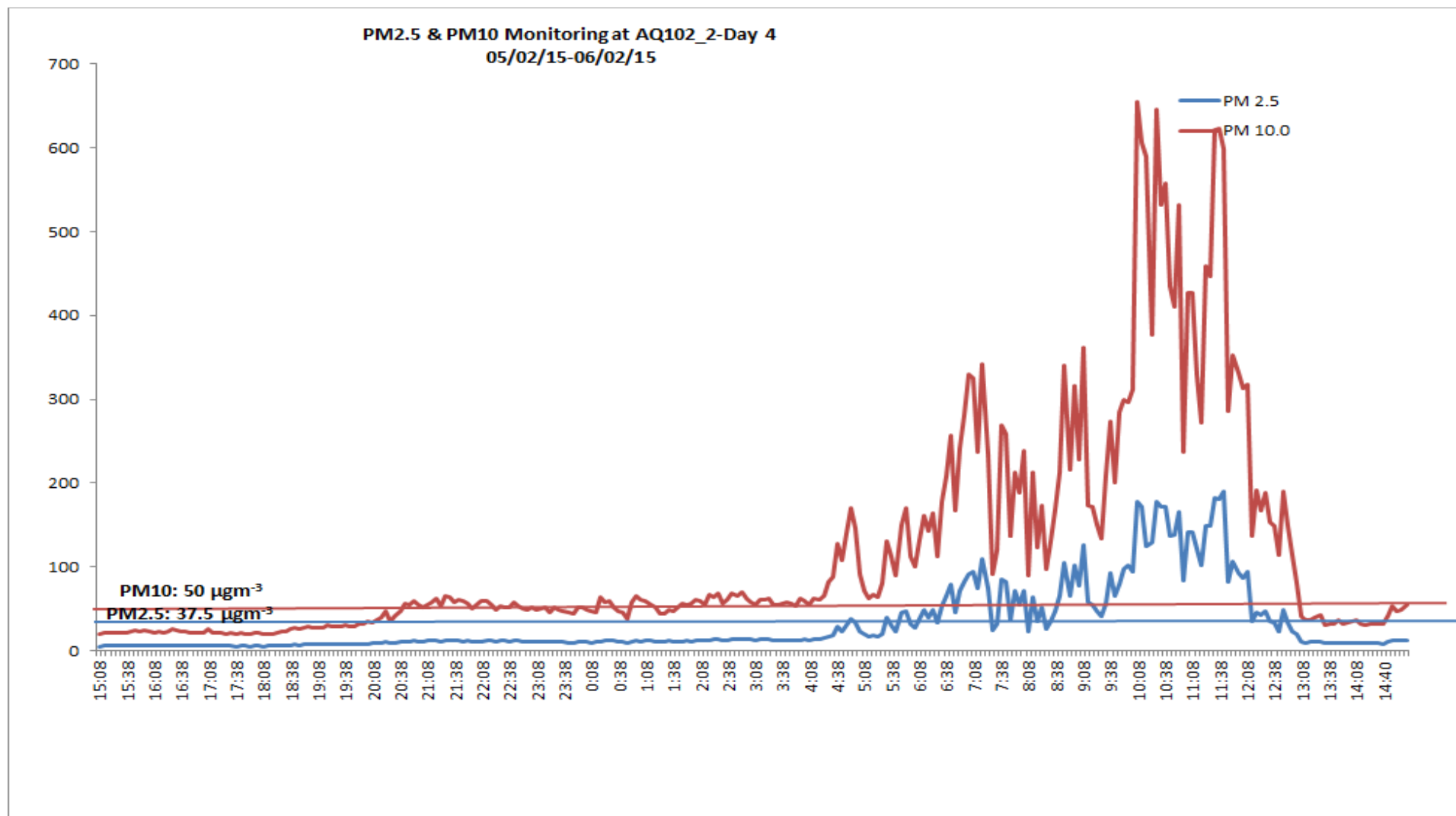
**Figure 39: Particulate concentration measured at Point AQ102\_R1 (Day 1)**



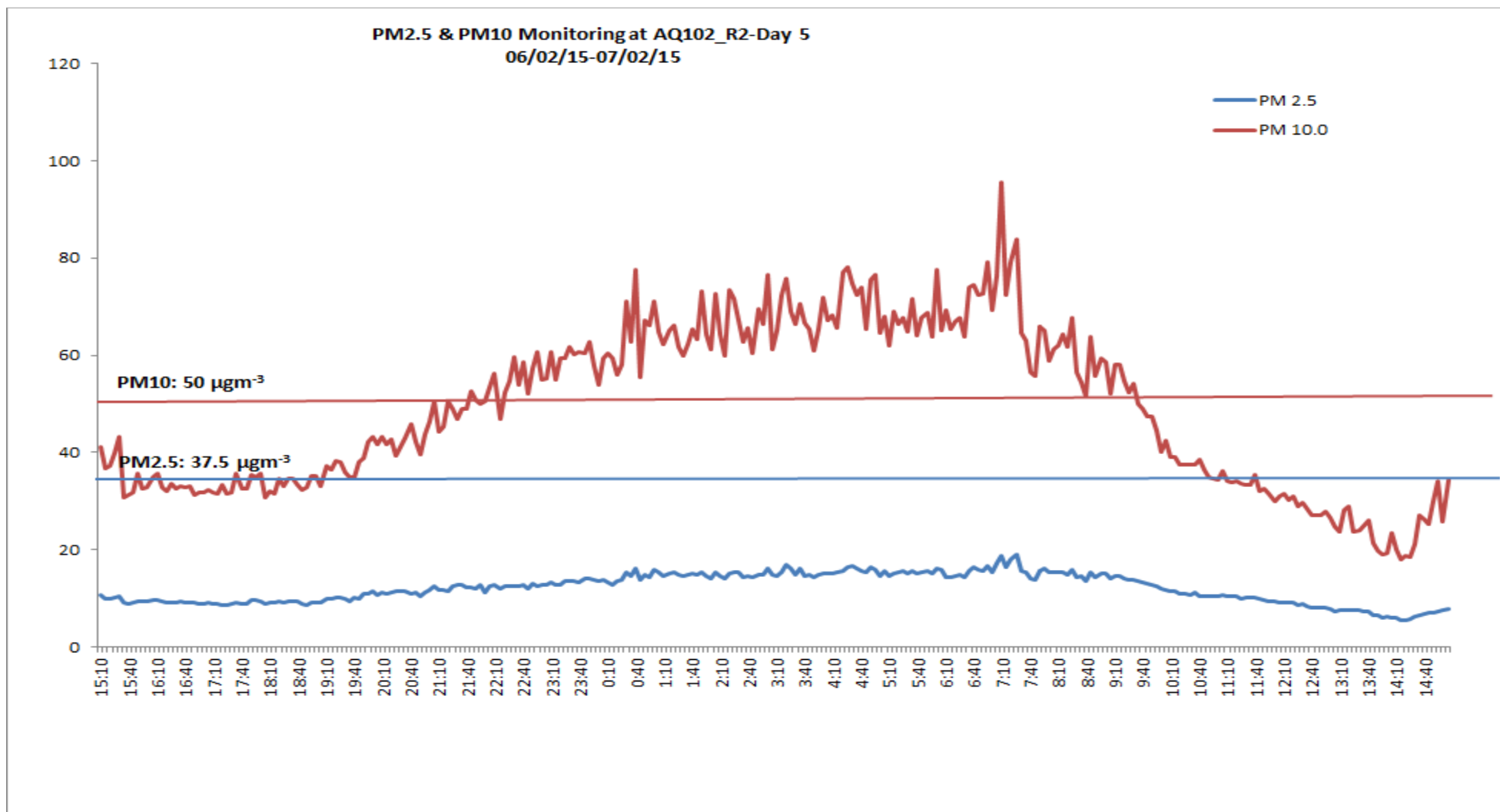
**Figure 40: Particulate concentration measured at Point AQ102\_R2 (Day 2)**



**Figure 41: Particulate concentration measured at Point AQ102\_R2 (Day 3)**

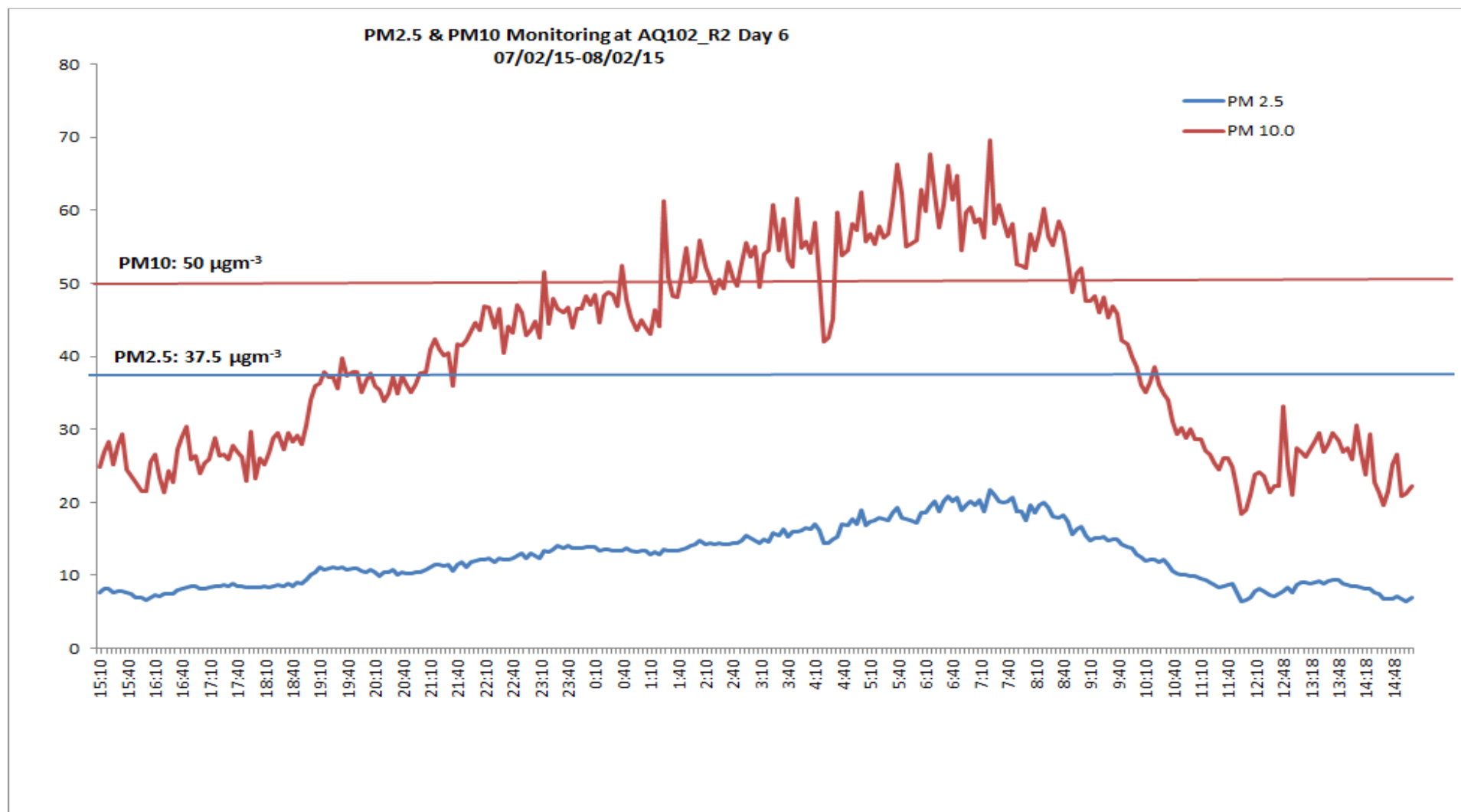


**Figure 42: Particulate concentration measured at Point AQ102\_R2 (Day 4)**

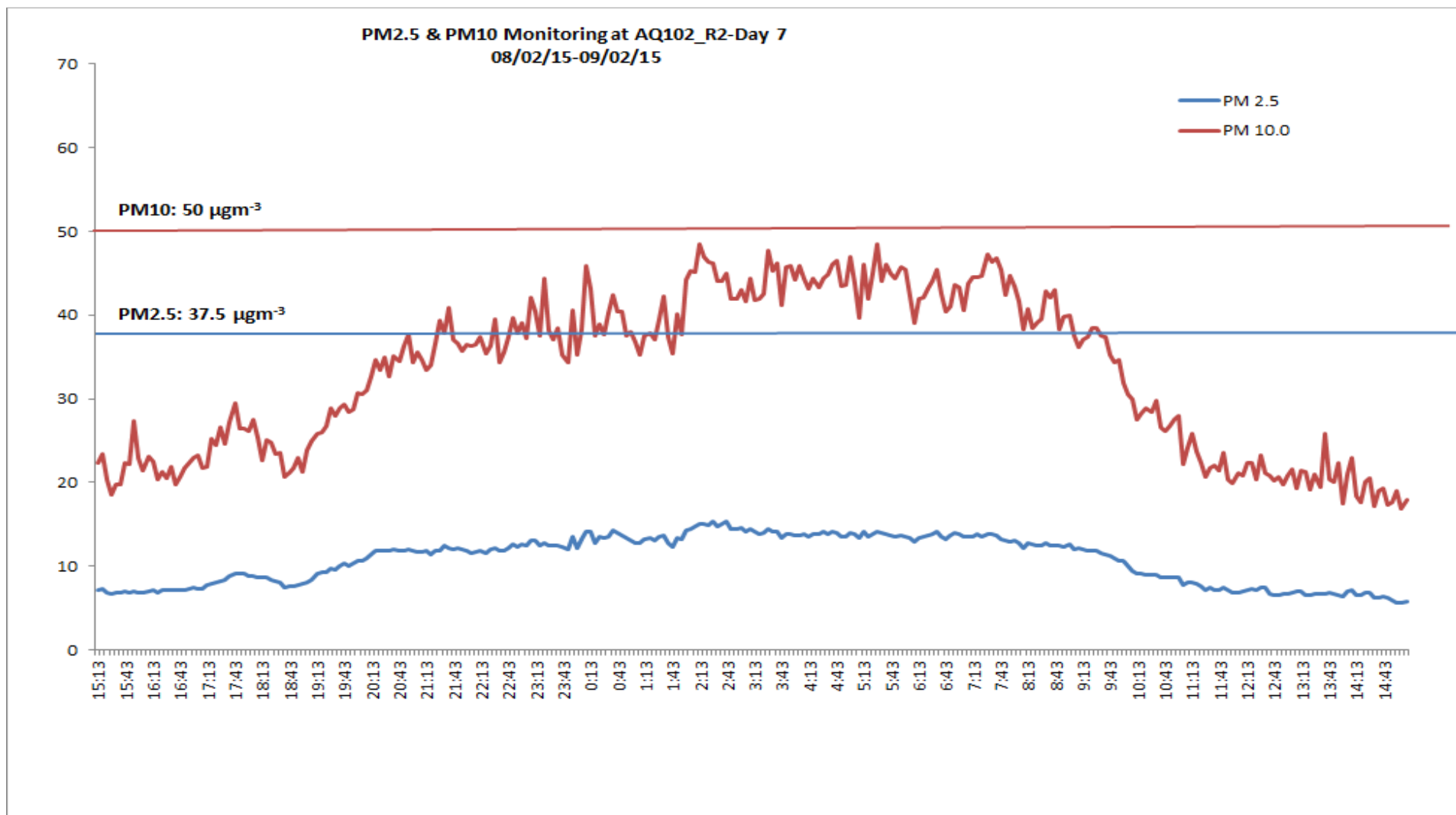


**Figure 43: Particulate concentration measured at Point AQ102\_R2 (Day 5)**

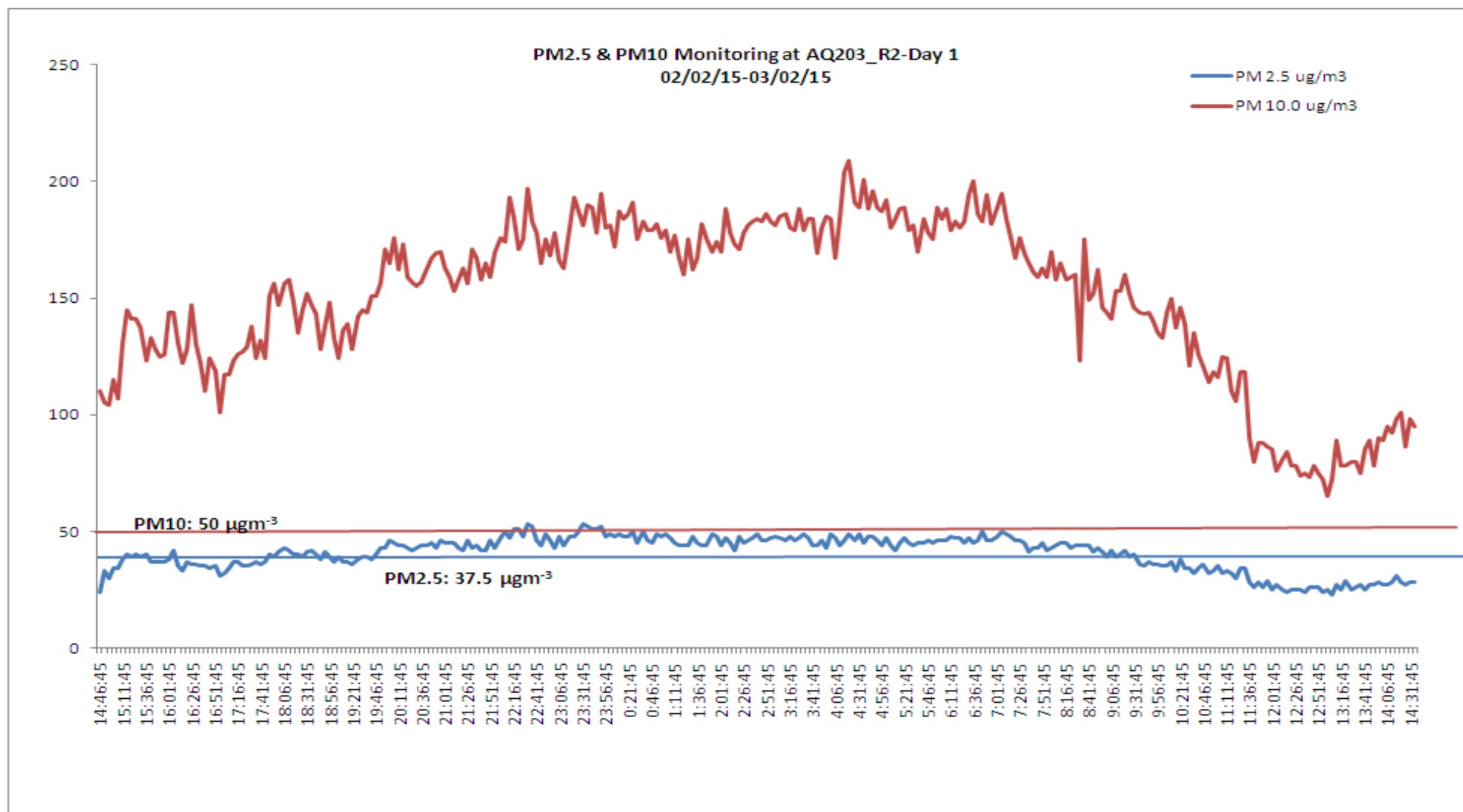




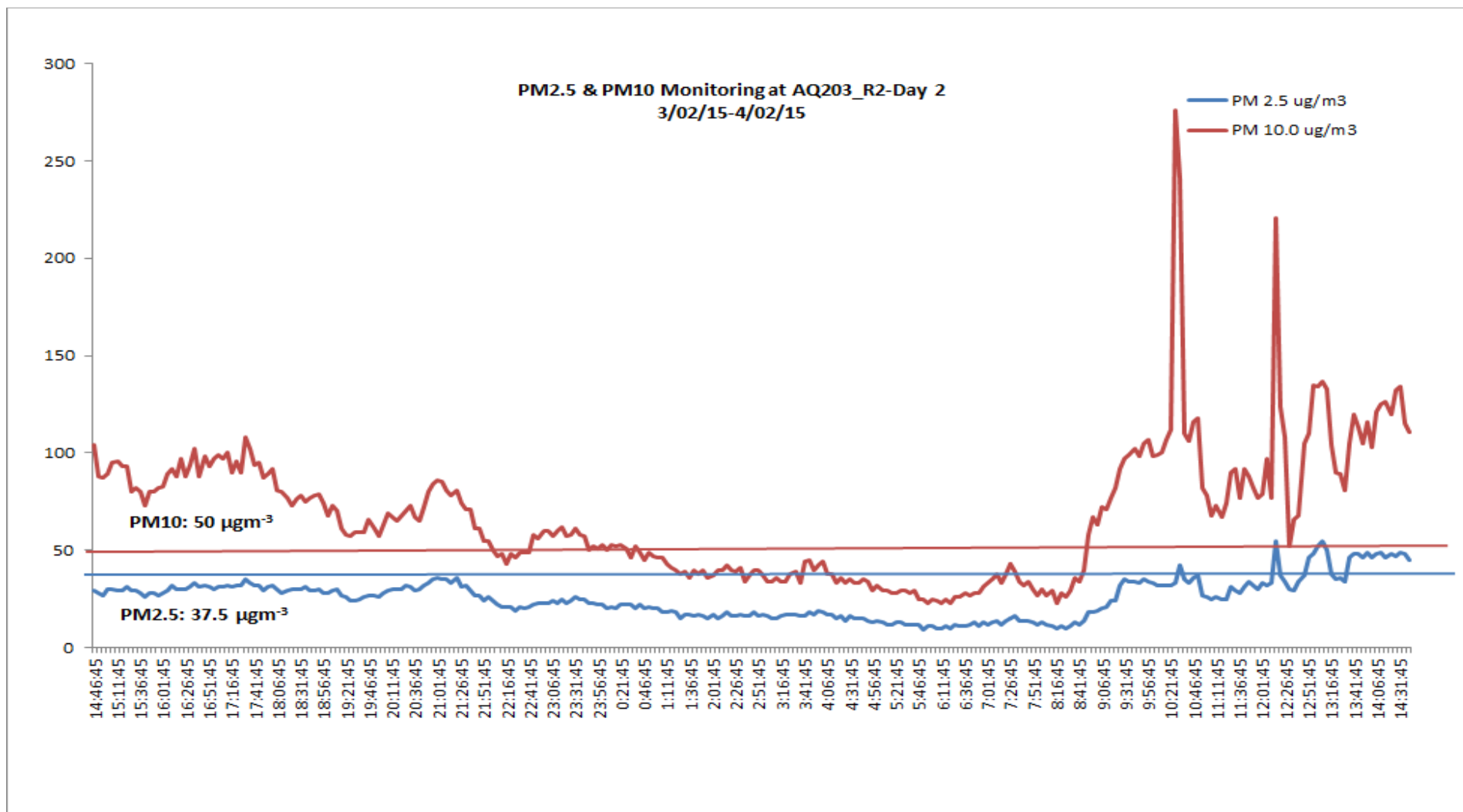
**Figure 44: Particulate concentration measured at Point AQ102\_R2 (Day 6)**



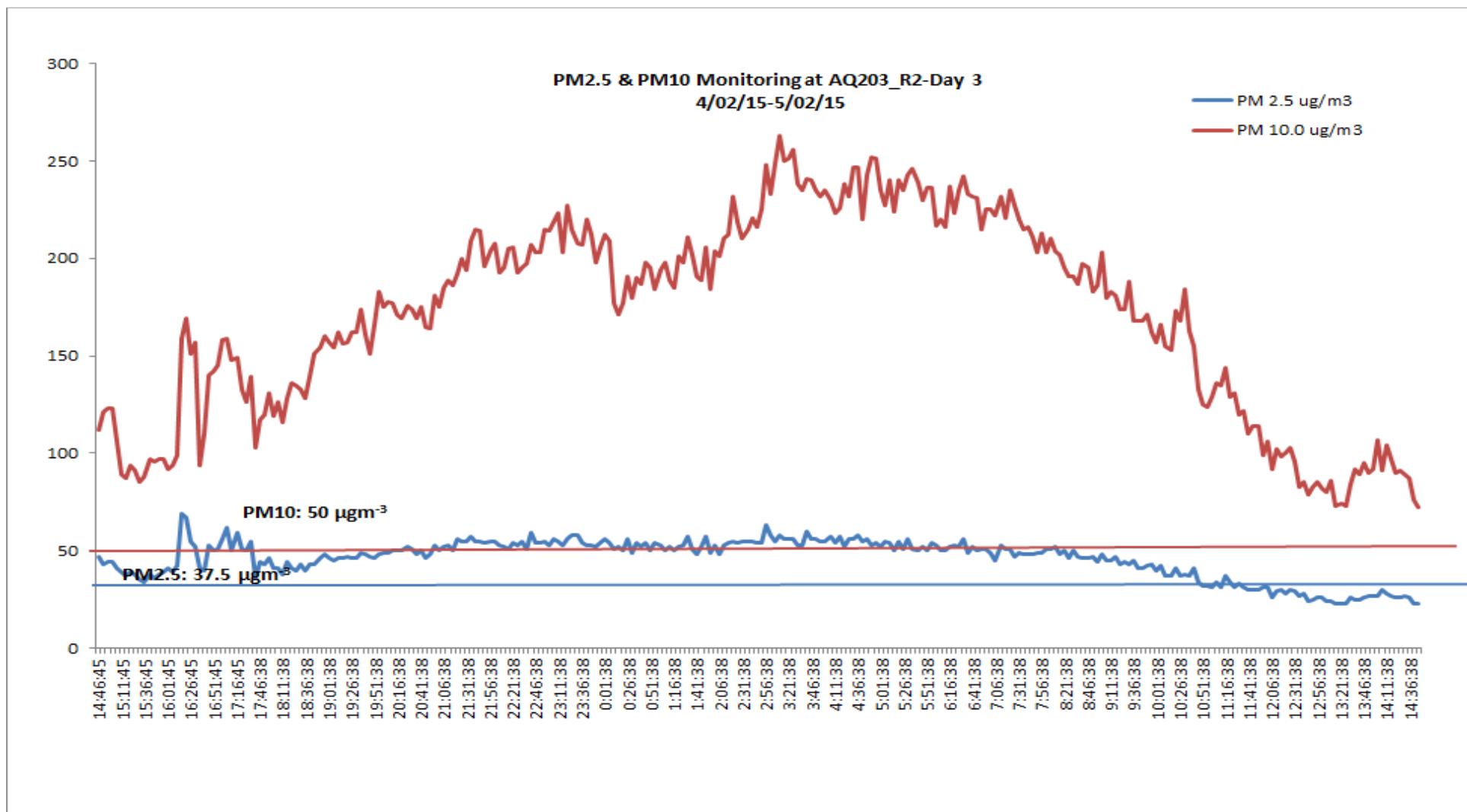
**Figure 45: Particulate concentration measured at Point AQ102\_R2 (Day 7)**



**Figure 46: Particulate concentration measured at Point AQ203\_R2 (Day 1)**

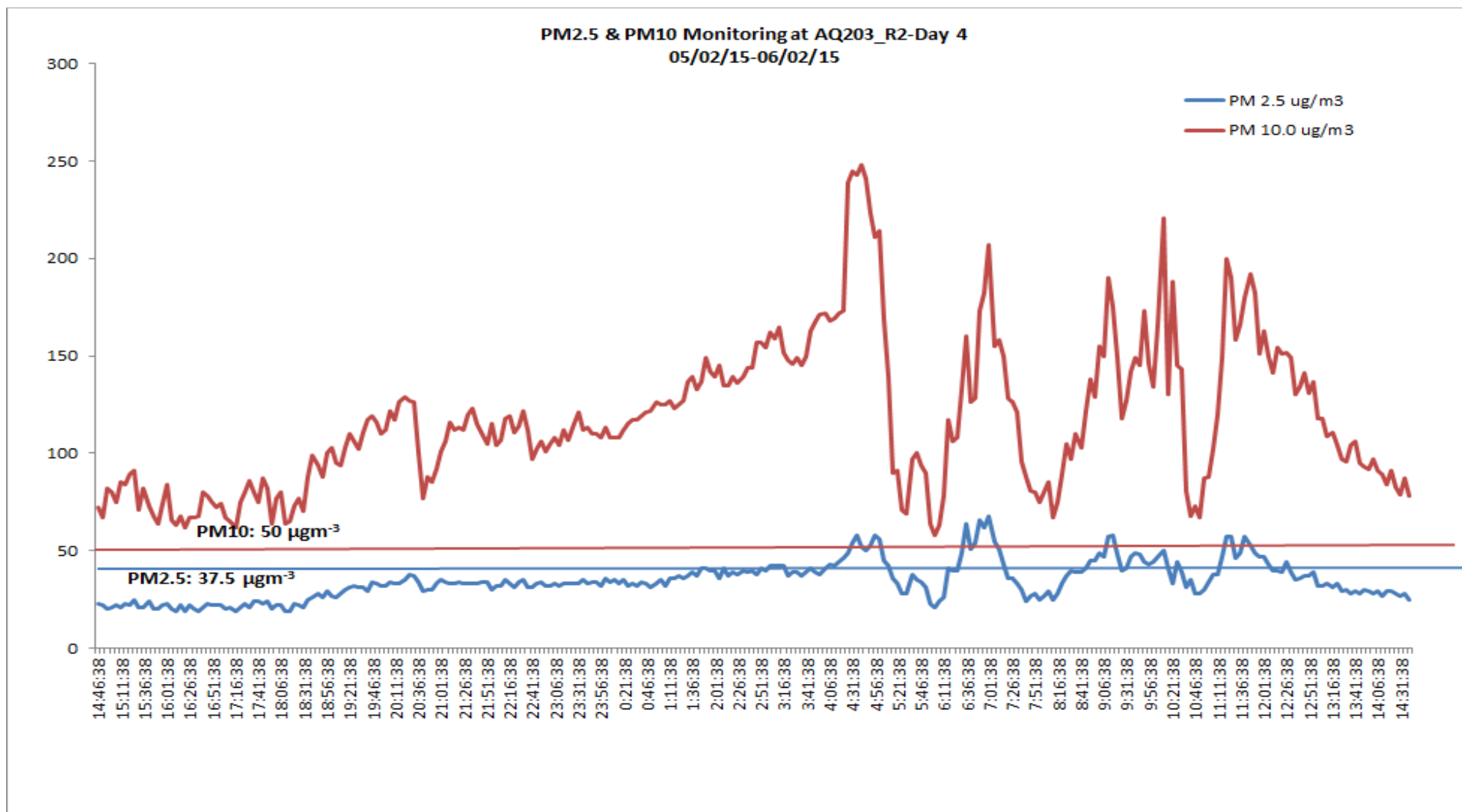


**Figure 47: Particulate concentration measured at Point AQ203\_R2 (Day 2)**

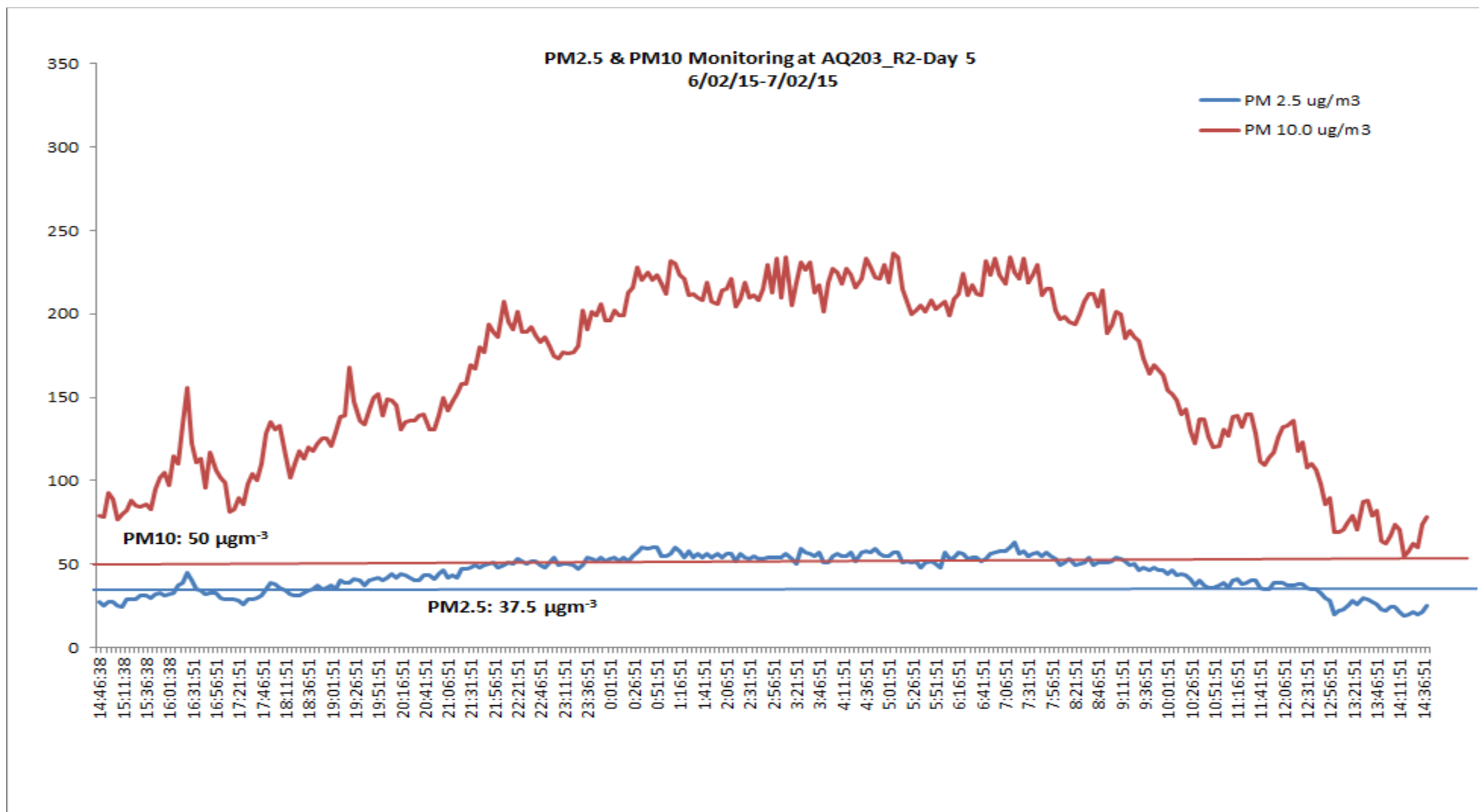


**Figure 48: Particulate concentration measured at Point AQ203\_R2 (Day 3)**

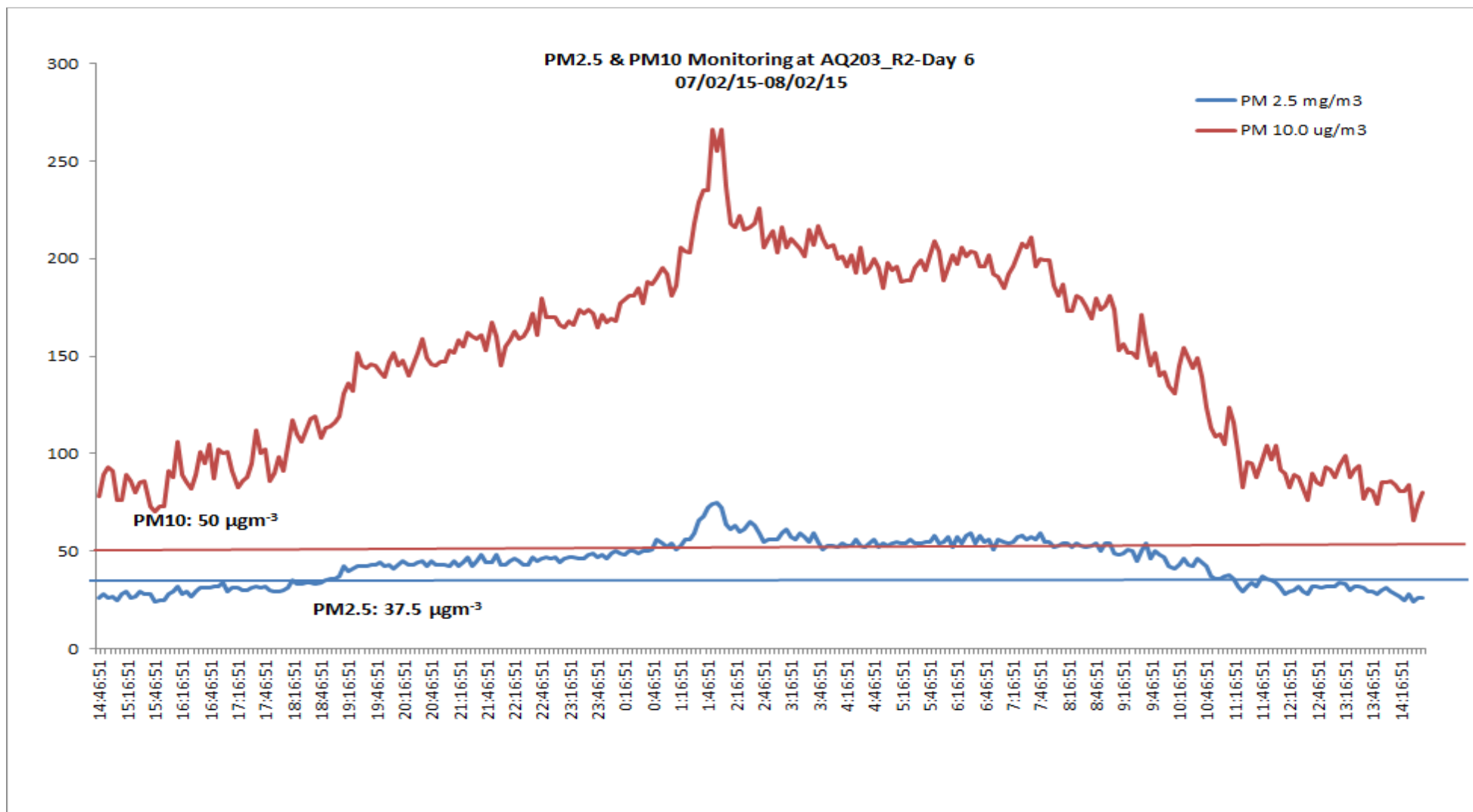




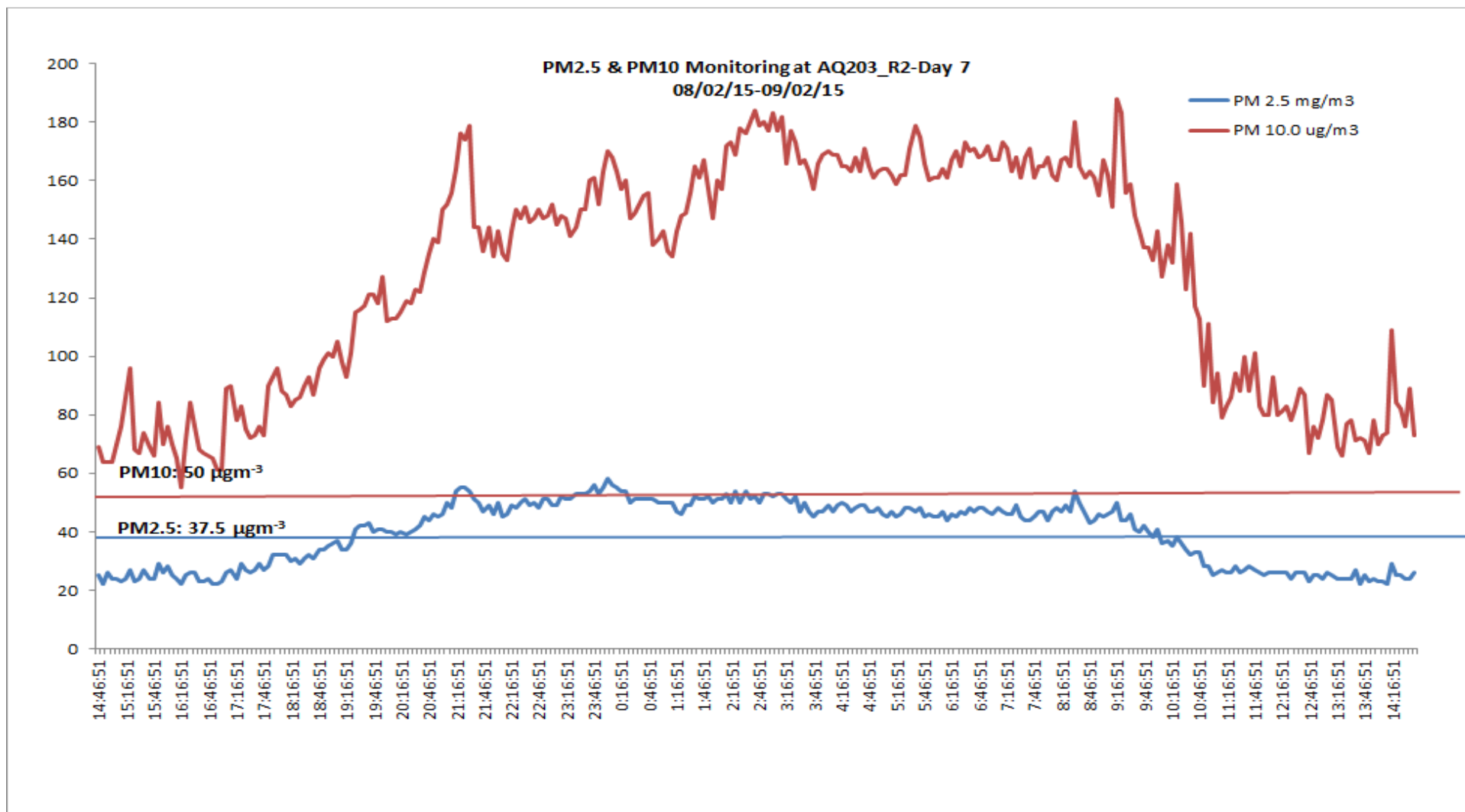
**Figure 49: Particulate concentration measured at Point AQ203\_R2 (Day 4)**



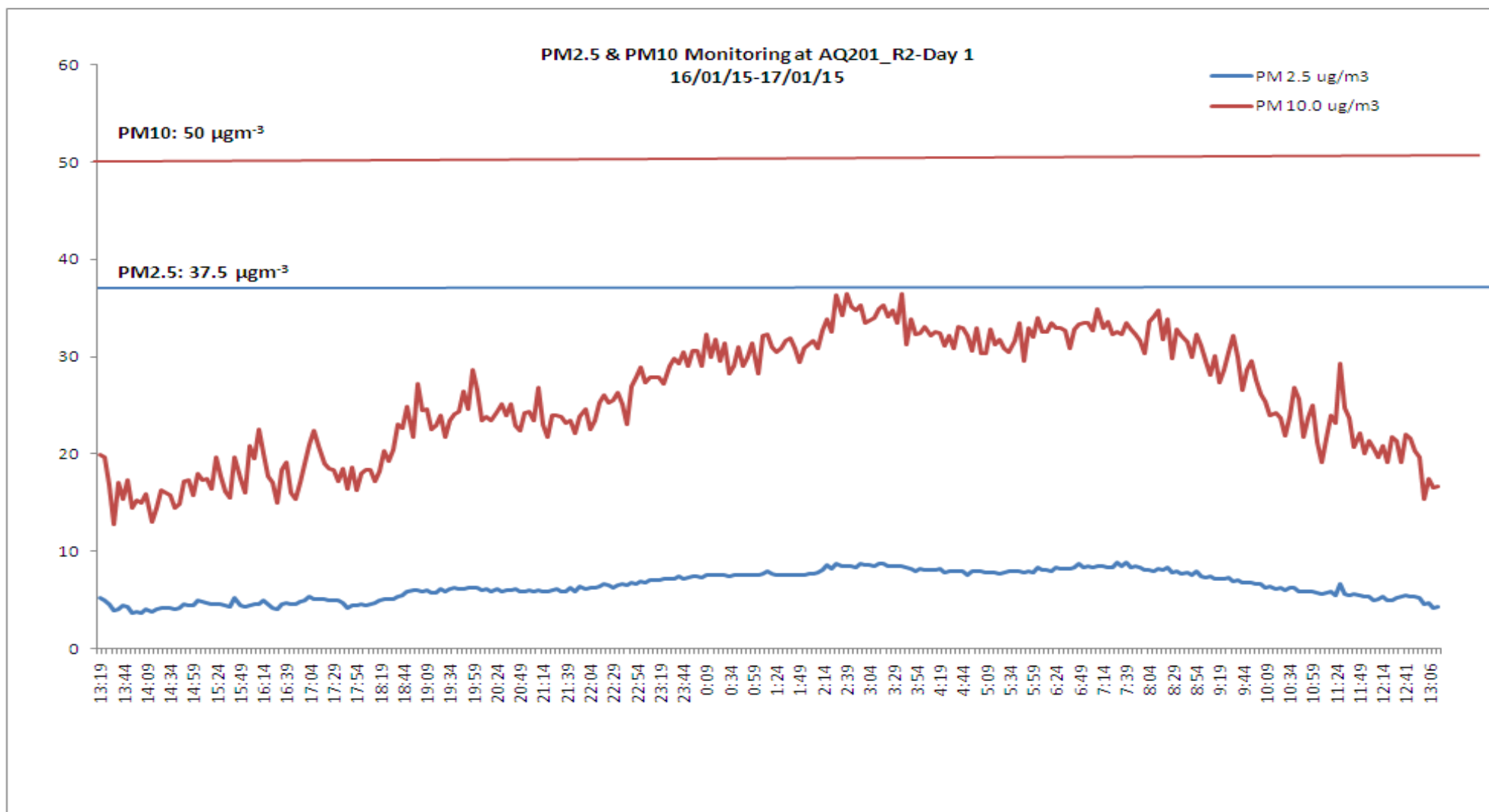
**Figure 50: Particulate concentration measured at Point AQ203\_R2 (Day 5)**



**Figure 51: Particulate concentration measured at Point AQ203\_R2 (Day 6)**

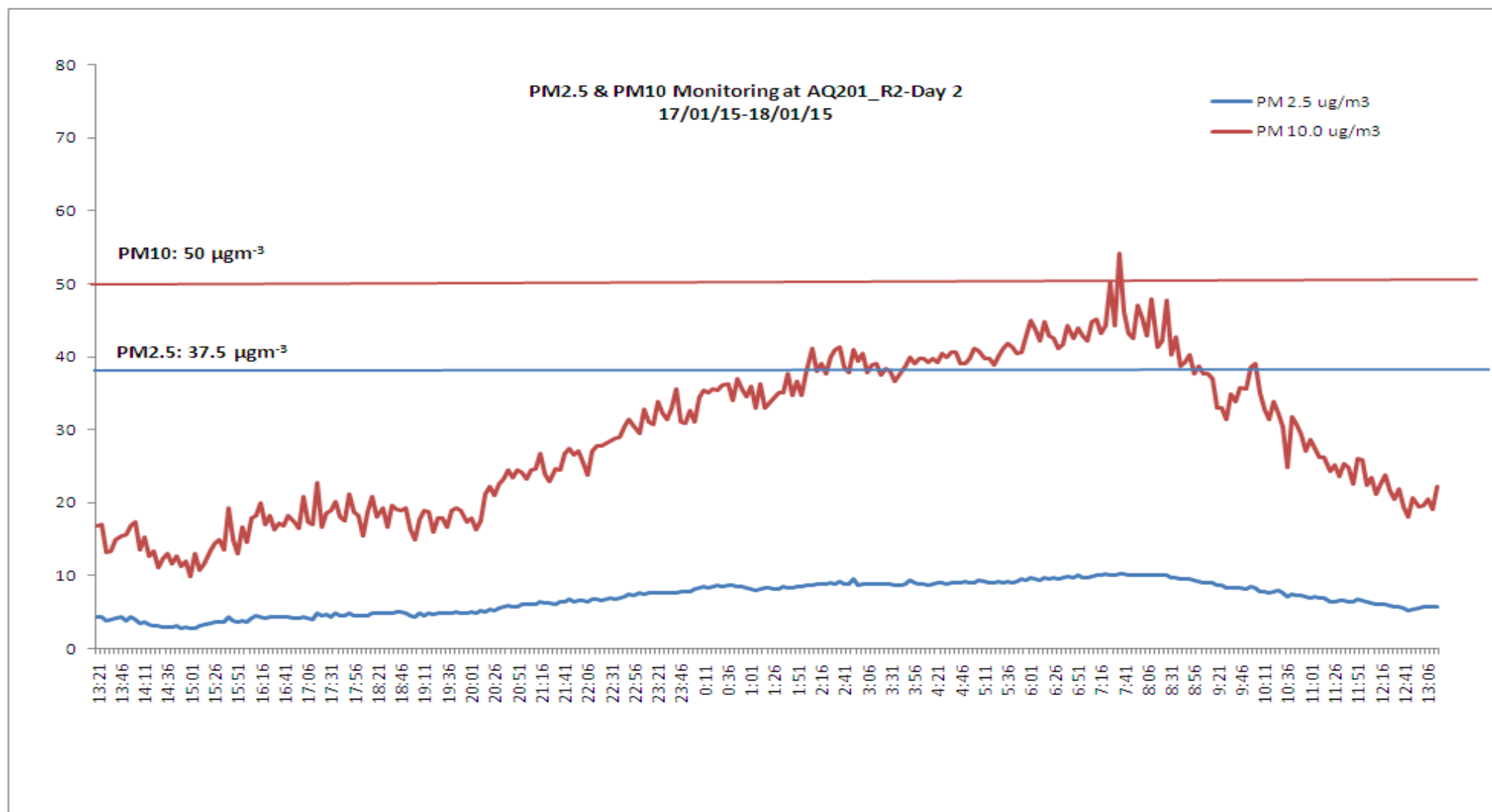


**Figure 52: Particulate concentration measured at Point AQ203\_R2 (Day 7)**

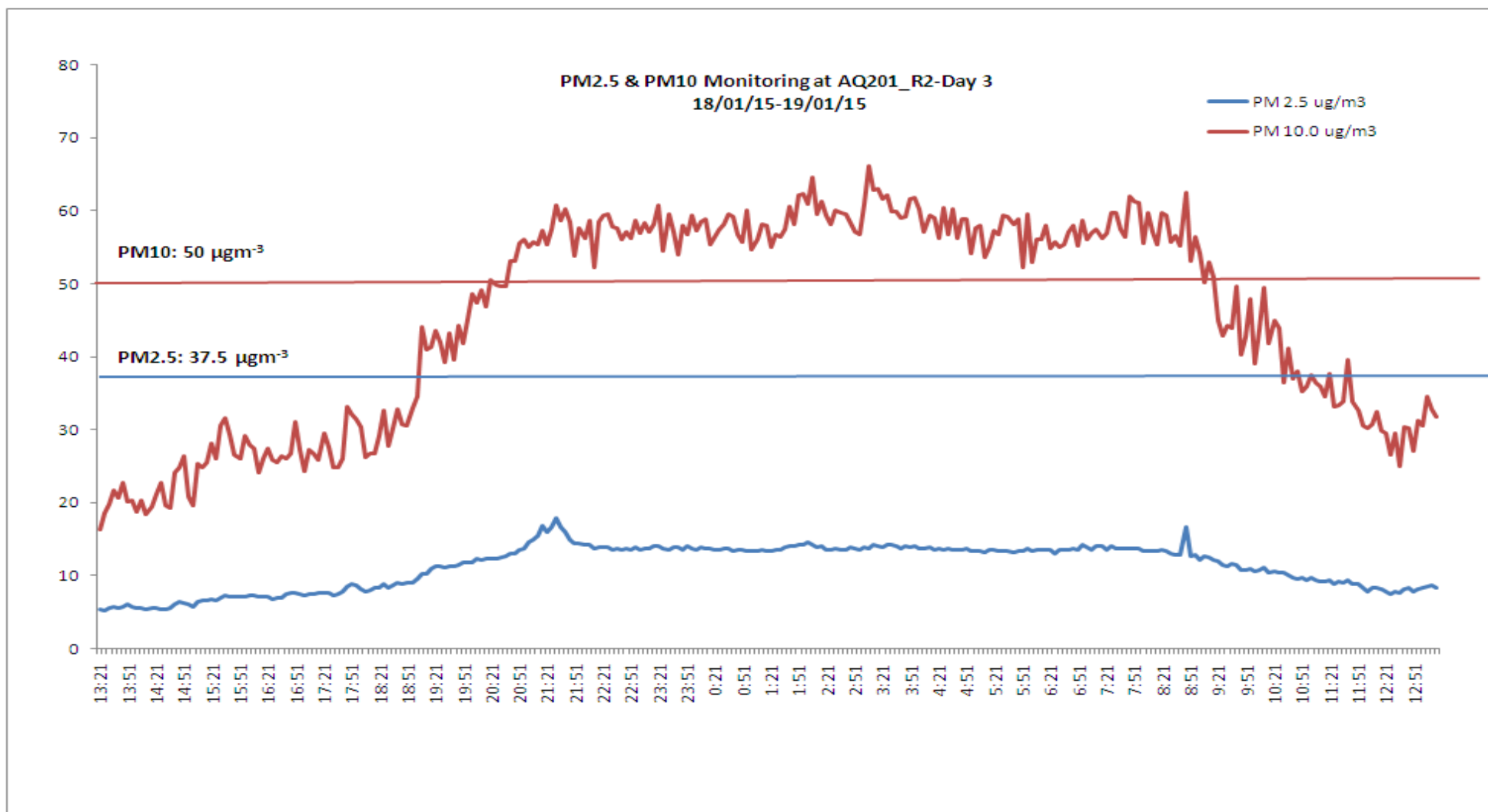


**Figure 53: Particulate concentration measured at Point AQ201\_R2 (Day 1)**

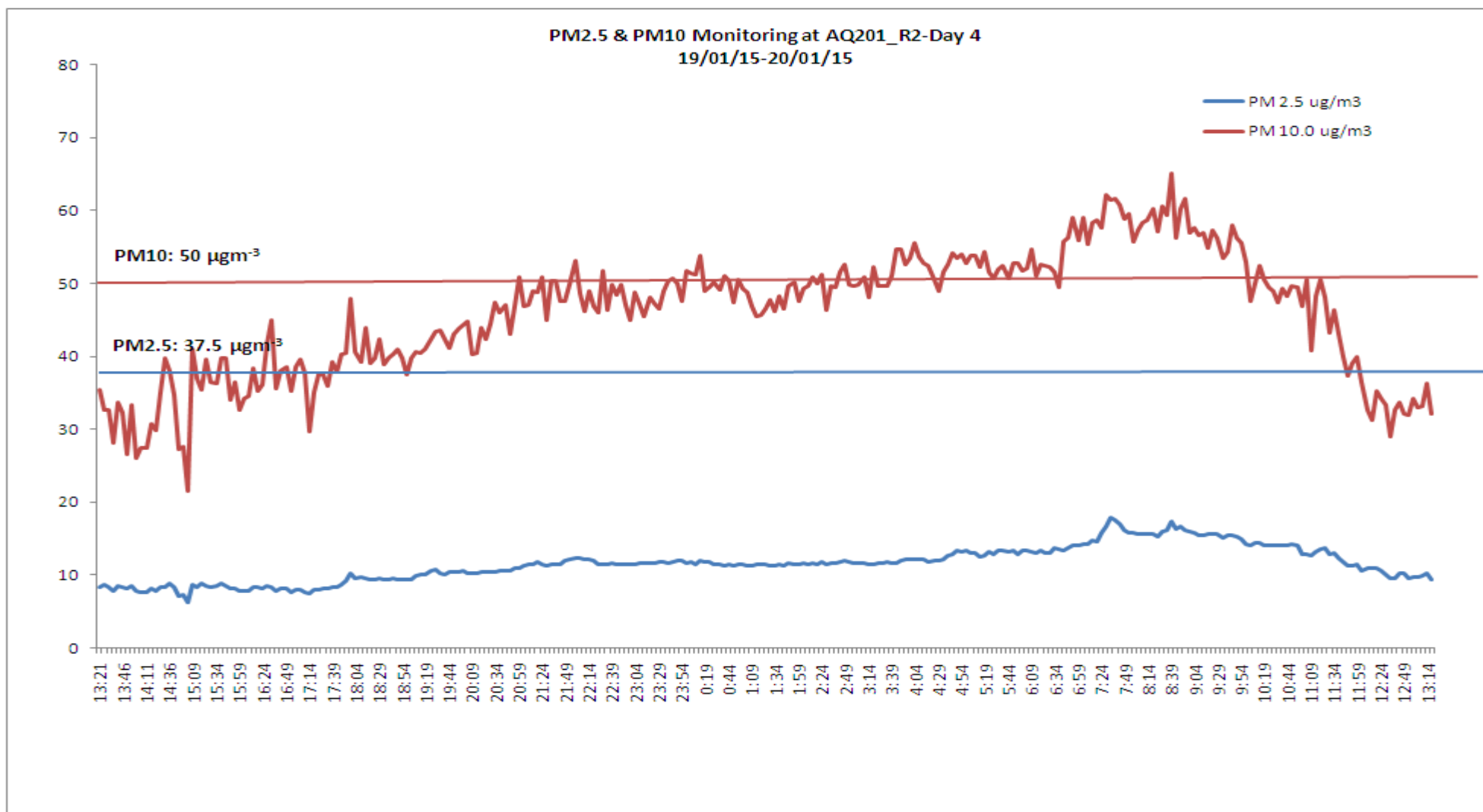




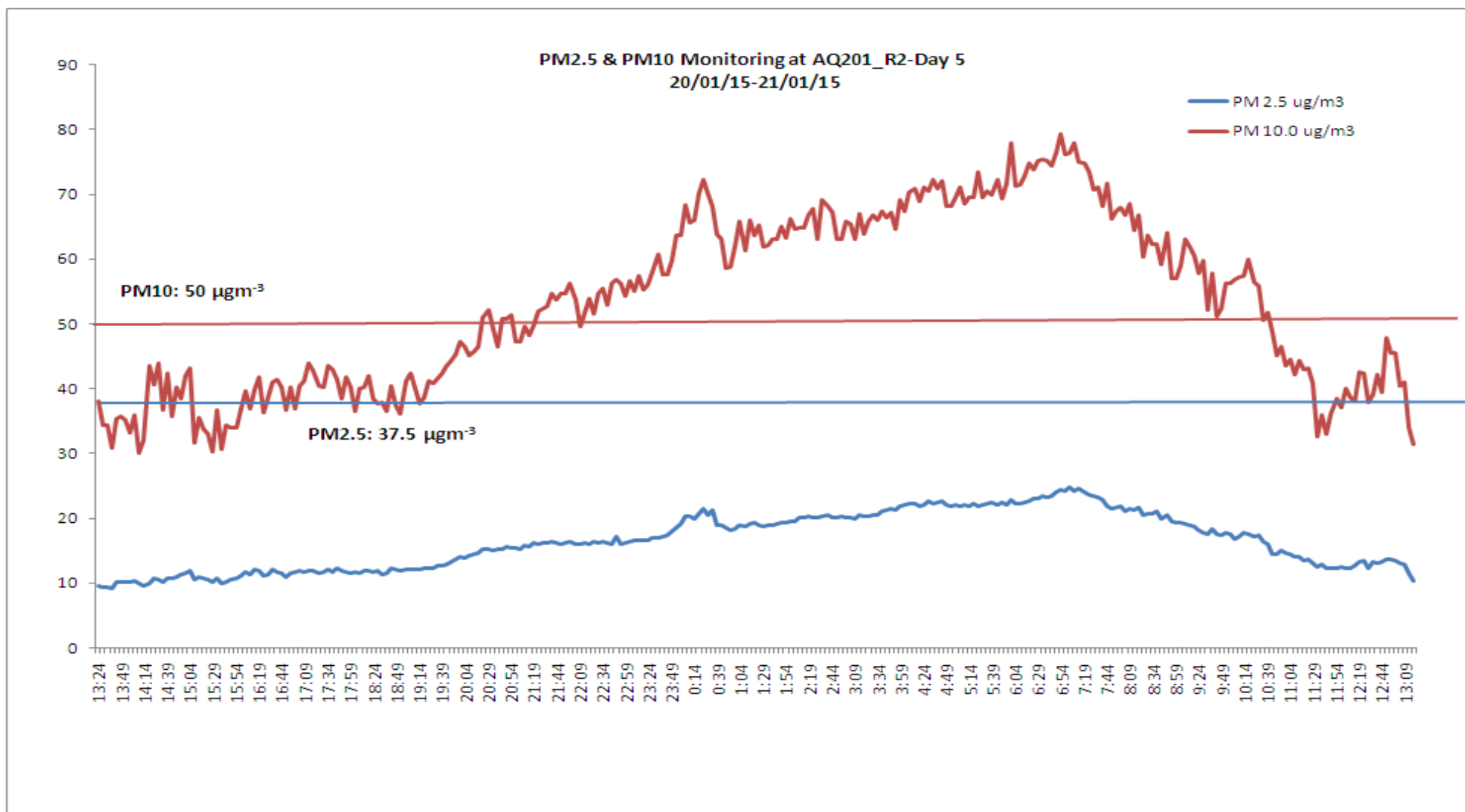
**Figure 54: Particulate concentration measured at Point AQ201\_R2 (Day 2)**



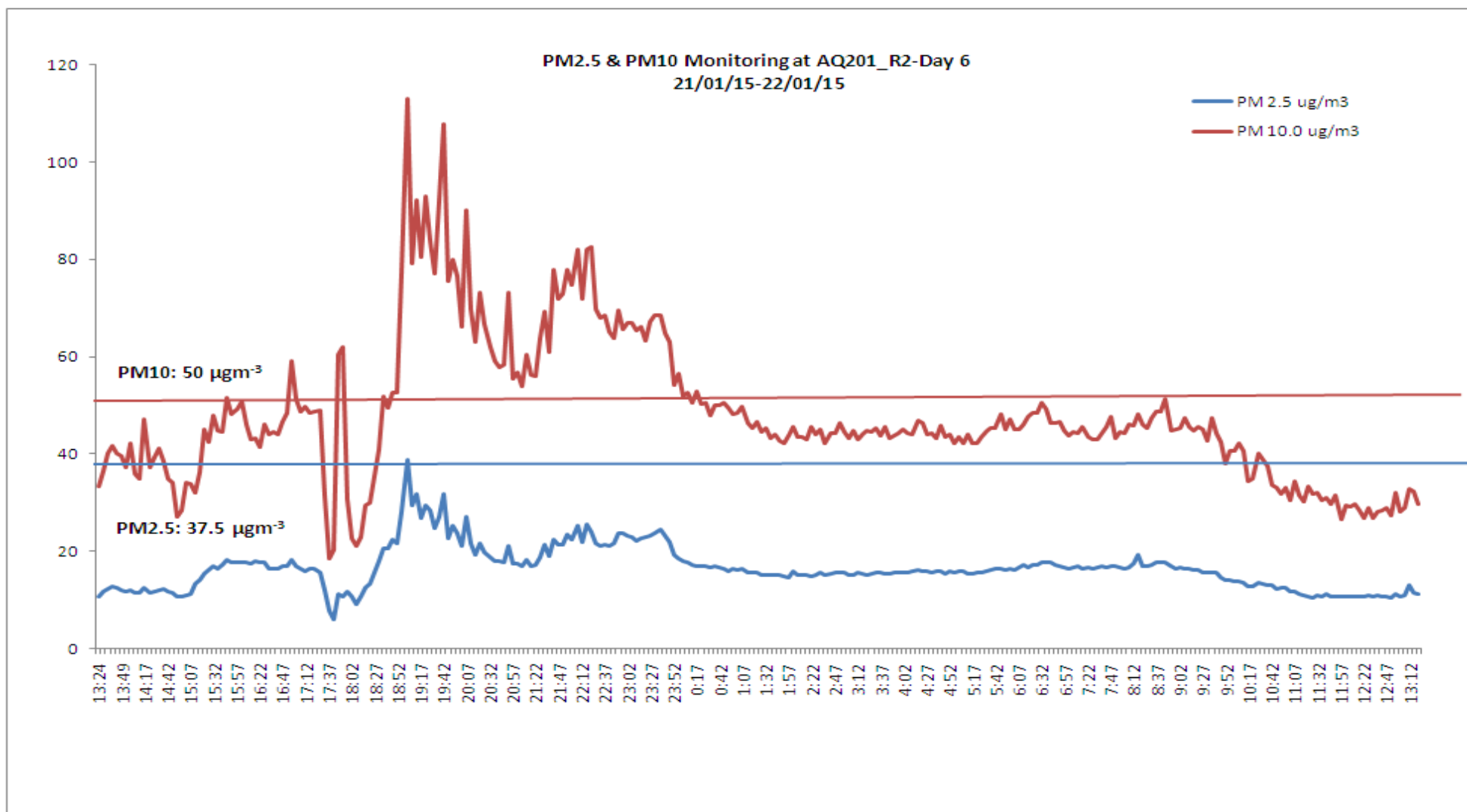
**Figure 55: Particulate concentration measured at Point AQ201\_R2 (Day 3)**



**Figure 56: Particulate concentration measured at Point AQ201\_R2 (Day 4)**

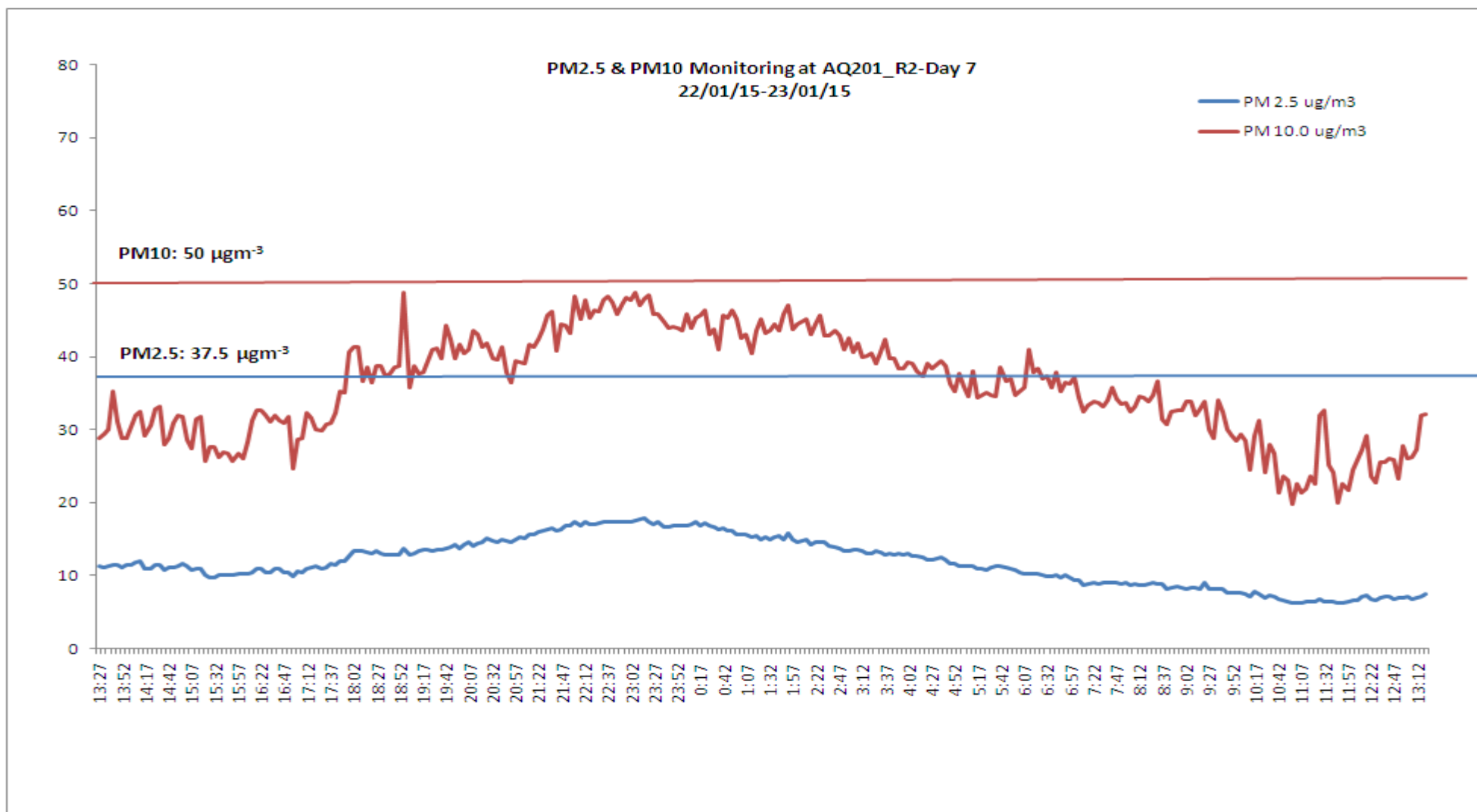


**Figure 57: Particulate concentration measured at Point AQ201\_R2 (Day 5)**

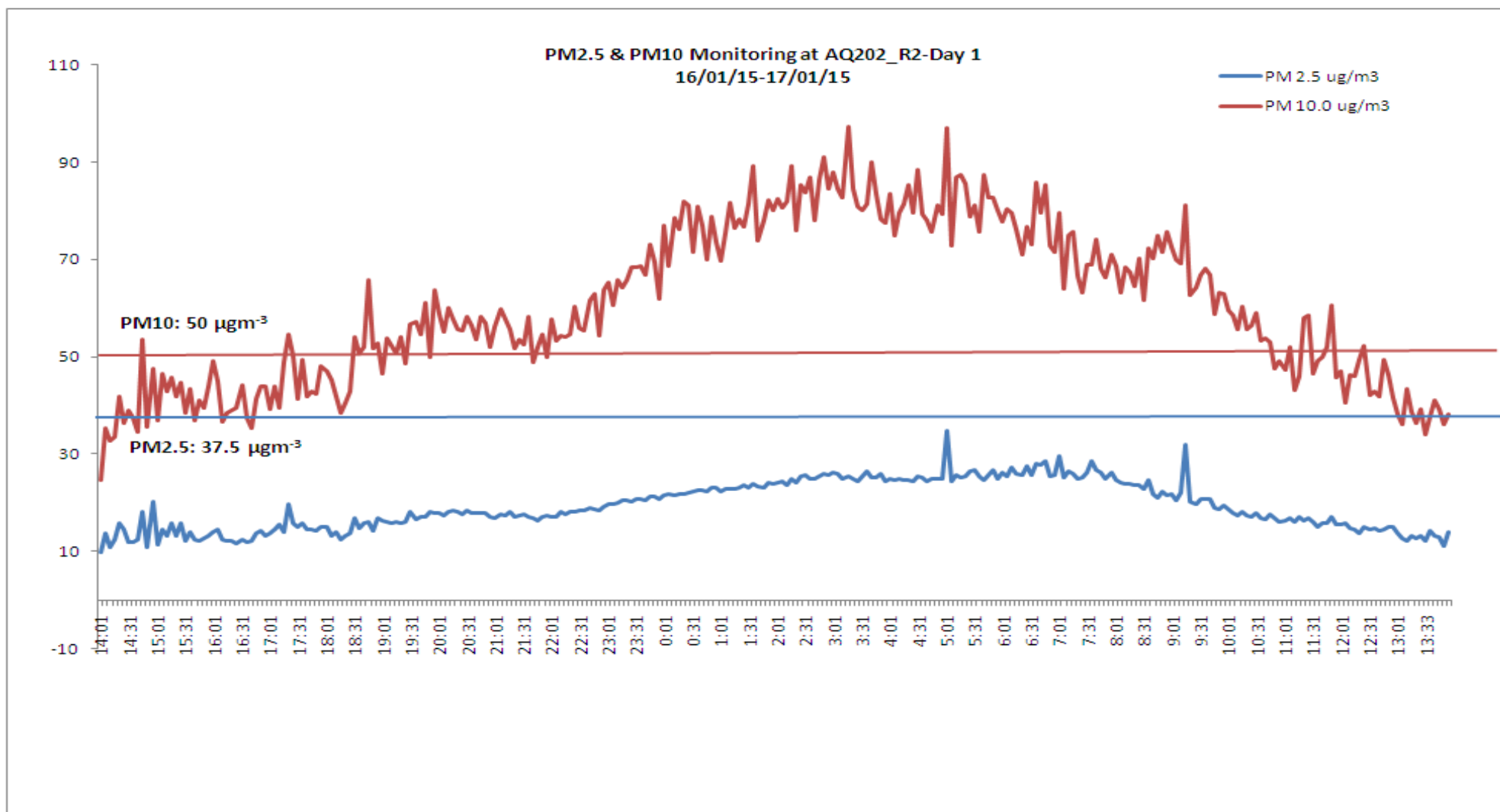


**Figure 58: Particulate concentration measured at Point AQ201\_R2 (Day 6)**





**Figure 59: Particulate concentration measured at Point AQ201\_R2 (Day 7)**



**Figure 60: Particulate concentration measured at Point AQ202\_R2 (Day 1)**

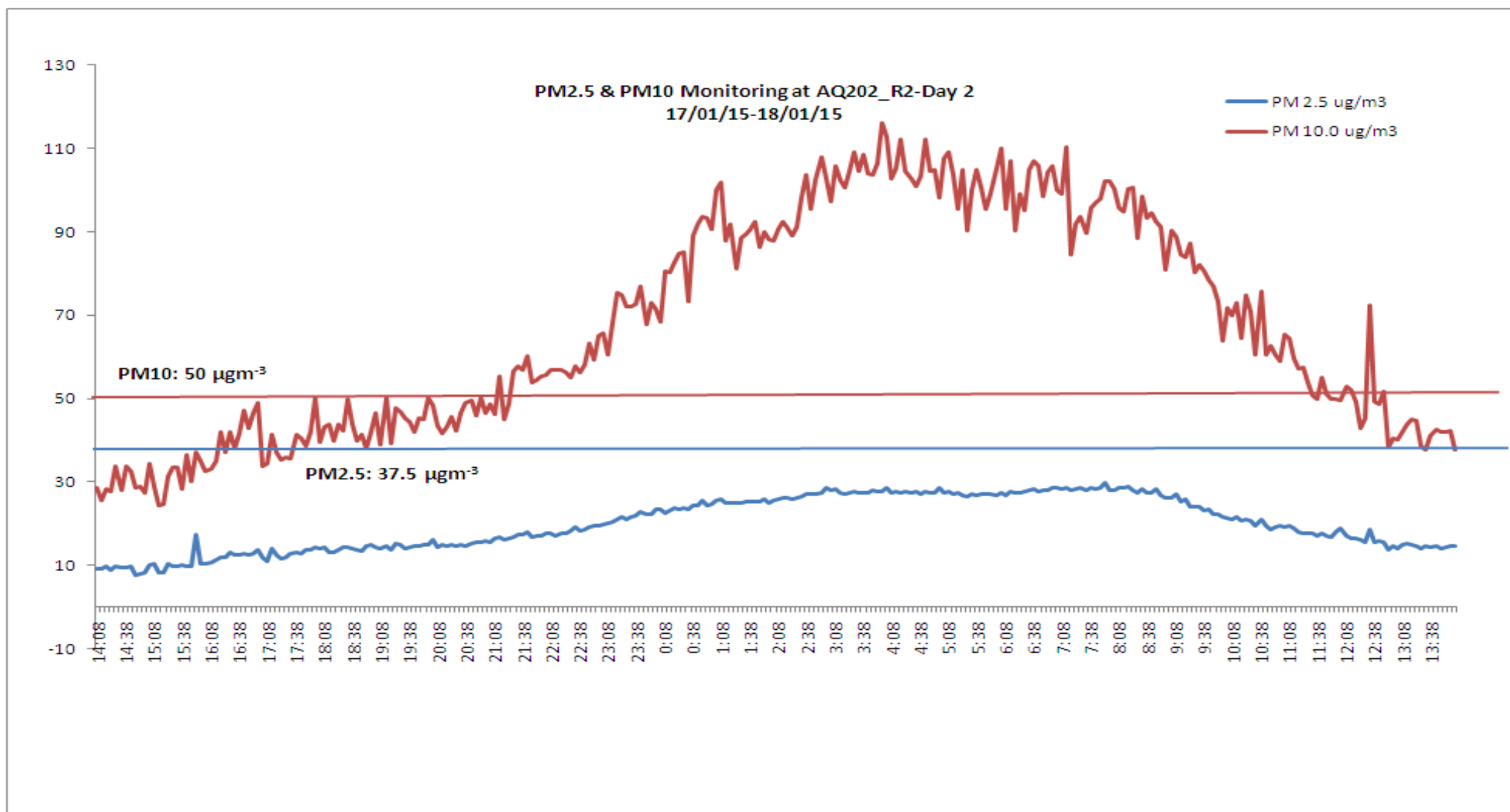
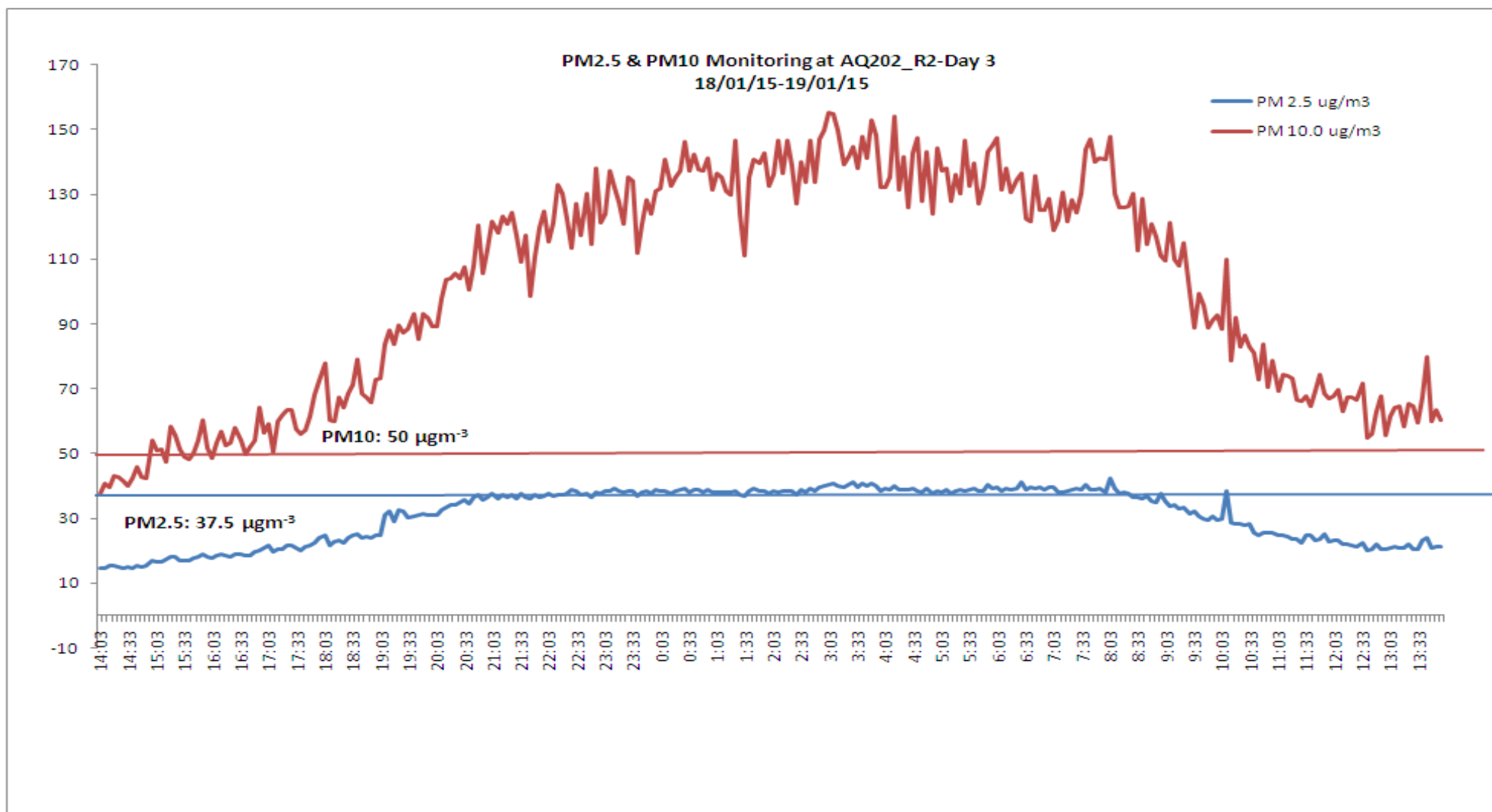
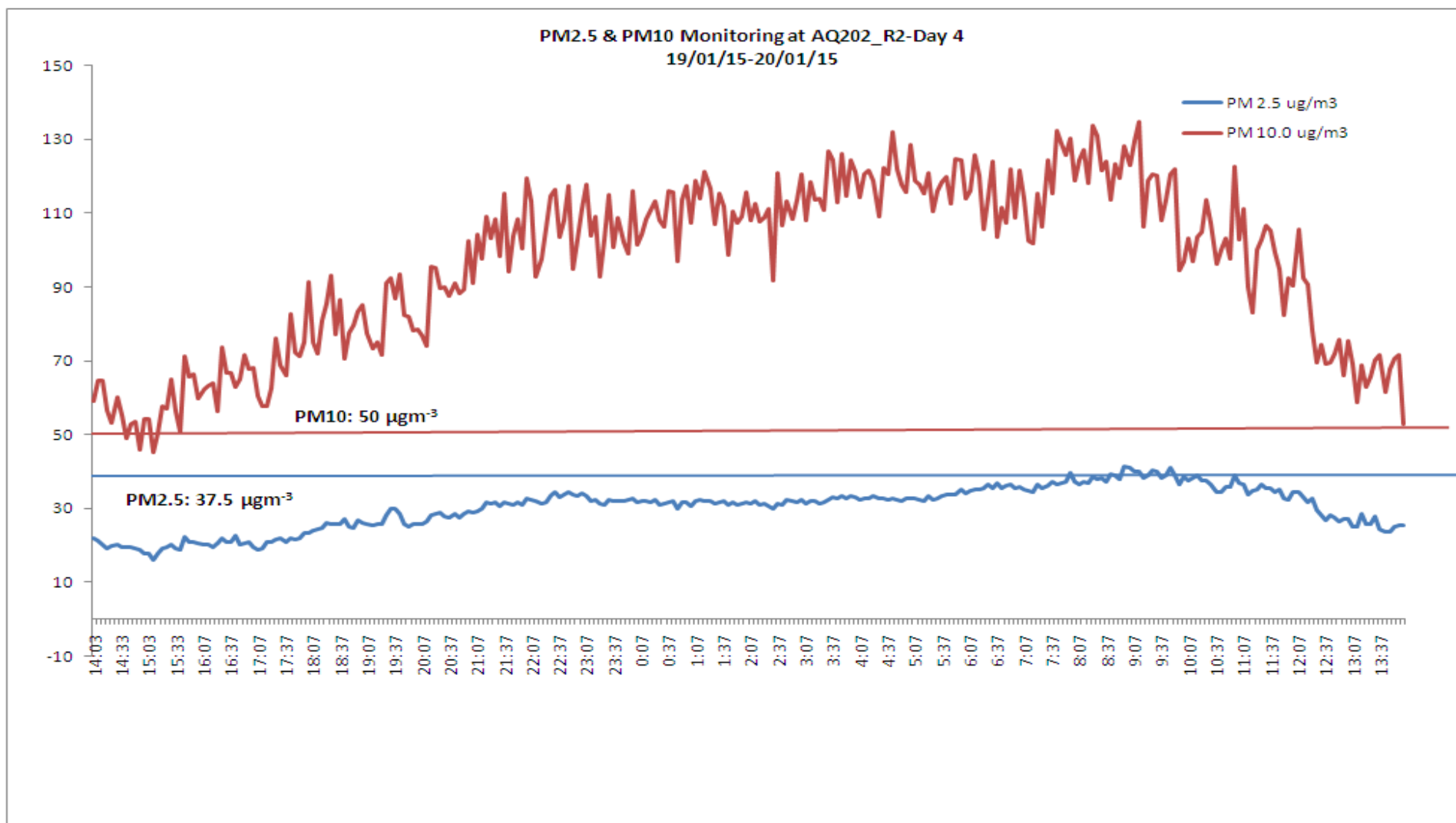


Figure 61: Particulate concentration measured at Point AQ202\_R2 (Day 2)

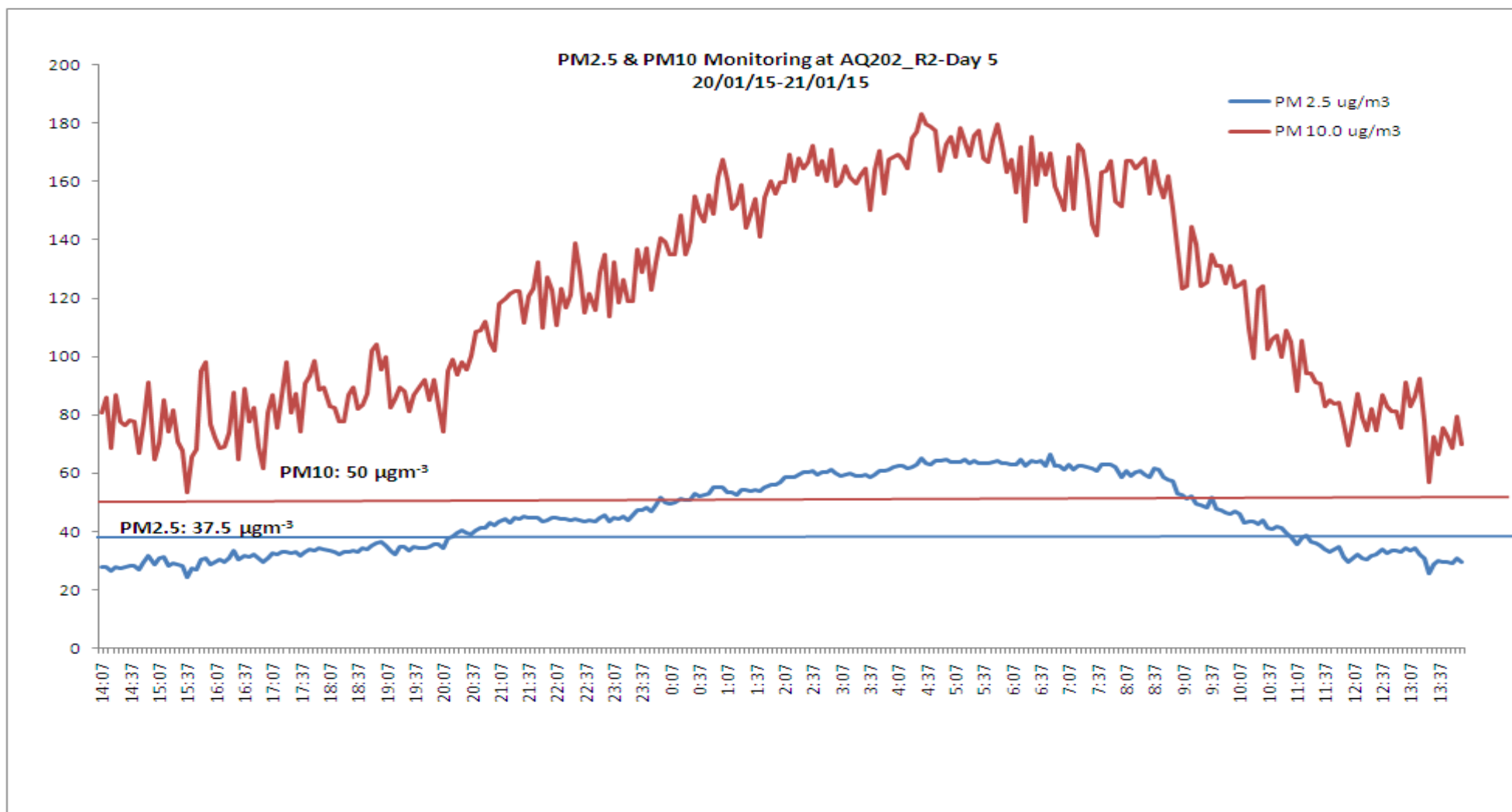


**Figure 62: Particulate concentration measured at Point AQ202\_R2 (Day 3)**

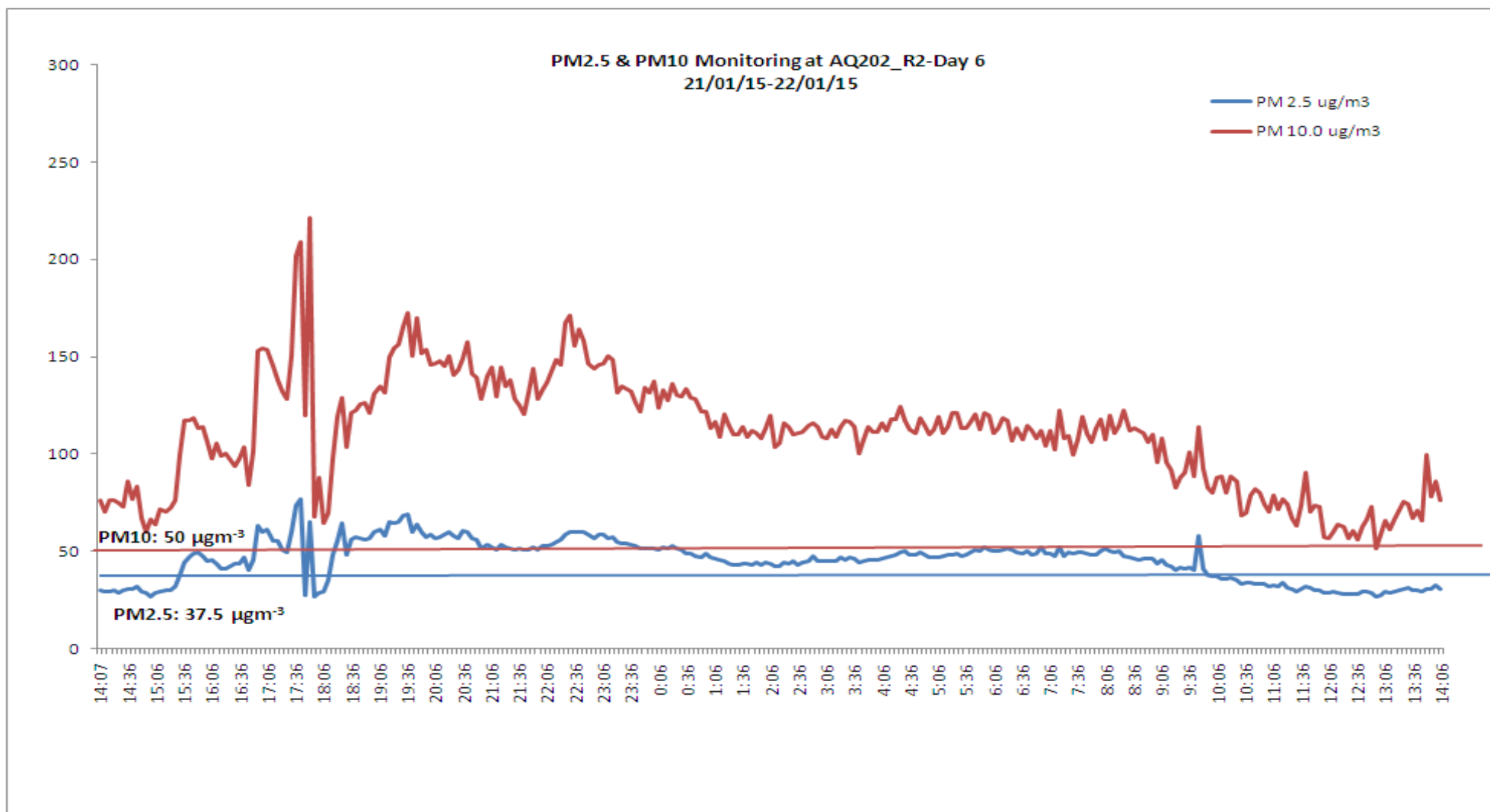


**Figure 63: Particulate concentration measured at Point AQ202\_R2 (Day 4)**

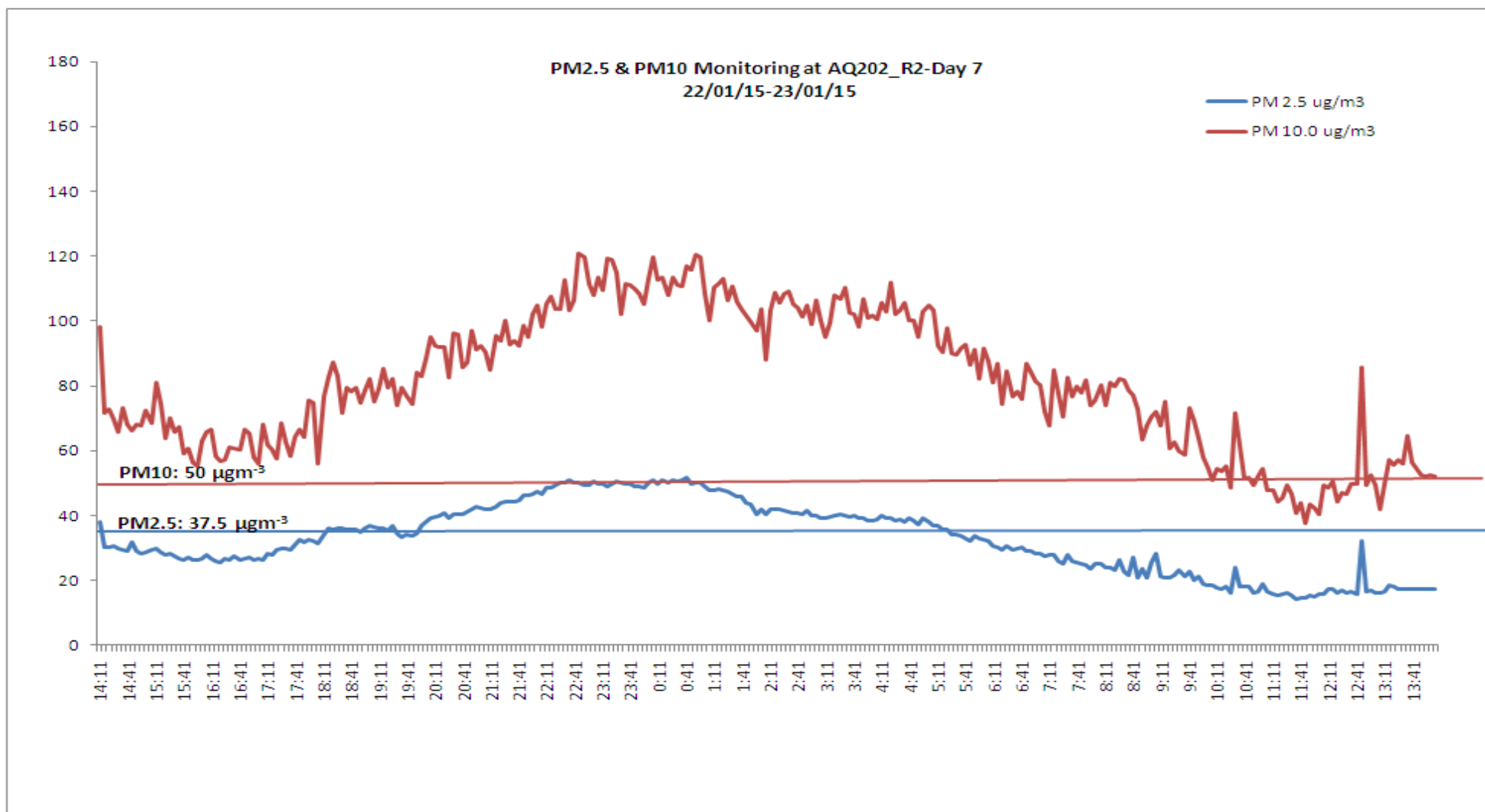




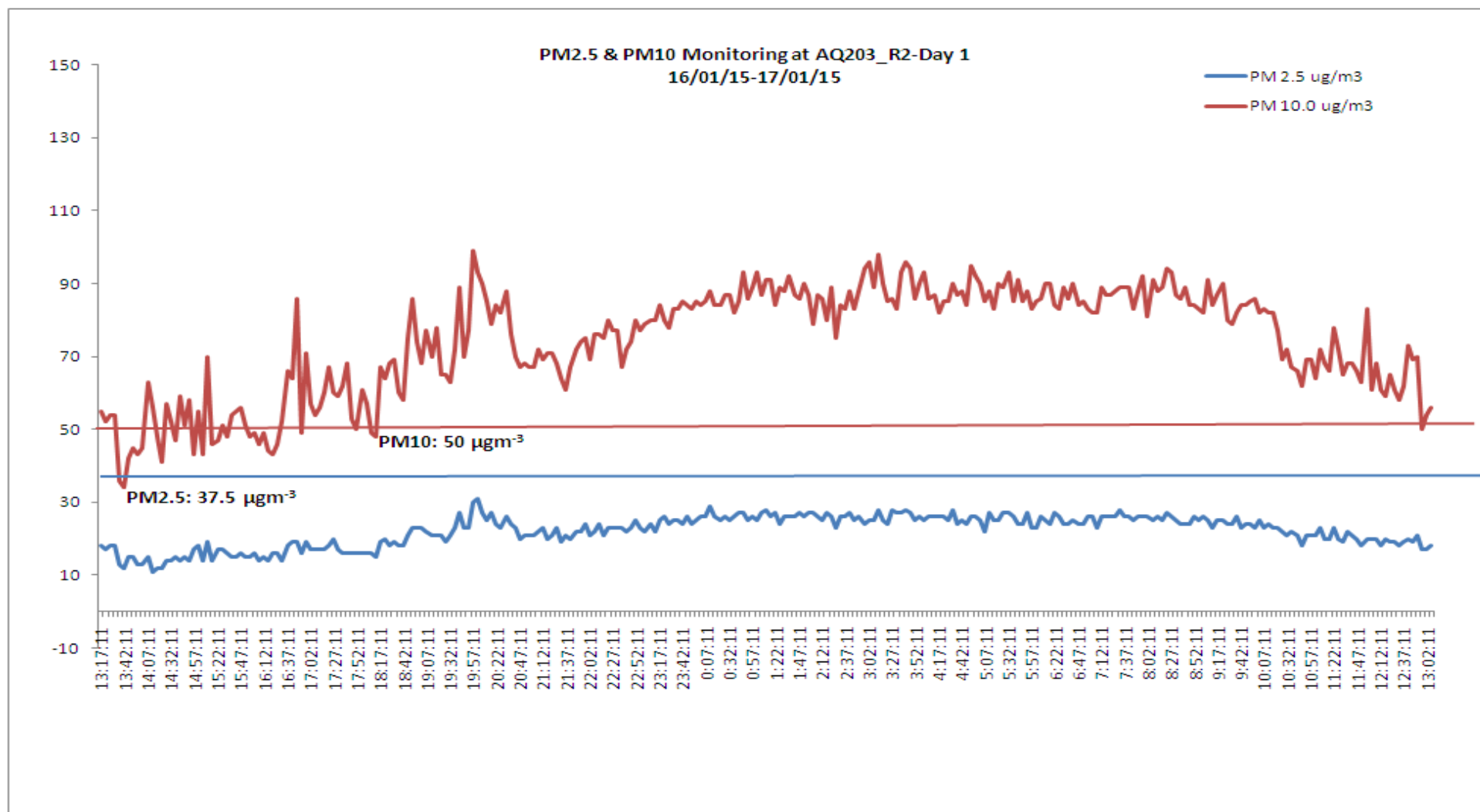
**Figure 64: Particulate concentration measured at Point AQ202\_R2 (Day 5)**



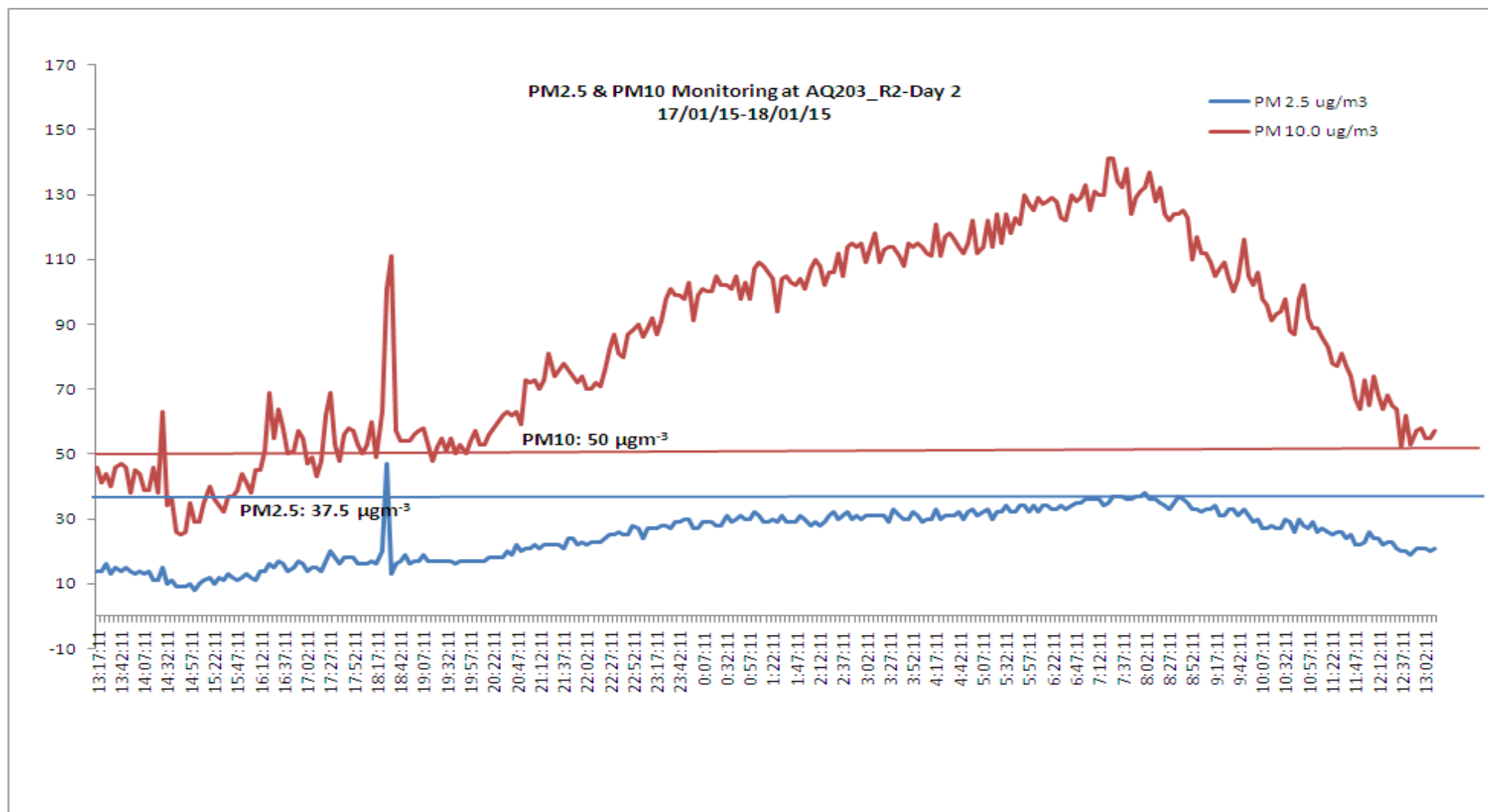
**Figure 65: Particulate concentration measured at Point AQ202\_R2 (Day 6)**



**Figure 66: Particulate concentration measured at Point AQ202\_R2 (Day 7)**

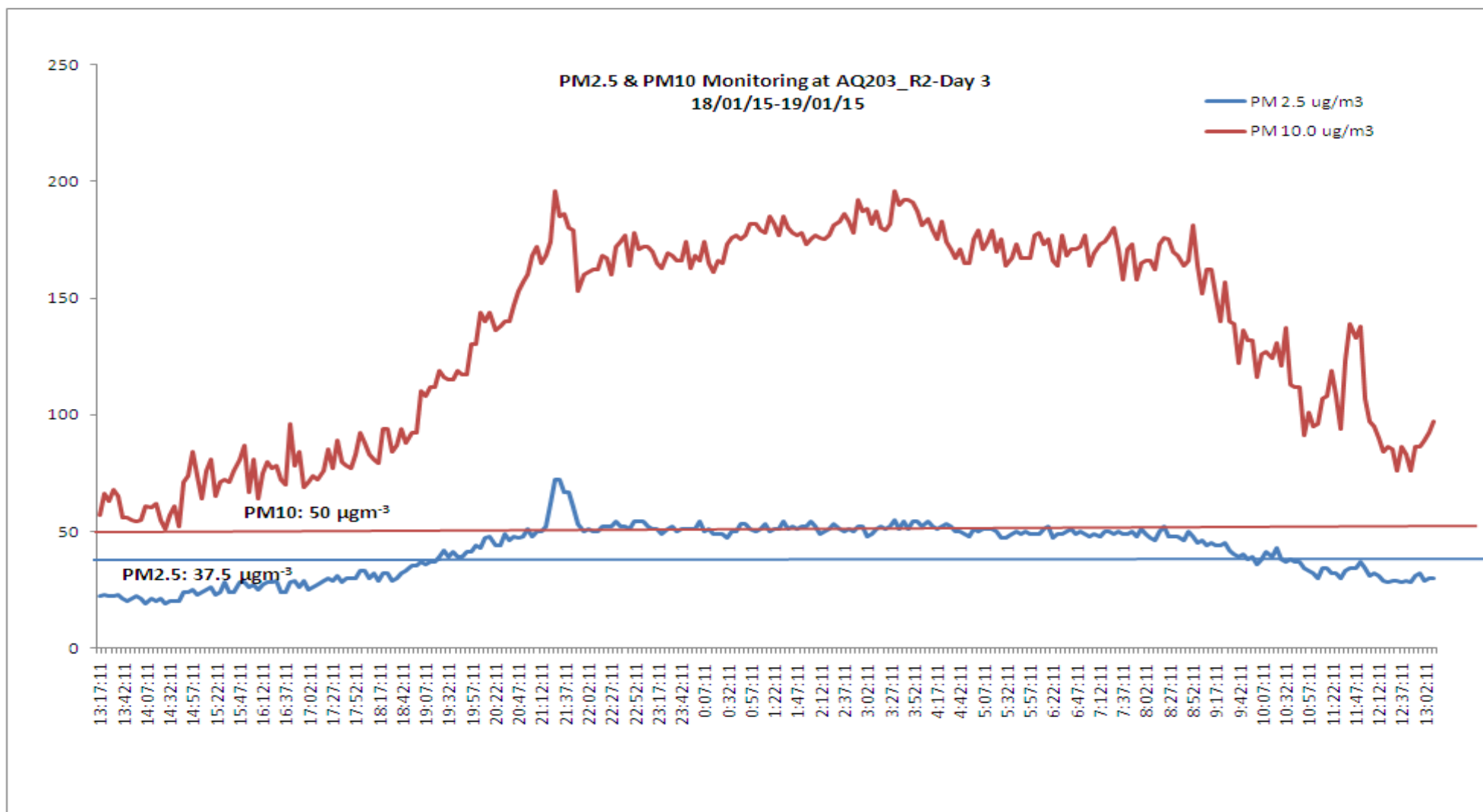


**Figure 67: Particulate concentration measured at Point AQ203\_R2 (Day 1)**

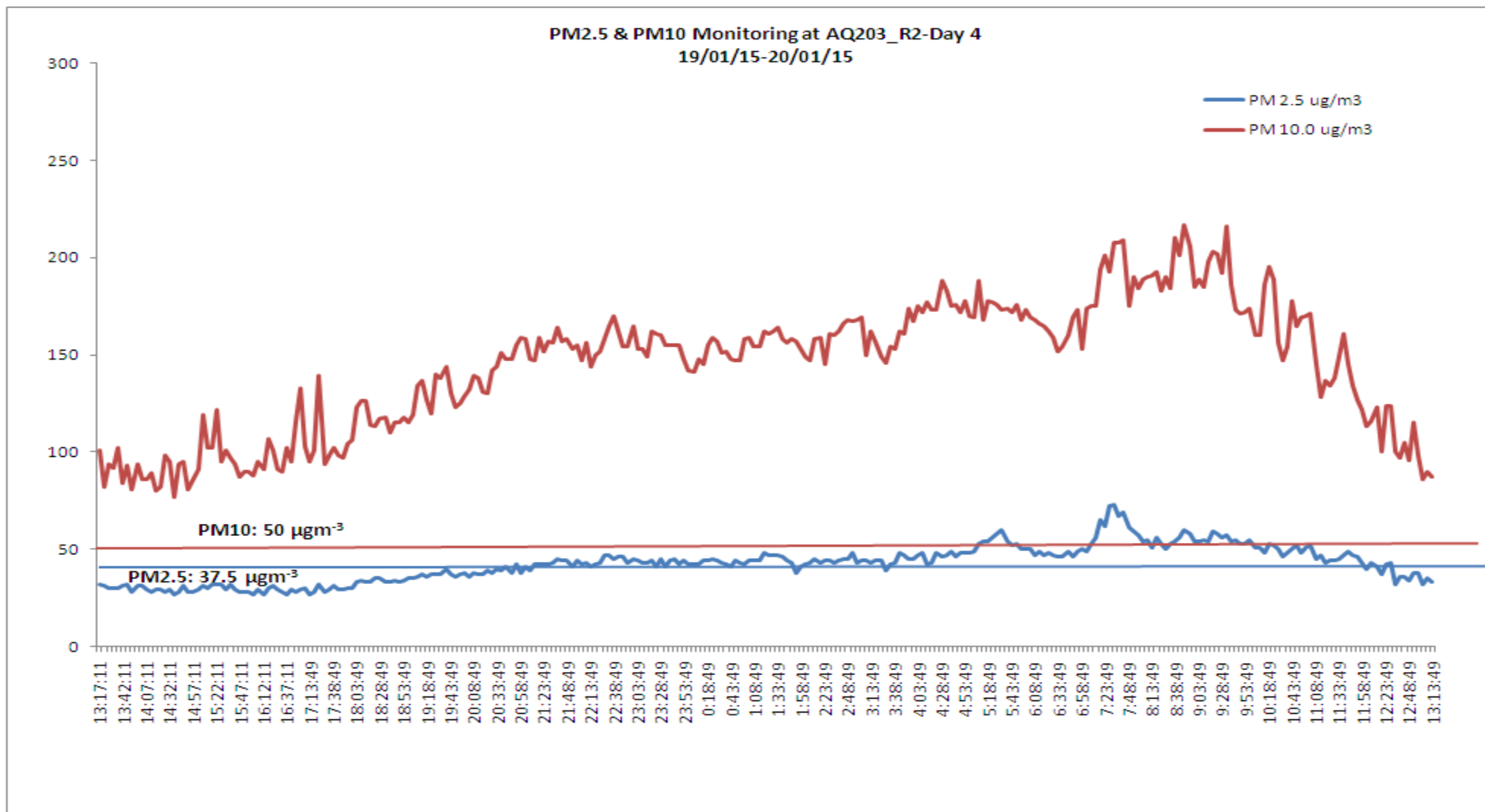


**Figure 68: Particulate concentration measured at Point AQ203\_R2 (Day 2)**

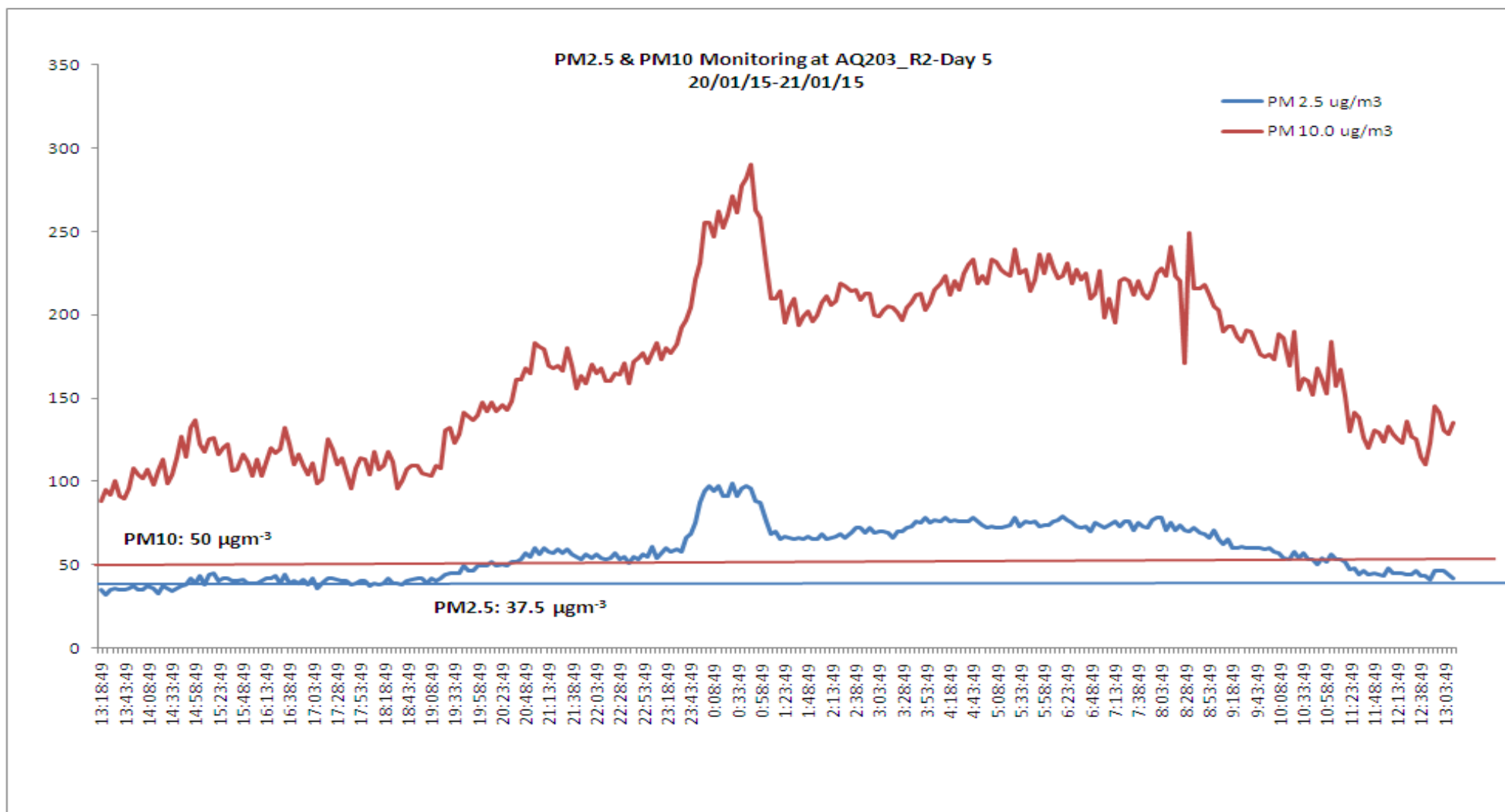




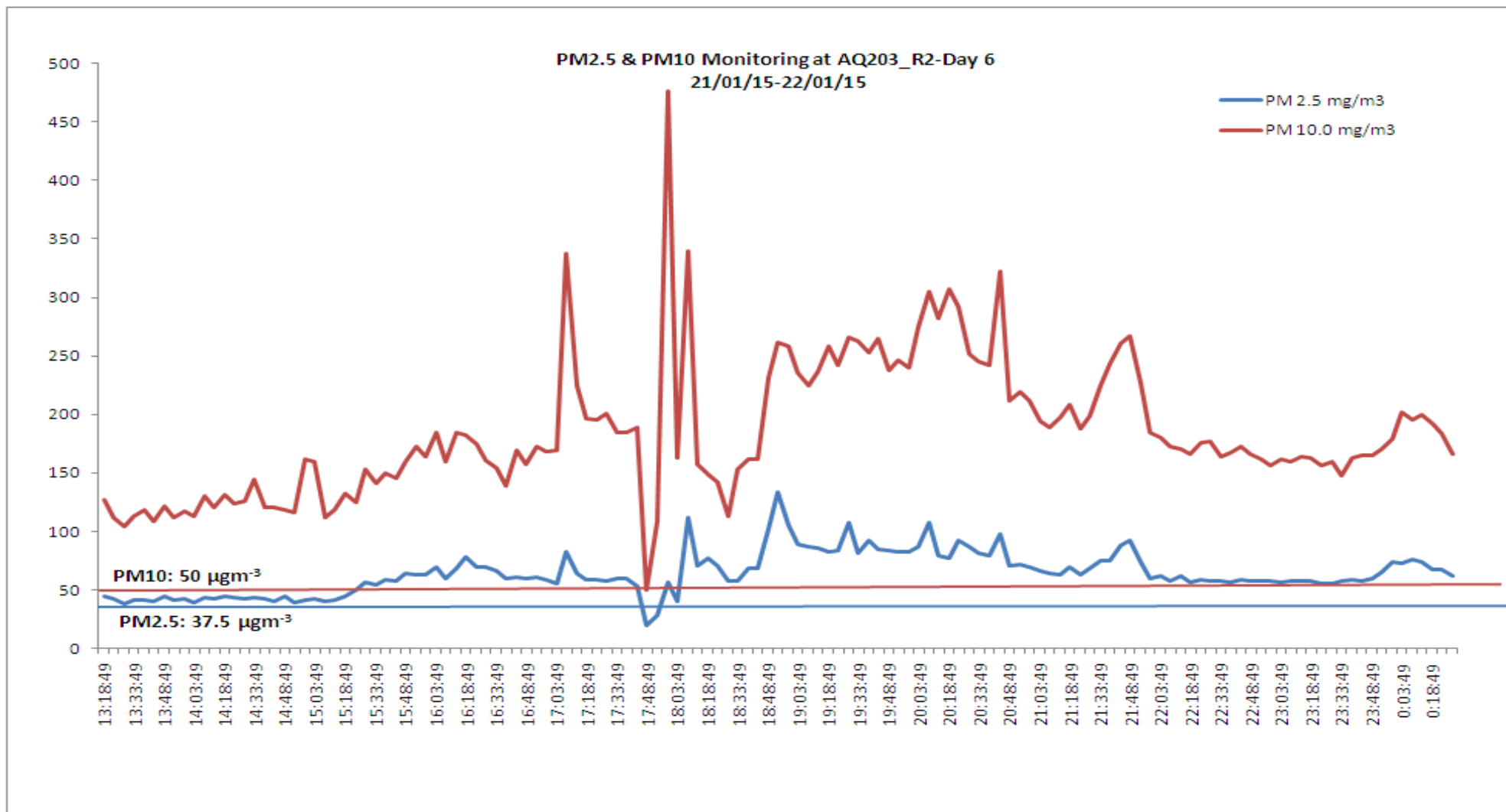
**Figure 69: Particulate concentration measured at Point AQ203\_R2 (Day 3)**



**Figure 70: Particulate concentration measured at Point AQ203\_R2 (Day 4)**



**Figure 71: Particulate concentration measured at Point AQ203\_R2 (Day 5)**



**Figure 72: Particulate concentration measured at Point AQ203\_R2 (Day 6)**

## 8.0 CONCLUSION

In general, all the PM<sub>2.5</sub> and PM<sub>10</sub> monitored at all sampling points were found to be within the limit stated in the Singapore Ambient Air Quality Targets by 2020 except periods listed in the following tables:

No. of Rounds	Monitoring Points	Parameters	
		Particulate Matter (PM <sub>2.5</sub> ) in $\mu\text{g m}^{-3}$	Particulate Matter (PM <sub>10</sub> ) in $\mu\text{g m}^{-3}$
First round of survey (R1)	AQ101	-	Day 1-4
	AQ102	-	Day 1,2,3 & 6
	AQ201	-	-
	AQ202	-	Day 1,2,3,5 & 7
Second round of survey (R2)	AQ101	-	Day 1,3,4,5 & 6
	AQ102	-	Day 3 & 4
	AQ201	-	Day 5
	AQ202	Day 5 & 6	Day 1-7
	AQ203 (16/01/15-22/01/15)	Day 3,4,5 & 6	Day 1-6
	AQ203 (02/02/15-09/02/15)	Day 1,3,5 & 6	Day 1-7
*Limit		37.5	50

In our opinion, as AQ202 is near to the roadway, hence the notably particulate level may associate to the engine exhaust emission from the vehicular traffic. On another note, the sources of particulate emission from AQ101 & AQ102 are likely from natural source mainly unpaved road (trail) and wind erosion within the park.

In conclusion, monitoring of the ambient air quality at the selected location is recommended during the enhancement work around the Central Catchment Nature Reserve (MacRitchie) Singapore. This exercise will help to determine the presence of air contaminants if any based on their daily operations and activities which will have any potential health hazard effect to the occupants on site. In addition, this will assists in reviewing the air quality of the selected location in relation to their local or any international regulatory deem applicable.

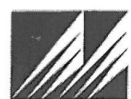
## 9.0 REFERENCES

Singapore Ambient Air Quality Targets Recommended by the National Environment Agency of Singapore.



# APPENDIX 1

## CALIBRATION CERTIFICATION OF FIELD EQUIPMENT



Met One  
Instruments

1600 Washington Blvd  
Grants Pass, OR 97526  
(541) 471-7111  
(541) 471-7116 (Fax)  
Service@metone.com

ATS-ENV-447Q

### Calibration Certificate

The calibration results on this report certify that this instrument complies with the product specifications at the time of calibration. Calibration was performed according to accepted industry methods using equipment, procedures, and standards that are traceable to NIST and ASTM and JIS.

Recommended calibration interval is 12 months from the first day of use.

Instrument Model# Aerocet-531S

Instrument Serial# R10448

Date of Calibration 1/13/2014

Sensor # 11855

Darleen Best

Calibration Technician

Quality Check

Temperature 22.5 °C

Relative Humidity 32 %

Test Procedure: AEROCET-531S-6100

PSL Size (µm)	Test Results	Test Spec.	Lot# NIST	Expiration
0.5	Pass	± 10%	39699	11/30/2014
0.7	Pass	± 10%	40240	3/31/2015
1.0	Pass	± 10%	40849	07/31/2015
2.5	Pass	± 10%	38982	5/31/2014
5.0	Pass	± 10%	41903	04/30/2016
10.0	Pass	± 10%	39409	08/31/2014

Standards	Model	SN	Cal Due
Particle Counter	GT-526	M1763	5/14/2014
FLOWMETER	DC-L	537	2/19/2014
MULTIMETER	189 Multimeter	94060816	6/25/2014
RH/Temp Sensor	083E-1-35	H8055	8/6/2014

This calibration certificate shall not be reproduced except in full, without the written approval of Met One Instruments Inc.



Document AEROCET-531S-9600 Rev A

18679



Met One  
Instruments

1600 Washington Blvd  
Grants Pass, OR 97526  
(541) 471-7111  
(541) 471-7116 (Fax)  
Service@metone.com

ATS-ENV-448Q

## Calibration Certificate

The calibration results on this report certify that this instrument complies with the product specifications at the time of calibration. Calibration was performed according to accepted industry methods using equipment, procedures, and standards that are traceable to NIST and ASTM and JIS.

Recommended calibration interval is 12 months from the first day of use.

Instrument Model# Aerocet-531S

Instrument Serial# R10449

Date of Calibration 1/13/2014

Sensor # 11856

Darleen Best

A17

Calibration Technician

R. Kern  
Quality Check

Temperature 22.5 °C

Relative Humidity 32 %

Test Procedure: AEROCET-531S-6100

PSL Size (µm)	Test Results	Test Spec.	Lot# NIST	Expiration
0.5	Pass	± 10%	39699	11/30/2014
0.7	Pass	± 10%	40240	3/31/2015
1.0	Pass	± 10%	40849	07/31/2015
2.5	Pass	± 10%	38982	5/31/2014
5.0	Pass	± 10%	41903	04/30/2016
10.0	Pass	± 10%	39409	08/31/2014

Standards	Model	SN	Cal Due
Particle Counter	GT-526	M1763	5/14/2014
FLOWMETER	DC-L	537	2/19/2014
MULTIMETER	189 Multimeter	94060816	6/25/2014
RH/Temp Sensor	083E-1-35	H8055	8/6/2014

This calibration certificate shall not be reproduced except in full, without the written approval of Met One Instruments Inc.



Document AEROCET-531S-9600 Rev A

18680



Met One  
Instruments

1600 Washington Blvd  
Grants Pass, OR 97526  
(541) 471-7111  
(541) 471-7116 (Fax)  
Service@metone.com

ATS - ENV - 424 Q

## Calibration Certificate

The calibration results on this report certify that this instrument complies with the product specifications at the time of calibration. Calibration was performed according to accepted industry methods using equipment, procedures, and standards that are traceable to NIST and ASTM and JIS.

Recommended calibration interval is 12 months from the first day of use.

Instrument Model# Aerocet-531

Instrument Serial# P13171

Date of Calibration 6/2/2014

Sensor # 10950

Daisy Jones

Calibration Technician

Quality Check

Temperature 24 °C

Relative Humidity 36 %

Test Procedure: AEROCET-531-6100

PSL Size (µm)	Test Results	Test Spec.	Lot# NIST	Expiration
0.5	Pass	± 10%	39699	11/30/2014
0.7	Pass	± 10%	REF	NA
1.0	Pass	± 10%	40849	07/31/2015
2.0	Pass	± 10%	42335	08/31/2016
3.0	Pass	± 10%	42940	02/28/2017
5.0	Pass	± 10%	REF	NA
7.0	Pass	± 10%	REF	NA
10.0	Pass	± 10%	REF	NA



Standards	Model	SN	Cal Due
Particle Counter	GT-526	M1763	11/14/2014
Dry Cal	Defender 510 high flow	133419	8/8/2014
DMM	189 Multimeter	83410061	3/21/2015
RH & Temp	083E-1-6	N13972	11/14/2014

*This calibration certificate shall not be reproduced except in full, without the written approval of Met One Instruments Inc.*



Met One  
Instruments

1600 Washington Blvd  
Grants Pass, OR 97526  
(541) 471-7111  
(541) 471-7116 (Fax)  
Service@metone.com

ATS-ENV-435A

## Calibration Certificate

The calibration results on this report certify that this instrument complies with the product specifications at the time of calibration. Calibration was performed according to accepted industry methods using equipment, procedures, and standards that are traceable to NIST and ASTM and JIS.

Recommended calibration interval is 12 months from the first day of use.

Instrument Model# Aerocet-531

Instrument Serial# P13172

Date of Calibration 6/2/2014

Sensor # 10951

Daisy Jones 

AT13

Calibration Technician

Quality Check

Temperature 24 °C

Relative Humidity 36 %

Test Procedure: AEROCET-531-6100

PSL Size (µm)	Test Results	Test Spec.	Lot# NIST	Expiration
0.5	Pass	± 10%	39699	11/30/2014
0.7	Pass	± 10%	REF	NA
1.0	Pass	± 10%	40849	07/31/2015
2.0	Pass	± 10%	42335	08/31/2016
3.0	Pass	± 10%	42940	02/28/2017
5.0	Pass	± 10%	REF	NA
7.0	Pass	± 10%	REF	NA
10.0	Pass	± 10%	REF	NA

Standards	Model	SN	Cal Due
Particle Counter	GT-526	M1763	11/14/2014
Dry Cal	Defender 510 high flow	133419	8/8/2014
DMM	189 Multimeter	83410061	3/21/2015
RH & Temp	083E-1-6	N13972	11/14/2014

*This calibration certificate shall not be reproduced except in full, without the written approval of Met One Instruments Inc.*



Document AEROCET-531-9600 Rev B

20267





1600 Washington Blvd  
Grants Pass, OR 97526  
(541) 471-7111  
(541) 471-7116 (Fax)  
Service@metone.com

One  
instruments

## Calibration Certificate

calibration results on this report certify that this instrument complies with the product specifications at the time of calibration. Calibration was performed according to accepted industry standards using equipment, procedures, and standards that are traceable to NIST and ASTM and JIS.

Recommended calibration interval is 12 months from the first day of use.

Instrument Model# Aerocet-531

Instrument Serial# M10246

Date of Calibration 12/11/2014

Sensor # 9659

Calibration Technician Andy Jones

Quality Check A125

Calibration Technician

Quality Check

Temperature 24 °C

Relative Humidity 41 %

Procedure: AEROCET-531-6100

PSL Size (µm)	Test Results	Test Spec.	Lot# NIST	Expiration
0.5	Pass	± 10%	39699	12/15/2014
0.7	Pass	± 10%	REF	NA
1.0	Pass	± 10%	42896	2/28/2017
2.0	Pass	± 10%	43049	03/30/2017
3.0	Pass	± 10%	42940	02/28/2017
5.0	Pass	± 10%	REF	NA
7.0	Pass	± 10%	REF	NA
10.0	Pass	± 10%	REF	NA

Standards	Model	SN	Cal Due
Particle Counter	GT-526	M1759	1/27/2015
Dry Cal	Defender 510 high flow	133419	9/2/2015
DMM	189 Multimeter	83410061	3/21/2015
RH/TEMP SENSOR	083E-1-6	R20313	09/29/2015

This calibration certificate shall not be reproduced except in full, without the written approval of Met One Instruments Inc.



## APPENDIX 2

### SITE PHOTO (ROUND 1)



AQ101\_R1



AQ102\_R1





AQ201\_R1



AQ202\_R1



## SITE PHOTO (ROUND 2)



AQ101\_R2



AQ102\_R2





**AQ201\_R2**



**AQ202\_R2**



**AQ203\_R2**

Annex 7.0

## Ecology and Biodiversity Field Survey Methodology



## **ANNEX 7.0 ECOLOGY & BIODIVERSITY FIELD SURVEY METHODOLOGY**

### **A7.1 MAPPING OF STREAMS**

The objectives of the ecological baseline surveys are to establish the baseline ecological status along the two corridors. This is to facilitate the assessment and evaluation of potential ecological impacts due to the C1001 Project and to develop a monitoring and mitigation plan to reduce any potential impacts identified.

### **A7.2 GOVERNING LEGISLATION**

#### **A7.2.1 The Environmental Protection and Management Act**

The Environmental Pollution Control Act (EPCA) consolidated previous separate laws on air, water and noise pollution and hazardous substances control and it provides a legislative framework for the control of environmental pollution. The title of the EPCA was amended to the Environmental Protection and Management Act (EPMA) on 1 January 2008, to provide for the protection and management of the environment and resource conservation.

#### **A7.2.2 Parks and Trees Act (PTA)**

The *Parks and Trees Act*, 2006 (PTA) which came into effect on 1st August 2005 provides for the planting, maintenance and conservation of trees and plants within national parks, nature reserves, tree conservation areas, heritage road green buffers and other specified areas. The National Parks Board is the responsible regulatory authority. Regulations enacted under this Act are as follows:

- *The Parks & Trees Regulations 2006;*
- *The Parks & Trees Preservation Order 1998;*
- *Parks & Trees (Composition of Offences Regulations) 2006;*
- *Parks & Trees (Planning Areas) Notifications 2006; and*
- *Parks & Trees (Heritage Road Green Buffers) Order 2006.*

A list of areas designated in the Schedule - Part I of this Act is specified as national parks and the areas designated in the Schedule - Part II are designated as nature reserves. National parks and nature reserves are set aside for the following purposes:

- The propagation, protection and conservation of the trees, plants, animals and other organisms of Singapore, whether indigenous or otherwise;
- The study, research and preservation of objects and places of aesthetic, historical or scientific interest;
- The study, research and dissemination of knowledge in botany, horticulture, biotechnology, or natural and local history; and

- Recreational and educational use by the public.

The Act specifies a list of restricted activities in respect to trees and animals in the national parks and nature reserves. Approval from the Commissioner must be obtained prior to conducting any of these restricted activities. Penalties of up to S\$ 20,000 are given to any person guilty of destroying, damaging or defacing any object of zoological, botanical, geological, ethnological, scientific or aesthetic interest within any national park or nature reserve. The majority of Corridor 1 is located within the Central Catchment Nature Reserve (*Figure A-1*).

The Act also ensures that mature trees (with a girth above 1 m when measured 50 cm from the ground) within the gazetted Tree Conservation Areas (TCA) and trees maintained by the Board are not felled unnecessarily. There are currently two TCAs in Singapore. Part of Corridor 2 is located within one of them as indicated in *Figure A-1*.

#### **A7.2.3 Wild Animals and Birds Act (WABA)**

This is legislation under Agri-Food and Veterinary Authority (AVA) of Singapore. The WABA relates to the protection of wild animals and birds. It prohibits the “killing, taking or keeping” of any of such species without a license. The penalty for such offences includes a fine of S\$ 1,000 and forfeiture of the animal or bird. WABA also sets aside special areas as bird sanctuaries where the killing, taking or netting or snaring of any bird is prohibited. The import of such species constitutes an offence. The Act also describes the powers of relevant authorities to make orders, issue licenses and make arrests. The Schedule provides a list of specified wild animals and birds.

Specific laws have also been enacted to protect wildlife in areas such as nature reserves, national parks, water catchment area parks and other parks.

#### **A7.2.4 The Singapore Green Plan**

The Singapore Green Plan (SGP) is Singapore's environmental blueprint, mapping out the strategic direction for Singapore to preserve, protect and enhance the environment. Its objective is to ensure that Singapore, through sound environmental management, achieves economic development that meets the needs of the present generation without compromising the needs of future generations ie, achieves sustainable development. The first SGP was released in 1992 by the then Ministry of the Environment, now known as the Ministry of the Environment and Water Resources (MEWR). MEWR updated it and released the Singapore Green Plan 2012 (SGP 2012) in 2002. The SGP 2012 was reviewed in 2005, with the latest revision released in 2006 including six key focus areas each overseen by an ‘Action Programme Committee’ and ‘Coordinating Committee’. The areas are: Air and Climate Change; Water; Waste Management; Conserving Nature; Public Health; and International Environmental Relations and it identifies four targets for nature and biodiversity conservation:

- Keep Nature Areas for as long as possible;
- Verify and update information on indigenous flora and fauna through biodiversity surveys;
- Establish more parks and green linkages; and
- Set up a National Biodiversity Reference Centre.





Figure A-1 Cross Island Line Corridor Options at the Central Catchment Nature Reserve



Many of recommendations and programmes in the SGP 2012 have been successfully implemented, including the pledge to set aside 5 per cent of total land to be preserved as nature sites. These represented a wide range of natural habitats found in Singapore, from primary and secondary forests to marshland and mangrove swamps. They were chosen because of their ecological stability and ability to sustain a wide variety of wildlife. Other reasons included their potential for recreation, educational and scientific research and their compatibility with other developments.

#### **A7.2.5 Sustainable Singapore Blueprint**

Looking beyond SGP 2012, in April 2009, the Inter-Ministerial Committee on Sustainable Development (formed in January 2008) launched a new national framework to guide Singapore's sustainable development efforts up until 2030. Called the 'Sustainable Singapore Blueprint', it set higher targets than those in the SGP 2012 and developed some new initiatives. For example it expanded on the SGP 2012 target to 'establish more parks and green linkages' and set a target to 'provide 0.8 ha of park land per 1000 persons by 2020 and in the shorter term increase the amount of green park space by 900 ha by 2020, increase the length of park connectors from 100 to 360 km by 2020 and developing new leisure options around green space'. It also establishes a new initiative to develop a National Biodiversity Strategy and Action Plan (NBSAP) as stipulated by being a signatory of the Convention on Biological Diversity (see below).

#### **A7.2.6 Convention on Biological Diversity**

The Convention on Biological Diversity (CBD) entered into force on 29 December 1993. It has three main objectives:

- The conservation of biological diversity;
- The sustainable use of the components of biological diversity; and
- The fair and equitable sharing of the benefits arising out of the utilization of genetic resources.

National Biodiversity Strategies and Action Plans (NBSAP) are the principal instruments for implementing the Convention at the national level (Article 6). The Convention requires countries to prepare a national biodiversity strategy (or equivalent instrument) and to ensure that this strategy is mainstreamed into the planning and activities of all those sectors whose activities can have an impact (positive and negative) on biodiversity.

Singapore signed the Convention on Biological Diversity on 12 June 1992 and subsequently became a Party on 21 December 1995. The National Biodiversity Centre (NBC) of the National Park Board (NParks) represents Singapore in the CBD. As one of the Parties, Singapore established a detailed NBSAP in September 2009, before which the SGP 2012 served as the NBSAP (see 'The Singapore Green Plan' above). The aim of Singapore's NBSAP is to create an urban biodiversity conservation model that champions environmental sustainability in an urban setting with well-endowed natural heritage. The following principles guide its implementation:

- The biodiversity resources of Singapore are our natural heritage and should be conserved for future generations;

- Considerations on biodiversity and ecosystems are factored into the national planning process; and
- A balanced view is adopted of national priorities and international and regional obligations.

Currently there are five Strategies and corresponding Actions established in Singapore's NBSAP, with three goals mirroring the objectives of the CBD. The five Strategies and Actions are:

#### **Strategy 1: Safeguard our biodiversity**

Conserve Singapore's habitats and ecosystems for long-term sustainability, so that Singaporeans can benefit from their multiple functions. Concerted efforts should be made to protect existing native species, habitats and ecosystems, and to re-establish species which once existed.

##### *Actions:*

- Implement species conservation and recovery programmes;
- Rehabilitate areas that have previously been degraded;
- Extend green corridors to counter fragmentation; and
- Utilize parks for ex-situ conservation and to house or re-create ecosystems that have been lost.

#### **Strategy 2: Consider biodiversity issues in policy and decision-making**

The government will take into account biodiversity issues when making decisions and adopt holistic approaches towards conserving our natural environment.

##### *Actions:*

- Incorporate biodiversity conservation considerations, including integrated coastal management principles, into existing administrative processes;
- Enhance biodiversity assessment capabilities; and
- Strengthen the current processes on access and benefit sharing, to ensure that biodiversity conservation is considered when granting access to Singapore's natural genetic resources.

#### **Strategy 3: Improve knowledge of our biodiversity and the natural environment**

A keen knowledge of how the key ecosystems respond to our activities will enable us to conserve and use them in a sustainable manner. It is essential that we support taxonomic studies, document our biodiversity and conduct ecological research.

##### *Actions:*

- Encourage and facilitate research, in particular on ecosystem and species-specific biodiversity conservation, the interactions between the biological components and their physical environment, biodiversity valuation studies and the impact of climate change on biodiversity;
- Monitor the health of ecosystems and species as part of the management process;
- Develop and maintain a central information portal on biodiversity to facilitate more informed decision-making;
- Maintain a list of species with their conservation status (red data list); and
- Compile case studies on and assess best practices that have been implemented.

#### **Strategy 4: Enhance education and public awareness**

Knowledge and awareness are pre-requisites for action hence communication on biodiversity issues is critical in driving public involvement. Effective communication will create greater awareness and interest in our natural heritage and instill a sense of national pride.

##### *Actions:*

- Increase appreciation, awareness and understanding of Singaporeans for nature through public seminars, road shows and events;
- Promote volunteerism through biodiversity interest groups; and

- 
- Incorporate elements of biodiversity conservation into the curricula of all levels of education.

#### **Strategy 5: Strengthen partnerships with all stakeholders and promote international collaboration**

The most effective mode of operation for biodiversity conservation is to engage all stakeholders, including private, public and people sectors (government agencies, academia, schools, conservation groups, amateur naturalists and private corporations), in a comprehensive partnership. Such partnerships should be pursued domestically and internationally as biodiversity issues cut across sectors and transcend national boundaries.

##### *Actions:*

- Encourage active participation in the stewardship of the environment for all sectors; and
- Promote partnerships with regional and international organizations, in particular the ASEAN Centre for Biodiversity and the Secretariat of the Convention on Biological Diversity, as an indication of our commitment to biodiversity conservation at the global level.

---

**Source:** *Conserving Our Biodiversity. Singapore's National Biodiversity Strategy and Action Plan.* National Parks Board 2009

### **A7.2.7 Singapore Index on Cities' Biodiversity**

In May 2008, Singapore proposed the establishment of an index to measure biodiversity in cities at the 9th Meeting of the Conference of the Parties to the Convention on Biological Diversity. Seventeen technical experts, comprising representatives from the Global Partnership on Cities and Biodiversity, convened at a workshop in Singapore in February 2009, to design the Singapore Index on Cities' Biodiversity.

The Singapore Index comprises three components; a) Biodiversity in the City, b) Ecosystem Services provided by the Native Biodiversity in the City, and c) Governance and Management of Biodiversity in the City. In this form, it would function as a monitoring tool.

The global responses from city officials, scientists, conservation managers, academics, *etc.* have been positive, and various cities are now testing out the draft index to validate its usefulness. The Users' Manual for the Singapore Index on Cities' Biodiversity is posted on the website of the Convention on Biological Diversity<sup>1</sup>.

### **A7.3 SECONDARY DATA REVIEW AND GAP ANALYSIS**

The baseline information draws upon a number of existing data sources. This includes studies and reports that have been organized and commissioned on the ecology and biodiversity of the Study Area and includes, but is not limited, to those listed below:

- Online publications from local government authorities (eg PUB, LTA) such as annual reports, guidebooks, climatological monitoring;

<sup>1</sup> Convention of Biological Diversity (2009). *Users' Manual for the Singapore Index on Cities' Biodiversity*. Available at <http://www.cbd.int/doc/groups/cities/cities-draft-user-manual-singapore-index-2009-07-01-en.pdf>



- Topographical, geological and hydrogeological maps;
- Cross Island Line Working Group Report (CRL WG) of 5 January 2014 (*Cheong et al, 2014*) (hereafter referred to as the 'CRL WG Report');
- Nature Society (Singapore) (NSS) Cross Island Line Discussion and Position Paper of 18 July 2013;
- Available publications and research data from National Parks Board (NParks), National University of Singapore (NUS), Raffles Museum of Biodiversity Research of the NUS, Nanyang Technological University (NTU), NSS, Singapore Botanic Gardens;
- Regular publications including Singapore Biodiversity Records and Gardens' Bulletin of Singapore; and
- Online internet research including publications from:
  - NParks' Flora and Fauna website <http://florafaunaweb.nparks.gov.sg>
  - [http://www.nparks.gov.sg/cms/index.php?option=com\\_content&view=article&id=60&Itemid=175](http://www.nparks.gov.sg/cms/index.php?option=com_content&view=article&id=60&Itemid=175)
  - NSS' website at <http://www.nss.org.sg/> including groups of various taxa listed.
  - BIOME – Nparks' Biodiversity and Environment Database <https://biome.nparks.gov.sg/Main.aspx>
  - Ecology Asia <http://www.ecologyasia.com/>
  - Butterflies of Singapore <http://butterflycircle.blogspot.com/>

In addition reference has been made to relevant international and national standards regarding conservation including but not limited to:

- Singapore Red Data Book – This was first published in 1994, and is the national reference for conservation plans and efforts of various governmental and non-governmental organizations, including listing of rare and protected species. The most recent publication is the 2008 version edited by Geoffrey Davison (NParks), Peter Ng (NUS) and Ho Hua Chew (NSS) and the conservation status for some species is under review; and
- The IUCN Red List of Threatened Species™ (<http://www.iucnredlist.org/>) – The IUCN has been assessing the conservation status of species on a global scale for the past 50 years to highlight taxa threatened with extinction and promote their conservation. The list is regularly updated and widely recognized as the most comprehensive, objective global approach for evaluating the conservation status of plant and animal species.

Secondary information was gathered and reviewed to characterize the existing condition along the two corridors and to identify habitats and species of potential importance in the area. It should be noted that, among the reviewed information, the Cross-Island Line Discussion and Position Paper and Cross-Island Line Working Group Report are two comprehensive documents which summarize the existing key ecological information of the MacRitchie area within the Central Catchment Nature Reserve (CCNR). The CCNR is species rich and of recognized importance for conservation but is also considered

fragmented. Several major roads fragment the CCNR such as Mandai Road and Mandai Lake Road to the North, the Bukit-Timah Expressway to the west and Old Upper Thomson Road to the east of the CCNR. To a certain extent, the public trails within the CCNR and unofficial off-trail paths also serve to break up the continuity of the forests and the forest mix in the CCNR is varied. The MacRitchie Forest, which falls within the proposed corridor, is also not a homogenous forest habitat but rather made up of primary forest areas, forest areas at varying stages of regeneration, marshland, wetland, and a network of pristine freshwater streams, all supporting diverse forest species.

There is extensive ecological baseline information available within CCNR, which is considered to be enough to evaluate the overall ecological sensitivity and significance of the area, which is essential for ecological impact assessment. However, the potentially directly affected areas, in particular the indicative location for the SI works within the CCNR, may not have adequate information for detailed ecological impact assessment, ie, presence of rare/ protected/ unique floral and faunal species at the directly affected area(s), extent of faunal roosting/ foraging/ breeding/ nursery ground or wildlife corridors and/or migratory routes that may be affected etc. The Cross-Island Line Working Group Report also highlighted the need to undertake further flora studies within the MacRitchie Forest, particularly of areas potentially affected by the Cross Island Line SI works.

As a consequence, detailed ecological surveys along the proposed corridors, in particular within the CCNR, with special focus on flora groups and updating the vegetation/ habitat map, were required.

Given the ecological sensitivity of the CCNR and the availability of certain credible ecological information, no ground excavation/sample capture methods were used and non-harmful baseline survey techniques were adopted as a first choice for the C1001 Project, to avoid unnecessary disturbance of the Study Area.

The ecological survey techniques used are detailed in the following sections.

#### **A7.4 SENSITIVE RECEPTORS**

The majority of Corridor 1 and a small part of Corridor 2 fall within the gazetted CCNR, which is considered as the key ecological sensitive receiver. The CCNR is the largest nature reserve in Singapore, which has over 2,000 hectares of forest cover.

Dipterocarp forests, which are species-rich primary dryland forests, were once abundant in Singapore before human settlements developed, but are now extremely rare. Less than 0.5% of the original primary forest cover remains, found only in small patches of CCNR and Bukit Timah Nature Reserve (BTNR). An even rarer forest type in Singapore is primary freshwater swamp forest, with the most significant remaining patch being Nee Soon Swamp Forest in the CCNR.

The CCNR possesses a rich biodiversity of flora and fauna with a concentration of forest-specific species found nowhere else in Singapore<sup>1</sup>. The existing habitats are home to a high diversity of flora and fauna. Examples include Keruing (*Dipterocarpus* spp.) and Meranti (*Shorea* spp.) trees, as well as the critically endangered Banded Leaf Monkey (*Presbytis femoralis*) and Sunda Pangolin (*Manis javanica*).

<sup>1</sup> National Parks Board (27 February 2015) **Central Catchment Nature Reserve**. Available at [http://www.nparks.gov.sg/cms/index.php?option=com\\_visitorsguide&task=naturereserves&id=102&Itemid=379](http://www.nparks.gov.sg/cms/index.php?option=com_visitorsguide&task=naturereserves&id=102&Itemid=379)

The CCNR is home to some 44 mammals, 72 reptiles, 25 amphibians and all 34 remaining native freshwater fish species (NSS, 2013)<sup>1</sup>. The Nature Society (Singapore) Vertebrate Study Group members and NParks conducted joint forest field surveys in 1993-1997 and again in 2008-2010 throughout the CCNR resulting in a considerable amount of knowledge on the occurrence and relative abundance of native species for the various habitats. In addition, the CCNR and BTNR together represent one of three Important Bird Areas (IBAs) for Singapore and these nature reserves are recognized as globally important for the birdlife of lowland tropical rain-forest by Birdlife International.

Bukit Brown Cemetery and the associated Bukit Brown area are largely covered by woodland interspersed with patches of grassland and scrubland and fall within a Tree Conservation Area (TCA) under the *Parks and Trees (Preservation of Trees) Order (1991)* of the *Parks and Trees Act*. The area is considered as a sensitive receiver. One 2.5 day survey in December 2011 recorded over 110 plant species of which six are considered of conservation interest (Yellow-eyed Cerbera *Cerbera odollam*, the fern *Cheilanthes tenuifolia*, Dragon-tail Plant *Epipremnum pinnatum*, Sea Fig *Ficus superba*, Burmese Rosewood *Pterocarpus indicus*, and a *Trichosanthes* sp<sup>2</sup>). The area also supports considerable biodiversity such as various mammals, herpetofauna, dragonflies and butterflies (including the Common Birdwing *Troides helena cerberus* which is considered to be vulnerable by the Singapore Red Data Book<sup>3</sup>) and at least 90 resident and migrant bird species (13 of which are nationally threatened and over 45 associated with woodland/forested areas)<sup>4</sup> and in addition it is considered to be important culturally and recreationally.

The floral and faunal species of conservation interest identified within the Study Area from literature review as well as those reported from the C1001 Project ecological baseline surveys are also considered as sensitive receivers. Species of conservation interest have been defined as those that are listed as:

- CR, CR/D, EN, EN/D or VU, VU/D in the *Singapore Red Data Book* (2008) (*Singapore RDB*, 2008); and/or
- VU, EN or CR on the *IUCN Red List of Threatened Species* (IUCN 2015.01); and/or
- in Appendix I or II of the *Convention on International Trade in Endangered Species of Wild Fauna and Flora* (CITES).

#### **A7.5 ECOLOGICAL SURVEY AREA**

The Study Area for the purposes of ecology and biodiversity, is defined as the area within which ecological receptors (both terrestrial and aquatic) in and around the CCNR, could potentially be affected from the CRL development activities, ie pre-construction SI works, aboveground and underground construction works and operation of the railway.

Note that the CCNR in its entirety encompasses the forested watersheds of four inland reservoirs (MacRitchie, Upper Peirce, Lower Peirce and Upper Seletar) as well as the NSSF, and these central reservoirs present some physical barriers to wildlife movement and dispersal in the area. The CCNR is

<sup>1</sup> Nature Society Singapore (2013) *Cross Island Line Position Paper*.

<sup>2</sup> Land Transport Authority (2012). *Biodiversity Impact Assessment for the Bukit Brown Cemetery* (conducted by ERM)

<sup>3</sup> Land Transport Authority (2012). *Biodiversity Impact Assessment for the Bukit Brown Cemetery* (conducted by ERM)

<sup>4</sup> Nature Society Singapore (2011) *Nature Society's Position on Bukit Brown*. Available at <http://www.nss.org.sg/documents/Nature%20Society's%20Position%20on%20Bukit%20Brown.pdf>

actually considered a highly fragmented habitat, with other barriers limiting wildlife movement and dispersal including fenced areas and several major roads such as Mandai Road and Mandai Lake Road to the North, the Bukit-Timah Expressway separating BTNR and CCNR to the west, and Old Upper Thomson Road to the east.

To a certain extent, the public trails within the CCNR and unofficial off-trail paths also serve to break up the continuity of the habitats, while the forest mix in the CCNR is varied such that the lack of a contiguous forest type may limit the movement of animals that are highly sensitive to forest habitat type. In addition to fragmentation effects, the CCNR also experiences several internal stressors throughout its entirety, from human use (eg high usage, night entry, illegal uses including mountain biking and poaching), developmental (eg pipe jacking, construction, urban developments in close proximity) and environmental pressures (eg release of domestic pets, invasion of exotic species, fire and storm damage). Although the impacts of individual pressures are localized, the stress exerted on the CCNR by all these pressures may have a cumulative effect. NParks has sought to relieve some of the pressures around the CCNR by creating buffer zones in the form of nature parks (ie Springleaf Nature Park, Windsor Nature Park, Chestnut Nature Park) aiming to relieve visitor pressure on the CCNR and provide additional green spaces for species to seek refuge in. In addition, in 2013, the eco-link wildlife crossing between BTNR and CCNR was completed to reconnect these two fragmented forests.

The Study Area only falls on the MacRitchie area of the CCNR. This forest area is fragmented due to the presence of forest trails and the MacRitchie reservoir which cuts off the Lornie forest from the MacRitchie core nature area. The Singapore Island Country Club's golf courses to the north and south of the forest also present barriers to animal dispersal to other parts of the CCNR and adjacent forests. The MacRitchie area also faces current and future pressures in the form of cross-country marathons, pipe jacking projects and siltation to its streams from earthworks and these collective pressures.

As outlined in *Chapter 2*, for the purpose of this baseline, consideration is given to ecological receptors associated with the CRL footprint (for the two alignment options being considered) and its *Area of Influence* (AOI), including the alignment itself and any activities or structures that would be located on the ground surface, for example the SI works, and considering committed developments that are at or in close proximity to the alignment as well as surface structures. As illustrated on *Figure A-1*, this will include part of the CCNR, green areas such as the golf courses and the aquatic environment of surface water bodies immediately above the alignments and immediately down hydraulic gradient of the alignment options.

*Figure A-1* illustrates the presence of existing boardwalks, trails and treetop walks within, and in the vicinity of the Corridors. ERM is aware that much of this area is popular with the public for recreational walking. In determining sampling/ transect locations, ERM made use of existing access routes so as to minimize disturbance to the surrounding environment. The number and location of sampling transects was determined based on:

- Habitat/ vegetation types identified (the key habitats include primary forest, wetland forest, regeneration forest, wetland marsh and streams);
- Site conditions such as topography, slope and aspect, proximity to flowering plants, slopes, hydrology etc;
- The EF Consultant's indicative location for the SI works within the CCNR;

- The likely location of other physical structures and activities associated with the SI works and the Construction and Operation of the Project (including access roads).

Special attention was paid to those areas which will be directly impacted by the proposed development.

#### **A7.6 SURVEY METHODOLOGY**

As noted above, the CCNR boasts a rich diversity of flora and fauna with a concentration of forest-specific species found nowhere else in Singapore<sup>1</sup>. Key ecosystem components and processes as well as the target taxa groups of the C1001 Project area that are considered most relevant, important, valuable, susceptible and sensitive to change or are fundamental to the functioning of the ecosystem have initially been selected as the focal points of surveys. Based on experience, it is not practical or cost-effective for baseline surveys to provide exhaustive ecological information, as collection of a great deal of data with little focus does not facilitate subsequent ecological assessments. Efforts should therefore be focused on project footprint areas or locations where direct impacts are likely to happen and/or are indicative of the quality of specific habitats. These locations were further reviewed after consultation with the EF Consultant regarding the location of SI works, areas of construction activities and operational areas as well as findings from initial baseline assessments.

The surveys were designed to identify the existing ecological status of the area in order to enable ecological impact assessment and to recommend any appropriate mitigation measures. The ecological baseline data including the extensive ecological baseline information available within CCNR and further surveys (which identified in *Section 2.3 Gap Analysis*) are expected to provide insight into the ecological functions and importance of the habitats in question. Such information is relevant and essential for subsequent impact identification, evaluation and mitigation. The following taxa groups, which are sufficiently well-known taxonomically, have enough existing historical data, demonstrate species-habitat relationships, and/ or contain sufficiently abundant species with habitat specificity, were selected for the ecological baseline surveys for the C1001 Project:

- Habitat and vegetation with special focus on Primary Forests, Freshwater Streams, Heritage Trees and other plant species of conservation interest;
- Avifauna (birds) with a focus on bird species of conservation interest;
- Terrestrial mammals including bats with a focus on mammal species of conservation interest;
- Herpetofauna (amphibians and reptiles) with a focus on species of conservation interest;
- Butterflies (generally considered as a good indicator of forest quality) and odonates (dragonflies and damselflies) (generally considered as a good indicator of wetland/ stream habitat quality) with a special focus on species of conservation interest. It should be noted that other insect groups (eg, beetles, spiders, wasps, bees and ants) are not selected as they are either not sufficiently well-known taxonomically within Singapore, lacking information to demonstrate species-habitat relationships, or they lack available, historical information. It would therefore be difficult to draw meaningful conclusions from any data collected; and

<sup>1</sup> National Parks Board (27 February 2015) **Central Catchment Nature Reserve**. Available at [http://www.nparks.gov.sg/cms/index.php?option=com\\_visitorsguide&task=naturereserves&id=102&Itemid=379](http://www.nparks.gov.sg/cms/index.php?option=com_visitorsguide&task=naturereserves&id=102&Itemid=379)



- Aquatic community including freshwater fish and decapod crustacean with special focus on species of conservation interest. Should any other aquatic invertebrates (ie insect larvae) be targeted, in particular stream indicator species which are sensitive to pollution and disturbance (*Ephemeroptera*, *Plecoptera*, and *Trichoptera* ie, EPT taxa), intrusive survey techniques, such as kick sampling, would be involved. Such techniques unavoidably disturb the stream and require sample collection and the collected specimen should also be preserved for sorting (which will be mixed with leaf litters and other natural materials) and identification. In order to avoid unnecessary impacts to the ecosystem of the pristine freshwater streams and given the streams are considered of high ecological importance, the survey taxa group therefore excludes other aquatic invertebrates (ie, insect larvae).

In addition, background illumination levels (light intensity) were measured by a handheld light meter (Model: EXTECH EA30) during the night-time surveys. Readings were obtained from four locations within CCNR in the Study Area, as shown in *Figure A-3*, in January/ February 2015, including the junction of BKLF01 and TT01, the entrance of transect OT01, ST06 near the edge of Bukit Golf Course and the entrance of TT01 joining Bukit Kalang Service Reservoir Road. The results were found to be close to zero, ranging from 0.00-0.02 lux for the three locations further inside CCNR, which have no artificial light. The location next to Bukit Kalang Service Reservoir Road, which has a street light along the road, had a higher reading of 0.17 lux (range 0.04-0.23).

#### **A7.6.1 Habitat Mapping, Vegetation and Trees**

*Figure A-2* gives an indication of habitats present in the area as per the Cross-Island Line Discussion and Position Paper (NSS, 2013)<sup>1</sup>. An updated habitat map was prepared based on available recent aerial photographs, a map of MacRitchie Area Central Catchment Nature Reserve (provided by NParks) and the field ground truthing at the beginning of the ecological baseline surveys, including surveys for streams. Assuming that existing data in relation to the location of plant species of conservation interest was incomplete, floral surveys were designed to achieve a representative sample of the proposed Study Area within the survey period and target searches for plants of conservation interest. Given the adoption of non-intrusive (ie, no ground excavation/sample capture etc) survey techniques and survey efforts being confined to along the survey transects and a few localities (ie sampling plots), the majority of the wetland habitats were not surveyed in this study, and therefore aquatic plant species of conservation interest were not encountered during the present surveys.

The data collection methods included plot sampling and transect surveys, combined with systematic rapid habitat assessments for forests to delineate the forest type with special focus on primary forest, structure and composition. In plot sampling, the forest areas were first classified into strata according to vegetation type namely Primary Forest, Regeneration Forest A, Regeneration Forest B, Wetland Forest and Wetland Marsh. From each stratum 25 m x 25 m sampling plots were established independently and placed randomly so that each forest type was well presented. All standing trees with diameter at breast height (DBH)  $\geq 5$  cm within each plot were assessed. Tree DBH (measured at a point 1.30 m above ground level) was measured over bark, to the nearest cm using a diameter tape. Total tree heights were estimated using Suunto Clinometer and range finder. The identification was based on bark, slash and leaf characteristics. However, trees that could not be identified to species level by non-intrusive approaches (ie no collection of fresh plant material) were identified up to genus level. Transects along the 5 m belt on both sides of designated trails were surveyed to record

<sup>1</sup> Nature Society Singapore (2013) Cross Island Line Position Paper.

encountered/ representative trees and other plant species in indicative corridors 1 and 2. Additional focused transects were conducted in sites of high conservation value, eg, primary forest patches, as well as in habitats of importance to species of conservation interest in indicative corridors 1 and 2. The ecological specialists have worked closely with the EF Consultant to determine specific survey locations for habitat and vegetation surveys. *Figure A-3* indicates the sampling plots and survey transects.

The habitat mapping, in combination with the other ecological surveys, was used to identify any areas with high ecological and biodiversity value in relation to the SI works and subsequent construction and operation of the Project.

#### **A7.6.2 Avifauna**

Birds were surveyed over transects where any birds encountered were identified and counted. Within the survey period, surveys were planned to be conducted monthly although suitable survey periods had to reflect appropriate weather conditions (eg no rain) and times of the day (eg dawn, dusk) that corresponded to peak bird activity, as well as migratory season. Qualitative night-time bird surveys were conducted. Any notable behavior such as migration, feeding, roosting or breeding of the birds and the associated habitats and vegetation where they show such behavior were recorded.

Due to the size of the area to be covered and the requirement to stay on the existing tracks, it was thought impractical to conduct a standard point count method across the whole C1001 Project area (as often employed in forest habitat). Instead a method was employed whereby transects were walked to make observations, and where aggregations and activities of birds were noted to record all species.

To record avifauna data a series of 'Mackinnon Lists' (Mackinnon & Philips, 1993)<sup>1</sup> were made as a means of calculating relative abundance and to produce a species discovery curve. To do this, during the surveys, lists were made by recording each new species until a predetermined number of species was reached to complete a list (One list = ten species in this case). A species can only be recorded once in each list but it may then be recorded in subsequent lists. Using Mackinnon List technique for avifauna, surveys are normally repeated until a minimum of ten and preferably more than fifteen lists have been produced for each site. When recording data for Mackinnon Lists the observer is free to search for birds in as efficient a manner as possible, using whatever search techniques are appropriate for the site. However, the observer should endeavor to cover different ground at least from one list to the next to avoid recording the same individuals on repeated lists.

In addition to the above, information was also taken for each species siting, giving information on the local transect recorded so that later information on habitat preference could be outlined and some indication of distribution within the Study Area could be made.

#### **A7.6.3 Terrestrial Mammals including Bats**

As most mammals occur at low densities, all sightings, tracks, and signs of mammals (including droppings) were actively searched for (including day and night surveys) along the survey transects. The day transects was walked between 0730 to 1330 hours and 1600 to 1800 hours while night transect was walked between 1830 and 2300 hours to increase the detection probability. A bat detector was employed during night surveys to identify bat activities as well as species composition as far as practical.

<sup>1</sup> Mackinnon, J. and Phillips, K. (1993) *A Field Guide to the Birds of Sumatra, Java and Bali*. Oxford University Press, Oxford.

Any special mammal species-habitat relationships observed (foraging/ breeding ground) during the survey was recorded and marked on the habitat map as far as practical.

Given concerns raised during focus group discussions, camera trapping, using Bushnell camera set-ups, was employed instead of intrusive traditional trapping, to help quantify and identify mammals in the Study Area. The camera trapping targeted medium and large terrestrial animals or arboreal mammals, which spend substantial time on the ground. Camera traps were deployed at 10 locations over two separate periods (November 2014 to February 2015 and September 2015 to November 2015), in various forest types in order to capture species inhabiting different habitats. The setting locations included Primary Forest, Regeneration Forest A and B, Isolated Forest and 100 m vicinity of Wetland Forest, where the forest floor was inaccessible due to occasional flooding. The time delay between photographs was set to a minimum of 30 seconds, to reduce shots of the same individual on a single situation. Consecutive photographs of individuals of the same species taken within one hour were defined as one independent capture to avoid over estimation of the relative abundance. All cameras were operated 24 hours a day with continuous monitoring. The cameras were checked every 40 to 60 days to reload new SD cards and batteries. Rats and mice, and poor photographs of squirrels and tree shrews were pooled together as rodents and squirrels respectively, for the purposes of discussion and because they are often indistinguishable on photographs. Photographs of animals that are only visible partly were categorized as unidentified. Captured images were visualized and quantified with standard indices of animal activity and this data was used to assess mammal relative abundances and diversity in the Study Areas wherever possible. Locations of camera traps are indicated in *Figure A-3*.

#### **A7.6.4      *Herpetofauna (Amphibians and Reptiles)***

Visual encounter transects were used to survey for amphibians and reptiles. Visual encounter transects are the standard sampling technique for herpetofauna and covered a representative sample of the Study Area. Visual encounter transects were both diurnal (0730 to 1330 hours) and nocturnal (1830 to 2300 hours), conducted on foot and consisted of slowly moving through relevant areas (focused on breeding habitats and places where prey are found) and identifying any species observed. The transects focused on the taxa and areas of highest conservation interest identified within the Study Area and included auditory detection of species-specific calls to survey for frogs and toads. Any special species-habitat relationships observed (foraging/ breeding ground) during the survey were recorded and marked on the habitat map as far as practical.

#### **A7.6.5      *Butterflies and Odonates (Dragonflies and Damselflies)***

Butterflies, dragonflies and damselflies of different habitats within the Study Area were surveyed using transect and MacKinnon List techniques, subject to the on-site conditions. Butterflies, dragonflies and damselflies encountered along transects were identified and counted.

#### **A7.6.6      *Aquatic Community including Freshwater Fish and Decapod Crustaceans***

Bankside visual assessment was undertaken to identify observable aquatic community and their relative abundance. No specimens were collected but species' location was recorded using GPS. The assessment was undertaken during both daytime (0800 to 1700 hours) and at night (2000 to 2130 hours) using headlamps. All fish and decapod crustaceans were identified to species or genus level insofar as possible.

Note that baseline data collection included abiotic parameters (including water quality and stream parameters and signs of impacts and pollution sources) that will serve as good monitoring indicators of the stream conditions and cause fewer disturbances to the aquatic biotic community when collecting the data. For example, pH and DO levels can be measured in situ; visual attributes indicate turbidity, suspended solid levels, potential pollution (eg from oil on water surface, debris, etc) and odor can also indicate potential pollutions sources (eg. from sewage spillages) and the naturalness of the stream can also reflect stream health. For future potential abiotic parameters monitoring during SI works (if confirmed to be conducted within CCNR of the Study Area), signs of impacts and pollution source(s) are easily identified by an Environmental Specialist/ Ecologist who is experienced in field surveys, feedback is immediate and action can be taken quickly to stop the impact source and reduce adverse effects. Results of biotic surveys are generally more harmful for the data collection (often requiring organisms to be collected and preserved for analysis) and require time for sorting, identification and data interpretation slowing reaction time. Collecting baseline information primarily on abiotic parameters is therefore considered as a sensitive, non-intrusive (ie, ground excavation/sample capture) and effective impact monitoring method for the aquatic community given the highly sensitive nature of the CCNR and pristine natural streams.



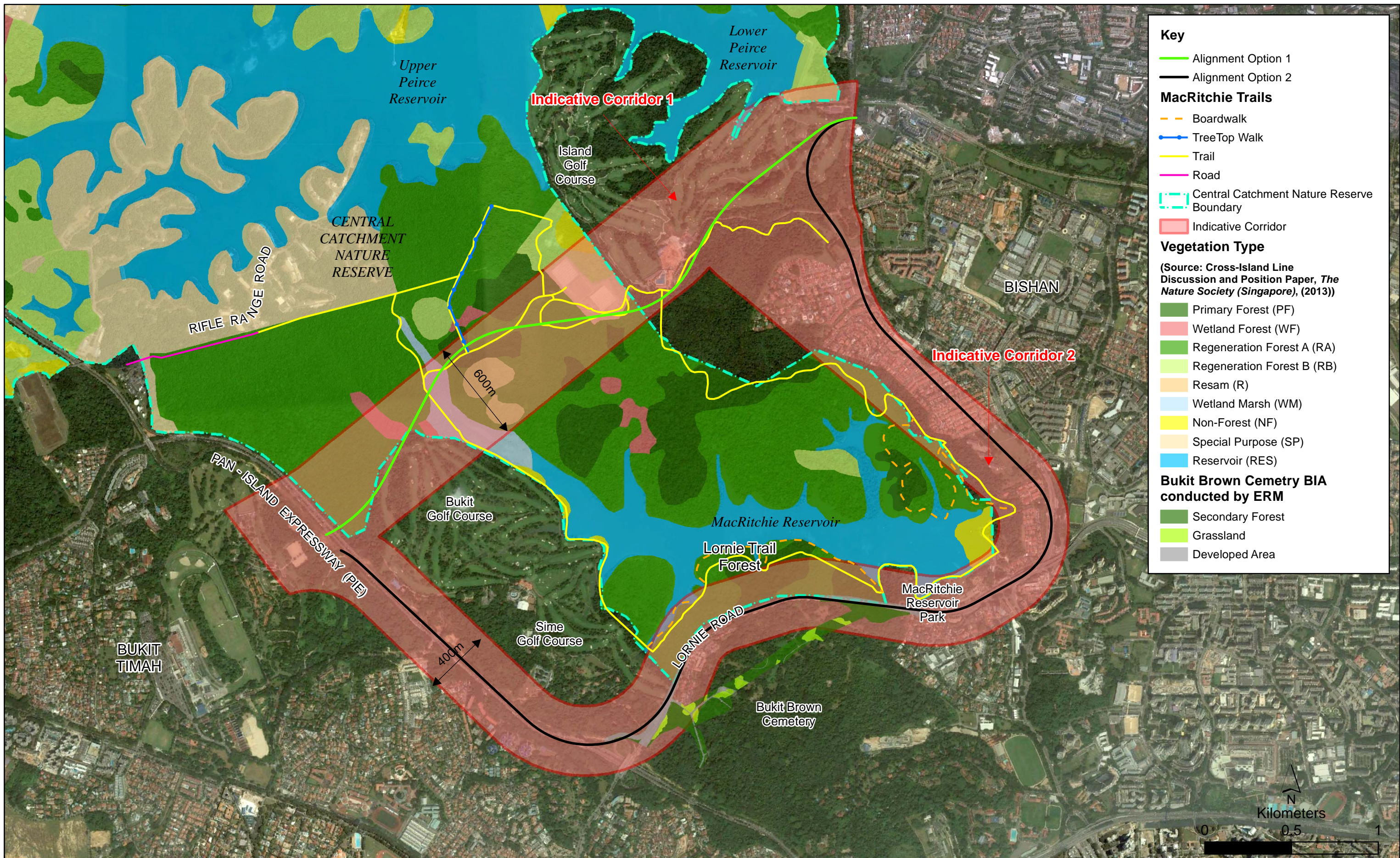


Figure A-2 Vegetation Type within the Central Catchment Nature Reserve



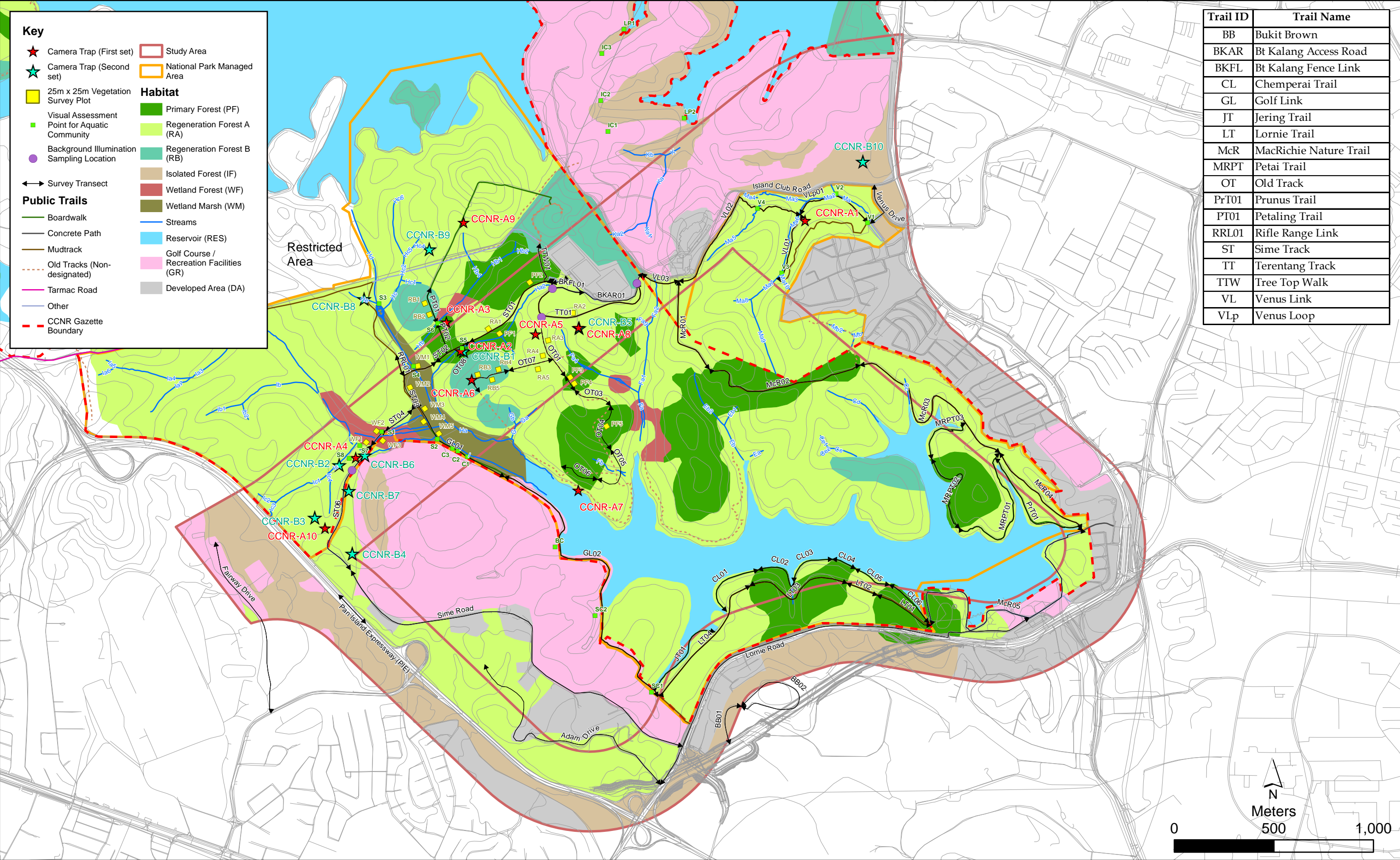


Figure A-3 Location of Survey Transects, Vegetation Plots and Camera Traps

## A7.7 PRIMARY DATA ANALYSIS

In analyzing the primary data, a number of calculations have been made in order to help determine such things as importance of species, relative abundance, etc.

For vegetation, importance values (IVs) have been assigned based on species data recorded within the plots. The value of IV ranges from 0 to 100 and the larger the IV, the more dominant a species. The following formulas have been used to calculate IV:  $IV = Rf + Rd + Rba$ , where:

Rf is relative frequency calculated as 
$$\text{Relative frequency (Rf)} = \frac{\text{Frequency of a species}}{\text{Sum frequency of all species}} \times 100$$

Rd is relative density calculated as 
$$\text{Relative density (Rd)} = \frac{\text{Number of individual of a species}}{\text{Total number of individual s of all species}} \times 100$$

Rba is relative Coverage calculated as 
$$\text{Relative coverage (Rba)} = \frac{\text{Total basal area of a species}}{\text{Total basal area of all species}} \times 100$$

Species lists of each taxa group were generated from both primary data collected during the field surveys and secondary data from available literature. These are presented respectively in *Annex 9A-P*. For avifauna, odonates and butterflies, a Species Discovery Curve was created from primary data collected by using the MacKinnon Lists technique. The curve shows accumulating number of species that were detected during the field survey period. If the curve is reaching the asymptote, this indicates that most species across the survey period have been detected and that any further survey efforts (and extra MacKinnon Lists they would generate) would not be likely to provide a substantial increase in accumulative species. This gives an overall impression as to whether species may be present have not yet been recorded.

Data from the MacKinnon Lists also reflects the relative abundance of species throughout the Study Area. For this, the number of times a species was recorded on a MacKinnon List was compared to the total number of lists recorded, giving a relative abundance between 0 and 1 with 1 being the highest relative abundance score. Lastly, based on the location of species, a certain level of interpretation of species distribution across the site could be made along with species' habitat usage and / or preference.

## A7.8 SCHEDULE

Singapore experiences an equatorial monsoonal climate, with warm, humid conditions throughout the year and no distinct wet or dry season. The two main monsoon seasons which prevail are the Northeast monsoon season from December to early March and the Southwest Monsoon season from June to September. Separating the two monsoon seasons are the Inter-monsoon periods from late March to May and October to November respectively.

The ecological surveys covered up to fourteen (14) months of data collection activities covering inter-monsoon period and monsoon periods. The surveys commenced in October 2014 and lasted up to November 2015<sup>1</sup>, as illustrated in *Table A7-1*. Avifauna surveys covered the main breeding season.

<sup>1</sup> One camera trap (CCNR-B10 will remain in situ up to January 2016 due to failure during the September to November 2015 deployment

**TABLE A7-1: FREQUENCY OF THE DIFFERENT SURVEY ELEMENTS OVER A 14-MONTH SURVEY PERIOD**

Survey Elements	Oct '14	Nov '14	Dec '14	Jan '15	Feb '15	Mar '15	Apr '15	May '15	Jun '15	Jul '15	Aug '15	Sep '15	Oct '15	Nov '15
	Inter-Monsoon Period		Northeast Monsoon				Inter-Monsoon Period		Southwest Monsoon				Inter-Monsoon Period	
	Major Bird Migration				Major Bird Migration							Major Bird Migration		
						High Breeding Activity								
Habitat & Vegetation	D	D	D	D	D	D	D	D	D					
Avifauna		D & N	D & N	D & N	D & N	D & N		D	D & N			D & N	D & N	
Butterfly/ Odonate		D		D	D				D			D & N	D & N	
Terrestrial Mammals including Bats		D & N	D & N	D & N	D & N	D & N			D & N			D & N		
Camera trap deployment		D & N	D & N	D & N	D & N							D & N	D & N	D & N
Herpetofauna		D & N	D & N	D & N	D & N	D & N			D & N			D & N		
Aquatic Community including Freshwater fish & Decapod Crustaceans				D	D & N									

Notes:

D = Day Time Survey

N = Night Time Survey

## Annex 8.0

### Species Lists

Annex 8A-1

## Tree Species (Secondary Data)



ANNEX 8A TREE SPECIES IN MACRITCHIE FOREST WITHIN THE STUDY AREA, REPORTED FROM SECONDARY DATA<sup>1</sup>

No.	Scientific Name	Status given in CRL WG Report <sup>1</sup> , following Chong <i>et al</i> (2009) <sup>2</sup>	Remarks
1	<i>Acronychia porteri</i>	CRL WG Report reports '?'	Not listed in Chong <i>et al</i> (2009) but listed as LC on the IUCN Red List
2	<i>Actinodaphne malaccensis</i>	EN	
3	<i>Actinodaphne pruinosa</i>	EN	
4	<i>Adenanthera malayana</i>	VU	
5	<i>Adinandra dumosa</i>	CO	
6	<i>Aglaia exstipulata</i>	CR	
7	<i>Aglaia malaccensis</i>	CR	
8	<i>Aglaia odoratissima</i>	CR	
9	<i>Aglaia rufinervis</i>	CR	
10	<i>Aidia densiflora</i>	VU	
11	<i>Aidia wallichiana</i>	CRL WG Report reports '?'	Possible synonym of <i>Aidia densiflora</i> (Catalogue of Life 2015), which is listed by Chong <i>et al.</i> (2009) as VU
12	<i>Albizia splendens</i>	EN	
13	<i>Alphonsea maingayi</i>	CR	
14	<i>Alstonia angustifolia</i>	CO	
15	<i>Alstonia pneumatophora</i>	CR	
16	<i>Alstonia spatulata</i>	CR	
17	<i>Anisophyllea griffithii</i>	CR	
18	<i>Anisoptera megistocarpa</i>	CR	
19	<i>Antidesma coriaceum</i>	VU	
20	<i>Antidesma cuspidatum</i>	CO	
21	<i>Aporosa subcaudata</i>	EN	
22	<i>Aporosa benthamiana</i>	VU	
23	<i>Aporosa frutescens</i>	CO	
24	<i>Aporosa lucida</i>	CR	
25	<i>Aporosa miqueliana</i>	CRL WG Report reports '?'	Possible synonym of <i>Aporosa lucida</i> var. <i>lucida</i> (Catalogue of Life 2015), which is listed by Chong <i>et al.</i> (2009) as CR
26	<i>Aporosa nervosa</i>	VU	
27	<i>Aporosa nigricans</i>	EN	
28	<i>Aporosa penangensis</i>	EX	
29	<i>Aporosa symplocoides</i>	CO	
30	<i>Aquilaria malaccensis</i>	VU	
31	<i>Archidendron clypearia</i>	CO	
32	<i>Archidendron contortum</i>	VU	
33	<i>Archidendron globosum</i>	CR	
34	<i>Aromadendron elegans</i>	CRL WG Report reports '?'	Listed on IUCN Red List as DD as a synonym for <i>Magnolia elegans</i> ( <a href="http://www.iucnredlist.org/details/191872/0">http://www.iucnredlist.org/details/191872/0</a> ) which is listed as CR by Chong <i>et al.</i> (2009)
35	<i>Artocarpus anisophyllus</i>	EN	
36	<i>Artocarpus dadah</i>	EN	
37	<i>Artocarpus elasticus</i>	CO	
38	<i>Artocarpus fulvicortex</i>	CR	
39	<i>Artocarpus hispidus</i>	CR	
40	<i>Artocarpus integer</i>	Exotic	
41	<i>Artocarpus kemando</i>	EN	
42	<i>Artocarpus lanceifolius</i>	CR	
43	<i>Artocarpus lowii</i>	CR	
44	<i>Artocarpus nitidus</i>	CR	
45	<i>Baccaurea kunstleri</i>	EN	
46	<i>Baccaurea maingayi</i>	CR	
47	<i>Baccaurea parviflora</i>	CO	
48	<i>Baccaurea pyriformis</i>	EX	
49	<i>Baccaurea racemosa</i>	EN	
50	<i>Baccaurea reticulata</i>	CR	
51	<i>Baccaurea sumatrana</i>	VU	
52	<i>Beilschmiedia madang</i>	EN	
53	<i>Bhesa paniculata</i>	CO	
54	<i>Bhesa robusta</i>	VU	
55	<i>Blumeodendron tokbrai</i>	VU	
56	<i>Bouea oppositifolia</i>	VU	
57	<i>Brackenridgea hookeri</i>	EN	
58	<i>Bridelia stipularis</i>	VU	
59	<i>Buchananina arborescens</i>	CO	
60	<i>Calophyllum ferrugineum</i>	CO	
61	<i>Calophyllum lanigerum</i>	EN	Not listed separately to <i>Calophyllum lanigerum</i> v. <i>austrocoriaceum</i> by Chong <i>et al.</i> (2009). One entry as EN
62	<i>Calophyllum lanigerum</i> v. <i>austrocoriaceum</i>	CRL WG Report reports '?'	Listed by Chong <i>et al.</i> (2009) as EN
63	<i>Calophyllum macrocarpum</i>	CR	
64	<i>Calophyllum pulcherrimum</i>	CO	
65	<i>Calophyllum rubiginosum</i>	EN	

No.	Scientific Name	Status given in CRL WG Report <sup>1</sup> , following Chong <i>et al.</i> (2009) <sup>2</sup>	Remarks
66	<i>Calophyllum rufigemmatum</i>	EN	
67	<i>Calophyllum sundaicum</i>	CR	
68	<i>Calophyllum tetarpterum</i>	VU	
69	<i>Calophyllum teysmannii</i>	VU	
70	<i>Calophyllum wallichianum v. incrassatum</i>	CRL WG Report reports '?'	Listed by Chong <i>et al.</i> (2009) as VU
71	<i>Camptosperma auriculatum</i>	CO	
72	<i>Canarium costatum</i>	CRL WG Report reports '?'	Possible synonym of <i>Dacryodes costata</i> (Catalogue of Life 2015), which is listed by Chong <i>et al.</i> (2009) as EN
73	<i>Canarium grandifolium</i>	CR	
74	<i>Canarium littorale</i>	CO	
75	<i>Canarium patentinervium</i>	EN	
76	<i>Canthium confertum</i>	EN	
77	<i>Canthium glabrum</i>	EN	
78	<i>Carallia brachiata</i>	EN	
79	<i>Castanopsis malaccensis</i>	CR	
80	<i>Castanopsis megacarpa</i>	CR	
81	<i>Castanopsis wallichii</i>	CR	
82	<i>Cheilosa montana v. malayana</i>	EX	
83	<i>Chisocheton divergens</i>	CRL WG Report reports '?'	Possible synonym of <i>Chisocheton patens</i> (Catalogue of Life 2015), which is listed by Chong <i>et al.</i> (2009) as CR
84	<i>Chisocheton patens</i>	CRL WG Report reports '?'	Listed by Chong <i>et al.</i> (2009) as CR
85	<i>Chisocheton pentandrus</i>	CRL WG Report reports '?'	Listed by Chong <i>et al.</i> (2009) as CR
86	<i>Cinnamomum iners</i>	CO	
87	<i>Cinnamomum javanicum</i>	CR	
88	<i>Cleisanthus sumatranus</i>	VU	
89	<i>Clerodendrum laevifolium</i>	CO	
90	<i>Cratoxylum arborescens</i>	VU	
91	<i>Cratoxylum formosum</i>	EN	
92	<i>Cratoxylum maingayi</i>	CR	
93	<i>Croton laevifolius</i> (synonym <i>C. oblongus</i> )	CRL WG Report reports '?'	Chong <i>et al.</i> (2009) lists <i>C. laevifolius</i> as synonym of <i>C. oblongus</i> =EN
94	<i>Crypteronia griffithii</i>	CR	
95	<i>Cryptocarya impressa</i>	CR	
96	<i>Ctenolophon parvifolius</i>	CR	
97	<i>Cyathocalyx ramulifloris</i>	VU	
98	<i>Cyathocalyx ridleyi</i>	VU	
99	<i>Dacryodes costata</i>	EN	
100	<i>Dacryodes laxa</i>	EN	
101	<i>Dacryodes rostrata</i>	VU	
102	<i>Dacryodes rugosa</i>	CR	
103	<i>Dehaasia incrassata</i>	CR	
104	<i>Dialium platysepalum</i>	CR	
105	<i>Dillenia grandifolia</i>	EN	
106	<i>Diospyros buxifolia</i>	VU	
107	<i>Diospyros lanceifolia</i>	CO	
108	<i>Diospyros maingayi</i>	CR	
109	<i>Diospyros styraciformis</i>	VU	
110	<i>Diplospora malaccensis</i>	CR	
111	<i>Dipterocarpus caudatus</i>	CR	
112	<i>Dipterocarpus grandiflorus</i>	CR	
113	<i>Dipterocarpus kunstleri</i>	VU	
114	<i>Dipterocarpus sublamellatus</i>	VU	
115	<i>Dipterocarpus tempehes</i>	CR	
116	<i>Dracaena maingayi</i>	VU	
117	<i>Durio griffithii</i>	EN	
118	<i>Durio singaporensis</i>	VU	
119	<i>Dyera costulata</i>	CO	
120	<i>Dysoxylum cauliflorum</i>	VU	
121	<i>Dysoxylum flavescens</i>	CR	
122	<i>Elaeocarpus ferrugineus</i>	CO	
123	<i>Elaeocarpus mastersii</i>	CO	
124	<i>Elaeocarpus nitidus v. salicifolius</i>	VU	
125	<i>Elaeocarpus petiolatus</i>	CO	
126	<i>Elaeocarpus rugosus</i>	CR	
127	<i>Ellipanthus tomentosus</i>	CR	
128	<i>Endospermum diadenum</i>	VU	
129	<i>Eurycoma longifolia</i>	CR	
130	<i>Fagraea fragrans</i>	CO	
131	<i>Ficus kerkhovenii</i>	CR	
132	<i>Ficus variegata</i>	CO	
133	<i>Ficus vasculosa</i>	EN	
134	<i>Ganua kingiana</i>	CRL WG Report reports '?'	Possible synonym of <i>Madhuca kingiana</i> (Catalogue of Life 2015), which is listed by Chong <i>et al.</i> (2009) as EN
135	<i>Garcinia atroviridis</i>	CR	

No.	Scientific Name	Status given in CRL WG Report <sup>1</sup> , following Chong <i>et al</i> (2009) <sup>2</sup>	Remarks
136	<i>Garcinia eugeniifolia</i>	VU	
137	<i>Garcinia griffithii</i>	EN	
138	<i>Garcinia parvifolia</i>	CO	
139	<i>Garcinia scortechinii</i>	CR	
140	<i>Gardenia griffithii</i>	EX	
141	<i>Gardenia tubifera</i>	CR	
142	<i>Gironniera nervosa</i>	CO	
143	<i>Gironniera parvifolia</i>	EN	
144	<i>Gironniera subaequalis</i>	EN	
145	<i>Gluta wallichii</i>	CO	
146	<i>Gonystylus confusus</i>	EN	
147	<i>Gordonia multinervis</i>	EN	
148	<i>Gordonia singaporiensis</i>	EN	
149	<i>Grewia blattaefolia</i>	EN	
150	<i>Guioa pubescens</i>	VU	
151	<i>Gymnacranthera farquhariana</i>	CR	
152	<i>Gymnacranthera forbesii</i>	CR	
153	<i>Gynotroches axillaris</i>	CO	
154	<i>Heritiera borneensis</i>	CR	
155	<i>Heritiera borneensis javanica</i>	CRL WG Report reports '?'	Chong <i>et al.</i> (2009) lists both <i>H. borneensis</i> and <i>H. javanica</i> as separate species which are both CR
156	<i>Heritiera elata</i>	EN	
157	<i>Heritiera javanica</i>	CR	
158	<i>Heritiera simplicifolia</i>	EN	
159	<i>Hevea brasiliensis</i>	CO	
160	<i>Hopea griffithii</i>	CR	
161	<i>Hopea mengarawan</i>	EN	
162	<i>Horsfieldia crassifolia</i>	CR	
163	<i>Horsfieldia polyspherula</i>	VU	
164	<i>Horsfieldia sucosa</i>	EN	
165	<i>Horsfieldia wallichii</i>	CR	
166	<i>Horsfieldia polyspherula</i>	VU	
167	<i>Ilex cymosa</i>	CO	
168	<i>Ixonanthes icosandra</i>	VU	
169	<i>Ixonanthes reticulata</i>	CO	
170	<i>Kibatalia maingayi</i>	CR	
171	<i>Knema communis</i>	EN	
172	<i>Knema conferta</i>	EN	
173	<i>Knema furfuracea</i>	CR	
174	<i>Knema hookeriana</i>	CR	
175	<i>Knema latericia</i>	EN	
176	<i>Knema laurina</i>	EN	
177	<i>Knema malayana</i>	EN	
178	<i>Koelodapas longifoliam</i>	VU	
179	<i>Kokoona reflexa</i>	CR	
180	<i>Koompassia malaccensis</i>	EN	
181	<i>Licania splendens</i>	CO	
182	<i>Lithocarpus conocarpus</i>	CR	
183	<i>Lithocarpus encleisacarpus</i>	CR	
184	<i>Lithocarpus ewyckii</i>	EN	
185	<i>Lithocarpus lucidus</i>	EN	
186	<i>Lithocarpus sundaicus</i>	CR	
187	<i>Litsea accedens</i>	EN	
188	<i>Litsea castanea</i>	EN	
189	<i>Litsea costalis</i>	CR	Listed as a separate species to <i>Litsea costata</i> , in Chong <i>et al.</i>
190	<i>Litsea costata</i>	CR	Listed as a separate species to <i>Litsea costalis</i> , in Chong <i>et al.</i>
191	<i>Litsea elleptica</i>	CO	
192	<i>Litsea firma</i>	VU	
193	<i>Litsea grandis</i>	EN	
194	<i>Litsea ridleyi</i>	EN	
195	<i>Lophopetalum pallidum</i>	CR	
196	<i>Lophopetalum wightianum</i>	VU	
197	<i>Macaranga bancana</i>	CO	
198	<i>Macaranga conifera</i>	CO	
199	<i>Macaranga gigantea</i>	CO	
200	<i>Macaranga lowii</i>	VU	
201	<i>Madhuca sericea</i>	CR	
202	<i>Maesa ramentacea</i>	CO	
203	<i>Mallotus penangensis</i>	CR	
204	<i>Maranthes corymbosa</i>	EN	
205	<i>Melicope glabra</i>	VU	
206	<i>Memecylon megacarpum</i>	EN	
207	<i>Mezzettia parviflora</i>	CR	
208	<i>Microcos latifolia</i>	CRL WG Report reports '?'	<i>Microcos blattaefolia</i> is given as a synonym in Catalogue of Life (2015) and this species is listed at EN by Chong <i>et al.</i> (2009)

No.	Scientific Name	Status given in CRL WG Report <sup>1</sup> , following Chong et al (2009) <sup>2</sup>	Remarks
209	<i>Monocarpia marginalis</i>	VU	
210	<i>Myristica cinnamomea</i>	CR	
211	<i>Myristica crassa</i>	CR	
212	<i>Myristica elliptica</i>	EN	

No.	Scientific Name	Status given in CRL WG Report <sup>1</sup> , following Chong <i>et al</i> (2009) <sup>2</sup>	Remarks
213	<i>Myristica lowiana</i>	CR	
214	<i>Myristica maingayi</i>	CR	
215	<i>Nauclea officinalis</i>	CR	
216	<i>Neolitsea zeylanica</i>	?	
217	<i>Neoscortechinia kingii</i>	CR	
218	<i>Nephelium cuspidatum</i>	EN	Not listed separately to <i>Nephelium cuspidatum</i> v. <i>eripetalum</i> by Chong <i>et al.</i> (2009). One entry as EN. Listed by NParks as <i>Nephelium cuspidatum</i> Blume.
219	<i>Nephelium cuspidatum</i> v. <i>eripetalum</i>	CRL WG Report reports '?'	Listed by Chong <i>et al.</i> (2009) as EN
220	<i>Nothaphoebe umbelliflora</i>	CO	
221	<i>Ochanostachys amentacea</i>	VU	
222	<i>Palaquium obovatum</i>	VU	
223	<i>Palaquium rostratum</i>	CR	
224	<i>Parartocarpus bracteatus</i>	CR	
225	<i>Parinari oblongifolia</i>	CR	
226	<i>Parishia maingayi</i>	VU	
227	<i>Parkia speciosa</i>	VU	
228	<i>Payena obscura</i>	CR	
229	<i>Pellacalyx axillaris</i>	EN	
230	<i>Pentace triptera</i>	EN	
231	<i>Pertusadina eurhyncha</i>	VU	
232	<i>Phyllanthus emblica</i>	CR	
233	<i>Pimelodendron griffithianum</i>	VU	
234	<i>Planchonella maingayi</i>	CRL WG Report reports '?'	Possible synonym of <i>Pouteria maingayi</i> (Catalogue of Life 2015), which is listed by Chong <i>et al.</i> (2009) as EN
235	<i>Polyalthia jenkinsii</i>	CR	
236	<i>Polyalthia macropoda</i>	EN	
237	<i>Polyalthia sumatrana</i>	CR	
238	<i>Popowia fusca</i>	VU	
239	<i>Popowia pisocarpa</i>	VU	
240	<i>Porterandia anisophylla</i>	VU	
241	<i>Pouteria malaccensis</i>	VU	
242	<i>Prunus arborea</i>	CR	
243	<i>Prunus polystachya</i>	CO	
244	<i>Psychotria rostrata</i>	CR	
245	<i>Psydrax</i> sp.		Status cannot be given as species not identified
246	<i>Pternandra coerulescens</i>	VU	
247	<i>Pternandra echinata</i>	CRL WG Report reports '?'	Listed by NParks as <i>Pternandra echinata</i> Jack.
248	<i>Pyrenaria acuminata</i>	EN	
249	<i>Rhodamnia cinerea</i>	CO	
250	<i>Sandoricum koetjape</i>	EN	
251	<i>Santiria apiculata</i>	CO	
252	<i>Santiria griffithii</i>	CO	
253	<i>Santiria laevigata</i>	VU	
254	<i>Santiria rubiginosa</i>	VU	
255	<i>Santiria</i> sp.		Status cannot be given as species not identified
256	<i>Santiria tomentosa</i>	EN	
257	<i>Sarcotheca griffithii</i>	CR	
258	<i>Sarcotheca monophylla</i>	CRL WG Report reports '?'	Listed as NT on IUCN Red List
259	<i>Scaphium macropodum</i>	EN	
260	<i>Scorodocarpus borneensis</i>	EN	
261	<i>Shorea bracteolata</i>	CR	
262	<i>Shorea curtisii</i>	VU	
263	<i>Shorea curtisii</i> (Mixed)	CRL WG Report reports 'CR'	Only <i>Shorea curtisii</i> , not (Mixed), listed in Chong <i>et al.</i> (2009).
264	<i>Shorea gibbosa</i>	CR	
265	<i>Shorea gratissima</i>	CR	
266	<i>Shorea johorensis</i>	CR	
267	<i>Shorea leprosula</i>	VU	
268	<i>Shorea macroptera</i>	VU	
269	<i>Shorea ovalis</i>	CR	
270	<i>Shorea parvifolia</i>	EN	
271	<i>Shorea pauciflora</i>	VU	
272	<i>Shorea platycarpa</i>	CR	
273	<i>Sterculia macrophylla</i>	CR	
274	<i>Sterculia rubiginosa</i>	VU	
275	<i>Streblus elongatus</i>	VU	
276	<i>Strombosia ceylanica</i>	VU	
277	<i>Strombosia javanica</i>	VU	
278	<i>Swintonia schwenkii</i>	VU	
279	<i>Syzygium borneense</i>	CO	
280	<i>Syzygium chloranthum</i>	CR	
281	<i>Syzygium cumingianum</i>	CRL WG Report reports '?'	Possible synonym of <i>Syzygium accuminatissimum</i> which is listed by Chong <i>et al.</i> (2009) as EN. Listed by NParks as <i>Syzygium cumingianum</i> Gibbs.



No.	Scientific Name	Status given in CRL WG Report <sup>1</sup> , following Chong <i>et al</i> (2009) <sup>2</sup>	Remarks
282	<i>Syzygium duthieana</i>	CR	
283	<i>Syzygium filiforme</i>	EN	
284	<i>Syzygium filiformis</i> <i>v. clavimyrthus</i>	EN	
285	<i>Syzygium grande</i>	CO	
286	<i>Syzygium nemestrinum</i>	EN	
287	<i>Syzygium ngadimaniana</i>	EN	
288	<i>Syzygium nigricans</i>	EN	
289	<i>Syzygium oblongifolia</i>	CRL WG Report reports '?'	Possible synonym of <i>Syzygium maingayi</i> which is listed by Chong <i>et al.</i> (2009) as CR. <i>Eugenia</i> spp. and <i>Syzygium</i> spp. are commonly confused taxonomically. May be referring to <i>Eugenia oblongifolia</i> Duthie also.
290	<i>Syzygium pachyphyllum</i>	CR	
291	<i>Syzygium pauper</i>	EN	
292	<i>Syzygium pendens</i>	CR	
293	<i>Syzygium pseudoformosum</i>	CR	
294	<i>Syzygium ridleyi</i>	EN	
295	<i>Syzygium subdecussatum</i>	CR	
296	<i>Tarenna mollis</i>	CR	
297	<i>Tarenna odorata</i>	CR	
298	<i>Teijsmanniodendron coriaceum</i>	CR	
299	<i>Timonius wallichianus</i>	CO	
300	<i>Trigonachras acuta</i>	EN	
301	<i>Vatica maingayi</i>	CR	
302	<i>Vatica ridleyana</i>	CR	
303	<i>Vitex pinnata</i>	CO	
304	<i>Xanthophyllum affine</i>	EN	
305	<i>Xanthophyllum amoenum</i>	CR	
306	<i>Xanthophyllum ellipticum</i>	CR	
307	<i>Xanthophyllum eurchynchum</i>	VU	
308	<i>Xanthophyllum obscurum</i>	EN	
309	<i>Xanthophyllum stipitatum</i>	EN	
310	<i>Xanthophyllum vitellinum</i>	VU	
311	<i>Xerospermum noronhianum</i>	CR	
312	<i>Xylopia caudata</i>	VU	
313	<i>Xylopia ferruginea</i>	CO	
314	<i>Xylopia magna</i>	CR	
315	<i>Xylopia malayana</i>	CO	

#### References:

1. Cheong LF, Chua MAH, D'Rozario V, Jamal F, Khoon SK, Koh JKH, Lim KKP, O'Dempsey T and Rajathurai S (2014) **Cross Island Line Working Group Report (CRL Report)**.

NB The 'Checklist of Trees in the MacRitchie Forest' starting on p31 of the CRL Report (2014) numbers 413 species, however a number of species names are repeated in the list and numbering between 340 to 390 is in increments of 10

2. Chong K Y C, Tan H T W, Corlett R T (2009) **A Checklist of the Total Vascular Plant Flora of Singapore. Native, Naturalised and Cultivated Species. Raffles Museum of Biodiversity Research, NUS, Singapore.** Abbreviations include:

CO: Common; VU: Vulnerable; EN: Endangered; CR: Critically Endangered; EX: Extinct

3. Data received from Nparks on 6 May 2015 <MacRitchieFlora\_SING\_300315>

Annex 8A-2

## Flora Species (Secondary Data)

**ANNEX 8A-2 FLORA SPECIES WITHIN MACRITCHIE FOREST (WITHIN THE STUDY AREA)<sup>1</sup>**

<sup>1</sup> Data received from Nparks on 6 May 2015 <MacRitchieFlora\_SING\_300315> and by email on 4-Jun-2015. Related reference:  
Nparks news (4 June 2015) *Hanguana rubinea* and *Hanguana triangulata* <https://www.nparks.gov.sg/news/2015/6/factsheet-hanguana-rubinea-and-hanguana-triangulata>  
(Accessed July 2015)

Note: Information on locations of plant species has been supplied to agencies but is not repeated here to ensure that conservation of these species is not compromised

No.	Family	Scientific Name	Synonyms	Life Form <sup>2</sup>	Native (N)/ Exotic (E) <sup>2</sup>	SRDB National Status <sup>1</sup>	Status given in Chong et al (2009) <sup>2</sup>
1	Acanthaceae	<i>Hygrophila erecta</i> (Burm. f.) Hochr.	<i>Hygrophila phlomisoides</i> var. <i>roxburghii</i> C.B. Clarke	H	E - Casual	Not listed	Listed as <i>Hygrophila phlomisoides</i> Nees. Status not given
2	Achariaceae	<i>Ryparosa scortechinii</i> King	-	T	N	Not listed	CR
3	Agaricaceae	<i>Coprinus</i> sp.	-	Fungus	-	-	Not listed
4	Agaricaceae	<i>Cyathus</i> sp.	-	Fungus	-	-	Not listed
5	Amanitaceae	<i>Termitomyces</i> sp.	-	Fungus	-	-	Not listed
6	Anacardiaceae	<i>Buchananian sessilifolia</i> Blume	-	T	N	VU/D	VU
7	Anacardiaceae	<i>Camptosperma auriculatum</i> (Blume) Hook. f.	-			Not listed	Listed as <i>Camptosperma auriculata</i> Hook. F. Status CO
8	Anacardiaceae	<i>Camptosperma squamatum</i> Ridl.	-	T	N	Not listed	CO
9	Anacardiaceae	<i>Gluta wallichii</i> (Hook. f.) Ding Hou	-	T	N	Not listed	CO
10	Anacardiaceae	<i>Mangifera foetida</i> Lour	-	T	N	VU/D	VU
11	Anacardiaceae	<i>Mangifera odorata</i> Griff	-	T	N	VU/D	VU
12	Anacardiaceae	<i>Parishia insignis</i> Hook. f.	-	T	N	VU/D	VU
13	Aneuraceae	<i>Riccardia</i> sp.	-	L-H-M	-	Not listed	-
14	Anisophylleaceae	<i>Anisophyllea griffithii</i> Oliv.	-	T	N	CR/D	CR
15	Annonaceae	<i>Artabotrys suaveolens</i> (Blume) Blume	-	C	N	EN/D	EN
16	Annonaceae	<i>Cananga odorata</i> (Lam.) Hook. f. & Thomson	-	T	E	Not listed	Not listed
17	Annonaceae	<i>Cyathocalyx ramuliflorus</i> (Maingay ex Hook. f. & Thomson) Sche	-	T	N	Not listed	CO
18	Annonaceae	<i>Cyathocalyx ridleyi</i> (King) J. Sinclair	-	T	N	VU/D	VU
19	Annonaceae	<i>Cyathostemma viridiflorum</i> Griff.	-	C	N	VU/D	VU
20	Annonaceae	<i>Desmos dasymaschalus</i> (Blume) Safford	<i>Dasymaschalon</i> <i>dasymaschalum</i> (Blume) I.M. Turner	S	N	CR/D	Listed as <i>Desmos dasymaschalus</i> (Blume) Safford. Status CR
21	Annonaceae	<i>Desmos dumosus</i> (Roxb.) Safford	-	C	N	CR/D	CR
22	Annonaceae	<i>Desmos sinclairii</i>	<i>Desmos dumosus</i> (Roxb.) Safford	C	N	CR/D	Listed as <i>Desmos dumosus</i> (Roxb.) Safford. Status CR
23	Annonaceae	<i>Ellipeia cuneifolia</i> Hook. f. & Thomson	-	C	N	CR/D	CR
24	Annonaceae	<i>Fissistigma lanuginosum</i> (Hook. f. & Thomson) Merr.	-	C	N	EN/D	EN
25	Annonaceae	<i>Fissistigma latifolium</i> (Dunal) Merr. var. <i>ovoideum</i> (King) J. Sinclair	-	C	N	VU/D	VU
26	Annonaceae	<i>Goniotalamus macrophyllus</i> (Blume) Hook. f. & Thomson	-	S	N	VU/D	VU
27	Annonaceae	<i>Goniotalamus tapis</i> Miq.	-	T	N	VU/D	VU
28	Annonaceae	<i>Hubera rumphii</i> (Blume ex Hensch.) Chaowasku	<i>Polyalthia rumphii</i> (Blume ex Hensch.) Merr.	T	N	CR/D	Listed as, <i>Polyalthia rumphii</i> (Blume ex Hensch.) Merr. Status CR
29	Annonaceae	<i>Mitrella kentii</i> (Blume) Miq.	-	C	N	Not listed	CO
30	Annonaceae	<i>Mitrephora teysmanni</i> Scheff.	<i>Mitrephora maingayi</i> Hook. f. & Thomson (synonym)	T	N	Not listed	Listed as <i>Mitrephora maingayi</i> Hook. f. & Thomson. Status CO
31	Annonaceae	<i>Polyalthia angustissima</i> Ridl.	-	T	N	VU/D	VU
32	Annonaceae	<i>Polyalthia lateriflora</i> (Blume) King	-	T	N	CR/D	CR
33	Annonaceae	<i>Polyalthia macropoda</i> King	-	T	N	EN/D	EN
34	Annonaceae	<i>Popowia fusca</i> King	-	T	N	VU/D	VU
35	Annonaceae	<i>Popowia pisocarpa</i> (Blume) Endl.	-	T	N	VU/D	VU

No.	Family	Scientific Name	Synonyms	Life Form <sup>2</sup>	Native (N)/ Exotic (E) <sup>2</sup>	SRDB National Status <sup>1</sup>	Status given in Chong <i>et al</i> (2009) <sup>2</sup>
36	Annonaceae	<i>Pyramidanthe prismatica</i> (Hook. f. & Thomson) J. Sinclair	-	C	N	EN/D	EN
37	Annonaceae	<i>Uvaria cordata</i> (Dunal) Alston	-	C	N	Not listed	CO
38	Annonaceae	<i>Uvaria hirsuta</i> Jack	-	C	N	VU/D	VU
39	Annonaceae	<i>Uvaria javana</i> Dunal	-			Not listed	Not listed
40	Annonaceae	<i>Uvaria</i> sp.	-			-	-
41	Annonaceae	<i>Xylopia caudata</i> Hook. f. & Thomson	-	T	N	VU/D	VU
42	Annonaceae	<i>Xylopia elliptica</i> Maingay ex Hook. f. & Thomson	-			Not listed	Not listed
43	Annonaceae	<i>Xylopia ferruginea</i> (Hook. f. & Thomson) Hook. f. & Thoms	-	T	N	Not listed	CO
44	Annonaceae	<i>Xylopia malayana</i> Hook. f. & Thomson	-	T	N	Not listed	CO
45	Apocynaceae-apo	<i>Microchites serpyllifolius</i> (Blume) Kosterm.	-	C	N	Not listed	CR
46	Apocynaceae-apo	<i>Parameria polyneura</i> Hook. f.	-	C	N	CR/D	CR
47	Apocynaceae-apo	<i>Strophanthus caudatus</i> (L.) Kurz	-	C	N	CR/D	CR
48	Apocynaceae-apo	<i>Urceola brachysepalae</i> Hook. f.	-	C	N	EN/D	EN
49	Apocynaceae-apo	<i>Urceola elastica</i> Roxb.	-	C	N	CR/D	CR
50	Apocynaceae-apo	<i>Urceola torulosa</i> Hook. f.	-	C	N	EN/D	EN
51	Apocynaceae-asc	<i>Dischidia bengalensis</i> Colebr.	-	Epiphyte	N	NE	EX
52	Apocynaceae-asc	<i>Marsdenia maingayi</i> (Hook. f.) P.I. Forst.	<i>Stephanotis maingayi</i> Hook. fil.	C	N	Not listed	Listed as <i>Stephanotis maingayi</i> Hook. fil. Status EX
53	Apocynaceae-rau	<i>Alstonia angustifolia</i> Wall. ex A. DC.	-	T	N	Not listed	CO
54	Apocynaceae-rau	<i>Alstonia angustiloba</i> Miq.	-	T	N	Not listed	CO
55	Apocynaceae-rau	<i>Alstonia pneumatophora</i> Back. ex L.G. den Berger	-	T	N	CR/D	CR
56	Apocynaceae-rau	<i>Alstonia spatulata</i> Blume	-	T	N	VU/D	VU
57	Apocynaceae-rau	<i>Alyxia reinwardtii</i> Blume	-	C	N	Not listed	CO
58	Apocynaceae-rau	<i>Dyera costulata</i> (Miq.) Hook. f.	-	T	N	Not listed	CO
59	Apocynaceae-rau	<i>Leuconotis griffithii</i> Hook. f.	-	C	N	VU/D	VU
60	Apocynaceae-rau	<i>Tabernaemontana corymbosa</i> Roxb. ex Wall.	-	T	N	EN/D	EN
61	Apocynaceae-rau	<i>Tabernaemontana pauciflora</i> Blume	-	S	N	VU/D	VU
62	Apocynaceae-rau	<i>Willughbeia coriacea</i> Wall.	<i>Willughbeia firmus</i> (Blume) Kuntze			Not listed	Not listed
63	Apocynaceae-rau	<i>Willughbeia edulis</i> Roxb.	-	C	N	NE	EX
64	Apocynaceae-rau	<i>Willughbeia tenuiflora</i> Dyer ex Hook. f.	-	C	N	CR/D	CR
65	Aquifoliaceae	<i>Ilex cymosa</i> Blume	-	T	N	Not listed	CO
66	Aquifoliaceae	<i>Ilex macrophylla</i> Hook. f.	<i>Ilex latifolia</i> Thunb.	T	N	VU/D	VU
67	Araceae	<i>Amydrium medium</i> (Zoll. & Moritzi) Nicolson	-	C	N	EN/D	EN
68	Araceae	<i>Cryptocoryne griffithii</i> Schott	-	H	N	CR/D	CR
69	Araceae	<i>Cyrtosperma merkusii</i> (Hassk.) Schott	-	H	N	VU/D	VU
70	Araceae	<i>Epipremnopsis media</i> (Zoll. & Moritzi) Engl.	<i>Amydrium medium</i> (Zoll. & Moritzi) Nicolson	C	N	Listed as <i>Amydrium medium</i> . Status EN/D	Listed as <i>Amydrium medium</i> (Zoll. & Moritzi) Nicolson. Status EN
71	Araceae	<i>Homalomena humilis</i> (Jack) Hook. f. var. <i>pumila</i> (Hook. f.) Furtado	-	H	N	EN/D	EN
72	Araceae	<i>Schismatoglottis wallichii</i> Hook. f.	-	H	N	VU/D	VU

No.	Family	Scientific Name	Synonyms	Life Form <sup>2</sup>	Native (N)/ Exotic (E) <sup>2</sup>	SRDB National Status <sup>1</sup>	Status given in Chong et al (2009) <sup>2</sup>
73	Aristolochiaceae	<i>Thottea grandiflora</i> Rottb.	-			VU/D	VU
74	Asparagaceae	<i>Dracaena porteri</i> Baker	-	S	N	Not listed	CO
75	Asparagaceae	<i>Dracaena umbratica</i> Ridl.	-	S	N	Not listed	VU
76	Auriculariaceae	<i>Auricularia</i> sp.	-	-	-	-	-
77	Blechnaceae	<i>Blechnum finlaysonianum</i> Wall. ex Hook. & Grev.	-	H	N	VU/D	VU
78	Boletaceae	<i>Chamonixia mucosa</i> (Petri) Corner & Hawker	-	-	-	Not listed	Not listed
79	Boraginaceae	<i>Tournefortia tetrandra</i> Blume	-	C	N	NE	EX
80	Burseraceae	<i>Canarium littorale</i> Blume	-	T	N	Not listed	CO
81	Burseraceae	<i>Canarium patentinervium</i> Miq.	-	T	N	EN/D	EN
82	Burseraceae	<i>Canarium pilosum</i> Benn.	-	T	N	EN/D	EN
83	Burseraceae	<i>Dacryodes puberula</i> (Benn.) H.J. Lam	-	Not listed	Not listed	Not listed	Not listed
84	Burseraceae	<i>Santiria conferta</i> Benn.	-	T	N	CR/D	CR
85	Burseraceae	<i>Santiria griffithii</i> (Hook. f.) Engl.	-	T	N	Not listed	CO
86	Burseraceae	<i>Santiria laevigata</i> Blume	-	T	N	VU/D	VU
87	Burseraceae	<i>Santiria oblongifolia</i> Blume	<i>Canarium eupteron</i> Miq.	-	-	Not listed	Not listed
88	Burseraceae	<i>Santiria tomentosa</i> Blume	-	T	N	EN/D	EN
89	Calostomataceae	<i>Mitremyces orirubra</i>	-	Fungus	-	Not listed	Not listed
90	Calymperaceae	<i>Arthrocomus schimperi</i> (Dozy & Molk.) Dozy & Molk.	-	L-H-M	-	Not listed	Not listed
91	Calymperaceae	<i>Calymperes palisotii</i> Schwaegr.	-	L-H-M	-	Not listed	Not listed
92	Calymperaceae	<i>Mitthyridium flavum</i> (Muell. Hal.) H. Rob.	-	L-H-M	-	Not listed	Not listed
93	Calymperaceae	<i>Mitthyridium repens</i> (Harv. in Hook.) H. Rob.	-	L-H-M	-	Not listed	Not listed
94	Calymperaceae	<i>Mitthyridium</i> sp.	-	L-H-M	-	-	-
95	Calymperaceae	<i>Syrrhopodon spiculosus</i> Hook. & Grev.	-	L-H-M	-	Not listed	Not listed
96	Calypogeiaceae	<i>Calypogeia arguta</i> Nees & Mont. ex Nees	-	L-H-M	-	Not listed	Not listed
97	Calypogeiaceae	<i>Calypogeia</i> sp.	-	L-H-M	-	-	-
98	Calypogeiaceae	<i>Calypogeia</i> sp.	-	L-H-M	-	-	-
99	Cannabaceae	<i>Girroniera nervosa</i> Planch.	-	T	N	-	CO
100	Cannabaceae	<i>Girroniera subaequalis</i> Planch.	-	T	N	EN/D	EN
101	Cannabaceae	<i>Trema cannabina</i> Lour.	-	S	N	Not listed	CO
102	Celastraceae	<i>Bhesa robusta</i> (Roxb.) Ding Hou	-	T	N	VU/D	VU
103	Celastraceae	<i>Kokoona reflexa</i> (Laws.) Ding Hou	-	T	N	CR/D	CR
104	Celastraceae	<i>Lophopetalum multinervium</i> Ridl.	-	T	N	EN/D	EN
105	Celastraceae	<i>Lophopetalum pallidum</i> Laws.	-	-	-	Not listed	Not listed
106	Celastraceae	<i>Lophopetalum wightianum</i> Arn.	-	T	N	VU/D	VU
107	Celastraceae	<i>Salacia korthalsiana</i> Miq.	-	C	N	CR/D	CR
108	Celastraceae	<i>Salacia viminea</i> Wall. ex Laws	-	C	N	CR/D	CR
109	Chrysobalanaceae	<i>Licania splendens</i> (Korth.) Prance	-	T	N	Not listed	CO
110	Chrysobalanaceae	<i>Parinari oblongifolia</i> Hook. f.	-	T	N	CR/D	CR
111	Commelinaceae	<i>Amischotolype gracilis</i> (Ridl.) I.M. Turner	-	H	N	Not listed	CO
112	Commelinaceae	<i>Amischotolype marginata</i> Hassk.	<i>Amischotolype mollissima</i> Hassk.	C	N	CR/D	CR



No.	Family	Scientific Name	Synonyms	Life Form <sup>2</sup>	Native (N)/ Exotic (E) <sup>2</sup>	SRDB National Status <sup>1</sup>	Status given in Chong et al (2009) <sup>2</sup>
113	Compositae	<i>Vernonia arborea</i> Buch.-Ham.	-	T	N	VU/D	VU
114	Connaraceae	<i>Agelaea borneensis</i> (Hook. f.) Merr.	-	C	N	VU/D	VU
115	Connaraceae	<i>Agelaea trinervis</i> (Llanos) Merr.	-	-	-	Not listed	Not listed
116	Connaraceae	<i>Cnestis palala</i> (Lour.) Merr.	-	C	N	Not listed	CO
117	Connaraceae	<i>Connarus monocarpus</i> L. ssp. <i>Malayensis</i> Leenh.	-	C	N	CR/D	CR
118	Connaraceae	<i>Rourea mimosoides</i> (Vahl) Planch.	-	C	N	EN/D	EN
119	Convolvulaceae	<i>Erycibe festiva</i> Prain	-	C	N	NE	EX
120	Convolvulaceae	<i>Erycibe leucoxyloides</i> King ex Prain	-	C	E		Not given
121	Convolvulaceae	<i>Erycibe maingayi</i> C.B. Clarke	-	C	N	NE	EX
122	Corioliaceae	<i>Nigropus durus</i>	-	Fungus	-	Not listed	Not listed
123	Corioliaceae	<i>Pyroformes albomarginatus</i>	-	Fungus	-	Not listed	Not listed
124	Cornaceae	<i>Alangium longiflorum</i> Merr.	-	-	-	Not listed	Not listed
125	Crypteroniaceae	<i>Crypteronia griffithii</i> C.B. Clarke	-	T	N	CR/D	CR
126	Cyperaceae	<i>Cyperus halpan</i> L.	-	H	N	Not listed	Not listed
127	Cyperaceae	<i>Eleocharis dulcis</i> (Burm. f.) Hensch.	-	H	N	Not listed	CO
128	Cyperaceae	<i>Eleocharis ochrostachys</i> Steud.	-	H	N	-	Y
129	Cyperaceae	<i>Mapania cuspidata</i> (Miq.) Uittien	-	H	N	VU/D	VU
130	Cyperaceae	<i>Rhynchospora corymbosa</i> (L.) Britt.	-	H	N	Not listed	Not given
131	Cyperaceae	<i>Rhynchospora rubra</i> (Lour.) Makino	-	H	-	Not listed	Not given
132	Cyperaceae	<i>Scleria oblata</i> S.T. Blake	-	H	-	Not listed	Not given
133	Cyperaceae	<i>Scleria rugosa</i> R. Br.	-	H	-	Not listed	Not given
134	Dicranaceae	<i>Campylopus comosus</i> (Schwaegr.) Bosch & Sande Lac.	-	L-H-M	-	Not listed	Not listed
135	Dicranaceae	<i>Campylopus</i> sp.	-	L-H-M	-	Not listed	Not listed
136	Dilleniaceae	<i>Dillenia excelsa</i> (Jack) Gilg	-	T	N	CR/D	CR
137	Dilleniaceae	<i>Dillenia suffruticosa</i> (Griff.) Martelli	-	S	N	Not listed	CO
138	Dilleniaceae	<i>Tetracera arborescens</i> Jack	-	C	N	EN/D	EN
139	Dilleniaceae	<i>Tetracera fagifolia</i> Blume	-	C	N	VU/D	VU
140	Dilleniaceae	<i>Tetracera indica</i> (Christm. & Panz.) Merr.	-	C	N	Not listed	CO
141	Dilleniaceae	<i>Tetracera</i> sp.	-	-	-	-	-
142	Dioscoreaceae	<i>Dioscorea laurifolia</i> Wall. ex Hook. f.	-	C	N	Not listed	CO
143	Dioscoreaceae	<i>Dioscorea prainiana</i> Knuth	-	C	N	CR/D	CR
144	Dioscoreaceae	<i>Dioscorea pyrifolia</i> Kunth var. <i>ferruginea</i> Prain & Burkill	-	C	N	Not listed	<i>Dioscorea pyrifolia</i> Kunth mentioned with Status CO
145	Dioscoreaceae	<i>Dioscorea tenuifolia</i> Ridl.	-	C	N	NE	EX
146	Dipterocarpaceae	<i>Anisoptera megistocarpa</i> Slooten	-	T	N	CR/D	CR
147	Dipterocarpaceae	<i>Dipterocarpus costulatus</i> Slooten	-	T	N	VU/D	VU
148	Dipterocarpaceae	<i>Dipterocarpus elongatus</i> Korth.	-	T	N	CR/D	CR
149	Dipterocarpaceae	<i>Dipterocarpus gracilis</i> Blume	-	-	-	Not listed	Not listed
150	Dipterocarpaceae	<i>Dipterocarpus grandiflorus</i> (Blanco) Blanco	-	T	N	VU/D	VU
151	Dipterocarpaceae	<i>Dipterocarpus kunstleri</i> King	-	T	N	CR/D	CR
152	Dipterocarpaceae	<i>Dipterocarpus megacarpus</i> Madani	-	-	-	Not listed	Not listed
153	Dipterocarpaceae	<i>Dipterocarpus sublamellatus</i> Foxw.	-	T	N	VU/D	VU

No.	Family	Scientific Name	Synonyms	Life Form <sup>2</sup>	Native (N)/ Exotic (E) <sup>2</sup>	SRDB National Status <sup>1</sup>	Status given in Chong <i>et al</i> (2009) <sup>2</sup>
154	Dipterocarpaceae	<i>Dipterocarpus tempehes</i> Slooten	-	T	N	CR/D	CR
155	Dipterocarpaceae	<i>Hopea ferruginea</i> Parijs	-	-	-	Not listed	Not listed
156	Dipterocarpaceae	<i>Hopea griffithii</i> Kurz	-	T	N	CR/D	CR
157	Dipterocarpaceae	<i>Shorea gibbosa</i> Brandis	-	T	N	CR/D	CR
158	Dipterocarpaceae	<i>Shorea grattissima</i> (Wall. ex Kurz) Dyer	-	T	N	CR/D	CR
159	Dipterocarpaceae	<i>Shorea johorensis</i> Foxw.	-	-	-	Not listed	Not listed
160	Dipterocarpaceae	<i>Shorea macroptera</i> Dyer	-	T	N	VU/D	VU
161	Dipterocarpaceae	<i>Shorea ochrophloia</i> Strugnell ex Symington	-	T	N	CR/D	CR
162	Dipterocarpaceae	<i>Shorea parvifolia</i> Dyer	-	T	N	EN/D	EN
163	Dipterocarpaceae	<i>Shorea pauciflora</i> King	-	T	N	VU/D	VU
164	Dipterocarpaceae	<i>Vatica maingayi</i> Dyer	-	T	N	CR/D	CR
165	Dipterocarpaceae	<i>Vatica odorata</i> (Griff.) Symington	-	T	-	Not listed	Not listed
166	Dipterocarpaceae	<i>Vatica odorata</i> (Griff.) Symington ssp. <i>odorata</i>	-	T	-	Not listed	Not listed
167	Dipterocarpaceae	<i>Vatica ridleyana</i> Brandis	-	T	N	CR/D	CR
168	Ebenaceae	<i>Diospyros buxifolia</i> (Blume) Hiern	-	T	N	VU/D	VU
169	Ebenaceae	<i>Diospyros confusa</i> Bakh.	-	T	N	CR/D	CR
170	Ebenaceae	<i>Diospyros discolor</i> Willd.	-	T	E	Not listed	Not given
171	Ebenaceae	<i>Diospyros maingayi</i> (Hiern) Bakh.	-	T	N	CR/D	CR
172	Ebenaceae	<i>Diospyros styraciformis</i> King & Gamble	-	T	N	VU/D	VU
173	Elaeocarpaceae	<i>Elaeocarpus ferrugineus</i> (Jack) Steud.	-	T	N	Not listed	CO
174	Elaeocarpaceae	<i>Elaeocarpus mastersii</i> King	-	T	N	Not listed	CO
175	Elaeocarpaceae	<i>Elaeocarpus obtusus</i> Blume ssp. <i>Apiculatus</i> (Mast.) Coode	-	-	-	Not listed	Not listed
176	Elaeocarpaceae	<i>Elaeocarpus petiolatus</i> (Jack) Wall.	-	T	N	Not listed	CO
177	Elaeocarpaceae	<i>Elaeocarpus salicifolius</i> King	-	-	-	Not listed	Not listed
178	Entolomataceae	<i>Entoloma flavidum</i>	-	-	-	Not listed	Not listed
179	Entolomataceae	<i>Entoloma</i> sp.	-	-	-	-	-
180	Entolomataceae	<i>Entoloma</i> sp.	-	-	-	-	-
181	Eriocaulaceae	<i>Eriocaulon truncatum</i> Buch.-Ham. ex Mart.	-	H	-	Not listed	Not given
182	Euphorbiaceae	<i>Agrostistachys longifolia</i> (Wight) Benth.	-	T	N	Not listed	CO
183	Euphorbiaceae	<i>Alchornea villosa</i> (Benth.) Müll. Arg.	-	S	N	CR/D	CR
184	Euphorbiaceae	<i>Blumeodendron tokbrai</i> (Blume) J.J. Sm.	-	T	N	VU/D	VU
185	Euphorbiaceae	<i>Croton caudatus</i> Geiseler	-	T	N	Not listed	CO
186	Euphorbiaceae	<i>Croton laevifolius</i> Blume	<i>Croton oblongus</i> Burm. f.	T	N	EN/D	Listed as <i>Croton oblongus</i> . Status EN
187	Euphorbiaceae	<i>Endospermum diadenum</i> (Miq.) Airy Shaw	-	T	N	VU/D	VU
188	Euphorbiaceae	<i>Koilocarpus longifolium</i> Hook. f.	-	T	N	VU/D	VU
189	Euphorbiaceae	<i>Macaranga bancana</i> (Miq.) Müll. Arg.	-	T	N	Not listed	CO
190	Euphorbiaceae	<i>Macaranga conifera</i> (Zoll.) Müll. Arg.	-	T	N	Not listed	CO
191	Euphorbiaceae	<i>Macaranga griffithiana</i> Müll. Arg.	-	T	N	Listed as <i>Macaranga motleyana</i> spp. <i>Griffithiana</i> with VU/D status	VU
192	Euphorbiaceae	<i>Macaranga hullettii</i> King ex Hook. f.	-	T	N	CR/D	CR
193	Euphorbiaceae	<i>Macaranga hypoleuca</i> (Rchb. f. & Zoll.) Müll. Arg.	-	T	N	Not listed	CO

No.	Family	Scientific Name	Synonyms	Life Form <sup>2</sup>	Native (N)/ Exotic (E) <sup>2</sup>	SRDB National Status <sup>1</sup>	Status given in Chong et al (2009) <sup>2</sup>
194	Euphorbiaceae	<i>Macaranga lowii</i> King ex Hook. f.	-	T	N	VU/D	VU
195	Euphorbiaceae	<i>Macaranga trichocarpa</i> (Rchb. f. & Zoll.) Müll. Arg.	-	S	N	EN/D	EN
196	Euphorbiaceae	<i>Pimelodendron griffithianum</i> (Müll. Arg.) Benth.	-	T	N	VU/D	VU
197	Euphorbiaceae	<i>Triadica cochinchinensis</i> Lour.	-	T	N	Not listed	CO
198	Euphorbiaceae	<i>Trigonostemon longifolius</i> Baill.	<i>Trigonostemon heteranthus</i> Baill.	S	N	CR/D	Listed as <i>Trigonostemon heteranthus</i> Baill. Status CR
199	Fagaceae	<i>Castanopsis lucida</i> (Nees) Soepadmo	-	T	N	CR/D	CR
200	Fagaceae	<i>Castanopsis malaccensis</i> Gamble	-	T	N	CR/D	CR
201	Fagaceae	<i>Castanopsis schefferiana</i> Hance	-	T	N	CR/D	CR
202	Fagaceae	<i>Castanopsis</i> sp.	-	-	-	-	-
203	Fagaceae	<i>Castanopsis wallichii</i>	-	T	N	CR/D	CR
204	Fagaceae	<i>Lithocarpus encleisacarpus</i> (Korth.) A. Camus	-	T	N	CR/D	CR
205	Fagaceae	<i>Lithocarpus ewyckii</i> (Korth.) Rehder	-	T	N	EN/D	EN
206	Fagaceae	<i>Lithocarpus hystrix</i> (Korth.) Rehder	-	T	N	CR/D	CR
207	Fagaceae	<i>Lithocarpus wallichianus</i> (Lindl. ex Hance) Rehder	-	T	N	CR/D	CR
208	Fissidentaceae	<i>Fissidens crassinervis</i> Sande Lac.	-	L-H-M	-	Not listed	Not listed
209	Fissidentaceae	<i>Fissidens pellucidus</i> Hornsch.	-	L-H-M	-	Not listed	Not listed
210	Ganodermataceae	<i>Amauroderma rugosum</i> (Blume & T. Nees) Torrend	-	Fungus	-	Not listed	Not listed
211	Ganodermataceae	<i>Amauroderma</i> sp.	-	Fungus	-	-	-
212	Ganodermataceae	<i>Ganoderma australe</i> (Fr.) Pat.	-	Fungus	-	Not listed	Not listed
213	Gentianaceae	<i>Cyrtophyllum fragrans</i> (Roxb.) DC.	<i>Fagraea ridleyi</i> Gandoger	C	N	NE	Listed as <i>Fagraea ridleyi</i> Gandoger. Status EX
214	Gnetaceae	<i>Gnetum microcarpum</i> Blume	-	C	N	EN/D	CR
215	Gramineae	<i>Axonopus affinis</i> A. Chase	<i>Axonopus fissifolius</i> (Raddi) Kulm	H	E	Not listed	Listed as <i>Axonopus fissifolius</i> (Raddi) Kulm. Status not given.
216	Gramineae	<i>Cynodon dactylon</i> (L.) Pers.	-	H	N	Not listed	CO
217	Gramineae	<i>Digitaria ciliaris</i> (Retz.) Koeler	-	H	-	Not listed	-
218	Gramineae	<i>Digitaria mollicoma</i> (Kunth) Henrard	-	H	N	Not listed	CO
219	Gramineae	<i>Eragrostis unioides</i> (Retz.) Nees ex Steud.	-	H	N	Not listed	CO
220	Gramineae	<i>Ischaemum magnum</i> Rendle	-	-	-	Not listed	-
221	Gramineae	<i>Isachne kunthiana</i> (Wight & Arn. ex Steud.) Miq.	-	H	N	Not listed	CO
222	Gramineae	<i>Ischaemum timorense</i> Kunth	-			Not listed	-
223	Gramineae	<i>Leptaspis urceolata</i> (Roxb.) R. Br.	<i>Scrotochloa urceolata</i> (Roxb.) Judz.	H	N	Not listed	Listed as <i>Scrotochloa urceolata</i> (Roxb.) Judz. Status VU.
224	Gramineae	<i>Lophatherum gracile</i> Brongn	-	H	N	Not listed	CO
225	Gramineae	<i>Ottochloa nodosa</i> (Kunth) Dandy	-	H	N	Not listed	CO
226	Gramineae	<i>Pogonatherum crinitum</i> (Thunb.) Kunth	-	H	N	Not listed	CO
227	Gramineae	<i>Sacciolepis indica</i> (L.) Chase	-	H	-	Not listed	-
228	Gramineae	<i>Scrotochloa urceolata</i> (Roxb.) Judz.	-	H	N	VU/D	Y

No.	Family	Scientific Name	Synonyms	Life Form <sup>2</sup>	Native (N)/ Exotic (E) <sup>2</sup>	SRDB National Status <sup>1</sup>	Status given in Chong <i>et al</i> (2009) <sup>2</sup>
229	Guttiferae	<i>Calophyllum austrocoriaceum</i> Whitmore	<i>Calophyllum lanigerum</i> Miq. var. <i>austrocoriaceum</i> (T. C. Whitmore) P. F. Stevens	T	N	Not listed	Listed as <i>Calophyllum lanigerum</i> Miq. var. <i>austrocoriaceum</i> (T. C. Whitmore) P. F. Stevens. Status EN
230	Guttiferae	<i>Calophyllum lanigerum</i> Miq. var. <i>austrocoriaceum</i> (Whitmore) P.F. Stevens	-	T	N	EN/D	EN
231	Guttiferae	<i>Calophyllum pulcherrimum</i> Wall. ex Choisy	-	T	N	Not listed	CO
232	Guttiferae	<i>Calophyllum rubiginosum</i> M. R. Hend. & Wyatt-Sm.	-	T	N	EN/D	EN
233	Guttiferae	<i>Calophyllum teysmannii</i> Miq.	-	T	N	VU/D	VU
234	Guttiferae	<i>Garcinia griffithii</i> T. Anderson	-	T	N	EN/D	EN
235	Guttiferae	<i>Garcinia nervosa</i> Miq.	-	T	N	CR/D	CR
236	Guttiferae	<i>Garcinia parviflora</i> Benth.	-	T	-	Not listed	-
237	Guttiferae	<i>Garcinia parviflora</i> (Miq.) Miq.	-	T	-	Not listed	-
238	Hanguanaceae	<i>Hanguana rubinea</i>	-	H	N	Not listed but Nparks state 'Critically Endangered at national and global levels (due to endemic status). Location within MacRitchie Area confirmed	Only lists <i>Hanguana malayana</i> (Jack) Merr. as VU
239	Hanguanaceae	<i>Hanguana triangulata</i>	-	H	N	Not listed but Nparks state 'Critically Endangered at national and global levels (due to endemic status). Location within MacRitchie Area not confirmed	-
240	Hanguanaceae	<i>Hanguana neglecta</i>	-	H	N	Not listed but Nparks state 'not endemic but rare and native to Singapore'	-
241	Hanguanaceae	<i>Hanguana nitens</i>	-	H	N	Not listed but Nparks state 'not endemic but rare and native to Singapore'	-
242	Hymenochaetaceae	<i>Coltricia</i> sp.	-	-	-	-	-
243	Hymenochaetaceae	<i>Hymenochaete</i> sp.	-	-	-	-	-
244	Hypericaceae	<i>Cratoxylum maingayi</i> Dyer	-	T	N	Not listed	CR
245	Hyphodermataceae	<i>Schizopora</i> sp.	-	-	-	-	-
246	Hypnaceae	<i>Isopterygium albescens</i> (Hook.) A. Jaeger	-	-	-	Not listed	-
247	Irvingiaceae	<i>Irvingia malayana</i> Oliv. ex Benn.	-	T	N	CR/D	CR
248	Ixonanthaceae	<i>Ixonanthes icosandra</i> Jack	-	T	N	VU/D	VU
249	Ixonanthaceae	<i>Ixonanthes reticulata</i> Jack	-	T	N	Not listed	CO
250	Labiatae	<i>Callicarpa longifolia</i> Lam.	-	S	N	EN/D	EN
251	Labiatae	<i>Clerodendrum disparifolium</i> Blume	-	-	-	Not listed	Not listed
252	Labiatae	<i>Clerodendrum laevifolium</i> Blume	-	T	N	Not listed	CO
253	Labiatae	<i>Clerodendrum penduliflorum</i> Wall.	-	-	-	Not listed	Not listed
254	Labiatae	<i>Clerodendrum villosum</i> Blume	-	S	N	VU/D	VU
255	Labiatae	<i>Vitex vestita</i> Wall. ex Schauer	-	T	N	CR/D	CR
256	Labiatae	<i>Volkameria inermis</i> L.	<i>Clerodendrum inerme</i> (L.) Gaertn.	C	N	Not listed	CO
257	Lauraceae	<i>Actinodaphne pruinosa</i> Nees	-	T	N	EN/D	EN
258	Lauraceae	<i>Alseodaphne intermedia</i> Kosterm.	-	T	N	CR/D	CR
259	Lauraceae	<i>Alseodaphne oblancoolata</i> (Merr.) Kosterm.	-	-	-	Not listed	Not listed
260	Lauraceae	<i>Beilschmiedia madang</i> Blume	-	T	N	EN/D	EN

No.	Family	Scientific Name	Synonyms	Life Form <sup>2</sup>	Native (N)/ Exotic (E) <sup>2</sup>	SRDB National Status <sup>1</sup>	Status given in Chong et al (2009) <sup>2</sup>
261	Lauraceae	<i>Cryptocarya griffithiana</i> Wight	-	T	N	CR/D	CR
262	Lauraceae	<i>Lindera lucida</i> (Blume) Boerl.	-	T	N	VU/D	VU
263	Lauraceae	<i>Litsea accedens</i> (Blume) Boerl.	-	T	N	EN/D	EN
264	Lauraceae	<i>Litsea accedens</i> (Blume) Boerl. var. <i>accedens</i>	-	T	N	EN/D	EN
265	Lauraceae	<i>Litsea castanea</i> Hook. f.	-	T	N	EN/D	EN
266	Lauraceae	<i>Litsea costalis</i> (Nees) Kosterm.	-	T	N	EN/D	CR
267	Lauraceae	<i>Litsea elliptica</i> Blume	-	T	N	VU/D	CO
268	Lauraceae	<i>Litsea firma</i> (Blume) Hook. f.	-	T	N	VU/D	VU
269	Lauraceae	<i>Litsea grandis</i> (Wall. ex Nees) Hook. f.	-	T	N	EN/D	EN
270	Lauraceae	<i>Litsea lanceolata</i> (Blume) Kosterm.	-	S	N	NE	EX
271	Lauraceae	<i>Nothaphoebe</i> sp.	-	-	-	-	-
272	Leguminosae-cae	<i>Bauhinia semibifida</i> Roxb.	-	C	N	VU/D	VU
273	Leguminosae-cae	<i>Dialium indum</i> L.	-	T	N	CR/D	CR
274	Leguminosae-cae	<i>Dialium platysepalum</i> Baker	-	T	N	CR/D	CR
275	Leguminosae-cae	<i>Koompassia excelsa</i> (Becc.) Taub.	-	T	E	Not listed	Not given
276	Leguminosae-cae	<i>Koompassia malaccensis</i> Maing. ex Benth.	-	T	N	EN/D	EN
277	Leguminosae-cae	<i>Saraca cauliflora</i> Baker	<i>Saraca declinata</i> (Jack) Miq	T	E	Not listed	Listed as <i>Saraca declinata</i> (Jack) Miq. Status 'Cultivated only'
278	Leguminosae-mim	<i>Adenanthera pavonina</i> L.	-	T	E	Not listed	Not given
279	Leguminosae-mim	<i>Albizia falcata</i> (L.) Fosberg	<i>Falcata</i> <i>moluccana</i>	T	E	Not listed	Listed as <i>Falcata</i> <i>moluccana</i> . Status not given
280	Leguminosae-mim	<i>Archidendron microcarpum</i> (Benth.) Nielsen	-	T	E	EN/D	EN
281	Leguminosae-mim	<i>Entada spiralis</i> Ridl.	-	C	N	Not listed	CO
282	Leguminosae-mim	<i>Parkia speciosa</i> Hassk.	-	T	N	VU/D	VU
283	Leguminosae-mim	<i>Pithecellobium jiringa</i> (Jack) Prain	<i>Archidendron jiringa</i> (Jack) I.C. Nielsen	T	N	VU/D	Listed as <i>Archidendron jiringa</i> (Jack) I.C. Nielsen. Status VU
284	Leguminosae-pap	<i>Andira inermis</i>	-	T	E	Not listed	-
285	Leguminosae-pap	<i>Callerya eriantha</i> (Benth.) Schot	-	C	N	CR/D	CR
286	Leguminosae-pap	<i>Dalbergia pseudosissoo</i> Miq.	<i>Dalbergia rostrata</i> Hassk.;	C	N	Not listed	CO
287	Leguminosae-pap	<i>Derris maingayana</i> Baker	<i>Derris amoena</i> var. <i>maingayana</i> Prain	C	N	VU/D	Listed as <i>Derris amoena</i> var. <i>maingayana</i> Prain. Status VU
288	Leguminosae-pap	<i>Kunstleria ridleyi</i> Prain	-	C	N	EN/D	EN
289	Leguminosae-pap	<i>Ormosia bancana</i> (Miq.) Merr.	-	T	N	EN/D	EN
290	Leguminosae-pap	<i>Spatholobus ferrugineus</i> (Zoll. & Moritz) Benth.	-	C	N	Not listed	CO
291	Leguminosae-pap	<i>Spatholobus ridleyi</i> Prain ex King	-	C	N	CR/D	CR
292	Lejeuneaceae	<i>Lejeunea</i> sp.	-	L-H-M	-	-	-
293	Lentibulariaceae	<i>Utricularia aurea</i> Lour.	-	H	N	Not listed	Not given
294	Lentibulariaceae	<i>Utricularia bifida</i> L.	-	H	N	Not listed	Not given
295	Lentibulariaceae	<i>Utricularia caerulea</i> L.	-	H	N	Not listed	Not given
296	Lepidoziaceae	<i>Acromastigum inaequilaterum</i> (Lem. & Lindenb.) A. Evans	-	L-H-M		Not listed	N - synonyms not found in book
297	Lepidoziaceae	<i>Acromastigum</i> sp.	-	L-H-M		Not listed	-



No.	Family	Scientific Name	Synonyms	Life Form <sup>2</sup>	Native (N)/ Exotic (E) <sup>2</sup>	SRDB National Status <sup>1</sup>	Status given in Chong <i>et al</i> (2009) <sup>2</sup>
298	Lepidoziaceae	<i>Bazzania</i> sp.	-	L-H-M		Not listed	-
299	Linaceae	<i>Indorouchera griffithiana</i> (Planch.) Hallier f.	-	C	N	Not listed	CO
300	Loganiaceae	<i>Strychnos ignatii</i> Bergius	-	C	N	VU/D	VU
301	Loganiaceae	<i>Strychnos maingayi</i> C.B. Clarke	-	C	N	CR/D	CR
302	Lycopodiaceae	<i>Huperzia carinata</i> (Desv. ex Poir.) Trevis.	-	L-H-M	N	NE	EX
303	Lygodaceae	<i>Lygodium microphyllum</i> (Cav.) R. Br.	-	C	N	Not listed	CO
304	Maesaceae	<i>Maesa ramentacea</i> Wall. ex Roxb.	-	S	N	Not listed	CO
305	Magnoliaceae	<i>Magnolia candolii</i> (Blume) H. Keng	<i>Magnolia singaporensis</i> (Ridl.) H. Keng and <i>M. liliifera</i> (L.) Baill. var. <i>singaporensis</i> (Ridl.) Govaerts	T	N	Listed as <i>Magnolia candolii</i> var. <i>singaporensis</i> . Status EN/D	Listed as <i>Magnolia singaporensis</i> (Ridl.) H. Keng = <i>M. liliifera</i> (L.) Baill. var. <i>singaporensis</i> (Ridl.) Govaerts. Status EN
306	Magnoliaceae	<i>Magnolia villosa</i> (Miq.) H. Keng	-	T	N	CR/D	CR
307	Malvaceae-bro	<i>Pentace triptera</i> Mast.	-	T	N	Not listed	EN
308	Malvaceae-byt	<i>Byttneria maingayi</i> Mast.	-	C	N	CR/D	CR
309	Malvaceae-gre	<i>Grewia laevigata</i> Vahl	-	C	N	VU/D	VU
310	Malvaceae-gre	<i>Microcos hirsuta</i> (Korth.) Burret	-	T	N	CR/D	Listed as <i>Microcos hirsutus</i> (Korth.) Burret. Status CR
311	Malvaceae-hel	<i>Durio griffithii</i> (Mast.) Bakh.	-	T	N	EN/D	EN
312	Malvaceae-hel	<i>Durio singaporensis</i> Ridl.	-	T	N	VU/D	VU
313	Malvaceae-ste	<i>Scaphium affine</i> (Mast.) Pierre	-	-	-	Not listed	Not listed
314	Malvaceae-ste	<i>Scaphium linearicarpum</i> (Mast.) Pierre	-	T	N	CR/D	CR
315	Malvaceae-ste	<i>Scaphium macropodum</i> (Miq.) Beumée ex Heyne	-	T	N	EN/D	EN
316	Malvaceae-ste	<i>Sterculia macrophylla</i> Vent.	-	T	N	CR/D	CR
317	Malvaceae-ste	<i>Sterculia rubiginosa</i> Vent.	-	T	N	VU/D	VU
318	Malvaceae-ste	<i>Sterculia</i> sp.	-	-	-	-	-
319	Marantaceae	<i>Phrynium hirtum</i> Ridl.	-	-	-	Not listed	Not listed
320	Marantaceae	<i>Stachyphrynium sumatranum</i> K. Schum.	-	-	-	Not listed	Not listed
321	Marasmiaceae	<i>Marasmiellus</i> sp.	-	Fungus		Not listed	-
322	Marasmiaceae	<i>Marasmius</i> sp.	-	Fungus		Not listed	-
323	Melastomataceae	<i>Dissochaeta divaricata</i> (Willd.) G. Don	<i>Diplectria divaricata</i> (Willd.) Kuntze	C	N	CR/D	Listed as <i>Diplectria divaricata</i> (Willd.) Kuntze. Status CR
324	Melastomataceae	<i>Dissochaeta monticola</i> Blume	<i>Dissochaeta intermedia</i> Herb. Batav. ex Triana	C	N	NE	Listed as <i>Dissochaeta intermedia</i> Herb. Batav. ex Triana. Status EX
325	Melastomataceae	<i>Dissochaeta viminalis</i> (Jack) Clausen	<i>Diplectria viminalis</i> (Jack) Kuntze	C	N	CR/D	Listed as <i>Diplectria viminalis</i> (Jack) Kuntze. Status CR
326	Melastomataceae	<i>Melastoma malabathricum</i> L.	-	S	N	Not listed	CO
327	Melastomataceae	<i>Pternandra coerulescens</i> Jack	-	T	N	VU/D	VU
328	Melastomataceae	<i>Pternandra echinata</i> Jack	-	T	N	VU/D	VU
329	Melastomataceae	<i>Pternandra tuberculata</i> (Korth.) M.P. Nayar	-	T	N	CR/D	CR
330	Meliaceae	<i>Aglaia glabriflora</i> Hiern	<i>Aglaia leptantha</i> Miq	T	N	CR/D	Listed as <i>Aglaia leptantha</i> Miq. Status CR
331	Meliaceae	<i>Aglaia multinervis</i> Pannell	-	T	N	NE	EX
332	Meliaceae	<i>Aglaia rufinervis</i> (Blume) Benth.	-	T	N	CR/D	CR
333	Meliaceae	<i>Chisocheton patens</i> Blume	-	T	N	CR/D	CR
334	Meliaceae	<i>Dysoxylum cauliflorum</i> Hiern	-	T	N	VU/D	VU

No.	Family	Scientific Name	Synonyms	Life Form <sup>2</sup>	Native (N)/ Exotic (E) <sup>2</sup>	SRDB National Status <sup>1</sup>	Status given in Chong et al (2009) <sup>2</sup>
335	Meliaceae	<i>Dysoxylum flavescens</i> Hiern	-	T	N	CR/D	CR
336	Memecylaceae	<i>Memecylon amplexicaule</i> Roxb.	-	T	N	CR/D	CR
337	Memecylaceae	<i>Memecylon lilacinum</i> Zoll. & Moritz	-	T	N	CR/D	CR
338	Memecylaceae	<i>Memecylon paniculatum</i> Jack	-	T	N	CR/D	CR
339	Menispermaceae	<i>Fibraurea tinctoria</i> Lour.	-	C	N	Not listed	CO
340	Menispermaceae	<i>Limacia scandens</i> Lour.	-	C	N	VU/D	VU
341	Menyanthaceae	<i>Nymphoides indica</i> (L.) Kuntze	-	H	N	EN/D	EN
342	Meripilaceae	<i>Rigidoporus lineatus</i>	-	Fungus	-	Not listed	
343	Meruliaceae	<i>Gloeoporus sulphureus</i>		Fungus	-	Not listed	-
344	Monimiaceae	<i>Matthaea sancta</i> Blume	-	S	N	EN/D	EN
345	Moraceae	<i>Artocarpus anisophyllus</i> Miq.	-	T	N	EN/D	EN
346	Moraceae	<i>Artocarpus dadah</i> Miq.	-	T	N	EN/D	EN
347	Moraceae	<i>Artocarpus elasticus</i> Reinw. ex Blume	<i>A. scortechinii</i> King	T	N	Not listed	Listed as <i>A. scortechinii</i> King. Status CO
348	Moraceae	<i>Artocarpus fulvicortex</i> F.M. Jarrett	-	T	N	CR/D	CR
349	Moraceae	<i>Artocarpus hispidus</i> F.M. Jarrett	-	T	N	Not listed	CR
350	Moraceae	<i>Artocarpus lanceifolius</i> Roxb.	-	T	N	CR/D	CR
351	Moraceae	<i>Artocarpus rigidus</i> Blume	-	T	N	VU/D	VU
352	Moraceae	<i>Artocarpus scortechinii</i> King	<i>Artocarpus elasticus</i> Reinw. ex Blume	T	N	EN/D	Listed as <i>Artocarpus elasticus</i> Reinw. ex Blume. Status CO
353	Moraceae	<i>Ficus aurantiacea</i> Griff.	-			Not listed	N - synonyms not found in book
354	Moraceae	<i>Ficus aurata</i> (Miq.) Miq.	-	T	N	Not listed	VU
355	Moraceae	<i>Ficus bracteata</i> Wall. ex Miq.	-	T (Strangler)	N	CR/D	CR
356	Moraceae	<i>Ficus chartacea</i> (Wall. ex Kurz) King	-	S	N	VU/D	VU
357	Moraceae	<i>Ficus delosyce</i> Corner	-	T (Strangler)	N	NE	EX
358	Moraceae	<i>Ficus fistulosa</i> Reinw. ex Blume	-	T	N	Not listed	CO
359	Moraceae	<i>Ficus globosa</i> Blume	-	S	N	EN/D	EN
360	Moraceae	<i>Ficus grossularioides</i> Burm. f.	-	T	N	Not listed	CO
361	Moraceae	<i>Ficus microcarpa</i> L.f.	-	T (Strangler)	N	Not listed	CO
362	Moraceae	<i>Ficus retusa</i> L.	-	T	N	CR/D	CR
363	Moraceae	<i>Ficus sagittata</i> Koenig ex Vahl	-	C	N	CR/D	CR
364	Moraceae	<i>Ficus subgelderii</i> Corner	-	T (Strangler)	N	*2 varieties available var. <i>subgelderii</i> CR/D var. <i>rigida</i> NE	var. <i>subgelderii</i> EX var. <i>rigida</i> CR
365	Moraceae	<i>Parartocarpus bracteatus</i> (King ex Hook.) Becc.	-	T	N	CR/D	CR
366	Moraceae	<i>Streblus elongatus</i> (Miq.) Corner	-	T	N	VU/D	VU
367	Mycenaceae	<i>Dictyopanus pusillus</i> (Pers. ex Lév.) Singer	-	Fungus	-	Not listed	Not listed
368	Myristicaceae	<i>Gymnacranthera farquhariana</i> (Hook. f. & Thomson) Warb. var. <i>farquhariana</i>	-	T	N	CR/D	CR
369	Myristicaceae	<i>Gymnacranthera forbesii</i> (King) Warb. var. <i>forbesii</i>	-	T	N	CR/D	CR
370	Myristicaceae	<i>Horsfieldia polyspherula</i> (Hk.f. em. King) JS var. <i>polyspherula</i>	-	T	N	VU/D	VU
371	Myristicaceae	<i>Knema communis</i> J. Sinclair	-	T	N	Not listed	EN
372	Myristicaceae	<i>Knema hookeriana</i> (Wall. ex Hook. f. & Thomson) Warb.	-	T	N	CR/D	CR
373	Myristicaceae	<i>Knema latericia</i> Elmer	<i>Knema latericia</i> subsp. <i>ridleyi</i> (Gandoger) W.J.J.O. de Wilde	T	N	EN/D	Listed as <i>Knema latericia</i> subsp. <i>ridleyi</i> (Gandoger) W.J.J.O. de Wilde. Status EN
374	Myristicaceae	<i>Knema latericia</i> Elmer ssp. <i>latericia</i>	<i>Knema latericia</i> subsp. <i>ridleyi</i> (Gandoger) W.J.J.O. de Wilde	T	N	EN/D	Listed as <i>Knema latericia</i> subsp. <i>ridleyi</i> (Gandoger) W.J.J.O. de Wilde. Status EN

No.	Family	Scientific Name	Synonyms	Life Form <sup>2</sup>	Native (N)/ Exotic (E) <sup>2</sup>	SRDB National Status <sup>1</sup>	Status given in Chong et al (2009) <sup>2</sup>
375	Myristicaceae	<i>Knema latericia</i> Elmer ssp. <i>Ridleyi</i> (Gand.) W.J. de Wilde	-	T	N	EN/D	EN
376	Myristicaceae	<i>Myristica crassa</i> King	-	T	N	CR/D	CR
377	Myrsinaceae	<i>Ardisia colorata</i> Roxb.	-	S	N	Not listed	CO
378	Myrsinaceae	<i>Ardisia teysmanniana</i> Scheff.	-	S	N	EN/D	EN
379	Myrsinaceae	<i>Embelia canescens</i> Jack	-	C	N	EN/D	EN
380	Myrsinaceae	<i>Embelia lampani</i> Scheff.	-	C	N	Not listed	CO
381	Myrsinaceae	<i>Labisia pumila</i> (Blume) Fern.-Vill.	-	H	N	VU/D	VU
382	Myrtaceae	<i>Eugenia chlorantha</i> Duthie	<i>Syzygium chloranthum</i> (Duthie) Merr. & L.M.Perry.	T	N	Listed as <i>Syzygium chloranthum</i> . Status CR/D	Listed as <i>Syzygium chloranthum</i> (Duthie) Merr. & L.M.Perry. Status CR
383	Myrtaceae	<i>Eugenia duthieana</i> King	<i>Syzygium duthieanum</i> (King) Masam.	T	N	Listed as <i>Syzygium duthieanum</i> . Status CR/D	Listed as <i>Syzygium duthieanum</i> (King) Masam. Status CR
384	Myrtaceae	<i>Eugenia oblongifolia</i> Duthie	<i>Syzygium maingayi</i> Chantaran. & J.Pam..	T	N	Listed as <i>Syzygium maingayi</i> . Status CR/D	Listed as <i>Syzygium maingayi</i> Chantaran. & J.Pam.. Status CR
385	Myrtaceae	<i>Eugenia pustulata</i> Duthie	<i>Syzygium pustulatum</i> (Duthie) Merr.	T	N	Listed as <i>Syzygium pustulatum</i> . Status CR/D	Listed as <i>Syzygium pustulatum</i> (Duthie) Merr. Status CR
386	Myrtaceae	<i>Eugenia ridleyi</i> King	<i>Syzygium ridleyi</i> (King) Chantaran. & J.Pam	T	N	Listed as <i>Syzygium ridleyi</i> . Status EN/D	EN
387	Myrtaceae	<i>Syzygium borneense</i> (Miq.) Miq.	-	T	N	Not listed	CO
388	Myrtaceae	<i>Syzygium claviflorum</i> (Roxb.) Wall. ex A.M. Cowan & Cowan	-	T	N	CR/D	CR
389	Myrtaceae	<i>Syzygium cumingianum</i> Gibbs	<i>Syzygium acuminatissimum</i> (Blume) DC.			EN/D	Y
390	Myrtaceae	<i>Syzygium duthieanum</i> (King) Masam.	<i>Eugenia duthieana</i> King	T	N	CR/D	CR
391	Myrtaceae	<i>Syzygium filiforme</i> (Wall. ex Duthie) P. Chantaranonthai	<i>Eugenia filiformis</i> Wall. ex Duthie	T	N	Not listed	Listed as <i>Syzygium filiforme</i> Wall. Ex Duthie Chantaran. & J. Pam. var <i>filiforme</i> . Status EN; and = <i>S. filiforme</i> Wall. Ex Duthie P. Chantaranonthai & J. Pam var. <i>clavimirtus</i> Koord. & Valetton I.M. Turner
392	Myrtaceae	<i>Syzygium grande</i> (Wight) Walp.	-	T	N	Not listed	CO
393	Myrtaceae	<i>Syzygium lineatum</i> (DC.) Merr. & L.M. Perry	-	T	N	Not listed	CO
394	Myrtaceae	<i>Syzygium nemestrinum</i> (M. R. Hend.) I.M. Turner	-	T	N	EN/D	EN
395	Myrtaceae	<i>Syzygium pseudoformosum</i> (King) Merr. & L.M. Perry	-	T	N	CR/D	CR
396	Myrtaceae	<i>Syzygium pustulatum</i> (Duthie) Merr.	-	T	N	CR/D	CR
397	Myrtaceae	<i>Syzygium zeylanicum</i> (L.) DC.	-	S	N	Not listed	CO
398	Nepenthaceae	<i>Nepenthes ampullaria</i> Jack	-	C	N	VU/D	VU
399	Nepenthaceae	<i>Nepenthes gracilis</i> Korth.	-	C	N	Not listed	CO
400	Nyssaceae	<i>Mastixia trichotoma</i> Blume	<i>Mastixia trichotoma</i> var. <i>maingayi</i> (C.B.Clarke) Danser	T	N	CR/D	Listed as <i>Mastixia trichotoma</i> var. <i>maingayi</i> (C.B.Clarke) Danser. Status CR
401	Olacaceae	<i>Erythralium scandens</i> Blume	-	C	N	VU/D	VU
402	Olacaceae	<i>Ochanostachys amentacea</i> Mast.	-	T	N	VU/D	VU
403	Olacaceae	<i>Scorodocarpus borneensis</i> (Baill.) Becc.	-	T	N	EN/D	EN
404	Olacaceae	<i>Strombosia ceylanica</i> Gardn.	-	T	N	Not listed	VU
405	Olacaceae	<i>Strombosia javanica</i> Blume	-	T	N	Not listed	VU
406	Oleaceae	<i>Olea brachiata</i> (Lour.) Merr.	-	T	N	VU/D	VU
407	Opiliaceae	<i>Champerea manillana</i> (Blume) Merr.	-	T	N	Not listed	CO
408	Opiliaceae	<i>Lepionurus sylvestris</i> Blume	-	S	N	CR/D	CR
409	Orchidaceae	<i>Anoectochilus geniculatus</i> Ridl.	-	H	N	NE	EX
410	Orchidaceae	<i>Bulbophyllum sessile</i> (J. König) J.J. Sm.	<i>Bulbophyllum clandestinum</i> Lindl	Epiphyte	N	CR/D	Listed as <i>Bulbophyllum clandestinum</i> Lindl. Status CR
411	Orchidaceae	<i>Eulophia spectabilis</i> (Dennst.) Suresh	-	H	N	CR/D	CR
412	Orchidaceae	<i>Gastrodia javanica</i> (Blume) Lindl.	-	H	N	CR/D	CR
413	Orchidaceae	<i>Liparis ferruginea</i> Lindl.	-	Epiphyte	N	CR/D	CR

No.	Family	Scientific Name	Synonyms	Life Form <sup>2</sup>	Native (N)/ Exotic (E) <sup>2</sup>	SRDB National Status <sup>1</sup>	Status given in Chong et al (2009) <sup>2</sup>
414	Orchidaceae	<i>Vanilla griffithii</i> Rchb. f.	-	C	N	VU/D	VU
415	Pallaviciniaceae	<i>Pallavicinia</i> sp.	-	-	-	-	-
416	Palmae	<i>Calamus diepenhorstii</i> Miq.	-	C	N	EN/D	EN
417	Palmae	<i>Licuala ferruginea</i> (Kurz) Craib	-	S	N	EN/D	EN
418	Palmae	<i>Nenga pumila</i> (Kurz) Craib	-	T	N	Not listed	Listed as var. <i>pachystachya</i> (Blume) Fernando. Status CR
419	Palmae	<i>Pholidocarpus kingianus</i> (Kurz) Craib	-	T	N	NE	EX
420	Palmae	<i>Pinanga limosa</i> (Kurz) Craib	-	S	N	NE	EX
421	Pandaceae	<i>Galearia caseariifolia</i>	-	-	-	Not listed	Not listed
422	Pandaceae	<i>Galearia fulva</i> (Tul.) Miq.	-	T	N	VU/D	VU
423	Pandaceae	<i>Galearia maingayi</i> Hook. f.	-	T	N	CR/D	CR
424	Pandanaceae	<i>Freycinetia sumatrana</i> Hemsl.	-	C	N	Not listed	CO
425	Passifloraceae	<i>Adenia macrophylla</i> (Blume) Koord. var. <i>singaporeana</i> (Wall. ex G. Don) W.J. de Wilde	-	C	N	VU/D	VU
426	Pentaphylacaceae	<i>Adinandra dumosa</i> Jack	-	T	N	Not listed	CO
427	Pentaphylacaceae	<i>Eurya acuminata</i> DC.	-	S	N	Not listed	CO
428	Pentaphylacaceae	<i>Temstroemia bancana</i> Miq.	-	T	N	NE	EX
429	Pentaphylacaceae	<i>Temstroemia coriacea</i> Wall.	<i>Adinandra acuminata</i> Korth. (accepted name)	T	N	CR/D	Listed as <i>Adinandra acuminata</i> Korth. (accepted name) Status CR
430	Phanerochaetaceae	<i>Climacodon dubitativus</i> (Lloyd) Ryvarden	-	-	-	Not listed	N - synonyms not found in book
431	Phyllanthaceae	<i>Actephila excelsa</i> (Dalzell) Müll. Arg.	-	S	N	Not listed	Listed as var. <i>javanica</i> (Miq.) P. & H. Status VU
432	Phyllanthaceae	<i>Antidesma coriaceum</i> Tul.	-	T	N	VU/D	VU
433	Phyllanthaceae	<i>Antidesma cuspidatum</i> Müll. Arg.	-	T	N	Not listed	CO
434	Phyllanthaceae	<i>Antidesma neurocarpum</i> Miq.	-	T	N	EN/D	EN
435	Phyllanthaceae	<i>Aporosa maingayi</i> Hook. f.	-	-	-	Not listed	
436	Phyllanthaceae	<i>Aporosa benthamiana</i> Hook. f.	-	T	N	VU/D	VU
437	Phyllanthaceae	<i>Aporosa bracteosa</i> Pax & K.Hoffm.	<i>Aporosa subcaudata</i> King ex Gage	T	N	EN/D	Listed as <i>Aporosa subcaudata</i> King ex Gage. Status EN
438	Phyllanthaceae	<i>Aporosa chondroneura</i> (Airy Shaw) Schot	-	-	-	Not listed	Not listed
439	Phyllanthaceae	<i>Aporosa falcifera</i> Hook. f.	-	T	N	CR/D	CR
440	Phyllanthaceae	<i>Aporosa frutescens</i> Blume	-	T	N	Not listed	CO
441	Phyllanthaceae	<i>Aporosa microstachya</i> (Tul.) Müll. Arg.	-	T	N	EN/D	EN
442	Phyllanthaceae	<i>Aporosa miqueliana</i> Müll. Arg.	<i>Aporosa lucida</i> (Miq.) Airy Shaw var. <i>lucida</i>	T	N	CR/D	Listed as <i>Aporosa lucida</i> (Miq.) Airy Shaw var. <i>lucida</i> . Status CR
443	Phyllanthaceae	<i>Aporosa nervosa</i> Hook. f.	-	T	N	VU/D	VU
444	Phyllanthaceae	<i>Aporosa nigricans</i> Hook. f.	-	T	N	EN/D	EN
445	Phyllanthaceae	<i>Aporosa prainiana</i> King ex Gage	-	T	N	VU/D	VU
446	Phyllanthaceae	<i>Aporosa symplocoides</i> (Hook. f.) Gage	-	T	N	Not listed	CO
447	Phyllanthaceae	<i>Baccaurea bracteata</i> Müll. Arg.	-	T	N	CR/D	CR
448	Phyllanthaceae	<i>Baccaurea griffithii</i> Hook. f.	<i>Baccaurea macrocarpa</i> (Miq.) Müll.Arg.	T	N	NE	Listed as <i>Baccaurea macrocarpa</i> (Miq.) Müll.Arg. Status CR
449	Phyllanthaceae	<i>Baccaurea macrophylla</i> (Müll. Arg.) Müll. Arg.	-	T	N	CR/D	EX
450	Phyllanthaceae	<i>Baccaurea minor</i> Hook. f.	-	T	N	CR/D	CR
451	Phyllanthaceae	<i>Baccaurea parviflora</i> (Müll. Arg.) Müll. Arg.	-	T	N	Not listed	CO
452	Phyllanthaceae	<i>Baccaurea polyneura</i> Hook. f.	<i>Baccaurea hookeri</i> Gage; <i>B. kunstleri</i> King ex. Gage	T	N	Not listed	EN
453	Phyllanthaceae	<i>Baccaurea sumatrana</i> (Miq.) Müll. Arg.	-	T	N	VU/D	VU
454	Phyllanthaceae	<i>Breynia discigera</i> Müll. Arg.	-	T	N	CR/D	CR
455	Phyllanthaceae	<i>Breynia racemosa</i> (Blume) Müll. Arg.	-	C	N		CO
456	Phyllanthaceae	<i>Bridelia pustulata</i> Blume	-	T	N	CR/D	CR

No.	Family	Scientific Name	Synonyms	Life Form <sup>2</sup>	Native (N)/ Exotic (E) <sup>2</sup>	SRDB National Status <sup>1</sup>	Status given in Chong et al (2009) <sup>2</sup>
457	Phyllanthaceae	<i>Bridelia tomentosa</i> Blume	-	T	N	Not listed	CO
458	Phyllanthaceae	<i>Cleistanthus sumatranus</i> (Miq.) Müll. Arg.	-	T	N	VU/D	VU
459	Phyllanthaceae	<i>Glochidion hypoleucum</i> (Miq.) Boerl.	<i>Glochidion lutescens</i> Blume	S	N	CR/D	Listed as <i>Glochidion lutescens</i> Blume. Status CR
460	Phyllanthaceae	<i>Glochidion lutescens</i> Blume	<i>Glochidion hypoleucum</i> (Miq.) Boerl.	S	N	CR/D	Listed as <i>Glochidion hypoleucum</i> (Miq.) Boerl. Status CR
461	Phyllanthaceae	<i>Glochidion microbotrys</i> Hook. f.	<i>Glochidion borneense</i> (Müll.Arg.) Boerl.	T	N	CR/D	Listed as <i>Glochidion borneense</i> (Müll.Arg.) Boerl. Status CR
462	Phyllanthaceae	<i>Glochidion sericeum</i> Hook. f.	-	S	N	CR/D	CR
463	Phyllanthaceae	<i>Glochidion singaporense</i> Gage	-	S	N	CR/D	CR
464	Phyllanthaceae	<i>Glochidion</i> sp.	-	-	-	-	-
465	Phyllanthaceae	<i>Glochidion superbum</i> Baill.	-	T	N	-	CO
466	Phyllanthaceae	<i>Glochidion wallichianum</i> Müll. Arg.	-	T	N	NE	EX
467	Piperaceae	<i>Piper ribesoides</i> Wall.	-	C	N	NE	EX
468	Piperaceae	<i>Piper</i> sp.	-	-	-	-	-
469	Plantaginaceae	<i>Adenosma indicum</i>	-	H	-	-	Not given
470	Plantaginaceae	<i>Adenosma javanica</i> (Blume) Koord.	-	H	N	-	Listed as <i>Adenosma javanicum</i> Blume. Koord. Status CO
471	Pleurotaceae	<i>Pleurotus</i> sp.	-	-	-	-	-
472	Podocarpaceae	<i>Dacrycarpus imbricatus</i> (Blume) de Laub. var. <i>patulus</i> de Laub.	-	T	E	Not listed	Not given
473	Polygalaceae	<i>Xanthophyllum amoenum</i> Chodat	-	T	N	CR/D	CR
474	Polygalaceae	<i>Xanthophyllum discolor</i> Chodat	-	T	N	EN/D	EN
475	Polygalaceae	<i>Xanthophyllum eurhynchum</i> Miq.	-	S	N	VU/D	VU
476	Polygalaceae	<i>Xanthophyllum flavescens</i> Roxb.	-	-	-	Not listed	Not listed
477	Polygalaceae	<i>Xanthophyllum griffithii</i> Hook. f. ex A.W. Benn.	-	T	N	var. <i>ssp erectum</i> listed as EN/D	Listed as <i>ssp. erectum</i> . Status EN
478	Polygalaceae	<i>Xanthophyllum palembanicum</i> Miq.	-	-	-	Not listed	Not listed
479	Polygalaceae	<i>Xanthophyllum vitellinum</i> (Blume) D. Dietr.	-	T	N	VU/D	VU
480	Polypodiaceae	<i>Pyrrosia longifolia</i> (Burm.) C.V. Morton	-	Epiphyte	N	Not listed	CO
481	Polyporaceae	<i>Hexagonia tenuis</i> Speg.	-	Fungus	-	Not listed	Not listed
482	Polyporaceae	Indet.	-	Fungus	-	Not listed	Not listed
483	Polyporaceae	<i>Lentinus</i> sp.	-	Fungus	-	Not listed	Not listed
484	Polyporaceae	<i>Lentinus squarrosulus</i> Mont.	-	Fungus	-	Not listed	Not listed
485	Polyporaceae	<i>Microporus affinis</i> (Blume & T. Nees) Kuntze	-	Fungus	-	Not listed	Not listed
486	Polyporaceae	<i>Microporus vernicipes</i> (Berk.) Kuntze	-	Fungus	-	Not listed	Not listed
487	Polyporaceae	<i>Perenniporia ochroleuca</i> (Berk.) Ryvarden	-	Fungus	-	Not listed	Not listed
488	Polyporaceae	<i>Polyporus irregularis</i> Pers.	-	Fungus	-	Not listed	Not listed
489	Polyporaceae	<i>Polyporus</i> sp.	-	Fungus	-	Not listed	Not listed
490	Polyporaceae	<i>Trametes feei</i> (Fr.) Pat.	-	Fungus	-	Not listed	Not listed
491	Polyporaceae	<i>Trametes lactinea</i> (Berk.) Sacc.	-	Fungus	-	Not listed	Not listed
492	Polyporaceae	<i>Trametes scubrosa</i>	-	Fungus	-	Not listed	Not listed
493	Polyporaceae	<i>Trametes</i> sp.	-	Fungus	-	Not listed	Not listed
494	Psathyrellaceae	<i>Psathyrella</i> sp.	-	Fungus	-	Not listed	Not listed
495	Putranjivaceae	<i>Drypetes pendula</i> Ridl.	-	T	N	CR/D	CR
496	Rhamnaceae	<i>Ventilago malaccensis</i> Ridl.	-	C	N	EN/D	EN
497	Rhamnaceae	<i>Ventilago</i> sp.	-	-	-	-	-
498	Rhamnaceae	<i>Ziziphus calophylla</i> Wall. ex Hook. f.	-	C	N	-	VU
499	Rhizophoraceae	<i>Carallia brachiata</i> (Lour.) Merr.	-	T	N	EN/D	EN
500	Rhizophoraceae	<i>Gynotroches axillaris</i> Blume	-	T	N	-	CO
501	Rosaceae	<i>Prunus grisea</i> (Blume) Kalkman	-	T	N	*var. <i>tormentosa</i> listed as CR/D	Listed as *var. <i>tormentosa</i> (Koord. & Valetton) Kalkman. Status CR
502	Rosaceae	<i>Prunus polystachya</i> (Hook. f.) Kalkman	-	T	N	Not listed	CO
503	Rubiaceae	<i>Aidia densiflora</i> (Wall.) Masam.	-	T	N	VU/D	VU
504	Rubiaceae	<i>Caelospermum truncatum</i> (Wall.) Baill. ex K. Schum.	-	C	N	Listed as <i>Caelospermum truncatum</i> , Status CR/D	CR



No.	Family	Scientific Name	Synonyms	Life Form <sup>2</sup>	Native (N)/ Exotic (E) <sup>2</sup>	SRDB National Status <sup>1</sup>	Status given in Chong et al (2009) <sup>2</sup>
505	Rubiaceae	<i>Canthium confertum</i> Korth.	-	T	N	EN/D	EN
506	Rubiaceae	<i>Canthium molle</i> King & Gamble	-	C	N	NE	EX
507	Rubiaceae	<i>Chassalia curviflora</i> Thwaites	-	S	N	EN/D	Listed as <i>Chassalia curviflora</i> Wall. Thw. Status EN
508	Rubiaceae	<i>Chassalia chartacea</i> Craib	-	S	N	VU/D	VU
509	Rubiaceae	<i>Coptosapelta griffithii</i> Hook. f.	-	C	N	NE	EX
510	Rubiaceae	<i>Coptosapelta tomentosa</i> (Blume) Valetton ex K. Heyne	<i>Coptosapelta flavescens</i> (Blume) Val. Ex K. Heyne	C	N	NE	Listed as <i>Coptosapelta flavescens</i> . Status EX
511	Rubiaceae	<i>Gaertnera grisea</i> Hook. f. ex C.B. Clarke	-	S	N	VU/D	VU
512	Rubiaceae	<i>Gynochthodes coriacea</i> Blume	-	C	N	VU/D	VU
513	Rubiaceae	<i>Hedyotis congesta</i> R. Br. ex G. Don	<i>Oldenlandia cristata</i> (Willd. ex Roem. & Schult.)	H	N	VU/D	Listed as <i>Oldenlandia cristata</i> (Willd. ex Roem. & Schult.). Status VU
514	Rubiaceae	<i>Hedyotis herbacea</i> L.	<i>Oldenlandia herbacea</i> (L.) Roxb.	H	-	Listed as <i>Oldenlandia herbacea</i> (L.) Roxb. Status not given	-
515	Rubiaceae	<i>Hedyotis verticillata</i> (L.) Lam.	-	H	-	-	-
516	Rubiaceae	<i>Ixora javanica</i> (Blume) DC.	-	S	E	-	-
517	Rubiaceae	<i>Ixora pendula</i> Jack	-	S	N	* var. <i>pendula</i> EN/D	EN
518	Rubiaceae	<i>Lasianthus attenuatus</i> Jack	<i>L. densifolius</i> Miq.	S	N	VU/D	Listed as <i>L. densifolius</i> Miq. Status VU
519	Rubiaceae	<i>Lasianthus singaporensis</i> King & Gamble	<i>Lasianthus ridleyi</i> King & Gamble	S	N	VU/D	Listed as <i>Lasianthus ridleyi</i> King & Gamble. Status VU
520	Rubiaceae	<i>Pavetta indica</i> L.	-	-	-	-	N - synonyms not found in book
521	Rubiaceae	<i>Pavetta wallichiana</i> Steud.	-	S	N	VU/D	VU
522	Rubiaceae	<i>Porterandia anisophyllea</i> (Jack ex Roxb.) Ridl.	-	T	N	VU/D	VU
523	Rubiaceae	<i>Psychotria maingayi</i> Hook. f.	-	C	N	CR/D	CR
524	Rubiaceae	<i>Psychotria penangensis</i> Hook. f.	-	C	N	VU/D	VU
525	Rubiaceae	<i>Psychotria rostrata</i> Blume	-	S	N	CR/D	CR
526	Rubiaceae	<i>Psydrax</i> sp.	-	-	-	-	-
527	Rubiaceae	<i>Rothmannia macrophylla</i> (R. Br. ex Hook. f.) Bremek.	-	S	N	VU/D	VU
528	Rubiaceae	<i>Timonius flavescens</i> (Jack) Baker	-	T	N	CR/D	CR
529	Rubiaceae	<i>Timonius wallichianus</i> (Korth.) Valetton	-	T	N	-	CO
530	Rubiaceae	<i>Uncaria attenuata</i> Korth.	-	C	N	NE	EX
531	Rubiaceae	<i>Uncaria gambir</i> (W. Hunt.) Roxb.	-	C	E	Not listed	Not given
532	Rubiaceae	<i>Uncaria lanosa</i> Wall. var. <i>glabrata</i> (Blume) Ridsdale	-	C	N	CR/D	CR
533	Rubiaceae	<i>Uncaria longiflora</i> (Poir.) Merr. var. <i>pteropoda</i> (Miq.) Ridsdale	-	C	N	CR/D	CR
534	Rubiaceae	<i>Urophyllum corymbosum</i> (Blume) Korth.	<i>Maschalocorymbus corymbosus</i> (Blume) Bremek	S	-	NE	Listed as <i>Maschalocorymbus corymbosus</i> (Blume) Bremek. Status not given
535	Rubiaceae	<i>Urophyllum glabrum</i> Wall.	-	-	-	VU/D	Y
536	Rubiaceae	<i>Urophyllum griffithianum</i> (Wight) Hook. f.	-	S	N	VU/D	VU
537	Rubiaceae	<i>Urophyllum hirsutum</i> (Wight) Hook. f.	-	S	N	EN/D	EN
538	Rutaceae	<i>Euodia robusta</i> Hook. f.	-	-	-	-	-
539	Rutaceae	<i>Glycosmis chlorosperma</i> (Blume) Spreng. var. <i>chlorosperma</i>	-	S	N	VU/D	VU
540	Rutaceae	<i>Luvunga crassifolia</i> Tanaka	-	C	N	CR/D	CR
541	Rutaceae	<i>Paramignya scandens</i> (Griff.) Craib (Burkill) Swingle	-	C	N	var. <i>ridleyi</i> listed as CR/D	Listed as var. <i>ridleyi</i> . Status CR
542	Sabiaceae	<i>Meliosma pinnata</i> (Roxb.) Maxim.	-	T	N	var. ssp <i>ridleyi</i> listed as NE	Listed as var. ssp <i>ridleyi</i> . Status EX
543	Salicaceae	<i>Casearia clarkei</i> King	-	T	N	NE	EX
544	Salicaceae	<i>Flacourtia rukam</i> Zoll. & Moritz	-	T	N	VU/D	VU
545	Santalaceae	<i>Scleropyrum pentandrum</i> (Dennst.) Mabb.	-	T	N	CR/D	CR

No.	Family	Scientific Name	Synonyms	Life Form <sup>2</sup>	Native (N)/ Exotic (E) <sup>2</sup>	SRDB National Status <sup>1</sup>	Status given in Chong <i>et al</i> (2009) <sup>2</sup>
546	Santalaceae	<i>Scleropyrum wallichianum</i> (Wight & Arn.) Am.	<i>Scleropyrum pentandrum</i> (Dennst.) D.J. Mabberley	T	N	CR/D	Listed as <i>Scleropyrum pentandrum</i> (Dennst.) D.J. Mabberley. Status CR
547	Sapindaceae	<i>Guioa pubescens</i> (Zoll. & Moritz) Radlk.	-	T	N	VU/D	VU
548	Sapindaceae	<i>Mischocarpus sundaicus</i> Blume	-	T	N	VU/D	VU
549	Sapindaceae	<i>Nephelium cuspidatum</i> Blume	-	T	N	*var <i>eripetalum</i> listed as EN/D	Listed as <i>Nephelium cuspidatum</i> Blume var. <i>eripetalum</i> (Miq.) Leenh. Status EN
550	Sapindaceae	<i>Nephelium cuspidatum</i> Blume var. <i>ophioides</i> (Radlk.) Leenh.	-	-	-	-	N - synonyms not found in book
551	Sapindaceae	<i>Nephelium maingayi</i> Hiern	-	-	-	-	-
552	Sapindaceae	<i>Trigonachras acuta</i> (Hiern) Radlk.	-	T	N	EN/D	EN
553	Sapindaceae	<i>Xerospermum noronhianum</i> (Blume) Blume	-	T	N	CR/D	CR
554	Sapotaceae	<i>Chrysophyllum lanceolatum</i> [non Casar.](Blume) A. DC.	<i>Chrysophyllum roxburghii</i> G.Don	T	N	CR/D	Listed as <i>Chrysophyllum roxburghii</i> G.Don . Status CR
555	Sapotaceae	<i>Madhuca sericea</i> H.J. Lam	-	T	N	CR/D	CR
556	Sapotaceae	<i>Palaquium microphyllum</i> King & Gamble	-	T	N	CR/D	CR
557	Sapotaceae	<i>Palaquium obovatum</i> (Griff.) Engl.	-	T	N	VU/D	VU
558	Sapotaceae	<i>Palaquium oxleyanum</i> Pierre	-	T	N	NE	EX
559	Sapotaceae	<i>Palaquium rostratum</i> (Miq.) Burck	-	T	N	CR/D	CR
560	Sapotaceae	<i>Payena lucida</i> (Wall. ex G. Don) A. DC.	-	T	N	CR/D	CR
561	Sapotaceae	<i>Pouteria malaccensis</i> (C.B. Clarke) Baehni	-	T	N	VU/D	VU
562	Sapotaceae	<i>Sarcosperma paniculatum</i> (King) Stapf & King	-	T	N	NE	EX
563	Sarcosomataceae	<i>Gallliella javanica</i>	-	Fungus	-	Not listed	Not listed
564	Selaginellaceae	<i>Selaginella atro-viridis</i> (Hook. & Grev.) Spring	-	L-H-M	-	Not listed	Not listed
565	Sematophyllaceae	<i>Acanthorrhynchium papillatum</i> (Harv.) M. Fleisch.	-	L-H-M	-	Not listed	Not listed
566	Sematophyllaceae	<i>Taxithelium papillatum</i> (Harv.) Broth. var. <i>angustifolium</i> Dixon	-	L-H-M	-	Not listed	Not listed
567	Sematophyllaceae	<i>Trichosteleum fleischeri</i> B.C. Tan, B.C. Ho & B. K.-B. Seah	-	L-H-M	-	Not listed	Not listed
568	Sematophyllaceae	<i>Trichosteleum singapurense</i> M. Fleisch.	-	L-H-M	-	Not listed	Not listed
569	Sematophyllaceae	<i>Trichosteleum</i> sp.	-	L-H-M	-	Not listed	Not listed
570	Smilacaceae	<i>Smilax calophylla</i> A. DC.	-	C	N	EN/D	EN
571	Staphyleaceae	<i>Dalrympelea sphaerocarpa</i> var. <i>sphaerocarpa</i>	-	-	-	Not listed	Not listed
572	Staphyleaceae	<i>Turpinia sphaerocarpa</i> Hassk.	-	T	N	CR/D	CR
573	Stemonuraceae	<i>Gomphandra quadrifida</i> (Blume) Sleumer	-	S	N	VU/D	VU
574	Strophariaceae	<i>Gymnopilus</i> sp.	-	-	-	-	-
575	Styracaceae	<i>Styrax benzoin</i> Dryand.	-	T	N	CR/D	CR
576	Symplocaceae	<i>Symplocos fasciculata</i> Zoll.	-	T	N	VU/D	VU
577	Tectariaceae	<i>Tectaria barberi</i> (Hook.) Copel.	-	H	N	-	CO
578	Tectariaceae	<i>Tectaria singaporeana</i> (Hook. & Grev.) Copel.	-	H	N	-	CO
579	Theaceae	<i>Gordonia multinervis</i> King	-	T	N	EN/D	EN
580	Theaceae	<i>Gordonia penangensis</i> Ridl.	-	T	N	CR/D	CR
581	Theaceae	<i>Gordonia singaporiana</i> Wall. ex Ridl.	-	T	N	EN/D	EN
582	Theaceae	<i>Polyspora multinervis</i> King	<i>Gordonia multinervis</i> King	T	N	EN/D	Listed as <i>Gordonia multinervis</i> King. Status EN
583	Theaceae	<i>Pyrenaria acuminata</i> Planch.	-	T	N	-	EN
584	Thelypteridaceae	<i>Christella parasitica</i> (L.) Lév.	-	H	-	Not listed	Not given

No.	Family	Scientific Name	Synonyms	Life Form <sup>2</sup>	Native (N)/ Exotic (E) <sup>2</sup>	SRDB National Status <sup>1</sup>	Status given in Chong <i>et al</i> (2009) <sup>2</sup>
585	Thelypteridaceae	<i>Cyclosorus dentatus</i> (Forssk.) Ching	<i>Christella dentata</i> (Forsskal) Brownsey &	H	-	Not listed	Not given
586	Thymelaeaceae	<i>Aquilaria microcarpa</i> Baill.	-	T	N	CR/D	CR
587	Thymelaeaceae	<i>Gonystylus confusus</i> Airy Shaw	-	T	N	EN/D	EN
588	Thymelaeaceae	<i>Wikstroemia ridleyi</i> Gamble	-	S	E	Not listed	Not given
589	Tricholomataceae	<i>Marasmiellus</i> sp.	-	-	-	-	-
590	Violaceae	<i>Rinorea anguifera</i> (Lour.) Kuntze	-	T	N	CR/D	CR
591	Vitaceae	<i>Ampelocissus elegans</i> (Kurz) Gagnep.	-	C	N	EN/D	EN
592	Vitaceae	<i>Ampelocissus gracilis</i> (Wall.) Planch.	-	C	N	EN/D	EN
593	Vitaceae	<i>Cayratia mollissima</i> (Wall.) Gagnep.	-	C	N	EN/D	EN
594	Vitaceae	<i>Cissus hastata</i> Miq.	-	C	-	Not listed	Not given
595	Vitaceae	<i>Nothocissus spicifera</i> (Griff.) Latiff	-	C	N	CR/D	CR
596	Woodsiaceae	<i>Diplazium kunsteri</i> Holttum	-	F	-	Not listed	Not listed
597	Xanthorrhoeaceae	<i>Dianella ensifolia</i> (L.) DC.	-	H	N	Not listed	CO
598	Xylariaceae	<i>Ustulina</i> sp.	-	-	-	-	-
599	Zingiberaceae	<i>Globba leucantha</i> Miq. var. <i>peninsularis</i> Holttum	-	H	N	CR/D	CR
600	Zingiberaceae	<i>Hornstedtia leonurus</i> (J. König) Retz.	-	H	N	CR/D	CR
601	Zingiberaceae	<i>Hornstedtia scyphifera</i> (J. König) Steud.	-	H	N	VU/D	VU
602	Zingiberaceae	<i>Zingiber puberulum</i> Ridl.	<i>Zingiber puberulum</i> var. <i>ovoideum</i> Holttum	H	N	EN/D	Listed as <i>Zingiber puberulum</i> var. <i>ovoideum</i> Holttum. Status EN
603	Zingiberaceae	<i>Zingiber singaporense</i>		H	N		

#### References:

0. IUCN Red List of Threatened Species 2015.02. Retrieved from <http://www.iucnredlist.org/> Abbreviations include:

DD: Data Deficient; LC: Least Concern; NT: Near Threatened; VU: Vulnerable; EN: Endangered; CR: Critically Endangered

1. Davison GWH, Ng PKL and Ho HC. (2008) **Singapore Red Data Book**. Abbreviations include:

DD: Data Deficient (status indeterminate, requires further validation); VU: Vulnerable; EN: Endangered; CR: Critically Endangered; NE: Presumed Nationally extinct; EX: Globally Extinct

2. Chong K Y C, Tan H T W, Corlett R T (2009) **A Checklist of the Total Vascular Plant Flora of Singapore. Native, Naturalised and Cultivated Species**.

Raffles Museum of Biodiversity Research, NUS, Singapore. Abbreviations include:

CO: Common; VU: Vulnerable; EN: Endangered; CR: Critically Endangered; EX: Extinct

3. The Plant List <http://www.theplantlist.org>

4. Grin Taxonomy <http://www.ars-grin.gov>

5. Catalogue of Life [www.catalogueoflife.org](http://www.catalogueoflife.org)

#### Notes

##### Key Life-form

T Tree  
S Shrub  
H Herb  
C Climber  
F Fern  
L-H Liverworts,  
Hornworts and  
Mosses &  
clubmosses  
Fun Fungus  
Epip Epiphyte

Annex 8B

## Bird Species (Secondary Data)

ANNEX 8B BIRD SPECIES IN STUDY AREA, REPORTED FROM SECONDARY DATA

No.	Scientific Name	Common Name [English]	CONSERVATION STATUS					Status in Nature Reserves 1997 <sup>5</sup>
			IUCN Red List (2015.02) <sup>1</sup>	SRDB National Status <sup>2</sup>	NSS (2011) <sup>3</sup>	CRL WG Report 'International Conservation Status' <sup>4</sup>	CRL WG Report 'National Status' <sup>4</sup>	
1	<i>Fregata andrewsi</i>	Christmas Frigatebird	CE	Sp. not listed	R/NBV **	ITT	Not given	
2	<i>Ardea cinerea</i>	Grey Heron	LC	VU	C/RB ##	Not given	VU(NT)	
3	<i>Ardea purpurea</i>	Purple Heron	LC		EN	C/RB #	Not given	EN
4	<i>Butorides striatus</i>	Little or Striated Heron	Not Assessed	Sp. not listed	C/RB WV	Not given	LC	
5	<i>Ardeola bacchus</i>	Chinese Pond Heron	LC	Sp. not listed	C/WV	Not given	Not given	
6	<i>Egretta garzetta</i>	Little Egret	LC	Sp. not listed	C/WV	Not given	Not given	
7	<i>Casmerodius albus</i>	Great Egret	LC	Sp. not listed	C/WV	Not given	Not given	
8	<i>Mesophoxys intermedia</i>	Intermediate or Yellow-billed Egret	LC	Sp. not listed	U/WV	Not given	Not given	
9	<i>Bubulcus coromandus</i>	Eastern Cattle Egret	LC	Sp. not listed	C/R(B) WV	Not given	Not given	
10	<i>Nycticorax nycticorax</i>	Black-crowned Night Heron	LC	CR	U/RB ##	Not given	CR	
11	<i>Gorsachius melanolophus</i>	Malayan Night Heron	LC	Sp. not listed	R/WV PM	Not given	Not given	
12	<i>Ixobrychus sinensis</i>	Yellow Bittern	LC	Sp. not listed	C/RB WV	Not given	Not given	
13	<i>Ixobrychus eurhythmus</i>	Von Schrenk's Bittern	LC	Sp. not listed	U/WV	Not given	Not given	
14	<i>Ixobrychus cinnamomeus</i>	Cinnamon Bittern	LC	Sp. not listed	C/RB WV	Not given	Not given	
15	<i>Ixobrychus flavicollis</i>	Black Bittern	LC	Sp. not listed	U/PM WV	Not given	Not given	
16	<i>Pandion haliaetus</i>	Osprey	LC	Sp. not listed	C/NBV	Not given	Not given	
17	<i>Aviceda leuphotes</i>	Black Baza	LC	Sp. not listed	C/PM WV	Not given	Not given	
18	<i>Pernis ptilorhynchus</i>	Oriental or Crested Honey Buzzard	LC	Sp. not listed	C/PM WV	Not given	Not given	
19	<i>Elanus caeruleus</i>	Black-winged Kite	LC	Sp. not listed	C/RB	Not given	LC	
20	<i>Haliastur indus</i>	Brahminy Kite	LC	Sp. not listed	C/RB	Not given	LC	
21	<i>Haliaeetus leucogaster</i>	White-bellied Sea-Eagle	LC	Sp. not listed	C/RB	Not given	LC	
22	<i>Ichthyophaga ichthyaeus</i>	Grey-headed Fish-Eagle	NT	CR	R/RB ##	INT	CR	
23	<i>Spilornis cheela</i>	Crested Serpent-Eagle	LC	CR	R/R(B) ##	Not given	CR	Key species. In McRR
24	<i>Circus spilonotus</i>	Eastern Marsh Harrier	LC	Sp. not listed	U/WV	Not given	Not given	
25	<i>Accipiter gularis</i>	Japanese Sparrowhawk	LC	Sp. not listed	C/PM WV	Not given	Not given	
26	<i>Accipiter virgatus</i>	Besra	LC	Sp. not listed	R/PM. Rarity	Not given	Not given	
27	<i>Accipiter soloensis</i>	Chinese Goshawk / Sparrowhawk	LC	Sp. not listed	U/PM	Not given	Not given	
28	<i>Hieraetus kieneni/ Lophotriorchis kieneni</i>	Rufous-bellied Eagle	LC	Sp. not listed	R/WV. Rarity	Not given	Not given	
29	<i>Spizaetus cirrhatus/ Nisaetus cirrhatus</i>	Changeable Hawk-Eagle	LC	EN	U/RB ##	Not given	EN(VU)	
30	<i>Microhierax fringillarius</i>	Black-thighed Falconet	LC	CR	R/R(B) ##. Rarity	Not given	CR	
31	<i>Falco peregrinus</i>	Peregrine Falcon	LC	Sp. not listed	U/WV	Not given	Not given	
32	<i>Rallina fasciata</i>	Red-legged Crane	LC	VU	U/RB WV ##	Not given	VU(LC)	
33	<i>Rallina eurizonoides</i>	Slaty-legged Crane	LC	Sp. not listed	R/WV PM. Rarity	Not given	Not given	
34	<i>Porzana pusilla</i>	Baillon's Crane	LC	Sp. not listed	U/WV PM	Not given	Not given	
35	<i>Amaurornis phoenicurus</i>	White-breasted Waterhen	LC	Sp. not listed	C/RB WV	Not given	LC	
36	<i>Gallinix cinerea</i>	Watercock	LC	Sp. not listed	U/WV	Not given	Not given	
37	<i>Hydrophasianus chirurgus</i>	Pheasant-tailed Jacana	LC	Sp. not listed	R/WV	Not given	Not given	
38	<i>Vanelius indicus</i>	Red-wattled Lapwing	LC	EN	U/RB ##	Not given	EN	
39	<i>Pluvialis fulva</i>	Pacific Golden Plover	LC	Sp. not listed	C/WV PM	Not given	Not given	
40	<i>Tringa totanus</i>	Common Redshank	LC	Sp. not listed	C/WV PM	Not given	Not given	
41	<i>Tringa stagnatilis</i>	Marsh Sandpiper	LC	Sp. not listed	C/WV PM	Not given	Not given	
42	<i>Tringa nebularia</i>	Common Greenshank	LC	Sp. not listed	C/WV	Not given	Not given	
43	<i>Tringa glareola</i>	Wood Sandpiper	LC	Sp. not listed	C/WV PM	Not given	Not given	
44	<i>Tringa hypoleucos</i>	Common Sandpiper	LC	Sp. not listed	C/WV PM	Not given	Not given	
45	<i>Gallinago megala</i>	Swinhoe's Snipe	LC	Sp. not listed	R/WV. Rarity	Not given	Not given	
46	<i>Glareola maldivarum</i>	Oriental Pratincole	LC	Sp. not listed	U/PM	Not given	Not given	
47	<i>Treron curvirostra</i>	Thick-billed Green-Pigeon	LC	EN	U/RB ##	Not given	EN	
48	<i>Treron fulvicollis</i>	Cinnamon-headed Green-Pigeon	NT	Sp. not listed	R/NBV *, Rarity	INT	Not given	
49	<i>Treron olax</i>	Little Green-Pigeon	LC	CR	R/R(B) ##	Not given	CR	
50	<i>Treron vernans</i>	Pink-necked Green-Pigeon	LC	Sp. not listed	A/RB	Not given	LC	
51	<i>Ptilinopus jambu</i>	Jambu Fruit-Dove	NT	Sp. not listed	U/NBV *	Not given	Not given	
52	<i>Ducula aenea</i>	Green Imperial Pigeon	LC	Sp. not listed	R/NBV. Rarity	Not given	(CR)	
53	<i>Columba livia</i>	Rock or Common Pigeon	LC	Sp. not listed	A/RB	Not given	Not given	
54	<i>Streptopelia chinensis</i>	Spotted dove	LC	Sp. not listed	A/RB	Not given	LC	
55	<i>Geopelia striata</i>	Zebra Dove	LC	Sp. not listed	C/RB	Not given	LC	
56	<i>Chalcophaps indica</i>	Common Emerald Dove	LC	Sp. not listed	U/R(B)	Not given	NT	
57	<i>Trichoglossus haematodus</i>	Rainbow or Coconut Lorikeet	LC	Sp. not listed	C/IRB	Not given	Not given	
58	<i>Psittacula krameri</i>	Rose-ringed Parakeet	LC	Sp. not listed	U/IRB	Not given	Not given	
59	<i>Psittacula longicauda</i>	Long-tailed Parakeet	NT	Sp. not listed	C/RB *	INT	LC	
60	<i>Psittinus cyanurus</i>	Blue-rumped Parrot	NT	CR	R/R(B) ##	INT	CR	Key species. In McRR
61	<i>Loriculus galgulus</i>	Blue-crowned Hanging Parrot	LC	EN	U/R(B) ##	Not given	EN(VU)	Key species. In McRR
62	<i>Cacatua sulphurea</i>	Yellow-crested Cockatoo	CR	Sp. not listed	U/IRB **	ITT	Not given	
63	<i>Cacatua goffiniana, C. goffini</i>	Tanimbar Cockatoo, Tanimbar Corella	NT	Sp. not listed	C/IRB *	INT	Not given	
64	<i>Clamator coromandus</i>	Chestnut-winged Cuckoo	LC	Sp. not listed	U/PM WV	Not given	Not given	
65	<i>Hierococcyx sparveroides</i>	Large Hawk-Cuckoo	LC	Sp. not listed	R/WV PM. Rarity	Not given	Not given	
66	<i>Hierococcyx lugax</i>	Malaysian Hawk-Cuckoo	LC	Sp. not listed	U/NBV	Not given	Not given	
67	<i>Hierococcyx niscolor</i>	Hodgson's Hawk-Cuckoo	LC	Sp. not listed	R/WV. Rarity	Not given	Not given	
68	<i>Cuculus micropterus</i>	Indian Cuckoo	LC	Sp. not listed	C/WV PM	Not given	Not given	
69	<i>Cuculus saturatus</i>	Oriental Cuckoo	LC	Sp. not listed	R/PM. Rarity	Not given	Not given	
70	<i>Cacomantis sonnerati</i>	Banded Bay Cuckoo	LC	Sp. not listed	U/RB	Not given	NT	
71	<i>Cacomantis merulinus</i>	Plaintive Cuckoo	LC	Sp. not listed	U/RB	Not given	(CR)	
72	<i>Cacomantis sepulchralis</i>	Rusty-breasted Cuckoo	LC	VU	U/RB ##	Not given	VU	
73	<i>Chrysococcyx xanthorhynchus</i>	Violet Cuckoo	LC	EN	U/RB WV ##	Not given	EN	
74	<i>Chrysococcyx minutillus</i>	Little Bronze-Cuckoo	LC	Sp. not listed	C/RB	Not given	LC	
75	<i>Sumiculus lugubris</i>	Asian Drongo-Cuckoo	LC	CR	U/RB WV ##	Not given	CR	Key species. In McRR
76	<i>Eudynamis scolopacea</i>	Asian Koel	LC	Sp. not listed	C/RB WV	Not given	LC	
77	<i>Phaenicophaeus sumatranus</i>	Chestnut-bellied Malkoha	NT	Sp. not listed	U/RB #	INT	NT	
78	<i>Centropus sinensis</i>	Greater Coucal	LC	Sp. not listed	U/RB	Not given	NT	
79	<i>Centropus bengalensis</i>	Lesser Coucal	LC	Sp. not listed	C/RB	Not given	LC	
80	<i>Otus sunia</i>	Oriental Scops Owl	LC	Sp. not listed	R/WV PM. Rarity	Not given	Not given	
81	<i>Otus lempiji</i>	Collared or Sunda Scops Owl	LC	Sp. not listed	C/RB	Not given	LC	
82	<i>Ketupa ketupu</i>	Butfy Fish Owl	LC	CR	R/RB ##	Not given	CR	
83	<i>Ninox scutulata</i>	Brown Boobook / Hawk-Owl	LC	Sp. not listed	C/RB WV	Not given	LC	Key species
84	<i>Strix seloputo</i>	Spotted Wood Owl	LC	CR	R/RB ##	Not given	CR	
85	<i>Eurostopodus temminckii</i>	Malaysian Eared Nightjar	LC	CR	R/R(B) ##	Not given	CR	Key species. In McRR
86	<i>Caprimulgus indicus</i>	Grey Nightjar	LC	Sp. not listed	R/WV PM. Rarity	Not given	Not given	
87	<i>Caprimulgus macrurus</i>	Large-tailed Nightjar	LC	Sp. not listed	C/RB	Not given	LC	
88	<i>Hydrochous gigas, Collocalia gigas</i>	Waterfall Swift, Giant Swiftlet	NT	Sp. not listed	Sp. not listed	INT	Not given	
89	<i>Collocalia germani, Aerodramus luciphagus</i>	Germain's Swiftlet	LC	Sp. not listed	C/RB	Not given	LC	
90	<i>Collocalia maxima</i>	Black-Nest Swiftlet	LC	Sp. not listed	C/RB	Not given	LC	
91	<i>Aerodramus brevirostris, Collocalia gigas</i>	Himalayan Swiftlet	LC	Sp. not listed	Sp. not listed	Not given	Not given	
92	<i>Collocalia esculenta</i>	Glossy Swiftlet	LC	CR	R/R(B) ##. Rarity	Not given	CR	Key species. In McRR
93	<i>Hirundapus cochinchinensis</i>	Silver-backed Needletail	LC	Sp. not listed	U/WV PM	Not given	Not given	



No.	Scientific Name	Common Name [English]	CONSERVATION STATUS					Status in Nature Reserves 1997 <sup>5</sup>
			IUCN Red List (2015.02) <sup>1</sup>	SRDB National Status <sup>2</sup>	NSS (2011) <sup>3</sup>	CRL WG Report 'International Conservation Status' <sup>4</sup>	CRL WG Report 'National Status' <sup>4</sup>	
94	<i>Hirundapus giganteus</i>	Brown-backed Needletail	LC	Sp. not listed	U/WV PM	Not given	Not given	
95	<i>Apus pacificus</i>	Fork-tailed Swift	LC	Sp. not listed	U/PM WV	Not given	Not given	
96	<i>Apus acuticauda</i>	Dark-rumped Swift	VU	Sp. not listed	Sp. not listed	ITT	Not given	
97	<i>Apus nipalensis</i>	House Swift	LC	Sp. not listed	C/RB	Not given	LC	
98	<i>Cypsiurus balaisensis</i>	Asian Palm Swift	LC	Sp. not listed	C/RB	Not given	LC	
99	<i>Hemiprocne longipennis</i>	Grey-rumped Treeswift	LC	Sp. not listed	C/RB	Not given	NT	
100	<i>Hemiprocne comata</i>	Whiskered Treeswift	LC	Sp. not listed	R/NBV. Rarity	Not given	Not given	
101	<i>Alcedo atthis</i>	Common Kingfisher	LC	Sp. not listed	C/WV	Not given	Not given	
102	<i>Alcedo meninting</i>	Blue-eared Kingfisher	LC	CR	R/RB ##	Not given	CR	Key species. In McRR
103	<i>Ceyx erithaca</i>	Black-backed Kingfisher	LC	Sp. not listed	R/WV	Not given	Not given	
104	<i>Pelargopsis capensis</i>	Stork-billed Kingfisher	LC	Sp. not listed	U/RB	Not given	LC	
105	<i>Halcyon coromanda</i>	Ruddy Kingfisher	LC	CR	R/RB WV ##	Not given	CR	
106	<i>Halcyon smymensis</i>	White-throated Kingfisher	LC	Sp. not listed	C/RB	Not given	LC	
107	<i>Halcyon pileata</i>	Black-capped Kingfisher	LC	Sp. not listed	U/WV PM	Not given	Not given	
108	<i>Todiramphus chloris</i>	Collared Kingfisher	LC	Sp. not listed	A/RB	Not given	LC	
109	<i>Merops philippinus</i>	Blue-tailed Bee-eater	LC	Sp. not listed	C/WV	Not given	Not given	
110	<i>Merops viridis</i>	Blue-throated Bee-eater	LC	Sp. not listed	C/MB	Not given	LC	
111	<i>Eurystomus orientalis</i>	Oriental Dollarbird	LC	Sp. not listed	C/RB WV	Not given	NT	
112	<i>Anthracoeros albirostris</i>	Oriental Pied Hornbill	LC	CR	U/RB ##	Not given	CR(EN)	
113	<i>Megalaima lineata</i>	Lined Barbet	LC	Sp. not listed	U/IRB	Not given	Not given	
114	<i>Megalaima rafflesii</i>	Red-crowned Barbet	NT	Sp. not listed	U/RB #*	INT	NT	Key species
115	<i>Megalaima haemacephala</i>	Coppersmith Barbet	LC	Sp. not listed	C/RB	Not given	LC	
116	<i>Micropternus brachyurus</i> , <i>Celeus brachyurus</i>	Rufous Woodpecker	LC	Sp. not listed	U/RB	Not given	NT	
117	<i>Picus vittatus</i>	Laced Woodpecker	LC	Sp. not listed	C/RB	Not given	LC	
118	<i>Chrysophlegma miniaceum</i> , <i>Picus miniaceus</i>	Banded Woodpecker	LC	Sp. not listed	C/RB	Not given	LC	
119	<i>Dinopium javanense</i>	Common Flameback / Goldenback	LC	Sp. not listed	C/RB	Not given	LC	
120	<i>Dryocopus javensis</i>	White-bellied Woodpecker	LC	CR	R/R(B) ##	Not given	CR	Key species. In McRR
121	<i>Dendrocopos moluccensis</i>	Sunda Pygmy Woodpecker	LC	Sp. not listed	A/RB	Not given	LC	
122	<i>Pitta moluccensis</i>	Blue-winged Pitta	LC	Sp. not listed	U/WV PM	Not given	Not given	
123	<i>Pitta sordida</i>	Hooded Pitta	LC	Sp. not listed	U/WV PM	Not given	Not given	
124	<i>Riparia riparia</i>	Common Sand Martin	LC	Sp. not listed	U/WV PM	Not given	Not given	
125	<i>Hirundo rustica</i>	Barn Swallow	LC	Sp. not listed	A/WV PM	Not given	Not given	
126	<i>Hirundo tahitica</i>	Pacific Swallow	LC	Sp. not listed	C/RB	Not given	LC	
127	<i>Cecropis daurica</i> , <i>Hirundo daurica</i>	Red-rumped Swallow	LC	Sp. not listed	U/PM WV	Not given	Not given	
128	<i>Delichon dasyopus</i>	Asian House Martin	LC	Sp. not listed	U/PM	Not given	Not given	
129	<i>Lalage nigra</i>	Pied Triller	LC	Sp. not listed	C/RB	Not given	LC	
130	<i>Pericrocotus divaricatus</i>	Ashy Minivet	LC	Sp. not listed	C/WV PM	Not given	Not given	
131	<i>Pericrocotus speciosus</i>	Scarlet Minivet	LC	CR	R/R(B) ##	Not given	CR	Key species. Confined to BTNR
132	<i>Aegithina tiphia</i>	Common Iora	LC	Sp. not listed	C/RB	Not given	LC	
133	<i>Chloropsis cyanopogon</i>	Lesser Green Leafbird	NT	CR	U/R(B) ##*	Not given	CR	Key species. In McRR
134	<i>Chloropsis sonnerati</i>	Greater Green Leafbird	LC	CR	U/R(B) ##	Not given	CR	Key species. In McRR
135	<i>Chloropsis cochinchinensis</i>	Blue-winged Leafbird	LC	Sp. not listed	C/R(B) #	Not given	NT	
136	<i>Pycnonotus zeylanicus</i>	Straw-headed Bulbul	VU	EN	U/RB ##**	ITT	EN	
137	<i>Pycnonotus melanoleucos</i>	Black-and-White Bulbul	NT	Sp. not listed		Not given	Not given	
138	<i>Pycnonotus atriceps</i>	Black-headed Bulbul	LC	CR	R/RB ##	Not given	CR*	Key species. In McRR
139	<i>Pycnonotus flaviventris</i> , <i>Pycnonotus melanicterus</i>	Black-crested Bulbul	LC	Sp. not listed	U/IRB	Not given	Not given	
140	<i>Pycnonotus jocosus</i>	Red-whiskered Bulbul	LC	Sp. not listed	U/IRB	Not given	Not given	
141	<i>Pycnonotus goiavier</i>	Yellow-vented Bulbul	LC	Sp. not listed	A/RB	Not given	LC	
142	<i>Pycnonotus plumosus</i>	Olive-winged Bulbul	LC	Sp. not listed	C/RB	Not given	LC	
143	<i>Pycnonotus simplex</i>	Cream-vented Bulbul	LC	Sp. not listed	U/RB #	Not given	Not given	Key species
144	<i>Pycnonotus brunneus</i>	Asian Red-eyed Bulbul	LC	EN	U/RB ##	Not given	EN	Key species. Breeding recorded. In McRR
145	<i>Hemixos cinereus</i> , <i>Hemixos flava</i>	Ashy or Cinereous Bulbul	LC	Sp. not listed	U/NBV	Not given	Not given	
146	<i>Dicrurus leucophaeus</i>	Ashy Drongo	LC	Sp. not listed	R/WV. Rarity	Not given	Not given	
147	<i>Dicrurus annectans</i>	Crow-billed Drongo	LC	Sp. not listed	U/WV PM	Not given	Not given	
148	<i>Dicrurus aeneus</i>	Bronzed Drongo	LC	Sp. not listed		Not given	Not given	
149	<i>Dicrurus paradiseus</i>	Greater Racket-tailed Drongo	LC	Sp. not listed	C/RB	Not given	LC	
150	<i>Ortolus chinensis</i>	Black-naped Oriole	LC	Sp. not listed	C/RB	Not given	LC	
151	<i>Irena puella</i>	Asian Fairy Bluebird	LC	Sp. not listed	C/RB #	Not given	LC	key species
152	<i>Platysmurus leucopterus</i>	Black Magpie	NT	Sp. not listed		INT	Not given	
153	<i>Corvus splendens</i>	House Crow	LC	Sp. not listed	C/IRB	Not given	Not given	
154	<i>Corvus macrorhynchos</i>	Southern Jungle or Large-billed Crow	LC	Sp. not listed	C/RB	Not given	LC	
155	<i>Trichastoma rostratum</i>	White-chested Babbler	NT	CR	R/RB ##*	INT	CR	
156	<i>Malaccocincla malaccensis</i>	Short-tailed Babbler	NT	Sp. not listed	C/RB *	INT	LC	Key species. Breeding recorded
157	<i>Malaccocincla abbotti</i>	Abbott's Babbler	LC	Sp. not listed	U/RB	Not given	NT	
158	<i>Malacopteron magnirostre</i>	Moustached Babbler	LC	CR	R/RB ##. Rarity	Not given	CR	Key species. In McRR
159	<i>Stachyris erythroptera</i>	Chestnut-winged Babbler	LC	EN	U/RB ##	Not given	EN	Key species. In McRR
160	<i>Macronous gularis</i>	Pin-striped Tit-babbler	LC	Sp. not listed	C/RB	Not given	LC	
161	<i>Garrulax leucolophus</i>	White-crested Laughingthrush	LC	Sp. not listed	C/IRB	Not given	Not given	
162	<i>Leucodioptron canorum</i> , <i>Garrulax canorus</i>	Chinese Hwamei	LC	Sp. not listed	R/IRB	Not given	Not given	
163	<i>Luscinia cyane</i>	Siberian Blue Robin	LC	Sp. not listed	R/PM WV	Not given	Not given	
164	<i>Copsychus saularis</i>	Oriental Magpie-Robin	LC	EN	U/RB ##	Not given	EN	
165	<i>Copsychus malabaricus</i>	White-rumped Shama	LC	CR	R/RB ##	Not given	CR(EN)	
166	<i>Geokichla citrina</i> , <i>Zoothera citrina</i>	Orange-headed Thrush	LC	Sp. not listed	R/WV	Not given	Not given	
167	<i>Geokichla sibirica</i> , <i>Zoothera sibirica</i>	Siberian Thrush	LC	Sp. not listed	R/PM. Rarity	Not given	Not given	
168	<i>Turdus obscurus</i>	Eyebrowed Thrush	LC	Sp. not listed	U/PM	Not given	Not given	
169	<i>Gerygone sulphurea</i>	Golden-bellied Gerygone	LC	Sp. not listed	C/RB	Not given	LC	
170	<i>Phylloscopus inornatus</i>	Yellow-browed Warbler	LC	Sp. not listed	R/PM WV. Rarity	Not given	Not given	
171	<i>Phylloscopus borealis</i>	Arctic Warbler	LC	Sp. not listed	C/WV PM	Not given	Not given	
172	<i>Phylloscopus coronatus</i>	Eastern Crowned Warbler	LC	Sp. not listed	U/WV	Not given	Not given	
173	<i>Acrocephalus orientalis</i> , <i>Acrocephalus arundinaceus</i>	Oriental Reed Warbler, Great Reed	LC	Sp. not listed	C/WV	Not given	Not given	
174	<i>Locustella certhiola</i>	Pallas's Grasshopper Warbler	LC	Sp. not listed	U/WV PM	Not given	Not given	
175	<i>Locustella lanceolata</i>	Lanceolated Warbler	LC	Sp. not listed	R/WV PM. Rarity	Not given	Not given	
176	<i>Orthotomus sutorius</i>	Common Tailorbird	LC	Sp. not listed	C/RB	Not given	LC	
177	<i>Orthotomus atrogularis</i>	Dark-necked Tailorbird	LC	Sp. not listed	C/RB	Not given	LC	
178	<i>Orthotomus ruficeps</i>	Ashy Tailorbird	LC	Sp. not listed	C/RB	Not given	LC	
179	<i>Orthotomus sericeus</i>	Rufous-tailed Tailorbird	LC	Sp. not listed	U/RB	Not given	LC	
180	<i>Prinia flaviventris</i>	Yellow-bellied Prinia	LC	Sp. not listed	C/RB	Not given	LC	

No.	Scientific Name	Common Name [English]	CONSERVATION STATUS					Status in Nature Reserves 1997 <sup>5</sup>
			IUCN Red List (2015.02) <sup>1</sup>	SRDB National Status <sup>2</sup>	NSS (2011) <sup>3</sup>	CRL WG Report 'International Conservation Status' <sup>4</sup>	CRL WG Report 'National Status' <sup>4</sup>	
181	<i>Rhinomyias brunneatus</i>	Brown-chested Jungle-Flycatcher	VU	Sp. not listed	R/WV PM **. Rarity	ITT	Not given	
182	<i>Muscicapa sibirica</i>	Dark-sided Flycatcher	LC	Sp. not listed	U/WV PM	Not given	Not given	
183	<i>Muscicapa dauurica</i>	Asian Brown Flycatcher	LC	Sp. not listed	C/WV PM	Not given	Not given	
184	<i>Muscicapa williamsoni</i>	Brown-streaked Flycatcher	Not Assessed	Sp. not listed	R/RW Rarity	Not given	Not given	
185	<i>Muscicapa ferruginea</i>	Ferruginous Flycatcher	LC	Sp. not listed	U/WV PM	Not given	Not given	
186	<i>Ficedula zanthopygia</i>	Yellow-rumped Flycatcher	LC	Sp. not listed	U/PM	Not given	Not given	
187	<i>Ficedula mugimaki</i>	Mugimaki Flycatcher	LC	Sp. not listed	U/PM	Not given	Not given	
188	<i>Cyanoptila cyanomelana</i>	Blue-and-white Flycatcher	LC	Sp. not listed	R/PM. Rarity	Not given	Not given	
189	<i>Rhipidura javanica</i>	Malaysian Pied Fantail	LC	Sp. not listed	C/RB	Not given	LC	
190	<i>Hypothymis azurea</i>	Black-naped Monarch	LC	CR	R/R(B) ##. Rarity	Not given	CR	
191	<i>Terpsiphone atrocauda</i>	Japanese Paradise-flycatcher	NT	Sp. not listed	R/PM *. Rarity	INT	Not given	
192	<i>Terpsiphone paradisi</i>	Asian Paradise-flycatcher	LC	Sp. not listed	C/PM WV	Not given	Not given	
193	<i>Motacilla cinerea</i>	Grey Wagtail	LC	Sp. not listed	U/WV PM	Not given	Not given	
194	<i>Dendronanthus indicus</i>	Forest Wagtail	LC	Sp. not listed	U/WV PM	Not given	Not given	
195	<i>Lanius cristatus</i>	Brown Shrike	LC	Sp. not listed	C/WV PM	Not given	Not given	
196	<i>Lanius tigrinus</i>	Tiger Shrike	LC	Sp. not listed	C/WV PM	Not given	Not given	
197	<i>Aplonis panayensis</i>	Asian Glossy Starling	LC	Sp. not listed	C/RB	Not given	LC	
198	<i>Agropsar sturninus</i> , <i>Sturnus sturninus</i>	Purple-backed or Daurian Starling	LC	Sp. not listed	C/WV PM	Not given	Not given	
199	<i>Acridotheres tristis</i>	Common Myna	LC	Sp. not listed	C/RB	Not given	LC	
200	<i>Acridotheres javanicus</i> , <i>Acridotheres cinereus</i>	Javan Myna, Pale-bellied Myna, White-vented Myna	LC	Sp. not listed	A/IRB	Not given	Not given	
201	<i>Gracula religiosa</i>	Common Hill Myna	LC	Sp. not listed	U/RB #	Not given	NT	
202	<i>Anthreptes malacensis</i>	Brown-throated Sunbird	LC	Sp. not listed	C/RB	Not given	LC	
203	<i>Leptocoma brasiliana</i> , <i>Nectarinia sperata</i>	Van Hasselt's or Purple-throated Sunbird	LC	Sp. not listed	C/RB	Not given	LC	
204	<i>Cinnyris jugularis</i> , <i>Nectarinia jugularis</i>	Olive-backed Sunbird	LC	Sp. not listed	C/RB	Not given	LC	
205	<i>Aethopyga siparaja</i>	Crimson Sunbird	LC	Sp. not listed	C/RB	Not given	LC	
206	<i>Arachnothera longirostra</i>	Little Spiderhunter	LC	Sp. not listed	U/RB	Not given	LC	Keys species. Breeding recorded
207	<i>Arachnothera crassirostris</i>	Thick-billed Spiderhunter	LC	CR	R/R(B) ##. Rarity	Not given	CR	Key species
208	<i>Arachnothera chrysogenys</i>	Yellow-eared Spiderhunter	LC	CR	R/R(B) ##. Rarity	Not given	CR	Key species
209	<i>Dicaeum chrysorrheum</i>	Yellow-vented Flowerpecker	LC	CR	R/R(B) ##. Rarity	Not given	CR	Key species. Breeding recorded
210	<i>Dicaeum trigonostigma</i>	Orange-bellied Flowerpecker	LC	Sp. not listed	C/RB	Not given	LC	
211	<i>Dicaeum cruentatum</i>	Scarlet-backed Flowerpecker	LC	Sp. not listed	C/RB	Not given	LC	
212	<i>Zosterops palpebrosus</i>	Oriental White-eye	LC	Sp. not listed	U/I? RB	Not given	Not given	
213	<i>Passer montanus</i>	Eurasian Tree Sparrow	LC	Sp. not listed	C/RB(I)?	Not given	LC	
214	<i>Lonchura striata</i>	White-rumped Munia	LC	CR	R/RB ##. Rarity	Not given	CR	
215	<i>Lonchura leucogastroides</i>	Javan Munia	LC	Sp. not listed	U/IRB	Not given	Not given	
216	<i>Lonchura punctulata</i>	Scaly-breasted Munia	LC	Sp. not listed	C/RB	Not given	LC	
217	<i>Lonchura malacca</i> , <i>Munia atricapilla</i>	Black-headed or Chestnut Munia	LC	Sp. not listed	C/RB	Not given	CR	
218	<i>Lonchura maja</i>	White-headed Munia	LC	Sp. not listed	C/RB	Not given	CR	

#### References

1. IUCN Red List of Threatened Species 2015.02. Retrieved from <http://www.iucnredlist.org/> Abbreviations include:

DD: Data Deficient; LC: Least Concern; NT: Near Threatened; VU: Vulnerable; EN: Endangered; CR: Critically Endangered

2. Davison GWH, Ng PKL and Ho HC. (2008) **Singapore Red Data Book**. Abbreviations include:

DD: Data Deficient (status indeterminate, requires further validation); VU: Vulnerable; EN: Endangered; CR: Critically Endangered

NE: Presumed Nationally extinct; EX: Globally Extinct

3. NSS Bird Group Records Committee (2011 unpublished) **Checklist of the Birds of Singapore**. Abbreviations include:

ABUNDANCE - RB: Resident Breeder; R(B): Resident, breeding not proven; WV: Winter Visitor; PM: Passage Migrant; MB: Migrant Breeder; MBV: Non-breeding Visitor; A: Accidental Visitor; I: Introduced;

?: Status Unknown

STATUS - A: Abundant; C: Common; U: Uncommon; R: Rare. Rarity: Classified as Rarities

CONSERVATION STATUS: \*\* Globally Threatened Species; \* Globally Near-threatened Species; ## Nationally Threatened Species; # Nationally Near-threatened Species

4. Cheong LF, Chua MAH, D'Rozario V, Jamal F, Khoo SK, Koh JKH, Lim KKP, O'Dempsey T and Rajathurai S (2014) **Cross Island Line Working Group Report**. Abbreviations for National Status include:

LC: Least Concern; NT: Near Threatened; VU: Vulnerable; EN: Endangered; CR: Critically Endangered; NT: Nationally threatened/ near-threatened

When a second status is given in brackets this indicates 2008 status is under review and likely to change to that given in brackets

Abbreviations to International Status include ITT: internationally threatened; INT: internationally near-threatened

5. Lim, K.S (1997). **Bird Biodiversity in the Nature Reserves of Singapore**. In Chan, L & Corlett, R.T. (Eds), Biodiversity in the Nature Reserves of Singapore. (pp. 225 – 244). Singapore: National Parks Board.

Annex 8C

## Mammal Species (Secondary Data)

**ANNEX 8C MAMMAL SPECIES IN STUDY AREA, REPORTED FROM SECONDARY DATA**

No.	Scientific Name	Common Name [English]	CONSERVATION STATUS			
			IUCN Red List (2015.02) <sup>1</sup>	CITES Appendix	SRDB National Status <sup>2</sup>	CRL WG Report 'National Status' <sup>3</sup>
1	<i>Tupaia glis</i>	Common Treeshrew	LC		LC	LC
2	<i>Galeopterus variegatus</i>	Malayan Colugo	LC		LC	LC
3	<i>Nycticebus coucang</i>	Sunda Slow Loris	VU	Appendix I	CR	CR (Internationally VU)
4	<i>Macaca fascicularis</i>	Long-tailed Macaque	LC	Appendix II	LC	LC
5	<i>Callosciurus notatus</i>	Plantain Squirrel	LC		LC	LC
6	<i>Iomys horsfieldii</i>	Horsfield's Flying Squirrel	LC		EN	EN
7	<i>Sundasciurus tenuis</i>	Slender Squirrel	LC		LC	LC
8	<i>Rattus annandalei</i>	Annandale's Rat	LC		LC	LC
9	<i>Rattus tiomanicus</i>	Malaysian Wood Rat	LC		LC	LC
10	<i>Cynopterus brachyotis</i>	Common Fruit Bat, Lesser Dog-faced Fruit Bat	LC		LC	LC
11	<i>Eonycteris spelaea</i>	Cave Nectar Bat	LC		LC	LC
12	<i>Pteropus vampyrus</i>	Large Flying Fox	NT	Appendix II	Not Assessed	Not Assessed (Internationally NT, visitor)
13	<i>Rhinolophus lepidus</i>	Glossy Horseshoe Bat	LC		LC	LC
14	<i>Rhinolophus luctus</i>	Greater Woolly Horseshoe Bat	LC		CR	CR
15	<i>Rhinolophus trifolatus</i>	Trefoil Horseshoe Bat	LC		CR	CR
16	<i>Saccolaimus saccolaimus</i>	Pouch-bearing Bat	LC		LC	LC
17	<i>Nycteris tragata</i>	Malayan Slit-faced Bat	NT		CR	CR (Internationally NT)
18	<i>Cheiromeles torquatus</i>	Naked Bulldog Bat	LC		CR	CR
19	<i>Myotis muricola</i>	Whiskered Myotis	LC		LC	LC
20	<i>Myotis adversus</i>	Grey Large-footed Myotis	LC		LC	LC
21	<i>Pipistrellus</i> sp.	Unconfirmed species			Not Assessed	Not Assessed
22	<i>Scotophilus kuhlii</i>	Lesser Asiatic Yellow House Bat	LC		LC	LC
23	<i>Tylonycteris robustula</i>	Greater Bamboo Bat	LC		LC	LC
24	<i>Manis javanica</i>	Sunda Pangolin	CR	Appendix II	CR	CR (Internationally EN)
25	<i>Arctogalidia trivirgata</i>	Small-toothed Palm Civet	LC		CR	CR
26	<i>Paquma larvata</i>	Masked Palm Civet	LC	Appendix III	CR	CR (Indeterminate status)
27	<i>Paradoxurus hermaphroditus</i>	Common Palm Civet	LC	Appendix III	LC	LC
28	<i>Viverra zangalunga</i>	Malay Civet	LC		Not Assessed	Not Assessed (Indeterminate status)
29	<i>Sus scrofa</i>	Wild Pig	LC		LC	LC
30	<i>Tragulus kanchil</i>	Lesser Mousedeer, Lesser Oriental Chevrotain	LC		CR	CR

**References**

1. IUCN Red List of Threatened Species 2015.02. Retrieved from <http://www.iucnredlist.org/> Abbreviations include:

DD: Data Deficient; LC: Least Concern; NT: Near Threatened; VU: Vulnerable; EN: Endangered; CR: Critically Endangered

2. Davison GWH, Ng PKL and Ho HC. (2008) **Singapore Red Data Book**. Abbreviations include:

DD: Data Deficient (status indeterminate, requires further validation); VU: Vulnerable; EN: Endangered; CR: Critically Endangered; NE: Presumed Nationally extinct; EX: Globally Extinct

3. Cheong LF, Chua MAH, D'Rozario V, Jamal F, Khoon SK, Koh JKH, Lim KKP, O'Dempsey T and Rajathurai S (2014)

**Cross Island Line Working Group Report**. Abbreviations for National Status include:

LC: Least Concern; NT: Near Threatened; VU: Vulnerable; EN: Endangered; CR: Critically Endangered

Annex 8D

## Herpetofauna (Secondary Data)



**ANNEX 8D HERPETOFAUNA SPECIES IN STUDY AREA, REPORTED FROM SECONDARY DATA**

No.	Scientific Name	Common Name [English]	CONSERVATION STATUS				
			IUCN Red List (2015.02) <sup>1</sup>	CITES Appendix	SRDB National Status <sup>2</sup>	CRL WG Report 'National Status' <sup>3</sup>	NUS Broad-Based Biodiversity Study 'Country Status' (Abundance Category at MacRitchie Reservoir) <sup>6</sup>
REPTILES							
1	<i>Cuora amboinensis</i>	Malayan Box Terrapin, Southeast Asian Box Turtle	VU	All <i>Cuora</i> spp. are Appendix II	Sp. not listed	LC (Internationally VU)	Native. Restricted, Common (1)
2	<i>Heosemys grandis</i>	Giant Asian Pond Turtle	VU	Appendix II	Sp. not listed	Sp. not listed	Sp. not listed
3	<i>Heosemys spinosa</i>	Spiny Hill Terrapin, Sunburst Turtle	EN	Appendix II	VU	VU (Internationally EN)	Sp. not listed
4	<i>Notochelys platynota</i>	Malayan Flat-shelled Terrapin	VU	Appendix II	EN	EN (Internationally VU)	Sp. not listed
5	<i>Trachemys decussata</i>	Cuban Slider	Not assessed		Sp. not listed	Sp. not listed	Alien. Unknown (3)
6	<i>Trachemys scripta elegans</i>	Red-eared Slider	Not assessed		Sp. not listed	Sp. not listed	Alien. Widespread, Common (4)
7	<i>Amyda cartilaginea</i>	Asian Softshell Turtle	VU	Appendix II	EN	EN (Internationally VU)	Sp. not listed
8	<i>Dogania subplana</i>	Malayan Forest Softshell Turtle	LC	Appendix II	CR	CR	Sp. not listed
9	<i>Aphanotis fusca</i>	Dusky Earless Agamid, Dusky Earless Agama	LC		EN	EN	Sp. not listed
10	<i>Bronchocela cristatella</i>	Green Crested Lizard	LC		Sp. not listed	LC	Sp. not listed
11	<i>Draco melanopogon</i>	Black-bearded Flying Dragon	Not assessed		VU	VU	Sp. not listed
12	<i>Draco quinquefasciatus</i>	Five-banded Flying Dragon	Not assessed		EN	Not given	Sp. not listed
13	<i>Draco sumatranus</i>	Sumatran Flying Dragon	Not assessed		Sp. not listed	LC	Sp. not listed
14	<i>Cnemaspis kendallii</i>	Kendall's Rock Gecko	Not assessed		VU	VU	Sp. not listed
15	<i>Cyrtodactylus majulah</i>	Singapore Bent-Toed Gecko (formerly confused with Marbled Bent-Toed Gecko)	Not assessed		VU	??	Sp. not listed
16	<i>Gehyra mutilata</i>	Four-clawed Gecko	DD		Sp. not listed	LC	Sp. not listed
17	<i>Gekko monarchus</i>	Spotted House Gecko	Not assessed		Sp. not listed	LC	Sp. not listed
18	<i>Hemidactylus frenatus</i>	Spiny-Tailed House Gecko	LC		Sp. not listed	LC	Listed as Common House Gecko. Native. Widespread, Common (3)
19	<i>Hemiphyllodactylus typus</i>	Lowland Dwarf Gecko	LC		VU	VU	Sp. not listed
20	<i>Dasia grisea</i>	Brown Tree Skink	Not assessed		EN	EN	Sp. not listed
21	<i>Eutropis multifasciatus</i>	Many-Lined Sun Skink	Not assessed		Sp. not listed	LC	Listed as Common sun skink. Native. Widespread, Common (4)
22	<i>Eutropis rugifera</i>	Striped Sun Skink	Not assessed		EN	EN	Sp. not listed
23	<i>Lipinia vittigera</i>		Not assessed		EN	EN	Sp. not listed
24	<i>Sphenomorphus</i> sp.	Malayan Swamp Skink	Not assessed		Sp. not listed	CR	Sp. not listed
25	<i>Varanus nebulosus</i>	Clouded Monitor	LC	Appendix I	Sp. not listed	LC	Native. Restricted, Common (3)
26	<i>Varanus salvator</i>	Malayan Water Monitor	LC	All <i>Varanus</i> spp. are Appendix II	Sp. not listed	LC	Native. Widespread, Common (4)
27	<i>Xenopeltis unicolor</i>	Sunbeam Snake	LC		Sp. not listed	LC	Sp. not listed
28	<i>Broghammerus reticulatus</i>	Reticulated Python	Not assessed		Sp. not listed	LC	Sp. not listed
29	<i>Ahaetulla mycterizans</i>	Malayan Whip Snake, Big-eye Green Whip Snake	LC		CR	CR	Sp. not listed
30	<i>Ahaetulla prasina</i>	Oriental Whip Snake/ Gunther's Whip Snake	LC		Sp. not listed	LC	Native. Widespread, Common (2)
31	<i>Boiga cynodon</i>	Dog-toothed Cat Snake	LC		EN	EN	Native. Restricted, Rare (1)
32	<i>Boiga dendrophila</i>	Gold-ringed Cat Snake	Not assessed		VU	VU	Sp. not listed
33	<i>Calamaria lumbricoidea</i>	Variable Reed Snake	LC		EN	EN	Sp. not listed
34	<i>Calamaria schlegelii</i>	Pink-headed Reed Snake	LC		VU	VU	Sp. not listed
35	<i>Chrysopelea paradisi</i>	Paradise Gliding Snake	LC		Sp. not listed	LC	Sp. not listed
36	<i>Chrysopelea pelias</i>	Twin-barred Gliding Snake	LC		VU	VU	Sp. not listed
37	<i>Coelognathus flavolineatus</i>	Common Malayan Racer	LC		EN	EN	Sp. not listed
38	<i>Dendrelaphis caudolineatus</i>	Striped Bronzeback	Not assessed		Sp. not listed	LC	Sp. not listed
39	<i>Dendrelaphis formosus</i>	Elegant Bronzeback	LC		EN	EN	Sp. not listed
40	<i>Dendrelaphis haasi</i>	Hass' Bronzeback	LC		Sp. not listed	??	Sp. not listed
41	<i>Dendrelaphis pictus</i>	Painted Bronzeback	LC		Sp. not listed	LC	Native. Widespread, Common (2)
42	<i>Dendrelaphis cyanochloris</i>	Blue Bronzeback	LC		Sp. not listed	??	Sp. not listed
43	<i>Dendrelaphis kopsteini</i>	Red-necked Bronzeback	LC		VU	Not given	Sp. not listed
44	<i>Gongylosoma baliodeirum</i>	Orange-bellied Ringneck	LC		EN	EN	Sp. not listed
45	<i>Gonyosoma oxycephalum</i>	Red-tailed Racer	LC		EN	EN	Sp. not listed
46	<i>Lycodon capucinus</i>	House Wolf Snake	LC		Sp. not listed	LC	Sp. not listed
47	<i>Oligodon octolineatus</i>	Striped Kukri Snake	LC		Sp. not listed	LC	Sp. not listed
48	<i>Oligodon signatus</i>	Barred Kukri Snake	LC		CR	CR	Sp. not listed
49	<i>Pseudorabdion longiceps</i>	Dwarf Reed Snake	LC		EN	EN	Sp. not listed
50	<i>Ptyas carinata</i>	Keeled Rat Snake	LC		Sp. not listed	LC	Sp. not listed
51	<i>Ptyas korros</i>	Indochinese Rat Snake	Not assessed		Sp. not listed	LC	Sp. not listed

No.	Scientific Name	Common Name [English]	CONSERVATION STATUS				
			IUCN Red List (2015.02) <sup>1</sup>	CITES Appendix	SRDB National Status <sup>2</sup>	CRL WG Report 'National Status' <sup>3</sup>	NUS Broad-Based Biodiversity Study 'Country Status' (Abundance Category at MacRitchie Reservoir) <sup>5</sup>
52	<i>Sibynophis melanocephalus</i>	Black-headed Collared Snake	LC		EN	EN	Sp. not listed
53	<i>Macropisthodon rhodometas</i>	Blue-necked Keelback	LC		EN	EN	Sp. not listed
54	<i>Xenochrophis maculatus</i>	Spotted Keelback	LC		VU	EN	Sp. not listed
55	<i>Calliophis bivirgatus</i>	Blue Malayan Coral Snake	LC		VU	VU	Sp. not listed
56	<i>Calliophis intestinalis</i>	Banded Malayan Coral Snake	LC		VU	VU	Sp. not listed
57	<i>Naja sumatrana</i>	Black Spitting Cobra	LC	Appendix II	Sp. not listed	VU	Sp. not listed
58	<i>Ophiophagus hannah</i>	King Cobra	VU	Appendix II	EN	LC	Sp. not listed
59	<i>Tropidolaemus wagleri</i>	Wagler's Pit-viper	LC		EN	EN	Sp. not listed
<b>AMPHIBIANS</b>							
1	<i>Duttaphrynus melanostictus</i>	Asian Toad, Black-spectacled Toad	LC		Sp. not listed	LC	Native. Widespread, Common (3)
2	<i>Ingerophrynus quadruporcatus</i>	Four-ridged Toad	LC		Sp. not listed	LC	Native. Restricted, Common (2)
3	<i>Kaloula pulchra</i>	Banded Bullfrog, Malaysian Narrowmouth Toad	LC		Sp. not listed	Sp. not listed	Alien. Widespread, Common (3)
4	<i>Leptobrachium nigrops</i>	Black-eyed Litter Frog	LC		Sp. not listed	LC	Native. Restricted, Common (4)
5	<i>Fejervarya limnocharis</i>	Field Frog	LC		Sp. not listed	LC	
6	<i>Limnonectes blythii</i>	Malayan Giant Frog	NT		Sp. not listed	LC (Internationally NT)	Native. Restricted, Common (3)
7	<i>Limnonectes malesianus</i>	Malesian Frog	NT		Sp. not listed	LC (Internationally NT)	Sp. not listed
8	<i>Occidozyga sumatrana</i>	Yellow-bellied Puddle Frog, Sumatran Puddle Frog	LC		Sp. not listed	LC	Native. Restricted, Common (3)
9	<i>Hylarana erythraea</i>	Green Paddy Frog	LC		Sp. not listed	LC	Listed as Common Greenback. Status Native. Widespread, Common (3)
10	<i>Hylarana labialis</i>	Copper-cheeked Frog	LC		Sp. not listed	LC	Native. Restricted, Common (4)
11	<i>Hylarana baramica</i>	Golden-eared Rough-sided Frog	LC		VU	VU	Native. Restricted, Rare (2)
12	<i>Hylarana laterimaculata</i>	Masked Rough-sided Frog	LC		Sp. not listed	LC	Native. Restricted, Uncommon (1)
13	<i>Nyctixalus pictus</i>	Cinnamon Bush Frog	NT		VU	VU	
14	<i>Polypedates leucomystax</i>	Four-lined Tree Frog	LC		Sp. not listed	LC	Native. Widespread, Common (3)
15	<i>Kalophrynus limbooliati</i> , <i>Kalophrynus pleurostigma</i>	Black-spotted Sticky Frog	LC		VU	VU	Sp. not listed
16	<i>Microhyla heymonsi</i>	Dark-sided Chorus Frog	LC		Sp. not listed	LC	Sp. not listed
17	<i>Microhyla mantheyi</i>	Manthey's Chorus Frog	LC		CR	CR	Sp. not listed
18	<i>Microhyla butleri</i>	Painted Chorus Frog	LC		Sp. not listed	LC	Sp. not listed

#### References

- IUCN Red List of Threatened Species 2015.02. Retrieved from <http://www.iucnredlist.org/> Abbreviations include:  
NE: Not Evaluated; DD: Data Deficient; LC: Least Concern; NT: Near Threatened; VU: Vulnerable; EN: Endangered; CR: Critically Endangered
- Davison GWH, Ng PKL and Ho HC. (2008) **Singapore Red Data Book**. Abbreviations include:  
DD: Data Deficient (status indeterminate, requires further validation); VU: Vulnerable; EN: Endangered; CR: Critically Endangered  
NE: Presumed Nationally extinct; EX: Globally Extinct
- Cheong LF, Chua MAH, D'Rozario V, Jamal F, Khoon SK, Koh JKH, Lim KKP, O'Dempsey T and Raiathurai S (2014). **Cross Island Line Working Group Report**. Abbreviations for National Status include: LC: Least Concern; NT: Near Threatened; VU: Vulnerable; EN: Endangered; CR: Critically Endangered
- Ng PKL, Tan HTW, Hui TH, Yeo D (2008) **Final Report of the Broad-Based Biodiversity Study of Singapore's Reservoirs-MacRitchie Reservoir**. Dep. of Biological Sciences National University of Singapore. Definitions of status categories (Endangered, Vulnerable, Rare, Common) are based on IUCN categories and defined on p25&26  
Relative Abundance Definitions include: 1-Rare and/or restricted; 2-Uncommon and/or restricted; 3-Common and restricted; 4-Common and widespread

**Note** this study focused on the MacRitchie Reservoir area and a surrounding area within a 5-metre limit from the reservoir's water edge and immediately adjacent water bodies

Annex 8E

## Butterfly Species List (Secondary Data)

ANNEX 8E BUTTERFLY SPECIES IN STUDY AREA, REPORTED FROM SECONDARY DATA

No.	Scientific Name	Common Name [English]	IUCN Red List (2015.02) <sup>1</sup>	SRDB National Status <sup>2</sup> (refers to IUCN Status at the time in 2008)	CRL WG Report <sup>3</sup> National Status <sup>3</sup>
Family : Papilionidae Subfamily : Papilioninae					
1	<i>Chilasa clytia clytia</i>	Common Mime	Not Assessed	Not given	LC
2	<i>Graphium agamemnon agamemnon</i>	Tailed Jay	Not Assessed	Not given	LC
3	<i>Graphium everon everon</i>	Blue Jay	Not Assessed	Not given	LC
4	<i>Graphium sarpedon luctatus</i>	Common Bluebottle	Not Assessed	Not given	LC
5	<i>Papilio demoleus malayanus</i>	Lime Butterfly	Not Assessed	Not given	LC
6	<i>Papilio demoleon demoleon</i>	Banded Swallowtail	Not Assessed	Not given	LC
7	<i>Papilio iswara iswara</i>	Great Helen	Not Assessed	Not given	NT
8	<i>Papilio memnon aenor</i>	Great Mormon	Not Assessed	Not given	Sp. not listed
9	<i>Papilio polytes romulus</i>	Common Mormon	Not Assessed	Not given	LC
10	<i>Papilio prexaspes prexaspes</i>	Blue Helen	Not Assessed	VU	VU
11	<i>Pathysa antiphates itamputi</i>	Five Bar Swordtail	Not Assessed	Not given	LC
12	<i>Troides helena cerberus</i>	Common Birdwing	Not Assessed	VU	LC
Family : Pieridae Subfamily : Pierinae					
13	<i>Appias libythea offerna</i>	Striped Albatross	Not Assessed	Not given	LC
14	<i>Appias lycinda vesavo</i>	Chocolate Albatross	Not Assessed	Not given	Seasonal Migrant
15	<i>Delias hyparete metarete</i>	Painted Jezebel	Not Assessed	Not given	LC
16	<i>Leptosa nina malaya</i>	Psyche	Not Assessed	Not given	LC
Family : Pieridae Subfamily : Coliadinae					
17	<i>Catopsilia pyranthe pyranthe</i>	Mottled Emigrant	Not Assessed	Not given	LC
18	<i>Catopsilia pomona pomona</i>	Lemon Emigrant	Not Assessed	Not given	LC
19	<i>Eurema andersoni andersoni</i>	Anderson's Grass Yellow/ One-spot Yellow Grass	LC	Not given	LC
20	<i>Eurema blanda snelleni</i>	Three Spot Grass Yellow	Not Assessed	Not given	LC
21	<i>Eurema hecabe contubernalis</i>	Common Grass Yellow	Not Assessed	Not given	LC
22	<i>Eurema sari sodalis</i>	Chocolate Grass Yellow	Not Assessed	Not given	LC
23	<i>Eurema simulatrix tecmessa</i>	Not Assessed	Not Assessed	Not given	LC
24	<i>Garduca hanna distanti</i>	Tree Yellow	Not Assessed	Not given	LC
Family : Nymphalidae Subfamily : Danainae					
25	<i>Euploea crameri bremeri</i>	Spotted Black Crow	Not Assessed	Not given	LC
26	<i>Euploea eynodhovi gardineri</i>	Striped Black Crow	Not Assessed	Not given	LC
27	<i>Euploea mulciber mulciber</i>	Striped Blue Crow	Not Assessed	Not given	LC
28	<i>Euploea midamus singapura</i>	Blue Spotted Crow	Not Assessed	Not given	LC
29	<i>Euploea phaeareta castelnaui</i>	King Crow	Not Assessed	Not given	Sp. not listed
30	<i>Euploea radamanthus radamanthus</i>	Magpie Crow	Not Assessed	Not given	LC
31	<i>Parantica aedeoides aedeoides</i>	Dark Glassy Tiger	Not Assessed	Not given	LC
32	<i>Ideopsis vulcanis macrina</i>	Blue Glassy Tiger	Not Assessed	Not given	LC
33	<i>Idea stoll logani</i>	Common Tree Nymph	Not Assessed	Not given	NT
Family : Nymphalidae Subfamily : Satyrinae					
34	<i>Elymnias panthera panthera</i>	Tawny Palmfly	Not Assessed	Not given	LC
35	<i>Elymnias hypermnestra agina</i>	Common Palmfly	Not Assessed	Not given	LC
36	<i>Lethe europa malaya</i>	Bamboo Tree Brown	Not Assessed	Not given	LC
37	<i>Mycalesis fusca fusca</i>	Malayan Bush Brown	Not Assessed	Not given	LC
38	<i>Mycalesis mineus macromalaya</i>	Dark Brand Bush Brown	Not Assessed	Not given	LC
39	<i>Mycalesis orseis nautilus</i>	Purple Bush Brown	Not Assessed	Not given	LC
40	<i>Mycalesis perseus cepheus</i>	Dinky Bush Brown	Not Assessed	Not given	LC
41	<i>Mycalesis perseoides perseoides</i>	Long Brand Bush Brown in SRDB2008	Not Assessed	DD	LC
42	<i>Mycalesis visala phanis</i>	Long Brand Bush Brown. No name in SRDB2008	Not Assessed	Not given	LC
43	<i>Orsotriaena medus cinerea</i>	Nigger	Not Assessed	Not given	LC
44	<i>Ypthima huebneri</i>	Common Four Ring	Not Assessed	Not given	LC
45	<i>Ypthima baktus newboldi</i>	Common Five Ring	Not Assessed	Not given	LC
46	<i>Ypthima horsfieldi humei</i>	Malayan Five Ring	Not Assessed	Not given	LC
47	<i>Ypthima pandocus corticaria</i>	Common Three Ring	Not Assessed	Not given	LC
Family : Nymphalidae Subfamily : Morphinae					
48	<i>Amathusia phidippus phidippus</i>	Palm King	Not Assessed	Not given	Sp. not listed
49	<i>Faunis canens arcesilas</i>	Common Faun	Not Assessed	Not given	LC
50	<i>Thaumantis klugius klugior</i>	Dark Blue Jungle Glory	Not Assessed	Not given	LC
51	<i>Zeuxidia amethystus amethystus</i>	Saturn	Not Assessed	Not given	LC
Family : Nymphalidae Subfamily : Nymphalinae					
52	<i>Dolichocallis bisaltide bisaltide</i>	Autumn Leaf	Not Assessed	Not given	LC
53	<i>Hypolimnas anomala anomala</i>	Malayan Eggfly	Not Assessed	Not given	LC
54	<i>Hypolimnas bolina jacintha / Hypolimnas bolina bolina</i>	Jacintha Eggfly / Great Eggfly	Not Assessed	Not given	LC
55	<i>Junonia almana javana</i>	Peacock Pansy	LC	Not given	LC
56	<i>Junonia hedonia ida</i>	Chocolate Pansy	Not Assessed	Not given	LC
57	<i>Junonia orithya wallacei</i>	Blue Pansy	Not Assessed	Not given	LC
Family : Nymphalidae Subfamily : Heliconiinae					
58	<i>Cethosia hypsea hypsea</i>	Malay Lacewing	Not Assessed	Not given	LC
59	<i>Cethosia penthesilea methypsea</i>	Plain Lacewing	Not Assessed	CR	Sp. not listed
60	<i>Cirrochroa orissa orissa</i>	Banded Yeoman	Not Assessed	Not given	NT
61	<i>Cupha erymanthis lotis</i>	Rustic	Not Assessed	Not given	LC
62	<i>Phalanta phalantha phalantha</i>	Leopard	Not Assessed	Not given	LC
63	<i>Terinos teripander robertsia</i>	Royal Assyrian	Not Assessed	Not given	LC
64	<i>Vindula deione erotella</i>	Cruiser	Not Assessed	Not given	LC
Family : Nymphalidae Subfamily : Limenitidinae					
65	<i>Athyma asura idia</i>	Studded Sergeant	Not Assessed	Not given	LC
66	<i>Athyma kanwa kanwa</i>	Dot-Dash Sergeant	Not Assessed	Not given	LC
67	<i>Athyma nefte subrata</i>	Colour Sergeant	Not Assessed	Not given	LC
68	<i>Athyma reta moorei</i>	Malay Staff Sergeant	Not Assessed	Not given	Sp. not listed
69	<i>Athyma pravara helma</i>	Lance Sergeant	Not Assessed	Not given	LC
70	<i>Euthalia aconthea qurda</i>	Baron	Not Assessed	Not given	Sp. not listed
71	<i>Euthalia monina monina</i>	Malay Baron	Not Assessed	Not given	LC
72	<i>Lasippa heliodore dorela</i>	Burmese Lascar	Not Assessed	Not given	LC
73	<i>Lasippa itia siaka</i>	Malayan Lascar	Not Assessed	Not given	LC
74	<i>Lebadea martha parkeri</i>	Knight	Not Assessed	Not given	LC
75	<i>Lexias canescens pardalina</i>	Yellow Archduke	Not Assessed	Not given	NT
76	<i>Lexias dirtea mergula</i>	Black Tipped Archduke	Not Assessed	Not given	LC
77	<i>Lexias pardalis dirteana</i>	Archduke	Not Assessed	Not given	LC
78	<i>Moduza procris milonia</i>	Commander	Not Assessed	Not given	LC
79	<i>Neptis harita harita</i>	Chocolate Sailor	Not Assessed	VU	LC
80	<i>Neptis hylas papaia</i>	Common Sailor	Not Assessed	Not given	Sp. not listed
81	<i>Neptis leucoporus cresina</i>	Grey Sailor	Not Assessed	Not given	LC
82	<i>Pandita sinope sinope</i>	Colonel	Not Assessed	Sp. not listed	LC
83	<i>Pantoporia hordonia hordonia</i>	Common Lascar	Not Assessed	Not given	LC
84	<i>Pantoporia paraka paraka</i>	Perak Lascar	Not Assessed	Not given	LC
85	<i>Phaedyma columella siniga</i>	Short Banded Sailor	Not Assessed	Not given	LC
86	<i>Tanaecia lapis puseda</i>	Horsfield's Baron	Not Assessed	Not given	LC
87	<i>Tanaecia pelea pelea</i>	Malay Viscount	LC	Not given	LC
Family : Nymphalidae Subfamily : Apaturinae					
88	<i>Eulacura osteria kumana</i>	Purple Duke	Not Assessed	Not given	LC
Family : Nymphalidae Subfamily : Charaxinae					
89	<i>Polyura hebe plautus</i>	Plain Nawab	Not Assessed	Not given	LC
Family : Riodinidae					
90	<i>Abisara oeza niva</i>	Spotted Judy	LC	Not given	LC
91	<i>Abisara saturata kausambioides</i>	Malayan Plum Judy	Not Assessed	Not given	LC
92	<i>Abisara savitri savitri</i>	Malay Tailed Judy	Not Assessed	Not given	LC
93	<i>Laxta thuisto thuisto</i>	Lesser Harlequin	Not Assessed	Not given	NT
Family : Lycaenidae Subfamily : Poritiinae					
94	<i>Portia phlota phlota</i>	Malay Gem	Not Assessed	Not given	VU
95	<i>Portia sumatrae sumatrae</i>	Sumatran Gem	Not Assessed	Not given	LC
Family : Lycaenidae Subfamily : Miletinae					
96	<i>Alotinus unicolor unicolor</i>	Lesser Darkie	Not Assessed	Not given	LC
97	<i>Logania marmorata damis</i>	Pale Mottle	Not Assessed	Not given	LC
98	<i>Miletus biggsii biggsii</i>	Bigg's Brownie	Not Assessed	Not given	LC
99	<i>Miletus symethus petronius</i>	Blue Brownie	Not Assessed	Not given	LC
100	<i>Spalgis epus epus</i>	The Apelfy	Not Assessed	Not given	LC
Family : Lycaenidae Subfamily : Curetinae					
101	<i>Curetis santana malayica</i>	Malayan Sunbeam	Not Assessed	Not given	LC
Family : Lycaenidae Subfamily : Lycaeninae					
102	<i>Acytolepis puspa lambi</i>	Common Hedge Blue	Not Assessed	Not given	LC
103	<i>Anthea emolus gaberrus</i>	Ciliate Blue	Not Assessed	Not given	LC
104	<i>Arhopala abseus abseus</i>	Aberrant Oakblue	Not Assessed	Not given	LC
105	<i>Arhopala aedias agnis</i>	Large Metallic Oakblue	Not Assessed	DD	DD
106	<i>Arhopala ammon ammon</i>		Not Assessed	Not given	Sp. not listed

ANNEX 8E BUTTERFLY SPECIES IN STUDY AREA, REPORTED FROM SECONDARY DATA

No.	Scientific Name	Common Name [English]	CONSERVATION STATUS		
			IUCN Red List (2015.02) <sup>1</sup>	SRDB National Status <sup>2</sup> (refers to IUCN Status at the time in 2008)	CRL WG Report 'National Status' <sup>3</sup>
107	<i>Arhopala amphimuta amphimuta</i>		Not Assessed	NE	LC
108	<i>Arhopala athada athada</i>	Vinous Oakblue	Not Assessed	Not given	LC
109	<i>Arhopala atosia malayana</i>	Tailed Disc Oakblue	Not Assessed	Not given	LC
110	<i>Arhopala centaurus nakula</i>	Centaur Oak Blue	Not Assessed	Listed as 'Arhopala pseudocentaurus nakula' and no status given	LC
111	<i>Arhopala epimuta epiala</i>	Common Disc Oakblue	Not Assessed	Not given	LC
112	<i>Arhopala maior maior</i>		Not Assessed	DD	LC
113	<i>Arhopala myrzala lammas</i>		Not Assessed	Not given	CR
114	<i>Arhopala trogon</i>		Not Assessed	Not given	NT
115	<i>Caleta elia elvira</i>	Elbowed Pierrot	Not Assessed	Not given	LC
116	<i>Cheritra freja frigga</i>	Common Imperial	LC	Not given	LC
117	<i>Chilades pandava pandava</i>	Cycad Blue	Not Assessed	Not given	LC
118	<i>Deudorix epiarbas cinnabarus</i>	Cornelian	Not Assessed	Not given	LC
119	<i>Drupadia ravindra moorei</i>	Common Posy	Not Assessed	Not given	LC
120	<i>Drupadia theda thesmia</i>	Dark Posy	Not Assessed	Not given	LC
121	<i>Ecoxyklides theris distantii</i>	Banded Imperial	Not Assessed	Not given	LC
122	<i>Euchrysops cnelus cnelus</i>	Gram Blue	Not Assessed	Not given	LC
123	<i>Flos aedanus saturatus</i>	Plain PlushBlue	Not Assessed	Not given	LC
124	<i>Flos diardi capeta</i>	Bifid Plushblue	Not Assessed	Not given	LC
125	<i>Flos fulgida singapura</i>	Shining Plushblue	Not Assessed	Not given	LC
126	<i>Hypolycaena erylus teatus</i>	Common Tit	Not Assessed	Not given	LC
127	<i>Hypolycaena theclodes theclodes</i>		Not Assessed	Not given	Sp. not listed
128	<i>Ionolyce helicon merquiana</i>	Pointed Line Blue	Not Assessed	Not given	LC
129	<i>Jacoona anasua anasua</i>	Great Imperial	Not Assessed	DD	VU
130	<i>Jamides celeno aelianus</i>	Common Caerulean	Not Assessed	Not given	LC
131	<i>Loxura atymnus fuconius</i>	Yamfly	Not Assessed	Not given	LC
132	<i>Megisba malaya sikkima</i>	The Malayan	Not Assessed	Sp. not listed	LC
133	<i>Nacaduba berenice kerna</i>	Rounded 6-Line Blue	Not Assessed	Not given	LC
134	<i>Nacaduba berne neon</i>	Opacque Sixline Blue	Not Assessed	Not given	LC
135	<i>Nacaduba calaura malayica</i>	Dark Malayan Sixline Blue	Not Assessed	Not given	LC
136	<i>Nacaduba pactolus odon</i>	Large Four-line Blue	Not Assessed	NE	LC
137	<i>Nacaduba sanaya elioti</i>	Jewel Four-line Blue	LC	NE	LC
138	<i>Neocheritra amrita amrita</i>	Grand Imperial	Not Assessed	Not given	R
139	<i>Neoptheops zalmora zalmora</i>	The Quaker	Not Assessed	Not given	LC
140	<i>Prosothes dubiosa lumpura</i>	Tailless Line Blue	Not Assessed	Not given	LC
141	<i>Prosothes nora superdates</i>	Common Line-Blue	Not Assessed	Not given	LC
142	<i>Rachana jalindra burbona</i>	Banded Royal	Not Assessed	Sp. not listed	CR
143	<i>Rapala dienece dienece</i>	Scarlet Flash	Not Assessed	Not given	LC
144	<i>Rapala domitia domitia</i>	Yellow Flash	Not Assessed	Not given	Sp. not listed
145	<i>Rapala manea chozeba</i>	Slate Flash	Not Assessed	Not given	LC
146	<i>Rapala suffusa barthema</i>	Suffused Flash	Not Assessed	Not given	LC
147	<i>Rapala varuna orseis</i>	Indigo Flash	Not Assessed	Not given	LC
148	<i>Remelana langala travana</i>	Chocolate Royal	Not Assessed	Not given	LC
149	<i>Semanga superba deliciosa</i>		Not Assessed	Not given	LC
150	<i>Sinthusa nasaka amba</i>	Narrow Spark	Not Assessed	Not given	LC
151	<i>Spindasis lohita senama</i>	Long Banded Silverline	Not Assessed	Sp. not listed	Sp. not listed
152	<i>Spindasis svama terana</i>	Club/Black Banded Silverline	Not Assessed	Not given	LC
153	<i>Surendra vivarna amisenae/ Amblypodia vivarna</i>	Acacia Blue	LC	Not given	LC
154	<i>Tajuria mantra mantra</i>	Felder's Royal	Not Assessed	Not given	Sp. not listed
155	<i>Zellus amasa maximinianus</i>	Fluffy Tit	Not Assessed	Not given	LC
156	<i>Zizina otis lampia</i>	Lesser Grass Blue	Not Assessed	Not given	LC
<b>Family : Hesperidae Subfamily : Coeliadinae</b>					
157	<i>Burara etelka</i>	Great Orange Awlet	Not Assessed	<i>Bibasis etelka</i> given as 'Rare'	NT
158	<i>Burara harisa consobrina</i>	Orange Awlet	Not Assessed	<i>Bibasis harisa consobrina</i> , status not given	LC
159	<i>Hasora badra badra</i>	Common Awi	Not Assessed	Not given	LC
<b>Family : Hesperidae Subfamily : Pyrginae</b>					
160	<i>Odina hieroglyphica ortina</i>	Hieroglyphic Flat	Not Assessed	Sp. not listed	LC
161	<i>Odontoptilum angulatum angulatum</i>	Chestnut Angle	LC	Not given	LC
162	<i>Tagiades calligana</i>	Malayan Snow Flat	Not Assessed	Not given	NT
163	<i>Tagiades gana gana</i>	Large Snow Flat	Not Assessed	Not given	LC
164	<i>Tagiades iapetus atticus</i>	Common Snow Flat	Not Assessed	Not given	LC
165	<i>Tapena thwaitesi bornea</i>	Dark Flat	Not Assessed	EN	EN
<b>Family : Hesperidae Subfamily : Hesperinae</b>					
166	<i>Ampitia discoides cameris</i>	Bush Hopper	Not Assessed	Not given	LC
167	<i>Anisotroides nerita maura</i>	Chocolate Demon	Not Assessed	Not given	LC
168	<i>Caloris cornasa</i>	Full Stop Swift	Not Assessed	Not given	LC
169	<i>Eriopota thrax thrax</i>	Banana Skipper		Not given	LC
170	<i>Eriopota tonus</i>			Not given	LC
171	<i>Gangara lebaddea lebaddea</i>	Banded Redeye	Not Assessed	NE	CR
172	<i>Gangara thyrsis thyrsis</i>	Giant Redeye	Not Assessed	Not given	VU
173	<i>Lambrix salsala salsala</i>	Chestnut Bob	Not Assessed	Not given	LC
174	<i>Lambrix stellifer</i>	Starry Bob	Not Assessed	Not given	LC
175	<i>Notocrypta paralyos varians</i>	Banded Demon	Not Assessed	Not given	LC
176	<i>Oiens gola pseudolus</i>	Common Dartlet	Not Assessed	Not given	LC
177	<i>Pelepidas assamensis</i>	Great Swift	Not Assessed	Not given	Sp. not listed
178	<i>Pelepidas conjunctus conjunctus</i>	Conjoined Swift	Not Assessed	Sp. not listed	LC
179	<i>Pelepidas mathias mathias</i>	Small Branded Swift	Not Assessed	Not given	LC
180	<i>Plastigia naga</i>	Chequered Lancer	Not Assessed	Not given	LC
181	<i>Polytremis lubricans lubricans</i>	Contiguous Swift	Not Assessed	Not given	LC
182	<i>Potanthus omaha omaha</i>	Lesser Dart	Not Assessed	Not given	LC
183	<i>Potanthus trachala tyleri</i>	Detached Dart (/Lesser Band Dart in HK/ Broad Bident Dart in Thailand)	Not Assessed	Presumed Nationally Extinct (re-discovered 2011)	LC
184	<i>Pyronura latoia latoia</i>	Yellow Vein Lancer	Not Assessed	Not given	LC
185	<i>Quedara monteithi monteithi</i>		Not Assessed	Not given	NT
186	<i>Taractrocera archias quinta</i>	Yellow Grass Dart	Not Assessed	Not given	LC
187	<i>Taractrocera ardonia lama</i>	Spotted Grass Dart	Not Assessed	Not given	LC
188	<i>Telicota auqias auqias</i>	Palm Dart	Not Assessed	Not given	LC
189	<i>Telicota bestia bina</i>	Bestia Palm Dart	Not Assessed	Not given	LC
190	<i>Udaspes folis</i>	Grass Demon	Not Assessed	Not given	LC
191	<i>Unkana ambasa batara</i>	Hoary Palmer	Not Assessed	Not given	LC
192	<i>Zela storeyi</i>	Storey's Palmer	Not Assessed	CR	CR

References

1. IUCN Red List of Threatened Species 2015.02. Retrieved from <http://www.iucnredlist.org/> Abbreviations include:  
DD: Data Deficient; LC: Least Concern; NT: Near Threatened; VU: Vulnerable; EN: Endangered; CR: Critically Endangered

2. Davison GWH, Ng PKL and Ho HC. (2008) **Singapore Red Data Book**. Abbreviations include:  
DD: Data Deficient (status indeterminate, requires further validation); VU: Vulnerable; EN: Endangered; CR: Critically Endangered  
NE: Presumed Nationally extinct; EX: Globally Extinct

3. Cheong LF, Chua MAH, D'Rozario V, Jamal F, Khoo SK, Koh JKH, Lim KKP, O'Dempsey T and Rajathurai S (2014)

**Cross Island Line Working Group Report**. Abbreviations for National Status include:

LC: Least Concern; NT: Near Threatened; VU: Vulnerable; EN: Endangered; CR: Critically Endangered; NE: Nationally extinct



Annex 8F

## Odonate Species List (Secondary Data)

**ANNEX 8F ODONATE SPECIES IN STUDY AREA, REPORTED FROM SECONDARY DATA**

No.	Scientific Name	Common Name [English] (if available)	IUCN Red List (2015.02) <sup>1</sup>	SRDB National Status <sup>2</sup>	CRL WG Report 'National Status' <sup>3</sup>	NUS Broad-Based Biodiversity Study 'Country Status' (Abundance Category at MacRitchie Reservoir) <sup>4</sup>
<b>Suborder ZYGOPTERA (Damselflies)</b>						
<b>Family : Amphipterygidae</b>						
1	<i>Devadatta argyroides</i>	Malayan Grisette	LC	Sp. not listed	LC	Sp. not listed
<b>Family : Calopterygidae</b>						
2	<i>Neurobasis chinensis</i>	Green Metalwing	LC	NE	NE	Sp. not listed
3	<i>Vestalis amethystina</i>	Common Flashwing	LC	Sp. not listed	LC	Sp. not listed
<b>Family : Euphaeidae</b>						
4	<i>Euphaea impar</i>	Blue-sided satinwing	LC	Sp. not listed	LC	Sp. not listed
<b>Family : Lestidae (Spreadwings)</b>						
5	<i>Lestes praemorsus decipiens</i>	Crenulated Spreadwing	LC	Sp. not listed	NT	Native. Indeterminate (2)
6	<i>Platylestes heterostylus</i>	Slender Spreadwing	DD	Sp. not listed	CR	Sp. not listed
<b>Family : Megapodagrionidae</b>						
7	<i>Podolestes orientalis</i>	Blue-spotted Flatwing	LC	CR	NT	Sp. not listed
<b>Family : Coenagrionidae (Pond damsels/ Bluets)</b>						
8	<i>Agriocnemis femina</i>	Variable wisp/ Pinhead midget	LC	Sp. not listed	LC	Sp. not listed
9	<i>Agriocnemis nana</i>	Dwarf Wisp/ Nana midget	LC	CR	CR	Sp. not listed
10	<i>Amphicnemis gracilis</i>	Will-o-wisp/ Slender midget	Not Assessed	Sp. not listed	LC	Sp. not listed
11	<i>Archibasis melanocyana</i>	Blue-nosed sprite	Not Assessed	CR	VU	Sp. not listed
12	<i>Archibasis rebecca</i>	Rebecca's Sprite	NT	Sp. not listed	EN	Sp. not listed
13	<i>Archibasis viola</i>	Violet Sprite/ Oval-spotted sprite	LC	CR	LC	Sp. not listed
14	<i>Argiocnemis rubescens rubeola</i>	Variable Sprite/ Tiny midget	LC	CR	LC	Sp. not listed
15	<i>Ceriagrion cerinorubellum</i>	Ornate coraltail/ Bi-coloured damsel	LC	Sp. not listed	LC	Native. Widespread, Common (3)
16	<i>Ceriagrion chaoi</i>	Fiery coraltail	LC	Sp. not listed	NT	Sp. not listed
17	<i>Ischnura senegalensis</i>	Common bluetail	LC	Sp. not listed	LC	Sp. not listed
18	<i>Onychargia atrocyana</i>	Shorttail	LC	Sp. not listed	DD	Sp. not listed
19	<i>Pericnemis stictica</i>	Dryad	LC	CR	VU	Sp. not listed
20	<i>Pseudagrion australasiae</i>	Look-alike Sprite	LC	Sp. not listed	NT	Sp. not listed
21	<i>Pseudagrion microcephalum</i>	Blue Sprite	LC	Sp. not listed	LC	Native. Widespread, Common (4)
22	<i>Pseudagrion pruinsum</i>	Grey Sprite	LC	CR		Sp. not listed
23	<i>Teinobasis ruficollis</i>	Red-tailed Sprite	Not Assessed	CR	VU	Sp. not listed
<b>Family : Platycnemididae</b>						
24	<i>Coelliccia octogesima</i>	Telephone Sylvan	Not Assessed	Sp. not listed	LC	Sp. not listed
25	<i>Copera marginipes</i>	Yellow Featherlegs	LC	Sp. not listed	LC	Sp. not listed
<b>Family : Platystictidae</b>						
26	<i>Drepanosticta quadrata</i>		Not Assessed	Sp. not listed	LC	Sp. not listed
<b>Family : Protoneuridae</b>						
27	<i>Prodasineura collaris</i>	Collared Threadtail	LC	Sp. not listed	NT	Sp. not listed
28	<i>Prodasineura humeralis</i>	Orange-striped Threadtail	Not Assessed	Sp. not listed	NT	Sp. not listed
29	<i>Prodasineura notostigma</i>	Crescent Threadtail	Not Assessed	Sp. not listed	LC	Native. Widespread, Common (2)

**ANNEX 8F ODONATE SPECIES IN STUDY AREA, REPORTED FROM SECONDARY DATA**

No.	Scientific Name	Common Name [English] (if available)	IUCN Red List (2015.02) <sup>1</sup>	SRDB National Status <sup>2</sup>	CRL WG Report 'National Status' <sup>3</sup>	NUS Broad-Based Biodiversity Study 'Country Status' (Abundance Category at MacRitchie Reservoir) <sup>4</sup>
<b>Suborder ANISOPTERA (True Dragonflies)</b>						
<b>Family : Aeschnidae</b>						
30	<i>Anax guttatus</i>	Emperor	LC	Sp. not listed	LC	Native. Widespread, Common (1)
31	<i>Gynacantha dohrni</i>	Spoon-tailed Duskhawker	Not Assessed	Sp. not listed	LC	Sp. not listed
32	<i>Gynacantha subinterrupta</i>	Dingy Duskhawker	LC	Sp. not listed	LC	Sp. not listed
33	<i>Heliaeschna crassa</i>	Nighthawker	LC	Sp. not listed	DD	Sp. not listed
34	<i>Heliaeschna uninervulata</i>	Lesser Nighthawker	LC	Sp. not listed	DD	Sp. not listed
35	<i>Oligoaeschna amata</i>	Paddletail	Not Assessed	CR		Sp. not listed
36	<i>Tetracanthagyna plagiata</i>	Giant Hawker	LC	CR	NT	Sp. not listed
<b>Family : Gomphidae</b>						
37	<i>Ictinogomphus decoratus melaenops</i>	Common Flangetail	LC	Sp. not listed	LC	Native. Widespread, Common (4)
38	<i>Leptogomphus risi</i>	Rise Clubtail	LC	CR	DD	Sp. not listed
39	<i>Macrogomphus quadratus</i>	Forktail	Not Assessed	Sp. not listed	LC	Sp. not listed
40	<i>Microgomphus chelifera</i>	Tiny Sheartail	LC	Sp. not listed	NT	Sp. not listed
<b>Family : Corduliidae</b>						
41	<i>Epophthalmia vittigera</i>	Pond Cruiser	LC	Sp. not listed	LC	Sp. not listed
42	<i>Idionyx yolanda</i>	Shadowdancer	Not Assessed	CR	NT	Sp. not listed
43	<i>Macromia cincta</i>	Stream Cruiser	Not Assessed	Sp. not listed	DD	Sp. not listed
<b>Family : Libellulidae</b>						
44	<i>Acisoma panorpoides</i>	Trumpet Tail	LC	Sp. not listed	LC	Sp. not listed
45	<i>Aethriamanta brevipennis</i>	Scarlet Adjutant	LC	Sp. not listed	LC	Sp. not listed
46	<i>Aethriamanta gracilis</i>	Pond Adjutant	LC	Sp. not listed	LC	Sp. not listed
47	<i>Agrionoptera insignis</i>	Grenadier	LC	Sp. not listed	LC	Sp. not listed
48	<i>Agrionoptera sexlineata</i>	Handsome Grenadier	Not Assessed	CR	LC	Sp. not listed
49	<i>Brachydiplax chalybea</i>	Blue Dasher	LC	Sp. not listed	LC	Native. Widespread, Common (3)
50	<i>Brachythemis contaminata</i>	Common Amberwing	LC	Sp. not listed		Sp. not listed
51	<i>Chalybeothemis fluvialis</i>	Green-eyed Percher	LC	CR	NT	Sp. not listed
52	<i>Cratilla lineata</i>	Lined Forest-skimmer	LC	CR	Sp. not listed	Native. Critically Endangered (1)
53	<i>Cratilla metallica</i>	Dark-tipped Forest-skimmer	LC	Sp. not listed	LC	Sp. not listed
54	<i>Crocothemis servilia</i>	Oriental Scarlet	LC	Sp. not listed	LC	Native. Widespread, Common (4)
55	<i>Diplacodes nebulosa</i>	Black-tipped Percher	LC	Sp. not listed	LC	Sp. not listed
56	<i>Diplacodes trivialis</i>	Blue Percher	LC	Sp. not listed	LC	Native. Widespread, Common (3)
57	<i>Hydrobasileus croceus</i>	Water Monarch	LC	Sp. not listed	LC	Sp. not listed
58	<i>Indothemis limbata</i>	Restless Demon	LC	CR	NT	Sp. not listed
59	<i>Lathrecista asiatica</i>	Scarlet Grenadier	LC	Sp. not listed	LC	Sp. not listed
60	<i>Lyriothemis cleis</i>	Bombardier	LC	Sp. not listed	EN	Native. Widespread, Common (3)
61	<i>Macrodiplax cora</i>	Coastal Glider/ Cora's Pennant	LC	Sp. not listed	LC	Sp. not listed
62	<i>Nannophya pygmaea</i>	Scarlet Pygmy	LC	Sp. not listed	LC	Native. Widespread, Common (2)
63	<i>Nesoxenia lineata</i>	Striped Grenadier	LC	CR	LC	Native. Critically endangered (1)
64	<i>Neurothemis fluctuans</i>	Common Parasol	LC	Sp. not listed	LC	Native. Widespread, Common (4)
65	<i>Neurothemis ramburii</i>		LC	Sp. not listed	Sp. not listed	Native. Widespread, Common (4)

**ANNEX 8F ODONATE SPECIES IN STUDY AREA, REPORTED FROM SECONDARY DATA**

No.	Scientific Name	Common Name [English] (if available)	IUCN Red List (2015.02) <sup>1</sup>	SRDB National Status <sup>2</sup>	CRL WG Report 'National Status' <sup>3</sup>	NUS Broad-Based Biodiversity Study 'Country Status' (Abundance Category at MacRitchie Reservoir) <sup>4</sup>
66	<i>Onychothemis testacea</i>	Riverhawk	LC	Sp. not listed	DD	Sp. not listed
67	<i>Orchithemis pulcherrima</i>	Variable Sentinel	LC	Sp. not listed	LC	Sp. not listed
68	<i>Orthetrum chrysis</i>	Spine-tufted Skimmer	LC	Sp. not listed	LC	Native. Widespread, Common (2)
69	<i>Orthetrum glaucum</i>	Common Blue Skimmer	LC	Sp. not listed	LC	Sp. not listed
70	<i>Orthetrum luzonicum</i>	Slender Blue Skimmer	LC	Sp. not listed	LC	Sp. not listed
71	<i>Orthetrum sabina</i>	Variegated Green Skimmer/ Slender Skimmer	LC	Sp. not listed	LC	Native. Widespread, Common (2)
72	<i>Orthetrum testaceum</i>	Scarlet Skimmer	LC	Sp. not listed	LC	Sp. not listed
73	<i>Pantala flavescens</i>	Wandering Glider	LC	Sp. not listed	LC	Sp. not listed
74	<i>Potamarcha congener</i>	Common Chaser	LC	Sp. not listed		Sp. not listed
75	<i>Pseudothemis jorina</i>	Banded Skimmer	LC	CR	LC	Native. Critically Endangered (1)
76	<i>Rhodothemis rufa</i>	Common Redbolt	LC	Sp. not listed	LC	Native. Widespread, Common (3)
77	<i>Rhyothemis obsolescens</i>	Bronze Flutterer	LC	CR	LC	Native. Widespread, Common (2)
78	<i>Rhyothemis phyllis</i>	Yellow-barred Flutterer	LC	Sp. not listed	LC	Native. Widespread, Common (3)
80	<i>Rhyothemis pygmaea</i>	Small Bronze Flutterer	Not Assessed	Sp. not listed	Sp. not listed	Native. Widespread, Common (3)
79	<i>Rhyothemis triangularis</i>	Sapphire Flutterer	LC	Sp. not listed	LC	Native. Widespread, Common (2)
81	<i>Tholymis tillarga</i>	White-barred Duskhawk	LC	Sp. not listed	LC	Sp. not listed
82	<i>Tramea transmarina euryale</i>	Saddlebag Glider/ Red Glider Dragonfly	LC	CR	LC	Sp. not listed
83	<i>Trithemis aurora</i>	Crimson Dropwing	LC	Sp. not listed	LC	Sp. not listed
84	<i>Trithemis festiva</i>	Indigo Dropwing	LC	Sp. not listed	LC	Sp. not listed
85	<i>Tyriobapta torrida</i>	Treehugger	LC	Sp. not listed	LC	Native. Widespread, Common (2)
86	<i>Urothemis signata insignata</i>	Scarlet Basker	LC	Sp. not listed	LC	Sp. not listed
87	<i>Zyxomma petiolatum</i>	Slender Duskdarter	LC	Sp. not listed	LC	Sp. not listed

**References**

1. **IUCN Red List of Threatened Species** 2015.02. Retrieved from <http://www.iucnredlist.org/> Abbreviations include:

DD: Data Deficient; LC: Least Concern; NT: Near Threatened; VU: Vulnerable; EN: Endangered; CR: Critically Endangered

2. Davison GWH, Ng PKL and Ho HC. (2008) **Singapore Red Data Book**. The Nature Society (Singapore)

Abbreviations include:

DD: Data Deficient (status indeterminate, requires further validation); VU: Vulnerable; EN: Endangered; CR: Critically Endangered

NE: Presumed Nationally extinct; EX: Globally Extinct

3. Cheong LF, Chua MAH, D'Rozario V, Jamal F, Khoo SK, Koh JKH, Lim KKP, O'Dempsey T and Rajathurai S (2014)

**Cross Island Line Working Group Report**. Abbreviations for National Status include:

LC: Least Concern; NT: Near Threatened; VU: Vulnerable; EN: Endangered; CR: Critically Endangered; NE: Nationally extinct

4. Ng PKL, Tan HTW, Hui TH, Yeo D (2008) **Final Report of the Broad-Based Biodiversity Study of Singapore's Reservoirs-MacRitchie Reservoir**. Dep. of Biological Sciences, National University of Singapore. Definitions of status categories (Endangered, Vulnerable, Rare, Common) are based on IUCN categories and defined on p25&26  
Relative Abundance Definitions include: 1-Rare and/or restricted; 2-Uncommon and/or restricted; 3-Common and restricted; 4-Common and widespread

**Note** this study focused on the MacRitchie Reservoir area and a surrounding area within a 5-metre limit from the reservoir's water edge and immediately adjacent water bodies

Annex 8G

## Freshwater Fish (Secondary Data)



ANNEX B0 FISH &amp; AQUATIC COMMUNITY SPECIES IN STUDY AREA, REPORTED FROM SECONDARY DATA

No.	Scientific Name	Common Name (English)	NPA's <sup>1</sup>	CONSERVATION STATUS					
				I/CN Red List (2015.02) <sup>2</sup>	SRDB National Status <sup>3</sup>	CRL WG Report 'National Status' <sup>4</sup>	Nature Reserves 1997 <sup>5</sup>	MUS Broad-based Biodiversity Study (Abundance Category) <sup>6</sup>	
<b>Class Osteichthyes (Bony fishes)</b>									
<b>ORDER Osteocephaloformes (Bony-tongues and relatives)</b>									
<b>Family Notopterygidae (Old World knifefishes)</b>									
1	<i>Chitala ornata</i>	Clown Featherback/ Ocellated knifefish	Introduced	LC	Sp. not listed	Sp. not listed	Feral established, Aquarium fish	Sp. not listed	
2	<i>Osteogobius biwaensis</i>	Asawa	Introduced	Not Assessed	Sp. not listed	Sp. not listed	Escapee, Aquarium fish	Sp. not listed	
3	<i>Scleropages formosus</i>	Malayan Bonytongue (Asian Arowana is used as a trade name)	Introduced	EN	Sp. not listed	Sp. not listed	Feral established, Aquarium fish	Listed as <i>Scleropages formosus</i> - Alien, Widespread, Rare (1)	
<b>ORDER Cypriniformes (Carp and relatives)</b>									
<b>Family Cyprinidae (Carp and relatives)</b>									
4	<i>Silurymus schwaneri</i>	Stripe-tailed Tetra Barb	Introduced	LC	Sp. not listed	Sp. not listed	NE	Alien, Restricted, Common (3)	
5	<i>Boraras maculatus</i>	Malayan Pygmy Rasbora/ Dwarf Rasbora	Native	LC	CR	CR	EN	Native, Restricted, Rare (1)	
6	<i>Cyrtoclichthys apogon</i> (synonym of <i>Syngnatus apogonoides</i> and <i>Barbus apogon</i> listed on IUCN Red List)	Barbel-less Chempakas/ Beardless Bast	Native	LC	EN	EN	EN	Listed as Chempakas <i>Cyrtoclichthys apogon</i> - Native, Restricted, Widespread (1)	
7	<i>Etmus metallicus</i>	Siamese Flying Barb	Introduced	LC	Sp. not listed	Sp. not listed	Feral established, Aquarium fish	Sp. not listed	
8	<i>Hemipha macrolepidota</i>	Stripe-tailed Sebarrus	Introduced	LC	Sp. not listed	Sp. not listed	Escapee, Aquarium fish	Sp. not listed	
9	<i>Osteochilus hasselti</i> (as <i>Osteochilus vittatus</i> in SSR (2013) p118)	Tetrafil, Hasselt's Bony-tipped Barb	Introduced	LC	Sp. not listed	Sp. not listed	Feral established, Aquarium fish	Sp. not listed	
10	<i>Puntius semifasciatus</i>	Green Barb	Introduced	LC	Sp. not listed	Sp. not listed	Feral established, No data	Sp. not listed	
11	<i>Rasbora borapetensis</i>	Red-tailed Rasbora	Introduced	LC	Sp. not listed	Sp. not listed	CO	Alien, Widespread, Common (3)	
12	<i>Rasbora einthoveni</i>	Einhoven's Rasbora	Native	Not Assessed	Sp. not listed	VU	CO	Native, Restricted, Common (3)	
13	<i>Rasbora elegans</i>	Two-spot Rasbora	Native	LC	Sp. not listed	VU	CO	Native, Restricted, Common (3)	
14	<i>Syngnatus bancu/ Puntius bancu</i>	Saddle Barb	Native	Not Assessed	Sp. not listed	VU	EN	Sp. not listed	
15	<i>Syngnatus danconis</i>	Malayan Clown Barb	Native	Not Assessed	Sp. not listed	EX	EN		
16	<i>Syngnatus hexazona</i> (formerly <i>Puntius hexazona</i> )	Six-banded Tiger Barb	Native	Not Assessed	Sp. not listed	CR	EN	Native, Restricted, Common (3)	
17	<i>Syngnatus lateralis/ Puntius lateralis</i>	Spanner Barb/ T Barb	Native	LC	Sp. not listed	VU			
18	<i>Syngnatus peripentazona/ Puntius peripentazona</i>	Indonesian Tiger Barb	Introduced	LC	Sp. not listed	Sp. not listed		Listed as Tiger Barb <i>Syngnatus tetrazona</i> , Alien, Widespread, Common (3)	
19	<i>Trigonostigma heteromorphu/ Rasbora heteromorphu/ Rasbora aeneu</i>	Harlequin Rasbora	Native	LC	EN	EN	EN	Native, Restricted, Common (3)	
<b>Family Balitoridae (Beinotes loaches)</b>									
20	<i>Vesumichthys albobrunneus</i>	Grey-banded Sand loach	Native	DD	CR	Sp. not listed	EN	Sp. not listed	
<b>Family Cobitidae (Banded loaches)</b>									
21	<i>Pangio muraeniformis</i> (formerly <i>Pangio akarensis</i> )	Spotted Eel loach	Native	Not Assessed	EN	Sp. not listed	EN	Sp. not listed	
<b>ORDER Siluriformes (Catfishes)</b>									
<b>Family Siluridae (Old World river catfishes)</b>									
22	<i>Mystus siamensis</i>	Estuarine Banao	Native	LC	Sp. not listed	Sp. not listed	CO	Sp. not listed	
23	<i>Pseudomystus leucostriatus</i>	Dwarf Bumblebee Catfish	Native	LC	EN	Sp. not listed	NE	Sp. not listed	
24	<i>Pseudomystus rupestris</i>		Sp. not listed	Not Assessed	Sp. not listed	Sp. not listed	EN	Sp. not listed	
<b>Family Siluridae (Sweet catfishes)</b>									
25	<i>Slurichthys hasselti</i>	Hasselt's Leaf Catfish	Native	Not Assessed	EN	Sp. not listed	EN	Sp. not listed	
<b>Family Albulidae (Warty catfishes)</b>									
26	<i>Paratylos longirostris</i> (formerly <i>Paratylos variegatus</i> )	Singapore Little Warty Catfish/ Longnose Little Warty Catfish	Native	LC	CR	Sp. not listed	EN	Sp. not listed	
<b>Family Siluridae (Horse catfishes)</b>									
27	<i>Glyptothorax laevis</i>	Indochinese Winkle-bellied Catfish	Native	DD	Sp. not listed	Sp. not listed	NE	Sp. not listed	
<b>Family Clariidae (Walking catfishes)</b>									
28	<i>Clarias fuscus</i>	Common Walking Catfish	Native	LC	Sp. not listed	Sp. not listed	CO	Sp. not listed	
29	<i>Clarias gariepinus</i>	White-cheeked Walking Catfish/ African Sharptooth Catfish	Introduced	LC	Sp. not listed	Sp. not listed	NE	Sp. not listed	
30	<i>Clarias fuscus</i>	Forest Walking Catfish	Native	Not Assessed	Sp. not listed	VU	NE	Sp. not listed	
31	<i>Clarias nebulosus</i>	Slender Walking Catfish	Native	LC	CR	CR	NE	Sp. not listed	
32	<i>Clarias nebulosus</i>		Sp. not listed	Not Assessed	Sp. not listed	Sp. not listed	EN	Sp. not listed	
<b>Family Loricariidae (Armoured suckling catfish)</b>									
33	<i>Loricariichthys dybowskii</i> (possibly <i>Pterygoplichthys dybowskii</i> in Ng & Tan 2016)	Marbled-belly Armoured Suckling Catfish	Introduced	Not Assessed	Sp. not listed	Sp. not listed	NE	Listed as Vermiculated sailfin catfish <i>Pterygoplichthys dybowskii</i> - Alien, Widespread, Rare (2)	
34	<i>Pterygoplichthys pardalis</i>	Amazon sailfin catfish	Sp. not listed	Not Assessed	Sp. not listed	Sp. not listed	Alien, Widespread, Common (3)		
35	<i>Platypharodon variabilis</i>	Red-tailed Armoured Suckling Catfish	Introduced	Not Assessed	Sp. not listed	Sp. not listed	NE	Sp. not listed	
<b>ORDER Balitoridae (Dwarf loaches and halfbeaks/ Fish of the Needle fishes)</b>									
<b>Family Harporhamphidae (Halfbeaks)</b>									
36	<i>Demogenys collettei</i>	Banda Pygmy Halfbeak	Native	Not Assessed	Sp. not listed	LC	NE	Native, Widespread, Common (3)	
37	<i>Demogenys pusilla</i>	Wrestling halfbeak	Sp. not listed	Not Assessed	Sp. not listed	Sp. not listed	CO	Sp. not listed	
38	<i>Hemirhamphodon pogonognathus</i>	Malayan Forest Halfbeak	Native	LC	Sp. not listed	VU	EN	Sp. not listed	
39	<i>Cyrtichthys</i>	Indochinese halfbeak	Sp. not listed	Not Assessed	Sp. not listed	Sp. not listed	CO	Sp. not listed	
<b>ORDER Cyprinodontiformes (Poeciliidae)</b>									
<b>Family Aplocheilichthys (Poeciliidae)</b>									
40	<i>Aplocheilichthys punctata</i>	Whitetail	Native	LC	Sp. not listed	LC	CO	Native, Widespread, Common (3)	
<b>Family Poeciliidae (Live-bearing loachfishes)</b>									
41	<i>Gambusia affinis</i>	Mosquitofish	Introduced	LC	Sp. not listed	Sp. not listed	NE	Sp. not listed	
42	<i>Poecilia reticulata</i>	Guppy	Introduced	Not Assessed	Sp. not listed	Sp. not listed	Feral established, Aquarium fish and Pest	Sp. not listed	
43	<i>Poecilia sphenops</i>	Green Molly	Introduced	Not Assessed	Sp. not listed	Sp. not listed	Feral established, Aquarium fish	Sp. not listed	
<b>ORDER Serraniformes (Sea loaches and relatives)</b>									
<b>Family Serranidae (Sea loaches)</b>									
44	<i>Monopterus albus</i>	Oriental Swamp-eel	Native	LC	Sp. not listed	LC	CO	Native, Widespread, Common (3)	
<b>Family Muraenidae (Snake loaches)</b>									
45	<i>Microgobius maculatus</i>	Buff-backed Spring-eel	Native	LC	CR	Sp. not listed	EN	Sp. not listed	
<b>ORDER Perciformes (Perches and relatives)</b>									
<b>Family Ambloplitidae (Glass perchlets)</b>									
46	<i>Pseudomacropodus opercularis</i>	Indochinese Glass-perchlet	Introduced	LC	Sp. not listed	Sp. not listed	NE	Alien, Widespread, Common (3)	
<b>Family Nandidae (Leaf-fishes)</b>									
47	<i>Nandus nebulosus</i>	Malayan Leaf-fish/ Sundu Leaf-fish	Native	LC	CR	CR	NE	Sp. not listed	
<b>Family Cichlidae (Cichlids)</b>									
48	<i>Cichla ocellaris</i>	Parrotfish	Introduced	Not Assessed	Sp. not listed	Sp. not listed	NE	Alien, Widespread, Common (3)	
49	<i>Cichlasoma xanthurus</i>	Mayan Cichlid	Introduced	Not Assessed	Sp. not listed	Sp. not listed	NE	Sp. not listed	
50	<i>Cichlasoma auratus</i>	Golden Cichlid	Introduced	LC	Sp. not listed	Sp. not listed	NE	Sp. not listed	
51	<i>Geophagus altirostris</i>	Earthstar	Introduced	Not Assessed	Sp. not listed	Sp. not listed	NE	Alien, Widespread, Common (3)	
52	<i>Oreochromis mossambicus</i>	Common Tilapia	Introduced	NT (Oreochromis mossambicus listed as Mozambique Tilapia, Common Tilapia not listed)	Sp. not listed	Sp. not listed	Feral established, Fish food	Sp. not listed	
53	<i>Oreochromis niloticus</i>	Nile Tilapia	Introduced	Not Assessed	Sp. not listed	Sp. not listed	Escapee, Fish food	Sp. not listed	
54	<i>Oreochromis mossambicus</i>	Yellow Tilapia	Introduced	Not Assessed	Sp. not listed	Sp. not listed	NE	Sp. not listed	
55	<i>Oreochromis variabilis</i>	Red-bellied Tilapia	Introduced	Not Assessed	Sp. not listed	Sp. not listed	NE	Sp. not listed	
56	<i>Oreochromis variabilis</i>	Tilapia	Introduced	LC	Sp. not listed	Sp. not listed	NE	Sp. not listed	
<b>Family Eleotridae (Eleotrids) FISHBASE-SINGAPORE</b>									
57	<i>Coryphopterus maculatus</i>	Green Rock, Marbled Gudgeon, FISHBASE: <i>Muraena zebra</i>	Native	LC	Sp. not listed	Sp. not listed	CO	Native, Widespread, Common (3)	
<b>Family Gobiidae (Gobies)</b>									
58	<i>Gobiosoma doriai</i>	River Flathead Goby	Native	LC	Sp. not listed	Sp. not listed	NE	Sp. not listed	
59	<i>Gobiosoma boscianum</i>		Sp. not listed	Not Assessed	Sp. not listed	Sp. not listed	CO	Sp. not listed	
60	<i>Gobiosoma boscianum</i>		Native	Not Assessed	Sp. not listed	Sp. not listed	NE	Sp. not listed	
61	<i>Rhinogobius gurnieri</i>	East Asian River Goby	Introduced	LC	Sp. not listed	Sp. not listed	Feral established, No data	Sp. not listed	
<b>Family Anabantidae (Climbing perch)</b>									
62	<i>Anabas testudineus</i>	Asian Climbing Perch	Native	DD		LC	CO	Sp. not listed	
<b>Family Osphronemidae (Gouramis and fighting fish)</b>									
63	<i>Betta splendens</i>	Cornet Fighting fish, Paddyfield Fighting fish/ Paradise Betta	Native	LC	Sp. not listed	VU	UN	Sp. not listed	
64	<i>Betta pugnax</i>	Malayan Forest Fighting fish/ Forest Betta	Native	Not Assessed	Sp. not listed	VU	CO	Sp. not listed	
65	<i>Luciocephalus pulcher</i>	Malayan Plethead/ Brown Plethead	Native	Not Assessed	CR	CR	EN	Native, Restricted, Rare (1)	
66	<i>Osphronemus goramy</i>	Common Giant Gourami, Koi	Introduced	LC	Sp. not listed	Sp. not listed	Feral established, Fish food	Alien, Widespread, Common (3)	
67	<i>Trichogaster microlepis</i>	Moonlight Gourami	Introduced	Not Assessed	Sp. not listed	Sp. not listed	Feral established, Aquarium fish	Sp. not listed	
68	<i>Trichogaster pectoralis</i>	Snakeskin Gourami, Sepal Siam	Introduced	Not Assessed	Sp. not listed	Sp. not listed	Feral established, Fish food	Sp. not listed	
69	<i>Trichogaster trichopterus</i>	Three-spot Gourami	Native	I.R.	Sp. not listed	I.R.	CO	Sp. not listed	
70	<i>Trichopoma vittata</i>	Creaking Gourami	Native	LC	Sp. not listed	LC	CO	Native, Widespread, Widespread (1)	
<b>Family Channidae (Snakeheads)</b>									
71	<i>Channa argus</i>	Dwarf Snakehead	Native	LC	CR	Sp. not listed	EN	Sp. not listed	
72	<i>Channa asiatica</i>	Forest Snakehead	Native	LC	Sp. not listed	VU	CO	Native, Restricted, Rare (1)	
73	<i>Channa melanozona</i>	Black Snakehead	Native	LC	CR	Sp. not listed	EN	Sp. not listed	
74	<i>Channa micropetris</i>	Toman	Introduced	LC	Sp. not listed	Sp. not listed	Culture & Feral established, Fish food	Alien, Widespread, Common (3)	
75	<i>Channa striata</i>	Anasy Paddyfield Snakehead	Native	LC	Sp. not listed	LC	CO	Native, Widespread, Common (3)	

## References:

- Lin K.K.P. & No P.K.L. (1993). A Guide to the Freshwater Fishes of Singapore. Singapore: Singapore Science Centre.
- No P.K.L. & Lim K.K.P. (1997). The diversity and conservation status of fishes in the Nature Reserves of Singapore. In Chan, L. & Corlett, R.T. (Eds). Biodiversity in the Nature Reserves of Singapore. (pp. 245 – 265). Singapore: National Parks Board.
- Lim K.K.P. & Lim K.K.P. (1997). The diversity and conservation status of fishes in the Nature Reserves of Singapore. In Chan, L. & Corlett, R.T. (Eds). Biodiversity in the Nature Reserves of Singapore. (pp. 245 – 265). Singapore: National Parks Board.
- Lim K.K.P. & Lim K.K.P. (1997). The diversity and conservation status of fishes in the Nature Reserves of Singapore. In Chan, L. & Corlett, R.T. (Eds). Biodiversity in the Nature Reserves of Singapore. (pp. 245 – 265). Singapore: National Parks Board.
- Lim K.K.P. & Lim K.K.P. (1997). The diversity and conservation status of fishes in the Nature Reserves of Singapore. In Chan, L. & Corlett, R.T. (Eds). Biodiversity in the Nature Reserves of Singapore. (pp. 245 – 265). Singapore: National Parks Board.
- Lim K.K.P. & Lim K.K.P. (1997). The diversity and conservation status of fishes in the Nature Reserves of Singapore. In Chan, L. & Corlett, R.T. (Eds). Biodiversity in the Nature Reserves of Singapore. (pp. 245 – 265). Singapore: National Parks Board.
- Lim K.K.P. & Lim K.K.P. (1997). The diversity and conservation status of fishes in the Nature Reserves of Singapore. In Chan, L. & Corlett, R.T. (Eds). Biodiversity in the Nature Reserves of Singapore. (pp. 245 – 265). Singapore: National Parks Board.
- Lim K.K.P. & Lim K.K.P. (1997). The diversity and conservation status of fishes in the Nature Reserves of Singapore. In Chan, L. & Corlett, R.T. (Eds). Biodiversity in the Nature Reserves of Singapore. (pp. 245 – 265). Singapore: National Parks Board.
- Lim K.K.P. & Lim K.K.P. (1997). The diversity and conservation status of fishes in the Nature Reserves of Singapore. In Chan, L. & Corlett, R.T. (Eds). Biodiversity in the Nature Reserves of Singapore. (pp. 245 – 265). Singapore: National Parks Board.
- Lim K.K.P. & Lim K.K.P. (1997). The diversity and conservation status of fishes in the Nature Reserves of Singapore. In Chan, L. & Corlett, R.T. (Eds). Biodiversity in the Nature Reserves of Singapore. (pp. 245 – 265). Singapore: National Parks Board.
- Lim K.K.P. & Lim K.K.P. (1997). The diversity and conservation status of fishes in the Nature Reserves of Singapore. In Chan, L. & Corlett, R.T. (Eds). Biodiversity in the Nature Reserves of Singapore. (pp. 245 – 265). Singapore: National Parks Board.
- Lim K.K.P. & Lim K.K.P. (1997). The diversity and conservation status of fishes in the Nature Reserves of Singapore. In Chan, L. & Corlett, R.T. (Eds). Biodiversity in the Nature Reserves of Singapore. (pp. 245 – 265). Singapore: National Parks Board.
- Lim K.K.P. & Lim K.K.P. (1997). The diversity and conservation status of fishes in the Nature Reserves of Singapore. In Chan, L. & Corlett, R.T. (Eds). Biodiversity in the Nature Reserves of Singapore. (pp. 245 – 265). Singapore: National Parks Board.
- Lim K.K.P. & Lim K.K.P. (1997). The diversity and conservation status of fishes in the Nature Reserves of Singapore. In Chan, L. & Corlett, R.T. (Eds). Biodiversity in the Nature Reserves of Singapore. (pp. 245 – 265). Singapore: National Parks Board.
- Lim K.K.P. & Lim K.K.P. (1997). The diversity and conservation status of fishes in the Nature Reserves of Singapore. In Chan, L. & Corlett, R.T. (Eds). Biodiversity in the Nature Reserves of Singapore. (pp. 245 – 265). Singapore: National Parks Board.
- Lim K.K.P. & Lim K.K.P. (1997). The diversity and conservation status of fishes in the Nature Reserves of Singapore. In Chan, L. & Corlett, R.T. (Eds). Biodiversity in the Nature Reserves of Singapore. (pp. 245 – 265). Singapore: National Parks Board.
- Lim K.K.P. & Lim K.K.P. (1997). The diversity and conservation status of fishes in the Nature Reserves of Singapore. In Chan, L. & Corlett, R.T. (Eds). Biodiversity in the Nature Reserves of Singapore. (pp. 245 – 265). Singapore: National Parks Board.
- Lim K.K.P. & Lim K.K.P. (1997). The diversity and conservation status of fishes in the Nature Reserves of Singapore. In Chan, L. & Corlett, R.T. (Eds). Biodiversity in the Nature Reserves of Singapore. (pp. 245 – 265). Singapore: National Parks Board.
- Lim K.K.P. & Lim K.K.P. (1997). The diversity and conservation status of fishes in the Nature Reserves of Singapore. In Chan, L. & Corlett, R.T. (Eds). Biodiversity in the Nature Reserves of Singapore. (pp. 245 – 265). Singapore: National Parks Board.
- Lim K.K.P. & Lim K.K.P. (1997). The diversity and conservation status of fishes in the Nature Reserves of Singapore. In Chan, L. & Corlett, R.T. (Eds). Biodiversity in the Nature Reserves of Singapore. (pp. 245 – 265). Singapore: National Parks Board.
- Lim K.K.P. & Lim K.K.P. (1997). The diversity and conservation status of fishes in the Nature Reserves of Singapore. In Chan, L. & Corlett, R.T. (Eds). Biodiversity in the Nature Reserves of Singapore. (pp. 245 – 265). Singapore: National Parks Board.
- Lim K.K.P. & Lim K.K.P. (1997). The diversity and conservation status of fishes in the Nature Reserves of Singapore. In Chan, L. & Corlett, R.T. (Eds). Biodiversity in the Nature Reserves of Singapore. (pp. 245 – 265). Singapore: National Parks Board.
- Lim K.K.P. & Lim K.K.P. (1997). The diversity and conservation status of fishes in the Nature Reserves of Singapore. In Chan, L. & Corlett, R.T. (Eds). Biodiversity in the Nature Reserves of Singapore. (pp. 245 – 265). Singapore: National Parks Board.
- Lim K.K.P. & Lim K.K.P. (1997). The diversity and conservation status of fishes in the Nature Reserves of Singapore. In Chan, L. & Corlett, R.T. (Eds). Biodiversity in the Nature Reserves of Singapore. (pp. 245 – 265). Singapore: National Parks Board.
- Lim K.K.P. & Lim K.K.P. (1997). The diversity and conservation status of fishes in the Nature Reserves of Singapore. In Chan,

Annex 8H

## Vegetation Species List (Plot)

**ANNEX 8H TREE SPECIES IN THE STUDY AREA, REPORTED FROM PLOT SURVEYS**

No.	Latin Name	Family	Common Name [English]	Life Form	Native (N)/ Exotic (E)	IUCN Red List (2015.02) <sup>1</sup>	SRDB National Status <sup>2</sup>	Uses/ Remarks	HABITAT (Plot) [Importance Value (IV)] <sup>Note 1</sup>				
									PF	RA	RB	WF	WM
1	<i>Bouea oppositifolia</i>	Anacardiaceae	Plum Mango, Marrion Plum Tree	T	N		VU/D		-	0.4	-	-	-
2	<i>Buchanania sessifolia</i>	Anacardiaceae		T	N		VU/D		-	0.8	-	-	0.70
3	<i>Camposperma squamatum</i>	Anacardiaceae	Terentang jantan	T	N		DD		-	-	-	8.2	1.63
4	<i>Gluta wallichii</i>	Anacardiaceae		T	N				-	0.9	-	-	-
5	<i>Melanochyla auriculata</i>	Anacardiaceae		T	N		VU/D		0.3	-	0.7	-	-
6	<i>Parishia insignis</i>	Anacardiaceae		T	N				-	0.5	-	-	-
7	<i>Parishia maingayi</i>	Anacardiaceae		T	N				0.4	0.4	-	-	-
8	<i>Cyathocalyx carinatus</i>	Annonaceae		T	N		-	Synonym of <i>Drepananthus carinatus</i>	-	0.4	-	-	-
9	<i>Cyathocalyx ramuliflorus</i>	Annonaceae		T	N		-	Synonym of <i>Drepananthus ramuliflorus</i>	0.7	-	-	-	-
10	<i>Cyathocalyx ridleyi</i>	Annonaceae		T	N		EN/D		-	-	2.7	-	-
11	<i>Mezzettia leptopoda</i>	Annonaceae		T	N		Listed as <i>Mezzettia parviflora</i> , status CR/D	A synonym of <i>Mezzettia parviflora</i>	0.3	0.4	-	-	-
12	<i>Mezzettia parviflora</i>	Annonaceae		T	N		CR/D		1.9	-	-	-	-
13	<i>Mitrephora glabra</i>	Annonaceae		T	N		-	<i>Mitrephora glabra</i> var. <i>brevifolia</i> is a synonym	0.3	-	-	-	-
14	<i>Monocarpia marginalis</i>	Annonaceae		T	N		NE		0.4	-	-	-	-
15	<i>Polyalthia galuca</i>	Annonaceae		T	N		NE		0.8	-	-	-	-
16	<i>Polyalthia rumphii</i>	Annonaceae		T	N		CR/D		0.4	0.6	-	-	-
17	<i>Polyalthia sumatrana</i>	Annonaceae		T	N		CR/D		0.3	-	-	-	-
18	<i>Popowia fusca</i>	Annonaceae		T	N		VU/D		-	0.4	-	-	-
19	<i>Popowia pisocarpa</i>	Annonaceae		T	N		VU/D		0.3	-	-	-	-
20	<i>Xylopi caudata</i>	Annonaceae		T	N		VU/D		0.3	-	-	-	-
21	<i>Xylopi ferruginea</i>	Annonaceae		T	N		-		0.6	0.8	-	-	-
22	<i>Alstonia angustifolia</i>	Apocynaceae	Red-leafed Pulai	T	N	LC	DD		-	-	-	6.0	5.63
23	<i>Alstonia angustiloba</i>	Apocynaceae		T	N				-	0.6	1.44	-	-
24	<i>Alstonia pneumatophora</i>	Apocynaceae		T	N		CE		-	-	-	-	1.92
25	<i>Alstonia spathulata</i>	Apocynaceae	Marsh Pulai	T	N	LC	VU/D		-	1.9	1.47	2.1	2.66
26	<i>Dyera costulata</i>	Apocynaceae	Jelutong (PM'sia)	T	N		Common		5.7	5.2	-	-	-
27	<i>Dyera polyphylla</i>	Apocynaceae	Jelutong paya (PM'sia)	T	N				-	-	-	2.7	-
28	<i>Kopsia singapurensis</i>	Apocynaceae	Kopsia	T	N				0.5	-	-	-	-
29	<i>Ploiarium alternifolium</i>	Bonnetiaceae	Cicada tree, Riang Riang	T	N		DD		-	-	-	2.3	5.7
30	<i>Canarium littorale</i>	Burseraceae		T	N		-		0.3	-	-	1.0	-
31	<i>Canarium pilosum</i>	Burseraceae		T	N		EN/D		0.3	-	-	-	-
32	<i>Canthium glabrum</i>	Burseraceae		T	N		-		-	0.8	0.7	-	-
33	<i>Dacryodes costata</i>	Burseraceae		T	N		EN/D		0.9	-	-	-	-

**ANNEX 8H TREE SPECIES IN THE STUDY AREA, REPORTED FROM PLOT SURVEYS**

No.	Latin Name	Family	Common Name [English]	Life Form	Native (N)/ Exotic (E)	IUCN Red List (2015.02) <sup>1</sup>	SRDB National Status <sup>2</sup>	Uses/ Remarks	HABITAT (Plot) [Importance Value (IV)] <sup>Note 1</sup>				
									PF	RA	RB	WF	WM
34	<i>Dacryodes rostrata</i>	Burseraceae		T	N		VU/D		0.3	-	-	-	-
35	<i>Santiria laevigata</i>	Burseraceae		T	N		VU/D		0.5	-	-	-	0.8
36	<i>Santiria rubiginosa</i>	Burseraceae		T	N		VU/D		1.9	-	1.8	-	-
37	<i>Santiria tomentosa</i>	Burseraceae		T	N		EN/D		0.3	-	-	-	-
38	<i>Calophyllum ferrugineum</i>	Calophyllaceae		T	N		Common		1.0	16.1	15.47	-	0.83
39	<i>Calophyllum lanigerum</i>	Calophyllaceae		T	N				2.5	3.1	1.62	-	-
40	<i>Calophyllum pulcherrimum</i>	Calophyllaceae	Bintangor (PM'sia)	T	N		-		-	0.4	-	-	-
41	<i>Calophyllum ribuginosum</i>	Calophyllaceae	Bintangor daun karat	T	N		DD		1.2	0.8	1.08	1.4	-
42	<i>Calophyllum soulattri</i>	Calophyllaceae	Bintangor (PM'sia)	T	N	LC	CR/D		0.3	-	-	-	-
43	<i>Calophyllum teysmannii</i>	Calophyllaceae		T	N		VU/D		1.0	-	-	-	-
44	<i>Calophyllum wallichianum</i>	Calophyllaceae	Bintangor (PM'sia)	T	N		VU/D		-	1.0	-	-	-
45	<i>Camptosperma auriculatum</i>	Calophyllaceae	Terentang	T	N		-		-	2.2	3.08	-	3.49
46	<i>Gironniera nervosa</i>	Cannabaceae		T	N				2.3	3.9	1.5	-	0.8
47	<i>Gironniera parvifolia</i>	Cannabaceae		T	N				1.1	0.7	1.0	-	0.8
48	<i>Gironniera subaequalis</i> var1	Cannabaceae		T	N			The Plant List gives this species and 5 synonyms. Two var. recorded during surveys but not confirmed	-	0.8	-	-	-
49	<i>Gironniera subaequalis</i> var2	Cannabaceae		T	N			The Plant List gives this species and 5 synonyms. Two var. recorded during surveys but not confirmed	-	0.6	-	-	-
50	<i>Gonocaryum minus</i>	Cardiopteridaceae		T	N				-	0.5	-	-	-
51	<i>Lophopetalum multinervium</i>	Celastraceae	Perupok	T	N		CR/D	Timber	1.3	-	-	-	-
52	<i>Bhesa paniculata</i>	Celastraceae	Malayan Spindle Tree	T	N				0.5	1.4	-	-	-
53	<i>Bhesa robusta</i>	Celastraceae		T	N		VU/D		1.1	0.7	-	-	-
54	<i>Lophopetalum rigidum</i>	Celastraceae		T	N		-	Timber	0.3	-	-	-	-
55	<i>Parinari oblongifolia</i>	Chrysobalanaceae		T	N				-	0.4	-	-	-
56	<i>Garcinia eugeniifolia</i>	Clusiaceae		T	N		VU/D		-	0.4	1.3	1.1	-
57	<i>Garcinia forbesii</i>	Clusiaceae		T	N		CR/D		0.6	-	-	-	-
58	<i>Garcinia nervosa</i>	Clusiaceae		T	N		CR/D		-	-	0.9	-	-
59	<i>Garcinia parvifolia</i>	Clusiaceae		T	N		DD		-	-	2.4	1.3	-
60	<i>Alangium javanicum</i>	Cornaceae		T	N		CR/D		-	-	-	1.9	1.28
61	<i>Alangium nobile</i>	Cornaceae		T	N		CR/D		-	1.4	0.66	-	-
62	<i>Dillenia grandifolia</i>	Dilleniaceae	Simpoh Jangkang	T	N		Common		0.3	0.9	-	-	-
63	<i>Dillenia suffruticosa</i>	Dilleniaceae	Shrubby Simpoh	T	N		Common		-	-	-	3.9	8.4
64	<i>Hopea argentea</i>	Dipterocarpaceae		T	N				0.7	-	-	-	-
65	<i>Shorea curtisii</i>	Dipterocarpaceae	Seraya	T	N		VU/D	Timber	2.7	-	-	-	-
66	<i>Shorea gratissima</i>	Dipterocarpaceae	White Meranti	T	N	EN	CR/D	Timber	0.5	-	-	-	-
67	<i>Shorea parvifolia</i>	Dipterocarpaceae	Meranti Sarang Punai	T	N		EN/D	Timber	2.2	-	-	-	-
68	<i>Shorea pauciflora</i>	Dipterocarpaceae	Dark Red Meranti	T	N	EN	VU/D	Timber	5.0	-	-	-	-
69	<i>Shorea platycarpa</i>	Dipterocarpaceae	Light Red Meranti	T	N	CR	CR/D	Timber	-	1.3	-	-	-
70	<i>Diospyros evena</i>	Ebenaceae		T	N			Synonyms include <i>Ebenus motleyi</i> and <i>Maba motleyi</i>	0.8	-	-	-	-

**ANNEX 8H TREE SPECIES IN THE STUDY AREA, REPORTED FROM PLOT SURVEYS**

No.	Latin Name	Family	Common Name [English]	Life Form	Native (N)/ Exotic (E)	IUCN Red List (2015.02) <sup>1</sup>	SRDB National Status <sup>2</sup>	Uses/ Remarks	HABITAT (Plot) [Importance Value (IV)] <sup>Note 1</sup>				
									PF	RA	RB	WF	WM
71	<i>Diospyros lanceaeifolia</i>	Ebenaceae		T	N				0.3	1.1	-	-	-
72	<i>Elaeocarpus floribundus</i>	Elaeocarpaceae	Rugged Oil Fruit	T	N		EN/D		-	0.4	1.2	7.4	1.2
73	<i>Elaeocarpus griffithii</i>	Elaeocarpaceae		T	N				-	-	-	-	5.3
74	<i>Elaeocarpus masterii</i>	Elaeocarpaceae		T	N				0.7	0.6	2.1	-	-
75	<i>Elaeocarpus</i> sp.1	Elaeocarpaceae		T	N			Species recored as <i>Elaeocarpus scholaris</i> but identification not confirmed	-	0.4	-	-	-
76	<i>Elaeocarpus stipularis</i>	Elaeocarpaceae		T	N		VU/D		0.9	0.6	-	2.9	0.8
77	<i>Macaranga conifera</i>	Euphorbiaceae		T	N		-		0.3	0.4	0.7	3.5	3.4
78	<i>Macaranga gigantea</i>	Euphorbiaceae	Giant Mahang	T	N		-		-	-	-	-	1.9
79	<i>Macaranga pruinosa</i>	Euphorbiaceae		T	N		NE		-	-	-	-	0.8
80	<i>Macaranga triloba</i>	Euphorbiaceae		T	N		-		-	-	-	3.1	0.7
81	<i>Neoscortechinia kingii</i>	Euphorbiaceae		T	N		CR/D	Timber	-	-	0.7	-	-
82	<i>Ptychopyxis</i> sp.	Euphorbiaceae		T	N				0.4	-	-	-	-
83	<i>Adenanthra bicolor</i>	Fabaceae	Bicolor saga seeds	T	N	VU	-		0.7	1.3	-	-	-
84	<i>Adenanthra pavonina</i>	Fabaceae	Saga tree	T	N		-	Ornamental	-	-	-	1.5	-
85	<i>Archidendron clypearia</i>	Fabaceae		T	N		-		0.8	0.5	-	-	0.72
86	<i>Dialium indum</i>	Fabaceae		T	N		CR/D		0.6	-	-	-	-
87	<i>Dialium platysepalum</i>	Fabaceae		T	N		CR/D		0.7	-	-	-	-
88	<i>Koompassia malaccensis</i>	Fabaceae		T	N		EN/D		3.8	-	2.0	-	-
89	<i>Gnetum gnemon</i>	Gnetaceae		T	N				-	-	-	1.2	-
90	<i>Cratoxylum arborescens</i>	Hypericaceae	Pink Empat	T	N		EN/D		-	-	-	6.4	1.9
91	<i>Cratoxylum formosum</i>	Hypericaceae		T	N		-		-	0.5	-	-	-
92	<i>Cratoxylum maingayi</i>	Hypericaceae	Geronggang (M'sia)	T	N	LC	-		-	-	2.8	-	-
93	<i>Ixonanthes reticulata</i>	Ixonanthaceae		T	N				-	0.5	-	-	-
94	<i>Vitex pinnata</i>	Lamiaceae		T	N		-		-	-	-	-	1.5
95	<i>Vitex pubescens</i>	Lamiaceae		T	N			TPL <i>Vitex pubescens</i> as a synonym for <i>Vitex pinnata</i>	-	-	-	4.8	1.6
96	<i>Norrisia maior</i>	Laoganiaceae		T	N				-	1.3	-	-	-
97	<i>Actinodaphne malaccensis</i>	Lauraceae	Medang poyong	T	N		EN/D		0.5	-	-	-	-
98	<i>Alseodaphne bancana</i>	Lauraceae	Medang sisik (Bor)	T	N		CR/D		0.6	-	-	-	-
99	<i>Alseodaphne intermedia</i>	Lauraceae	Keledang uta (PMs'i'a)	T	N		CR/D		0.3	0.4	-	-	-
100	<i>Beilschmiedia madang</i>	Lauraceae		T	N		EN/D		0.3	0.4	-	-	-
101	<i>Cinnamomum iners</i>	Lauraceae		T	N		-		-	-	-	4.2	5.5
102	<i>Cinnamomum</i> sp.	Lauraceae		T	N		-	Suspected <i>Cinnamomum alpiniae</i> but not confirmed	-	-	-	-	0.8
103	<i>Cryptocarya impressa</i>	Lauraceae		T	N		CR/D		0.3	-	-	-	-
104	<i>Dehaasia incrassata</i>	Lauraceae		T	N		CR/D		-	-	1.0	-	-
105	<i>Lindera lucida</i>	Lauraceae		T	N				-	0.5	-	-	-
106	<i>Lithocarpus ewykii</i>	Lauraceae		T	N				-	2.3	-	-	-
107	<i>Litsea elliptica</i>	Lauraceae		T	N				2.2	2.5	0.7	-	3.3
108	<i>Litsea firma</i>	Lauraceae		T	N		NE		0.7	0.9	1.6	-	-
109	<i>Litsea grandis</i>	Lauraceae		T	N		EN/D		-	0.5	0.7	-	-

**ANNEX 8H TREE SPECIES IN THE STUDY AREA, REPORTED FROM PLOT SURVEYS**

No.	Latin Name	Family	Common Name [English]	Life Form	Native (N)/ Exotic (E)	IUCN Red List (2015.02) <sup>1</sup>	SRDB National Status <sup>2</sup>	Uses/ Remarks	HABITAT (Plot) [Importance Value (IV)] <sup>Note 1</sup>				
									PF	RA	RB	WF	WM
110	<i>Phoebe grandis</i>	Lauraceae		T	N		CR/D		-	0.6	-	-	-
111	<i>Magnolia acuminata</i> var. <i>candolii</i>	Magnoliaceae		T	N				-	-	0.7	-	-
112	<i>Durio singaporensis</i>	Malvaceae		T	N		VU		-	-	0.6	-	-
113	<i>Pentace triptera</i>	Malvaceae	Melunak	T	N			Timber	-	0.6	-	-	-
114	<i>Scaphium macropodum</i>	Malvaceae	Malva Nut	T	N		-		0.5	-	-	-	-
115	<i>Memecylon edule</i>	Melastomataceae		T	N				0.6	-	-	-	0.8
116	<i>Memecylon floridum</i>	Melastomataceae		T	N				0.3	-	0.7	-	-
117	<i>Memecylon megacarpum</i>	Melastomataceae		T	N				0.6	0.6	-	-	-
118	<i>Memecylon paniculatum</i>	Melastomataceae		T	N				0.3	0.4	-	-	-
119	<i>Pternandra echinata</i>	Melastomataceae		T	N		VU/D		0.5	0.6	2.1	-	-
120	<i>Pternandra multiflora</i>	Melastomataceae		T	N			Unresovled name (The Plant List v1.1)	0.5	0.4	-	-	-
121	<i>Aglaia leucophylla</i>	Meliaceae	Lantupak (Bor)	T	N		CR/D		0.3	-	-	-	-
122	<i>Aglaia malaccensis</i>	Meliaceae	Lantupak (Bor)	T	N		CR/D		0.4	1.1	-	-	-
123	<i>Aglaia rubiginosa</i>	Meliaceae	Lantupak (Bor)	T	N		CR/D		0.3	-	-	-	-
124	<i>Chisocheton pentandrus</i>	Meliaceae		T	N		CR/D		0.6	-	-	-	-
125	<i>Chisocheton sarawakanus</i>	Meliaceae		T	N		CR/D		-	0.6	-	-	-
126	<i>Artocarpus dadah</i>	Moraceae	Dadak (Sar)	T	N		EN/D		0.7	-	-	-	-
127	<i>Artocarpus elasticus</i>	Moraceae	Terap	T	N		-		0.6	1.1	-	-	-
128	<i>Artocarpus integer</i>	Moraceae	Cempedak	T	N		DD		-	-	-	1.4	-
129	<i>Artocarpus lanceifolius</i>	Moraceae		T	N		CR/D		0.4	-	-	-	-
130	<i>Artocarpus lowii</i>	Moraceae		T	N		CR/D		-	-	0.65	-	-
131	<i>Artocarpus nitidus</i>	Moraceae	Monkey-Jack	T	N		CR/D		3.8	0.4	0.81	-	-
132	<i>Artocarpus rigidus</i>	Moraceae	Pala munsoh (Sar)	T	N		VU/D		0.8	1.0	1.54	-	-
133	<i>Ficus lamponga</i>	Moraceae		T	N		-		-	1.2	-	-	-
134	<i>Ficus benamina</i>	Moraceae		T	N		CR/D		-	-	-	-	1.0
135	<i>Gymnacranthera bancana</i>	Myristicaceae		T	N				-	-	1.1	-	-
136	<i>Gymnacranthera forbesii</i>	Myristicaceae		T	N				0.4	-	-	-	1.4
137	<i>Horsfieldia polyspherula</i>	Myristicaceae		T	N				0.8	-	-	-	0.7
138	<i>Horsfieldia wallichii</i>	Myristicaceae		T	N				-	0.7	-	-	-
139	<i>Knema curtisii</i>	Myristicaceae		T	N				0.3	-	-	-	-
140	<i>Myristica cinnamomea</i>	Myristicaceae		T	N				0.3	-	-	-	-
141	<i>Myristica intermedia</i>	Myristicaceae		T	N			Unresovled name (The Plant List v1.1)	0.3	-	-	-	-
142	<i>Myristica maingayi</i>	Myristicaceae		T	N				0.3	-	-	-	-
143	<i>Knema intermedia</i>	Myrtaceae		T	N				1.3	-	0.7	-	-
144	<i>Rhodamnia cinerea</i>	Myrtaceae	Silverback	T	N				0.5	3.4	17.3	-	0.8



**ANNEX 8H TREE SPECIES IN THE STUDY AREA, REPORTED FROM PLOT SURVEYS**

No.	Latin Name	Family	Common Name [English]	Life Form	Native (N)/ Exotic (E)	IUCN Red List (2015.02) <sup>1</sup>	SRDB National Status <sup>2</sup>	Uses/ Remarks	HABITAT (Plot) [Importance Value (IV)] <sup>Note 1</sup>				
									PF	RA	RB	WF	WM
145	<i>Syzygium alcinae</i>	Myrtaceae		T	N		Listed as <i>Syzygium leucoxylon</i> , status NE	Synonym of <i>Syzygium leucoxylon</i>	-	-	-	-	1.9
146	<i>Syzygium arcuatinervium</i>	Myrtaceae		T	N		EN/D		0.5	-	-	-	-
147	<i>Syzygium beccarii</i>	Myrtaceae		T	N				0.5	-	-	-	-
148	<i>Syzygium cerinum</i>	Myrtaceae		T	N		Listed as <i>Syzygium cerinum</i> var. <i>cerinum</i> and var. <i>turbinatum</i> , both status EN	Synonym of <i>Syzygium incarnatu</i>	0.8	3.5	0.7	1.4	0.8
149	<i>Syzygium chlorantum</i>	Myrtaceae		T	N		CR/D		2.3	-	-	-	-
150	<i>Syzygium glabratum</i>	Myrtaceae		T	N		NE		-	-	0.7	-	-
151	<i>Syzygium glaucum</i>	Myrtaceae		T	N		VU/D		-	-	-	2.9	-
152	<i>Syzygium grande</i>	Myrtaceae		T	N		-		0.8	-	1.7	-	-
153	<i>Syzygium lineatum</i>	Myrtaceae		T	N		-	TPL gives 21 synonyms	0.5	-	-	-	-
154	<i>Syzygium microcalyx</i>	Myrtaceae		T	N		-		0.3	0.4	-	3.3	-
155	<i>Syzygium polyanthum</i>	Myrtaceae		T	N				0.6	0.6	-	-	-
156	<i>Syzygium ridleyi</i>	Myrtaceae		T	N		CR/D		-	1.3	-	-	-
157	<i>Brackendridgea hookeri</i>	Ochnaceae		T	N		EN/D		0.3	-	-	-	-
158	<i>Ochanostachys amentacea</i>	Olacaceae		T	N	DD	VU/D	Timber	0.7			-	-
159	<i>Strombosia ceylanica</i>	Olacaceae		T	N		-		0.4	-	-	-	-
160	<i>Strombosia javanica</i>	Olacaceae		T	N		-		1.6	0.5	-	-	-
161	<i>Ilex cymosa</i>	Ommastrephidae		T	N				0.3	0.4	-	6.8	5.7
162	<i>Ilex macrophylla</i>	Ommastrephidae		T	N				-		-	-	0.8
163	<i>Sarcotheca glauca</i>	Oxalidaceae		T	N			Unresovled name (The Plant	0.3	-	-	-	-
164	<i>Sarcotheca griffithii</i>	Oxalidaceae		T	N		CR/D		0.7	-	-	-	-
165	<i>Adinandra dumosa</i>	Pentaphylacaceae	Tiup Tiup	T	N		-		0.3	-	-	-	-
166	<i>Temstroemia penangiana</i>	Pentaphylacaceae		T	N		CR/D		-	-	1.6	-	-
167	<i>Antidesma coriaceum</i>	Phyllanthaceae		T	N		VU/D		-	0.4	-	-	-
168	<i>Antidesma cuspidatum</i>	Phyllanthaceae		T	N		-		0.3	-	0.70	-	-
169	<i>Aporosa benthamiana</i>	Phyllanthaceae		T	N		VU/D		0.8	0.4	0.68	1.0	-
170	<i>Aporosa miqueliana</i>	Phyllanthaceae		T	N		CR/D		0.3	-	-	-	-
171	<i>Aporosa nervosa</i>	Phyllanthaceae		T	N		VU/D		0.4	-	-	-	-
172	<i>Aporosa prainiana</i>	Phyllanthaceae		T	N		VU/D		-	-	-	-	2.35
173	<i>Aporosa symplocoides</i>	Phyllanthaceae		T	N		-		-	-	0.65	-	-
174	<i>Baccaurea costulata</i>	Phyllanthaceae		T	N		-		0.3	-	-	-	-
175	<i>Baccaurea kunstleri</i>	Phyllanthaceae		T	N		EN/D		0.3	-	-	-	-
176	<i>Baccaurea parviflora</i>	Phyllanthaceae	Engkuni (Sar)	T	N		-		-	0.4	-	-	-
177	<i>Baccaurea racemosa</i>	Phyllanthaceae	Tampoi (PM'sia)	T	N		EN/D		0.3	0.4	0.65	-	-

**ANNEX 8H TREE SPECIES IN THE STUDY AREA, REPORTED FROM PLOT SURVEYS**

No.	Latin Name	Family	Common Name [English]	Life Form	Native (N)/ Exotic (E)	IUCN Red List (2015.02) <sup>1</sup>	SRDB National Status <sup>2</sup>	Uses/ Remarks	HABITAT (Plot) [Importance Value (IV)] <sup>Note 1</sup>				
									PF	RA	RB	WF	WM
178	<i>Cleistanthus sumatranus</i>	Phyllanthaceae		T	N		VU/D		0.3	-	-	-	-
179	<i>Cleistanthus winkleri</i>	Phyllanthaceae		T	N		-		0.3	0.5	-	-	-
180	<i>Glochidion lutescens</i>	Phyllanthaceae		T	N				0.3	-	-	-	-
181	<i>Glochidion superbum</i>	Phyllanthaceae		T	N		DD		0.3	-	-	1.5	0.9
182	<i>Glochidion zeylanicum</i> var. <i>arborescens</i>	Phyllanthaceae		T	N		CR/D		-	-	-	3.9	4.6
183	<i>Xanthophyllum affine</i>	Polygalaceae		T	N		EN/D		1.2	-	-	-	-
184	<i>Xanthophyllum amoenum</i>	Polygalaceae		T	N	DD	CR/D		1.4	0.7	1.1	-	1.1
185	<i>Xanthophyllum ellipticum</i>	Polygalaceae		T	N	DD	CR/D			0.6	0.7	-	-
186	<i>Xanthophyllum griffithii</i>	Polygalaceae		T	N		EN/D		-	-	0.7	-	-
187	<i>Xanthophyllum stipitatum</i>	Polygalaceae		T	N		EN/D		0.4	-	-	-	-
188	<i>Xanthophyllum vitellinum</i>	Polygalaceae		T	N		VU/D		0.3	-	-	-	-
189	<i>Helicia petiolaris</i>	Proteaceae		T	N				1.2	1.5	1.3	-	-
190	<i>Drypetes pendula</i>	Putranjavaceae		T	N				1.0	-	-	-	-
191	<i>Carallia brachiata</i>	Rhizophoraceae		T	N				0.3	1.1	-	-	-
192	<i>Gynotroches axillaris</i>	Rhizophoraceae	Fish eye	T	N				-	-	1.6	3.4	9.0
193	<i>Pellacalyx axillaris</i>	Rhizophoraceae		T	N				-	0.7	-	6.2	3.0
194	<i>Pellacalyx saccardianus</i>	Rhizophoraceae		T	N				-	0.4	-	-	-
195	<i>Prunus polystachya</i>	Rosaceae		T	N		-		-	0.9	-	-	-
196	<i>Diplospora malaccensis</i>	Rubiaceae		T	N				0.3	-	-	-	-
197	<i>Euodia glabra</i>	Rubiaceae		T	N				-	0.5	-	-	-
198	<i>Gardenia griffithii</i>	Rubiaceae		T	N				0.5	-	1.5	-	-
199	<i>Gardenia pterocalyx</i>	Rubiaceae		T	N				-	0.4	0.6	-	-
200	<i>Gardenia tubifera</i>	Rubiaceae		T	N				-	0.6	-	-	-
201	<i>Nauclea officinalis</i>	Rubiaceae		T	N				0.3	-	-	-	-
202	<i>Tarenna costata</i>	Rubiaceae		T	N		CR/D		0.3	-	0.7	-	-
203	<i>Timonius borneensis</i>	Rubiaceae		T	N		-		0.8	-	-	-	-
204	<i>Timonius malaccensis</i>	Rubiaceae		T	N			Synonym of <i>Knoxia</i>	-	0.6	2.2	-	-
205	<i>Timonius wallichianus</i>	Rubiaceae	Malayan Chesnut	T	N				1.3	0.8	1.7	-	-
206	<i>Xerospermum</i> sp.	Sapindaceae		T	N		-		-	0.4	-	-	-
207	<i>Heritiera borneensis</i>	Sapotaceae		T	N				0.3	-	-	-	-
208	<i>Heritiera sumatrana</i>	Sapotaceae		T	N				-	0.5	-	-	-
209	<i>Palaquium microphyllum</i>	Sapotaceae		T	N			Timber	0.4	0.4	-	-	-
210	<i>Palaquium obovatum</i>	Sapotaceae		T	N			Timber	-	-	2.0	-	-
211	<i>Palaquium ridleyi</i>	Sapotaceae		T	N			Timber	-	-	0.8	-	-
212	<i>Palaquium rostratum</i>	Sapotaceae		T	N			Timber	0.7	-	-	-	-
213	<i>Palaquium rubiginosum</i>	Sapotaceae		T	N			Timber	-	0.5	-	-	-

ANNEX 8H TREE SPECIES IN THE STUDY AREA, REPORTED FROM PLOT SURVEYS

No.	Latin Name	Family	Common Name [English]	Life Form	Native (N)/ Exotic (E)	IUCN Red List (2015.02) <sup>1</sup>	SRDB National Status <sup>2</sup>	Uses/ Remarks	HABITAT (Plot) [Importance Value (IV)] <sup>Note 1</sup>				
									PF	RA	RB	WF	WM
214	<i>Planchonella maingayi</i>	Sapotaceae		T	N		Listed as <i>Pouteria maingayi</i> , status EN/D	Synonyms include <i>Lucuma maingayi</i> , <i>Planchonella borneensis</i> , <i>Pouteria maingayi</i> , <i>Siderocarpus borneensis</i> , <i>Sideroxylon borneense</i> , <i>Sideroxylon maingayi</i>	-	-	-	1.3	0.8
215	<i>Eurycoma longifolia</i>	Simaroubaceae		T	N				-	0.4	0.6	-	-
216	<i>Symplocos rubiginosa</i>	Symplocaceae		T	N		EN/D		0.5	0.4	-	-	-
217	<i>Aquilaria malaccensis</i>	Thymelaeaceae	Agarwood	T	N	VU	VU/D	Also listed on CITES Appendix	-	0.9	-	-	-
218	<i>Grewia borneensis</i>	Tiliaceae		T	N				0.3	-	-	-	-
Total									100.0	100.0	100.0	100.0	100.0
Number of species									127.0	94.0	57.0	31.0	43.0

References

1. IUCN Red List of Threatened Species 2015.02. Retrieved from <http://www.iucnredlist.org/> Abbreviations include:  
DD: Data Deficient; LC: Least Concern; NT: Near Threatened; VU: Vulnerable; EN: Endangered; CR: Critically Endangered
2. Davison GWH, Ng PKL and Ho HC. (2008) **Singapore Red Data Book**. The Nature Society (Singapore) Abbreviations include:  
DD: Data Deficient (status indeterminate, requires further validation); VU: Vulnerable; EN: Endangered; CR: Critically Endangered  
NE: Presumed Nationally extinct; EX: Globally Extinct (/D indicates a Sub-Category D of a particular status)
3. The Plant List (v1.1) (Sep 2013). Available at <http://www.theplantlist.org/>

Notes:

1 Importance Value is calculated as IV= Rf + Rd + Rba, where Rf is relative frequency, Rd is relative density and Rba is relative Coverage, as fully explained in the main text.

Habitat type	Key
Primary Forest	PF
Regeneration Forest A	RA
Regeneration Forest B	RB
Wetland Forest	WF
Wetland Marsh	WM

Life-form	Key
Tree	T
Shrub	S
Herb	H
Climber	C

Annex 8I-1

## Vegetation Species List (Transect)

## ANNEX 8I FLORA IN THE STUDY AREA, REPORTED FROM TRANSECTS

[illegible]

No.	Latin Name	Family	Common Name [English]	Life Form	Native (N)/ Exotic (E)	IUCN Red List (2015.02) <sup>1</sup>	SRDB National Status <sup>2</sup>	Uses/ Remarks	McR 01	McR 02	McR03	McR04	PT 02	ST01	ST03	ST04	ST06	TTW01	GL01a	BKAR01	BKF01	RRL01	OT01	OT02	VLp01	VL01	VL02	VL03	McR05	LT01	LT02	LT03	LT04	JT01	CL01	CL02	CL03	CL04	CL05	CL06	MRPT01	MRPT02	MRPT03	BKFL01	OT04	OT05	OT06	OT07	ST02	PT01		
48	<i>Picinarium alternifolium</i>	Bonnetiaceae	Cicada Tree, Riang Riang	T	N														+																				+	+	+											
49	<i>Canarium littorale</i>	Burseraceae		T	N																									+	+																					
50	<i>Dacryodes costata</i>	Burseraceae		T	N		EN/D													+	+																			+				+								
51	<i>Dacryodes rostrata</i>	Burseraceae		T	N		VU/D			+																																										
52	<i>Saniria laevigata</i>	Burseraceae		T	N					+																																										
53	<i>Saniria rubiginosa</i>	Burseraceae	kedondong kerantai	T	N		VU/D													+				+				+		+		+			+	+	+		+		+		+	+	+	+						
54	<i>Saniria tomentosa</i>	Burseraceae		T	N																															+								+	+							
55	<i>Gironniera nervosa</i>	Cannabaceae	Kasap	T	N				+	+		+				+	+		+	+		+	+	+			+	+	+	+		+	+	+		+			+	+	+		+		+			+		+		
56	<i>Gironniera parvifolia</i>	Cannabaceae		T	N						+																														+			+	+							
57	<i>Bhesa paniculata</i>	Celastraceae	Malayan Spindle Tree	T	N	LC			+						+																										+											
58	<i>Bhesa robusta</i>	Celastraceae		T	N		VU/D																																		+											
59	<i>Bhesa</i> sp.1	Celastraceae		T	Suspected N			Suspected as <i>Bhesa elliptica</i> but not confirmed									+																																			
60	<i>Lophopetalum multinervium</i>	Celastraceae		T	N			<b>Timber</b>																							+												+									
61	<i>Lophopetalum</i> sp.1	Celastraceae		T	Suspected N			<b>Timber</b> . Suspected as <i>Lophopetalum glabrum</i> (TPLv1.1 lists as unresolved name but COL 2015, as an accepted name) but not confirmed												+																																
62	<i>Lophopetalum</i> sp.2	Celastraceae		T	Suspected N			<b>Timber</b> . Suspected as <i>Lophopetalum rigidum</i> (TPLv1.1 lists as unresolved name but COL 2015, as an accepted name) with synonym <i>Lophopetalum subsessile</i> ) but not confirmed	+	+																												+														
63	<i>Lophopetalum wightianum</i>	Celastraceae	Mata Ulat, Perupok	T	N	LC	VU/D	<b>Timber</b>				+			+		+																																			
64	<i>Licania splendens</i>	Chrysobalanaceae	merbatu	T	N	LC																					+																									
65	<i>Parastemon urophyllus</i>	Chrysobalanaceae	Ngilas	T	N		EN/D																										+	+																		
66	<i>Parinari oblongifolia</i>	Chrysobalanaceae		T	N		CR/D																														+															
67	<i>Calophyllum teysmanii</i>	Clusiaceae		T	N																																															
68	<i>Calophyllum ferrugineum</i>	Clusiaceae	Bintangor	T	N				+	+						+	+				+	++	+							+				+								+					+			++		
69	<i>Calophyllum innophyllum</i>	Clusiaceae	Penaga laut	T	N		CR/D																							++																						
70	<i>Calophyllum lanigerum</i>	Clusiaceae	Bintangor	T	N				+		+								+	+						+	+								+																	
71	<i>Calophyllum macrocarpum</i>	Clusiaceae		T	N		CR/D																															+														
72	<i>Calophyllum pulcherrimum</i>	Clusiaceae		T	N				+		+						+			+																						+										
73	<i>Calophyllum rubiginosum</i>	Clusiaceae	Bintangor	T	N						+						+			+								+						+	+		+															
74	<i>Calophyllum rufigenmatum</i>	Clusiaceae	Bintangor	T	N										+																																					
75	<i>Calophyllum sundaicum</i>	Clusiaceae		T	N		CR/D																																			+										
76	<i>Calophyllum teysmannii</i>	Clusiaceae	Teysmans Bintangor	T	N		VU/D										+			+								+							+	+																
77	<i>Garcinia bancana</i>	Clusiaceae	Kandis	T	N		CR/D		+		+		+				+															+	+	+	+								+			+						
78	<i>Garcinia eugeniifolia</i>	Clusiaceae	Kandis	T	N		VU/D		+	+	+						+					+			+	+											+							+			+					
79	<i>Garcinia maingayi</i>	Clusiaceae		T	N		CR/D																												+																	
80	<i>Garcinia nervosa</i>	Clusiaceae		T	N						+++								+																									+								
81	<i>Garcinia parvifolia</i>	Clusiaceae	Kandis	T	N				+						+	+	+	+		+	+					+	+	+	+					+									+	+								
82	<i>Garcinia scortechinii</i>	Clusiaceae		T	N	LC	CR/D																																				+									
83	<i>Garcinia</i> sp.1	Clusiaceae		T	Suspected N			Suspected as <i>Garcinia apetala</i> but not confirmed.																			+																									
84	<i>Garcinia</i> sp.2	Clusiaceae		T	N			Suspected as <i>Garcinia brevipes</i> but not confirmed.																		+								+																		
85	<i>Mesua elegans</i>	Clusiaceae		T	N	LC	CR/D																																			+										
86	<i>Terminalia catappa</i>	Combretaceae	Sea Almond, ketapang	T	N			Ornamental																		+		+																								
87	<i>Terminalia subspatulata</i>	Combretaceae		T	N		CR/D																																													
88	<i>Alangium havilandii</i>	Comaceae		T	N				+	+																		+																								
89	<i>Alangium javanicum</i>	Comaceae		T	N											+	+	++		+	+		+						+	+	+	+	++	+	+	+			+	+	+	+	+	+	+	+	+			+		
90	<i>Alangium nobile</i>	Comaceae	mentulang bulu	T	N	LC					+			+					+																		+	+							+	+					+	
91	<i>Ctenolophon parvifolius</i>	Ctenolophonaceae		T	N		CR/D						+																																							
92	<i>Dillenia excelsa</i>	Dilleniaceae		T	N																								+																							
93	<i>Dillenia grandifolia</i>	Dilleniaceae	Stilted Simpoh	T	N		EN/D																												+																	
94	<i>Dillenia reticulata</i>	Dilleniaceae	Stilted Simpoh	T	N																																															
95	<i>Dillenia suffruticosa</i>	Dilleniaceae	Shrubby Simpoh, Simp	T	N										+	++++	+	++		+		+	+	+													+					+										
96	<i>Cotylelobium malayanum</i>	Dipterocarpaceae		T	N		Listed as <i>Cotylelobium lanceolatum</i> , status CR/D	Synonym of <i>Cotylelobium lanceolatum</i>					+																																							

















Annex 8I-2

## Vegetation Species List (Alignment Options 1 and 2)

**ANNEX 8II FLORA IN THE ALIGNMENT, REPORTED FROM TRANSECTS**

No.	Latin Name	Family	Common Name [English]	Life Form	Native (N)/ Exotic (E)	CONSERVATION STATUS		Uses/ Remarks	Alignment Option 1				Alignment Option 2	
						IUCN Red List (2015.02) <sup>1</sup>	SRDB National Status <sup>2</sup>		Transects along Sime Trail	Transects along Terentang Trail	Transect along Kalang Service Reservoir Road	Transects along Venus Trail Link	Transects along PIE and Lornie Road	Transects along Venus Drive
1	<i>Acacia auriculiformis</i>	Fabaceae		T	E			Cultivated	+				+++	
2	<i>Adenanthera pavonina</i>	Fabaceae		T	E			Cultivated; Naturalised	++	++				
3	<i>Adenia macrophylla</i>	Passifloraceae		C	N		VU	Cultivated	+					
4	<i>Adinandra dumosa</i>	Pentaphyllaceae		T	N			Cultivated	++					
5	<i>Aglaia</i> sp.	Meliaceae		T	N			Many Species are EN/CR or Extinct	+					
6	<i>Aglaonema commutatum</i>	Araceae		H	E			Cultivated	++					+++
7	<i>Alangium javanicum</i>	Cornaceae		T	N	LC	CR		++			+		
8	<i>Alchornea villosa</i>	Euphorbiaceae		T	N		CR		+	+				
9	<i>Alstonia angustifolia</i>	Apocynaceae		T	N			Cultivated					++	
10	<i>Ampelocissus</i> sp.	Vitaceae		C	N				+					
11	<i>Andira</i> sp.	Fabaceae		T	E					+				
12	<i>Anisophyllea disticha</i>	Anisophyllaceae		S	N			Cultivated		+				
13	<i>Antidesma cuspidatum</i>	Phyllanthaceae		T	N			Cultivated	+					
14	<i>Aporosa benthamiana</i>	Phyllanthaceae		T	N		VU		+					
15	<i>Aporosa</i> sp.	Phyllanthaceae		T	N				+	+		+		
16	<i>Aquilaria malaccensis</i>	Thymelaeaceae		T	N	VU	VU	Cultivated	+	++		+		
17	<i>Artabotrys suaveolens</i>	Annonaceae		C	N		EN		+					
18	<i>Artocarpus elasticus</i>	Moraceae		T	N			Cultivated	+	+				
19	<i>Artocarpus nitidus</i>	Moraceae		T	N		CR	Cultivated					++	
20	<i>Asplenium</i> sp.	Aspleniaceae		F;E	N			On dead tree/branch					++	
21	<i>Asystasia gangetica</i>	Acanthaceae		H	E			Cultivated; Naturalised	+++					
22	<i>Arthropphyllum diversifolium</i>	Arialaceae		T	N			Cultivated					+++	
23	Bamboo	Poaceae		S	E			Cultivated	+					++
24	<i>Bauhinia</i> sp.	Fabaceae		C	E			Cultivated	+	+				
25	<i>Bhesa paniculata</i>	Celastraceae		T	N	LC		Cultivated	+			+		
26	<i>Bucida</i> sp.	Combretaceae		T	E			Cultivated only					++	
27	<i>Bulbophyllum</i> sp.	Orchidaceae		E	Suspected N			Cultivated	+					
28	<i>Calophyllum inophyllum</i>	Calophyllaceae		T	N	LC	CR	Seedlings and Tree; Cultivated					++	
29	<i>Calophyllum</i> sp.	Calophyllaceae		T	N				+++	+++		+		
30	<i>Camptosperma auriculata</i>	Anacardiaceae		T	N			Cultivated	++++	+++		+++		
31	<i>Canthium</i> sp.	Rubiaceae		T	N					+				
32	<i>Carallia brachiata</i>	Rhizophoraceae		T	N		EN	Cultivated	+					
33	<i>Caryota mitis</i>	Arecaceae		P	N			Cultivated	+++	++++		+++	+++	
34	<i>Cerbera odollam</i>	Apocynaceae		T	N		VU	Cultivated						+

No.	Latin Name	Family	Common Name [English]	Life Form	Native (N)/ Exotic (E)	IUCN Red List (2015.02) <sup>1</sup>	SRDB National Status <sup>2</sup>	Uses/ Remarks	Transects along Sime Trail	Transects along Terentang Trail	Transect along Kalang Service Reservoir Road	Transects along Venus Trail Link	Transects along PIE and Lornie Road	Transects along Venus Drive
35	<i>Cinnamomum iners</i>	Lauraceae		T	N			Cultivated	++++	+++	+++	++	++++	+
36	<i>Clidemia hirta</i>	Melastomataceae		S	E			Cultivated	++++	++++		+++	+++	
37	<i>Costus speciosus</i>	Costaceae		H	N			Cultivated	++					
38	<i>Cratoxylum arborescens</i>	Hypericiaceae		T	N	LC	VU		+	++				
39	<i>Cratoxylum formosum</i>	Hypericiaceae		T	N	LC	EN	Cultivated	+	+++		+++	++++	
40	<i>Cyrtosperma merkusii</i>	Araceae		H	N		VU						++	
41	<i>Cucurbita</i> sp.	Cucurbitaceae		C	E			Naturalised; Cultivated.					++	
42	<i>Cynometra</i> sp.	Fabaceae		T	Suspected E				+					
43	<i>Derris</i> sp.	Fabaceae		C	N				+	++				
44	<i>Dicranopteris linearis</i>	Gleicheniaceae		F	N			Cultivated	++	+		++	+++	
45	<i>Dieffenbachia seguine</i>	Araceae		H	E			Cultivated					+++	
46	<i>Dillenia suffruticosa</i>	Dilleniaceae		S	N				++++	+++		+++	++++	
47	<i>Dioscorea</i> sp.	Dioscoreaceae		Seedlings	N			One species in Chong et al listed as a weed, one Common, majority of species are CR, and one extinct.	+	+				
48	<i>Diospyros</i> sp.	Ebenaceae		T	Suspected N					+				
49	<i>Dipterocarpus kunstleri</i>	Dipterocarpaceae		T	N	CR	CR	Planted roadside; Cultivated					+++	
50	<i>Dracaena</i> sp.	Ruscaceae		H	E			Cultivated	++					
51	<i>Elaeis guineensis</i>	Arecaceae		T	E			Cultivated only	++	+				++
52	<i>Elaeocarpus mastersii</i>	Elaeocarpaceae		T	N			Cultivated	+					+
53	<i>Elaeocarpus</i> sp.	Elaeocarpaceae		T	Suspected N				+++					+
54	<i>Eurycoma longifolia</i>	Simaroubaceae		T	N		CR	Cultivated		++				
55	<i>Fagraea fragrans</i>	Gentianaceae	Tembusu	T	N			Cultivated	+++	++		++		
56	<i>Falcataria moluccana</i>	Fabaceae		T	E			Naturalised; Cultivated.		+			++++	
57	<i>Ficus aurata</i>	Moraceae		T	N		VU		+++	+++			++	
58	<i>Ficus benjamina</i>	Moraceae		T	N							+	++	
59	<i>Ficus grossularioides</i>	Moraceae		S	N								++++	
60	<i>Ficus lamponga</i>	Moraceae		T	N		CR		++	++			++++	
61	<i>Ficus</i> sp. 1	Moraceae		T	Suspected N									+
62	<i>Ficus</i> sp. 2	Moraceae		C	Suspected N				+					
63	<i>Fissistigma latifolium</i>	Annonaceae		C	N				+	+				
64	<i>Flacourtia</i> sp. 1	Saliaceae		T	E				+					
65	<i>Garcinia griffithii</i>	Clusiaceae		T	N		EN	Cultivated	+					
66	<i>Garcinia parvifolia</i>	Clusiaceae		T	N			Cultivated	++	+		+		
67	<i>Garcinia scortechinii</i>	Clusiaceae		T	N	LC	CR		+					
68	<i>Garcinia</i> sp.	Clusiaceae		T	Uncertain				+					
69	<i>Girardinia nervosa</i>	Cannabaceae		T	N			Cultivated		+	+	+		

No.	Latin Name	Family	Common Name [English]	Life Form	Native (N)/ Exotic (E)	IUCN Red List (2015.02) <sup>1</sup>	SRDB National Status <sup>2</sup>	Uses/ Remarks	Transects along Sime Trail	Transects along Terentang Trail	Transect along Kalang Service Reservoir Road	Transects along Venus Trail Link	Transects along PIE and Lornie Road	Transects along Venus Drive
70	<i>Girroniera parvifolia</i>	Cannabaceae		T	N		EN					+		
71	<i>Girroniera</i> sp. (treelet)	Cannabaceae		T	N				+	+		+		
72	<i>Glochidion</i> sp. 1	Phyllanthaceae		T					++	++		+	+++	
73	<i>Glochidion zeylanicum</i>	Phyllanthaceae		T	N				+					
74	Grass (various species)	Poaceae		H	Uncertain				+++	+++		+++	++++	
75	<i>Gymnacanthra forbesii</i>	Myristicaceae		T	N		CR		++		+	+		
76	<i>Gynotroches axillaris</i>	Rhizophoraceae		T	N			Cultivated	++					
77	<i>Hedyotis</i> sp.	Rubiaceae		H	Suspected N				+					
78	<i>Heliciopsis</i> sp.	Proteaceae		T	Uncertain			Unresolved genus in Plant List v1.1	+	+			++	
79	<i>Hevea brasiliensis</i>	Euphorbiaceae		T	E			Naturalised; Cultivated.	++++			+++	++++	
80	<i>Hopea odorata</i>	Dipterocarpaceae		T	E			Cultivated only					++++	
81	<i>Imperata cylindrica</i>	Poaceae		H	Uncertain Origin				+	+			+++	
82	<i>Ixonanthes beccarii</i>	Ixonanthaceae		T				Unresolved name on Plant List v1.1	+	+				
83	<i>Ixonanthes</i> sp.	Ixonanthaceae		T	N				+			+		
84	<i>Khaya senegalensis</i>	Meliaceae		T	E			Planted roadside; Cultivated only					+++	
85	<i>Knema</i> sp.	Myristicaceae		T	N				+					
86	<i>Leea indica</i>	Vitaceae		T	N				+++					
87	Liana	-		C	N			Unidentified	+					
88	<i>Litsea accedens</i>	Lauraceae		T	N		EN		+	+				
89	<i>Litsea elliptica</i>	Lauraceae		T	N				+	+++				
90	<i>Litsea</i> sp.	Lauraceae		T	N							+		
91	<i>Lygodium</i> sp.	Lygodiaceae		F	Suspected N					+			+++	
92	<i>Macaranga gigantea</i>	Euphorbiaceae		T	N			Cultivated	++++	+++		+++	++++	
93	<i>Macaranga pruinosa</i>	Euphorbiaceae		T	N		Extinct	Possible misidentification		+				
94	<i>Magnolia champaca</i>	Magnoliaceae		T	E			Planted roadside					+++	
95	<i>Manihot esculenta</i>	Euphorbiaceae		S	E			Cultivated	++					++++
96	<i>Melastoma malabathricum</i>	Melastomataceae		S	N			Cultivated	++	+++		+++	++++	
97	<i>Menisperm</i> sp.	Menispermaceae		C	N				++	+		++		
98	<i>Mesua ferrea</i>	Clusiaceae		T	E				+					
99	<i>Mimusops elengi</i>	Sapotaceae		T	E			Cultivated						+
100	<i>Molineria</i> sp.	Hypoxidaceae		H	N		CR/VU	Depending on 1 of 2 species, either CR or VU.	+	++				
101	<i>Morinda citrifolia</i>	Rubiaceae		T	N			Cultivated					++	
102	<i>Musa</i> sp.	Musaceae		H	E			Cultivated						+++
103	<i>Nephelium cuspidatum</i>	Sapindaceae		T	N		EN	Cultivated			+			
104	<i>Nephelium lappaceum</i>	Sapindaceae		T	N	LC	CR	Cultivated	+	+	+	+	++	
105	<i>Norrisia maior</i>	Loganiaceae		T	N		CR					+		

No.	Latin Name	Family	Common Name [English]	Life Form	Native (N)/ Exotic (E)	IUCN Red List (2015.02) <sup>1</sup>	SRDB National Status <sup>2</sup>	Uses/ Remarks	Transects along Sime Trail	Transects along Terentang Trail	Transect along Kalang Service Reservoir Road	Transects along Venus Trail Link	Transects along PIE and Lornie Road	Transects along Venus Drive
106	<i>Oncosperma tigillaria</i>	Arecaceae		S	N		VU	Cultivated	++	++		++		
107	<i>Oreocnide</i> sp.1	Urticaceae		T	-			No such genus exists in Chong et al.	+	+		+	+++	
108	<i>Pandanus</i> sp.	Pandanaceae		H	N				++	++		++		
109	<i>Peltophorum pterocarpum</i>	Fabaceae		T	N		CR						+++	
110	<i>Pentace triptera</i>	Malvaceae		T	N		EN						++	
111	<i>Phoebe grandis</i>	Lauraceae		T	N		CR		+					
112	<i>Piper</i> sp.	Piperaceae		C	Suspected N				+++	++				
113	<i>Archidendron jiringa</i>	Fabaceae		T	N		VU						++	
114	<i>Pometia pinnata</i>	Sapindaceae		T	N		EN		+					
115	<i>Prunus polystachya</i>	Rosaceae		Seedlings	N								++	
116	<i>Psydrax</i> sp.	Rubiaceae		T	N				+					
117	<i>Pternandra</i> sp.	Melastomaceae		T	N					+				
118	<i>Pterocarpus indicus</i>	Fabaceae		T	E				+				++	
119	Rattan (various species)			P	Suspected all N				+++					
120	<i>Rhodamnia cinerea</i>	Myrtaceae		T	N				++	+	+	+++		
121	<i>Roystonea oleracea</i>	Arecaceae		P	E									++
122	<i>Salix</i> sp.	Salicaceae		T	E									+
123	<i>Samanea saman</i>	Fabaceae		T	E								+++	+++
124	<i>Sandoricum koetjape</i>	Meliaceae		T	N		EN	Cultivated	+					
125	<i>Santiria rubiginosa</i>	Burseraceae		T	N		VU		+					
126	<i>Santiria tomentosa</i>	Burseraceae		T	N	LC	EN						++	
127	<i>Sauropus</i> sp.	Phyllanthaceae		S	Suspected N								+++	
128	<i>Shorea</i> sp.	Dipterocarpaceae		T	N								+++	
129	<i>Smilax setosa</i>	Smilacaceae		C	N				+++	++				
130	<i>Spathodea campanulata</i>	Bignoniaceae		T	E			Naturalised* Cultivated	++				++++	
131	<i>Sterculia</i> sp.	Malvaceae		T	Uncertain								++	
132	<i>Strombosia</i> sp.	Oleaceae		T	N								++	
133	<i>Swietenia macrophylla</i>	Meliaceae		T	E						+			
134	<i>Symplocos</i> sp.1	Symplocaceae		T	N					++		+		
135	<i>Syzygium campulatum</i>	Myrtaceae		T	N			Ornamental; Planted; Cultivated					++++	
136	<i>Syzygium grande</i>	Myrtaceae		T	N			Used for roadside planting too	+	+				
137	<i>Syzygium incarnatum</i>	Myrtaceae		T	N		EN			+	+			
138	<i>Syzygium polyanthum</i>	Myrtaceae		T	N			Cultivated		+	+			+
139	<i>Tacca</i> sp.	Dioscoreaceae		H	Suspected N				+	+				
140	<i>Tetracera indica</i>	Dilleniaceae		C	N				+		+++	+	++++	
141	<i>Tetrastigma</i> sp.	Vitaceae		C	Suspected N				+	+			+++	

No.	Latin Name	Family	Common Name [English]	Life Form	Native (N)/ Exotic (E)	IUCN Red List (2015.02) <sup>1</sup>	SRDB National Status <sup>2</sup>	Uses/ Remarks	Transects along Sime Trail	Transects along Terentang Trail	Transect along Kalang Service Reservoir Road	Transects along Venus Trail Link	Transects along PIE and Lornie Road	Transects along Venus Drive
142	<i>Timonius</i> sp.	Rubiaceae		Seedlings	N								++	
143	<i>Timonius wallichianus</i>	Rubiaceae		T	N			Cultivated	+					
144	<i>Uncaria</i> sp.	Rubiaceae		C	Suspected N				+	+				
145	<i>Uvaria</i> sp.	Annonaceae		C	N				+					
146	<i>Vitex pinnata</i>	Lamiaceae		T	N			Cultivated	++					
147	<i>Vitex</i> sp.	Lamiaceae		Seedlings	Suspected N								++	
148	<i>Vitis</i> sp.	Vitaceae		C	E				+				++	
149	<i>Xanthophyllum affine</i>	Polygalaceae		T	N		EN			+				
150	<i>Xanthophyllum</i> sp.	Polygalaceae		T	N							+		
151	<i>Xylopia</i> sp.	Annonaceae		T	N				++	++++				

#### References

1. IUCN Red List of Threatened Species 2015.02. Retrieved from <http://www.iucnredlist.org/> Abbreviations include: DD: Data Deficient; LC: Least Concern; NT: Near Threatened; VU: Vulnerable; EN: Endangered; CR: Critically Endangered
2. Davison GWH, Ng PKL and Ho HC. (2008) **Singapore Red Data Book**. Abbreviations include: DD: Data Deficient (status indeterminate, requires further validation); VU: Vulnerable; EN: Endangered; CR: Critically Endangered NE: Presumed Nationally extinct; EX: Globally Extinct (/D indicates a Sub-Category D of a particular status)
3. Chong K Y C, Tan H T W, Corlett R T (2009) **A Checklist of the Total Vascular Plant Flora of Singapore. Native, Naturalised and Cultivated Species**. Raffles Museum of Biodiversity Research, NUS, Singapore. Abbreviations include: CO: Common; VU: Vulnerable; EN: Endangered; CR: Critically Endangered; EX: Extinct
4. **The Plant List (TPL) (v1.1)** (Sep 2013). Available at <http://www.theplantlist.org/>
5. Roskov Y. *et al.*, eds. (2015). **Species 2000 & ITIS Catalogue of Life, 18th May 2015 (COL)**. Available at [www.catalogueoflife.org/col](http://www.catalogueoflife.org/col). Species 2000: Naturalis, Leiden, the Netherlands.
6. Data received from Nparks on 6 May 2015 <MacRitchieFlora\_SING\_300315>

Key	Life-form
T	Tree
P	Palm
S	Shrub
H	Herb
C	Climber
E	Epiphyte
G	Grass
F	Fern

Relative abundance	Key
Sparse	+
Uncommon	++
Common	+++
Very common	++++



Annex 8J

## Bird Species List (Primary Data)

ANNEX 8J BIRD SPECIES IN STUDY AREA, REPORTED FROM PRIMARY SURVEYS

No.	Scientific Name	Common Name [English]	Photo Record	Family	CONSERVATION STATUS					Qualitative Data									Quantitative Data (from McKinnon Lists)		Remarks*
					IUCN Red List (2015.02) <sup>1</sup>	CITES (2015) <sup>2</sup>	SRDB National Status <sup>3</sup>	CRL WG Report 'National Status' <sup>4</sup>	Overall Abundance in Singapore <sup>5</sup>	PF	RA	RB	WF	WM	GR	RES	PA	Restricted Area	Number of Lists Species Recorded In	Relative Abundance	
Phasianidae (Pheasants and Allies)																					
1	<i>Gallus gallus</i>	Red Junglefowl	Yes	PHASIANIDAE	LC	Sp. not listed	EN	Sp. not listed	U	+	+					+			23	0.12	Heard in RA north of Adam Drive in June '15
Ardeidae (Hérons and Bitterns)																					
2	<i>Ardea purpurea</i>	Purple Heron	Yes	ARDEIDAE	LC	Sp. not listed	EN	EN	C							+			3	0.02	
3	<i>Egretta garzetta</i>	Little Egret		ARDEIDAE	LC	Sp. not listed	Not listed	Not given	C							+			1	0.01	
4	<i>Mesophoyx intermedia</i>	Intermediate Egret		ARDEIDAE	LC	Sp. not listed	Not listed	Not given	C							+			3	0.02	
5	<i>Casmerodius albus</i>	Great Egret		ARDEIDAE	LC	Sp. not listed	Not listed	Not given	C							+			1	0.01	
6	<i>Ixobrychus eurhythmus</i>	Yellow Bittern		ARDEIDAE	LC	Sp. not listed	Not listed	Not given	U							+			1	0.01	
7	<i>Nycticorax nycticorax</i>	Black-crowned Night-heron	Yes	ARDEIDAE	LC	Sp. not listed	CR	CR	U		+								From Camera Trap	/	Recorded from Camera Trapping
8	<i>Gorsachius melanophus</i>	Malayan Night-heron	Yes	ARDEIDAE	LC	Sp. not listed	Not listed	Not given	R		+								From Camera Trap	/	Recorded from Camera Trapping
Accipitridae (Kites, Hawks and Eagles)																					
9	<i>Nisaetus cirrhatus</i>	Changeable Hawk Eagle	Yes	ACCIPITRIDAE	LC	Appendix II	EN	EN(VU)	U		+					+			28	0.15	Juvenile observed in RA north of Adam Drive in June '15
10	<i>Accipiter gularis</i>	Japanese Sparrowhawk		ACCIPITRIDAE	LC	Appendix II	Not listed	Not given	C		+								2	0.01	
11	<i>Accipiter virgatus</i>	Besra		ACCIPITRIDAE	LC	Appendix II	Not listed	Not given	R						+				1	0.01	
12	<i>Accipiter soloensis</i>	Chinese Goshawk		ACCIPITRIDAE	LC	Appendix II	Not listed	Not given	U	+									1	0.01	Male in flight. Possibly the earliest date of this species recorded in Singapore (16 Sept)
13	<i>Haliastur indus</i>	Brahminy Kite	Yes	ACCIPITRIDAE	LC	Appendix II	LC	LC	C						+	+			6	0.03	
14	<i>Ichthyophaga ichthyaetus</i>	Grey-headed Fish Eagle	Yes	ACCIPITRIDAE	NT	Appendix II	CR	CR	R		+			+		+			7	0.04	
15	<i>Spilornis cheela</i>	Crested Serpent Eagle		ACCIPITRIDAE	LC	Appendix II	CR	CR	R		+								2	0.01	Flying overhead, over the MacRitchie Trail in Feb 2015
16	<i>Haliaeetus leucogaster</i>	White-bellied Sea-Eagle	Yes	ACCIPITRIDAE	LC	Appendix II	LC	LC	C		+					+			5	0.03	
Falconidae (Falcons)																					
17	<i>Falco peregrinus</i>	Peregrine Falcon		FALCONIDAE	LC	Appendix I	Not listed	Not given	U		+								1	0.01	
Rallidae (Rails, Crakes and Coots)																					
18	<i>Amauornis phoenicurus</i>	White-breasted Waterhen		RALLIDAE	LC	Sp. not listed	LC	LC	C*							+			2	0.01	
Charadriidae (Plovers)																					
19	<i>Vanellus indicus</i>	Red-wattled Lapwing		CHARADRIIDAE	LC	Sp. not listed	EN	EN	R*								+		Night Survey	/	Recorded on night survey of Island Club Road on Bukit Golf Course Jan 2nd visit.
Columbidae (Pigeons and Doves)																					
20	<i>Chalcophaps indica</i>	Emerald Dove	Yes	COLUMBIDAE	LC	Sp. not listed	NT	Sp. not listed	U	++	++								8	0.04	
21	<i>Treron vernans</i>	Pink-necked Green Pigeon	Yes	COLUMBIDAE	LC	Sp. not listed	Not listed	LC	C*	++	+++	++	++	++	+++		++++	++	57	0.30	Recorded foraging and perching. Also observed over the Restricted Area
22	<i>Treron curvirostra</i>	Thick-billed Green Pigeon	Yes	COLUMBIDAE	LC	Sp. not listed	EN	EN	U		+								3	0.02	
23	<i>Ptilinopus jambu</i>	Jambu Fruit-dove		COLUMBIDAE	NT	Sp. not listed	Not listed	Not given	U		+								n/a	/	Recorded on reconnaissance trip at ST09 prior to the start of MacKinnon Lists
24	<i>Columba livia</i>	Feral Pigeon		COLUMBIDAE	LC	Sp. not listed	Not listed	Sp. not listed	C*						+		++		5	0.03	

No.	Scientific Name	Common Name [English]	Photo Record	Family	CONSERVATION STATUS					Qualitative Data									Quantitative Data (from McKinnon Lists)		Remarks*
					IUCN Red List (2015.02) <sup>1</sup>	CITES (2015) <sup>2</sup>	SRDB National Status <sup>3</sup>	CRL WG Report 'National Status' <sup>4</sup>	Overall Abundance in Singapore <sup>5</sup>	PF	RA	RB	WF	WM	GR	RES	PA	Restricted Area	Number of Lists Species Recorded In	Relative Abundance	
25	<i>Spilopelia chinensis</i>	Spotted Dove	Yes	COLUMBIDAE	LC	Sp. not listed	LC	LC	C*						++		++		14	0.07	
Pittacidae (Parrots)																					
26	<i>Psittacula longicauda</i>	Long-tailed Parakeet	Yes	PSITTACIDAE	NT	Appendix II	LC	LC	C	+++	+++	+					++		69	0.37	Observed perching and flying overhead
27	<i>Loriculus galgulus</i>	Blue-crowned Hanging Parrot	Yes	PSITTACIDAE	LC	Appendix II	EN(VU)	EN(VU)	U	++					+				15	0.08	
28	<i>Cacatua goffini</i> (synonym: <i>Cactua goffiniana</i> )	Tanimbar Cockatoo	Yes	PSITTACIDAE	NT	Appendix I	Not listed	Not given	C						+				2	0.01	
Cuculidae (Cuckoos)																					
29	<i>Cuculus micropterus</i>	Indian Cuckoo		CUCULIDAE	LC	Sp. not listed	Not listed	Not given	C	+	+						+		2	0.01	
30	<i>Phaenicophaeus sumatranus</i>	Chestnut-bellied Malkoha	Yes	CUCULIDAE	NT	Sp. not listed	NT	Sp. not listed	U	+	++								14	0.07	
31	<i>Cacomantis merulinus</i>	Plaintive Cuckoo		CUCULIDAE	LC	Sp. not listed	Not listed	(CR)	U		+			+					2	0.01	Recorded along Jungle Walkway (RA) and calls heard in Jun '15 suggest attempted breeding within RA of CCNR
32	<i>Hierococcyx sparveroides</i>	Large Hawk-cuckoo		CUCULIDAE	LC	Sp. not listed	Not listed	Not given	R		+								1	0.01	
33	<i>Hierococcyx fugax</i>	Malaysian Hawk-cuckoo	Yes	CUCULIDAE	LC	Sp. not listed	Not listed	Not given	R*		+								3	0.02	
34	<i>Eudynamys scolopacea</i>	Asian Koel		CUCULIDAE	LC	Sp. not listed	LC	LC	C		+				+		++		19	0.10	Recorded at entrance to Venus Track. A female bird also observed perching in RA north of Adam Drive in Jun '15
35	<i>Centropus sinensis</i>	Greater Coucal		CUCULIDAE	LC	Sp. not listed	NT	NT	U						+				2	0.01	Recorded at entrance to Venus Track
36	<i>Centropus bengalensis</i>	Lesser Coucal		CUCULIDAE	LC	Sp. not listed	LC	LC	C		+								n/a	/	Recorded on reconnaissance trip prior to the start of MacKinnon Lists
37	<i>Clamator coromandus</i>	Chestnut-winged Cuckoo		CUCULIDAE	LC	Sp. not listed	Not listed	Not given	U	+	+								1	0.01	
38	<i>Surniculus lugubris</i>	Square-tailed Drongo-Cuckoo		CUCULIDAE	LC	Sp. not listed	CR	Sp. not listed	U	+	+								8	0.04	Calls heard in Jun '15 suggest attempted breeding within RA of CCNR and RA just south of CCNR near Bukit Golf Course
Strigidae (Owls)																					
39	<i>Otus lempiji</i>	Sunda Scops-owl	Yes	STRIGIDAE	LC	Sp. not listed	LC	Sp. not listed	C	+	+								11	0.06	Calls heard in Jun '15 suggest attempted breeding within RA of CCNR
40	<i>Strix seloputo</i>	Spotted Wood Owl		STRIGIDAE	LC	Sp. not listed	CR	CR	R	+									1	0.01	
41	<i>Strix leptogrammica</i>	Brown Wood-Owl		STRIGIDAE	LC	Appendix II	Not listed	LC	/	+									Night Survey	/	Record from Jun '15. Call recorded. Identification now confirmed as Brown Wood-Owl ( <i>Strix leptogrammica</i> ).
42	<i>Bubo sumatranus</i>	Barred Eagle Owl		STRIGIDAE	LC	Sp. not listed	Not listed	Sp. not listed	vR	+	+								Night Survey	/	One record from trail (transect McR03) at the edge of PF and RA in Dec '14
43	<i>Ninox scutulata</i>	Brown Hawk-owl	Yes	STRIGIDAE	LC	Sp. not listed	LC	LC	C	+	+								4	0.02	
44	<i>Ketupa ketupu</i>	Buffy Fish Owl	Yes	STRIGIDAE	LC	Appendix II	NT	CR	R		+			+					1	0.01	Seen twice along the stream habitat at close range
Caprimulgidae (Nightjars)																					
45	<i>Caprimulgus macrurus</i>	Large-tailed Nightjar	Yes	CAPRIMULGIDAE	LC	Sp. not listed	LC	LC	C		+				+		+		8	0.04	Observed resting on golf fairways during night surveys
Apodidae (Swifts)																					
46	<i>Apus nipalensis</i>	House Swift		APODIDAE	LC	Sp. not listed	LC	LC	C		+						+		7	0.04	
47	<i>Cypsiurus balasiensis</i>	Asian Palm Swift		APODIDAE	LC	Sp. not listed	LC	LC	C		+					+	+		34	0.18	Observed foraging in RA for CCNR and around Bukit Kalang Service Reservoir

No.	Scientific Name	Common Name [English]	Photo Record	Family	CONSERVATION STATUS					Qualitative Data								Quantitative Data (from McKinnon Lists)		Remarks*	
					IUCN Red List (2015.02) <sup>1</sup>	CITES (2015) <sup>2</sup>	SRDB National Status <sup>3</sup>	CRL WG Report 'National Status' <sup>4</sup>	Overall Abundance in Singapore <sup>5</sup>	PF	RA	RB	WF	WM	GR	RES	PA	Restricted Area	Number of Lists Species Recorded In		Relative Abundance
48	<i>Aerodramus germani</i>	Germain's Swiftlet		APODIDAE	LC	Sp. not listed	LC	LC	C	++	+++	++	++	++	+	+++	++	+++	89	0.47	Recorded over the Restricted Area and foraging in CCNR RA and around Bukit Kalang Service Reservoir. NParks only has Black-nest Swiftlet listed, but records show it is more likely to be Germain's. IUCN does not assess <i>Aerodramus germani</i> or 'Germain's Swiftlet'. Avifauna of Singapore (Lim, 2009) gives Germain's Swiftlet as <i>Collocalis fuciphaga</i> with <i>C. francica</i> and <i>Aerodramus fuciphagus</i> as alternative scientific names.
49	<i>Hirundapus</i> sp.	Needle tail species		APODIDAE	/	/	/	/	/								+		1	0.01	
Hemiprocnidae (Treeswifts)																					
50	<i>Hemiprocne longipennis</i>	Grey-rumped Treeswift	Yes	HEMIPROCNIDAE	LC	Sp. not listed	NT	NT	C	+		+							7	0.04	
51	<i>Hemiprocne</i> sp.	Treeswift species		HEMIPROCNIDAE	/	/	/	/	/						+		+		3	0.02	Suspected Whiskered Treeswift ( <i>Hemiprocne comata</i> ), which is rare in Singapore, but not confirmed
Coraciidae (Rollers)																					
52	<i>Eurystomus orientalis</i>	Oriental Dollar Bird	Yes	CORACIIDAE	LC	Sp. not listed	NT	NT	C	++	++								23	0.12	A pair observed perching together in the RA of CCNR in Jun '15
Alcedinidae (Kingfishers)																					
53	<i>Halcyon smyrnensis</i>	White throated Kingfisher	Yes	ALCEDINIDAE	LC	Sp. not listed	LC	LC	C		+					++			16	0.08	
54	<i>Halcyon pileata</i>	Black-caped Kingfisher		ALCEDINIDAE	LC	Sp. not listed	Not listed	Not given	U							+			1	0.01	
55	<i>Pelargopsis capensis</i>	Stork-billed Kingfisher		ALCEDINIDAE	LC	Sp. not listed	LC	LC	U							+			2	0.01	
56	<i>Ceyx erithacus</i>	Oriental Dwarf Kingfisher	Yes	ALCEDINIDAE	LC	Sp. not listed	Not listed	Sp. not listed	R		+								2	0.01	
57	<i>Alcedo atthis</i>	Eurasian Kingfisher	Yes	ALCEDINIDAE	LC	Sp. not listed	Not listed	Sp. not listed	C							+			2	0.01	
58	<i>Alcedo meninting</i>	Blue-eared Kingfisher	Yes	ALCEDINIDAE	LC	Sp. not listed	CR	CR	R										2	0.01	Seen in both day and night survey
59	<i>Todiramphus chloris</i>	Collard Kingfisher	Yes	ALCEDINIDAE	LC	Sp. not listed	LC	LC	C*						+		++		24	0.13	Also observed around Bukit Kalang Service Reservoir
Meropidae (Bee-eaters)																					
60	<i>Merops viridis</i>	Blue-throated Bee-eater		MEROPIDAE	LC	Sp. not listed	LC	LC	C	++	++					++	++		27	0.14	Observed foraging in RA in RA north of Adam Drive in Jun '15
61	<i>Merops philippinus</i>	Blue-tailed Bee-eater	Yes	MEROPIDAE	LC	Sp. not listed	Not listed	Not given	C	+	+					++	++		17	0.09	
Megalaimidae (Asian Barbets)																					
62	<i>Megalaima haemacephala</i>	Coppersmith Barbet		MEGALAIMIDAE	LC	Sp. not listed	LC	LC	C	+	+	+					++		13	0.07	Observed at entrance to Venus Trail
63	<i>Megalaima rafflesii</i>	Red-crowned Barbet	Yes	MEGALAIMIDAE	NT	Sp. not listed	NT	NT	U	+	+								20	0.11	Calls heard in Jun '15 suggest attempted breeding within RA of CCNR
64	<i>Megalaima lineata</i>	Lineated Barbet	Yes	MEGALAIMIDAE	LC	Sp. not listed	Not listed	Not given	U		+				+		++		8	0.04	Calls heard at boundary of Bukit Golf Course in Jun '15 suggest attempted breeding in the area
Picidae (Woodpeckers)																					
65	<i>Celeus brachyurus</i> (synonym: <i>Micropternus brachyurus</i> )*	Rufous Woodpecker		PICIDAE	LC	Sp. not listed	NT	NT	U	+									2	0.01	
66	<i>Chrysophlegma miniaceum</i>	Banded Woodpecker	Yes	PICIDAE	LC	Sp. not listed	LC	LC	C		++								9	0.05	Juvenile observed at boundary of Bukit Golf Course in Jun '15, confirming breeding in the area.

No.	Scientific Name	Common Name [English]	Photo Record	Family	CONSERVATION STATUS					Qualitative Data									Quantitative Data (from McKinnon Lists)		Remarks*
					IUCN Red List (2015.02) <sup>1</sup>	CITES (2015) <sup>2</sup>	SRDB National Status <sup>3</sup>	CRL WG Report 'National Status' <sup>4</sup>	Overall Abundance in Singapore <sup>5</sup>	PF	RA	RB	WF	WM	GR	RES	PA	Restricted Area	Number of Lists Species Recorded In	Relative Abundance	
67	<i>Dinopium javanense</i>	Common Flameback	Yes	PICIDAE	LC	Sp. not listed	LC	LC	C		+						+		9	0.05	Observed foraging in RA of CCNR in Jun '15
68	<i>Picoides moluccensis</i> (synonym: <i>Dendrocopus moluccensis</i> )	Sunda Pygmy Woodpecker		PICIDAE	LC	Sp. not listed	LC	LC	C*		+						+		1	0.01	
69	<i>Piccus vittatus</i>	Laced Woodpecker	Yes	PICIDAE	LC	Sp. not listed	LC	LC	C		+								8	0.04	
Pittidae (Pittas)																					
70	<i>Pitta sordida</i>	Hooded Pitta	Yes	PITTIDAE	LC	Sp. not listed	Not listed	Not given	U				+						2	0.01	
71	<i>Pitta moluccensis</i>	Blue-winged Pitta		PITTIDAE	LC	Sp. not listed	Not listed	Not given	U		+								1	0.01	
Aegithinidae (loras)																					
72	<i>Aegithina tiphia</i>	Common lora	Yes	AEGITHINIDAE	LC	Sp. not listed	Not listed	LC	C		+						++		13	0.07	Observed foraging in RA north of Adam Drive in June '15
Laniidae (Shrikes)																					
73	<i>Lanius cristatus</i>	Brown Shrike	Yes	LANIIDAE	LC	Sp. not listed	Not listed	Not given	C		+				+				5	0.03	
74	<i>Lanius tigrinus</i>	Tiger Shrike	Yes	LANIIDAE	LC	Sp. not listed	Not listed	Not given	C		+						+		5	0.03	
Oriolidae (Orioles)																					
75	<i>Oriolus chinensis</i>	Black-naped Oriole	Yes	ORIOLIDAE	LC	Sp. not listed	LC	LC	C*		+				+++		+++		31	0.16	Observed foraging in RA of CCNR and near Kalang Service Reservoir in Jun '15
Corvidae (Crows)																					
76	<i>Corvus macrorhynchos</i>	Large-billed Crow		CORVIDAE	LC	Sp. not listed	LC	Sp. not listed	C						+		+	+	15	0.08	Observed over the Restricted Area
Campephagidae (Minivets)																					
77	<i>Pericrocotus divaricatus</i>	Ashy Minivet		CAMPEPHAGIDAE	LC	Sp. Not listed	Not listed	Not given	C		+								1	0.01	
Dicruridae (Drongos)																					
78	<i>Dicrurus paradiseus</i>	Greater racket-tailed Drongo	Yes	DICRURIDAE	LC	Sp. not listed	LC	LC	C	+++	+++	++	++	++	+				110	0.58	Juvenile observed in RA bordering PF of CCNR in Jun '15, confirming breeding in the area
79	<i>Dicrurus</i> sp.	Drongo species		DICRURIDAE	/	/	/	/	/		+								1	0.01	Record from Jungle Walkway stairs. No rackets. Suspected Black Drongo ( <i>Dicrurus macrocerus</i> ), (uncommon in Singapore) but not confirmed.
80	<i>Dicrurus annectans</i>	Crow-billed Drongo		DICRURIDAE	LC	Sp. not listed	Not listed	Not given	U		+								4	0.02	Record from Jungle Walkway stairs.
Rhipiduridae (Fantails)																					
81	<i>Rhipidura javanica</i>	Pied Fantail		RHIPIDURIDAE	LC	Sp. not listed	LC	Sp. not listed	C					+					n/a	/	Recorded on reconnaissance trip prior to the start of MacKinnon Lists
Monarchidae (Monarchs)																					
82	<i>Terpsiphone paradisi</i>	Asian Paradise Flycatcher	Yes	MONARCHIDAE	LC	Sp. not listed	Not listed	Not given	C		+								15	0.08	
Pycnonotidae (Bulbuls)																					
83	<i>Pycnonotus plumosus</i>	Olive-winged Bulbul		PYCNONOTIDAE	LC	Sp. not listed	LC	LC	C	+	+++	++	++						70	0.37	Observed foraging in RA of CCNR and near Bukit Golf Course, in Jun '15
84	<i>Ixos malaccensis</i>	Streaked Bulbul		PYCNONOTIDAE	NT	Sp. not listed	Not listed	Sp. not listed	R		+	+							1	0.01	Recorded only on the Jungle Walkway (RA, RB). Not recorded directly in Project Area.
85	<i>Pycnonotus brunneus</i>	Red-eyed Bulbul		PYCNONOTIDAE	LC	Sp. not listed	EN	Sp. not listed	U	+	+	+							13	0.07	One record along Jungle Walkway (RA, RB)
86	<i>Pycnonotus simplex</i>	Cream-vented Bulbul		PYCNONOTIDAE	LC	Sp. not listed	Not listed	Not given	C		++								4	0.02	

No.	Scientific Name	Common Name [English]	Photo Record	Family	CONSERVATION STATUS					Qualitative Data									Quantitative Data (from McKinnon Lists)		Remarks*
					IUCN Red List (2015.02) <sup>1</sup>	CITES (2015) <sup>2</sup>	SRDB National Status <sup>3</sup>	CRL WG Report 'National Status' <sup>4</sup>	Overall Abundance in Singapore <sup>5</sup>	PF	RA	RB	WF	WM	GR	RES	PA	Restricted Area	Number of Lists Species Recorded In	Relative Abundance	
87	<i>Pycnonotus goiavier</i>	Yellow-vented Bulbul	Yes	PYCNONOTIDAE	LC	Sp. not listed	LC	LC	C*		+				+++		+++		45	0.24	
88	<i>Pycnonotus zeylanicus</i>	Straw-headed Bulbul	Yes	PYCNONOTIDAE	VU	Sp. not listed	EN	EN	U		+								1	0.01	
89	<i>Pycnonotus jocosus</i>	Red-whiskered Bulbul		PYCNONOTIDAE	LC	Sp. not listed	Not listed	Not given. Listed as 'Introduced'	U		+								3	0.02	
90	<i>Hemixos cinereus</i>	Cinereous Bulbul		PYCNONOTIDAE	LC	Sp. not listed	Not listed	Not given	U	+	+								4	0.02	Now a fairly accepted split from the Ashy Bulbul
Zosteropidae (white-eyes)																					
91	<i>Zosterops palpebrosus</i>	Oriental White-eye		ZOSTEROPIDAE	LC	Sp. not listed	Not listed	Not given	U						+		+		6	0.03	Observed foraging in RA north of Adam Drive in June '15
Hirundinidae (Swallows and Martins)																					
92	<i>Hirundo tahitica</i>	Pacific Swallow	Yes	HIRUNDINIDAE	LC	Sp. not listed	LC	LC	C	+	+++	++	++	+	+++	++++	+++	+++	32	0.17	Observed over the Restricted Area. Observed foraging over RA near Windsor Interim Green and near Kalang Service Reservoir in Jun '15
93	<i>Hirundo rustica</i>	Barn Swallow		HIRUNDINIDAE	LC	Sp. not listed	Not listed	Not given	C*						+				3	0.02	
94	<i>Riparia riparia</i>	Sand Martin		HIRUNDINIDAE	LC	Sp. not listed	Not listed	Sp. not listed	U									+	/	/	Recorded during reconnaissance trip prior to starting MacKinnon Lists
Sylviidae (Warblers and Allies)																					
95	<i>Phylloscopus borealis</i>	Arctic Warbler	Yes	SYLVIIDAE	LC	Sp. not listed	Not listed	Not given	C	+++	+++	++					++		64	0.34	
96	<i>Orthotomus sutorius</i>	Common Tailorbird		SYLVIIDAE	LC	Sp. not listed	LC	LC	C	++	++								22	0.12	Juvenile observed in RA of CCNR in Jun '15, confirming breeding in the area
97	<i>Orthotomus atrogularis</i>	Dark-necked Tailorbird	Yes	SYLVIIDAE	LC	Sp. not listed	LC	LC	C	+++	+++	++							87	0.46	
98	<i>Orthotomus sericeus</i>	Rufous-tailed Tailorbird		SYLVIIDAE	LC	Sp. not listed	LC	LC	U		+								5	0.03	
99	<i>Orthotomus ruficeps</i>	Ashy Tailorbird		SYLVIIDAE	LC	Sp. not listed	LC	LC	C	+	+	+							6	0.03	
100	<i>Phylloscopus coronatus</i>	Eastern Crowned Warbler		SYLVIIDAE	LC	Sp. not listed	LC	Not given	U	++	++								6	0.03	
Timaliidae (Babblers and Scimitar Babblers)																					
101	<i>Malacocincla abbotti</i>	Abbott's Babbler	Yes	TIMALIIDAE	LC	Sp. not listed	NT	NT	C*		++								4	0.02	
102	<i>Malacocincla</i> sp. then confirmed as being <i>Malacocincla malaccensis</i>	Babbler species then confirmed as being Short-tailed Babbler		TIMALIIDAE	NT	Sp. not listed	LC	LC	U*	+	+								8	0.04	Same bird recorded on a number of occasions calling close to Ranger Station but not directly seen. Identification confirmed from recording of calls in May 2015 as also being Short-tailed Babbler.
102 (same as above)	<i>Malacocincla malaccensis</i>	Short-tailed Babbler		TIMALIIDAE	NT	Sp. not listed	LC	LC	U*	+	+								6	0.03	
103	<i>Macronous gularis</i>	Striped Tit-babbler	Yes	TIMALIIDAE	LC	Sp. not listed	LC	Sp. not listed	C	+++	+++	++	++				+		110	0.58	Three juveniles recorded in Jun '15, one with RA of the CCNR, one near Kalang Service Reservoir and one in the RA just outside CCNR near Island Club Road
104	<i>Stachyris erythroptera</i>	Chestnut-winged Babbler		TIMALIIDAE	LC	Sp. not listed	EN	EN	U	+									4	0.02	
Irenidae (Fairy-bluebirds)																					
105	<i>Irena puella</i>	Asian Fairy Bluebird	Yes	IRENIDAE	LC	Sp. not listed	LC	LC	C	+	+								10	0.05	



No.	Scientific Name	Common Name [English]	Photo Record	Family	CONSERVATION STATUS					Qualitative Data									Quantitative Data (from McKinnon Lists)		Remarks*	
					IUCN Red List (2015.02) <sup>1</sup>	CITES (2015) <sup>2</sup>	SRDB National Status <sup>3</sup>	CRL WG Report 'National Status' <sup>4</sup>	Overall Abundance in Singapore <sup>5</sup>	PF	RA	RB	WF	WM	GR	RES	PA	Restricted Area	Number of Lists Species Recorded In	Relative Abundance		
Sturnidae (Starlings)																						
106	<i>Gracula religiosa</i>	Hill Myna	Yes	STURNIDAE	LC	Appendix II	NT	Sp. not listed	R	+++	+++						+		38	0.20		
107	<i>Acridotheres javanicus</i>	Javan Myna		STURNIDAE	Not Assessed	Sp. not listed	Not listed	Not given	C*	+	++					+++		++++	++++	59	0.31	Observed over the Restricted Area
107 (same)	<i>Acridotheres javanicus (Acridotheres grandisi)</i>	White-vented Myna	Yes	STURNIDAE	LC	Sp. not listed	Not listed	Sp. not listed	C*		+					+		+	/	/	All birds recorded as Javan Myna rather prior to confirmation	
108	<i>Aplonis panayensis</i>	Asian Glossy Starling	Yes	STURNIDAE	LC	Sp. not listed	LC	LC	C	++	+++	+	+	+	+++	++	++++	+++	83	0.44	Observed over the Restricted Area and in Jun '15, foraging around Kalang Service Reservoir	
Muscicapidae (Chats and Old World Flycatchers)																						
109	<i>Zoothera citrina</i>	Orange-headed Thrush	Yes	MUSCICAPIDAE	LC	Sp. not listed	Not listed	Listed as <i>Geokichla citrina</i> but status not given	R	+									1	0.01		
110	<i>Zoothera sibirica</i>	Siberian Thrush		MUSCICAPIDAE	LC	Sp. not listed	Not listed	Listed as <i>Geokichla sibirica</i> but status not given	R										1	0.01	Recorded 18 Sept and is probably the earliest date for recording this species in Singapore	
111	<i>Ficedula elisae</i>	Green backed Flycatcher		MUSCICAPIDAE	LC	Sp. not listed	Not listed	Sp. not listed	R		+								1	0.01	Also known as Narcissus Flycatcher	
112	<i>Ficedula mugimaki</i>	Mugimaki Flycatcher	Yes	MUSCICAPIDAE	LC	Sp. not listed	Not listed	Not given	U		+								1	0.01		
113	<i>Ficedula zanthopygia</i>	Yellow-rumped Flycatcher	Yes	MUSCICAPIDAE	LC	Sp. not listed	Not listed	Not given											4	0.02		
114	<i>Luscinia cyane</i>	Siberian Blue Robin		MUSCICAPIDAE	LC	Sp. not listed	Not listed	Not given	R*	+									4	0.02		
115	<i>Copsychus saularis</i>	Oriental Magpie Robin	Yes	MUSCICAPIDAE	LC	Sp. not listed	EN	EN	U		+			++	+				8	0.04		
116	<i>Copsychus malabaricus</i>	White-rumped Shama	Yes	MUSCICAPIDAE	LC	Sp. not listed	CR(EN)	CR(EN)	R	+	+								6	0.03		
117	<i>Rhinomyias</i> sp.	Flycatcher species		MUSCICAPIDAE	/	/	/	/	/		+	+							3	0.02	Record from Dec '14. Suspected Brown-chested Jungle Flycatcher ( <i>Rhinomyias brunneatus</i> ) (Vulnerable on IUCN Red List and a rare passage migrant/ winter visitor in Singapore). Identification not confirmed	
118	<i>Muscicapa dauurica</i>	Asian Brown Flycatcher	Yes	MUSCICAPIDAE	LC	Sp. not listed	Not listed	Not given	C	++	+++						++		23	0.12	Recorded along Jungle Walkway (RA)	
119	<i>Muscicapa griseisticta</i>	Grey-streaked Flycatcher	Yes	MUSCICAPIDAE	LC	Sp. not listed	Not listed	Sp. not listed	R		+								2	0.01	Wing length noted to extend to approximately half of tail during perching.	
120	<i>Muscicapa ferruginea</i>	Ferruginous Flycatcher		MUSCICAPIDAE	LC	Sp. not listed	Not listed	Sp. not listed	R	+									n/a	n/a	Recorded on reconnaissance trip, prior to start of MacKinnon lists	
121	<i>Cyornis glaucicomans</i>	Chinese Blue Flycatcher		MUSCICAPIDAE	LC	Sp. not listed	Not listed	Sp. not listed	R		+								1	0.01	Observed from car park at Venus Drive in December 2014. Identification and naming discussed and agreed with Dave Bakewell	
Chloropseidae (Leafbirds)																						
122	<i>Chloropsis sonnerati</i>	Greater Green Leafbird		CHLOROPSEIDAE	LC	Sp. not listed	CR	CR	R*		+								4	0.02		
123	<i>Chloropsis cochinchinensis</i>	Blue-winged Leafbird		CHLOROPSEIDAE	LC	Sp. not listed	NT	NT	C	+	++								7	0.04		
Dicaeidae (Flowerpeckers)																						
124	<i>Dicaeum trigonostigma</i>	Orange Bellied Flowerpecker	Yes	DICAEIDAE	LC	Sp. not listed	LC	LC	C	+++	++++								69	0.37	Observed foraging in RA for CCNR and near RA near Island Club Road in Jun '15	
125	<i>Dicaeum cruentatum</i>	Scarlet-backed Flowerpecker	Yes	DICAEIDAE	LC	Sp. not listed	LC	LC	C	+++	+++								27	0.14		
Nectariniidae (Sunbirds)																						
126	<i>Cinnyris jugularis</i>	Olive-backed Sunbird	Yes	NECTARINIIDAE	LC	Sp. not listed	LC	LC	U	+	++						++		34	0.18	Observed foraging in RA for CCNR and around Kalang Service Reservoir in Jun '15	
127	<i>Leptocoma brasiliana</i> (previously also <i>Nectarinia sperata</i> )	Van Hasselt's Sunbird (previously Purple-throated Sunbird)	Yes	NECTARINIIDAE	LC	Sp. not listed	LC	LC	C	++	+++								23	0.12		
128	<i>Aethopyga siparaja</i>	Crimson Sunbird	Yes	NECTARINIIDAE	LC	Sp. not listed	LC	LC	C	+++	+++								49	0.26	Recorded along Jungle Walkway (RA)	

No.	Scientific Name	Common Name [English]	Photo Record	Family	CONSERVATION STATUS					Qualitative Data									Quantitative Data (from McKinnon Lists)		Remarks*
					IUCN Red List (2015.02) <sup>1</sup>	CITES (2015) <sup>2</sup>	SRDB National Status <sup>3</sup>	CRL WG Report 'National Status' <sup>4</sup>	Overall Abundance in Singapore <sup>5</sup>	PF	RA	RB	WF	WM	GR	RES	PA	Restricted Area	Number of Lists Species Recorded In	Relative Abundance	
129	<i>Anthreptes malacensis</i>	Brown-throated Sunbird	Yes	NECTARINIIDAE	LC	Sp. not listed	LC	LC	C		++								15	0.08	Observed foraging in RA for CCNR and around Kalang Service Reservoir in Jun '15
Motacillinae (Wagtails and Pipits)																					
130	<i>Dendronanthus indicus</i>	Forest Wagtail	Yes	MOTACILLIDAE	LC	Sp. not listed	LC	Not given	U	+	+		+						6	0.03	
131	<i>Motacil / a alba</i>	White Wagtail		MOTACILLIDAE	LC	Sp. not listed	LC	Sp. not listed	U										1	0.01	
132	<i>Motacilla cinerea</i>	Grey Wagtail		MOTACILLIDAE	LC	Sp. not listed	LC	Not given	U										1	0.01	
Passeridae (Sparrows)																					
133	<i>Passer montanus</i>	Eurasian Tree Sparrow		PASSERIDAE	LC	Sp. Not listed	LC	LC	C								+		1	0.01	
Estrildidae (Estrildid finches)																					
134	<i>Lonchura atricapilla</i>	Black-headed / Chestnut Munia	Yes	ESTRILDIDAE	LC	Sp. not listed	Not listed	CR	C						+		+		3	0.02	
135	<i>Lonchura punctulata</i>	Scaly-breasted Munia	Yes	ESTRILDIDAE	LC	Sp. not listed	LC	LC	C		+								3	0.02	
136	<i>Lonchura leucogastroides</i>	Javan Munia		ESTRILDIDAE	LC	Sp. not listed	Not listed	Not given	U*				+						1	0.01	

Total Number of Species 52 93 16 11 10 27 20 37 7

References

1. IUCN Red List of Threatened Species 2015.02. Retrieved from http://www.iucnredlist.org/ Abbreviations include:  
DD: Data Deficient; LC: Least Concern; NT: Near Threatened; VU: Vulnerable; EN: Endangered; CR: Critically Endangered
2. CITES Appendices valid from 5 Feb 2015. Retrieved from http://www.cites.org/eng/app/appendices.php
3. Davison GWH, Ng PKL and Ho HC. (2008) Singapore Red Data Book. Where status under review, likely updated status is given in brackets  
Abbreviations include:  
DD: Data Deficient (status indeterminate, requires further validation); VU: Vulnerable; EN: Endangered; CR: Critically Endangered  
NE: Presumed Nationally extinct; EX: Globally Extinct
4. Cheong LF, Chua MAH, D'Rozario V, Jamal F, Khoon SK, Koh JKH, Lim KKP, O'Dempsey T and Rajathurai S (2014) Cross Island Line Working Group Report  
Abbreviations for National Status include:  
LC: Least Concern; NT: Near Threatened; VU: Vulnerable; EN: Endangered; CR: Critically Endangered; NE: Nationally extinct
5. National Parks Board Singapore 2009, Bird Species, viewed December 2014, <https://www.nparks.gov.sg/cms/index.php?option=com\_content&view=article&id=81&Itemid=188>. Referencing:  
Lim, K.S. (2007). Pocket checklist of the birds of the Republic of Singapore. Nature Society (Singapore).  
Wang, L.K. & Hails, C. (2007). An annotated checklist of the birds of Singapore. Raffles Bulletin of Zoology Supplement 15.

Abbreviations for Abundance include: A: Abundance; C: Common; U: Uncommon; R: Rare vR: Very Rare  
\* Denotes a difference in the listed Abundance between the two references used. The less abundant record is given.

Notes

Habitat type	Key
Primary Forest	PF
Regeneration Forest A	RA
Regeneration Forest B	RB
Wetland Forest	WF
Wetland Marsh	WM
Golf Course / Recreation Facility	GR
Reservoir	RES
Park Areas	PA
Restricted Area	/

Notes

Relative abundance	Key
Sparse	+
Uncommon	++
Common	+++
Very common	++++

Annex 8K

## Mammal Species List (Primary Data)

# ANNEX 8K MAMMAL SPECIES IN STUDY AREA, REPORTED FROM PRIMARY TRANSECT SURVEYS

Note: Information on locations of some species has been supplied to agencies but is not repeated here to ensure that conservation of these species is not compromised

No.	Scientific Name	Common Name [English]	Family	DATA TYPE			CONSERVATION STATUS			Abundance / Relative Abundance						
				Camera traps	Photo trap rate index (PTRI)	Observation	IUCN Red List (2015.02) <sup>1</sup>	CITES Appendix <sup>2</sup>	SRDB National Status <sup>3</sup>	PF	RA	RB	WF	WM	GR	Restricted Area
1	<i>Callosciurus notatus</i>	Plantain Squirrel	SCIURIDAE	66	5.17	63	LC		Not listed	+	++++	++	+	+	-	-
2	<i>Sundasciurus tenuis</i>	Slender Squirrel	SCIURIDAE	-	-	17	LC		Not listed	+	+++	++	+	-	-	-
3	<i>Iomys horsfieldii</i>	Horsfield's Flying Squirrel	SCIURIDAE	-	-	2	LC		EN	+	-	-	-	-	-	-
4	<i>Tupaia glis</i>	Common Tree Shrew	TUPAIIDAE	97	7.60	9	LC	II	Not listed	+	+	+	+			
5	<i>Galeopterus variegatus</i>	Malayan Colugo	CYNOCEPHALIDAE	-	-	9	LC		Not listed	++	+	+	-	-	-	-
							VU	II	CR	-	+	-	-	-	-	-
6	<i>Nycticebus coucang</i>	Greater Slow Loris	LORISIDAE	-	-	1										
7	<i>Sus scrofa</i>	Wild Boar	SUIDAE	45	5.72	-	LC		Not listed	+	+++	++	+	+	-	-
8	<i>Manis javanica</i>	Sunda Pangolin	MANIDAE	9	0.70	-	CR	II	CR	+	+	+	-	-	-	-
9	<i>Macaca fascicularis</i>	Long-tailed Macaque	CERCOPITHECIDAE	102	7.99	33	LC	II	Not listed	+	+++	++++	+	-	++	+
10	<i>Paradoxurus hermaphroditus</i>	Common Palm Civet	VIVERRIDAE	13	1.02	1	LC	III	Not listed	+	+	-	-	-	-	-
11	<i>Tragululus kanchil</i>	Lesser Mousedeer	TRAGULIDAE	10	0.78	1	LC		CR	-	-	+	-	-	-	-
							LC		Not listed	-	-	+	-	-	-	-
12	<i>Muntiacus muntjak</i>	Barking Deer, Red Muntjac	CERVIDAE	2	0.16	-										
13	<i>Canis familiaris</i>	Domestic Dog	CANIDAE	1	0.08	1	Not Assessed		Not listed	-	+	-	-	-	-	-
14	<i>Felis catus</i>	Domestic Cat	FELIDAE	1	0.08	-	Not Assessed		Not listed	-	-	+	-	-	-	-

## References

1. IUCN Red List of Threatened Species 2015.02. Retrieved from <http://www.iucnredlist.org/> Abbreviations include:  
DD: Data Deficient; LC: Least Concern; NT: Near Threatened; VU: Vulnerable; EN: Endangered; CR: Critically Endangered

2. CITES Appendices valid from 5 Feb 2015. Retrieved from <http://www.cites.org/eng/app/appendices.php>

3. Davison GWH, Ng PKL and Ho HC. (2008) **Singapore Red Data Book**. Where status under review, likely updated status is given in brackets  
Abbreviations include:  
DD: Data Deficient (status indeterminate, requires further validation); VU: Vulnerable; EN: Endangered; CR: Critically Endangered  
NE: Presumed Nationally extinct; EX: Globally Extinct

## Notes

Habitat type	Key
Primary Forest	PF
Regeneration Forest A	RA
Regeneration Forest B	RB
Wetland Forest	WF
Wetland Marsh	WM
Golf Course / Recreation Facility	GR
Restricted Area	/

Relative	Key
Sparse	+
Uncommon	++
Common	+++
Very common	++++

Annex 8L

## Herpetofauna Species List (Primary Data)

**ANNEX 8L HERPETOFAUNA SPECIES IN STUDY AREA, REPORTED FROM PRIMARY SURVEYS**

Note: Information on locations of some species has been supplied to agencies but is not repeated here to ensure that conservation of these species is not compromised

Note: Information on locations of some species has been supplied to agencies but is not repeated here to ensure that conservation of these species is not compromised													
No.	Scientific Name	Common Name	Family	CONSERVATION STATUS			Abundance / Relative Abundance						
				IUCN Red List (2015.02) <sup>1</sup>	CITES Appendix <sup>2</sup>	SRDB National Status <sup>3</sup>	PF	RA	RB	WF	WM	GR	Restricted Area
REPTILES													
1	<i>Aphanotis fusca</i>	Dusky Earless Agamid, Dusky Earless Agama	Agamidae	LC	Not Listed	EN	+						
2	<i>Bronchocela cristatella</i>	Green Crested Lizard	Agamidae	LC	Not Listed	Not Listed	+						
3	<i>Draco quinquefasciatus</i>	Five-banded Flying Dragon	Agamidae	Not Assessed	Not Listed	EN	+	+					
4	<i>Draco sumatranus</i>	Sumatran Flying Dragon	Agamidae	Not Assessed	Not Listed	Not Listed						+++	
5	<i>Cnemaspis peninsularis</i>	Peninsular Rock Gecko	Gekkonidae	Not Assessed	Not Listed	VU (as <i>Cnemaspis kendalli</i> )	+						
6	<i>Cyrtodactylus majulah</i>	Singapore Bent-Toed Gecko	Gekkonidae	Not Assessed	Not Listed	Not Listed	+						
7	<i>Gehyra mutilata</i>	Four-clawed Gecko	Gekkonidae	Not Assessed	Not Listed	Not Listed						+++	
8	<i>Gekko monachus</i>	Spotted House Gecko	Gekkonidae	Not Assessed	Not Listed	Not Listed		+				+++	+++
9	<i>Hemidactylus frenatus</i>	Spiny-Tailed House Gecko	Gekkonidae	LC	Not Listed	Not Listed		+++				+++	
10	<i>Hemidactylus platyurus</i>	Flat-tailed Gecko	Gekkonidae	Not Assessed	Not Listed	Not Listed						+++	
11	<i>Hemiphyllodactylus typus</i>	Lowland Dwarf Gecko	Gekkonidae	LC	Not Listed	VU	+	+					
12	<i>Eutropis multifasciata</i>	Common Sun Skink	Scincidae	Not Assessed	Not Listed	Not Listed	+++	+++				+++	
13	<i>Sphenomorphus</i> sp.	Malayan Swamp Skink	Scincidae	Not Assessed	Not Listed	CR	+			+			
14	<i>Ahaetulla prasina</i>	Oriental whip snake/ Gunther's Whip Snake	Lamprophiidae	LC	Not Listed	Not Listed	+						
15	<i>Pseudorabdion longiceps</i>	Dwarf Reed Snake	Calamariidae	LC	Not Listed	EN		+					
16	<i>Boiga dendrophila</i>	Gold-ringed Cat Snake	Colubridae	Not Assessed	Not Listed	VU		+		+			
17	<i>Chrysopelea pallas</i>	Twin-barred Gliding Snake	Colubridae	LC	Not Listed	VU					+		
18	<i>Dendrelaphis caudolineatus</i>	Striped Bronzeback	Colubridae	Not Assessed	Not Listed	Not Listed	+						
19	<i>Ptyas carinata</i>	Keeled Rat Snake	Colubridae	LC	Not Listed	Not Listed	+						
20	<i>Ptyas fusca</i>	White-bellied Rat Snake	Colubridae	LC	Not Listed	EN	+						++
21	<i>Macrophisthodon rhodomelas</i>	Blue-Necked Keelback	Natricidae	LC	Not Listed	EN		+					
22	<i>Xenochrophis maculatus</i>	Spotted Keelback	Natricidae	LC	Not Listed	VU	+			+			
23	<i>Broghammerus reticulatus</i>	Reticulated Python	Pythonidae	Not Assessed	II (as <i>Python reticulatus</i> )			+					
24	<i>Varanus nebulosus</i>	Clouded Monitor	Varanidae	LC	I	Not Listed	+++						
25	<i>Varanus salvator</i>	Malayan Water Monitor	Varanidae	LC	II	Not Listed		+		+			
26	<i>Tropidolaemus wagleri</i>	Wagler's Pit Viper	Viperidae	LC	Not Listed	EN	+						
27	<i>Amyda ornata</i>	Asian Softshell Turtle	Trionychidae	VU (for <i>Amyda cartilaginea</i> )	II	EN		+					
28	<i>Cuora amboinensis</i>	Malayan Box Terrapin	Geoemydidae	VU	II	Not Listed				+			
29	<i>Heosemys grandis</i>	Giant Asian Pond Turtle	Bataguridae	VU	II	Not Listed	+			+			
30	<i>Heosemys spinosa</i>	Spiny Hill Terrapin, Sunburst Turtle	Bataguridae	EN	II	VU	+	+		+			
31	<i>Notochelys platynota</i>	Malayan Flat-shelled Terrapin	Bataguridae	VU	II	EN	+			+			
32	<i>Trachemys scripta</i>	Red-eared Slider Turtle	Emydidae	LC	Not Listed	Not Listed				++++			
AMPHIBIANS													
1	<i>Duttaphrynus melanostictus</i>	Asian Toad, Black-spectacled Toad	Bufoinidae	LC	Not Listed	Not Listed		++++				+++	+++
2	<i>Fejervarya cancrivora</i>	Mangrove Frog	Dicroglossidae	LC	Not Listed	Not Listed	+						
3	<i>Fejervarya</i> aff. <i>limnocharis</i>	Cricket Frog	Dicroglossidae	LC	Not Listed	Not Listed		++++				+++	
4	<i>Hylarana baramica</i>	Golden-eared Rough-sided Frog	Ranidae	LC	Not Listed	Not Listed				++++			



No.	Scientific Name	Common Name	Family	CONSERVATION STATUS			Abundance / Relative Abundance						
				IUCN Red List (2015.02) <sup>1</sup>	CITES Appendix <sup>2</sup>	SRDB National Status <sup>3</sup>	PF	RA	RB	WF	WM	GR	Restricted Area
5	<i>Hylarana erythraea</i>	Green Paddy Frog	Ranidae	LC	Not Listed	Not Listed		++++		++++		+++	
6	<i>Hylarana labialis</i>	Copper-cheeked Frog	Ranidae	LC	Not Listed	Not Listed				++++			
7	<i>Hylarana laterimaculata</i>	Masked Rough-sided Frog	Ranidae	LC	Not Listed	Not Listed		++		++++			
8	<i>Kaloula pulchra</i>	Painted Bull Frog	Microhylidae	LC	Not Listed	Not Listed						+++	+++
9	<i>Leptobrachium nigrops</i>	Black-eyed Litter Frog	Megophryidae	LC	Not Listed	Not Listed	+++						
10	<i>Limnonectes blythii</i>	Malayan Giant Frog	Dicoglossidae	NT	Not Listed	Not Listed	+++	++		+++			
11	<i>Limnonectes malesianus</i>	Malesian Frog	Dicoglossidae	NT	Not Listed	Not Listed	+						
12	<i>Lithobates catesbeianus</i>	American Bull Frog	Ranidae	LC	Not Listed	Not Listed		+					+++
13	<i>Microhyla heymonsi</i>	Dark-sided Chorus Frog	Microhylidae	LC	Not Listed	Not Listed	++++			+++		++++	
14	<i>Microhyla mantheyi</i>	Manthey's Chorus Frog	Microhylidae	LC	Not Listed	CR	+			+			
15	<i>Ociodozys sumatrana</i>	Yellow-bellied Puddle Frog	Dicoglossidae	LC	Not Listed	Not Listed				+++			
16	<i>Nyctikalus pictus</i>	Cinnamon Bush Frog	Rhacophoridae	NT	Not Listed	VU	+						
17	<i>Polypedates leucomystax</i>	Four-lined Tree Frog	Rhacophoridae	LC	Not Listed	Not Listed						++++	

#### Notes

#### References

1. **IUCN Red List of Threatened Species** 2015.02. Retrieved from <http://www.iucnredlist.org/> Abbreviations include:  
DD: Data Deficient; LC: Least Concern; NT: Near Threatened; VU: Vulnerable; EN: Endangered; CR: Critically Endangered

2. **CITES Appendices** valid from 5 Feb 2015. Retrieved from <http://www.cites.org/eng/app/appendices.php>

3. Davison GWH, Ng PKL and Ho HC. (2008) **Singapore Red Data Book**. Where status under review, likely updated status is given in brackets  
Abbreviations include:  
DD: Data Deficient (status indeterminate, requires further validation); VU: Vulnerable; EN: Endangered; CR: Critically Endangered  
NE: Presumed Nationally extinct; EX: Globally Extinct

Habitat type	Key
Primary Forest	PF
Regeneration Forest A	RA
Regeneration Forest B	RB
Wetland Forest	WF
Wetland Marsh	WM
Golf Course / Recreation Facility	GR
Restricted Area	/
Relative abundance	Key
Sparse	+
Uncommon	++
Common	+++
Very common	++++

Annex 8M

## Butterfly Species List (Primary Data)

ANNEX 8M BUTTERFLY SPECIES IN STUDY AREA, REPORTED FROM PRIMARY SURVEYS

No.	Family	Scientific Name	Common Name [English]	CONSERVATION STATUS		Qualitative Data							Quantitative Data (from MacKinnon Lists)	
				IUCN Red List (2015.02) <sup>1</sup>	SRDB National Status <sup>2</sup>	PF	RA	RB	WF	WM	GR	Restricted Area	Number of Lists Species Recorded In	Relative Abundance
1	Papilionidae	<i>Papilio clytia</i>	Common Mime	Not Assessed	Sp. not listed		+						1	0.05
2	Papilionidae	<i>Papilio helenus</i>	Red Helen	Not Assessed	Sp. not listed		+						2	0.09
3	Papilionidae	<i>Papilio polytes</i>	Common Mormon	Not Assessed	Not given		++	+	+	+	+	+	11	0.50
4	Papilionidae	<i>Papilio memnon</i>	Great Mormon	Not Assessed	Not given		+				+		1	0.05
5	Papilionidae	<i>Papilio sarpedon luctatus</i>	Common Bluebottle	Not Assessed	Not given		++	+		+	+		8	0.36
6	Papilionidae	<i>Graphium agamemnon agamemnon</i>	Tailed Green Jay	Not Assessed	Not given		+				+		6	0.27
7	Papilionidae	<i>Pathysa antiphates itamputi</i>	Fivebar Swordtail	Not Assessed	Not given		+				+		2	0.09
8	Pieridae	<i>Phrissura cynis</i>	Forest White	Not Assessed	Sp. not listed		+						3	0.14
9	Pieridae	<i>Eurema hecabe</i>	Common Grass Yellow	Not Assessed	Not given		+	+	+	+	++	+	13	0.59
10	Pieridae	<i>Eurema sari</i>	Chocolate Grass Yellow	Not Assessed	Not given		+		+		+		4	0.18
11	Pieridae	<i>Catopsilia pomona</i>	Lemon Emigrant	Not Assessed	Not given		+		+		+		7	0.32
12	Pieridae	<i>Delias hyparete</i>	Painted Jezebel	Not Assessed	Not given		++	+	+	+	+		7	0.32
13	Pieridae	<i>Leptosia nina</i>	Psyche	Not Assessed	Not given		+						1	0.05
14	Danaidae	<i>Parantica agleoides</i>	Dark Glassy Tiger	Not Assessed	Not given		+						3	0.14
15	Danaidae	<i>Euploea radamanthus</i>	Magpie Crow	Not Assessed	Not given		+						0	0.00
16	Danaidae	<i>Euploea eynodhovi</i>	Lesser Striped Black Crow	Not Assessed	Not given		+						2	0.09
17	Satyridae	<i>Elymnias panthera</i>	Tawny Palmfly	Not Assessed	Not given		+						4	0.18
18	Satyridae	<i>Elymnias hypemnestra</i>	Common Palmfly	Not Assessed	Not given						+		0	0.00
19	Satyridae	<i>Lethes mekara</i>	Common Red Forester	Not Assessed	Sp. not listed		+						1	0.05
20	Satyridae	<i>Melanitis leda leda</i>	Common Evening Brown	Not Assessed	Not given	+							1	0.05
21	Satyridae	<i>Mycalesis visala phamis</i>		Not Assessed	Not given	+	+						5	0.23
22	Satyridae	<i>Mycalesis perseus cepheus</i>	Dingy Bush Brown	Not Assessed	Not given		+						1	0.05
23	Satyridae	<i>Mycalesis fusca</i>	Malayan Bush-Brown	Not Assessed	Not given		+						2	0.09
24	Satyridae	<i>Orsotriaena medus</i>	Dark Grass-Brown, Nlaqer	Not Assessed	Not given						+		2	0.09
25	Satyridae	<i>Ypthima pandocus</i>	Common Three-Ring	Not Assessed	Not given						+		3	0.14
26	Satyridae	<i>Ypthima huebneri</i>	Common Four-Ring	Not Assessed	Not given						+		2	0.09
27	Satyridae	<i>Ypthima baldus newboldi</i>	Common Five-Ring	Not Assessed	Not given		+	+	+		+	+	10	0.45
28	Amathusiidae	<i>Faunis canens</i>	Common Faun	Not Assessed	Sp. not listed	+	+						2	0.09
29	Amathusiidae	<i>Zeuxidia amethystus</i>	Saturn	Not Assessed	Sp. not listed		+						1	0.05
30	Nymphalidae	<i>Ariadne merione</i>	Common Castor	Not Assessed	Sp. not listed		+		+				3	0.14
31	Nymphalidae	<i>Hypolimnas bolina</i>	Great Egg-fly	Not Assessed	Not given		+		+				4	0.18
32	Nymphalidae	<i>Hypolimnas anomala anomala</i>	Malayan Egg-Fly	Not Assessed	Not given		+						1	0.05
33	Nymphalidae	<i>Cupha erymanthis</i>	Rustic	Not Assessed	Not given	+	+		+	+	+		7	0.32
34	Nymphalidae	<i>Athyma nefte subrata</i>	Colour Sergeant	Not Assessed	Not given		+	+					3	0.14
35	Nymphalidae	<i>Vindula dejone erotella</i>	Cruiser	Not Assessed	Not given		+						2	0.09
36	Nymphalidae	<i>Moduza procris</i>	Commander	Not Assessed	Not given	+	+						4	0.18
37	Nymphalidae	<i>Neptis hylas</i>	Common Sailor	Not Assessed	Not given		+		+				6	0.27
38	Nymphalidae	<i>Neptis leucoporus cresina</i>	Grey Sailor	Not Assessed	Not given		+	+					3	0.14
39	Nymphalidae	<i>Lasippa tige</i>	Malayan Lascar, Burmese Lascar	Not Assessed	Not given	+	+						2	0.09
40	Nymphalidae	<i>Bassarona teuta</i>	Banded Marquis	Not Assessed	Sp. not listed				+				1	0.05
41	Nymphalidae	<i>Cirrochroa orissa</i>	Banded Yeoman	Not Assessed	Not given		+						1	0.05
42	Nymphalidae	<i>Terinos terpander</i>	Royal Assyrian	Not Assessed	Sp. not listed	+							1	0.05
43	Nymphalidae	<i>Tanaecia peleia peleia</i>	Malay Viscount	LC	Not given		+						2	0.09
44	Nymphalidae	<i>Tanaecia iapis</i>	Horsfield's Baron	Not Assessed	Not given		+						2	0.09
45	Nymphalidae	<i>Tanaecia iulii</i>	Common Earl	Not Assessed	Sp. not listed		+						1	0.05
46	Nymphalidae	<i>Euthalia monina</i>	Malayan Baron	Not Assessed	Not given		+						2	0.09
47	Nymphalidae	<i>Lexias canescens</i>	Yellow Archduke	Not Assessed	Not given	+	+						4	0.18
48	Nymphalidae	<i>Lexias pardalis</i>	Archduke	Not Assessed	Not given		+		+				2	0.09
49	Nymphalidae	<i>Eulaceura osteria</i>	Elegant Emperor, Purple Duke	Not Assessed	Not given		+						1	0.05
50	Nymphalidae	<i>Lebadea martha parkeri</i>	Knight	Not Assessed	Not given	+	+		+				7	0.32
51	Nymphalidae	<i>Charaxes bernardus</i>	Tawny Rajah	Not Assessed	Lists <i>Charaxes bernardus</i> <i>crepax</i> as having 'IUCN Status NE' ie not evaluated (from 2008)	+							1	0.05
52	Nymphalidae	<i>Junonia almana</i>	Peacock Pansy	LC	Not given						+		3	0.14
53	Nymphalidae	<i>Junonia hedonia ida</i>	Chocolate Pansy	Not Assessed	Not given						+		1	0.05
54	Nymphalidae	<i>Junonia iphita</i>	Chocolate Soldier	Not Assessed	Sp. not listed	+	+				+		5	0.23
55	Lycaenidae	<i>Loxura atymnus</i>	Yamfly	Not Assessed	Not given	+							1	0.05
56	Lycaenidae	<i>Ecoxylides tharis</i>	Branded Imperial	Not Assessed	Not given	+	+				+		4	0.18
57	Lycaenidae	<i>Zeltis amasa</i>	Fluffy Tit	Not Assessed	Not given		+						1	0.05
58	Lycaenidae	<i>Zizina otis lampa</i>	Lesser Grass Blue	Not Assessed	Not given						+		6	0.27
59	Lycaenidae	<i>Miletus biggsii</i>	Biggs' Brownwing	Not Assessed	Not given						+		1	0.05
60	Lycaenidae	<i>Megisba malaya</i>	Malayan Pied Blue	Not Assessed	Not given		+						1	0.05
61	Lycaenidae	<i>Arhopala centaurus</i>	Centaur Oakblue	Not Assessed	Listed as <i>Arhopala pseudocentaurus nakula</i> . Status not given		+						1	0.05
62	Lycaenidae	<i>Drupadia ravindra moorei</i>	Common Posy	Not Assessed	Not given		+						1	0.05
63	Lycaenidae	<i>Janides celeno</i>	Common Cerulean	Not Assessed	Not given						+		2	0.09
64	Lycaenidae	<i>Ionolyce helicon</i>	Pointed Line Blue	Not Assessed	Not given		+						1	0.05
65	Lycaenidae	<i>Caleta elna</i>	Elbowed Pierrot	Not Assessed	Not given						+		2	0.09
66	Lycaenidae	<i>Logania marmorata Moore</i>	Pale Mottle	Not Assessed	Not given		+						0	0.00

No.	Family	Scientific Name	Common Name [English]	CONSERVATION STATUS		Qualitative Data							Quantitative Data (from MacKinnon Lists)	
				IUCN Red List (2015.02) <sup>1</sup>	SRDB National Status <sup>2</sup>	PF	RA	RB	WF	WM	GR	Restricted Area	Number of Lists Species Recorded In	Relative Abundance
67	Hesperiidae	<i>Burara harisa</i>	Orange-striped Awlet	Not Assessed	Orange Awlet listed as <i>Bibasis harisa consobrina</i> . Status not given.		+						1	0.05
68	Hesperiidae	<i>Tajades gana</i>	Large Snow Flat	Not Assessed	Not given				+				1	0.05
69	Hesperiidae	<i>Pemara pugnans</i>	Pugnacious Lancer	Not Assessed	Not given						+		1	0.05
70	Hesperiidae	<i>Pyronoeura latolia</i>	Malayan Yellow-veined Lancer	Not Assessed	Not given						+		1	0.05
71	Hesperiidae	<i>Lambrix salsala</i>	Chestnut Bob	Not Assessed	Not given					+			1	0.05
72	Hesperiidae	<i>Erionota thrax</i>	Banana Skipper	Not Assessed	Not given		+						1	0.05
73	Hesperiidae	<i>Eetion elia</i>	Whitespot Palmer	Not Assessed	Sp. not listed						+		1	0.05
74	Hesperiidae	<i>Matapa aria</i>	Common Redeye	Not Assessed	Not given		+						2	0.09
75	Hesperiidae	<i>Borbo cinnara</i>	Rice Swift	Not Assessed	Lists as having 'IUCN Status NE' ie not evaluated (from 2008)						+		1	0.05
76	Hesperiidae	<i>Oriens gola</i>	Common Dartlet	Not Assessed	Not given						+		2	0.09
77	Hesperiidae	<i>Plastingia naga</i>	Chequered Lancer	Not Assessed	Not given		+						0	0.00
78	Hesperiidae	<i>Potanthus omaha</i>	Lesser Dart	Not Assessed	Not given						+		4	0.18
79	Hesperiidae	<i>Telicota colon</i>	Pale Palm Dart	Not Assessed	Lists as having 'IUCN Status NE' ie not evaluated (from 2008)						+		1	0.05
80	Hesperiidae	<i>Cephrenes trichopepla</i>	Yellow Palm Dart	Not Assessed	Sp. not listed						+		1	0.05
81	Hesperiidae	<i>Ancistroides nigrita maura</i>	Chocolate Demon	Not Assessed	Not given						+		2	0.09
82	Hesperiidae	<i>Pelopidas conjunctus</i>	Conjoined Swift	Not Assessed	Sp. not listed						+		1	0.05
83	Hesperiidae	<i>Pelopidas agna</i>	Little Branded Swift	Not Assessed	Lists as having 'IUCN Status NE' ie not evaluated (from 2008)						+		1	0.05
84	Hesperiidae	<i>Caltoris cornasa</i>	Fullstop Swift	Not Assessed	Not given						+		3	0.14
Total Number of Species						13	55	7	14	6	35	3		

#### References

1. IUCN Red List of Threatened Species 2015.02. Retrieved from <http://www.iucnredlist.org/> Abbreviations include:

DD: Data Deficient; LC: Least Concern; NT: Near Threatened; VU: Vulnerable; EN: Endangered; CR: Critically Endangered

2. Davison GWH, Ng PKL and Ho HC. (2008) **Singapore Red Data Book**. Where status under review, likely updated status is given in brackets. Abbreviations include:

DD: Data Deficient (status indeterminate, requires further validation); VU: Vulnerable; EN: Endangered; CR: Critically Endangered

NE: Presumed Nationally extinct; EX: Globally Extinct

#### Notes

Habitat type	Key	Relative abundance	Key
Primary Forest	PF	Sparse	+
Regeneration Forest A	RA	Uncommon	++
Regeneration Forest B	RB	Common	+++
Wetland Forest	WF	Very common	++++
Wetland Marsh	WM		
Golf Course / Recreation Facility	GR		
Restricted Area	/		

Annex 8N

## Odonate Species List (Primary Data)

ANNEX 8N ODNATE SPECIES IN STUDY AREA, REPORTED FROM PRIMARY SURVEYS

Family	Scientific Name	Common Name [English]	CONSERVATION STATUS		Qualitative Data							Quantitative Data (from MacKinnon)	
			IUCN Red List (2015.02) <sup>1</sup>	Local/ National Protection in Singapore <sup>2</sup>	PF	RA	RB	WF	WM	GR	DA	Number of Lists Species Recorded In	Relative Abundance
Calopterygidae	<i>Vestalis amethystina</i>	Common Flashwing	LC	C	+	++						3	0.19
Chlorocyphidae	<i>Libellago aurantiaca</i>	Fiery Gem	LC	UC				+				1	0.06
Chlorocyphidae	<i>Libellago</i> sp.									+		0	0.00
Euphaeidae	<i>Euphaea impar</i>	Blue-sided Satinwing	LC	UC		+						1	0.06
Lestidae	<i>Lestes praemorsus decipiens</i>	Crenulated Spreadwing	LC	UC					+			3	0.19
Coenagrionidae	<i>Amphicnemis gracilis</i>	Will-o-wisp	Not Assessed	UC					+			0	0.00
Coenagrionidae	<i>Archibasis viola</i>	Violet Sprite	LC	UC				+				1	0.06
Coenagrionidae	<i>Ceragrion cerinorubellum</i>	Ornate Coraltail	LC	C	+			+	++		+	7	0.44
Coenagrionidae	<i>Pseudagrion australasiae</i>	Look-alike Sprite	LC	UC					+			2	0.13
Coenagrionidae	<i>Pseudagrion microcephalum</i>	Blue Sprite	LC	C					++			8	0.50
Platynemididae	<i>Copera marginipes</i>	Yellow Featherlegs	LC	C							+	1	0.06
Protoneuridae	<i>Prodasineura notostigma</i>	Crescent Threadtail	Not Assessed	C		+						1	0.06
Aeshnidae	<i>Gynacantha subinterrupta</i>	Duskhawker	LC	R/UC		+						3	0.19
Gomphidae	<i>Ictinophus decoratus</i>	Common Flangetail	Not Assessed	VC					+			3	0.19
Corduliidae	<i>Epophthalmia vittigera</i>	Pond Cruiser	LC	C		+			+			4	0.25
Corduliidae	<i>Macromia cincta</i>	Stream Cruiser	Not Assessed	R		+		+				2	0.13
Corduliidae	<i>Macromia cydippe</i>	Lesser Stream Cruiser	LC	VR				+				0	0.00
Libellulidae	<i>Acisoma panorpoides</i>	Trumpet Tail	LC	C					+			6	0.38
Libellulidae	<i>Agrioptera insignis</i>	Grenadier	LC	UC				+				2	0.13
Libellulidae	<i>Agrioptera sexlineata</i>	Handsome Grenadier	Not Assessed	UC		+						1	0.06
Libellulidae	<i>Brachydiplax chalybea</i>	Blue Dasher	LC	C					+			3	0.19
Libellulidae	<i>Brachythemis contaminata</i>	Common Amberwing	LC	C					+			1	0.06
Libellulidae	<i>Cratilla metallica</i>	Dark-tipped Forest-skimmer	LC	C	+	+						3	0.19
Libellulidae	<i>Crocothemis servilia</i>	Common Scarlet	LC	VC					+			8	0.50
Libellulidae	<i>Diplacodes nebulosa</i>	Black-tipped Percher	LC	UC					+			2	0.13
Libellulidae	<i>Diplacodes trivialis</i>	Blue Percher	LC	C					+			2	0.13
Libellulidae	<i>Hydrobasileus croceus</i>	Water Monarch	LC	C	+	+			+			7	0.44
Libellulidae	<i>Lathrecista asiatica</i>	Scarlet Grenadier	LC	C			+					1	0.06
Libellulidae	<i>Nannophya pygmaea</i>	Scarlet Pygmy	LC	C			+					2	0.13
Libellulidae	<i>Nesoxenia lineata</i>	Striped Grenadier	LC	UC					+			1	0.06
Libellulidae	<i>Neurothemis fluctuans</i>	Common Parasol	LC	VC	+	+++	++	++	+	+	+	14	0.88
Libellulidae	<i>Orchithemis pulcherrima</i>	Variable Sentinel	LC	C		+		+				2	0.13
Libellulidae	<i>Orthetrum chrysis</i>	Spine-tufted Skimmer	LC	C		++	+	+	++		+	9	0.56
Libellulidae	<i>Orthetrum glaucum</i>	Common Blue Skimmer	LC	C		++			+			9	0.56
Libellulidae	<i>Orthetrum sabina</i>	Variegated sabina	LC	VC		+			+			5	0.31
Libellulidae	<i>Orthetrum testaceum</i>	Scarlet Skimmer	LC	C		+						2	0.13
Libellulidae	<i>Pantala flavesceus</i>	Wandering Glider	LC	C			+					3	0.19
Libellulidae	<i>Pseudothemis jorina</i>	Banded Skimmer	LC	UC		+						4	0.25
Libellulidae	<i>Rhodothemis rufa</i>	Common Redbolt	LC	C		+			+			8	0.50
Libellulidae	<i>Rhyothemis triangularis</i>	Sapphire Flutterer	LC	UC					+			3	0.19
Libellulidae	<i>Rhyothemis phyllis</i>	Yellow-barred Flutterer	LC	VC		+						4	0.25
Libellulidae	<i>Trithemis aurora</i>	Crimson Dropwing	LC	C		+			+			6	0.38
Libellulidae	<i>Trithemis festiva</i>	Indigo Dropwing	LC	C		+						3	0.19
Libellulidae	<i>Tyriobapta torrida</i>	Treehugger	LC	C	+	+		+				2	0.13
Libellulidae	<i>Urothemis signata insignata</i>	Scarlet Basker	LC	C	+	+			+			6	0.38
Total Number of Species					7	22	5	10	23	2	4		

References

1. IUCN Red List of Threatened Species 2015.02.

Retrieved from <http://www.iucnredlist.org/>

Abbreviations include: DD: Data Deficient; LC: Least Concern;

NT: Near Threatened; VU: Vulnerable; EN: Endangered;

CR: Critically Endangered

2. Tang HB, Ken WL, Hämäläinen M (2010) **A photographic guide to the Dragonflies of Singapore**. Raffles Museum of Biodiversity Research. Pp.222

Habitat type	Key
Primary Forest	PF
Regeneration Forest A	RA
Regeneration Forest B	RB
Wetland Forest	WF
Wetland Marsh	WM
Golf Course / Recreation Facility	GR
Developed Area	DA
Restricted Area	/

Relative abundance	Key
Sparse	+
Uncommon	++
Common	+++
Very common	++++



Annex 8P

## Freshwater Fish Species List (Primary Data)

ANNEX 8P FISH & AQUATIC COMMUNITY SPECIES IN STUDY AREA, REPORTED FROM PRIMARY SURVEYS

No.	ORDER/ Family	Scientific Name	Common Name	CONSERVATION STATUS			Visual Assessment Point												
				Native (N)/ Exotic (E)	IUCN Red List (2015.02) <sup>1</sup>	Local/ National Protection Ref for Singapore	Stream (V1) Venus Link	Stream (V2) Venus Link	Stream (V3) Venus Link	Stream (V4) Venus Link	Stream (S1) Sime Trail	Stream (S2) Golf Link	Stream (S4) Sime Trail	Stream (S5) Sime Trail	Stream (S6) Sime Trail	Stream (S8) Sime Trail	Stream (C1) Golf Link	Stream (C2) Golf Link	Stream (C3) Golf Link
A	PISCES																		
1	CYPRINIFORMES																		
	Cyprinidae	<i>Trigonostigma heteromorpha</i>	Harlequin rasbora	N	LC	Endangered (Singapore Red Data Book); Restricted to few areas but common					++	++		+			+	+	+
	Cyprinidae	<i>Rasbora elegans</i>	Two-spot rasbora	N	LC	Restricted to few areas but common	++	+	+		++	++		+		+			+
	Cyprinidae	<i>Systomus lateristriga</i>	Spanner barb	N	Listed as <i>Barbodes lateristriga</i> , Status LC	Restricted to few areas but common								+	+	+			
	Cyprinidae	<i>Systomus banskii</i>	Saddle barb	N	Not Evaluated	Restricted to few areas but common	++	++	++	+	+	+			+	+			
	Cyprinidae	<i>Systomus</i> sp.	Tiger barb	N / E	/	Restricted to few areas but common					+	+	+				+		
	Cyprinidae	-	Chinese carp	E	/														
2	PERCIFORMES																		
	Channidae	<i>Channa lucius</i>	Forest snakehead	N	LC	Restricted to few areas and rare					+	+							
	Channidae	<i>Channa striata</i>	Common snakehead	N	LC	Widespread and common	+	+	+	+	+	+		+					
	Channidae	<i>Channa micropeltes</i>	Giant snakehead	E	LC	Widespread and common													
	Eleotridae	<i>Oxyeleotris marmorata</i>	Marbled gudgeon, Marbled Goby	N	LC	Widespread and common													
3	BELONIFORMES																		
	Hemiramphidae	<i>Dermogenys collettei</i>	Malayan pygmy halfbeak	N	Not Evaluated	Widespread and common	+	++		+	++	++	+	+	+	+	+	+	+
	Hemiramphidae	<i>Hemirhamphodon pogonognathus</i>	Malayan forest halfbeak	N	LC	Restricted to few areas but common		+			+	+							
4	CYPRINODONTIFORMES																		
	Aplocheilidae	<i>Aplocheilichthys panchax</i>	Whitespot, Blue panchax	N	LC	Widespread and common	+				+	+	+		+				+
	Poeciliidae	<i>Poecilia reticulata</i>	Guppy	E	Not Evaluated	Widespread and common	+	+		+									
5	SILURIFORMES																		
	Clariidae	<i>Clarias batrachus</i>	Common walking catfish	N	LC	Widespread and common	+	+											
	Siluridae	<i>Wallago attu</i>	Giant river catfish		NT														
6	RAJIFORMES																		
	Siluridae	-	Freshwater ray																
7	OSTEOGLOSSIFORMES																		
	Osteoglossidae	<i>Scleropages formosus</i>	Malayan Boneylingue (Asian Arowana is used as a trade name)	Introduced	EN	Widespread and rare							+						
B	DECAPODA																		
	Palaemonidae	<i>Macrobrachium</i> sp.1	Freshwater prawn							+									
	Palaemonidae	<i>Macrobrachium</i> sp.2	Freshwater prawn												+				
	Palaemonidae	<i>Macrobrachium</i> sp.3	Freshwater prawn									+							
	Brachyura	Unidentified	Freshwater crab												+				

Reference

1. IUCN Red List of Threatened Species 2015.02. Retrieved from <http://www.iucnredlist.org/> / Abbreviations include:  
DD: Data Deficient; LC: Least Concern; NT: Near Threatened; VU: Vulnerable; EN: Endangered; CR: Critically Endangered

Relative abundance	Key
Sparse	+
Uncommon	++
Common	+++
Very common	++++

ANNEX 8P FISH & AQUATIC COMMUNITY SPECIES IN STUDY AREA, REPORTED FROM PRIMARY SURVEYS

No.	ORDER/ Family	Scientific Name	Common Name	CONSERVATION STATUS			Visual Assessment Point							Remarks	
				Native (N)/ Exotic (E)	IUCN Red List (2015.02) <sup>1</sup>	Local/ National Protection Ref for Singapore	Lower Pierce Reservoir (LP1)	Lower Pierce Reservoir (LP2)	Pond (BC) - Bukit Golf Course	Pond (SC1)- Sime Golf Course	Pond (SC2)- Sime Golf Course	Pond (IC1)- Island Golf Course	Pond (IC2)- Island Golf Course		Pond (IC3)- Island Golf Course
A	PISCES														
1	CYPRINIFORMES														
	Cyprinidae	<i>Trigonostigma heteromorpha</i>	Harlequin rasbora	N	LC	Endangered (Singapore Red Data Book); Restricted to few areas but common									Observed. Commercial value (ornamental)
	Cyprinidae	<i>Rasbora elegans</i>	Two-spot rasbora	N	LC	Restricted to few areas but common									Observed. Commercial value (ornamental)
	Cyprinidae	<i>Systomus lateristriga</i>	Spanner barb	N	Listed as <i>Barbodes lateristriga</i> , Status LC	Restricted to few areas but common									Observed. Commercial value (ornamental)
	Cyprinidae	<i>Systomus banskii</i>	Saddle barb	N	Not Evaluated	Restricted to few areas but common									Observed. Commercial value (ornamental)
	Cyprinidae	<i>Systomus</i> sp.	Tiger barb	N / E	/	Restricted to few areas but common									Observed. Commercial value (ornamental)
	Cyprinidae	-	Chinese carp	E	/							+	+	+	Interview. Commercial value (ornamental & eaten)
2	PERCIFORMES														
	Channidae	<i>Channa lucius</i>	Forest snakehead	N	LC	Restricted to few areas and rare									Observed. Commercial value (eaten)
	Channidae	<i>Channa striata</i>	Common snakehead	N	LC	Widespread and common		+							Observed and interview. Commercial value (eaten)
	Channidae	<i>Channa micropeltes</i>	Giant snakehead	E	LC	Widespread and common		+							Interview. Commercial value (eaten)
	Eleotridae	<i>Oxyeleotris marmorata</i>	Marbled gudgeon, Marbled Goby	N	LC	Widespread and common		+							Observed and interview. Commercial value (eaten).
3	BELONIFORMES														
	Hemiramphidae	<i>Dermogenys collettei</i>	Malayan pygmy halfbeak	N	Not Evaluated	Widespread and common									Observed. Commercial value (ornamental)
	Hemiramphidae	<i>Hemirhamphodon pogonognathus</i>	Malayan forest halfbeak	N	LC	Restricted to few areas but common									Observed. Commercial value (ornamental)
4	CYPRINODONTIFORMES														
	Aplocheilidae	<i>Aplocheililus panchax</i>	Whitespot, Blue panchax	N	LC	Widespread and common									Observed. Commercial value (ornamental)
	Poeciliidae	<i>Poecilia reticulata</i>	Guppy	E	Not Evaluated	Widespread and common									Observed. Commercial value (ornamental)
5	SILURIFORMES														
	Clariidae	<i>Clarias batrachus</i>	Common walking catfish	N	LC	Widespread and common									Observed. Commercial value (eaten)
	Siluridae	<i>Wallago attu</i>	Giant river catfish		NT			+							Interview. Commercial value (eaten)
6	RAJIFORMES														
	Siluridae	-	Freshwater ray					+							Interview. Commercial value (eaten)
7	OSTEOGLOSSIFORMES														
	Osteoglossidae	<i>Scleropages formosus</i>	Malayan Boneytongue (Asian Arowana is used as a trade name)	Introduced	EN	Widespread and rare		+							Introduced.
B	DECAPODA														
	Palaemonidae	<i>Macrobrachium</i> sp.1	Freshwater prawn												Observed. Wild
	Palaemonidae	<i>Macrobrachium</i> sp.2	Freshwater prawn												Observed. Wild
	Palaemonidae	<i>Macrobrachium</i> sp.3	Freshwater prawn												
	Brachyura	Unidentified	Freshwater crab												Observed. Wild

Reference

1. IUCN Red List of Threatened Species 2015.02. Retrieved from <http://www.iucnredlist.org/> Abbreviations include:  
DD: Data Deficient; LC: Least Concern; NT: Near Threatened; VU: Vulnerable; EN: Endangered; CR: Critically Endangered

Relative abundance	Key
Sparse	+
Uncommon	++
Common	+++
Very common	++++

## Annex 9.0


# Baseline Information for Proposed Rotary Borehole Locations

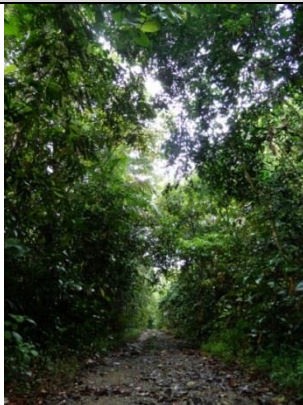
## ANNEX 9.0 BASELINE INFORMATION FOR PROPOSED ROTARY BOREHOLE LOCATIONS WITHIN AND IN CLOSE PROXIMITY TO THE CCNR

\*BH01, 20-34 are within the CCNR. BH02-19, 35-37 are in close proximity to the CCNR


Notes:


- 1) PF = Primary Forest (PF); RA = Regeneration Forest A; RB = Regeneration Forest B; WF = Wetland Forest; WM = Wetland Marsh; DA = Developed Area
- 2) 'At the proposed borehole' indicates at the proposed location itself and within a 10 m radius of the proposed borehole coordinates outlined in SI Strategy Issue 3
- 3) 'In the vicinity' indicates in the general area or close to the proposed borehole location i.e. within a 100 m radius of the proposed borehole worksite location, where physically accessible and visible

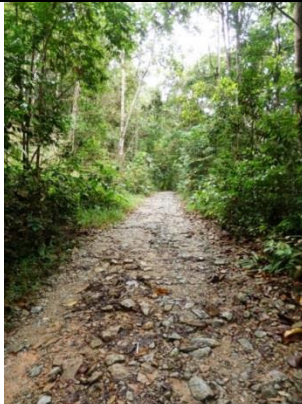
Borehole ID & Photograph of Location		Physical and Ecological observations for proposed borehole locations & their vicinity within CCNR for alignment option 1			
BH01		<u>At proposed borehole location</u>			
		<p>Just off main Trail. Site: Clearing in forest off main paved trail of SIME TRACK. Sparse to no ground cover observed. Gradient: Flat</p> <p><u>Dominant plant species at site</u> <i>Elaeis guineensis</i>, <i>Cinnamomum iners</i>, <i>Leea indica</i></p> <p><u>Plant species of conservation interest</u> None recorded</p> <p><u>Animal species of conservation interest</u> None recorded</p> <p><u>Animal species observed</u> Dark necked tailorbird (<i>Orthotomus atrogularis</i>), Long Tailed Macaque (<i>Macaca fascicularis</i>)</p> <p><u>In the vicinity</u></p> <p><u>Plant species of conservation interest</u> None recorded</p> <p><u>Animal species of conservation interest</u> Lesser Mousedeer (<i>Tragulus kanchil</i>), Barking Deer (<i>Muntiacus muntjac</i>) recorded by Camera Trap (ID: CCNR10) located approximately 85 m away.</p> <p><u>Other information</u> Several butterflies observed at large patch of ginger at initial stretch of access road. The small shrub species <i>Leea indica</i> was observed near BH01 (and BH04 and BH05) was also observed to attract several butterflies, bees and wasps. A body of water is located near the initial stretch of access road, approximately 15-20 m away from the trail towards the PIE.</p>			
<u>Ecology &amp; Biodiversity Sensitivity Rating</u>					
Terrestrial Habitats, Flora & Fauna		Aquatic Habitats, Flora & Fauna		Protected Areas	
High		Borehole outside stream/ wetland buffer zone		High	

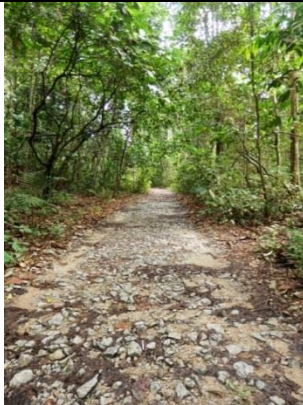
Borehole ID & Photograph of Location		Physical and Ecological observations for proposed borehole locations & their vicinity within CCNR for alignment option 1	
BH20		At proposed borehole location	
		<p><u>Trail</u>: Cobble/gravel section of the SIME track. Approximately 1.8 - 2.0 m wide. Sufficient space for a light vehicle to travel on.</p> <p><u>Gradient</u>: Flat</p> <p><u>Dominant plant species alongside track</u> <i>Rhodamnia cinerea</i>, <i>Cinnamomum iners</i>, <i>Alangium nobile</i> - Used as food sources for animals. Also Shrubs/Herbs: <i>Clidemia hirta</i> (exotic species)</p> <p><u>Plant species of conservation interest</u> <i>Ficus lamponga</i> x 1 (CR/RDB), <i>Pternandra coerulescens</i> x1 (VU/RDB) - Both used as food sources for animals. <i>Garcinia griffithii</i> x1 (EN/RDB), <i>Dioscorea</i> sp. seedlings (Status unknown but majority of <i>Dioscorea</i> listed as CR/RDB).</p> <p><u>Animal species of conservation interest</u> None recorded</p> <p><u>Animal species observed</u> Birds include: Pink-necked Green Pigeon (<i>Treron vernans</i>), Common Flameback (<i>Dinopium javanense</i>), Dark-necked Tailorbird (<i>Orthotomus atrogularis</i>) and a juvenile Striped Tit-babbler (<i>Macronous gularis</i>) confirming breeding in this area. Calls heard of Plaintive Cuckoo (<i>Cacomantis merulinus</i>) and Red-crowned Barbet (<i>Megalaima rafflesii</i>) in Jun '15 also indicated their possible breeding in the area. Plantain squirrel (<i>Callosciurus notatus</i>); perching dragonflies (site is relatively close to stream I)</p> <p><u>In the vicinity</u></p> <p><u>Plant species of conservation interest</u> <i>Adenia macrophylla</i> climber located approximately 10 m away from BH20.</p> <p><u>Animal species of conservation interest</u> Secondary data record of Sunda Pangolin (<i>Manis javanica</i>) (CR/RDB; CR/IUCN; CITES-II) approximately 50 m northeast</p> <p><u>Other information</u> Low overhanging foliage approximately 2.5-3m at lowest point. Erosion gullies observed on both sides of the trail. NParks had previously shared that there is a <i>Hanguana rubinea</i> (newly rediscovered) in proximity to BH20.</p>	
Ecology & Biodiversity Sensitivity Rating			
Terrestrial Habitats, Flora & Fauna		Aquatic Habitats, Flora & Fauna	
Protected Areas			
High		Borehole just outside stream & wetland buffer zone	
		High	

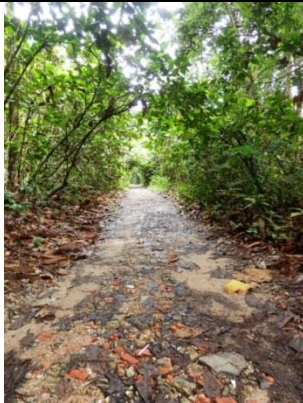



Borehole ID & Photograph of Location		Physical and Ecological observations for proposed borehole locations & their vicinity within CCNR for alignment option 1			
BH21		At proposed borehole location			
<div></div> <p>Some overhanging vegetation and branches</p> <p><b>Within RA</b></p>		<p>Just off main trail.</p> <p><u>Site</u>: Bare ground on an elevated forest clearing used for assembly. Can be accessed relatively easily.</p> <p><u>Gradient</u>: Flat but elevated</p> <p><u>Dominant plant species alongside track</u> <i>Rhodamnia cinerea</i>, <i>Cinnamomum iners</i>, <i>Dillenia suffruticosa</i>, <i>Syzygium zeylanicum</i> - Used as food sources for animals. <i>D. suffruticosa</i> flowers and fruits are fed on by insects, birds and mammals.</p> <p><u>Plant species of conservation interest</u> None recorded</p> <p><u>Animal species of conservation interest</u> None recorded</p> <p><u>Animal species observed</u> Butterfly feeding on tree sap. Birds included Greater racket-tailed Drongo (<i>Dicrurus paradiseus</i>), Yellow-vented Bulbul (<i>Pycnonotus goiavier</i>) Striped Tit-babbler (<i>Macronous gularis</i>), Orange Bellied Flowerpecker (<i>Dicaeum trigonostigma</i>). Calls heard of Sunda Scops-owl (<i>Otus lempiji</i>) in Jun '15 also indicated their possible breeding in the area.</p> <p><b><u>In the vicinity</u></b></p> <p><u>Plant species of conservation interest</u> None recorded</p> <p><u>Animal species of conservation interest</u> White-rumped (Shama <i>Copsychus</i>) <i>malabaricus</i> (CR/EN, Red Data Book; LC, IUCN) approximately 80 m away north. Secondary Data record of Sunda Pangolin (<i>Manis javanica</i>) (CR/RDB; CR/IUCN; CITES-II) approximately 40 m southeast.</p> <p><b><u>Other information</u></b> NParks had previously shared that there is a <i>Hornstedtia scyphifera</i> (VU/RDB) herb observed in the vicinity.</p>			
Ecology & Biodiversity Sensitivity Rating					
Terrestrial Habitats, Flora & Fauna		Aquatic Habitats, Flora & Fauna		Protected Areas	
High		Borehole just on the edge of wetland buffer zone		High	



Borehole ID & Photograph of Location		Physical and Ecological observations for proposed borehole locations & their vicinity within CCNR for alignment option 1	
BH22		At proposed borehole location	
<div></div> <p>Trail at proposed borehole location</p> <p><b>Between the edge of PR and RA</b></p>		<p><u>Trail:</u> Mudtrack section of the SIME track. Approximately 1.8 m wide. Located half in forested, half in relatively open shrubby area. Assume access to BH22 through Island Club Road, Terentang Trail (width &lt;1.5m at certain locations e.g. between BH29 and BH34), then Sime Track</p> <p><u>Gradient:</u> Relatively flat</p> <p><u>Dominant plant species alongside track</u> <i>Dillenia suffruticosa</i>. Also Shrubs/ Herb: <i>Clidemia hirta</i> (exotic species)</p> <p><u>Plant species of conservation interest</u> <i>Ficus aurata</i> (VU/RDB), <i>Ficus lamponga</i> (CR/RDB) - Both used as food sources for animals. One <i>Ficus</i> sp. observed immediately to Right of trail beside BH22 location, facing eastward direction.</p> <p><u>Animal species of conservation interest</u> Long-tailed Macaque <i>Macaca fascicularis</i> (CITES-II) x 16, Clouded monitor (<i>Varanus nebulosus</i>) (CITES-I), Hill Myna (<i>Gracula religiosa</i>) (CITES-II) and Long-tailed Parakeet (<i>Psittacula longicauda</i>) (CITES-II)</p> <p><u>Animal species observed</u> Keeled rat snake (<i>Ptyas carinata</i>). Foraging animals included Plantain squirrel (<i>Callosciurus notatus</i>). Birds included Emerald dove (<i>Chalcophaps indica</i>), Pink-necked Green Pigeon (<i>Treron vernans</i>), Chestnut-bellied Malkoha (<i>Phaenicophaeus sumatranus</i>), Asian Palm Swift (<i>Cypsiurus balasensis</i>), Germain's Swiftlet (<i>Aerodramus germani</i>), Dark-necked Tailorbird (<i>Orthotomus atrogularis</i>), Olive-backed Sunbird (<i>Cinnyris jugularis</i>), Purple-throated Sunbird (<i>Nectarinia sperata</i>), and a juvenile Greater racket-tailed Drongo (<i>Dicrurus paradiseus</i>) confirming breeding in this area. Calls heard of Square-tailed Drongo-Cuckoo (<i>Surniculus lugubris</i>) in Jun '15 also indicated their possible breeding in the area.</p> <p><u>In the vicinity</u> <u>Plant species of conservation interest</u> <i>Adenia macrophylla</i> (VU/RDB) on <i>Ficus aurata</i> observed approximately 10-15 m facing eastward direction. <i>Ampelocissus</i> sp. on <i>Alchornea villosa</i> observed approximately 15-20m in westward direction. <i>Molineria</i> sp. (VU or CR/RDB) cluster behind Petaling Hut.</p> <p><u>Animal species of conservation interest:</u> Spiny Hill Terrapin (<i>Heosemys spinose</i>) (VU/RDB; EN/IUCN, CITES-II) approximately 25 m west along trail; Harlequin Rasbora (<i>Trigonostigma heteromorphy</i>)a (EN/RDB) in stream Ha to the south. 2<sup>nd</sup> Data record of Sunda Pangolin (<i>Manis javanica</i>) (CR/RDB; CR/IUCN; CITES-II) approximately 60 m to the southwest; Dog-toothed Cat Snake (<i>Boiga cynodon</i>) (EN/RDB) approximately 50 m southwest.</p> <p><u>Animals species observed at site</u> Copper-cheeked Frog (<i>Hylarana labialis</i>) at stream Ha; Sunda Scops Owl (<i>Otus lempiji</i>) and Malayan Colugo (<i>Galeopterus variegatus</i>) approximately 80 m away.</p> <p><u>Other information</u> Open shrubby area with frequent visits by birds such as bulbuls, sunbirds, bee-eaters, leafbirds which were all reported at this location on many surveys.</p>	
Ecology & Biodiversity Sensitivity Rating			
Terrestrial Habitats, Flora & Fauna		Aquatic Habitats, Flora & Fauna	Protected Areas
High		Borehole just outside stream & wetland buffer zone	High

Borehole ID & Photograph of Location		Physical and Ecological observations for proposed borehole locations & their vicinity within CCNR for alignment option 1	
BH23		At proposed borehole location	
<div></div> <p>Between the edge of PF and RA</p>		<p><u>Trail</u>: Cobbled mudtrack section of the SIME Track. Approximately 1.8 m wide. Foilage relatively high. Assume access to BH23 through Island Club Road, Terentang Trail (width &lt;1.5 m at certain locations e.g. between BH29 and BH34), then Sime Track</p> <p><u>Gradient</u>: Flat</p> <p><u>Dominant plant species alongside track</u> <i>Dillenia suffruticosa</i> (both sides of trail), <i>Camptosperma auriculatum</i>, <i>Alangium javanicum</i> - Used as food sources for animals. Also Shrubs/Herbs: <i>Clidemia hirta</i>, <i>Asystasia gangetica</i>, Resam, <i>Tacca</i> sp.</p> <p><u>Plant species of conservation interest</u> <i>Symplocos rubiginosa</i> (EN/RDB), <i>Artocarpus nitidus</i> (CR/RDB), <i>Elaeocarpus griffithii</i> (NE/RDB)- Used as food sources for animals. <i>Psydrax</i> sp. possible location identified to be approximately 3-5m westward direction.</p> <p><u>Animal species of conservation interest</u> Clouded monitor (<i>Varanus nebulosus</i>) (CITES-I) and Hill Myna (<i>Gracula religiosa</i>) (CITES-II)</p> <p><u>Animal species observed</u> Plantain squirrel (<i>Callosciurus notatus</i>). Birds included Sunda Scops-owl (<i>Otus lempiji</i>), Large-tailed Nightjar (<i>Caprimulgus macrurus</i>), Germain's Swiftlet (<i>Aerodramus germani</i>), Oriental Dollar Bird (<i>Eurystomus orientalis</i>), Greater racket-tailed Drongo (<i>Dicrurus paradiseus</i>), Olive-winged Bulbul (<i>Pycnonotus plumosus</i>), Dark-necked Tailorbird (<i>Orthotomus atrogularis</i>)</p> <p><u>In the vicinity</u></p> <p><u>Plant species of conservation interest</u> <i>Ficus aurata</i> (VU/RDB), <i>F. lamponga</i> (CR/RDB) approximately 10-15m westward of BH23; <i>Garcinia scortechinii</i> x2 (CR/RDB) located approximately 10-15m eastward at BH24 location. Orchids observed on <i>Cynometra</i> sp. tree adjacent to BH24. <i>Psydrax</i> sp. climbers located between BH23 and BH24.</p> <p><u>Animal species of conservation interest</u> Long-tailed Macaque (<i>Macaca fascicularis</i>) (CITES-II) approximately 20 m east on track; Malayan Swamp Skink (<i>Sphenomorphus</i>) sp. (CR/RDB. Lives in restricted area) approximately 100 m to the west</p> <p><u>Other information</u> Food resources include flowering/ fruiting <i>Ficus</i> sp. Microclimate monitoring station mounted on tree observed just adjacent to BH23. On Sime Track leading towards BH23, 24 and 25, plant species of conservation interest observed to be <i>Ficus aurata</i>, <i>Ficus lamponga</i> (near Ranger Station). The path is lined largely with <i>Dillenia suffruticosa</i>, grass and weed species, <i>Caryota mitis</i>, resam and some juvenile palm individuals. NParks had also shared that there is a cluster of <i>Maranthes corymbosa</i> seedlings between BH23 and BH24.</p>	
Ecology & Biodiversity Sensitivity Rating			
Terrestrial Habitats, Flora & Fauna		Aquatic Habitats, Flora & Fauna	Protected Areas
High		Borehole just outside stream buffer zone	High

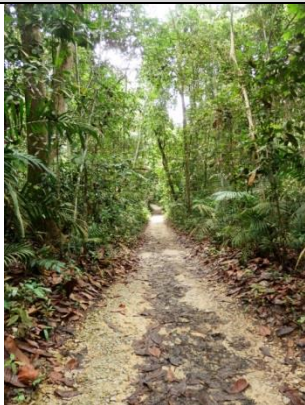
Borehole ID & Photograph of Location		Physical and Ecological observations for proposed borehole locations & their vicinity within CCNR for alignment option 1	
BH24		At proposed borehole location	
<div></div> <p>Between the edge of PF and RA</p>		<p><u>Trail</u>: Cobbled mudtrack section of the SIME Track. Approximately 2.1 m wide. Relatively high canopy cover (&gt; 2.5m). Assume access to BH24 through Island Club Road, Terentang Trail (width &lt;1.5m at certain locations e.g. between BH29 and BH34) and then Sime Track.</p> <p><u>Gradient</u>: Flat</p> <p><u>Dominant plant species alongside track</u> <i>Camposperma auriculatum</i>, <i>Dillenia suffruticosa</i>, <i>Macaranga gigantea</i>, <i>Artocarpus nitidus</i> - Used as food sources for animals. Also Shrubs/Herbs: <i>Clidemia hirta</i> (exotic species) and various species of grass and weeds.</p> <p><u>Plant species of conservation interest</u> <i>Artocarpus nitidus</i> (CR/RDB), <i>Elaeocarpus stipularis</i> (VU/RDB), <i>Garcinia scortechnii</i> x2 (CR/RDB).</p> <p><u>Animal species of conservation interest</u> Hill Myna (<i>Gracula religiosa</i>) (CITES-II), Clouded monitor (<i>Varanus nebulosus</i>) (CITES-I)</p> <p><u>Animal species observed</u> Sumatran Flying Dragon (<i>Draco sumatranus</i>). Foraging animals included Plantain squirrel (<i>Callosciurus notatus</i>). Birds included Emerald dove (<i>Chalcophaps indica</i>), Common Tailorbird (<i>Orthotomus sutorius</i>), Striped Tit-babbler (<i>Macronous gularis</i>)</p> <p><u>In the vicinity</u></p> <p><u>Plant species of conservation interest</u> <i>Ficus aurata</i> (VU/RDB), <i>F. lamponga</i> (CR/RDB) in westward direction after BH23 location; Orchids observed on <i>Cynometra</i> sp. tree adjacent to BH25 location, approximately 15m away from BH24. <i>Psydrax</i> sp. climbers located between BH23 and BH24.</p> <p><u>Animal species of conservation interest</u> Long-tailed Macaque <i>Macaca fascicularis</i> (CITES-II) approximately 20 m west on track.</p> <p><u>Other information</u> On Sime Track leading towards BH23, 24 and 25, plant species of conservation interest observed to be <i>Ficus aurata</i>, <i>Ficus lamponga</i> (near Ranger Station). The path is lined largely with <i>Dillenia suffruticosa</i>, grass and weed species, <i>Caryota mitis</i>, resam and some juvenile palm individuals. NParks had also shared that there is a cluster of <i>Maranthes corymbosa</i> seedlings between BH23 and BH24.</p>	
Ecology & Biodiversity Sensitivity Rating			
Terrestrial Habitats, Flora & Fauna		Aquatic Habitats, Flora & Fauna	
Protected Areas			
High		Borehole outside stream buffer zone	
		High	



Borehole ID & Photograph of Location		Physical and Ecological observations for proposed borehole locations & their vicinity within CCNR for alignment option 1	
BH25		At proposed borehole location	
		<p><u>Trail:</u> Cobbled mudtrack section of the SIME Track. Approximately 2.3 m wide. Less dense vegetation observed on both sides; largely leaf litter and trees located 1.5-1.8m away from trail. Possible for skirting path to be created. High canopy cover (&gt;2.5m) but low hanging trees observed 3-4 m north east of location. Overhanging branches would require clearance to access location. Assume access to BH25 through Island Club Road, Terentang Trail (width &lt;1.5m at certain locations e.g. between BH29 and BH34) and then Sime Track.</p> <p><u>Gradient:</u> Flat</p> <p><u>Dominant plant species alongside track</u> <i>Dillenia suffruticosa</i>, <i>Camposperma auriculatum</i> - Used as food sources for animals. Also Shrubs/Herbs: <i>Clidemia hirta</i> and various species of grass and weeds.</p> <p><u>Plant species of conservation interest</u> <i>Artocarpus nitidus</i> (CR/RDB), <i>Glochidion arborescens</i> (CR/RDB) - Food source. Orchids observed on <i>Cynometra</i> sp. tree adjacent to borehole location.</p> <p><u>Animal species of conservation interest</u> Hill Myna (<i>Gracula religiosa</i>) (CITES-II), Clouded monitor (<i>Varanus nebulosus</i>) (CITES-I)</p> <p><u>Animal species observed</u> Birds included Greater racket-tailed Drongo (<i>Dicrurus paradiseus</i>), Olive-winged Bulbul (<i>Pycnonotus plumosus</i>), White-vented Myna (<i>Acridotheres javanicus</i>), Brown-throated Sunbird (<i>Anthreptes malacensis</i>), Emerald dove (<i>Chalcophaps indica</i>). Also Plantain squirrel (<i>Callosciurus notatus</i>)</p> <p><u>In the vicinity</u> <u>Plant species of conservation interest</u> Presence of <i>Artocarpus nitidus</i> (CR/RDB), <i>Elaeocarpus stipularis</i> (VU/RDB); <i>Garcinia scorteichinii</i> x2 (CR/RDB) at BH24 location approximately 15 m away from BH25.</p> <p><u>Animal species of conservation interest</u> Golden-ringed Cat Snake (<i>Boiga dendrophila</i>) (VU/RDB) approximately 80 m east along track; Long-tailed Macaque (<i>Macaca fascicularis</i>) (CITES-II) approximately 20m east on track</p> <p><u>Other information</u> On Sime Track leading towards BH23, 24 and 25, plant species of conservation interest observed to be <i>Ficus aurata</i>, <i>Ficus lamponga</i> (near Ranger Station). The path is lined largely with <i>Dillenia suffruticosa</i>, grass and weed species, <i>Caryota mitis</i>, resam and some juvenile palm individuals.</p>	
			
View facing north east towards Ranger station			
View facing south west			
Between the edge of PF and RA			
Ecology & Biodiversity Sensitivity Rating			
Terrestrial Habitats, Flora & Fauna		Aquatic Habitats, Flora & Fauna	
Protected Areas			
High		Borehole just outside stream buffer zone	
		High	

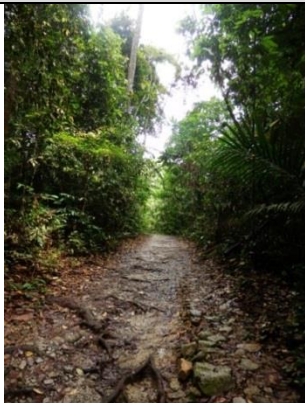





Borehole ID & Photograph of Location		Physical and Ecological observations for proposed borehole locations & their vicinity within CCNR for alignment option 1	
BH26		At proposed borehole location	
<div></div>		<p><u>Trail:</u> Cobbled mud track section of TERENTANG Trail. Approximately 1.6m wide. Tall tree with little overhanging foliage except for some branches at about 3m. Assume access to BH26 entering through Island Club Road and then Terentang Trail (width &lt;1.5m at certain locations e.g. between BH29 and BH34).</p> <p><u>Gradient:</u> On a slight upwards (walking in east direction)</p> <p><u>Dominant plant species alongside track</u> Silverback (<i>Rhodamnia cinerea</i>); Rattan was also observed in abundance on both sides of the trail. Also Shrubs/ Herb: <i>Anisophyllea disticha</i>; <i>Clidemia hirta</i>, <i>Dicranopteris linearis</i>, <i>Caryota mitis</i></p> <p><u>Plant species of conservation interest</u> <i>Artocarpus nitidus</i> (CR/RDB), <i>Ficus lamponga</i> (CR/RDB) - Food sources; <i>Syzygium incarnatum</i> (EN/RDB).</p> <p><u>Animal species of conservation interest</u> Hill Myna (<i>Gracula religiosa</i>) (CITES-II), Clouded monitor (<i>Varanus nebulosus</i>) (CITES-I)</p> <p><u>Animal species observed</u> Birds included Emerald dove (<i>Chalcophaps indica</i>), Dark-necked Tailorbird (<i>Orthotomus atrogularis</i>), Striped Tit-babbler (<i>Macronous gularis</i>), Olive-backed Sunbird (<i>Cinnyris jugularis</i>) and a juvenile Common Tailorbird (<i>Orthotomus sutorius</i>) confirming its breeding in this area; Also Plantain squirrel (<i>Callosciurus notatus</i>).</p> <p><u>In the vicinity</u></p> <p><u>Plant species of conservation interest</u> Between BH26 and BH27 – Clump of <i>Molineria</i> sp. (CR or VU/RDB) and <i>Cratoxylum arborescens</i> (VU/RDB).</p> <p><u>Animal species of conservation interest</u> Secondary data record of Dusky Earless Agamid, Dusky Earless Agama <i>Aphaniotis fusca</i> (EN/RDB) approximately 80 m to the north.</p> <p><u>Other information</u> <i>Eurycoma longifolia</i> (CR/RDB) treelets and <i>Aquilaria malaccensis</i> seedlings found along path on approach to BH26 from start of Terentang trail from Kalang Service Reservoir Road. Apart from the <i>Molineria</i> sp. (VU or CR/RDB) clump observed between BH26 and BH27, another significant patch is noted at the approach to BH26 from the trail head of Terentang trail from the Ranger Station Hut. Also at Terentang trail head from Ranger Station Hut, a babbler (<i>Maclocincla</i> sp.) was repeatedly heard and seen at the vegetation.</p>	
Ecology & Biodiversity Sensitivity Rating			
Terrestrial Habitats, Flora & Fauna		Aquatic Habitats, Flora & Fauna	
Protected Areas			
High		Borehole outside stream/ wetland buffer zone	
		High	






Borehole ID & Photograph of Location		Physical and Ecological observations for proposed borehole locations & their vicinity within CCNR for alignment option 1	
BH27		At proposed borehole location	
<div></div> <p>Within RA</p>		<p><u>Trail</u>: Bare ground area of the TERENTANG Trail located at entrance to old trail. Relatively wide clearing with high overhead vegetation. Assume access to BH27 entering through Island Club Road and then Terentang Trail (width &lt;1.5m at certain locations e.g. between BH29 and BH34). <u>Gradient</u>: Flat</p> <p><u>Dominant plant species alongside track</u> Silverback <i>Rhodamnia cinerea</i>, <i>Campnosperma auriculatum</i> - Used as food sources for animals. Also Shrubs/ Herb: <i>Anisophyllea disticha</i>; <i>Clidemia hirta</i>, <i>Dicranopteris linearis</i>, <i>Caryota mitis</i></p> <p><u>Plant species of conservation interest</u> <i>Elaeocarpus stipularis</i> (VU/RDB), <i>Artocarpus nitidus</i> (CR/RDB), <i>Pternandra echinata</i> (VU/RDB), <i>Prunus arborea</i> (CR/RDB) - All used as food sources for animals; <i>Litsea accedens</i> (EN/RDB), <i>Litsea accedens</i> (EN/RDB)</p> <p><u>Animal species of conservation interest</u> None recorded</p> <p><u>Other animal species observed</u> Birds included Coppersmith Barbet (<i>Megalaima haemacephala</i>), Greater racket-tailed Drongo (<i>Dicrurus paradiseus</i>), Dark-necked Tailorbird (<i>Orthotomus atrogularis</i>); Abbott's Babbler (<i>Malacocincla abbotti</i>), Striped Tit-babbler (<i>Macronous gularis</i>)</p> <p><u>In the vicinity</u> <u>Plant species of conservation interest</u>: Between BH26 and BH27 – Clump of <i>Molineria</i> sp. (CR or VU/RDB) and <i>Cratoxylum arborescens</i> (VU/RDB). Cluster of <i>Uncaria</i> sp. climbers spotted between BH34 and BH27.</p> <p><u>Animal species of conservation interest</u>:: Long-tailed Macaque (<i>Macaca fascicularis</i>) (CITES-II) approximately 100 m south.</p> <p><u>Other information</u> Flocks of birds containing various species were observed approximately 50 m away, near the entrance to the old trail to Shrine (T01). <i>Eurycoma longifolia</i> (CR/RDB) treelets and <i>Aquilaria malaccensis</i> seedlings found along path on approach to BH27 from start of Terentang trail from Kalang Service Reservoir Road. Apart from the <i>Molineria</i> sp. (VU or CR/RDB) clump observed between BH26 and BH27, another significant patch is noted at the approach to BH26 from the trail head of Terentang trail from the Ranger Station Hut.</p>	
Ecology & Biodiversity Sensitivity Rating			
Terrestrial Habitats, Flora & Fauna		Aquatic Habitats, Flora & Fauna	Protected Areas
High		Borehole outside stream/ wetland buffer zone	High

Borehole ID & Photograph of Location		Physical and Ecological observations for proposed borehole locations & their vicinity within CCNR for alignment option 1	
BH28		At proposed borehole location	
<div><p>High canopy but narrow trail</p><p><b>Within RA</b></p><div><p><i>A. malaccensis</i> seedlings and Exposed tree roots</p></div></div>		<p><u>Trail</u>: Mudtrack section of TERENTANG Trail. 1.6 m- 1.9 m wide. Exposed tree roots and with trees immediately to the side of the trail with no shrub gradient. Assume access to BH28 entering through Island Club Road and then Terentang Trail (width &lt;1.5m at certain locations e.g. between BH29 and BH34)</p> <p><u>Gradient</u>: On an upwards incline in an easterly direction</p> <p><u>Dominant plant species alongside track</u> Silverback <i>Rhodamnia cinerea</i>, <i>Elaeocarpus masterii</i>- Used as food sources for animals. Also Shrubs/ Herb: <i>Anisophyllea disticha</i>; <i>Clidemia hirta</i>, <i>Dicranopteris linearis</i>, <i>Caryota mitis</i>.</p> <p><u>Plant species of conservation interest</u> Two individuals of <i>Aquilaria malaccensis</i> (VU/RDB; VU/ IUCN) trees on left side of path (facing east) and numerous seedlings on left side of path (facing east) between BH28 and BH29. <i>Eurycoma longifolia</i> (CR/RDB) treelet found on left side of path (~2.5m away) (facing east).</p> <p><u>Animal species of conservation interest</u> Red Junglefowl (<i>Gallus gallus</i>) x 2 (EN/RDB; LC/IUCN)</p> <p><u>Animal species observed</u> Dark-necked Tailorbird (<i>Orthotomus atrogularis</i>)</p> <p><b><u>In the vicinity</u></b></p> <p><u>Plant species of conservation interest</u> <i>Aquilaria malaccensis</i> seedlings located between BH28 and BH29</p> <p><u>Animal species of conservation interest</u> Long-tailed Macaque (<i>Macaca fascicularis</i>) (CITES-II) x2, approximately 80 m west along trail and 80 m south.</p> <p><b><u>Other information</u></b> Path from start of Terentang trail to BH28 lined with <i>Xylopia</i> sp. and <i>Caryota mitis</i>, some individuals of <i>Ficus lamponga</i> (CR/RDB) and <i>F. aurata</i> (EN/RDB), one <i>Xanthophyllum affine</i> (EN/RDB). Exposed roots observed on ground, suspected to be from <i>Cratoxylum</i> sp. trees adjacent to the trail.</p>	
Ecology & Biodiversity Sensitivity Rating			
Terrestrial Habitats, Flora & Fauna		Aquatic Habitats, Flora & Fauna	Protected Areas
High		Borehole outside stream/ wetland buffer zone	High



Borehole ID & Photograph of Location		Physical and Ecological observations for proposed borehole locations & their vicinity within CCNR for alignment option 1	
BH29		At proposed borehole location	
		<p><u>Trail:</u> Soft mudtrack section of TERENTANG Trail, with some foliage protruding out onto path. Approximately 1.5 m wide with some very large trees on left of path (facing east) and dense vegetation with an erosion gully on the right (facing east). Assume access to BH29 entering through Island Club Road and then Terentang Trail. Width is &lt;1.5m between BH29 and BH34.</p> <p><u>Gradient:</u> Flat</p>	
Within RA			
			
Soft substrate leading to BH29 may pose mobilisation issues		<p><u>Dominant plant species alongside track</u></p> <p>Silverback <i>Rhodamnia cinerea</i>, <i>Elaeocarpus masterii</i>- Used as food sources for animals. Also Shrubs/ Herb: <i>Anisophyllea disticha</i>; <i>Clidemia hirta</i>, <i>Dicranopteris linearis</i>, <i>Caryota mitis</i>.</p> <p><u>Plant species of conservation interest</u></p> <p><i>Aquilaria malaccensis</i> (VU/RDB; VU/ IUCN) x2 individuals on left of path (facing east) and numerous seedlings on left side of path between BH28 and BH29 (facing east).</p> <p><u>Animal species of conservation interest</u></p> <p>Red Junglefowl <i>Gallus gallus</i> x 2 (EN/RDB; LC/IUCN)</p> <p><u>Animal species observed</u></p> <p>Yellow-vented Bulbul (<i>Pycnonotus goiavier</i>)</p> <p><u>In the vicinity</u></p> <p><u>Plant species of conservation interest:</u> <i>Aquilaria malaccensis</i> seedlings located between BH28 and BH29</p> <p><u>Animal species of conservation interest:</u> None recorded</p> <p><u>Other information</u></p> <p>Exposed roots observed on ground.</p>	
Ecology & Biodiversity Sensitivity Rating			
Terrestrial Habitats, Flora & Fauna		Aquatic Habitats, Flora & Fauna	
Protected Areas			
High		Borehole outside stream/ wetland buffer zone	
		High	

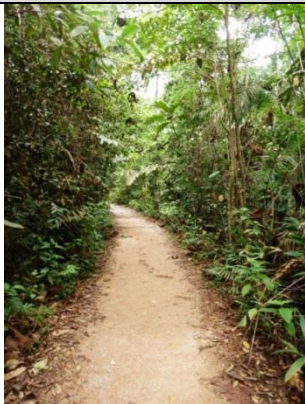


Borehole ID & Photograph of Location		Physical and Ecological observations for proposed borehole locations & their vicinity within CCNR for alignment option 1	
BH30		At proposed borehole location	
<div><p>The edge of RA and DA, on the Bukit Kalang Service Reservoir Road</p><p>PUB cable marker</p></div>		<p>Located on Bukit Kalang Service Reservoir Road</p> <p><u>Site</u>: Plants are either part of the TERENTANG Trail forest fringe with a grassy buffer verge of around 2.5-3.5 m separation from Kalang Service Reservoir Road (which is an approximately 3 m wide tarmacked road as per pictures), or located within the fenced off Service Reservoir compound.</p> <p><u>Gradient</u>: Downwards incline (in east direction)</p> <p><u>Dominant plant species alongside road</u> <i>Cinnamomum iners</i>, <i>Syzygium chloranthum</i>. Also Shrubs/ Herb: Grass dominated banks with <i>Clidemia hirta</i> (exotic species), <i>Tetracera indica</i>, <i>Melastoma malabathricum</i>, <i>Nephelium cuspidatum</i>.</p> <p><u>Plant species of conservation interest</u> <i>Cratoxylum cochinchinense</i> (EN/RDB; LC/ IUCN), <i>Nephelium cuspidatum</i> (EN/RDB).</p> <p><u>Animal species of conservation interest</u> None recorded</p> <p><u>Animal species observed</u> Birds included Chestnut-bellied Malkoha (<i>Phaenicophaeus sumatranus</i>), Asian Palm Swift (<i>Cypsiurus balasienensis</i>), Germain's Swiftlet (<i>Aerodramus germani</i>), White-vented Myna (<i>Acridotheres javanicus</i>) and sunbirds and flowerpeckers foraging</p> <p><u>In the vicinity</u></p> <p><u>Plant species of conservation interest</u> None recorded</p> <p><u>Animal species of conservation interest</u> None recorded</p> <p><u>Other information</u> There is an open drain leading towards Island Club Road; uncertain final destination of water in drain. Also a PUB cable located underground as per marker in the ground.</p>	
Ecology & Biodiversity Sensitivity Rating			
Terrestrial Habitats, Flora & Fauna		Aquatic Habitats, Flora & Fauna	Protected Areas
High		Borehole outside stream/ wetland buffer zone	High





Borehole ID & Photograph of Location		Physical and Ecological observations for proposed borehole locations & their vicinity within CCNR for alignment option 1	
BH31		At proposed borehole location	
<div><p>The edge of RA and DA, on the Bukit Kalang Service Reservoir Road</p><div><p>Underground utilities marker</p></div></div>		<p>Located on Bukit Kalang Service Reservoir Road_</p> <p><u>Site</u>: Plants are either part of the TERENTANG Trail forest fringe with a grassy buffer verge of around 2.0-3.5 m separation from Kalang Service Reservoir Road (which is an approximately 3 m wide tarmacked road as per pictures), or located within the fenced off Service Reservoir compound.</p> <p><u>Gradient</u>: Downwards incline (in east direction)</p> <p><u>Dominant plant species alongside road</u> <i>Caryota mitis</i>, <i>Cinnamomum iners</i>, <i>Gymnacranthera forbesii</i>, <i>Rhodamnia cinerea</i>, <i>Melastoma malabathricum</i>. Also Shrubs/ Herb: Grass dominated banks with <i>Clidemia hirta</i> (exotic species), <i>Tetracera indica</i>. <i>Nephelium cuspidatum</i></p> <p><u>Plant species of conservation interest</u> <i>Syzygium incarnatum</i> (EN/RDB), <i>Nephelium cuspidatum</i> (EN/RDB).</p> <p><u>Animal species of conservation interest</u> None recorded</p> <p><u>Animal species observed</u> Birds included Chestnut-bellied Malkohas (<i>Phaenicophaeus sumatranus</i>), White-vented Myna (<i>Acridotheres javanicus</i>), Asian Glossy Starling (<i>Aplonis panayensis</i>) and sunbirds and flowerpeckers foraging</p> <p><u>In the vicinity</u> <u>Plant species of conservation interest</u> None recorded</p> <p><u>Animal species of conservation interest</u> None recorded</p> <p><u>Other information</u> There is an open drain leading towards Island Club Road; uncertain final destination of water in drain. Also a sign in the ground indicating underground Water pipes, Sewer pipes, Electricity cables and Telecommunication cables.</p>	
Ecology & Biodiversity Sensitivity Rating			
Terrestrial Habitats, Flora & Fauna		Aquatic Habitats, Flora & Fauna	Protected Areas
High		Borehole outside stream/ wetland buffer zone	High

Borehole ID & Photograph of Location		Physical and Ecological observations for proposed borehole locations & their vicinity within CCNR for alignment option 1	
BH32		At proposed borehole location	
<div></div> <p><b>Just within Bukit Kalang Service Reservoir Area, a Developed Area (DA)</b></p>		<p>Located on Bukit Kalang Service Reservoir Road_</p> <p><u>Site</u>: Plants are either part of the TERENTANG Trail forest fringe with a grassy buffer verge of around 2.0-3.5 m separation from Kalang Service Reservoir Road (which is an approximately 3 m wide tarmacked road as per pictures), or located within the fenced off Service Reservoir compound.</p> <p><u>Gradient</u>: Downwards incline (in east direction)</p> <p><u>Plant species within compound</u></p> <p>Grass, <i>Swietenia macrophylla</i>, <i>Filicium decipens</i></p> <p><u>Plant species of conservation interest</u></p> <p>None recorded</p> <p><u>Animal species of conservation interest</u></p> <p>None recorded</p> <p><u>Animal species observed</u></p> <p>Dragonfly breeding (in adjacent concrete drain). Birds included Scaly Breasted Munias (<i>Lonchura punctulata</i>) spotted foraging within compound at grassy areas and Black-naped Oriole (<i>Oriolus chinensis</i>), Asian Glossy Starling (<i>Aplonis panayensis</i>).</p> <p><u>In the vicinity</u></p> <p><u>Plant species of conservation interest</u></p> <p><i>Glochidion arborescens</i> (CR/RDB), <i>Syzygium incarnatum</i> (EN/RDB) but these are located at</p> <p><u>Animal species of conservation interest</u></p> <p>None recorded</p> <p><u>Other information</u></p> <p>There is an open drain leading towards Island Club Road; uncertain final destination of water in drain. Also a sign in the ground indicating underground Water pipes, Sewer pipes, Electricity cables and Telecommunication cables.</p>	
Ecology & Biodiversity Sensitivity Rating			
Terrestrial Habitats, Flora & Fauna		Aquatic Habitats, Flora & Fauna	Protected Areas
High		Borehole outside stream/ wetland buffer zone	High






Borehole ID & Photograph of Location		Physical and Ecological observations for proposed borehole locations & their vicinity within CCNR for alignment option 1			
BH33		At proposed borehole location			
<div><p>The edge of R and DA, on the Bukit Kalang Service Reservoir Road</p><p>Nearby underground utilities marker</p></div>		<p>Located on Bukit Kalang Service Reservoir Road</p> <p><u>Site</u>: Plants are either part of the TERENTANG Trail forest fringe with a grassy buffer verge of around 2.0-3.5 m separation from Kalang Service Reservoir Road (which is an approximately 3 m wide tarmacked road as per pictures), or located within the fenced off Service Reservoir compound.</p> <p><u>Gradient</u>: Downwards incline (in east direction)</p> <p><u>Dominant plant species alongside track</u> <i>Caryota mitis</i>, <i>Cinnamomum iners</i>, <i>Gymnacranthera forbesii</i>, <i>Rhodamnia cinerea</i>, <i>Melastoma malabathricum</i>. Also Shrubs/ Herb: Grass dominated</p> <p><u>Plant species of conservation interest</u> <i>Syzygium incarnatum</i> (EN/RDB)</p> <p><u>Animal species of conservation interest</u> None recorded</p> <p><u>Animal species observed</u> Sunbirds and flowerpeckers foraging in addition to Chestnut-bellied Malkoha (<i>Phaenicophaeus sumatranus</i>), Asian Palm Swift (<i>Cypsiurus balasensis</i>), Germain's Swiftlet (<i>Aerodramus germani</i>), Collard Kingfisher (<i>Todiramphus chloris</i>), Pacific Swallow (<i>Hirundo tahitica</i>), Dark-necked Tailorbird (<i>Orthotomus atrogularis</i>), Olive-backed Sunbird (<i>Cinnyris jugularis</i>), Brown-throated Sunbird (<i>Anthreptes malacensis</i>). A juvenile Striped Tit-babbler (<i>Macronous gularis</i>), was observed here in June '15 confirming breeding of this species in the area.</p> <p><u>In the vicinity</u> <u>Plant species of conservation interest</u>: None recorded</p> <p><u>Animal species of conservation interest</u>: None recorded</p> <p><u>Other information</u> There is an open drain leading towards Island Club Road; uncertain final destination of water in drain. Also a sign in the ground indicating underground utilities.</p>			
Ecology & Biodiversity Sensitivity Rating					
Terrestrial Habitats, Flora & Fauna		Aquatic Habitats, Flora & Fauna		Protected Areas	
High		Borehole outside stream/ wetland buffer zone		High	

Borehole ID & Photograph of Location		Physical and Ecological observations for proposed borehole locations & their vicinity within CCNR for alignment option 1	
BH34		At proposed borehole location	
		<p><u>Trail:</u> Soft substrate/ground section of the TERENTANG Trail. Approximately 2.2 m wide. Vegetation around 3.5-5m at lower points. Trail between BH34 and entrance to TERENTANG Trail is 2-2.3 m wide.</p> <p><u>Gradient:</u> Flat</p> <p><u>Dominant plant species alongside track</u> <i>Caryota mitis</i> (at least 5 individuals located on right side of path facing east, all fruiting), <i>Prunus arborea</i> (CR/RDB), <i>Artocarpus elasticus</i>, <i>Fissistigma</i> sp. climber. Also Shrubs/ Herb: Grass and weed dominated banks with <i>Clidemia hirta</i> (exotic species), <i>Anisophyllea disticha</i>, <i>Lygodium</i> sp.</p> <p><u>Other Plant species of conservation interest</u> <i>Alstonia spatulata</i> (VU/RDB;LC/IUCN), <i>Alstonia angustifolia</i> (LC/IUCN), <i>Bhesa paniculata</i> (LC/IUCN), <i>Lophopetalum multinervium</i> (EN/RDB), <i>Ficus aurata</i> (VU/RDB)</p> <p><u>Animal species of conservation interest</u> Hill Myna (<i>Gracula religiosa</i>) (CITES-II), Clouded monitor (<i>Varanus nebulosus</i>) (CITES-I)</p> <p><u>Animal species observed</u> Birds included Emerald dove (<i>Chalcophaps indica</i>), Sunda Scops-owl (<i>Otus lempiji</i>), Large-tailed Nightjar (<i>Caprimulgus macrurus</i>), Black-naped Oriole (<i>Oriolus chinensis</i>). Also Plantain squirrel (<i>Callosciurus notatus</i>).</p> <p><u>In the vicinity</u> <u>Plant species of conservation interest</u> None recorded</p> <p><u>Animal species of conservation interest</u> Red Junglefowl (<i>Gallus gallus</i>) (EN/RDB; LC/IUCN) 80 m away, near entrance of the TERENTANG Trial</p> <p><u>Other information</u> Dead logs surrounding trail may provide conducive environment for herpetofauna and invertebrates.</p>	
Within RA			
			
Many <i>Caryota mitis</i>			
			
Rotting logs			
Ecology & Biodiversity Sensitivity Rating			
Terrestrial Habitats, Flora & Fauna		Aquatic Habitats, Flora & Fauna	
Protected Areas			
High		Borehole outside stream/ wetland buffer zone	
		High	

Borehole ID & Photograph of Location		Physical and Ecological observations for proposed borehole locations within and in the vicinity of CCNR, for alignment option 1
BH02, BH03, BH04, BH05, BH06, BH07, BH09 & BH11		Boreholes grouped due to their close proximity and with same habitat nature and similar environment.
<p><b>All within RA</b></p>  <p>Looking along Sime Trail from south to RH turn where <b>BH02</b> is located</p>  <p>Trail at <b>BH03</b></p>  <p>Trail at <b>BH05</b></p>  <p>Bamboo clutch near <b>BH04, BH05</b></p>		<p><b>In the vicinity of the proposed borehole locations</b></p> <p>Along main Sime Trail.</p> <p><u>Site</u>: Gravel/paved section of the SIME track. Approximately 2 m wide track that can be accessed via a 2 m tarmac road, from Bukit Golf Course.</p> <p><u>Gradient</u>: Flat</p> <p><u>Dominant plant species alongside track</u>  <i>Hevea brasiliensis</i>, <i>Elaeis guineensis</i>, <i>Cinnamomum iners</i>, <i>Costus speciosus</i>, <i>Leea indica</i>, <i>Dracaena</i> sp., <i>Piper</i> sp. climber, various species of grass</p> <p><u>Plant species of conservation interest</u>  <i>Ficus lamponga</i> (CR/RDB) near BH11 approximately 5 m north, <i>Aquilaria malaccensis</i> (VU/IUCN; VU/RDB) in Regeneration Forest Alocated approximately 5-10 m away from BH09 and BH11.</p> <p><u>Animal species of conservation interest recorded within 100m</u> Long-tailed Macaque (<i>Macaca fascicularis</i>) (CITES-II), Lesser Mousedeer (<i>Tragulus kanchil</i>), Barking Deer (<i>Muntiacus muntjac</i>) recorded by Camera Trap (ID: CCNR10) located approximately 85 m away from BH01, Hill Myna (<i>Gracula religiosa</i>) (CITES-II) foraging at BH02.</p> <p>Anecdotal evidence of Sunda Pangolin (<i>Manis javanica</i>) (CR/IUCN; CR/RDB; CITES-II) foraging at Bukit Golf Course which is located approximately 60m from BH11 at its closest point and 250 m away at the farthest point away from these boreholes.</p> <p><u>Other animal species observed</u>  Birds including Olive-winged Bulbul (<i>Pycnonotus plumosus</i>), Dark necked tailorbird (<i>Orthotomus atrogularis</i>), Black-naped Oriole (<i>Oriolus chinensis</i>), Striped Tit-babbler (<i>Macronous gularis</i>), Square-tailed Drongo-Cuckoo (<i>Surniculus lugubris</i>) with calls near BH06 indicating possible breeding in the area, Greater racket-tailed Drongo (<i>Dicrurus paradiseus</i>)</p> <p><u>Other information</u>  Bamboo clutch at BH04, BH05 (on Left side of track, facing east). Several butterflies observed at large patch of ginger at initial stretch of access road. The small shrub species <i>Leea indica</i> was also observed near BH04 and BH05 (and BH01) was also observed to attract several butterflies, bees and wasps. A body of water is located near the initial stretch of access road, approximately 15-20 m away from the trail towards the PIE.</p>
<b>Ecology &amp; Biodiversity Sensitivity Rating</b>		
<b>Terrestrial Habitats, Flora &amp; Fauna</b>	<b>Aquatic Habitats, Flora &amp; Fauna</b>	<b>Protected Areas</b>
High	Borehole outside stream/ wetland buffer zone	High, located within NParks Managed Area



Borehole ID & Photograph of Location		Physical and Ecological observations for proposed borehole locations within and in the vicinity of CCNR, for alignment option 1	
BH08, BH10, BH12, BH13,BH14, BH15, BH16, BH17, BH18, BH19		Boreholes grouped due to their close proximity and with same habitat nature and similar environment.	
<b>All within Golf Course</b>  BH10  BH12  BH13  BH14  BH15		<b><u>In the vicinity of the proposed boreholes locations</u></b> At Bukit Golf Course, either located on the fairway or just adjacent to the edge of the forested area continuous with MacRitchie forest. <u>Site:</u> Bare ground covered with grass that is regularly mowed. Mature trees scatter the perimeters of the fairways. <u>Gradient:</u> Flat at some parts to slightly undulating.  <u>Dominant plant species</u> <i>Dillenia suffruticosa</i> -dominated edge of forested area. Scattered trees comprised of a variety of species, largely <i>Cinnamomum verum</i> and <i>Fagraea fragrans</i> . <u>Plant species of conservation interest:</u> None recorded.  <u>Animal species of conservation interest recorded within 100m</u> Based on anecdotal evidence, golf boundary is foraging area for Sunda Pangolin ( <i>Manis javanica</i> ) (CR/RDB; CR/IUCN; CITES-II). White-rumped Shama ( <i>Copsychus malabaricus</i> ) (CR[EN]/RDB; LC, IUCN)near BH12. <u>Other animal species observed</u> Long Tailed Macaque ( <i>Macaca fascicularis</i> ), Collared Kingfisher ( <i>Todiramphus chloris</i> ), Common Flameback ( <i>Dinopium javanense</i> ), Long-tailed Parakeet ( <i>Psittacula longicauda</i> ), Striped Tit-babbler ( <i>Macronous gularis</i> ), Cream-vented Bulbul ( <i>Pycnonotus simplex</i> ), Lineated Barbet ( <i>Megalaima lineata</i> ), Pink-necked Green Pigeon ( <i>Treron vernans</i> ) and Large-tailed Nightjar ( <i>Caprimulgus macrurus</i> ) observed resting on fairways at night. A juvenile Banded Woodpecker ( <i>Chrysophlegma miniaceum</i> ) also observed near BH12.  <u>Other information</u> It is noted that all trees within the Golf Course are mature individuals that have been tagged for conservation.   BH16  BH17  BH18  BH19	
<b><u>Ecology &amp; Biodiversity Sensitivity Rating</u></b>			
<b>Terrestrial Habitats, Flora &amp; Fauna</b>		<b>Aquatic Habitats, Flora &amp; Fauna</b>	
High		Borehole outside stream/ wetland buffer zone	
		<b>Protected Areas</b>	
		Located outside CCNR or NParks Managed Area but at habitat extended from CCNR	

Borehole ID & Photograph of Location		Physical and Ecological observations for proposed borehole locations & their vicinity within CCNR for alignment option 1	
BH35, BH36 & BH37		Boreholes grouped due to their close proximity and with same habitat nature and similar environment	
		<b><u>In the vicinity of the proposed borehole locations</u></b> <u>Trail</u> : Section of Venus Trail Link ranging from bare to cobbled ground. Approximately 2.0-2.2 m wide at most parts but path leading to/from BH 35 is narrower at 1.9m due to presence of trees directly at edge of trail. <u>Gradient</u> : Flat at BH 36 and BH 37 but BH 35 is situated at a gradient sloping upwards towards the intersection of MacRitchie Nature Trail and Venus Trail Link.	
BH35		<u>Dominant plant species alongside track</u> <i>Caryota mitis</i> (at least 5 individuals located on right side of path facing east, all fruiting), <i>Rhodamnia cinerea</i> , <i>Hevea brasiliensis</i> , some patches of <i>Oncosperma tigillaria</i> . Also Shrubs/ Herb: Grass dominated banks with <i>Clidemia hirta</i> (exotic species) and <i>Dicranopteris linearis</i>	
		<u>Plant species of conservation interest</u> Two individuals of <i>Cratoxylum formosum</i> (EN/RDB). <i>Aquilaria malaccensis</i> (VU/IUCN; VU/RDB) located approximately 20 m east of BH 35, 10 m away from the trail edge	
BH36		<u>Animal species of conservation interest</u> Blue-crowned Hanging Parrot ( <i>Loriculus galgulus</i> ) (EN/RDB) observed on palm tree at Island Golf Course, located approximately 10 m away from trail where Boreholes are situated. Hill Myna ( <i>Gracula religiosa</i> ) (CITES-II), Clouded monitor ( <i>Varanus nebulosus</i> ) (CITES-I)	
		<u>Other animal species observed</u> Emerald dove ( <i>Chalcophaps indica</i> ); Greater racket-tailed Drongo ( <i>Dicrurus paradiseus</i> ), Olive-winged Bulbul ( <i>Pycnonotus plumosus</i> ), Yellow-vented Bulbul ( <i>Pycnonotus goiavier</i> ), Red-whiskered Bulbul ( <i>Pycnonotus jocosus</i> ), Dark-necked Tailorbird ( <i>Orthotomus atrogularis</i> ), Purple throated sunbird ( <i>Leptocoma brasiliana</i> ), Orange Bellied Flowerpecker ( <i>Dicaeum trigonostigma</i> ), Sunda Scops-owl ( <i>Otus lempiji</i> ), Large-tailed Nightjar ( <i>Caprimulgus macrurus</i> ), Black-naped Oriole ( <i>Oriolus chinensis</i> ), Asian Glossy Starling ( <i>Aplonis panayensis</i> ) and Asian Palm Swift ( <i>Cypsiurus balasiensis</i> ), Germain's Swiftlet ( <i>Aerodramus germani</i> ), Pacific Swallow ( <i>Hirundo tahitica</i> ), Arctic warbler ( <i>Phylloscopus borealis</i> ) all flying overhead. Striped Tit-babbler ( <i>Macronous gularis</i> ) juvenile observed near BH35. Plantain squirrel ( <i>Callosciurus notatus</i> )	
BH37		<u>Other information</u> No other key information	
<b><u>Ecology &amp; Biodiversity Sensitivity Rating</u></b>			
<b>Terrestrial Habitats, Flora &amp; Fauna</b>		<b>Aquatic Habitats, Flora &amp; Fauna</b>	<b>Protected Areas</b>
High		Borehole outside stream/ wetland buffer zone	Located outside CCNR or NParks Managed Area but at habitat extended from CCNR

**ERM has over 137 offices  
Across the following  
countries worldwide**

Argentina	Netherlands
Australia	Peru
Belgium	Poland
Brazil	Portugal
China	Puerto Rico
France	Singapore
Germany	Spain
Hong Kong	Sweden
Hungary	Taiwan
India	Thailand
Indonesia	UK
Ireland	USA
Italy	Venezuela
Japan	Vietnam
Korea	
Malaysia	
Mexico	

**ERM's Singapore Office**

120 Robinson Road #10-01,  
Singapore 068913  
T: +65 6324 9636  
F: +65 6226 1636

[www.erm.com](http://www.erm.com)