



# **SPECIALIST CONSULTANCY SERVICES FOR ENVIRONMENTAL IMPACT ASSESSMENT (EIA) AT BUKIT BATOK**

## **Final EIA Report**

14 May 2025

Intended for  
**National Parks Board**

Document type  
**TAC/23123/Final EIA Report**

Submitted by



**TEMBUSU**

Asia

Description Final Environmental Impact Assessment for Specialist Consultancy Services for Environmental Impact Assessment (EIA) at Bukit Batok

Project Ref TAC/23123

Rev No	Date	Description	Prepared by	Checked by	Approved by
00	04/04/2025	Issued for submission to Client	AC, JYW, TK, LS	SP	SCT
01	14/05/2025	Amended as per comments received	AC	JYW	SCT

**TEMBUSU Asia Consulting Pte Ltd**

1 Commonwealth Lane #06-06

One Commonwealth Building

Singapore 149544

T +65 6238 4009

F +65 6570 5254

Co. Reg. No. 201732581C

*Disclaimer: The document is strictly confidential and may only be used for the purpose for which it was commissioned. This document is not to be used, copied, or transferred to any other party without written authorisation from TEMBUSU Asia Consulting Pte Ltd.*

## CONTENT

<b>ABBREVIATIONS</b> .....	<b>9</b>
<b>GLOSSARY</b> .....	<b>11</b>
<b>EXECUTIVE SUMMARY</b> .....	<b>13</b>
<b>1 INTRODUCTION</b> .....	<b>19</b>
1.1 Objectives of the Environmental Impact Assessment Report .....	20
1.2 Report Structure .....	20
1.3 Limitations of the Environmental Impact Assessment Report.....	21
<b>2 DESKTOP STUDY</b> .....	<b>22</b>
2.1 Historical Land Use.....	22
2.2 Flora Biodiversity Literature Review .....	25
2.3 Fauna Biodiversity Literature Review .....	25
2.4 Ecological Connectivity .....	26
<b>3 PROJECT OVERVIEW</b> .....	<b>27</b>
3.1 Overview of Development Works .....	27
3.2 Project Activities .....	27
<b>4 EIA APPROACH</b> .....	<b>28</b>
4.1 Singapore’s EIA Context.....	28
4.2 EIA Scope.....	28
4.3 Environmental Legislations, Regulations and Guidelines .....	29
4.4 Environmental Aspects .....	30
4.5 Identification of Sensitive Receptors .....	30
4.6 Impact Assessment Methodology .....	30
<b>5 BIODIVERSITY</b> .....	<b>34</b>
5.1 Conventions.....	34
5.2 Baseline Survey Methodology.....	37
5.3 Flora Survey Baseline Results .....	46
5.4 Fauna Survey Baseline Surveys .....	56
5.5 Discussion on Biodiversity Findings .....	68
5.6 Areas of Ecological Value .....	70
5.7 Impact Assessment.....	76
<b>6 Surface Water Quality</b> .....	<b>95</b>
6.1 Relevant Environmental Legislation, Guidelines, and Standards.....	95

6.2	Surface Water Quality .....	96
6.3	Results and Discussion of Water Quality Findings .....	99
6.4	Impact Assessment.....	104
<b>7</b>	<b>ENVIRONMENTAL MANAGEMENT AND MONITORING PLAN.....</b>	<b>111</b>
7.1	Overview.....	111
7.2	Construction EMMP.....	111
7.3	EMMP Team.....	112
7.4	Environmental Objectives .....	113
7.5	Training requirements .....	113
7.6	Environmental Emergency Response Procedure.....	114
7.7	EMMP Reporting and Documentation .....	115
7.8	Wildlife Management Plan .....	116
7.9	Flora Management Plan.....	128
7.10	Lighting Management Plan (LMP) .....	133
7.11	Biodiversity Monitoring Requirements .....	133
<b>8</b>	<b>CONCLUSION.....</b>	<b>139</b>
<b>9</b>	<b>REFERENCES .....</b>	<b>140</b>
	<b>APPENDIX A List of Plant Species Recorded at Study Area.....</b>	<b>A</b>
	<b>APPENDIX B Photographs of Plants Observed at Study Area.....</b>	<b>B</b>
	<b>APPENDIX C List of Fauna Species Recorded at Study Area .....</b>	<b>C</b>
	<b>APPENDIX D Photographs of Animals Observed at Study Area.....</b>	<b>D</b>
	<b>APPENDIX E Surface Water Quality Laboratory Test Report.....</b>	<b>E</b>
	<b>APPENDIX F Arborist Assessment Matrix .....</b>	<b>F</b>

## FIGURES

Figure 1-1. Study Area and Proposed Land Use of Project Area as shown on URA's gazetted Master Plan 2019.....	13
Figure 1-2. Locally threatened fauna species found in the study area.....	15
Figure 1-3. AHEV in the Study Area.....	16
Figure 1-4 Proposed Retained Area (PRA).....	17
Figure 1-1. Study Area and Proposed Land Use of Project Area as shown on URA's gazetted Master Plan 2019.....	19
Figure 2-1. Historical maps showing Study Area and its vicinity, from years 1945, 1966, 1969 and 1983.....	22
Figure 2-2. Historical maps showing Study Area and its vicinity, from years 1987, 1993, 2005 and 2010.....	23
Figure 2-3. Parks, nature parks and nature reserves connected by the BBNC that are in proximity to the Study Area.....	26
Figure 5-1. Flora survey area.....	37
Figure 5-2. Locations of transects for terrestrial fauna surveys.....	42
Figure 5-3. Locations of points for terrestrial fauna surveys.....	43
Figure 5-4. Locations of camera traps deployed within the Study Area.....	44
Figure 5-5. Example of a camera trap setup.....	45
Figure 5-6 Habitat map.....	47
Figure 5-7. Representative photos of habitat types in Study Area. A: Native-dominated young secondary forest; B: Abandoned kampung; C: Urban vegetation; D: Scrubland.....	48
Figure 5-8 Flora species of conservation significance. A: <i>Ficus glandulifera</i> ; B: <i>Ficus vasculosa</i> ; C: <i>Macaranga griffithiana</i> ; D: <i>Glochidion zeylanicum</i> var. <i>zeylanicum</i> .....	51
Figure 5-9. Spatial distribution of flora species of CR, EN and VU conservation statuses likely of native regeneration, further categorised by trees and climbers/shrubs.....	51
Figure 5-10. Spatial distribution of keystone flora species.....	52
Figure 5-11. Spatial distribution of large trees according to local conservation status.....	53
Figure 5-12. Examples of tree structural defects. A: Decay at tree base; B: Previous failure wound; C: Fruiting body; D: Multiple attachments.....	54
Figure 5-13. Trees recommended to be retained. A: <i>Ficus glandulifera</i> ; B: <i>Ficus vasculosa</i> .....	55
Figure 5-14. Spatial distribution of large trees according to VTA recommendations.....	56
Figure 5-15. Birds recorded in the Study Area. A: Greater racket-tailed drongo ( <i>Dicrurus paradiseus</i> ); B: Olive-winged bulbul ( <i>Pycnonotus plumosus</i> ).....	57
Figure 5-16. Birds recorded in open areas of maintained turf. A: Paddyfield pipit ( <i>Anthus rufulus</i> ); B: Scaly-breasted munia ( <i>Lonchura punctulata</i> ).....	58
Figure 5-17. Spectrogram showing the acoustic call characteristics of <i>Saccolaimus saccolaimus</i> .....	59
Figure 5-18. Spectrogram showing the acoustic call characteristics of <i>Pipistrellus stenopterus</i> .....	59
Figure 5-19. Spectrogram showing the acoustic call characteristics of <i>Taphozous melanopogon</i> .....	60
Figure 5-20. Spectrogram showing the acoustic call characteristics of <i>Myotis muricola</i> .....	60
Figure 5-21. Spectrogram showing the acoustic call characteristics of <i>Scotophilus kuhlii</i> .....	60
Figure 5-22. Reptiles recorded in Study Area. A: Green crested lizard ( <i>Bronchocela cristatella</i> ); B: Painted bronzeback ( <i>Dendrelaphis pictus</i> ).....	61
Figure 5-23. Non-native amphibians recorded in Study Area. A: Greenhouse frog.....	

( <i>Eleutherodactylus planirostris</i> ); B: Banded bullfrog ( <i>Kaloula pulchra</i> ). .....	62
Figure 5-24. Larval forms of amphibians found in ephemeral water puddles. A: Banded bullfrog ( <i>Kaloula pulchra</i> ); B: Dark-sided chorus frog ( <i>Microhyla heymonsi</i> ). .....	63
Figure 5-25. Ephemeral water puddles in simpoh air ( <i>Dillenia suffruticosa</i> ) cluster .....	63
Figure 5-26. Harlequin ( <i>Taxila haquinus haquinus</i> ) adult male. ....	64
Figure 5-27. Forest-dependent odonata observed in the Study Area. A–B: spear-tailed duskhawker ( <i>Gynacantha dohrni</i> ) adult female; C: red-tailed sprite ( <i>Teinobasis ruficollis</i> ) adult male. ....	65
Figure 5-28 Organisms found in an ephemeral water puddle. A: Larval odonate; B: Malayan trumpet snail ( <i>Melanoides tuberculata</i> ) .....	66
Figure 5-29 A: Common emerald dove ( <i>Chalcophaps indica</i> ); B: Sunda scops owl ( <i>Otus lempiji</i> ) .....	68
Figure 5-30 Locally threatened fauna species found in the Study Area .....	70
Figure 5-31. Map of the BBNC, with location of Study Area marked by a red star .....	71
Figure 5-32 AHEV in the Study Area .....	71
Figure 5-33 Location of Tengah North RAC relative to Zone A of the AHEV .....	72
Figure 5-34 Location of Bukit Gombak Park and CCKPC relative to Zone B of the AHEV ...	73
Figure 5-35 Location of Tengah North RAC relative to Zone C of the AHEV .....	74
Figure 5-36 Proposed PRA, proposed trees to retain and complementary planting area.....	75
Figure 5-37 Fauna-attracting shrubs to be considered for planting between streetscape trees. A: <i>Callicarpa longifolia</i> ; B: <i>Vitex trifolia</i> ; C: <i>Leea indica</i> ; D: <i>Tarennia fragrans</i> . A and C are species that naturally occur in the Study Area.....	82
Figure 5-38 Site conditions showing sparse canopy between streetscape trees. A–B: Bukit Batok Road; C–D: Bukit Batok West Avenue 5. ....	83
Figure 5-39 Planting style and density of CCKPC .....	84
Figure 5-40. Example of ideal light shielding .....	87
Figure 6-1. Locations of surface water quality sampling points.....	96
Figure 6-2. Photographs showing dry conditions with insufficient water for sampling .....	99
Figure 7-1 Environmental Incidence Reporting Flowchart .....	115
Figure 7-2 Trapping Programme Flowchart.....	119
Figure 7-3 Example of the permanent hoarding .....	122
Figure 7-4 Phased Clearance Layout.....	122
Figure 7-5 Example of clearance direction .....	123
Figure 7-6 Temporary Hoarding Along Cleared Areas.....	124
Figure 7-7 Permanent Hoarding After Completion of Clearance.....	124
Figure 7-8. Tree Protection Zone Diagram.....	130
Figure 7-9 Illustration of a notch cut .....	132

## TABLES

Table 1-1. Summary of key mitigation measures to be implemented.....	17
Table 1-2. Summary of impact assessment .....	18
Table 4-1. List of applicable Singapore legislations, regulations, and guidelines .....	29
Table 4-2. Overview of identified sensitive receptors.....	30
Table 4-3. List of parameters and respective scores assigned in RIAM method.....	32
Table 4-4. Description of the value of magnitudes in RIAM method .....	32
Table 4-5. List of ES range along with the degree of impact associated with each range....	33
Table 5-1. Local conservation status definitions for flora species in Singapore adapted from Lindsay, et al. (2022).....	35
Table 5-2. Conservation status for flora & fauna species & respective definitions, adapted from IUCN Red List (IUCN, 2024), SRDB3 (2024). .....	36
Table 5-3. Static parameters collected for the tiered census flora surveys .....	38
Table 5-4. Habitat types found within Singapore and general description of each habitat, modified from NParks' BIA Guidelines (2024) .....	39
Table 5-5. Survey timings, frequency, and methodology for each fauna taxonomic group. .	41
Table 5-6. Coordinates of the camera traps within Study Area.....	44
Table 5-7 Types of habitats by area and percentages of area.....	47
Table 5-8 Distribution of flora species found in the Study Area based on local conservation status .....	49
Table 5-9. Flora species of local conservation significance encountered within the Study Area and likely source of stock. Flora species classified under “Either of Native Regeneration or Cultivated Stock” can either be of native germplasm or from germplasm of cultivated stock	49
Table 5-10. Summary of Tree Health .....	55
Table 5-11. Summary of Tree Structure .....	55
Table 5-12. Summary of VTA recommendations.....	55
Table 5-13. Number of species recorded and species of local conservation significance per terrestrial fauna group.....	56
Table 5-14. List of all bird species of local and global conservation significance observed in the Study Area. ....	57
Table 5-15. Call structure summary of bat species recorded during acoustic sampling. ....	59
Table 5-16. List of butterfly species of conservation significance found in the Study Area...	64
Table 5-17. Number of detections for each species per camera trap.....	66
Table 5-18 Recommended native flora species to be included in the landscape design of the future development .....	81
Table 5-19. Environmental Scores of the identified impacts on site's biodiversity with corresponding mitigation measures for Study Area activities.....	91
Table 6-1. Coordinates of surface water quality sampling locations .....	97
Table 6-2. <i>In-situ</i> surface water quality parameters.....	97
Table 6-3 <i>Ex-situ</i> surface water quality parameters tested in the laboratory.....	97
Table 6-4. Results of surface water quality parameters tested <i>in-situ</i> .....	99
Table 6-5. Results of the surface water quality parameters analysed <i>ex-situ</i> .....	101
Table 6-6. Environmental Scores of the identified impacts on site's surface water quality with corresponding mitigation measures.....	108
Table 7-1. Roles and Responsibilities of EMMP Team Members .....	112
Table 7-2. Training programme for Site Personnel.....	114
Table 7-3. Monthly Environmental Performance Report Framework .....	116

Table 7-4 List of identified target species .....	118
Table 7-5 Wildlife response and rescue plan.....	125
Table 7-6 TPZ size required for different girth range .....	129
Table 7-7 Tree Replacement Ratio .....	130
Table 7-8 Parameters to take note during monthly tree inspections. ....	134
Table 7-9 Parameters to take note during for plants monitoring .....	135
Table 7-10 Recommended Environmental Monitoring Plan for construction phase .....	136
Table 8-1. Summary of impact assessment .....	139
Table 8-2. Summary of key mitigation measures to be implemented.....	139

## ABBREVIATIONS

Abbreviation	Definition
AHEV	Area of High Ecological Value
AMEV	Area of Moderate Ecological Value
BBNC	Bukit Batok Nature Corridor
BTNR	Bukit Timah Nature Reserve
CCKPC	Choa Chu Kang Park Connector
CCNR	Central Catchment Nature Reserve
CF	Constant frequency
CFU	Colony Forming Unit
CHE	Compensatory Habitat Enhancement
CITES	The Convention on International Trade in Endangered Species of Wild Fauna and Flora
EIA	Environmental Impact Assessment
EMMP	Environmental Management and Monitoring Plan
EQOs	Environmental Quality Objectives
FM	Frequency-modulated
GPS	Global Positioning System
ha	hectares
HDB	Housing & Development Board
hr	hour
HTNS	HomeTeamNS
Inc.	Incorporated
ISA	International Society of Arboriculture
IUCN	International Union for the Conservation of Nature
kHz	kilohertz
m	metre
mg/L	milligram per litre
mins	minutes
mL	millilitre
ms	milliseconds
n.d.	no date
NDYSF	Native-dominated Young Secondary Forest
NEA	National Environment Agency
NParks	National Parks Board
NTU	Nephelometric Turbidity Unit
PUB	Public Utilities Board
PRA	Proposed Retained Area
QCF	Quasi-constant frequency
RAC	Recommended Area of Conservation
s	seconds
SRDB3	3 <sup>rd</sup> edition Singapore Red Data Book
STC	Sound Transmission Class
μS/cm	microsiemens per centimeter
TAC	TEMBUSU Asia Consulting Pte Ltd

<b>Abbreviation</b>	<b>Definition</b>
URA	Urban Redevelopment Authority
VTA	Visual Tree Assessment
WAV	Waveform Audio File

## GLOSSARY

**Abundance:** The number of a single species recorded at any given time period or location.

**Biodiversity:** The variety of plant and animal life in the world, habitat or location, a high level of which is usually considered to be important and desirable. Biodiversity can be assessed at more focused taxonomic groups such as “bird biodiversity”, in which case it is interchangeably with “diversity”.

**Conservation Status:** A status given to a species that is threatened with becoming extinct either locally or globally. These species may be restricted to only a small area, show noticeable decline in abundance over time, or have a historically low global population size. Assessments can be made either at global level under the IUCN’s Red List of Threatened Species or at national level (e.g., Singapore’s Red Data Book of Threatened Plants and Animals).

**Ecology:** The pattern of relations between organisms and their environment.

**Edge Effect:** The effect of an abrupt transition between two quite different adjoining ecological communities on the numbers and kinds of organisms in the marginal habitat

**Fauna:** Referring to all animal life present in an area. Animals are defined as any species from the Kingdom Animalia.

**Flora:** Referring to all plant life present in an area. Plants are defined as any species from the Kingdom Plantae.

**Genus:** A taxonomic group above species. A genus consists of closely related species. For example, Grey Heron and Purple Heron are closely related species in the same genus *Ardea*, hence their scientific names are *Ardea cinerea* and *Ardea purpurea* respectively.

**Habitat:** The natural home or environment of an animal, plant, or other organisms.

**Herpetofauna:** A taxonomic sub-group that includes amphibians and reptiles.

**Impact:** Any positive or negative alteration of existing conditions caused directly or indirectly by the project.

**kHz (kilohertz):** A measure of frequency equivalent to 1,000 cycles per second. Human hearing may extend up to 20 kHz. Most bat calls are beyond 20 kHz, extending locally up to 245 in the case of *Kerivoula hardwickii*.

**Microclimate:** Local atmospheric zone where the climate differs from the surrounding area.

**Mitigation Measure:** Means to prevent, reduce, or control negative environmental effects of a project, and repair any damage to the environment caused by those effects through replacement, restoration, compensation, or any other means.

**Ms (milliseconds):** 1/1000 of a second. Duration of individual bat pulses typically range from 2 ms, in some species of *Myotis*, to more than 50 ms, in some local emballonurids such as *Saccolaimus saccolaimus*.

**Odonates:** A taxonomic sub-group of Insects that includes dragonflies and damselflies.

**Population:** The term population can be in reference to the total number of a species found in a given area (e.g., global population, or Singapore population). It is also used as a term to define distinct sub-sets of a species based on the level of inter-mixing. For example, an island may hold two populations of a species if there are two groups of the same species present and those groups are sufficiently prevented (geographically or behaviourally) from mixing, forming separate breeding populations.

**Species:** The standard classification of living organisms. It is defined as a group of living organisms consisting of similar individuals capable of exchanging genes or interbreeding. It is represented by the second word of the scientific name of an organism. For example, the scientific name of a long-tailed macaque is *Macaca fascicularis*, where *fascicularis* is its species name.

**Taxa:** In reference to a specific taxonomic group. In order of specificity, the taxonomic groups are Kingdom, Phylum, Class, Order, Family, Genus, Species.

**Transect:** A predefined line or belt along which observations and/or measurements are taken.

# EXECUTIVE SUMMARY

## Introduction

TEMBUSU Asia Consulting Pte Ltd ('TAC') has been commissioned by the National Parks Board (NParks) on behalf of the Housing & Development Board (HDB) to provide Specialist Consultancy Services for Environmental Impact Assessment (EIA) at Bukit Batok Neighbourhood 3 (hereafter referred to as the 'Project Area') (NParks/F/6/2023) (Figure 1-1). The EIA aims to understand the baseline environmental conditions and ecological connectivity of the approximately 5.5ha Study Area (dotted in yellow), in order to inform the ecological value of the site, which in turn will serve to guide detailed planning for the area. The Study Area is located on land zoned 'Residential' in URA's Master Plan since 2014. The rest of the Project Area of approximately 9ha (in red) is currently occupied by various interim uses, such as Bukit Batok Driving Centre, HomeTeamNS (HTNS) Golf Driving Range, HTNS Bukit Batok Clubhouse and a former Heavy Vehicle Park.



**Figure 1-1.** Study Area and Proposed Land Use of Project Area as shown on URA's gazetted Master Plan 2019

## Objectives of Environmental Impact Assessment

An Environmental Impact Assessment (EIA) was undertaken to assess the environmental impacts of the proposed development and building works, with the goal of providing clear and concise technical information of potential environmental impacts associated with the proposed work activities to facilitate management and decision-making processes.

The key objectives of this EIA are to:

- Understand and update the environmental baseline through the collection of primary and secondary data.
- Assess the impacts of the building works for the proposed development at Bukit Batok during the construction and operation phases of the project on the environment.
- Present appropriate mitigation measures to reduce the level of impact for each activity assessed that has a moderate to major impact.
- Recommend an environmental management framework to monitor the mitigation measures implementation.

It is understood that the information presented in the EIA report will contribute to decisions on:

- The overall acceptability of any environmental impacts that are likely to arise due to the construction of the proposed development at Bukit Batok.
- The conditions and requirements for the construction of the proposed development at Bukit Batok to mitigate any environmental impacts whenever practicable; and
- The acceptability of residual impacts after the proposed mitigation measures are implemented.

The undertaking of the EIA will therefore promote environmentally sound and sustainable development. The following environmental aspects are considered in this EIA study:

- Terrestrial Biodiversity
- Surface Water Quality

A summary of the main findings on the environmental aspects is provided below.

## Environmental Baseline Findings

### Desktop Study

A study was carried out for a site appreciation of the study area which focused on the historical land use of the study area, biodiversity and ecological connectivity. The site appreciation highlighted the ecological connectivity of the study area, which is located along the Bukit Batok Nature Corridor (BBNC), which aims to support the wider ecological connectivity between Tengah, Bukit Timah Nature Reserve (BTNR) and Central Catchment Nature Reserve (CCNR) (NParks, 2024). Due to the study area's location between Tengah Forest corridor and Bukit Gombak Park, it plays a role in supporting ecological connectivity of the area.

### Terrestrial Biodiversity

The terrestrial flora baseline survey recorded a total of 111 flora species – of which 82 were native, 27 were non-native, and two (2) species were uncertain in origin. 18 of the 20 total species of conservation significance were assessed to be at least partially of native regeneration. One (1) mature *Ficus glandulifera* tree was recommended to be retained within the Study Area.

The current study recorded a total of 117 terrestrial fauna species, mainly comprising of bird and butterfly species. Other mammal, reptile, amphibian and odonate species were found in smaller numbers (< 15 species). Three (3) species of local conservation significance were recorded – the straw-headed bulbul (*Pycnonotus zeylanicus*), Swinhoe’s white-eye (*Zosterops simplex*) and the Harlequin (*Taxila haquinus haquinus*) (Figure 1-2).

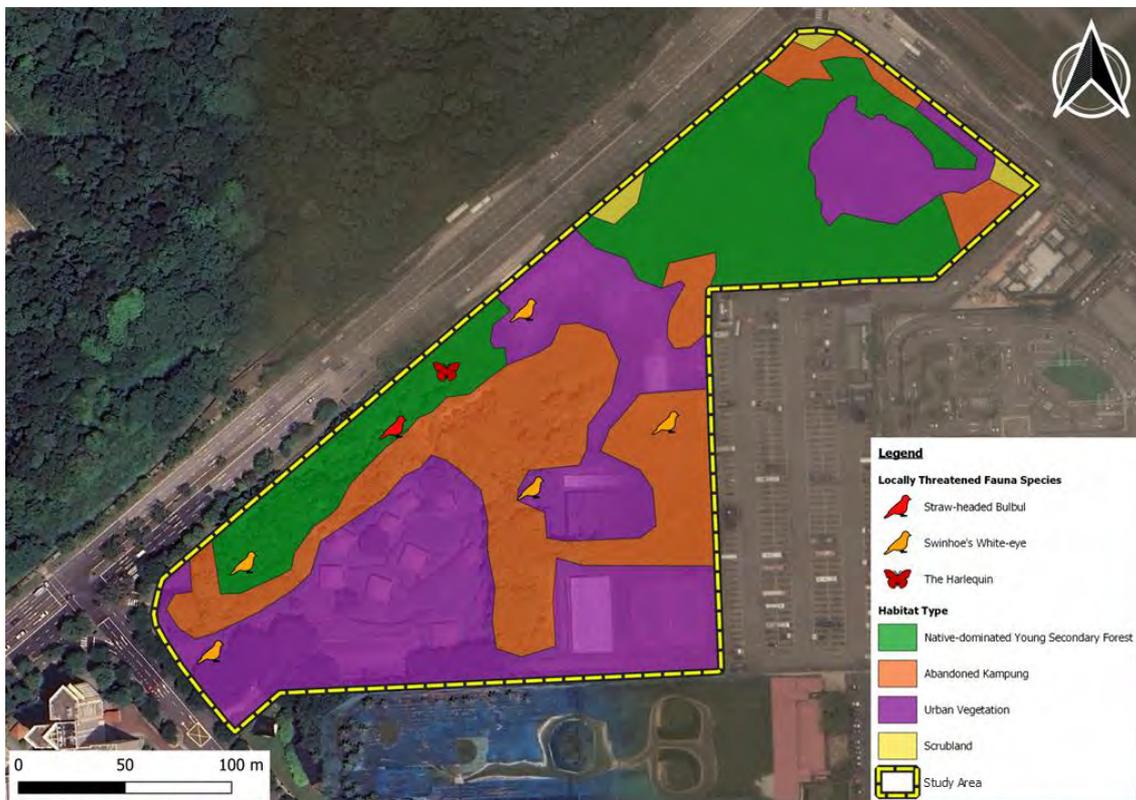


Figure 1-2. Locally threatened fauna species found in the study area

Integrating habitat mapping, flora and fauna survey findings, an Area of High Ecological Value (AHEV) within the Study Area consisting of native dominated secondary forests is identified.



**Figure 1-3. AHEV in the Study Area**

### **Surface Water Quality**

Three (3) surface water quality stations all stormwater drains, were identified and surveyed for the collection of baseline water quality within the Study Area. Overall, the findings of the current study are within the maximum permissible limits under the NEA *Allowable Limits for Trade Effluent Discharge to Watercourse or Controlled Watercourse*.

### **Recommended Key Mitigation Measures**

To reduce the environmental impact of the development, key mitigation measures on site include the establishment of proposed retained area (PRA) (Figure 1-4), compensatory planting along green buffer and streetscape areas incorporating fauna-attracting landscape planting palette with native flora species whenever possible. To reduce disturbance to biodiversity within the PRA from noise and light, measures such as installing noise barrier around the PRA, developing a Light Management Plan (LMP) and scheduling of heavy construction works. The full list of the recommended key mitigation measures is summarised in Table 1-1.



**Figure 1-4 Proposed Retained Area (PRA)**

**Table 1-1.** Summary of key mitigation measures to be implemented

Environmental aspect	Key mitigation measures
<b>Pre-Construction/ Construction Phase</b>	
<b>Biodiversity</b>	<ul style="list-style-type: none"> <li>Proposed retained area (PRA)</li> <li>Incorporate native plant species such as those recommended in Table 5-18 into planned landscape planting palette</li> <li>Phased/directional clearance of vegetation</li> <li>Implement Light Management Plan (LMP) if night works are necessary</li> <li>Install hoarding and noise barriers around the work site</li> <li>Physically tag trees to be retained and transplanted on site</li> <li>Establish Tree Protection Zones (TPZ) for trees to be retained</li> <li>Identify plants to be transplanted</li> <li>Ensure Pre-felling fauna inspection of trees and burrows</li> <li>As far as practicable, avoid the commencement of tree felling during the peak bird nesting period (February to July)</li> <li>Monitor tree and vegetation health regularly</li> <li>Conduct daily checks of ECM blankets and pits</li> <li>Ensure ECM blankets are made of biodegradable material with no plastic mesh netting</li> <li>Conduct biodiversity awareness trainings for workers</li> <li>Install 6m noise barrier along boundary of the PRA during all construction stages</li> </ul>
<b>Surface Water Quality</b>	<ul style="list-style-type: none"> <li>Implement PUB-approved ECM Plan Emergency spill kits to be present to handle any chemical spillages</li> </ul>
<b>Operation Phase</b>	
<b>Biodiversity</b>	<ul style="list-style-type: none"> <li>Establish green link through future development to facilitate volant fauna movement</li> <li>Proposed wildlife bridge and animal culvert</li> </ul>

## Summary of Impact Assessment

An overview of impact assessment for both construction and operational phases are summarised in Table 1-2.

**Table 1-2.** Summary of impact assessment

Environmental aspect	Impacts before mitigation	ES	Residual Impacts after mitigation	ES
<b>Pre-construction/Construction Phase</b>				
Biodiversity	Moderate Negative to Slight Negative	-108 to -14	Moderate Negative to Slight Positive	-81 to 9
Surface Water Quality	Slight Negative	-21 to -12	Slight Negative	-7
<b>Operation Phase</b>				
Biodiversity	Moderate Negative to Slight Positive	-81 to 27	Slight Negative to Slight Positive	-32 to 27

A Nature Group Engagement session was conducted on 20<sup>th</sup> November 2024 where the EIA findings were shared, and mitigation strategies were discussed.

# 1 INTRODUCTION

TEMBUSU Asia Consulting Pte Ltd (TAC) has been commissioned by the National Parks Board (NParks) on behalf of HDB to carry out an Environmental Impact Assessment (EIA) at Bukit Batok Neighbourhood 3 (hereafter referred to as the 'Project Area'). As part of the EIA, TAC has carried out a detailed baseline surveys of the existing environmental conditions (i.e., flora, fauna, surface water quality) and ecological connectivity of the approximately 5.5ha site (hereafter referred to as "Study Area" (dotted in yellow), so as to give clarity on planning and design considerations, as well as provide rationale to refine respective project plans. The Study Area is located on land zoned "Residential" in URA's Master Plan since 2014 and it is located within the HTNS Adventure Centre (Lot Number: MK10-04050N) (Figure 1-1). The rest of the Project Area of approximately 9ha (in red) is currently occupied by various interim uses, such as Bukit Batok Driving Centre, HomeTeamNS (HTNS) Golf Driving Range, HTNS Bukit Batok Clubhouse and a former Heavy Vehicle Park.



**Figure 1-1.** Study Area and Proposed Land Use of Project Area as shown on URA's gazetted Master Plan 2019

The Study Area is located within the Bukit Batok Nature Corridor (BBNC) and sits in close vicinity to large nature spaces such as Tengah Forest Corridor, Bukit Panjang Hill, Bukit Gombak Hill, Bukit Timah Nature Reserve (BTNR) and Central Catchment Nature Reserve (CCNR). This study aims to establish a baseline understanding of the ecological components through examination of flora, fauna, and water quality at the Study Area.

## 1.1 Objectives of the Environmental Impact Assessment Report

An Environmental Impact Assessment (EIA) was undertaken to assess the environmental impacts of the proposed development and building works.

The goal of the EIA is to provide clear and concise technical information of potential environmental impacts associated with the proposed work activities to facilitate management and decision-making processes.

The key objectives of this EIA are to:

- Understand and update the environmental baseline through the collection of primary and secondary data.
- Assess the impacts of the building works for the proposed development at Bukit Batok during the construction and operation phases of the project on the environment.
- Present appropriate mitigation measures to reduce the level of impact for each activity assessed that has a moderate to major impact.
- Recommend an environmental management framework to monitor the mitigation measures implementation.

It is understood that the information presented in the EIA report will contribute to decisions on:

- The overall acceptability of any environmental impacts that are likely to arise due to the construction of the proposed development at Bukit Batok.
- The conditions and requirements for the construction of the proposed development at Bukit Batok to mitigate any environmental impacts whenever practicable; and
- The acceptability of residual impacts after the proposed mitigation measures are implemented.

The undertaking of the EIA will therefore promote environmentally sound and sustainable development.

## 1.2 Report Structure

The EIA report is structured as follows:

- Chapter 1 introduces the project, the objectives of an EIA, report structure, and its limitations.
- Chapter 2 presents the findings of the desktop study of the Study Area
- Chapter 3 provides an overview of the project's development works, and construction activities associated with the proposed project.
- Chapter 4 outlines the EIA approach, including its scope, environmental aspects covered, sensitive receptors, and impact assessment methodology.
- Chapter 5 provides information on the baseline survey methodology, results, assesses impacts on biodiversity and proposes mitigation measures.
- Chapter 6 describes the baseline surface water quality survey methodology, results, the impacts in the project Study Area and proposes mitigation measures

on the impacts.

- Chapter 7 outlines the Environmental Management and Monitoring Plan framework
- Chapter 8 summarises the key findings of the project.
- Chapter 9 lists the references used in the report.

### **1.3 Limitations of the Environmental Impact Assessment Report**

The EIA is conducted in accordance with the requirements specified by HDB and NParks in the Invitation to Tender (ITT), and outcome of consultancy with the relevant Technical Agencies. The extent of collection of baseline data is guided by these requirements.

During the baseline surveys, there were limitations faced regarding the collection of surface water quality data due to the lack of sufficient water at all sampling point locations. As a result, sampling was carried out for only 1 dry weather event collection. Due to the elusive nature of certain fauna species, not all species present within the study can be observed during the baseline visual encounter surveys. To manage this limitation, the survey transects were strategically planned to ensure good coverage of the Study Area, and remote sensing and bioacoustics sampling were also carried out to supplement visual surveys. A desktop study on biodiversity was also conducted to collect secondary data thorough a review of publicly available literature.

In preparing this report, we relied, in whole or in part, on data and information provided by HDB, NParks and third parties, which have been assumed to be accurate, complete, and reliable as of the time of writing.

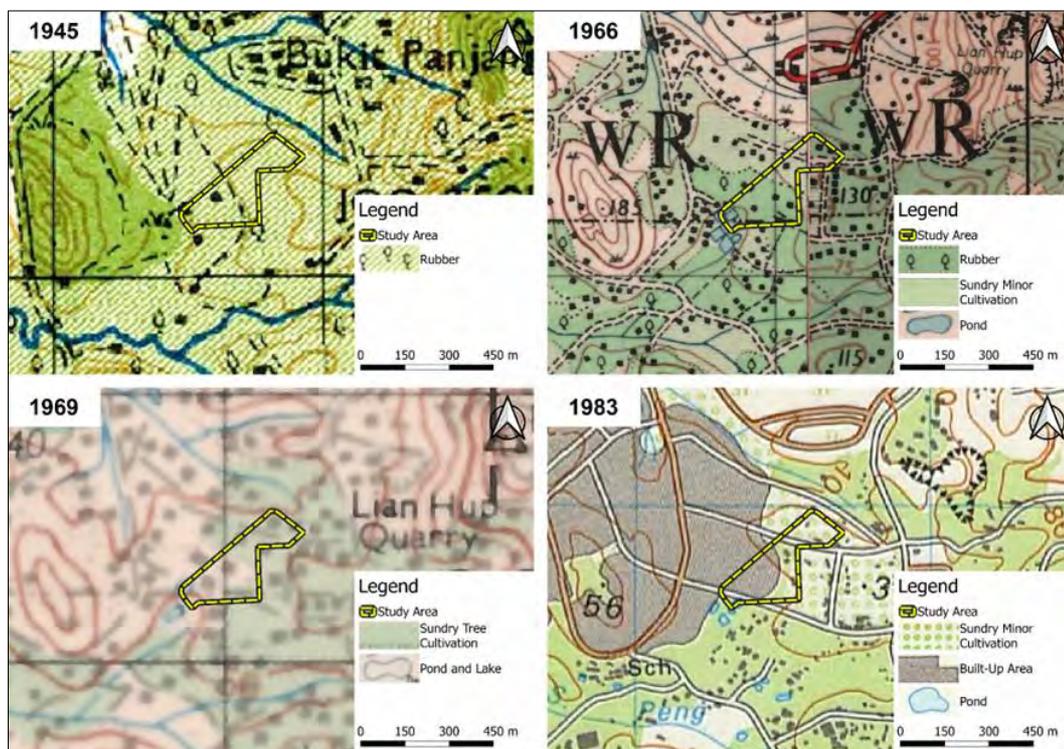
## 2 DESKTOP STUDY

A desktop study was conducted to collect secondary data, comprising a thorough review of publicly available literature and material on land use history, current land use, hydrological conditions, biodiversity and ecological connectivity of the Study Area. A chronological account of the land use history was derived from, and materials made available by Historical Maps of Singapore (NUS, 2024).

Other resources studied in this section include Environmental Impact Assessments (EIAs), media releases, and information provided by statutory boards (HDB, URA, NLB, NParks). As previous baseline surveys encompassing the Study Area were not found, studies performed at nearby areas were examined and discussed in relation to the available knowledge of the Study Area including baseline studies conducted at Tengah North and Bukit Batok Hillside Nature Park, and vascular plant flora of Bukit Batok (Jacobs, 2021; ESC, 2020; Davison & Chew, 2019; Neo et al., 2013).

### 2.1 Historical Land Use

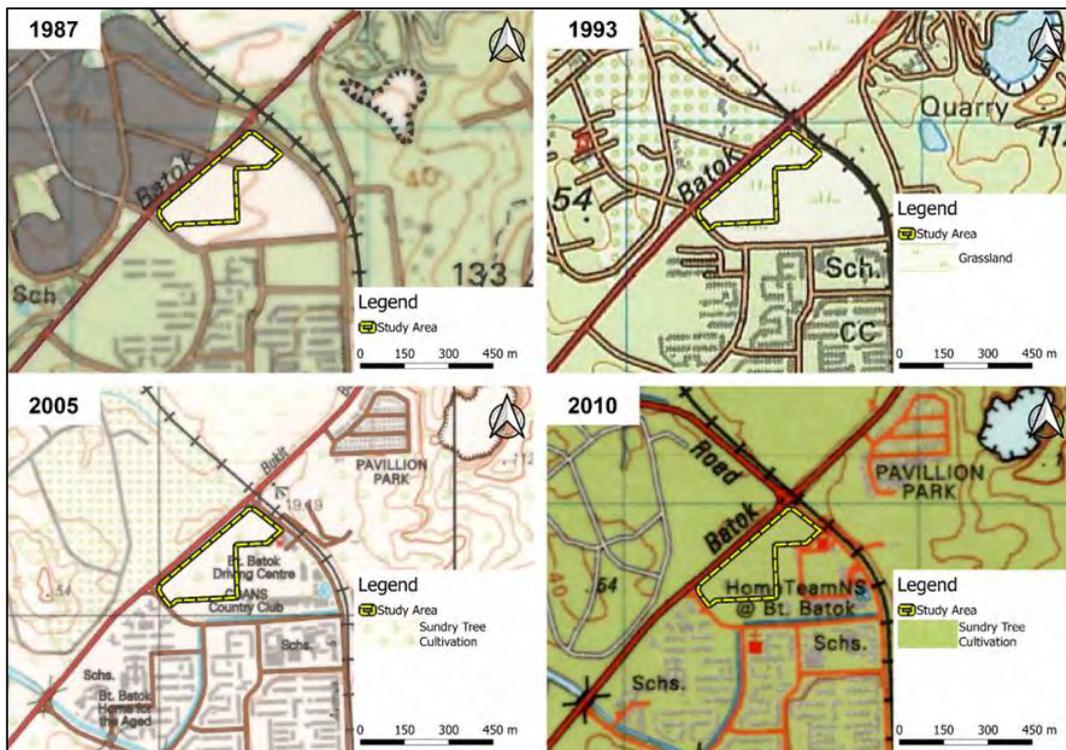
The earliest indication of land use in the Study Area was for gambier and pepper plantations in 1885, which covered much of West Bukit Timah (Survey Department, Singapore, 1885), where the present Study Area is situated. Chinese gambier and pepper plantations pre-date European settlement in 1819 and such plantations are estimated to have begun to Singapore in the late 1790s on newly cleared forests (Jackson, 1965; Corlett, 1992).



**Figure 2-1.** Historical maps showing Study Area and its vicinity, from years 1945, 1966, 1969

and 1983.<sup>1</sup>

In 1903, the large-scale cultivation of rubber trees was introduced in Singapore. While the year in which rubber plantations spread into the Study Area is unclear, by 1943, the Study Area and its vicinity contained rubber cultivation (Figure 2-2). From the 1950s, rubber cultivation in Bukit Batok began to be either cleared or abandoned (Neo et al., 2013), although it was documented to cover the Study Area entirely until 1966, when sundry minor cultivation was recorded in the northern half of Study Area boundary. From 1969 onwards, the vegetation in the Study Area was labelled as either sundry tree cultivation or sundry minor cultivation, suggesting that former rubber plantations might have been replaced by fruit and ornamental trees (Yee et al., 2016).



**Figure 2-2.** Historical maps showing Study Area and its vicinity, from years 1987, 1993, 2005 and 2010.<sup>2</sup>

The first public housing developments in Bukit Batok New Town were completed in the 1980s (The Business Times, 1981) and Bukit Batok has become increasingly built-up (Figure 2-2). By 1987, the construction of Bukit Batok Road, Bukit Batok West Avenue 5 and Bukit Batok West Avenue 7, which form the current boundary of the Project Area, were completed. The Bukit Batok Driving Centre was officially opened in April 1990, which further added to the clearance of vegetated land in the present Project Area adjacent to the Study Area (Singapore Business Directory, 2022). In 1993, the Study Area was documented to contain only grassland vegetation (NUS, 2024). On 30 March 1998, the former Singapore Civil Defense Association for National Servicemen Country Club was opened, incorporating the undeveloped land of the Study Area within the clubhouse grounds (Ho, 1999). It was re-launched as HTNS Bukit Batok on 24 April

<sup>1</sup> <https://libmaps.nus.edu.sg>

<sup>2</sup> <https://libmaps.nus.edu.sg>

2005 with the formation of HTNS (Wong, 2005).

Presently, the Study Area consists mostly of forested land but also contains urban vegetation and urban areas which are part of HTNS Bukit Batok Adventure Centre used for outdoor recreation and leisure activities.

## 2.2 Flora Biodiversity Literature Review

Tengah Forest, Bukit Batok Hillside Nature Park and Bukit Batok Town Park are the closest secondary forest patches to the Study Area, which are likely to be the source of seed dispersal and natural regeneration for the forests in the Study Area.

Across from Bukit Batok Road lies Tengah North, where many locally threatened native flora species can be found, such as *Melicope lunu-ankenda*, *Ficus vasculosa*, *Glochidion zeylanicum* var. *zeylanicum*, *Leea angulata*, *Callicarpa longifolia* and *Rubus moluccanus* (Jacobs, 2021). Tengah Forest is also home to *Mucuna biplicata* which was recently newly discovered in Singapore (Ho & Lua, 2022).

Bukit Batok Town Park was found to have the highest diversity of nationally threatened flora compared with the other forest patches in Bukit Batok area (Neo, et al., 2013). These species include the *Macaranga griffithiana*, *Baccaurea sumatrana*, *Symplocos fasciculata* and *Pternandra coerulea*. Bukit Batok Hillside Nature Park also has a high diversity of native flora species. Nationally threatened species such as *Melicope lunu-ankenda*, *Macaranga griffithiana*, and *Ficus vasculosa* (Neo et al., 2013; ESC, 2020) were found.

## 2.3 Fauna Biodiversity Literature Review

An environmental study at the nearby forested site of Bukit Batok Hillside Nature Park recorded the presence of forest-dependent species, such as the Malay tailed Judy (*Abisara savitri savitri*), copper-cheeked frog (*Chalcorana labialis*), common treeshrew (*Tupaia glis*), and slender squirrel (*Sundasciurus tenuis*) among 81 fauna species (ESC, 2020).

Searches conducted on iNaturalist, a crowdsourced biodiversity database, revealed that at least 11 fauna species within the targeted taxonomic groups have been recorded in the Study Area, comprising five (5) bird, five (5) butterfly, and one (1) mammal species. Bird species include the oriental dollarbird (*Eurystomus orientalis*), spotted dove (*Spilopelia chinensis*) and common tailorbird (*Orthotomus sutorius*).

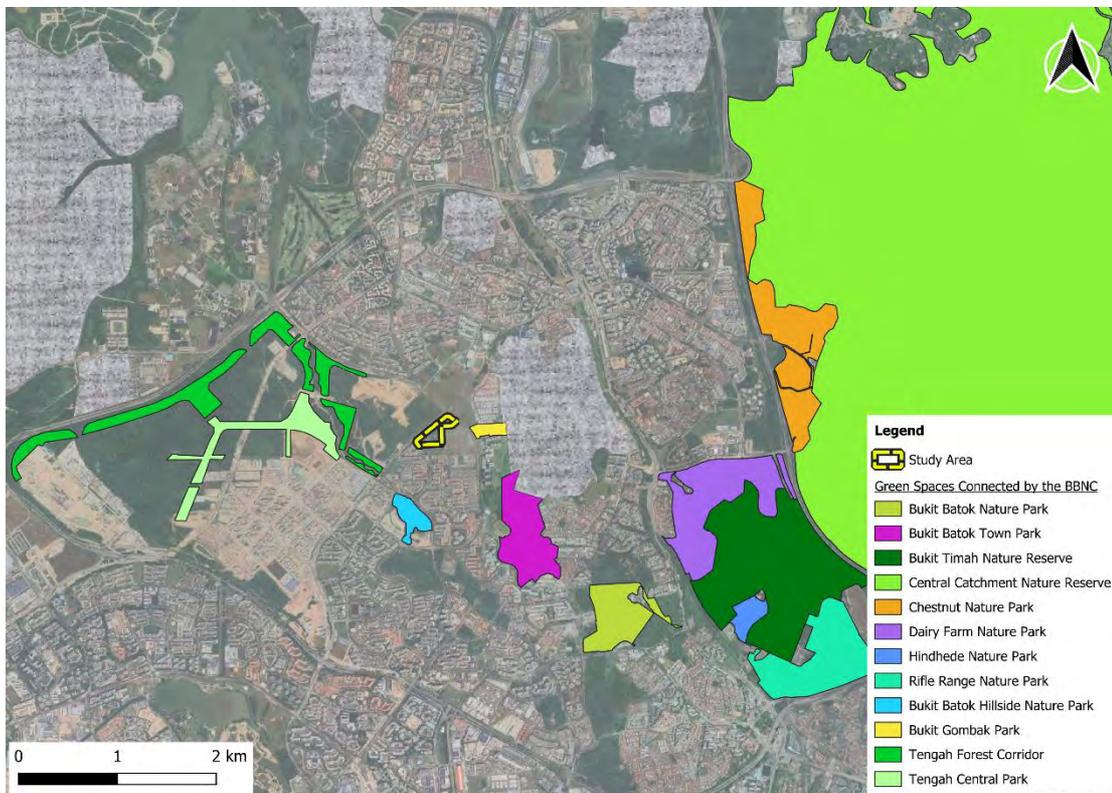
As there is limited information on the biodiversity within the Study Area, further searches on the surrounding areas were carried out. These searches found at least 28 species of birds including the locally vulnerable Oriental magpie-robin (*Copsychus saularis*) (Soh, 2024) and raptors such as the Brahminy kite (*Haliastur indus*) (Tan, 2024).

An environmental study by AECOM at Tengah South recorded numerous species of conservation significance (AECOM, 2021). This includes 12 species of nationally extinct butterfly rediscoveries, with two (2) species of the *Troides* genus being protected under The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). Three (3) species of turtles found in the survey — the Malayan box terrapin (*Cuora amboinensis*), giant Asian pond turtle (*Heosemys grandis*) and the Asian softshell turtle (*Amyda cartilaginea*) — are recognised as vulnerable under the International Union for Conservation of Nature (IUCN) Red List (IUCN, 2024).

The survey also found 13 species of birds of conservation significance. These include the globally critically endangered straw-headed bulbul (*Pycnonotus zeylanicus*) and raptors such as the grey-headed fish eagle (*Haliaeetus ichthyaetus*) which occupy the highest trophic position in food webs keeping prey numbers in check. Also recorded was the critically endangered Sunda pangolin (*Manis javanica*).

## 2.4 Ecological Connectivity

The Study Area is located along the BBNC, which aims to support the wider ecological connectivity between Tengah, BTNR and CCNR (NParks, 2024) by connecting forest patches such as the Tengah Forest Corridor, Bukit Batok Hillside Nature Park, Bukit Batok Town Park, and Bukit Batok Nature Park (Figure 2-3). BBNC includes planned and completed nature ways which pass through the Study Area, discussed further in Section 5.6.



**Figure 2-3.** Parks, nature parks and nature reserves connected by the BBNC that are in proximity to the Study Area

## 3 PROJECT OVERVIEW

### 3.1 Overview of Development Works

#### ***Preliminary Works, Setting Out, and EMMP***

The project will begin with preliminary works, covering the construction of site office and temporary access roads, establishment of hoarding along the contract boundary, mobilisation of equipment into the site areas. This phase also includes the setting out of the detailed EMMP.

#### ***Infrastructure works and building works***

The proposed development works entails the following activities:

- Site clearance with the removal of vegetation and trees
- Earthworks
- Infrastructure works
- Building works

#### ***Architectural works, landscape works and commissioning of services***

Architectural works such as painting and tiling works are expected in the final phase of the project. In this phase, landscaping (e.g. softscapes and signages) will also be expected.

### 3.2 Project Activities

The following construction activities are expected to take place to facilitate the proposed housing developments:

- Site Clearance: Tree felling and vegetation clearance
- Soil investigation works: Borehole drilling
- Trial trenching works: Excavation for the detection of existing utilities and underground structures
- Earthworks: Cut and fill to achieve development's platform level
- Roadworks: Filling of road base material, laying of premix, laying of services etc.
- Sewer works: Construction of shafts, pipe jacking of sewer pipes etc.
- Building works: Construction of residential development

## 4 EIA APPROACH

### 4.1 Singapore's EIA Context

Singapore adopts a systematic framework to determine and mitigate the potential impact of any new development on the environment. In general, development projects are required to undergo a thorough evaluation process that addresses the development's potential impact on traffic, public health, heritage, and the environment. In addition, proposed development projects near sensitive areas, such as Nature Reserves, Nature Areas, marine and coastal areas, forested areas, and other areas of significant biodiversity or with potential trans-boundary impact, are subject to greater scrutiny.

For this study, the methodology deployed to establish the baseline conditions was submitted to HDB and relevant Technical Agencies prior to the commencement of the study to confirm the scope.

### 4.2 EIA Scope

This study was conducted in accordance with the requirements specified during the scoping consultation process with the relevant Technical Agencies. A methodology writeup describing the scope was submitted to the relevant Technical Agencies prior to the commencement of the study.

This EIA shall:

- Identify and describe the elements of the community and environment aspects likely to be affected by the Project and/or likely to cause ecological impacts, including both the natural and man-made environment and the associated environmental constraints to and by the Project;
- Describe the baseline conditions of the proposed Study Area and the environmental constraints considering seasonal migratory variations;
- Establish EQOs and define the acceptable impact levels in a given environmental receptor;
- Define, classify and assess potential impacts and determine the significance of impacts on sensitive receptors; including ecological connectivity to the surrounding greeneries;
- Identify the freshwater discharges, water quality and parameters affecting the receiving watercourses
- Quantify and assess the magnitude, likelihood of the potential environmental impacts;
- Propose and justify effective mitigation measures (if any) to minimise environmental impacts (e.g. pollution, environmental disturbance and nuisance) during construction of the Project;
- Identify, predict and evaluate the residual environmental impacts (i.e. after practicable mitigation) and the cumulative effects expected to arise during construction of the Project in relation to the sensitive receptors and potential affected uses;
- Identify, assess and specify methods, measures and standards, to be included during construction of the Project which are necessary to mitigate the residual

environmental impacts and cumulative effects and reduce them to minimal levels;

- Investigate the extent of the secondary environmental impacts that may arise from the proposed mitigation measures and to identify constraints associated with the mitigation measures (if any) recommended in the EIA, as well as the provision of any necessary modification;
- Tailor mitigation measures to address different type and stages of construction works; and
- Propose an Environmental Monitoring and Management Plan (EMMP) to document specific monitoring and environmental impact management procedures for the Project.

### 4.3 Environmental Legislations, Regulations and Guidelines

Table 4-1 lists the relevant legislation, regulations and guidelines that govern the various environmental parameters within Singapore. The latest legislations and relevant subsidiary regulations can be accessed from the website of Singapore Statutes Online (SSO) (n.d.) at <https://sso.agc.gov.sg/>.

**Table 4-1.** List of applicable Singapore legislations, regulations, and guidelines

Parameter	Legislation, Regulations and Guidelines
General	<ul style="list-style-type: none"> <li>• Code of Practice on Pollution Control SS593, 2013</li> <li>• Environmental Protection and Management Act, rev. 2020</li> <li>• Environmental Public Health Act, rev. 2020</li> </ul>
Biodiversity	<ul style="list-style-type: none"> <li>• Animals and Birds Act, 2020</li> <li>• Endangered Species (Import and Export) Act, 2020</li> <li>• Fisheries Act, 2020</li> <li>• Parks &amp; Trees Act, 2020</li> <li>• Parks &amp; Trees Regulations, 2006</li> <li>• Parks &amp; Trees Preservation Order 1998</li> <li>• Parks &amp; Trees (Composition of Offences) Regulations, 2006</li> <li>• Parks &amp; Trees (Heritage Road Green Buffers) Order, 2006</li> <li>• Parks &amp; Trees (Planning Areas) Notifications, 2006</li> <li>• Wildlife Act, 2020</li> <li>• NParks Biodiversity Impact Assessment (BIA) Guidelines, 2024</li> <li>• CITES (the Convention on International Trade in Endangered Species of Wild Fauna and Flora, also known as the Washington Convention), 1983</li> <li>• IUCN Red List of Threatened Species, 2023</li> <li>• Singapore Red Data Book, Third Edition (online), 2023</li> </ul>
Surface Water Quality	<ul style="list-style-type: none"> <li>• Code of Practice on Pollution Control SS593, 2013</li> <li>• Environmental Protection and Management Act 2020, Part V on water pollution</li> <li>• Environmental Protection and Management Act (Trade Effluent) Regulations, 2008</li> <li>• PUB Code of Practice on Surface Water Drainage, 2018</li> <li>• PUB Guidebook on Erosion and Sediment Control at Construction Sites, 2018</li> <li>• PUB Handbook on Managing Urban Runoff, 2013</li> <li>• Sewerage and Drainage Act, rev. 2020</li> <li>• Sewerage and Drainage (Surface Water Drainage) Regulations, rev. 2007</li> <li>• Sewerage and Drainage (Trade Effluent) Regulations, rev. 2007</li> </ul>

#### 4.4 Environmental Aspects

The environmental aspects that were studied for this project, along with a brief description of each aspect and explanation of its relevance in the study, are presented below.

##### ***Biodiversity***

This aspect covers flora and fauna groups inhabiting the project site that may be impacted by future construction and operation of the project. The main groups studied are vegetation on site, birds, mammals, amphibians, reptiles, butterflies, and odonates. Impacts to biodiversity during the project implementation were assessed, and mitigation measures to address the potential impacts are recommended.

##### ***Surface Water Quality***

This aspect concerns the effects on the drainage channels, which include potential blockage of drainage channels, increased concentrations of suspended solids and water quality of receiving watercourses. Adverse impacts to drainage pattern and water quality may occur from soil erosion and sediment transport during and discharge into receiving watercourses.

#### 4.5 Identification of Sensitive Receptors

Table 4-2 provides the overview of the identified sensitive biodiversity receptors that may be affected during the development of the proposed project.

**Table 4-2.** Overview of identified sensitive receptors

Environmental Aspects	Sensitive receptors
Biodiversity	<ul style="list-style-type: none"> <li>• Native flora and fauna of international conservation significance (i.e., classified as critically endangered, endangered, or vulnerable according to IUCN classification system) within Study Area</li> <li>• Native flora and fauna of national conservation significance (i.e., classified as critically endangered, endangered, or vulnerable according to Singapore Red Data Book 3 or other relevant local status publications) within the Study Area</li> <li>• Native flora and fauna endemic to Singapore within Study Area</li> <li>• Habitats with high ecological value (i.e., environments that support species of conservation significance)</li> <li>• Species that are susceptible to noise pollution (e.g., species that require a quiet environment to find prey and species with acute hearing)</li> <li>• Species that are susceptible to light disturbance (e.g., nocturnal fauna) within the PRA</li> </ul>
Surface Water Quality	<ul style="list-style-type: none"> <li>• Receiving watercourses</li> <li>• Bukit Batok Canal</li> </ul>

#### 4.6 Impact Assessment Methodology

The overall approach for the assessment of impacts is as follows:

- I. Identification of potential impacts on identified sensitive receptors
- II. Assessment of potential impacts without mitigation
- III. Recommendation of proposed mitigation measures

#### IV. Assessment of residual impacts with mitigation measures

##### **4.6.1 Identification of Impacts**

The proposed project involves infrastructure and building works within the project Study Area. This will involve site clearance, earthworks, building works with heavy construction activities such as piling, fixing of precast walls, use of crawler cranes and tower cranes. Potential impacts which may arise from the above-mentioned activities were identified. Some impacts to the sensitive receptors may include habitat loss, reduced ecological connectivity and species mortality, increased edge effect<sup>3</sup>, as well as noise, air, and light pollution during construction and operation phases of the project.

Assessment of the impacts of the proposed development will include:

- Elements of the community, man-made environment, and natural environment likely to be affected by the project (including ecological impacts);
- Impacts to from runoff and siltation on drainage channels
- Noise, on biodiversity
- Impacts on sensitive receptors; including ecological connectivity to the surrounding green areas;
- Water pollution and construction waste management;
- Magnitude and likelihood of the potential environmental impacts;
- Environmental impacts (e.g., pollution, environmental disturbance and nuisance) during building works;
- Residual environmental impacts (i.e., after practicable mitigation) and the cumulative effects expected to arise during earthworks and infrastructure works in relation to the sensitive receptors and potential affected uses; and
- Extent of the secondary environmental impacts that may arise from the proposed mitigation measures.

##### **4.6.2 Assessment of Impacts**

Based on the impact analysis of construction and operation activities of the proposed development, suitable mitigation measures are recommended to lower the magnitude of negative impacts on the environment to within acceptable levels as much as practically possible.

Potential impacts were quantified using the Rapid Impact Assessment Matrix (RIAM) method, a scoring system in which impacts of each construction activity are evaluated against environmental receptors (Pastakia & Barber, 1998). The RIAM method attributes values to each condition based on its importance (I), magnitude (M), permanence (P), reversibility (R), and cumulative impact (C).

The parameters of RIAM are tabulated in Table 4-3 below.

---

<sup>3</sup> i.e., higher temperature, light, noise, and pollution levels on the edges compared to the interior of a forest resulting in retraction or loss of species sensitive to these disturbances.

**Table 4-3.** List of parameters and respective scores assigned in RIAM method

Parameter	Description	Score
<b>Importance (I)</b>	Important to national/international interests	5
	Important to regional/national interests	4
	Important to areas immediately outside the local condition	3
	Important to the local condition (within a large direct impact area)	2
	Important only to the local condition (within a small direct impact area)	1
<b>Magnitude (M)</b>	Major positive benefit or change	+4
	Moderate positive benefit or change	+3
	Minor positive benefit or change	+2
	Slight positive benefit or change	+1
	No change/status quo	0
	Slight negative disadvantage or change	-1
	Minor negative disadvantage or change	-2
	Moderate negative disadvantage or change	-3
	Major negative disadvantage or change	-4
<b>Permanence (P)</b>	No change/Not applicable	1
	Temporary	2
	Permanent	3
<b>Reversibility (R)</b>	No change/Not applicable	1
	Reversible or controllable through Environmental Management and Monitoring Plan	2
	Irreversible	3
<b>Cumulative Impact (C)</b>	No change / Not applicable	1
	Non-cumulative/single	2
	Cumulative/synergistic	3

Given the ambiguity in the nature of assessing the “magnitude” component, we use the following criteria, tabulated in Table 4-4 to aid the assessment.

**Table 4-4.** Description of the value of magnitudes in RIAM method

Magnitude	Description
Major positive benefit or change	Refers to significant improvements in baseline conditions and a significant reduction of stress or improvement in the baseline states of sensitive receptors.
Moderate positive benefit or change	Refers to significant improvements in local baseline conditions, which may lead to a moderate reduction of stress to sensitive receptors or improvement in their baseline state.
Minor positive benefit or change	Refers to minor positive benefit or change implies that positive changes to baseline conditions are discernible but local. These changes may lead to local and limited reduction of stress to sensitive receptors.
Slight positive benefit or change	Refers to slight positive benefit or change implies that changes in baseline conditions are unlikely to be detectable on-site, and thus are unlikely to cause discernible reduction of stress to sensitive receptors.
No change/status quo	Refers to no change/status quo implies that changes in the baseline conditions are not expected, and unlikely to cause any stress to sensitive receptors.
Slight negative disadvantage or change	Refers to changes in baseline conditions that are unlikely to be detectable in the field, and thus are unlikely to cause discernible stress to sensitive receptors.
Minor negative disadvantage or change	Refers to negative changes to baseline conditions that are discernible but local. These may also refer to changes that are approaching thresholds for

<b>Magnitude</b>	<b>Description</b>
change	established standards or guidelines. These changes may lead to a local and limited increase in stress to sensitive receptors.
Moderate negative disadvantage or change	Refers to significant adverse changes in local baseline conditions. These may also refer to changes that are very close to exceeding established standards or guidelines or causing significant ecological impacts. These changes may lead to a moderate increase of stress to sensitive receptors.
Major negative disadvantage or change	Refers to significant adverse changes in baseline conditions. These may also refer to changes that exceed established standards or guidelines or causing a complete loss of certain habitats or ecological components. These changes may lead to an unacceptable increase of stress to sensitive receptors.

These values will then contribute to the condition's environmental score, where:

$$\text{Environmental Score (ES)} = I * M * (P + R + C).$$

The ES attained for each condition correlates to a measure of its impact, tabulated in Table 4-5.

**Table 4-5.** List of ES range along with the degree of impact associated with each range

<b>Range</b>	<b>Impact</b>
116 to 180	Major positive change/impact
81 to 115	Moderate positive change/impact
37 to 80	Minor positive change/impact
7 to 36	Slight positive impact
-6 to +6	No impact / Status quo / Not applicable
-7 to -36	Slight negative change/impact
-37 to -80	Minor negative change/impact
-81 to -115	Moderate negative change/impact
-116 to -180	Major negative change/impact

### 4.6.3 Mitigation Measures

In general, mitigation measures follow two concepts:

- ALARP : "As Low as Reasonably Practical"
- BATNEEC : "Best Available Technology Not Entailing Excessive Costs"

The first concept is a hierarchy of actions that aims to find anything that can be done to avoid, minimise, or reduce the predicted/ potential adverse (negative) environmental impacts, as practically feasible and reasonable. The second concept comes in when discussing whether to adopt certain available technology that could address or reduce environmental impacts. This EIA utilises both concepts for the development of mitigation measures for this project.

## 5 BIODIVERSITY

Several species of conservation significance reside in the forest habitats along BBNC. As part of the wildlife corridor between the Western Catchment and CCNR, the Study Area serves as a stepping stone habitat and facilitates animal species to move from one forest patch to another in search of resources.

### 5.1 Conventions

The main references for flora conservation statuses include a combination of those in the third edition of the Singapore Red Data Book (SRDB3) (NParks, 2024), Flora of Singapore – Checklist and bibliography (Lindsay et al., 2022) and The Checklist of the Total Vascular Plant Flora of Singapore (Chong et al., 2009). For faunal species, local conservation statuses were mainly derived from SRDB3 (NParks, 2024), while global conservation statuses were derived from the IUCN Red List of Threatened Species (IUCN, 2024).

Table 5-1 provides the flora species conservation status definitions according to Lindsay et al. (2022). Table 5-2 provides a consolidated list of global and local fauna statuses from the IUCN Red List (2024) and SRDB3 (2024), respectively. In this report, flora species with local status of Extinct (EX), Presumed Nationally Extinct (NEx), Critically Endangered (CR), Endangered (EN), Vulnerable (VU), and Data Deficient (DD) are considered to be of conservation significance, whereas fauna species of conservation significance are of CR, EN, and VU conservation status. Exotic plant species with no local status were categorised as Not Evaluated.

**Table 5-1.** Local conservation status definitions for flora species in Singapore adapted from Lindsay, et al. (2022)

<b>Local Status</b>		<b>Definition</b>
<b>Native</b>		Originated or arrived in Singapore without intentional or unintentional involvement of human activities.
	Extinct (EX)	Globally extinct.
	Presumed Nationally Extinct (NEx)	Not recorded in Singapore within the last 30 years. Endemic species that are presumed nationally extinct will consequently also be presumed to be globally extinct.
	Critically Endangered (CR)	Fewer than 50 mature individuals estimated to be in Singapore; or if more than 50 but fewer than 250 mature individuals, with evidence of rapid decline or decline and fragmentation of populations.
	Endangered (EN)	Between 50 and 250 mature individuals estimated to be in Singapore, with no evidence of decline or fragmentation of populations.
	Vulnerable (VU)	Between 250 to 1000 mature individuals estimated in Singapore.
	Least Concern (LC)	More than 1000 mature individuals estimated in Singapore.
	Data Deficient (DD)	Not enough information available to assess the risk of extinction.
<b>Cryptogenic</b>		Uncertain whether presence in Singapore is from natural dispersal or as a result of human activities.
<b>Non-native (=Exotic)</b>		Presence in Singapore is because of intentional or unintentional involvement of human activities.
	Naturalised	Species that have established self-sustaining wild (i.e., non-cultivated) populations such that long-term persistence in Singapore is likely without additional introduction of new individuals or propagules.
	Casual	Species that occur in the wild in Singapore as escapes or relics of cultivation but do not form self-sustaining populations, such that their presence is ephemeral once the original individuals die or are removed without additional introduction of new individuals or propagules. This includes taxa that were formerly considered to be naturalised but have since died out. Those for which we have no record of occurrence in the wild for more than 30 years are still treated as casual but are further highlighted.
	Cultivated Only	Only found in cultivation.
	Not Evaluated (NE)	Not yet assessed for risk of extinction. This includes some species for which there are grounds for rejecting or questioning a previous assessment but for which a new assessment is pending.

**Table 5-2.** Conservation status for flora & fauna species & respective definitions, adapted from IUCN Red List (IUCN, 2024), SRDB3 (2024).

Conservation Status	Definition
<b>Global</b>	
Extinct (EX)	There is no reasonable doubt that the last individual has died. Exhaustive surveys in known and/or expected habitat, at appropriate times, throughout its historic range have failed to record an individual. Surveys should be over a time frame appropriate to the taxon's life cycle and life form.
Extinct in the Wild (EW)	Known only to survive in cultivation, in captivity or as a naturalized population (or populations) well outside the past range. Exhaustive surveys in known and/or expected habitat, at appropriate times, throughout its historic range have failed to record an individual. Surveys should be over a time frame appropriate to the taxon's life cycle and life form.
Critically Endangered (CR)	Considered to be facing an extremely high risk of extinction in the wild.
Endangered (EN)	Considered to be facing a very high risk of extinction in the wild.
Vulnerable (VU)	Considered to be facing a high risk of extinction in the wild.
Near Threatened (NT)	Does not qualify as Critically Endangered, Endangered or Vulnerable now, but is close to qualifying for or is likely to qualify for a threatened category in the near future.
Least Concern (LC)	Does not qualify for Critically Endangered, Endangered, Vulnerable or Near Threatened. Widespread and abundant taxa are included in this category.
Data Deficient (DD)	Inadequate information to make a direct, or indirect, assessment of its risk of extinction based on its distribution and/or population status. A taxon in this category may be well studied, and its biology well known, but appropriate data on abundance and/or distribution are lacking. Data Deficient is therefore not a category of threat.
Not Evaluated (NE)	Not yet been evaluated against the criteria.
<b>Local</b>	
Presumed Nationally Extinct (NE)	This species is extinct in Singapore but still survives outside Singapore. It has not been recorded with the last 30 years (plants) and 50 years (animals).
Critically Endangered (CR)	There are fewer than 50 mature individuals, or if more than 50 mature individuals but less than 250, with some evidence of decline or fragmentation.
Endangered (EN)	There are fewer than 250 mature individuals, and no other evidence of decline or fragmentation.
Vulnerable (VU)	There are fewer than 1000 mature individuals, but more than 250 and there may or may not be any other evidence of decline, small range size, or fragmentation.

## 5.2 Baseline Survey Methodology

This section of the report describes the existing environmental conditions of the Study Area. The baseline is developed mainly from primary field data and analysis of secondary desktop surveys. Detailed survey components and their methodologies are presented below. Sensitive environmental receptors include terrestrial flora and fauna.

### 5.2.1 Terrestrial Flora Surveys

Flora surveys will utilise a tiered census methodology, in which all woody flora species of girth  $\geq 1$  m and all native vascular flora of conservation significance will be recorded. Other flora species will be recorded opportunistically where applicable. All recorded species will be compiled in a species inventory list. The flora surveys will be conducted within the boundary of the flora survey area, which can be found below in Figure 5-1.



Figure 5-1. Flora survey area

Each two-personnel survey team will consist of at least one flora specialist or ISA-certified arborist. Where required, plant samples will be collected to facilitate species identification. The locations of flora species will be recorded using the Garmin GPSMAP 64s unit. The static parameters collected during the flora surveys can be found below in Table 5-3.

**Table 5-3.** Static parameters collected for the tiered census flora surveys

Static Parameter	Description
Coordinates	In SVY21 (EPSG:3414) Coordinate Reference System
Collection date	Date when the tree was geolocated
Tree Identification Number	Unique identification number for every surveyed tree
Flora Species	Scientific and common* names
Growth Form	Tree, shrub, palm, fern, climber/vine, etc.
Girth	Circumference of the tree (m) at 1.0 m height
Height	Height of the tree (m)
Canopy	Canopy width of the tree (m)
Surveyor's remarks	Any remarks about the tree, if applicable
Image <sup>^</sup>	At least one (1) colour image of every surveyed tree

\* = Some flora species within the Southeast Asian region have no common name

<sup>^</sup> = To be provided as supplementary material

### ***Tree Tagging and Mapping***

In addition to GPS mapping conducted as part of the flora baseline studies, all large trees (measuring  $\geq 1$  m girth) will also be temporarily marked using brightly coloured weather-resistant flagging tape with its assigned unique tree identification number written on the tape and included in the topography map.

### ***Visual Tree Assessment***

Basic tree assessments will be carried out for identified large trees and/or trees with conservation status by a certified arborist. Based on tree assessment results and consideration of final ground level and development footprint, the arborist will recommend if trees can be conserved or shall be removed.

### Habitat Mapping

Habitat maps are to be produced using a combination of recorded data and site observations during flora surveys. Habitat types within the site will be identified during vegetation surveys based on species compositions at canopy level within various areas of the site (Table 5-4).

**Table 5-4.** Habitat types found within Singapore and general description of each habitat, modified from NParks' BIA Guidelines (2024)

Habitat	Description	Source
Primary forest	Contains an emergent layer that has dipterocarp trees such as <i>Shorea</i> and <i>Dipterocarpus</i> . Has a continuous layer of tall native trees, a sub-canopy consisting of smaller trees, and an understorey dominated by saplings of big tree species interspersed with other shrubs and treelets.	(Tan et al., 2007)
Native-dominated young secondary forest	Developed on land cleared not long before the 1960s, or on degraded soils and not near other native-dominated forests. Dominated by native pioneer trees such as <i>Adinandra</i> , <i>Macaranga</i> , <i>Mallotus</i> and <i>Trema</i> .	(Yee et al., 2016)
Native-dominated old secondary forest	Developed on land cleared much earlier than the 1950s, often on less degraded soil and with higher species richness than early successional native dominated secondary forest. Common species found in the canopy layer include <i>Alstonia</i> spp., <i>Calophyllum</i> spp., <i>Camposperma</i> spp., <i>Elaeocarpus</i> spp., <i>Garcinia</i> spp., <i>Litsea</i> spp., <i>Rhodamnia</i> spp. and <i>Syzygium</i> spp. Common understorey plants include <i>Anisophyllea disticha</i> and <i>Agrostistachys borneensis</i> .	(Yee et al., 2019)
Abandoned Land Forest	Developed from an abandoned kampung/plantation or orchard, usually dominated by fruit trees such as <i>Durio zibethinus</i> , <i>Nephelium lappaceum</i> , or ornamental plants such as <i>Spathodea campanulata</i> , <i>Aglaonema commutatum</i> , <i>Dieffenbachia seguine</i> and <i>Heliconia</i> spp.. Abandoned plantations are usually dominated by <i>Hevea brasiliensis</i> .	(Yee et al., 2019)
Albizia/Acacia/Leucaena/Cecropia Dominated Forest	Developed on land recently cleared, plant communities dominated by exotic tree species such as <i>Acacia auriculiformis</i> , <i>Falcataria moluccana</i> , <i>Leucaena leucocephala</i> and <i>Cecropia pachystachya</i> .	(NParks, 2024)
Scrubland/Grassland	Exposed areas with very little tree cover, typically dominated by grasses, shrubs and herbs. These can be further split into Grassland (dominated by members of the grass and sedge family), Scrubland dominated by ferns (e.g. <i>Dicranopteris linearis</i> ), or by herbs and shrubs (e.g. <i>Mimosa</i>	(Yee et al., 2011)

Habitat	Description	Source
	<i>pigra</i> , <i>Melastoma malabathricum</i> , <i>Piper aduncum</i> , <i>Pipterus argenteus</i> , <i>Ficus</i> spp. etc.), often with absent or scattered trees of <i>Acacia auriculiformis</i> , <i>Leucaena leucocephala</i> , <i>Mallotus paniculatus</i> , <i>Dillenia suffruticosa</i> , etc.). These subsequently develop into denser open woodland with patches of trees within the scrubland.	
Freshwater Swamp Forest	Formed where slow-flowing streams drain into shallow valleys. The swamp is flooded periodically or semi-permanently, resulting in waterlogged soils that are anaerobic and unstable. Dominated by plants with special adaptations such as stilt roots, plank-like buttresses and pneumatophores. Examples include <i>Xylopia fusca</i> and <i>Palaquium xanthochymum</i> .	(Tan et al., 2007)
Riparian Vegetation	Found along the banks of natural and naturalised streams. Common species on stream banks in secondary forest patches include <i>Angiopteris evecta</i> , <i>Alsophila latebrosa</i> and <i>Dillenia suffruticosa</i> . Vegetation along native forest streams are more diverse and species such as <i>Cyrtosperma merkusii</i> , <i>Lasia spinosa</i> and <i>Hanguana</i> spp. can be present.	(Yee et al., 2019)
Urban Vegetation	Consists of turf, shrubs or trees (often mostly non-native) which are planted by humans. This type of vegetation is typically managed for aesthetic purposes.	(NParks, 2024)

### 5.2.2 Terrestrial Fauna Surveys

The terrestrial fauna field assessment covered five (5) fauna groups: birds, herpetofauna (reptiles and amphibians), mammals (volant and non-volant), odonates (dragonflies and damselflies), and butterflies. Opportunistic fauna encounters outside their dedicated survey timings were also recorded.

Terrestrial baseline fauna surveys were conducted mainly through visual encounter surveys, camera trapping and acoustic surveys. The surveys covered secondary forest, scrubland and urban vegetation habitats. As many animals (particularly mammals and herpetofauna) are nocturnal, both diurnal and nocturnal surveys were conducted. Table 5-5 summarizes the survey methods and appropriate survey timings for each taxonomic group.

**Table 5-5.** Survey timings, frequency, and methodology for each fauna taxonomic group.

<b>Taxonomic Group</b>	<b>Survey Timings</b>	<b>No. of surveys</b>	<b>Survey Methodology</b>
Birds	0700 – 1100	2 Migratory Season, 2 Non-migratory Season	Point count surveys
Mammals (Non-volant)	0700 – 1100 2000 – 0000	2 Diurnal, 2 Nocturnal	Visual encounter surveys: call recognition along transects
	24 hrs	60 days	Camera traps attached on tree trunks 30 cm above ground level
Mammals (Bats)	1900 – 0700	2	Acoustic recording
Herpetofauna	0700 – 1100 2000 – 0000	2 Diurnal, 2 Nocturnal	Visual encounter survey: call recognition along transects
Butterflies	0900 – 1200	2	Visual encounter survey along transects
Odonates	0900 – 1200	2	Visual encounter survey along transects

A species checklist of taxonomic groups of interest, as well as their conservation status in Singapore were compiled. The locations of encounters with the fauna species of conservation significance were recorded and plotted on a map.

#### **Visual Encounter and Call Recognition Surveys**

The terrestrial fauna surveys were conducted by at least two (2) observers walking at a steady pace, along systematic transects illustrated below in Figure 5-2. GPS locations, species name and number of individuals were recorded for every visual or call recognition encounter. Survey timings and frequency can be found in Table 5-5 above.



**Figure 5-2.** Locations of transects for terrestrial fauna surveys

***Point Count Survey***

Point count surveys involved identifying birds by sight and sound (within a 50 m radius around each point) for 10 minutes at the fauna points shown in Figure 5-3. Only diurnal point count bird surveys were conducted (see Table 5-5 for the survey timings and frequency).



**Figure 5-3.** Locations of points for terrestrial fauna surveys

### ***Camera Trapping***

To supplement the visual encounter surveys, camera trapping was also conducted within the Study Area. This method is particularly useful for elusive or rare animals that are not often encountered. A total of four (4) camera traps were deployed for a period of 63 days between 5 March 2024 and 6 May 2024 (Figure 5-4 & Table 5-6).



**Figure 5-4.** Locations of camera traps deployed within the Study Area

**Table 5-6.** Coordinates of the camera traps within Study Area

ID	Latitude (°N)	Longitude (°E)
CAM1	1.3662487	103.7459865
CAM2	1.3670201	103.7471286
CAM3	1.3667915	103.7480284
CAM4	1.3678115	103.7479135

The cameras were secured on tree trunks roughly 30 cm above the ground (Figure 5-5). The camera traps were programmed to be continuously active 24 hrs a day, with the camera capturing a sequence of three (3) photos and a 10-second video per trigger. Species captured were identified to the lowest taxonomic level possible. An independent detection was defined as a capture of an individual occurring more than five minutes apart from a previous detection of the same species. The number of independent detections was used to calculate the total number of detections at each camera trap.



**Figure 5-5.** Example of a camera trap setup

### ***Acoustic Bat Surveys***

Acoustic bat surveys were conducted to survey microchiropteran bats, as echolocation is used by microchiropteran bats to navigate their environment and locate food (Schnitzler et al., 2003). As the echolocation call characteristics of bats (pulses, frequencies, duration, and shape) are somewhat unique to each species, the analysis of calls can be used to identify bats to species (Fenton & Bell, 1981). As megachiropteran bats rely on their vision and do not echolocate, visual encounter surveys were used to detect megachiropteran bats.

Acoustic sampling was conducted using a handheld Echo Meter Touch 2 Pro (Wildlife Acoustics, Inc.) attached to an Android (Android Inc.) mobile device during nocturnal terrestrial surveys. The Echo Meter functions by detecting ultrasonic sounds in real-time and converting them into audible digital signals that can be heard and visualized using the Echo Meter Touch App on the Android mobile device. When sounds resembling a bat call was detected, it was automatically recorded and saved onto the Android mobile device as a 16-bit full spectrum WAV file.

Bat call structure varies based on habitat type (cluttered vs. uncluttered) and foraging mode (gleaning, trawling, aerial) (Schnitzler et al., 2003). Bat call identification is aided by further classifying them into one of six call types based on frequency (frequency-modulated [FM], constant frequency [CF], and quasi-constant frequency [QCF]), and to a lesser degree, habitat use (Denzinger & Schnitzler, 2013; Yoh et al., 2022):

- FM-CF-FM calls used by forest specialists of the family Rhinolophidae.
- CF-FM calls used by forest specialists of the family Hipposideridae.
- QCF Multiharmonic (QCF-MH) calls used by open space foragers of the family Emballonuridae.

- FM Multiharmonic (FM-MH) calls used by forest specialists of the families Megadermatidae and Nycteridae.
- FM Broadband (FM-B) calls used by edge/gap foragers of the family Vespertilionidae.
- FM-QCF calls used by edge/gap foragers of the families Vespertilionidae.

References used to identify the calls of Singapore's bat species include Pottie et al. (2005), Lane et al. (2006) and Baker & Lim (2012). Although the sole published resource regarding bat calls from Singapore is Pottie et al. (2005), the study only reported bat calls for 13 out of Singapore's 26 microchiropteran bats. The bat calls in this study were identified using a call library generated from Pottie et al. (2005) combined with published calls from neighbouring countries (Heller, 1989; Kingston et al., 2009; Hughes et al., 2011). Echolocation signatures for several species in Singapore collated from these references can be found in Table 5-15.

Recorded bat call structures were then analysed using Kaleidoscope Lite Analysis Software (Wildlife Acoustics, Inc.). Key call structure parameters include call shape, frequency (kHz) and duration (ms). Each echolocation recording was identified to species level based on call shape, frequency (minimum, maximum, and peak) and call duration (Pottie et al., 2005). Once these parameters were inspected, the results were compared to echolocation signatures found in Table 5-15.

## **5.3 Flora Survey Baseline Results**

### **5.3.1 *Habitat Mapping***

The Study Area can be divided into four habitat types: native-dominated young secondary forest (NDYSF), abandoned kampung, urban vegetation, and scrubland. The habitat map, summary of habitat areas, and representative photos of habitats can be found below in Figure 5-6, Table 5-7, and, Figure 5-7. respectively.



**Figure 5-6** Habitat map

**Table 5-7** Types of habitats by area and percentages of area

Habitat Type	Area	Percentage
Native-dominated Young Secondary Forest	1.51 ha	27.5%
Abandoned Kampung	1.46 ha	26.5%
Urban Vegetation	2.46 ha	44.8%
Scrubland	0.06 ha	1.2%
<b>Total</b>	<b>5.49 ha</b>	<b>100.0%</b>



**Figure 5-7.** Representative photos of habitat types in Study Area. **A:** Native-dominated young secondary forest; **B:** Abandoned kampung; **C:** Urban vegetation; **D:** Scrubland.

The two patches of NDYSF can be found in the northern and western regions of the Study Area. They are generally characterised by the presence of common native species such as *Cinnamomum iners*, *Dillenia suffruticosa*, *Mallotus paniculatus* and *Ficus variegata*. There were also a significant number of threatened climber species, such as the locally endangered *Cayratia mollissima*; and vulnerable *Rubus moluccanus* var. *angulosus* and *Gynochthodes rigida*.

Throughout the Study Area, extensive regeneration of common native tree and climber species was observed. These species include *Cinnamomum iners*, *Aphanamixis polystachya*, *Claoxylon indicum*, *Dimocarpus lichi*, *Arthrophyllum jackianum*, and *Macaranga griffithiana*.

A large portion (44.8%) of the Study Area comprises urban vegetation, which comprises chalets, a carpark, paintball arena, high elements course and lawn. Urban vegetation was mostly characterised by *Axonopus compressus* and cultivated *Samanea saman*.

Abandoned kampung dominated by *Spathodea campanulata* could be found mostly adjacent to the areas categorised under urban vegetation. According to the BIA Guidelines (NParks, 2020) and past land use history, it is likely that these areas are abandoned orchards, although it is worth noting that native regeneration is also apparent

in these areas.

There were several small patches of scrubland habitats in the northern part of the Study Area. They are characterised by shrubs, grasses and herbs such as *Dicranopteris linearis*, *Imperata cylindrica* and *Melastoma malabathricum*, and climbers such as *Smilax setosa*, *Embelia ribes*, *Paederia foetida*, *Erycibe tomentosa* and *Tetracera indica*.

### 5.3.2 Flora Baseline Survey

The terrestrial flora baseline survey recorded a total of 111 flora entries identified to species level. Of these, 81 (73.6%) are native, 27 (24.5%) are non-native, and two (2) (1.8%) species are uncertain in origin. The summary of local conservation status of these species can be found below in Table 5-8. The species list and representative flora images are provided in **Appendix A** and **Appendix B**, respectively. The full flora inventory containing all the static parameters and photos for each flora entry were provided as additional attachments.

**Table 5-8** Distribution of flora species found in the Study Area based on local conservation status

Origin	Local Status	Number of Species	Percentage of Species
<b>Native</b>		<b>82</b>	<b>73.9%</b>
	Least Concern	62	55.9%
	Vulnerable	13	11.7%
	Endangered	4	3.6%
	Critically Endangered	2	1.8%
	Data Deficient	1	0.9%
<b>Non-native</b>		<b>27</b>	<b>24.3%</b>
	Cultivated Only	3	2.7%
	Casual	12	10.8%
	Naturalised	11	9.9%
	Excluded	1	0.9%
<b>Uncertain</b>		<b>2</b>	<b>1.8%</b>
	Cryptogenic	2	1.8%
<b>Total Number of Species</b>		<b>111</b>	<b>100.0%</b>

20 of all 111 species (18.2%) found within the Study Area were identified to be of conservation significance, 18 of which were assessed to be at least partially of native regeneration (Table 5-9) as these species are typically not cultivated.

**Table 5-9.** Flora species of local conservation significance encountered within the Study Area and likely source of stock. Flora species classified under “Either of Native Regeneration or Cultivated Stock” can either be of native germplasm or from germplasm of cultivated stock

S/N	Scientific Name	Common Name	Local Status
<b>Likely a result of Native Regeneration</b>			
1	<i>Callicarpa longifolia</i>	Long leaved beauty berry, Nasi-nasi	VU
2	<i>Dacryodes cf. rostrata</i>	Kedondong kerut, Kembayau	VU
3	<i>Ficus glandulifera</i>	Gaping fig	EN
4	<i>Ficus vasculosa</i>	White fig, Ara nasi	VU

5	<i>Glochidion zeylanicum</i> var. <i>zeylanicum</i>	-	VU
6	<i>Gynochthodes</i> cf. <i>praetermissa</i>	-	VU
7	<i>Gynochthodes rigida</i>	-	VU
8	<i>Lindera lucida</i>	-	VU
9	<i>Litsea umbellata</i>	Blue laurel, Medang	VU
10	<i>Macaranga</i> cf. <i>recurvata</i>	-	CR
11	<i>Macaranga griffithiana</i>	Mahang bulan, Mahang tutup	VU
12	<i>Morinda elliptica</i>	-	EN
13	<i>Pavetta wallichiana</i>	-	VU
14	<i>Rubus moluccanus</i> var. <i>angulosus</i>	Tempu rengat, Broad-leaf bramble	VU
15	<i>Trema tomentosum</i>	-	VU
16	<i>Uncaria</i> cf. <i>acida</i>	-	EN
<b>Likely of Cultivated Stock</b>			
1	<i>Sandoricum koetjape</i>	Sentul, Santol	VU
2	<i>Syzygium myrtifolium</i>	Kelat oil, Kelat paya	CR
<b>Either of Native Regeneration or Cultivated Stock</b>			
1	<i>Cayratia mollissima</i>	-	EN
2	<i>Dimocarpus lichi</i>	Mata kucing	DD

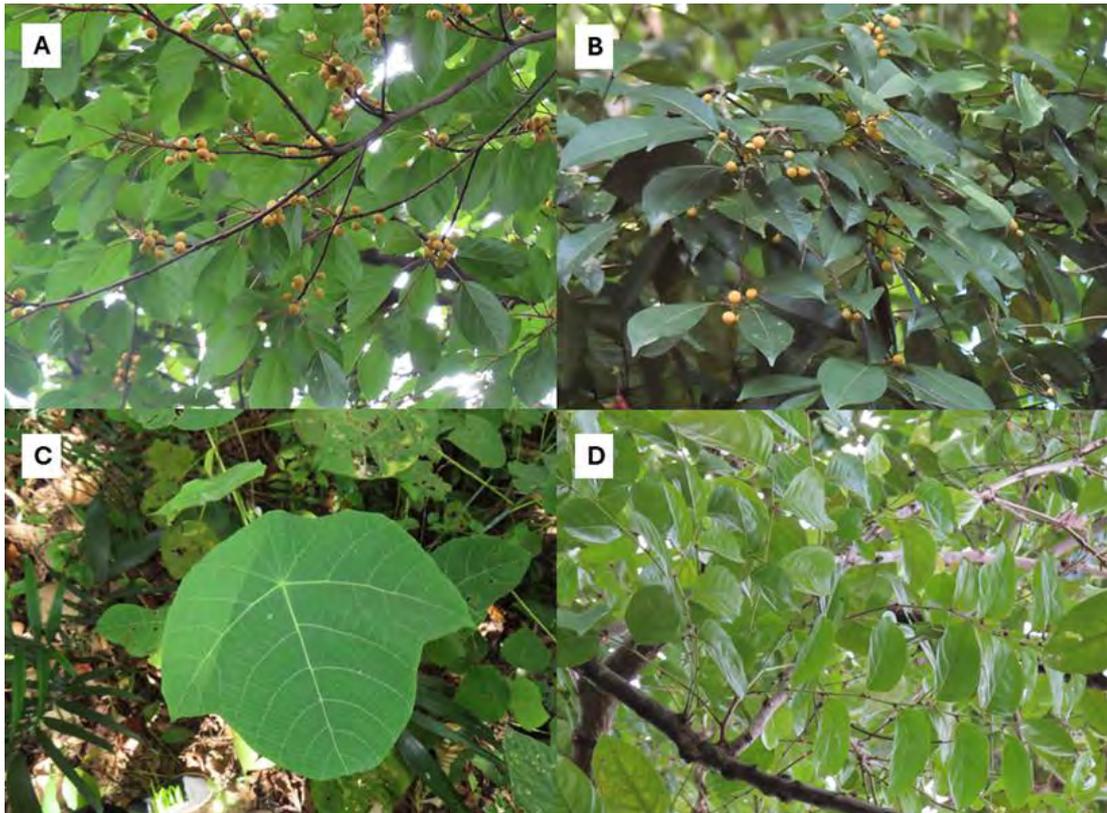
(Lindsay, et al., Flora of Singapore: Checklist and bibliography, 2022; NParks, 2023; Chong et al., 2009)

Generally, in forested areas, *Cinnamomum iners*, *Dillenia suffruticosa*, *Ficus variegata*, *Mallotus paniculatus*, *Clausena excavata* and *Claoxylon indicum* were the most abundant species of least concern in local status.

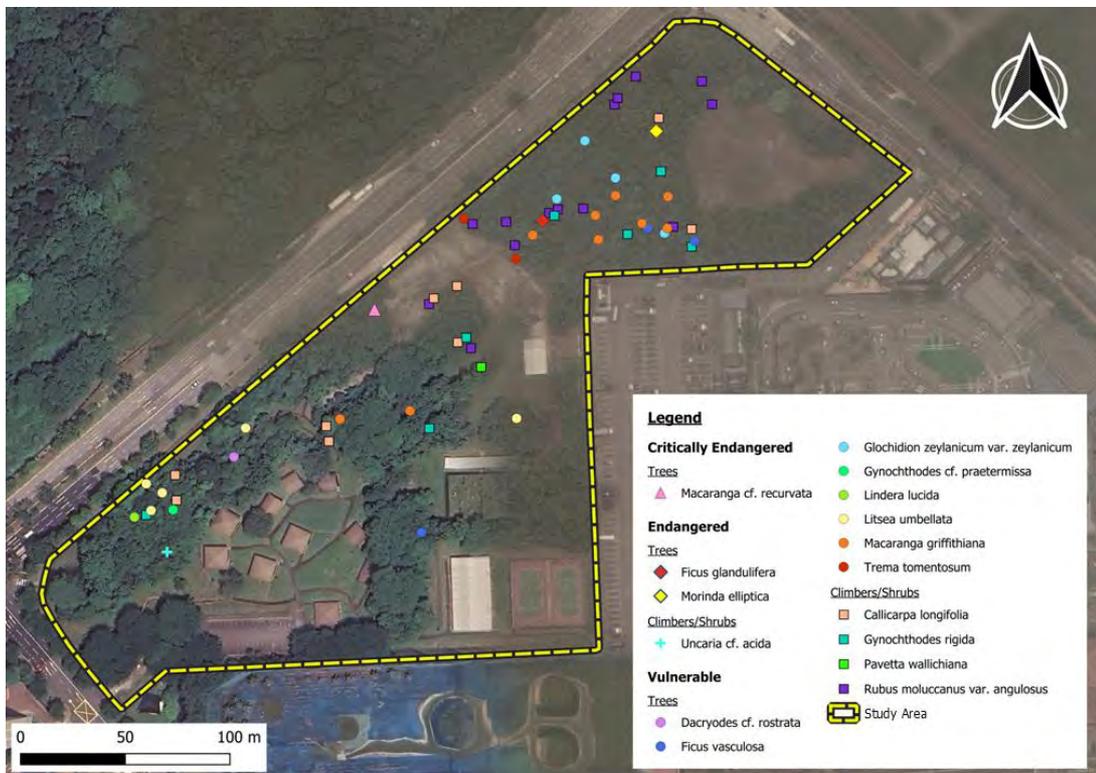
The Study Area is also home to the *Ficus glandulifera* and *Ficus vasculosa*, two keystone species of conservation significance. Notably, numerous Asian glossy starlings (*Aplonis panayensis*) and yellow-vented bulbuls (*Pycnonotus goiavier*) were observed to be foraging on a fruiting *Ficus vasculosa* tree.

Some of the flora species of conservation significance found in this baseline survey corresponded to previous records in nearby forest patches. *Glochidion zeylanicum* var. *zeylanicum*, *Callicarpa longifolia* and *Rubus moluccanus* var. *angulosus* were previously found in Tengah Forest (Singapore Herbarium Online, 2024; Jacobs, 2021); whereas *Macaranga griffithiana* and *Ficus vasculosa* could be found in Bukit Batok Town Park and Bukit Batok Hillside Nature Park, respectively (Neo et al., 2013; ESC, 2020). This may suggest seed dispersal and thus genetic exchange into and from the nearby forest patches.

Photos of four (4) of these species and the spatial distribution of species of conservation significance, likely a result of native regeneration, can be found in Figure 5-8 and Figure 5-9. respectively. *Cayratia mollissima* and *Dimocarpus lichi* were excluded from Figure 5-9. as they were locally abundant.



**Figure 5-8** Flora species of conservation significance. **A:** *Ficus glandulifera*; **B:** *Ficus vasculosa*; **C:** *Macaranga griffithiana*; **D:** *Glochidion zeylanicum* var. *zeylanicum*



**Figure 5-9.** Spatial distribution of flora species of CR, EN and VU conservation statuses likely of native regeneration, further categorised by trees and climbers/shrubs

There were eight (8) keystone flora species, with a total of 29 individuals. *Ficus* spp. are generally considered to be keystone species as the mature individuals provide steady supply of food for fauna throughout the year. Their spatial distribution is shown below (Figure 5-10.).

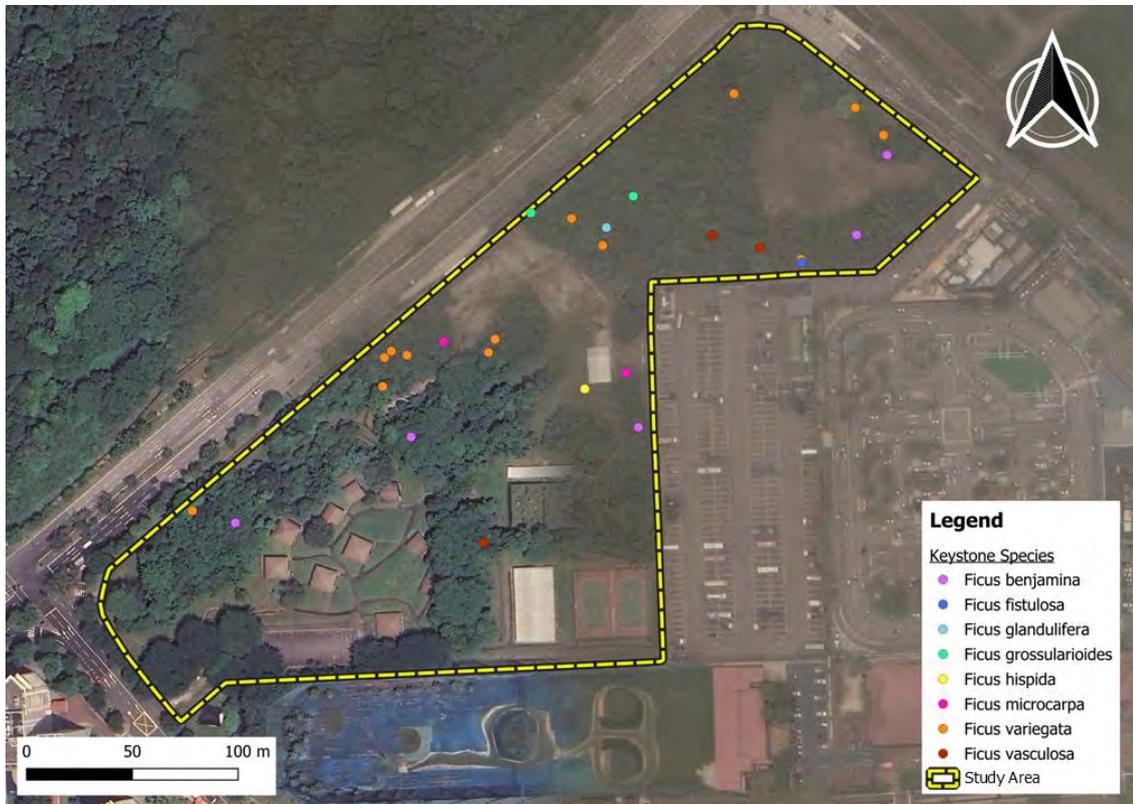


Figure 5-10. Spatial distribution of keystone flora species

### 5.3.3 Large Trees and VTA Summary

A total of 213 large trees ( $\geq 1$  m girth) consisting of 39 species were recorded during this terrestrial flora baseline study, the vast majority of which are common or exotic. In descending order of occurrence, the most common species within the Study Area are *Spathodea campanulata*, *Dillenia suffruticosa*, *Falcataria falcata*, *Cinnamomum iners* and *Ficus variegata*. There were only a few large trees of local conservation significance. These individuals tended to be concentrated in the NDYSF habitat in the northern part of the Study Area. The spatial distribution of large trees categorised by their local conservation status can be found in Figure 5-11.



**Figure 5-11.** Spatial distribution of large trees according to local conservation status

Visual tree assessment (VTA) had been conducted for large trees following International Society of Arboriculture (ISA) guidelines. As no development footprint had been provided at the time of writing, the recommendations were presented solely based on tree condition. Broadly, trees of fair health and structure with no defects were given no follow-up recommendations (i.e., prescribed “NIL”), but subject to change with development details. Where a tree of conservation significance had a combination of good structure and health, it was recommended to be retained. On the other hand, if a tree with defects was also an undesirable landscape species, it was generally recommended to be removed – for instance, *Spathodea campanulata* trees found to have previous branch failure wound or decay were recommended for removal. Examples of common tree structural defects can be found in Figure 5-12.



**Figure 5-12.** Examples of tree structural defects. **A:** Decay at tree base; **B:** Previous failure wound; **C:** Fruiting body; **D:** Multiple attachments

Out of the 213 large trees, slightly fewer than half of these trees (47.4%) were prescribed a “NIL” recommendation, although the plan and footprint of the future development are required to ascertain if the trees are to be removed or retained. About 89 (41.8%) of these trees are recommended to be removed, while a small proportion (9.9%) of trees have more specific recommendations (e.g., deadwooding, crown reduction, etc.). “Other” category is mostly relevant to the trees close to developed areas such as carpark and chalets, where we mostly recommended tree pruning if dead branches are observed above chalets and carparks.

One *Ficus glandulifera* located in vicinity to the proposed PRA (Section 5.6) was recommended to be retained. The summary of the VTA results such as health, structure and recommendations, and spatial distribution of all 213 trees according to recommendations are shown in Table 5-10 and Figure 5-14, respectively.



**Figure 5-13.** Trees recommended to be retained. **A:** *Ficus glandulifera*; **B:** *Ficus vasculosa*

**Table 5-10.** Summary of Tree Health

Health	Number of Trees	Percentage of Trees
Good	120	56.3%
Fair	86	40.4%
Poor	7	3.3%
<b>Total</b>	<b>213</b>	<b>100.0%</b>

**Table 5-11.** Summary of Tree Structure

Recommendation	Number of Trees	Percentage of Trees
Good	17	8.0%
Fair	107	50.2%
Poor	89	41.8%
<b>Total</b>	<b>213</b>	<b>100.0%</b>

**Table 5-12.** Summary of VTA recommendations

Recommendation	Number of Trees	Percentage of Trees
Retain	2	0.9%
Remove	89	41.8%
NIL	101	47.4%
Other	21	9.9%
<b>Total</b>	<b>213</b>	<b>100.0%</b>



**Figure 5-14.** Spatial distribution of large trees according to VTA recommendations

## 5.4 Fauna Survey Baseline Surveys

The study found a total of 117 species of terrestrial fauna, comprising three (3) species of local conservation significance. The complete list of terrestrial fauna sightings and photographs of observed animals can be found in **Appendix C** and **Appendix D** respectively which is summarised in Table 5-13.

**Table 5-13.** Number of species recorded and species of local conservation significance per terrestrial fauna group

Terrestrial Fauna Group		Total number of recorded species	Species of Local Conservation Significance		
			VU	EN	CR
Birds		45	1	1	-
Mammals	Non-volant mammals	4	-	-	-
	Bats	6	-	-	-
Reptiles		11	-	-	-
Amphibians		6	-	-	-
Butterflies		35	-	-	1
Odonates		10	-	-	-
<b>TOTAL</b>		<b>117</b>	<b>1</b>	<b>1</b>	<b>1</b>

### 5.4.1 Birds

Of the 429 species of birds known to occur in Singapore (Bird Society of Singapore, 2024), 45 species were recorded in the current surveys, of which two (2) are locally

threatened (NParks, 2024) (Table 5-14). Although the Javan myna (*Acridotheres javanicus*) is globally vulnerable (IUCN, 2024), it is not of local conservation value as it is non-native to Singapore.

**Table 5-14.** List of all bird species of local and global conservation significance observed in the Study Area.

No.	Family	Species name	Common Name	Local Status	Global Status
1	Psittacidae	<i>Psittacula longicauda</i>	Long-tailed Parakeet	NT	VU
2	Pycnonotidae	<i>Pycnonotus zeylanicus</i>	Straw-headed Bulbul	EN	CR
3	Sturnidae	<i>Acridotheres javanicus</i>	Javan Myna	-	VU
4	Zosteropidae	<i>Zosterops simplex</i>	Swinhoe's White-eye	VU	LC

Bird species recorded in the Study Area are generally typical of secondary forests, urban vegetation and parkland, comprising largely of sunbirds, starlings, bulbuls and doves. Although the extent of secondary forest in the Study Area is small, forest-associated species such as the greater racket-tailed drongo (*Dicrurus paradiseus*), pin-striped tit-babbler (*Mixornis gularis*) and olive-winged bulbul (*Pycnonotus plumosus*) were recorded (Figure 5-15.). Moreover, the presence of large open areas of maintained turf also support species such as the paddyfield pipit (*Anthus rufulus*) and scaly-breasted munia (*Lonchura punctulata*) (Figure 5-16.).



**Figure 5-15.** Birds recorded in the Study Area. **A:** Greater racket-tailed drongo (*Dicrurus paradiseus*); **B:** Olive-winged bulbul (*Pycnonotus plumosus*)



**Figure 5-16.** Birds recorded in open areas of maintained turf. **A:** Paddyfield pipit (*Anthus rufulus*); **B:** Scaly-breasted munia (*Lonchura punctulata*)

The globally critically endangered straw-headed bulbul (*Pycnonotus zeylanicus*) is a particularly noteworthy species as there are only an estimated 573 individuals in Singapore (Chiok et al., 2020). With declining numbers in South-East Asia, the Singapore population makes up 22.9-57.3% of its global population, making Singapore an important stronghold for this species (Chiok et al., 2019; Chiok et al., 2020). Though much of Singapore's population occurs in protected areas such as Pulau Ubin and BTNR, straw-headed bulbuls (*Pycnonotus zeylanicus*) are also frequently encountered in degraded scrubland and secondary forests that lie outside of protected areas (Yong et al., 2018), similar to those within the Study Area.

Other notable species recorded include the Asian brown flycatcher (*Muscicapa dauurica*), the sole migratory species recorded in the surveys, as well as the white-crested laughingthrush (*Garrulax leucolophus*) which is commonly seen in the Bukit Batok area.

#### **5.4.2 Mammals**

There are currently 76 known species of terrestrial mammals extant in Singapore (NParks, 2024). A total of four (4) non-volant mammal species and six (6) bat species were encountered during the current surveys, with no species of conservation significance. Of the non-volant mammals encountered, all are common in Singapore and found within a range of habitats around Singapore.

Recorded only in camera traps in this study, the common Malayan treeshrew (*Tupaia glis*) is a native species known to inhabit protected nature reserves in Singapore such as the CCNR, Bukit Batok Nature Park, and the Western Catchment, as well as adjacent scrubland and parkland (GBIF, 2023). The common Malayan treeshrew (*Tupaia glis*) possibly uses the study site to traverse between these forested catchments, underscoring the importance of ensuring ecological connectivity is retained during the upcoming development along BBNC.

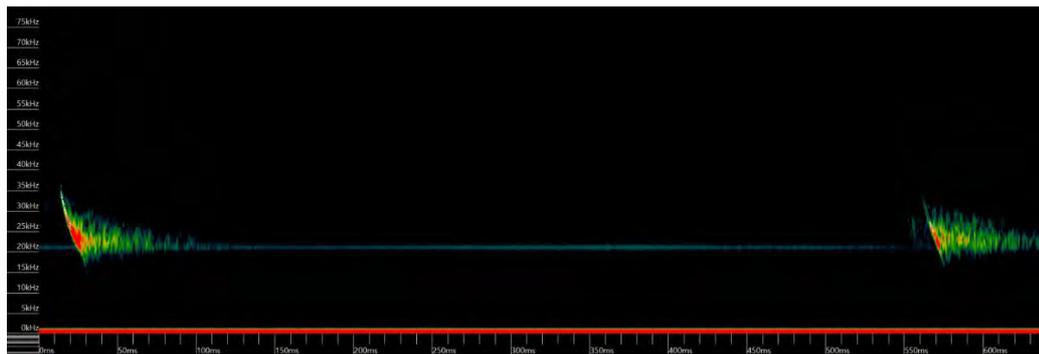
Known to thrive in urban areas, a feral cat (*Felis catus*) and an unidentified rat were recorded at the study site. While the surveyed area is forested, it is surrounded by both residential and non-residential urban areas. The encroachment of urban wildlife into the forested spaces in the Study Area suggests significant overlap between human-

inhabited spaces and wildlife habitats.

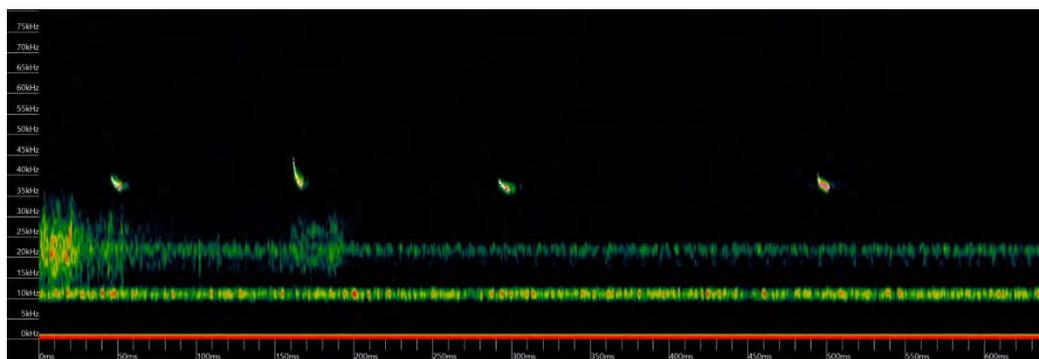
The call structure and spectrograms for the five (5) microchiropteran bat species recorded during acoustic sampling are presented in Table 5-15, and Figure 5-17 to Figure 5-21.

**Table 5-15.** Call structure summary of bat species recorded during acoustic sampling.

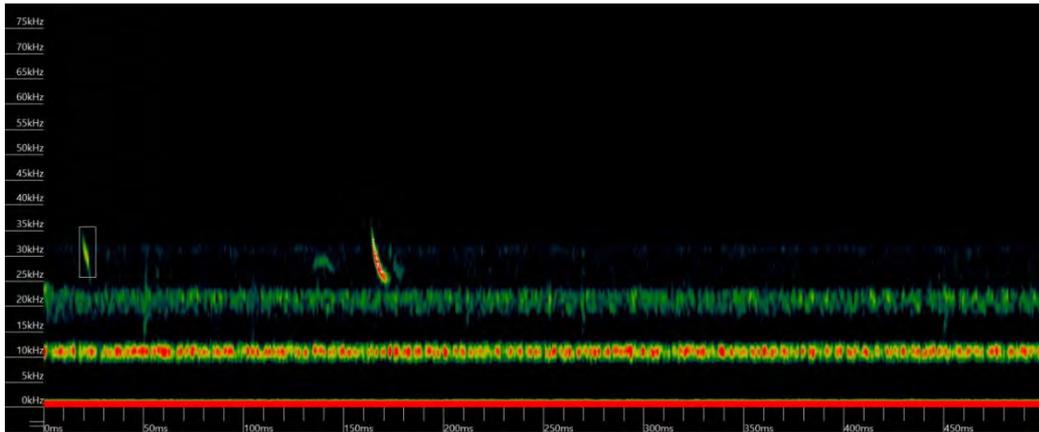
Species name	Frequency (kHz)		Peak Frequency (kHz)	Call duration (ms)	Source
	Maximum	Minimum			
<i>Saccolaimus saccolaimus</i>	23.5 ± 1.32	21.8 ± 1.42	22.6 ± 0.42	12.20 ± 0.08	(Pottie et al., 2005)
<i>Taphozous melanopogon</i>	28.7 ± 1.24	25.2 ± 0.82	27.9 ± 0.56	10.43 ± 0.06	(Pottie et al., 2005)
<i>Myotis muricola</i>	79.9 ± 1.02	53.7 ± 0.48	57.2 ± 0.01	4.98 ± 0.07	(Pottie et al., 2005)
<i>Scotophilus kuhlii</i>	84.9 ± 2.25	36.6 ± 0.46	43.3 ± 0.16	4.01 ± 0.03	(Pottie et al., 2005)
<i>Pipistrellus stenopterus</i>	56.0 ± 1.81	32.9 ± 0.28	37.8 ± 0.38	9.70 ± 0.21	(Kingston et al., 2003)



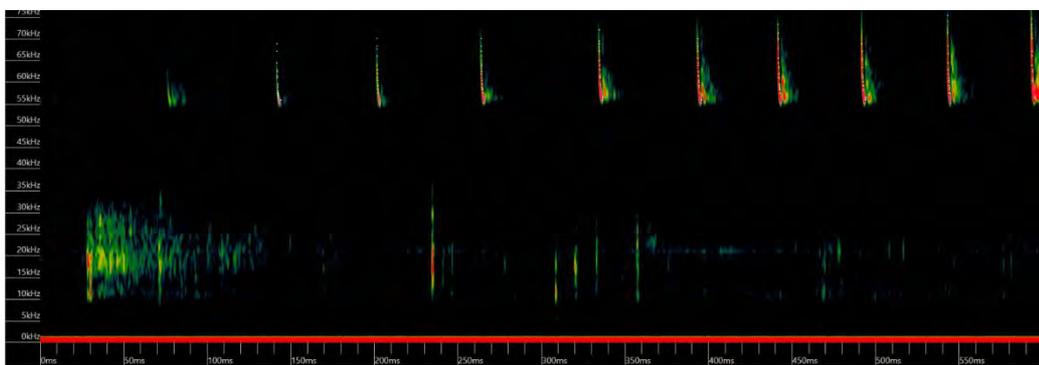
**Figure 5-17.** Spectrogram showing the acoustic call characteristics of *Saccolaimus saccolaimus*



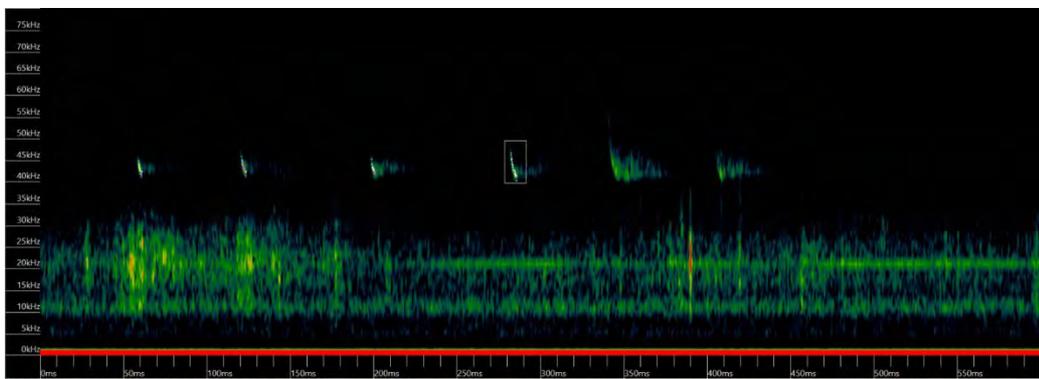
**Figure 5-18.** Spectrogram showing the acoustic call characteristics of *Pipistrellus stenopterus*



**Figure 5-19.** Spectrogram showing the acoustic call characteristics of *Tapozous melanopogon*



**Figure 5-20.** Spectrogram showing the acoustic call characteristics of *Myotis muricola*



**Figure 5-21.** Spectrogram showing the acoustic call characteristics of *Scotophilus kuhlii*

All six (6) bat species recorded are habitat generalists, adapted to foraging in open environments such as around artificial streetlights and tree crowns in suburban to urban areas (McKenzie & Bullen, 2019; Tzi et al., 2010; Zhu et al., 2012). Indeed, the Study Area is characterised by multiple sources of artificial light, including streetlights on roads bordering the site, as well as multiple path lights within the Study Area. This likely favours the use of the site by bat species adapted to urban environments disturbed by artificial light sources and noise. Apart from the lesser dog-faced fruit bat (*Cynopterus brachyotis*) which belongs to the megachiroptera suborder, all the remaining bats recorded during this study are from the microchiroptera suborder. Unlike microchiropteran bats, the lesser dog-faced fruit bat (*Cynopterus brachyotis*) utilises its keen sense of sight and smell to forage instead of using echolocation, which is why it

was not detected by calls and excluded from the acoustic sampling findings above. This species is also the only frugivorous bat recorded. Due to its ability to retain viable seeds for more than 12 hrs, this species is an important long-distance seed disperser (Shilton et al., 1999). This highlights the ecological importance of the Study Area also for seed dispersal, helping to improve genetic exchange and long-term population viability of forests.

### 5.4.3 Reptiles

A total of 11 species comprising 10 lizards and one (1) snake were recorded during the present surveys out of the 135 species of reptiles recorded in Singapore (Figueroa et al., 2023). Three (3) non-native species – the mourning lizard (*Lepidodactylus lugubris*), Brooke's house gecko (*Hemidactylus brookii*) and changeable lizard (*Calotes versicolor*) – and one (1) unidentified skink were recorded. The remaining seven (7) native species recorded are common and widely distributed in Singapore and are not locally or globally threatened (Figueroa et al., 2023).

The current surveys recorded both the native green crested lizard (*Bronchocela cristatella*) (Figure 5-22) and non-native changeable lizard (*Calotes versicolor*). Diong et al. (1994) and Figueroa (2023) assessed that the once ubiquitous species green crested lizard (*Bronchocela cristatella*) has been outcompeted and displaced mostly into forested habitats by the changeable lizard (*Calotes versicolor*). This species was introduced as recently as the 1980s and has rapidly proliferated to become the one of the most abundant reptiles in Singapore (Lim & Chou, 1990; Figueroa et al., 2023). Ginal et al. (2022) reported that changeable lizards (*Calotes versicolor*) had likely spread globally as stowaways on maritime routes and suggested that Singapore's position as a global trans-shipment hub may have further facilitated their dispersal to yet uncolonized regions.

The painted bronzeback (*Dendrelaphis pictus*) (Figure 5-22) was the only snake recorded. Considered to be the nation's most prevalent snake (Figueroa et al., 2023), the painted bronzeback (*Dendrelaphis pictus*) is regularly found in disturbed forest habitats like those found in the Study Area.



**Figure 5-22.** Reptiles recorded in Study Area. **A:** Green crested lizard (*Bronchocela cristatella*); **B:** Painted bronzeback (*Dendrelaphis pictus*).

#### 5.4.4 Amphibians

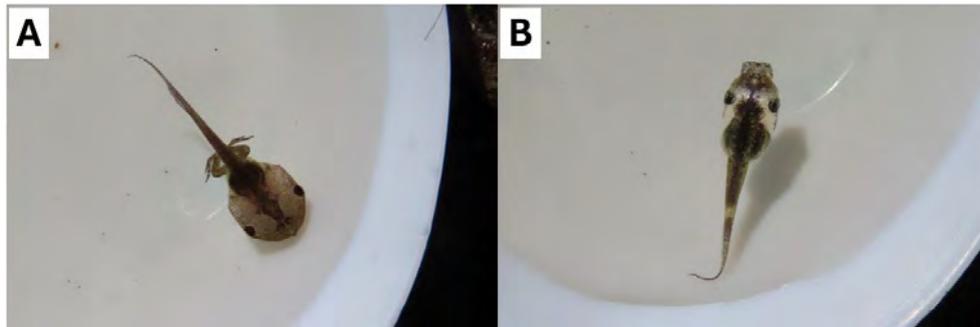
31 species of amphibians comprising two (2) caecilians and 29 frogs are currently known from Singapore (Figueroa et al., 2023). The present surveys in the Study Area reported six (6) frog species. Of these, two (2) – the four-lined tree frog (*Polypedates leucomystax*) and the dark-sided chorus frog (*Microhyla heymonsi*) – are native, while the remaining four (4) frogs are introduced. None of the species recorded were listed as locally or globally threatened.

The Asian toad (*Duttaphrynus bengalensis*), greenhouse frog (*Eleutherodactylus planirostris*), banded bullfrog (*Kaloula pulchra*) and Mukhlesur's narrow-mouthed frog (*Microhyla mukhlesuri*) are non-native and have established populations in Singapore (Figueroa et al., 2023) (Figure 5-23). In particular, the greenhouse frog (*Eleutherodactylus planirostris*) was by far the most frequently encountered amphibian in this study. This species hatches as small frogs from eggs laid in moist leaf axils or leaf litter (Kraus & Campbell, 2002) and may have been introduced to Singapore through the horticultural trade (Groenewoud & Law, 2016). The Mukhlesur's narrow-mouthed frog (*Microhyla mukhlesuri*) is considered invasive in Singapore and is now recorded in habitats where it may outcompete native other microhylid frogs that also inhabit leaf litter (Figueroa et al., 2023).



**Figure 5-23.** Non-native amphibians recorded in Study Area. **A:** Greenhouse frog (*Eleutherodactylus planirostris*); **B:** Banded bullfrog (*Kaloula pulchra*).

Larval forms of the banded bullfrog (*Kaloula pulchra*) and dark-sided chorus frog (*Microhyla heymonsi*) (Figure 5-24) were encountered opportunistically in July 2024 during the Southwest Monsoon season, where ephemeral water puddles had formed in a simpoh air (*Dillenia suffruticosa*) cluster with uneven ground conditions (Figure 5-25). The inundation of water between each simpoh air (*Dillenia suffruticosa*) cluster created microhabitats suitable for these frog species to breed in temporary puddles. The banded bullfrog (*Kaloula pulchra*) is known to often breed in temporary flooded bodies of water after periods of heavy rain regardless of the presence of leaf litter, whereas dark-sided chorus frog (*Microhyla heymonsi*) tadpoles tended to be found in ditches, ruts or flooded grassland (Leong & Chou, 1999).



**Figure 5-24.** Larval forms of amphibians found in ephemeral water puddles. **A:** Banded bullfrog (*Kaloula pulchra*); **B:** Dark-sided chorus frog (*Microhyla heymonsi*).



**Figure 5-25.** Ephemeral water puddles in simpoh air (*Dillenia suffruticosa*) cluster

Amphibian species richness is largely dependent on the degree of habitat structural complexity, types of waterbodies present and degree of human disturbance (Bateman & Merritt, 2022; Decena et al., 2020; Bickford et al., 2010). Anthropogenic modification of habitats has been shown to reduce the diversity of amphibians globally (Cordier et al., 2021; Hamer & McDonnell, 2008), as well as in Singapore (Bickford et al., 2010). The low amphibian species richness recorded corresponds with the current absence of permanent freshwater bodies and suggests that the habitats present may be unsuitable to support species with more stringent habitat requirements.

#### **5.4.5 Butterflies**

361 butterfly species are currently extant in Singapore (NParks, 2023). A total of 35 butterfly species were recorded in the Study Area during the present surveys. The

species recorded are mostly typical of urban vegetation, parkland and secondary forest habitat. The locally critically endangered Harlequin (*Taxila haquinus haquinus*) (NParks, 2023) was the sole species of conservation significance recorded (Table 5-16; Figure 5-26). Other notable species include the Malay staff sergeant (*Athyma reta moorei*) and dark tit (*Hypolycaena thecloides*).

**Table 5-16.** List of butterfly species of conservation significance found in the Study Area

No.	Family	Species name	Common Name	Local Status	Global Status
1	Riodinidae	<i>Taxila haquinus haquinus</i>	Harlequin	CR	-



**Figure 5-26.** Harlequin (*Taxila haquinus haquinus*) adult male.

In Singapore, the Harlequin (*Taxila haquinus haquinus*) had a restricted distribution, occurring only in Pulau Tekong and the Western Catchment Area despite the widespread occurrence and cultivation of its sole larval host, the seashore ardisia (*Ardisia elliptica*) (Khew, 2007; Yong et al., 2019; Kong et al., 2021; NParks, 2023). *Ex-situ* rearing and translocation efforts under the NParks species recovery programme has contributed to the occurrence of the Harlequin in new locations, namely Sungei Buloh Wetland Reserve and Pasir Ris Park (iNaturalist, n.d.; NParks, 2017). However, the viability of these translocated populations is yet to be determined. Given that only a single adult male Harlequin was recorded near T2P3 and no early stages were detected on *Ardisia elliptica* along the visual encounter transects, the likelihood of the species breeding within the Study Area is low. The individual recorded was likely an individual which had strayed either from their strongholds in Jalan Bahar or Tengah Forest.

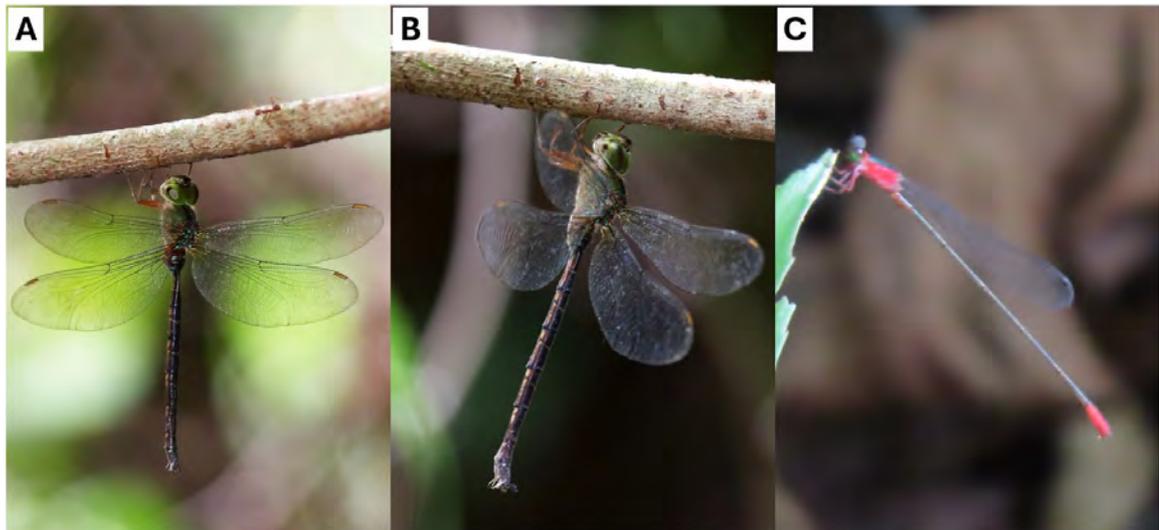
The Malay staff sergeant (*Athyma reta moorei*) occurs in primary and secondary forests in Singapore and is locally near-threatened (iNaturalist, n.d.; Khew, 2015; NParks, 2023). The larvae of the Malay staff sergeant were documented by Kirton et al. (2020) to feed on the locally vulnerable *Glochidion zeylanicum* var. *zeylaicum* (NParks, 2024), of which a mature tree was recorded in the Study Area.

Although the early stages of the Malay staff sergeant (*Athyma reta moorei*) were not encountered, the early stages of two (2) other forest species were observed. These are

the yamfly (*Loxura atymnus fuconius*) and dark tit (*Hypolycaena thecloides*), which were observed on their larval hosts, bearded smilax (*Smilax setosa*) and common flagellaria (*Flagellaria indica*), respectively (Corbet et al., 1992; Tan & Khew, 2012; Robinson et al., 2023). These species are not uncommon in Singapore and are found in suitable habitats such as primary forest, native dominated secondary forest or at forest fringes.

#### 5.4.6 Odonates

136 odonate species are recorded in Singapore, of which 126 are currently extant (Ngiam & Ng, 2022; NParks, 2022). A total of ten (10) species, comprising two (2) damselflies and eight (8) dragonflies, were recorded in the Study Area during the present surveys, all of which are native and widespread in Singapore (Ngiam & Ng, 2022; NParks, 2022). Of the ten (10) odonates found, the spear-tailed duskhawker (*Gynacantha dohrni*) and red-tailed sprite (*Teinobasis ruficollis*) occur in forested areas in Singapore (Figure 5-27), while the remaining eight (8) species inhabit disturbed habitats with suitable waterbodies for breeding, such as urban areas, grassland or parkland (Ngiam & Davison, 2011; Ngiam & Ng, 2022).



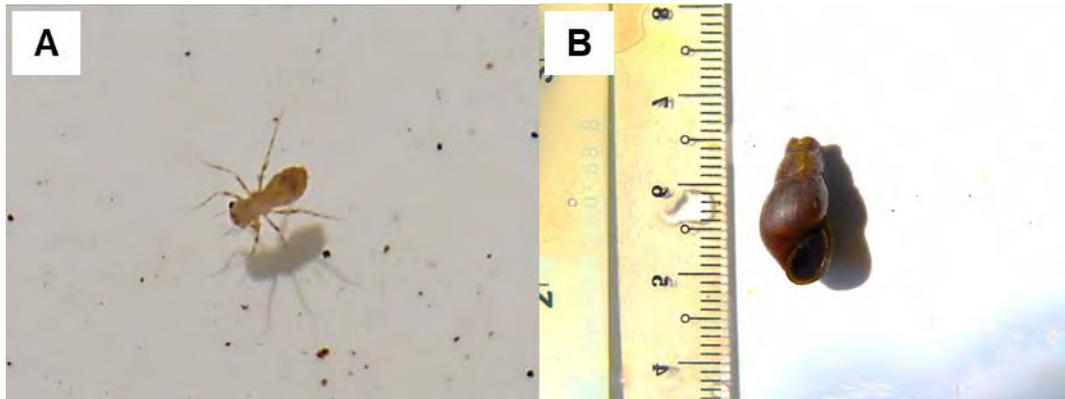
**Figure 5-27.** Forest-dependent odonata observed in the Study Area. **A–B:** spear-tailed duskhawker (*Gynacantha dohrni*) adult female; **C:** red-tailed sprite (*Teinobasis ruficollis*) adult male.

Both sexes of the spear-tailed duskhawker (*Gynacantha dohrni*) (Figure 5-27) were observed resting in the Study Area along all three (3) transects. This species is crepuscular and favours habitats with dense vegetation, breeding in shallow leafy-bottomed pools (Ngiam & Ng, 2022). Suitable breeding pools may form in the vicinity of SW03 during periods of prolonged rainfall, although male guarding or female ovipositing behaviours were not observed. The individuals observed may also have dispersed from breeding habitats nearby, to hawk for insects in the Study Area. This species has been recorded in nearby wooded areas such as Bukit Batok Hillside Nature Park (Gan, 2022).

A single red-tailed sprite (*Teinobasis ruficollis*) individual was observed in a patch of NDYSF near T3P5. It is a rare forest-dependent species inhabiting shaded areas in nature reserves and nature parks and may breed in similar pools as the spear-tailed

duskhawker (*Gynacantha dohrni*) (Murphy, 1997; Ngiam & Ng, 2022).

Indeed, a larval odonate (Figure 5-28) was encountered opportunistically in July 2024 in the same ephemeral puddle (Figure 5-28) as the two tadpole species detailed above. Odonates can breed in ephemeral puddles and fly elsewhere in their adult form once the puddle dries out. This suggests that when such puddles form in the Study Area during the monsoon season, a transient ecosystem with its own food web springs to life, composed of voracious predators to herbivores such as odonate nymphs or the freshwater Malayan trumpet snail (*Melanoides tuberculata*), respectively (Figure 5-28).



**Figure 5-28** Organisms found in an ephemeral water puddle. **A:** Larval odonate; **B:** Malayan trumpet snail (*Melanoides tuberculata*)

#### 5.4.7 Camera Trapping

The four (4) camera traps deployed yielded a total of 487 independent detections which comprise 19 identified fauna species (Table 5-17).

**Table 5-17.** Number of detections for each species per camera trap

S/N	Species	CAM 1	CAM 2	CAM 3	CAM 4
1	Clouded monitor	-	32	-	-
2	Collared kingfisher	1	-	-	-
3	Common Malayan treeshrew	14	39	3	-
4	Common emerald dove	1	5	17	-
5	Common mormon	-	1	-	1
6	Domestic cat	-	1	-	-
7	Laced woodpecker	-	1	-	-
8	Large-tailed nightjar	-	1	-	-
9	Olive-winged bulbul	1	-	-	-
10	Painted Jezebel	-	-	1	-
11	Pink-necked green pigeon	1	-	-	-
12	Plantain squirrel	16	9	10	5
13	Red junglefowl	3	71	16	2
14	Spotted dove	-	3	-	-
15	Sunda scops owl	3	-	4	-
16	White-breasted waterhen	-	140	-	-

S/N	Species	CAM 1	CAM 2	CAM 3	CAM 4
17	White-crested laughingthrush	7	1	7	-
18	Yellow-vented bulbul	-	1	-	1
19	Unidentified rat ( <i>Rattus</i> sp.)	13	61	13	1
-	Unidentified rail (Rallidae sp.)	-	1	-	-
-	Unidentified rodent	7	10	3	2
-	Unidentified	2	7	2	2
<b>Total Number of Detections</b>		<b>69</b>	<b>384</b>	<b>76</b>	<b>14</b>
<b>Total Number of Identified Species</b>		<b>10</b>	<b>14</b>	<b>8</b>	<b>5</b>

Ground-dwelling birds such as the red junglefowl (*Gallus gallus*) and white-breasted waterhen (*Amaurornis phoenicurus*) generally dominated the detections, especially evident in CAM 2 where they made up more than half of the detections. However, this is likely an over-detection of these birds, given that multiple chicks were captured for both species, suggesting that CAM 2 was likely located within or near the nesting ground of these birds.

CAM 2 also saw the highest species richness recorded in this study, though the species recorded are largely typical of disturbed habitats, consistent with its location in abandoned kampong habitat. On the other hand, CAM 3, located in the NDYSF habitat, saw the largest number of detections of the uncommon resident common emerald dove (*Chalcophaps indica*), as well as the Sunda scops owl (*Otus lempiji*) (Figure 5-29).



**Figure 5-29 A:** Common emerald dove (*Chalcophaps indica*); **B:** Sunda scops owl (*Otus lempiji*)

## 5.5 Discussion on Biodiversity Findings

The forested habitats within Study Area are highly fragmented by multiple trails and turfed fields between various sports and leisure facilities within HTNS Bukit Batok Adventure Centre. This fragmentation<sup>4</sup> has caused the formation of multiple forest edges characterised by species adapted to disturbed areas, such as sun-loving climbers including *Mikania micrantha*, *Tetracera indica*, and tree species *Macaranga conifera* and *Mallotus paniculatus*. Despite the high level of fragmentation, regeneration of late-successional forest species was observed in both the NDYSF habitats, and to a lesser extent in the abandoned kampung habitat, which include *Litsea umbellata*, *Syzygium*

<sup>4</sup> Forest fragmentation refers to the subdivision of large, continuous forested areas into small fragments by human-made structures such as roads (Franklin et al., 2002). Habitat fragmentation has been found to reduce biodiversity by 13 to 75% globally and cripple key ecosystem functions (Haddad et al., 2015).

*grande* and *Syzygium cerasiforme*.

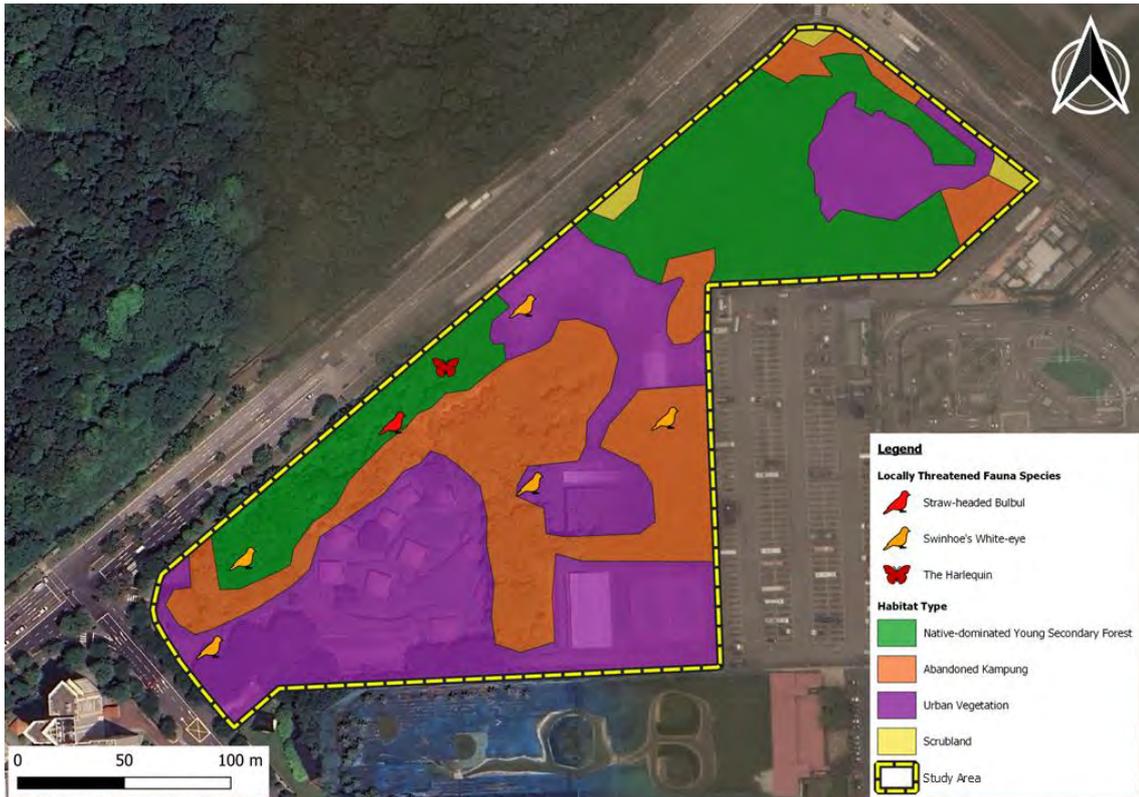
Many flora species of conservation significance occurred singly or in small numbers on site, such as *Pavetta wallichiana*, *Macaranga cf. recurvata*, *Lindera lucida*, *Morinda elliptica* and *Dacryodes cf. rostrata*. These species produce small fleshy fruits, and their occurrence suggests fauna-assisted seed dispersion across the neighbouring forest parcels, especially to the NDYSF habitats in the Study Area.

The presence of a few mature figs is also of ecological significance in the Study Area. *Ficus* species are widely considered to be keystone species in tropical Southeast Asia owing to their provision of a steady supply of ripe syconia year-round (Lok, et al., 2013). In fact, mature *Ficus vasculosa*, *Ficus glandulifera*, *Ficus variegata* and *Ficus microcarpa* individuals were observed to be fruiting. Besides mature figs, multiple flora species observed in the Study Area are fauna-attracting, such as *Rubus moluccanus* var. *angulosus*, *Leea indica* and *Callicarpa longifolia*.

Several frugivorous birds were recorded in the study, such as the Asian glossy starling (*Aplonis panayensis*), doves and bulbuls. A particularly notable finding in the current surveys was the record of the straw-headed bulbul (*Pycnonotus zeylanicus*) detected in the NDYSF habitat (Figure 5-30). Its occurrence has also been noted in surrounding areas of Tengah Forest and Bukit Gombak Nature Park (iNaturalist, 2023; iNaturalist, 2022) suggesting that this species potentially uses the Study Area to travel between the Western and Central Catchment Areas.

Singapore is a major stronghold for the straw-headed bulbul as it is the only location in the world where its population is known to be increasing (Yong et al., 2018). The straw-headed bulbul is a highly prized songbird in the pet trade, leading to extensive poaching of the wild bulbul population in its geographic range of South-East Asia. Combined with the pervasive threat of habitat loss, this species is critically endangered (CR) globally and is close to extirpation or extirpated in Sumatra, Java, Myanmar and Thailand (Eaton, et al., 2015; Shepherd, Shepherd, & Foley, 2013), where it is native. Singapore has made great progress through its strict enforcement against poaching and strong conservation efforts; in 2017, it was found that the straw-headed bulbul population was increasing steadily on Pulau Ubin, while remaining stable on the Singapore mainland (Yong, et al., 2018).

Combining floristic and faunistic findings, the NDYSF habitats in the Study Area, where a large proportion of species of conservation significance was found (Figure 5-30), should be prioritised for conservation as far as possible. Given the assemblages found in the Study Area, this location may not just be beneficial, but necessary in the greater ecological connectivity in the western region of Singapore. For example, a study on odonates found that ecological networks are suggested to be as effective as protected areas for conservation (Pryke et al., 2015), highlighting the need for well-planned wildlife corridors to preserve and protect Singapore's biodiversity.



**Figure 5-30** Locally threatened fauna species found in the Study Area

## 5.6 Areas of Ecological Value

The Study Area lies in the northwestern-most part of the BBNC, a series of nature parks, nature ways and park connectors (NParks, 2024) (Figure 5-31) linking forest patches west of the CCNR (Figure 2-3). In the immediate vicinity of the Study Area lies Tengah Forest Corridor to the west and Bukit Gombak Park to the east. Hence, an AHEV is identified in the Study Area to serve as an important stepping stone habitat in the northern section of the BBNC. The AHEV makes up 26.9% of the Study Area and consists of three zones – Zones A, B, and C of 0.93 ha, 0.1 ha and 0.45 ha, respectively (Figure 5-32).

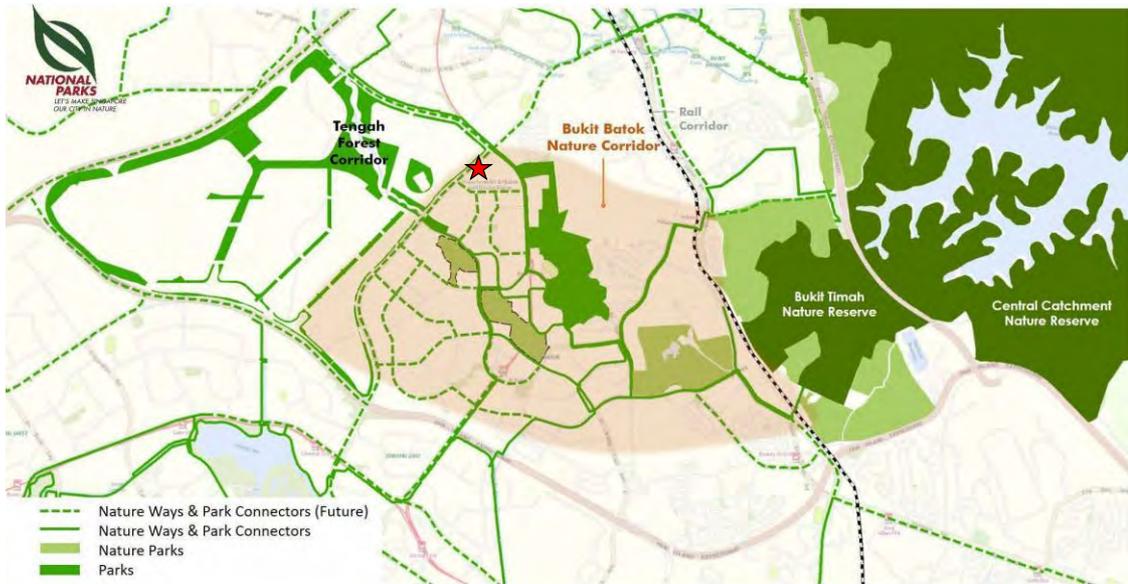


Figure 5-31. Map of the BBNC, with location of Study Area marked by a red star <sup>5</sup>



Figure 5-32 AHEV in the Study Area

### 5.6.1 Zone A

Zone A is consisting predominantly of NDYSF habitat, bisected by a patch of maintained

<sup>5</sup> <https://www.facebook.com/nparksbuzz/photos/a.228201063886044/3702442039795245/?type=3>

lawn. It contains multiple flora species of conservation significance, such as a mature *Ficus glandulifera*, *Glochidion zeylanicum* var. *zeylanicum* and locally abundant climbers and shrubs including *Rubus moluccanus* var. *angulosus*, *Gynochthodes rigida* and *Callicarpa longifolia*. The northern portion of zone A also includes an area that forms ephemeral water puddles during the wet season, supporting some aquatic fauna including snails and frogs, as detailed in Section 5.4.4.

This zone is identified primarily because of its proximity and complementarity to a forested patch in Tengah North, separated by Bukit Batok Road. An Environmental Impact Study conducted in 2021 and EMMP updated in 2024 had identified a 14.9 ha Recommended Area of Conservation (RAC) in the eastern boundary of the site to enhance connectivity to forests in Bukit Batok and Bukit Gombak (Jacobs, 2021; AECOM, 2024) (Figure 5-33).



**Figure 5-33** Location of Tengah North RAC relative to Zone A of the AHEV

The Tengah North RAC was proposed to be retained to provide connectivity for volant species such as birds and butterflies (Jacobs, 2021; AECOM, 2024). Zone A improves overall ecological connectivity in the area by allowing volant species to disperse further eastwards and vice versa.

Additionally, in the current study, the globally critically endangered straw-headed bulbul (*Pycnonotus zeylanicus*) was recorded in the western boundary of the site at Zone A. This species was also largely recorded in the eastern boundary of the Tengah North site where the RAC is located (Jacobs, 2021). Since it is likely that the straw-headed bulbul (*Pycnonotus zeylanicus*) moves between Tengah Forest and the Study Area, conserving Zone A may prove critical in maintaining gene flow for this species along the BBNC and

beyond.

### 5.6.2 Zone B

Zone B is a linear strip of at least 10 m width, consisting of a mix of all four habitat types recorded in this study – NDYSF, abandoned kampung, urban vegetation, and scrubland – located on the eastern boundary of the Study Area. Despite the relatively lower overall flora species diversity, it maintains connectivity towards the east. Choa Chu Kang Park Connector (CCKPC) across Bukit Batok West Avenue 5 from the Study Area provides connectivity to Bukit Gombak Park, which lies just 155 m away from the Study Area (Figure 5-34).



**Figure 5-34** Location of Bukit Gombak Park and CCKPC relative to Zone B of the AHEV

Zone B is identified to encourage crossing between the Study Area and Bukit Gombak Park through CCKPC. Bukit Gombak Park is one of two major pathways through which fauna can move between Tengah Forest and BTNR, the other being through Bukit Batok Hillside Nature Park and Bukit Batok Central Nature Park further south.

### 5.6.3 Zone C

Zone C is contiguous with the northern portion of Zone A and contains the most mature NDYSFs in the Study Area (Figure ). The zone has multiple mature native tree species such as *Claoxylon indicum*, *Mallotus paniculatus* and *Clausena excavata*, and the forest edges are dominated by large populations of *Rubus moluccanus* var. *angulosus* and *Callicarpa longifolia*.



**Figure 5-35** Location of Tengah North RAC relative to Zone C of the AHEV

Zone C has wetter soil compared to the drier western portion of Zone A, as evidenced by the presence of several tree species associated with waterlogged soils or swampy areas, such as *Glochidion zeylanicum* var. *zeylanicum* (Yao, et al., 2020) and *Macaranga griffithiana* (Whitmore et al., 2024). It is possible that Zone C can serve as a refuge for fauna species dependent on the nearby ephemeral water puddles at Zone A.

Terrestrial connectivity of the identified AHEV will unlikely be usable by most amphibians due to the lack of permanent water bodies. As such, other conservation strategies such as translocation or captive breeding may be more suitable in ensuring amphibian gene flow across the BBNC for native frog species. However, for amphibian species with less stringent habitat requirements such as the native dark-sided chorus frog (*Microhyla heymonsi*) whose larvae were found in an ephemeral water puddle in Zone A (Figure 5-24), the wetter soil in Zone C appears to be sufficient to allow gene flow across the Study Area.

#### **5.6.4 Proposed Retained Area (PRA) and mitigation measures**

The Proposed Retained Area (PRA) was determined through a comprehensive evaluation of several factors, including site constraints, development considerations, ecological connectivity, Tree Protection Zones (TPZ), and the viability of the existing vegetation.

The PRA will retain 0.48 ha of the existing vegetation at the west of the Study Area with

width averaging 20m. It comprises of native-dominated young secondary forest and compensatory planting size of 0.24 ha. It will retain 25 large trees in addition to the *Ficus glandulifera* (Figure 5-36).



**Figure 5-36** Proposed PRA, proposed trees to retain and complementary planting area

Given the site constraints and development considerations such as planned road widening works at Bukit Batok Road and Bukit Batok West Avenue 5, future development plans as laid out in the Master Plan 2019 including construction of a future MRT station, the AHEV is adjusted to derive the final proposed retained area (PRA). The PRA recommendation involved the following key considerations:

- 1) The future road reserve line was considered to determine the outer boundary of the proposed PRA
- 2) Potential areas for ecological connectivity enhancement are identified and considered to be part of the PRA at Bukit Batok Road and towards Bukit Batok West Ave 5, which will be achieved by implementing green buffer along the proposed PRA outer boundary of 3m and 5m width subject to road category.
- 3) The boundary of proposed PRA is further refined by considering the recommended tree protection zones of the trees to determine the inner boundary of the proposed PRA.

The PRA was determined in consultations with the agencies and consideration of the impacts assessed. The proposed PRA retains 0.48 ha of existing vegetation strip at the west of the Study Area with width averaging 20m and allowing implementation of TPZ

for the large trees within this PRA, and compensatory planting size of 0.24 ha. The resulting PRA will lead to retention of 11 flora species of conservation significance and 25 large trees in addition to the *Ficus glandulifera* (Figure 5-36).

Impact assessment for the proposed PRA is detailed in subsequent sections.

## 5.7 Impact Assessment

The pre-construction, construction, and operation phases of the development could have a range of impacts on the ecology and physical environment of the Study Area. With retention of PRA, the residual impacts according to RIAM are Minor Negative to Slight Negative and Minor Positive for habitat enhancement during the operation phase.

### 5.7.1 Identification of Sources of Potential Impacts

Sources of impacts on the sensitive biodiversity receptors is the felling of trees, earthworks, infrastructure works and building works. Tree felling and vegetation clearance contribute to habitat loss, changes to ecological connectivity, and species mortality for both flora and fauna. As the site is part of the BBNC ecological connectivity is also affected. Sources of impacts during the different phases of the project are identified as the following:

#### *Pre-construction / Construction Phase*

- Vegetation clearance for vehicular access, storage of equipment, setting up of temporary hoarding, and other forms of working space (temporary)
- Vegetation clearance and tree-felling activities (permanent)
- Heavy construction activities such as piling (temporary)
- Noise from earthworks, infrastructure works and building works (temporary)
- Generation of light and noise (temporary)
- Surface runoff and siltation (temporary)

#### *Operation Phase*

- Human-wildlife conflict (permanent)
- Edge effects on the PRA from increased light and noise due to increased human activity (permanent)
- Changes to ecological connectivity to other vegetated areas in the vicinity (permanent)

### 5.7.2 Identification of Potential Impacts

This section summarises the potential impacts affecting biodiversity receptors that may take place during the pre-construction, construction, and operation phases.

#### *Pre-construction / Construction Phase*

The project involves vegetation clearance excluding the PRA. The following section details these impacts.

### Habitat Loss – Native Dominated Secondary Forest

As vegetation clearance and tree felling will be carried out on site and part of the earthworks. Vegetation clearance leads to the loss of habitats for fauna species and reduction of foraging habitat, food sources, roosting, breeding and nesting sites, and other resources needed for the continued survival of a species. The clearance works will result in the loss of native-dominated young secondary forests and the loss of such habitats is of high consequence.

### Species Mortality

The sensitive biodiversity receptors are identified to be the flora and fauna species present within the Study Area. During the pre-construction and construction phase, there will be vegetation clearance and tree felling as part of the earthworks. These activities will cause the mortality flora species on site. The impact of species mortality will be direct. With retention of PRA, retention of 11 flora species of conservation significance is expected.

Impact assessments on species mortality typically focus on species that are globally or locally threatened according to the local and international databases. Section 5.3 presented the composition of flora and fauna on the project site. Overall, the project site contains a few flora and fauna species of conservation value. Amongst the threatened fauna species observed in the Study Area all of them are volant (e.g., birds) and highly mobile.

Given these species' capability to fly, they are likely able to use other similar habitats in the area, including the remaining forested patches Tengah North Forest and Bukit Gombak Park. However, with rapid developments in Singapore in recent years, the number of suitable habitats for such species are decreasing, and few studies have been done to show the carrying capacity of remaining patches of habitat for fauna species. Apart from the threatened fauna species, birds in general are particularly vulnerable while they are nesting and will be impacted if schedules of vegetation clearance do not consider the possibility of nesting birds.

Additionally, some animals, particularly reptiles and amphibians, may become entrapped when navigating through the worksite, especially by getting stuck in ECM blankets or falling into pits. Measures should ensure this is minimized throughout the construction period.

### Ecological Connectivity to Other Vegetated Areas in Vicinity

The Study Area is located along the BBNC, which aims to provide ecological connectivity between the Western Catchment, BTNR and CCNR. As the Study Area serves as a stepping stone between Tengah Forest Corridor, and CCNR the loss of habitats will affect the overall ecological connectivity of the BBNC.

### Edge Effects

Edge effects are commonly observed when vegetation clearance creates new forest edges. These new edges are then exposed to abiotic and biotic changes such as increased light intensity and temperature, noise, increased soil nutrient content, and

changes in air and soil moisture levels. Should there be nightworks within the area, artificial lighting may also cause species disturbance. Alteration of natural cycles of light and dark by artificial light sources can negatively impact the ecosystem if not managed properly. Some fauna species, particularly nocturnal species which rely on their hearing for movement, communication, and foraging, are vulnerable to increased night-time noise levels. The edge effect may lead to changes in microclimates, forest structure, and ecological interactions. Gradual deterioration of habitats and changes in flora and fauna communities in the areas adjacent to the proposed development due to edge effects may also occur.

#### Potential Roadkill

The Study Area is bounded by three roads – Bukit Batok Road and Bukit Batok West Avenue 5 and 7. Bukit Batok Road is a major road with higher traffic. During the construction phase, traffic volume is also likely to increase from construction vehicles accessing the site. Mitigation measures should be implemented to minimise any incidence of roadkill. Roadkill may pose negative impacts on both the wildlife present on the site as well as drivers along the road.

#### Human–Wildlife Conflict

The presence of wildlife within the project site may result in human-wildlife conflict during the construction phase. Measures should be taken to prevent fauna species from entering the working area, and that construction personnel are trained in actions to take upon wildlife encounters. Without such measures, there will be a higher risk of injury to construction personnel or fauna species during the construction phase.

#### Disturbance To Flora and Fauna Species from Generated Light and Noise

Impacts to flora and fauna within the PRA from light and noise pollution should be avoided particularly for sensitive or threatened species highlighted in Chapter 4. Increased artificial light during the night disrupts the circadian rhythms of animals and distorts the day-night cycle of plants. Impacts include increased predation pressure by diurnal carnivores on nocturnal animals, exhaustion of insects being attracted to artificial light, foraging disruption of birds, and the alteration of breeding and sleeping cycles.

Moreover, artificial night lights have been shown to have an impact on migratory birds, a large proportion of which migrate at night. In general, the risk of bird collisions increases with increased light emissions (Ogden, 2002). Insects such as fireflies communicate through bioluminescent signals, which can only be achieved in the absence of background light (Longcore & Rich, 2004). Fruit bats play the ecological role of seed dispersers and pollinators, and reduced foraging activities in artificially illuminated areas may result in the loss of pollinating and seed-dispersal services they provide (Lewanzik & Voigt, 2014).

These examples of altered foraging, reproduction, migration, and communication behaviour are all a result of disorientation due to the altered light environment. The cumulative effects of such behavioural changes induced by artificial night lighting can have the potential to disrupt key ecosystem functions (Longcore & Rich, 2004). The source of impacts includes artificial lighting used to illuminate the project site, particularly if night works are conducted. The impacts of light on the fauna in the remaining PRA

(used by nocturnal species including various species of bats and frogs) will be further exacerbated by nightworks and edge effects.

Fauna species within the PRA are likely to be impacted by increased noise levels. These impacts are more likely for nocturnal species such as bats and frogs as they rely on their sense of hearing for movement, communication, and foraging. Chronic and frequent noise such as traffic noise interferes with animals' abilities to detect important sounds, whereas intermittent and unpredictable noise such as piling, honking from vehicles and machinery and shouting is often perceived as a threat (Francis & Barber, 2013). This can alter the species behaviour and impair their ability to forage and avoid predation, leading to decreased survivability. The effects of noise on fauna are poorly understood since both stimuli and responses can vary.

### ***Operation Phase***

The main impacts from this project are likely to be felt during the construction phase. However, due to the Study Area's proximity to Tengah North Forest, its designated RAC and the possible retention of the PRA, there will likely still be impacts on biodiversity. An increase in human activities will likely lead to an increase in noise levels, light levels, and potential human-wildlife conflict.

### ***Human-wildlife Conflict***

The presence of a forested area (e.g., Tengah North Forest directly adjacent to residential buildings or within the PRA) will result in wildlife being in closer proximity to the residents. If measures are not taken to exclude animals from residential buildings, and to raise the residents' awareness to the surrounding biodiversity, human-wildlife conflict is more likely to occur.

### ***Disturbance To Flora and Fauna Species from Generated Light and Noise***

During the operation phase, the high-rise residential blocks and increased human traffic to the area will result in far higher light levels due to the closer proximity of the light sources to the remaining PRA. Higher noise levels from anthropogenic activities are expected to cause impacts to fauna within the PRA.

### ***Overall Impact***

Based on the assessment above, some of the potential impacts on site's biodiversity are deemed to be permanent in nature while the others are short-term and reversible. Appropriate measures are to be proposed to minimise these impacts.

Additionally, impacts of physical parameters are discussed in the relevant chapters. Impacts of surface water quality are addressed in Chapter 6, impacts of noise are discussed in Chapter 7, impacts related to air quality are discussed in Chapter 8, impacts related to light are discussed in Chapter 9, impacts of waste management are discussed in Chapter 10, impacts related to vector control are discussed in Chapter 11.

### **5.7.3 Mitigation Measures**

Mitigation measures are to be implemented wherever significant negative impacts are predicted, to reduce the impacts on the environment. Most of the biodiversity mitigation measures are covered in this chapter. Additionally, mitigation measures related to other environmental aspects are covered in relevant chapters as well.

#### ***Pre-construction / Construction Phase***

##### ***Site Hoarding***

The full working area should be hoarded, with hoardings embedded at a depth of 300 mm to prevent animals from digging under the hoarding. The Contractor should engage an Arborist to ensure that the hoarding does not damage any major tree roots (of retained trees both inside and outside the hoarding). Hoarding should be monitored regularly to ensure that no animals may enter the site either through gaps or by digging under the hoarding. In the event of any wildlife encounter, the Contractor should follow the wildlife response and rescue plan elaborated in the EMMP document.

Mortality from roadkill of highly mobile fauna species such as monitor lizards should be avoided. Having a hoarding along the work site, as well as directional phased clearance of trees in the direction towards the PRA, could help to prevent animals from running onto the road.

##### ***PRA Hoarding***

In addition to hoarding up the boundaries of the project boundary there should be hoarding installed along the boundary of the PRA to minimise impacts to its retained habitat. The PRA hoarding is to be installed after wildlife shepherding and phase clearance is conducted on site. The hoarding should be installed properly with no gaps to ensure that there is no wildlife movement from the PRA into the construction site.

##### ***Management of Human–Wildlife Encounters***

As described above, mortality from roadkill can be avoided by installing hoarding around the worksite to prevent animals from running onto the roads. To prevent other wild animals from scavenging at the construction site, areas for food consumption, storage, and waste disposal should be demarcated and maintained. There should also be no consumption of food and drink within forested areas. The presence of snakes, bees, long-tailed macaques may pose a threat to human health and safety. Although during the baseline surveys no long-tailed macaques were observed, given the site's proximity to the Tengah Forest, long-tailed macaques have also been considered as a potential presence on site. Prior to the commencement of works, beehives should be relocated out of the construction site to reduce the risk of such encounters. Wildlife proof bins can also be utilised in the site to discourage macaques from returning to site.

NParks' advisory on how to keep macaques at bay are provided on their website (<https://www.nparks.gov.sg/avs/animals/wildlife-in-singapore/macaques>).

Construction personnel should also be briefed on what to do should they encounter specific wild animals. In the event of wildlife encounters, the Wildlife Response and Rescue Protocol, which will be elaborated upon in the CEMMP document, should be

followed.

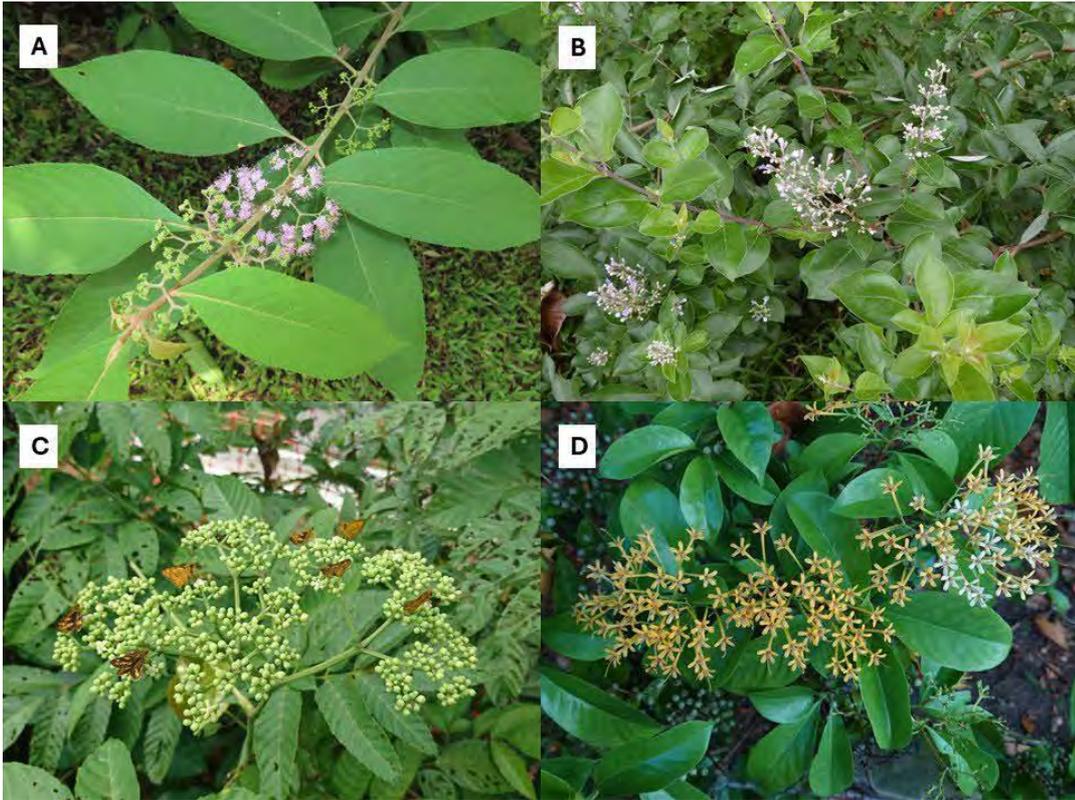
**Plant Salvaging and Planting of Native Species**

To remedy the adverse impact to biodiversity, it is recommended to salvage saplings and small individuals of plants of conservation value within understorey patch that will be affected by development works. We recommend the transplanting of *Callicarpa longifolia*, *Ficus vasculosa*, *Glochidion zeylanicum* var. *zeylanicum*, *Lindera lucida*, *Litsea umbellata*, *Pavetta wallichiana*, *Rubus moluccanus* var. *angulosus* and *Trema tomentosum*.

Native and fauna-attracting plants can be included in the landscape design of the future development, a list of recommended plants can be found in Table 5-18 and photos of some of the plants can be found in Figure 5-37.

**Table 5-18** Recommended native flora species to be included in the landscape design of the future development

No.	Scientific name	Common name	Growth form
1	<i>Ardisia elliptica</i>	Seashore ardisia, Mata pelandok	Shrub, Tree
2	<i>Callicarpa longifolia</i>	Long leaved beauty berry, Nasi-nasi	Shrub
3	<i>Clerodendrum disparifolium</i>	Swaddling flower, Celeguri	Shrub, Tree
4	<i>Clerodendrum villosum</i>	-	Shrub, Tree
5	<i>Leea indica</i>	Bandicoot berry, Common tree-vine	Shrub, Tree
6	<i>Melastoma malabathricum</i>	Common sendudok, Singapore rhododendron	Shrub, Tree
7	<i>Syzygium grande</i>	Sea apple, Jambu laut	Tree
8	<i>Kopsia singaporensis</i>	Singapore kopsia	Shrub, Tree
9	<i>Tarennia fragrans</i>	River tarennia	Shrub, Tree
10	<i>Vitex trifolia</i>	Simpleleaf chastetree	Shrub



**Figure 5-37** Fauna-attracting shrubs to be considered for planting between streetscape trees.  
**A:** *Callicarpa longifolia*; **B:** *Vitex trifolia*; **C:** *Leea indica*; **D:** *Tarenna fragrans*. A and C are species that naturally occur in the Study Area

#### Enhancements to Nature Corridor Outside AHEV

The absence of contiguous tree canopy between the Tengah North RAC, Study Area and Bukit Gombak Park may restrict the use of the AHEV to volant animals such as birds and butterflies. Bukit Batok Road is a major six-lane road, with intermittent planting of trees on the centre divider. The tree species planted include the rain tree (*Samanea saman*), island lychee (*Pometia pinnata*), Sentul (*Sandoricum koetjape*) and golden penda (*Xanthostemon chrysanthus*), among which only the rain tree (*Samanea saman*) can form a spreading canopy, as the other species tend to form relatively columnar and compact canopy. Bukit Batok West Avenue 5, on the other hand, is a four-lane road with no plantings on the centre divider. Although the CCKPC contains dense shrub planting, the pavement beside the Study Area only comprises sparse planting of *Khaya senegalensis* and *Pentaspadon motley* (Figure 5-38)



**Figure 5-38** Site conditions showing sparse canopy between streetscape trees. **A–B:** Bukit Batok Road; **C–D:** Bukit Batok West Avenue 5.

As part of Bukit Batok Township Nature Way, CCKPC is already characterised by multi-tiered planting aimed at creating a forest-like structure along roads to strengthen connectivity between green spaces (NParks, 2024) (Figure 5-39). TAC recommends that more shrub species can be planted in between the existing streetscape trees along Bukit Batok West Avenue 5 opposite CCKPC. These will not only provide more habitat niches and food sources for fauna, but also allow forest-dependent species to cross between suitable habitats more easily.

AECOM (2024) also recommended sparsely planted landscaping along the edges of Bukit Batok Road to reduce the risk of roadkill by disincentivising ground-dwelling fauna to move along busy road junctions. As such, native single-stem forest species which do not form large fleshy fruits are recommended for planting to encourage mainly volant animals to utilise this corridor. Such species include pianggu (*Horsfieldia irya*), shore laurel (*Neolitsea cassia*), spicate eugenia (*Syzygium zeylanicum*), and penaga laut (*Calophyllum inophyllum*). These plantings seek to complement the Tengah North RAC, which increases in width south-westwards to funnel wildlife towards a potential wildlife crossing across Bukit Batok Road along Bukit Batok West Avenue 7 (AECOM, 2024).



**Figure 5-39** Planting style and density of CCKPC

#### Flora Management Plan

The detailed plant salvaging and tree protection guidelines will be provided in the CEMMP document, including the requirements of personnel qualification, specifications of nursery, transplanting, tree assessment, tree felling and so on. A summary of the flora management plan with guidelines to arborist and flora monitoring is provided below.

Prior to any site clearance and plant salvaging processes, the Contractor is to liaise with NParks on plants they plan to salvage.

A basic arborist assessment matrix had been prepared during baseline survey period. Upon award of contract and confirmation of development footprint, the Contractor will need to engage their arborist to assess the trees listed in the arborist assessment matrix, record any new large trees with unique tree id number, and prepare an arborist assessment report. The arborist assessment report shall record tree information such as site and tree photos, species, height, girth, crown spread, tree health, form, structure, site observations and assessment for the trees affected by proposed development footprint. The arborist assessment report should also include mitigation measures to reduce construction impact on trees to be retained. This tree assessment report will then serve as a record of pre-development tree condition, and to be utilised when performing monthly monitoring for retained trees on site.

Trees identified for retention onsite or at the boundaries of the construction footprint of the working area and boundary of the PRA should be demarcated by Tree Protection Zones (TPZs) determined by an ISA-certified Arborist. TPZ should be installed prior to construction zone, and monthly monitoring should be conducted by the Arborist to

maintain records of tree health and TPZ integrity. If the tree needs to be pruned due to machinery access, the pruning will need to be carried out by landscape contractors with relevant qualifications under supervision of the Arborist.

#### Tree Felling Protocol

Prior to the any tree felling, HDB's Standard Operating Procedure (SOP) on tree felling must be implemented. This includes labelling each tree with laminated or weather protected A4 sheet to indicate if the tree is to be retained, felled, or translocated. This minimizes the risk of felling any trees that were supposed to be retained.

During tree felling operation works, the Contractor shall exercise all necessary precaution to ensure safety of workers and road users.

#### Flora Monitoring

The Contractor will need to engage a flora specialist to conduct monthly flora monitoring of PRA during the whole construction period. Some of the key monitoring parameters include:

- Identify any vegetation disturbance that are of natural causes (e.g. tree failure)
- Identify any vegetation disturbance that might be of manmade causes (e.g. machinery damage, soil erosion due to excavation)
- Along the forest edges of retained forest patches, regular weeding shall be conducted with help of the Contractor's workers to remove clusters of *Miconia crenata*, *Miconia dependens* and saplings of exotic species such as *Acacia auriculiformis*, *Cecropia pachystachya*, *Falcataria falcata* and *Leucaena leucocephala* to minimize disturbance to forest edge

#### Pre-felling Fauna Inspections

Mortality of fauna species should be avoided. In general, all the fauna of conservation value recorded are either volant or highly mobile, hence the works should not greatly affect their survivability. However, several measures can be put in place to further decrease species mortality. Prior to any tree felling, the project site should be inspected for nests, tree holes, and burrows. If any active nesting activity is observed, young birds should be allowed to fledge prior to tree felling. If necessary, other species (e.g., mammals) should be translocated prior to tree felling.

#### Phased Directional Clearance

Tree Protection Zones (TPZs) are to be set up for all retained trees before any tree felling activity commences. In situations where a tree to be felled falls within the TPZ of a retained tree, an Arborist should be present to monitor the tree removal. If the retained tree is likely to be affected during the felling, the Arborist can provide recommendations on the spot.

As the project site is isolated and does not have physical connectivity to other vegetated areas, wildlife shepherding to areas outside the Study Area is not possible. As such phased directional clearance is recommended, where clearance will be carried out in phases. This will allow easier management of non-volant fauna on site, in conjunction to phased clearance active translocation of target non-volant fauna is to be carried out.

The details of the proposed directional tree felling plan will be further elaborated on in the EMMP document. Commencement of tree felling works are also to avoid the peak nesting period of many birds (between the months of February and July) if possible. Moreover, the equipment used to crush the tree trunks should be well-maintained and in good working condition to prevent buildup of dead wood on site.

#### *Avoiding Impacts on Sensitive Habitats Within the PRA*

Direct impacts on important habitats should be avoided and direct impacts on other habitats should be minimised where possible. The placement of working spaces should avoid the PRA, which comprises of native-dominated secondary forest habitat. If the PRA is affected, mitigation measures should be put in place. Species in PRA likely to be affected by increased noise, light, and vibration disturbance. To reduce these impacts, hoarding should be installed to surround the entire working area, if night works are to be carried out a Light Management Plan (LMP) is to be developed and implemented to reduce impacts from light, and machinery causing vibration may be placed on isolators. The details of these impacts are further elaborated upon in their respective chapters. Indirect impacts to important habitats outside the Study Area (e.g., Tengah North Forest) should also be avoided.

#### *Ecological Connectivity*

There is also a feasibility study by NParks on proposed non-volant fauna crossings between Study Area, within Tengah and beyond Tengah. These non-volant fauna crossings can potentially connect to the PRA during pre-construction and construction phases to provide connectivity for non-volant fauna between the Study Area and surrounding greeneries.

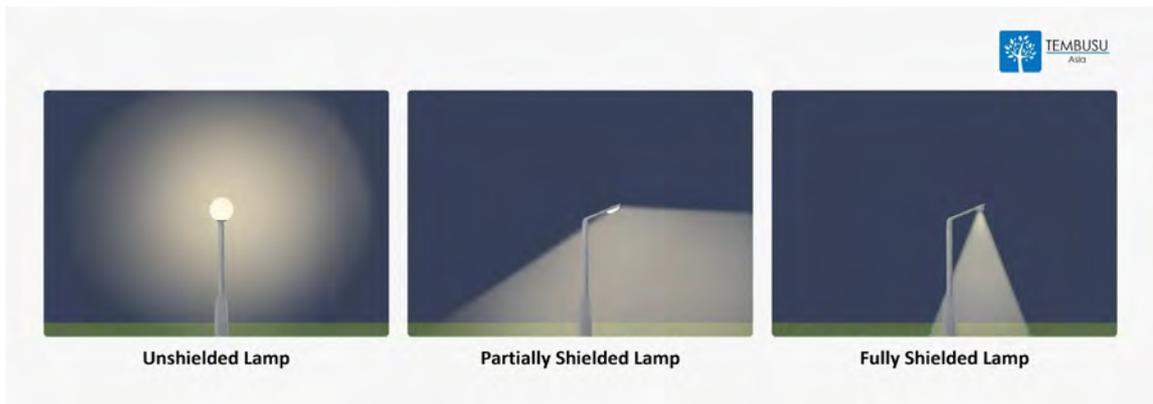
#### *Minimising Fauna Entrapment*

All ECM blankets used throughout the site should be made of biodegradable material with no plastic mesh netting. These blankets should minimise the likelihood of entrapment of fauna such as snakes and monitor lizards. ECM blankets and pits should be inspected daily to identify and rescue any entrapped fauna.

#### *Work Timings for Heavy Construction for Light Management*

Due to the sensitive nature of forest animals, particularly nocturnal animals, heavy construction works (including tree clearance, piling, and pipejacking) are recommended to be scheduled within daylight hours (8 am – 6 pm) if possible. Should there be a need for nightworks within 35m of the PRA boundary, a detailed LMP should be developed with consultation with NParks prior to the start of nightworks to mitigate light impacts.

If light nightworks are to be conducted, construction lights should be shielded, and facing downwards and away from forested areas, which will eliminate light falling outside the area intended to be lit (known as light spill). Examples of ideal shielded lighting can be seen in Figure 5-40 . All artificial lights should be turned off outside working hours unless required for safety & security reasons



**Figure 5-40.** Example of ideal light shielding

The LMP should minimally include the following aspects:

- Objectives of LMP
- Purposes and categories of artificial lighting required
- Spatial layout of lighting utilised in project site
- Designs of lighting utilised – including height and shielding design
- Specifications of lighting utilised – lighting temperature, spectrum, and brightness
- Additional measures in place if white or non-shielded lighting is required
- Implementation of monitoring plan

### Noise Management

A 6m noise barrier (STC20) shall be maintained along the PRA boundary facing the construction area for protection of the RPA biodiversity and conservation of the trees. The exact hoarding heights might be subject to change and shall follow the final CEMMP document.

Additionally, the following recommendations should be implemented during pre-construction and construction phase:

- Schedule heavy construction works within daylight hours (8 am – 6 pm) if possible
- Use acoustic enclosures for noise-generating equipment such as rig engines, compressors, generators, drilling tools, etc
- Install portable noise barriers around drilling rigs
- Install a silencer at the exhaust pipe of the engines throughout drilling operations
- Stagger piling activities (e.g., sheet piles, bored piles, and RC piles) where possible to minimise cumulative impact
- Avoid piling where possible (e.g., install concrete footing instead of piling)
- Deploy quieter equipment and vehicles where possible
- Use a silent piler for sheet piling work where possible
- Use hydraulic and electric tools in place of pneumatic equipment such as concrete breakers where possible
- Implement any means of reducing the sound levels for any exhaust systems in bulldozers, dump trucks and excavators

- Ensure all noise and acoustic barriers are able to reduce at least 10dB(A) from source noise levels
- Remind construction personnel on noise-reduction behaviours (e.g., reducing the drop height of materials) during daily toolbox meetings
- Care shall be taken when loading or unloading vehicles, dismantling, or moving materials to reduce impact noise
- Start-up plant and vehicles sequentially instead of simultaneously
- Ensure all machinery used are well-maintained
- Shut down vehicles and machinery when not in use
- For vehicles and machinery known to emit high levels of noise in one direction, orientate the noise away from the PRA

In summary, the mitigation measures that should be implemented to mitigate the impacts on sensitive biodiversity receptors as follows:

- Schedule heavy construction activities within daylight hours (i.e., 8 am – 6 pm) if possible
- Install and embed hoarding along the perimeter of the working boundaries
- Ensure project layout avoids targeted sensitive receptors and habitats within the PRA
- Conduct relocation of fauna when required
- Physically tag trees to be retained and transplanted on site
- Establish Tree Protection Zones (TPZ) for trees to be retained
- Physically demarcate Tree Protection Areas for retained trees
- Ensure safety of construction personnel during tree felling
- As far as practicable, avoid the commencement of tree felling during the peak bird nesting period (February to July)
- Visually inspect trees and holes for nesting fauna prior to felling
- Conduct daily checks of ECM blankets and pits to rescue any entrapped fauna
- Ensure ECM blankets are made of biodegradable material with no plastic mesh netting
- Implement proper ECMs to prevent impact to adjacent habitats
- Utilise inert construction material
- Ensure equipment, vehicles, and footwear are in good working condition prior to commencing works
- Establish designated areas for food consumption and waste disposal
- Conduct information sessions for workers on what to do in wildlife encounters
- Conduct regular monitoring of trees and vegetation health within the project site
- Conduct regular water quality monitoring at ECM discharge points

The mitigation measures that should be implemented in the PRA are as follows:

- No encroachment and construction activities within the PRA
- Ensure no dumping of construction debris in the PRA
- Identify plants of conservation significance or native origins to be transplanted in the PRA area or used for landscaping where possible
- Conduct relocation of beehives or fauna when required

- Engage an Arborist to monitor the tree removal in situations where a tree to be felled falls within the TPZ of a retained tree
- Conduct daily checks of ECM blankets and pits to rescue any entrapped fauna
- Implement proper ECMs to prevent impact to the PRA and its biodiversity
- Ensure ECM blankets are of biodegradable material with no plastic mesh netting

### ***Operation Phase***

The impacts from the operation phase of this project are related mostly to an increase in human presence in the area, leading to increased levels of noise and light into PRA (if retained), species and habitat disturbance, and potential human wildlife conflict. The following general mitigation measures are proposed to mitigate some of these impacts. Mitigation measures for the impact of noise and light during the operation phase are further addressed in their respective chapters.

### ***Habitat Enhancement***

In order to reduce the impacts of edge effects on the PRA, its edges should be planted with hedge plants and other forested plants. This can be done utilizing salvaged native common species from the land clearance stage. The planting palette for the edge should include native species of various plant forms (e.g., tree, shrub, herbaceous plants) to mimic the structure of a healthy forested area.

### ***Ecological Connectivity***

The design of the future developments will take into consideration the ecological connectivity of the site, which strives to create a connection between the Tengah Forest Corridor, the Study Area and Bukit Gombak Park. Conceptually, a proposed green link weaving through the future developments consisting of selected species planted at strategic locations, can help provide canopy and understorey layers to facilitate volant fauna movement. Green buffers of 3 to 5 meters within development area can be designed as to facilitate volant fauna movement. Non-volant fauna crossings between Study Area, within Tengah and beyond Tengah are currently under study by NParks. These crossings could potentially complement the development designs to further increase the Study Area's connectivity to surrounding greeneries.

### ***Develop Biodiversity Awareness among Residents***

Programmes to familiarize residents should be developed to cultivate an awareness of wildlife in the area and what to do should wildlife be encountered. This could take the form of signages around the PRA. By developing an understanding of the natural world among people, this could help to reduce negative wildlife encounters.

### ***Noise and Light Management***

As with the pre-construction/ construction phases, light spill should be minimised as far as possible using shielded lighting (Figure 5-40) and directed downwards and away from vegetated areas. Other measures to be implemented include:

- Adjust the number and intensity of lights abutting the PRA to minimum levels required for safety and security
- Use motion-activated lighting in areas less frequently visited

For noise, as per HDB guidelines, residents are to be advised to avoid noisy recreational activities during the quiet hours between 10:30 pm and 7:00 am. Enforcement should also be carried out for noise nuisances in common spaces such as entertainment and F&B outlets; and amenities such as playgrounds, pavilions, void decks, basketball, and badminton courts after 10.30 pm.

#### **5.7.4 Evaluation of Impacts**

Table 5-19 summarises the impacts listed in Section 5.7.2 evaluated using the RIAM method with their corresponding Environmental Scores for retention of PRA. With due consideration that the recommended mitigation measures listed in Section 5.7.3 are implemented by the Contractor, the residual impacts were once again evaluated using the RIAM method. Residual impacts are expected to be in the minor negative to no impact range if all the mitigation measures are implemented

**Table 5-19.** Environmental Scores of the identified impacts on site's biodiversity with corresponding mitigation measures for Study Area activities

Phase	Impact Component	Sensitive Receptors	Predicted Impacts Without Mitigation							Mitigation Measures	Residual Impacts With Mitigation						
<b>Ecology</b>																	
Pre-Construction and Construction	Habitat loss due to vegetation clearance	Flora	4	-3	3	3	3	-108	Moderate Negative	<ul style="list-style-type: none"> <li>Retention of part of native-dominated young secondary forest with PRA</li> </ul>	4	-2	3	3	3	-72	Minor Negative
		Volant fauna	3	-3	3	3	3	-81	Moderate Negative		3	-2	3	3	3	-54	Minor Negative
		Non volant fauna	3	-3	3	3	3	-81	Moderate Negative		3	-2	3	3	3	-54	Minor Negative
	Ecological connectivity to other vegetated areas in vicinity	Flora	3	-4	3	3	3	-108	Moderate Negative	<ul style="list-style-type: none"> <li>Retention of PRA</li> <li>Potential PRA connectivity to proposed wildlife bridge and animal culvert</li> </ul>	3	-3	3	3	3	-81	Moderate Negative
		Volant fauna	3	-4	3	3	3	-108	Moderate Negative		3	-3	3	3	3	-81	Moderate Negative
		Non volant fauna	1	-1	3	3	3	-9	Slight Negative		1	1	3	3	3	9	Slight Positive
	Species mortality due to vegetation clearance	Flora	3	-4	3	3	3	-108	Moderate Negative	<ul style="list-style-type: none"> <li>Retention of PRA</li> <li>Phased directional clearance of vegetation</li> <li>Active translocation of wildlife</li> <li>Visual inspections of trees and holes for nesting birds and animals prior to felling.</li> <li>Plant salvaging</li> </ul>	3	-2	3	3	3	-54	Minor Negative
		Volant fauna	3	-2	3	3	2	-48	Minor Negative		3	-1	3	3	2	-24	Slight Negative
		Non volant fauna	2	-3	3	3	2	-48	Minor Negative		2	-2	3	3	2	-32	Slight Negative
	Edge Effect on Proposed Retained Area (PRA)	Flora	2	-3	3	2	3	-48	Minor Negative	<ul style="list-style-type: none"> <li>Hoarding of at least 4m along the PRA boundary</li> <li>No encroachment into PRA</li> </ul>	2	-2	3	3	3	-36	Slight Negative
		Volant fauna	2	-3	3	2	3	-48	Minor Negative		2	-1	3	3	3	-18	Slight Negative
		Non volant fauna	2	-3	3	2	3	-48	Minor Negative		2	-1	3	3	3	-18	Slight Negative
	Roadkill or road injury to fauna attempting to cross the road.	Non volant fauna	2	-3	3	2	2	-42	Minor Negative	<ul style="list-style-type: none"> <li>Hoarding of Study Area prior to vegetation clearance and works</li> <li>Phased/directional clearance of vegetation</li> <li>Wildlife shepherding and translocation</li> </ul>	2	-1	3	2	2	-14	Slight Negative
		Volant fauna	1	-2	3	2	2	-14	Slight Negative		1	-1	3	2	2	-7	Slight Negative

	Human-Wildlife Conflict	Non volant fauna	1	-2	3	2	2	-14	Slight Negative	<ul style="list-style-type: none"> <li>• Designated eating areas for construction personnel</li> <li>• Biodiversity awareness training for construction personnel</li> <li>• Wildlife Response and Rescue Protocol</li> <li>• Wildlife incidence reporting framework</li> </ul>	1	-1	3	2	2	-7	Slight Negative
	Noise Disturbance to fauna species around the Study Area (e.g., Tengah Forest North) and within the PRA due to construction activities	Volant fauna	2	-3	2	2	3	-42	Minor Negative	<ul style="list-style-type: none"> <li>• Install 6 m high noise barriers (STC20) around PRA boundary and section of boundary facing sensitive receptors</li> <li>• Schedule heavy construction works within daylight hours (8 am – 6 pm) if possible</li> <li>• Conduct continuous noise level monitoring throughout the construction phase</li> <li>• Maintain construction noise levels within NEA's acceptable limits</li> <li>• Use acoustic enclosures for noise-generating equipment such as rig engines, compressors, generators, drilling tools, etc</li> <li>• Install portable noise barriers around drilling rigs</li> <li>• Install a silencer at the exhaust pipe of the engines throughout drilling operations</li> <li>• Stagger piling activities (e.g., sheet piles, bored piles, and RC piles)</li> <li>• Avoid piling where possible (e.g., install</li> </ul>	2	-2	2	2	3	-28	Slight Negative
		Non volant fauna	2	-3	2	2	3	-42	Minor Negative		2	-2	2	2	3	-28	Slight Negative



	planting and landscaping	Non volant fauna	3	1	3	3	3	27	Slight Positive	-	3	1	3	3	3	27	Slight Positive
	Human-Wildlife Conflict	Volant fauna	1	-2	3	2	2	-14	Slight Negative	<ul style="list-style-type: none"> <li>Wildlife-proof bin centres and bins</li> <li>Educational signage on wildlife</li> </ul>	1	-1	3	2	2	-7	Slight Negative
		Non volant fauna	1	-2	3	2	2	-14	Slight Negative		1	-1	3	2	2	-7	Slight Negative
	Edge Effects on Proposed Retained Area (PRA)	Flora	2	-3	3	2	3	-48	Minor Negative	<ul style="list-style-type: none"> <li>Maintain buffer distance between PRA and development footprint</li> <li>Buffer planting along PRA boundary</li> <li>Adjust design of development to reduce anthropogenic activities nearby to PRA</li> </ul>	2	-2	3	2	3	-32	Slight Negative
		Volant fauna	2	-3	3	2	3	-48	Minor Negative		2	-2	3	2	3	-32	Slight Negative
		Non volant fauna	2	-3	3	2	3	-48	Minor Negative		2	-2	3	2	3	-32	Slight Negative
	Disturbance to fauna species in and around the project site due to noise from anthropogenic activities	Volant fauna	1	-3	2	2	3	-21	Slight Negative	Enforcement actions to deter noise nuisances from residents at common spaces and amenities after 10.30 pm.	1	-2	2	2	3	-14	Slight Negative
		Non volant fauna	1	-3	2	2	3	-21	Slight Negative		1	-2	2	2	3	-14	Slight Negative
	Disturbance to the flora and fauna in Proposed Retained Area (PRA) due to lights from high-rise residential blocks and increased human traffic	Flora	2	-2	3	2	3	-32	Slight Negative	<ul style="list-style-type: none"> <li>Use shielded lights that are directed downwards and away from PRA</li> <li>Adjust the number and intensity of lights abutting the forest to minimum levels required for safety and security</li> <li>Use motion-activated lighting in areas less frequently visited</li> <li>Buffer planting with hedges along the boundary of the PRA</li> </ul>	2	-1	3	2	3	-16	Slight Negative
		Volant fauna	2	-2	3	2	3	-32			2	-1	3	2	3	-16	Slight Negative
		Non volant fauna	2	-2	3	2	3	-32			2	-1	3	2	3	-16	Slight Negative

## 6 Surface Water Quality

This section describes the relevant legislations and standards for water quality that are applicable to the current project, and the methodology and results for the baseline water quality in the Study Area.

### 6.1 Relevant Environmental Legislation, Guidelines, and Standards

Singapore environmental legislations concerning the management and/or protection of surface water quality, which are used as guiding documents throughout various project development stages (i.e., pre-construction, construction, and operation), are presented below:

#### ***Sewerage and Drainage Act 1999, (Revised 2020)***

Act to provide for and regulate the construction, maintenance, improvement, operation and use of sewerage and land drainage systems, to regulate the discharge of sewage and trade effluent and for matters connected therewith. This act is under the jurisdiction of PUB.

#### ***Sewerage and Drainage (Surface Water Drainage) Regulations 1999, (Revised 2007)***

Provides details on the measures and considerations to be implemented to protect the stormwater drainage system. This regulation is under the jurisdiction of PUB.

#### ***Sewerage and Drainage (Trade Effluent) Regulations 1999, (Revised 2007)***

Provides details on the measures and considerations to be implemented to regulate trade effluent discharge into public sewerage system. This regulation is under the jurisdiction of PUB.

#### ***Environmental Protection and Management (Trade Effluent) Regulations 1999, (Revised 2008)***

Discusses details on the measures and considerations to be implemented to regulate trade effluent discharge into public watercourse. This regulation is under the jurisdiction of NEA.

#### ***PUB Code of Practice on Surface Water Drainage (Seventh Edition, 2018)***

Discusses guidelines on appropriate measures to be implemented for the protection of stormwater drainage system and the management of surface water drainage (e.g., development and implementation of an Earth Control Measures [ECM] Plan). This code is under the jurisdiction of PUB.

#### ***PUB Handbook on Managing Urban Runoff (First Edition, 2013)***

Outlines information on stormwater management strategies, resources for designing stormwater drainage systems, source solutions to on-site stormwater management, and receptor solutions to protect developments from flood risks. This document is published by PUB.

***PUB Guidebook on Erosion and Sediment Control at Construction Sites (2018)***

Provides best practices on keeping waterways free of muddy water, industry standards on effective earth control measures, and guidelines on ECM provisions on construction sites. This document is published by PUB.

***PUB Circular on Preventing Muddy Water from the Construction Site (2015)***

Stipulates that all new construction sites with site area of 0.2 ha and above, sites with problematic ECM, and sites within sensitive areas are required to implement closed-circuit television (CCTV) including a Silt Imagery Detection System (SIDS) at the public drain to monitor the surface run-off discharges from the sites. This circular is published by and under the jurisdiction of PUB.

For the purpose of the current study, the water quality findings were compared against the threshold values stipulated under the National Environment Agency (NEA) Allowable Limits for Trade Effluent Discharge to Watercourse or Controlled Watercourse.

## 6.2 Surface Water Quality

### 6.2.1 Survey Methodology

Baseline surface water quality assessment was performed at three (3) sampling points (i.e., SW01, SW02, SW03) during two (2) dry weather conditions (i.e., 18 March 2024 and 17 May 2024) and one (1) wet weather condition (i.e., 17 April 2024 or 14 May 2024). The site map showing the indicative locations of the surface water quality locations, along with the GPS coordinates of each location, are shown in Figure 6-1 and Table 6-1 respectively.



**Figure 6-1.** Locations of surface water quality sampling points

**Table 6-1.** Coordinates of surface water quality sampling locations

Station ID	Latitude	Longitude
SW01	1.365702	103.746129
SW02	1.365916	103.746003
SW03	1.367073	103.746699

### 6.2.2 *In-situ Measurements*

In-situ measurements were taken at each sampling location using their respective testing method (Table 6-2), where the American Public Health Association (APHA) describes the standard methods for the examination of water and wastewater (APHA, 2017). Measured parameters include pH, temperature, turbidity, conductivity, and dissolved oxygen. The results of the measurements were then compared against threshold limits based on those set by NEA (2023).

**Table 6-2.** *In-situ* surface water quality parameters

Test Parameter	Unit	Threshold Limit <sup>6</sup>	Test Method
pH	-	6 – 9	APHA 4500-H B
Temperature	°C	45	APHA 2550 B
Turbidity	NTU	-	APHA 2130 B
Conductivity	µS/cm	-	APHA 2510 B
Dissolved Oxygen	mg/L	-	APHA 4500-O-G

### 6.2.3 *Ex-situ Laboratory Analysis*

In addition to *in-situ* measurements, collected water samples were sent to a SINGLAS-accredited laboratory for analysis. The test method used follows the APHA standard methods (2017) as stated in Table 6-3. The laboratory results were then compared against allowable limits set by NEA (2023). *Enterococcus* values, which are not regulated by Singapore standards, were compared with the Australian Guideline for Urban Stormwater Management (2000).

**Table 6-3** *Ex-situ* surface water quality parameters tested in the laboratory

Test Parameter	Unit	Threshold Limit	Test Method
(Threshold limit referenced to NEA's allowable limits unless otherwise stated)			
Biological Oxygen Demand (BOD5)	mg/L	50	APHA 5210 B
Chemical Oxygen Demand (COD)	mg O <sub>2</sub> /L	100	APHA 5220 C
Salinity	mg/L	-	APHA 2520 B
Total Suspended Solids	mg/L	50	APHA 2540 D
Total Dissolved Solids	mg/L	-	APHA 2540 C
Orthophosphate (PO <sub>4</sub> -P)	mg/L	5	APHA 4110 B

<sup>6</sup> NEA's Allowable Limits for Trade Effluent Discharge to Watercourse guideline

Test Parameter	Unit	Threshold Limit	Test Method
(Threshold limit referenced to NEA's allowable limits unless otherwise stated)			
Total Phosphorus	mg/L	-	SOP-WAT-020
Nitrate (NO <sub>3</sub> as N)	mg/L	-	APHA 4110 B
Total Nitrogen	mg/L	-	SOP-WAT-048
Total Alkalinity	mg CaCO <sub>3</sub> /L	-	APHA 2320 B
Total Organic Carbon (TOC)	mg/L	-	APHA 5310 D
Ammoniacal Nitrogen	mg/L	-	APHA 4500-NH <sub>3</sub> E
Arsenic (As)	mg/L	0.1	APHA 3120 B
Barium (Ba)	mg/L	2	APHA 3120 B
Beryllium (Be)	mg/L	-	APHA 3120 B
Boron (B)	mg/L	5	APHA 3120 B
Iron (Fe)	mg/L	10	APHA 3120 B
Manganese (Mn)	mg/L	5	APHA 3120 B
Tin (Sn)	mg/L	-	APHA 3120 B
*Cadmium (Cd)	mg/L	0.1	APHA 3120 B
*Chromium (Cr)	mg/L	1	APHA 3120 B
*Copper (Cu)	mg/L	0.1	APHA 3120 B
*Lead (Pb)	mg/L	0.1	APHA 3120 B
*Mercury (Hg)	mg/L	0.05	APHA 3120 B
*Nickel (Ni)	mg/L	1	APHA 3120 B
*Silver (Ag)	mg/L	0.1	APHA 3120 B
*Selenium (Se)	mg/L	0.5	APHA 3120 B
*Zinc (Zn)	mg/L	1	APHA 3120 B
*Total Metal	mg/L	1	APHA 3120 B
Oil and Grease (Total)	mg/L	10	APHA 5520 B/F
Oil and Grease (Hydrocarbon)	mg/L	10	APHA 5520 B/F
<i>Enterococcus</i>	CFU/100mL	40,000 <sup>7</sup> / 200,000 <sup>8</sup>	APHA 9230 C

\*Where 2 or more of the metals specified in the table are present, the concentration of the metals shall not be more than 1 mg/L.

<sup>7</sup> Values for dry weather sample in Australian Guideline for Urban Stormwater Management (2000)

<sup>8</sup> Values for wet weather sample in Australian Guideline for Urban Stormwater Management (2000)

## 6.3 Results and Discussion of Water Quality Findings

### 6.3.1 In-situ Measurements

It was noted that the sampling points did not have sufficient water for sampling at all three points on 18 March 2024 and at SW03 on 17 May 2024. As such, there are no results presented on those sampling trips. Figure 6-2 below shows the site conditions on the sampling dates.



**Figure 6-2.** Photographs showing dry conditions with insufficient water for sampling

Where water sampling was possible, the *in-situ* water quality measurements are presented in Table 6-4. The laboratory reports are provided in **Appendix E**.

**Table 6-4.** Results of surface water quality parameters tested *in-situ*

Test Parameter	Unit	Threshold	Dry weather (17 May)		Wet weather (17 Apr)		
			SW01	SW02	SW01	SW02	SW03
pH	-	6 - 9	7.06	7.2	7.54	7.59	6.61
Temperature	°C	45	30.27	29.96	30.65	30.46	26.69
Turbidity	NTU	-	0.35	9.7	1.2	4.7	27
Conductivity	µS/cm	-	506	470	637	611	91
Dissolved Oxygen	mg/L	-	5.45	5.54	2.11	2.88	5.05

Overall, the *in-situ* surface water quality readings did not show any exceedances across all sampling locations. The pH levels ranged from 6.61 to 7.59, which are within the threshold limits for watercourses (NEA, 2023). The baseline temperatures measured

were relatively stable, ranging from 26.69 to 30.65 °C, showing little to no fluctuation.

The baseline turbidity readings ranged from 0.35 to 27 NTU, with the highest turbidity readings measured at SW03 (27 NTU) during the wet weather conditions, primarily due to its location with respect to a closed canopy vegetation patch, as opposed to the comparatively open canopy locations of SW01 and SW02. Higher turbidity levels in SW03 are mainly facilitated by the influence of accumulated foliage and leaf packs, which are reported to produce coarse particulate organic matter over time (Nakajima et al., 2006).

Baseline conductivity readings ranged from 91 to 637  $\mu\text{S}/\text{cm}$ , with the lowest reading measured at SW03. During wet weather conditions, both SW01 (637  $\mu\text{S}/\text{cm}$ ) and SW02 (611  $\mu\text{S}/\text{cm}$ ) had relatively higher conductivity levels compared to SW03 (91  $\mu\text{S}/\text{cm}$ ). This pattern is likely attributable to the proximity of the two stations (i.e., SW01 and SW02) to impervious surfaces (i.e., car park area), which are documented to facilitate the delivery of potential contaminants (through surface runoff) into nearby waterways (Baker et al., 2019). SW02 is also in close proximity to a bin centre which stores/ temporarily holds general wastes and could be regarded as a contributing factor to the observed conductivity readings due to possible leachate influx.

As for dissolved oxygen, the measured concentrations ranged from 2.11 to 5.54 mg/L. During wet weather conditions, both SW01 (2.11 mg/L) and SW02 (2.88 mg/L) received lower dissolved oxygen concentrations as opposed to SW03 (5.05 mg/L). This trend is likely associated with the recorded water temperatures across sites – with both SW01 and SW02 having higher temperatures compared to SW03. Water temperature and dissolved oxygen are inversely related in that higher water temperature generally results to lower dissolved oxygen (Rajwa-Kuligiewicz et al., 2015). The same pattern can be observed when the SW01 and SW02 readings are compared to their dry weather condition counterparts; higher dissolved oxygen levels were recorded following lower water temperatures.

### 6.3.2 Ex-situ Laboratory Analysis

The results of the *ex-situ* laboratory analysis are shown in Table 6-5. The full results are provided in **Appendix E**.

**Table 6-5.** Results of the surface water quality parameters analysed *ex-situ*

Test Parameter	Unit	Threshold	Dry weather (17 May)		Wet weather (17 Apr)		
			SW01	SW02	SW01	SW02	SW03
Biological Oxygen Demand (BOD5)	mg/L	50	3	3	12	11	<2
Chemical Oxygen Demand (COD)	mg O <sub>2</sub> /L	100	8	8	35	35	8
Salinity	mg/L	-	240	220	300	290	40
Total Suspended Solids	mg/L	50	<1	9	5	<1	7
Total Dissolved Solids	mg/L	-	314	295	318	306	23
Orthophosphate (PO <sub>4</sub> -P)	mg/L	5	<0.10	<0.10	<0.01	<0.01	<0.10
Total Phosphorus	mg/L	-	<0.10	<0.10	<0.01	<0.01	<0.10
Nitrate (NO <sub>3</sub> as N)	mg/L	-	0.4	0.24	0.67	0.26	0.63
Total Nitrogen	mg/L	-	6.7	1.1	0.8	1.4	1.7
Total Alkalinity	mg CaCO <sub>3</sub> /L	-	273	242	234	236	36.5
Total Organic Carbon (TOC)	mg/L	-	2.68	3.11	1.42	1.48	5.47
Ammoniacal Nitrogen	mg/L	-	<0.10	<0.10	1.58	1.55	<0.10
Arsenic (As)	mg/L	0.1	<0.01	<0.01	<0.01	<0.01	<0.01
Barium (Ba)	mg/L	2	<0.01	<0.01	<0.01	<0.01	<0.01
Beryllium (Be)	mg/L	-	<0.01	<0.01	<0.01	<0.01	<0.01
Boron (B)	mg/L	5	<0.01	<0.01	<0.01	0.12	<0.01
Iron (Fe)	mg/L	10	<0.10	<0.10	<0.01	0.28	<0.10
Manganese (Mn)	mg/L	5	<0.01	0.23	<0.01	0.31	<0.01
Tin (Sn)	mg/L	-	<0.10	<0.10	<0.01	0.12	<0.10
*Cadmium (Cd)	mg/L	0.1	<0.003	<0.003	<0.003	<0.003	<0.003
*Chromium (Cr)	mg/L	1	<0.01	<0.01	<0.01	<0.01	<0.01
*Copper (Cu)	mg/L	0.1	<0.01	<0.01	<0.01	<0.01	<0.01
*Lead (Pb)	mg/L	0.1	<0.01	<0.01	<0.01	<0.01	<0.01
*Mercury (Hg)	mg/L	0.05	<0.001	<0.001	<0.001	<0.001	<0.001

Test Parameter	Unit	Threshold	Dry weather (17 May)		Wet weather (17 Apr)		
			SW01	SW02	SW01	SW02	SW03
*Nickel (Ni)	mg/L	1	<0.01	<0.01	<0.01	<0.01	<0.01
*Silver (Ag)	mg/L	0.1	<0.10	<0.10	<0.01	<0.01	<0.10
*Selenium (Se)	mg/L	0.5	<0.01	<0.01	<0.01	<0.01	<0.01
*Zinc (Zn)	mg/L	1	<0.01	<0.01	<0.01	<0.01	0.04
*Total Metal	mg/L	1	<0.001	<0.001	<0.001	<0.001	0.04
Oil and Grease (Total)	mg/L	10	2	3.6	<1	<1	3.4
Oil and Grease (Hydrocarbon)	mg/L	10	<1	1.1	<1	<1	1
Enterococcus	CFU/100mL	40,000 / 200,000	166	357	282	570	151

All the *ex-situ* surface water quality measurements complied with the threshold limits.

Total suspended solids (TSS) ranged from 5 to 9 mg/L and are within the threshold value set by NEA (50 mg/L), with SW02 achieving the highest TSS levels (9 mg/L) under dry weather conditions. Similarly, total dissolved solids (TDS) ranged from 23 to 318 mg/L, with SW01 having the greatest TDS levels (318 mg/L) under wet weather conditions.

Biological oxygen demand (BOD) was recorded with values ranging from 3 to 12 mg/L, while chemical oxygen demand (COD) had concentrations ranging from 8 to 35 mg O<sub>2</sub>/L. Under wet weather conditions, both SW01 and SW02 have had similar measurements for BOD (i.e., SW01 = 12 mg/L, SW02 = 11 mg/L) and COD (i.e., 35 mg O<sub>2</sub>/L; in both cases) and were within NEA's maximum allowable limits for uncontrolled watercourses (i.e., BOD = 50 mg/L; COD = 100 mg O<sub>2</sub>/L). Total organic carbon (TOC) measurements for all samples collected ranged from 1.42 to 5.47 mg/L, with SW03 achieving the highest concentration (5.47 mg/L) under wet weather conditions.

Salinity and total alkalinity ranged from 40 to 300 mg/L and 36.5 to 273.0 mg CaCO<sub>3</sub>/L, respectively. SW01 showed the highest recorded levels for both parameters, with salinity at 300 mg/L under wet weather conditions and total alkalinity at 273.0 mg CaCO<sub>3</sub>/L under dry weather conditions.

Oil and grease (total) ranged from 2.0 to 3.6 mg/L, with the highest concentration recorded in SW02 (3.6 mg/L); whereas oil and grease (hydrocarbon) was recorded in both SW02 (1.1 mg/L) and SW03 (1.0 mg/L). Both parameters are within the maximum allowable limits for uncontrolled watercourses of 10 mg/L for both parameters.

For nutrient parameters, nitrate (NO<sub>3</sub> as N) had a recorded range of 0.26 to 0.67 mg/L, with SW01 having the highest nitrate concentration under wet weather conditions. In turn, total nitrogen (TN) had a recorded range of 0.8 to 6.7 mg/L, with SW01 having the highest TN values under dry weather conditions. Ammoniacal nitrogen concentrations were detected only for SW01 (1.58 mg/L) and SW02 (1.55 mg/L) under wet weather conditions. Both orthophosphate (PO<sub>4</sub>-P) and total phosphorus (TP) were undetected from the collected samples.

For heavy metals, boron (B), iron (Fe), tin (Sn), and manganese (Mn) were only detected in SW02 at concentrations equal to 0.12 mg/L, 0.28 mg/L, 0.12 mg/L, 0.27 mg/L [mean], respectively. While zinc (Zn) was only detected at SW03 (0.04 mg/L), arsenic (As), barium (Ba), beryllium (Be), cadmium (Cd), chromium (Cr), copper (Cu), lead (Pb), mercury (Pb), nickel (Ni), silver (Ag), selenium (Se) were undetected at all stations during both wet and dry weather conditions. *Enterococcus* counts were found highest in SW02 (i.e., dry weather = 357 CFU/ 100 mL; wet weather = 570 CFU/ 100 mL), primarily due to its proximity to an identified bin centre which could potentially have facilitated leachate inputs.

## 6.4 Impact Assessment

### 6.4.1 Identification of Potential Impacts

#### *Pre-Construction / Construction Phase*

Activities planned in this area include vegetation clearance, earthworks, infrastructure works, and building works. Based on these activities, the following potential impacts on surface water quality are identified:

#### Soil Erosion and Surface Runoff

Construction runoff may cause physical, biological, and/or chemical impacts to the surface water quality of receiving watercourses during the construction phase. The sources of potential runoff in the project site include:

- Land clearance and site preparation of construction work areas
- Runoff from exposed soil surface and earth working areas
- Runoff from dust suppression sprays
- Soil investigation works
- Piling works

Physical effects may include soil erosion, potential blockage of drainage channels, and increased concentrations of suspended solids. Impacts are expected to be the greatest in areas with exposed, disturbed soil. This impact could worsen if there are soil stockpiles left unprotected in the construction area and no mitigation measures are in place. Runoff containing particulates will increase concentrations of suspended solids, sediments, and other contaminants and thus create additional burdens on the existing stream in the project site. This may cause chemical changes to the stream, which may affect the sensitive aquatic biodiversity. Significant amounts of silt discharge into water streams may affect the local ecology if proper mitigation measures are not implemented.

#### Trade Effluent

Activities such as piling works are expected to generate trade effluent, which include processed wastewater such as bentonite slurry, concrete washout, and excess grouting materials from construction activities. If the trade effluent contains a significant amount of concrete and cement-derived materials, it may cause primary chemical effects such as increasing turbidity, discoloration, elevation in pH, and accretion of solids. A number of secondary effects may also result in intoxication of water biota due to elevated pH value, and reduced decay rate of microorganisms and photosynthetic rate due to the decreased light penetration.

Hence, all trade effluent from the construction site shall not be discharged to any receiving watercourse without prior treatment. It must be treated separately from surface runoff before being discharged. The treated trade effluent from construction activities must have written approval from NEA if it is discharged into any watercourse or from PUB if it is discharged into public sewers. The trade effluent must also be treated to levels prescribed by the respective authorities (i.e., NEA or PUB).

#### Oil, Fuel & Chemical Spillage and Waste Disposal

Construction activities may require on-site storage and handling of potential polluting

material such as fuel, lubricant, cement, as well as packaging materials. The following sources can affect the water quality within the Study Area.

- Fuel and lubricants from maintenance of vehicles and equipment
- Illegal dumping of debris and rubbish (such as packaging, construction materials, and waste)
- Accidental spillage of liquids stored on-site (e.g., oil, grease, diesel, solvents)

No hazardous chemicals as specified under EPM (Hazardous Substances) regulations are expected to be used in the construction activities in this area.

#### Sewage Discharge

The on-site sanitary facilities within the work areas may generate sewage. The discharge of sewage into Bukit Batok Canal or receiving watercourse directly or indirectly could adversely impact the water quality of receiving watercourses.

#### **Operation Phase**

No impacts on surface water quality are expected during operation phase

#### **6.4.2 Mitigation Measures**

##### **Pre-Construction / Construction Phase**

In order to mitigate impacts to water quality from development activities, the following measures are recommended.

#### Implementation of Earth Control Measures (ECM)

An appropriate ECM plan is to be prepared and endorsed by a Qualified Erosion Control Professional (QECP) before the commencement of construction works. The ECM plan must be approved by PUB. Moreover, the Contractor should implement the following measures:

- Implement the ECM plan throughout the entire duration of the construction
- Ensure ECM tanks have surplus capacities to minimise overflow and silty discharge
- Implement proper sediment control measures to capture and retain silt, which may include perimeter cut-off drains, perimeter silt fence, silt traps and silt treatment systems
- QECP to review ECM plan implementation regularly during the construction period to ensure that the measures put in place remain effective
- Environmental Control Officer (ECO) to carry out regular monitoring of the ECM treatment plant
- Carry out regular maintenance of ECM
- Check the weather forecast from the NEA website to preempt rain events and take the appropriate ECM actions
- Inspect and maintain ECM after rain events
- Conduct continuous monitoring of discharges (e.g., TSS) from the site
- Ensure that site discharges are treated to comply with respective allowable limits (e.g., 50 mg/L of TSS for discharges processed through ECM and 30 mg/L of TSS for trade effluent) before discharging into a public drain

- Reduce exposed earth areas by scheduling construction activities to minimise bare surfaces, planning the site layout, and implementing effective site drainage systems to facilitate flow. Other measures may include the use of paving, biodegradable erosion control blankets, and canvas covers
- Remove ECM only after completion of the works. The QECP should authorise the removal of the ECM.

#### Trade Effluent Management

- Provide storage tanks of adequate size and sufficient numbers to temporarily store trade effluent before treatment and disposal
- Provide sampling point for collection of trade effluent to be tested for parameters stipulated in the Regulations, depending on the discharge point (i.e., sewer, watercourse, controlled watercourse)
- Conduct regular water quality monitoring according to the proposed EMMP during the construction and operation phase
- Install and maintain trade effluent treatment facilities (e.g., slurry treatment plant, grease trap and suspended solid settling tank) as per NEA's requirements
- Kerb the areas where trade effluent is being transported out to minimise spills.

#### Oil, Fuel & Chemical Spillage and Waste Disposal Management

- Conduct all slurry preparation activities within a designated area that has adequate containment measures
- Ensure that slurry water, including bentonite slurry, is contained within the working area and does not enter any watercourses or surface water drains
- Place storage tanks for slurry and supply lines as far as possible from surface water drains or watercourses
- Provide secondary containment for micropile storage tanks for slurry
- Monitor any bentonite use to prevent ground infiltration and potential groundwater pollution
- Ensure all liquids are properly labelled and stored in appropriate containers at a safe location on site (i.e., under a shelter with kerb surrounding). Personnel handling these liquids must be suitably trained
- Minimise vehicle fuelling and major maintenance of equipment within the Study Area.
- Ensure diesel/fuel tanks are located away from waterbodies
- Ensure that the inside of the hose is cleared after refuelling to prevent diesel leakage
- Provide appropriate concrete wash bays and ensure no washing in or near any waterbody
- Ensure that the water used for dust control does not cause erosion within the work area or runs offsite
- Contain all excess loose soil and rock prior to the commencement of works
- Conduct regular water quality monitoring according to the proposed EMMP during the construction and operation phase
- Provide waste bins within the work areas for proper disposal of construction debris and rubbish

- Engage a licensed waste collector to remove foreign material from site. Any foreign material must not be illegally disposed of in the water bodies
- Provide emergency spill kits on site in the event of any chemical spillages. An emergency response team should also be trained in the use of these spill kits.

#### Sewage Discharge

- No discharge of sewage into receiving recourses or Bukit Batok Canal
- Deploy adequate portable toilets for construction personnel
- Ensure that the toilets are cleaned and maintained by an approved sanitary waste collector.

#### **6.4.3 Evaluation of Impacts**

Table 6-6 summarises the impacts listed in Section 6.4.1 evaluated using the RIAM method with their corresponding Environmental Scores. With due consideration that the recommended mitigation measures listed in Section 6.4.2 are implemented by the Contractor, the residual impacts were once again evaluated using the RIAM method. Residual impacts are expected to mostly be in the range of slight impact to no impact if all the mitigation measures are implemented.

**Table 6-6.** Environmental Scores of the identified impacts on site's surface water quality with corresponding mitigation measures

Phase	Impact component	Predicted impact before mitigation							Mitigation measures	Predicted impact after mitigation						
		I	M	P	R	C	ES	Impact		I	M	P	R	C	ES	Impact
<b>Ecology</b>																
Pre-construction/ construction	Soil erosion and surface runoff	1	-3	2	2	3	-21	Slight Negative	<ul style="list-style-type: none"> <li>• Implement the ECM plan approved by PUB</li> <li>• Ensure ECM tanks have surplus capacities to minimise overflow and silty discharge</li> <li>• Implement proper sediment control measures to capture and retain silt</li> <li>• QECP to review the ECM plan regularly to ensure the measures remain effective</li> <li>• Conduct regular monitoring of the ECM treatment plant</li> <li>• Conduct regular maintenance of ECM</li> <li>• Check the weather forecast from the NEA website to pre-empt rain events and take the appropriate ECM actions</li> <li>• Inspect and maintain ECM after rain events</li> <li>• Conduct continuous monitoring of discharges (e.g., TSS) from the site</li> <li>• Ensure discharges comply with allowable limits</li> <li>• Minimise exposed earth areas</li> </ul>	1	-1	2	2	2	-7	Slight Negative
	Improper disposal of trade effluent	1	-2	2	2	3	-14	Slight Negative	<ul style="list-style-type: none"> <li>• Provide storage tanks of adequate size and sufficient numbers to temporarily store trade effluent before treatment and disposal</li> <li>• Provide sampling point for collection of trade effluent to be tested for parameters stipulated as per regulations</li> <li>• Regular water quality monitoring is to be conducted according to the proposed EMMP</li> <li>• Install and maintain trade effluent treatment facilities as per NEA's requirements</li> <li>• Kerb the areas where trade effluent is being transported out to minimise spills</li> </ul>	1	-1	2	2	3	-7	Slight Negative

Phase	Impact component	Predicted impact before mitigation							Mitigation measures	Predicted impact after mitigation						
		I	M	P	R	C	ES	Impact		I	M	P	R	C	ES	Impact
	Accidental oil/ fuel/ chemical spillage and improper waste disposal	1	-2	2	2	3	-14	Slight Negative	<ul style="list-style-type: none"> <li>• Conduct all slurry preparation activities within a designated area that has adequate containment measures</li> <li>• Ensure that slurry water, including bentonite slurry, is contained within the working area and does not enter any watercourses or surface water drains</li> <li>• Place storage tanks for slurry and supply lines as far as possible from surface water drains or watercourses</li> <li>• Provide secondary containment for micropile storage tanks for slurry and any storage tanks for oil/grease</li> <li>• Monitor any bentonite use to prevent bentonite materials from polluting the groundwater</li> <li>• Ensure all liquids are properly labelled and stored in appropriate containers</li> <li>• Minimise vehicle fuelling and major maintenance of equipment within the Study Area.</li> <li>• Ensure diesel/ fuel tanks are located away from waterbodies</li> <li>• Ensure that the diesel has stopped leaking from the hose before removing it</li> <li>• Ensure that the inside of the hose is cleared after refuelling</li> <li>• Provide appropriate concrete wash bays and ensure no washing in or near any waterbody</li> <li>• Conduct regular water quality monitoring according to the proposed EMMP</li> <li>• Proper disposal of construction debris and rubbish</li> <li>• Engage a licensed waste collector to remove foreign material from site. Any foreign material</li> </ul>	1	-1	2	2	3	-7	Slight Negative

Phase	Impact component	Predicted impact before mitigation							Mitigation measures	Predicted impact after mitigation						
		I	M	P	R	C	ES	Impact		I	M	P	R	C	ES	Impact
									<ul style="list-style-type: none"> <li>must not be illegally disposed of in the water bodies</li> <li>Provide emergency spill kits on site and train an emergency response team to use the kits</li> </ul>							
	Improper sewage discharge	1	-2	2	2	3	-12	Slight Negative	<ul style="list-style-type: none"> <li>No discharge of sewage into Bukit Batok Canal</li> <li>Deploy adequate portable toilets for construction personnel</li> <li>Ensure the toilets are cleaned and maintained by an approved sanitary waste collector</li> </ul>	1	-1	2	2	3	-7	Slight Negative
<b>Human Health and Safety</b>																
Pre-construction / Construction	Impact to water quality due to accidental spillage of construction materials, fuel, and solvents	1	-3	2	2	3	-21	Slight Negative	<ul style="list-style-type: none"> <li>Provide storage tanks of adequate size and sufficient numbers to temporarily store trade effluent before treatment and disposal</li> <li>Provide sampling point for collection of trade effluent to be tested for parameters as per regulations</li> <li>Install and maintain trade effluent treatment facilities as per NEA's requirements</li> <li>Conduct water quality monitoring regularly</li> </ul>	1	-1	2	2	3	-7	Slight Negative

## 7 ENVIRONMENTAL MANAGEMENT AND MONITORING PLAN

### 7.1 Overview

The Environmental Management and Monitoring Plan (EMMP) is a systematic approach to mitigate environmental impacts and monitor the implementation of these mitigation measures to ensure that project implementation will not cause any significant adverse impact to the site and the surrounding environment. It is also a useful tool to assess whether the mitigation measures taken are effective to reduce or mitigate the potential impacts caused by this project to minimal and acceptable levels during the construction.

The EMMP framework presented in this chapter is an outcome from the EIA process. This EMMP framework consolidates the mitigation and monitoring strategy required for this project and appointed Contractor shall adhere to this strategy, develop it further and implement throughout during the construction phase

### 7.2 Construction EMMP

Before the construction works start, the appointed Contractor and Environmental Consultant will establish a detailed Construction EMMP (CEMMP) based on this EMMP framework, which is to be implemented and monitored during the construction phase. The Contractor shall be responsible for submitting and obtaining approval for CEMMP from HDB, NParks, and other relevant Technical Agencies before commencement of works.

The CEMMP is to include the identified mitigation measures of this EIA and shall address the methodologies of the construction works prior to their commencement. Additionally, Fauna and Flora Management Plans recommended in this chapter need to be incorporated in CEMMP with involvement of flora and fauna specialists from the EMMP team to finetune and implement ecological mitigation measures recommended in this report. The CEMMP should also include waste management practices including restricting use & spillage of chemicals during construction phase into surrounding forested area.

The CEMMP shall include environmental monitoring comprises of compliance inspections for prescribed mitigation measures and ambient environmental data collection, generally requiring sample collection and analysis. The environmental monitoring activities should also ensure that the project does not cause any significant long-term environmental impacts, in particular cumulative impacts, and that the existing environmental conditions and biodiversity are maintained.

Monthly environmental monitoring reports with all monitoring results (compliance and ambient monitoring), identified problems and additional actions taken to mitigate these problems should be prepared and submitted to the relevant authorities during the construction phase. Each subsequent monthly monitoring report should report on successful or failed follow-up actions until a problem has been effectively mitigated.

Table 7-10 provides the overview of recommended EMMP measures for this project which is to be incorporated into the CEMMP by the Contractor. The environmental monitoring locations are to be finalized by the EMMP team during CEMMP formulation in consultation with relevant stakeholders.

### 7.3 EMMP Team

The Contractors shall be responsible for implementing all the environmental requirements specified in this EIA report including CEMMP conditions as well as requirements mandated by the applicable regulations and relevant authorities. It is recommended that to implement the CEMMP, an EMMP team having necessary qualifications and experience shall be available throughout the construction period to support the Contractor. The EMMP team should include but not limited to the following:

**Table 7-1.** Roles and Responsibilities of EMMP Team Members

<b>Role Name</b>	<b>Qualification</b>	<b>Responsibilities</b>
Environmental Manager/ Environment Control Officer (ECO)	Valid registration with the National Environment Agency (NEA) and demonstrated previous work experience in developments of similar size or complexity.	To act as CEMMP in-charge and lead the implementation and reporting requirements of CEMMP during construction phase. Responsible for managing all environmental issues arising from the construction work which includes the monitoring and ensuring the implementation and management of change of the CEMMP, the environmental performance of the project, investigation of incidents, inspections of site and implementing corrective/ preventive measures. To coordinate with other EMMP team members for advice on specific issues related to CEMMP implementation. To prepare monthly environmental performance monitoring reports.
Contractor's Qualified Erosion Control Professional (QECP)	Valid registration with the Institution of Engineers Singapore (IES)	Responsible to prepare, submit and obtain approval for Earth Control Measures (ECM) Plan from PUB prior to Contractors start work. To ensure that the Contractors implement the ECM in compliance with the ECM Plan and conduct periodic monitoring of ECM Plan.
Arborist/ Flora Specialist	Certified Arborist (CA) with an International Society of Arboriculture (ISA) certification with 8 years' experience.	To prepare project site specific flora management plan as part of CEMMP, utilizing the EMMP framework recommended in the EIA and assist the Contractor in obtaining authority approval. To review the flora that will be affected, and to provide monitoring and advice to the Contractor on matter related to tree protection. To visit the site fortnightly to oversee the implementation of flora management plan and provide monthly reports. To advise and implement specific measures in the case of tree pruning prior clearance, tree injury, and construction activities affecting tree roots. To provide checks on Tree Protection Zone (TPZ). To assist in reporting requirements of CEMMP during

Role Name	Qualification	Responsibilities
		construction phase. To liaise with NParks on addressing any comments/ requirements related to flora implementation measures.
Ecologist / Wildlife Specialist	Experience in wildlife in Singapore and/or the region	To prepare project site specific fauna management plan as part of CEMMP, utilizing the EMMP framework recommended in the EIA and assist the Contractor in obtaining authority approval. To conduct a pre-clearance wildlife inspection and prepare Wildlife management protocols as necessary during site clearance stage. To provide advice and inspection related to wildlife throughout the construction duration and to identify, rescue & manage any trapped and/or injured wildlife at project site. To visit the site fortnightly to oversee the implementation of fauna management plan and to provide biodiversity awareness training to site personnel. To assist in reporting requirements of CEMMP during construction phase. To liaise with NParks on addressing any comments/ requirements related to wildlife implementation measures.

#### 7.4 Environmental Objectives

Environmental Objectives for the project are recommended below. Contractors are required to adhere to the Environmental Objectives during entire construction stage.

- Minimise removal of conservation significant flora species at or adjacent to worksite.
- Maximise harvesting of sapling, and transplant of conservation significant flora species that will be affected.
- Prevent risk of fauna injury related to construction such as from fauna re-entry to worksite.
- Prevent human – wildlife conflicts at or near to worksite.
- Ensure retained, translocated, and planted flora’s health.
- Ensure noise impacts comply with adjusted Maximum Permissible Noise Limits.
- Ensure water quality impacts comply with PUB and NEA allowable limits for trade effluent quality.
- Ensure no transmission of vector borne disease.
- Ensure no indiscriminate / illegal disposal of waste.
- Ensure no spillage / leakage of hazardous material.

#### 7.5 Training requirements

The site personnel involved in implementation of CEMMP shall be adequately trained. Training needs assessment shall be conducted regularly and should include the concerned sub-contractors also. The contractors shall ensure that trainings are conducted before the starting the construction work and at a regular interval during

construction phase for the site personnel. The recommended training program is provided in Table 7-2.

**Table 7-2. Training programme for Site Personnel**

<b>Training Schedule</b>	<b>Training Topics</b>	<b>Conducted By</b>	<b>Target Audience</b>	<b>Frequency</b>
Prior to commencement of activities on site	CEMMP Requirements Biodiversity & Environmental Awareness	EMMP Consultant	Environmental Manager/ ECO/ Project Manager / Construction Manager/ Construction Engineers/ Site Supervisors/ Sub-contractors	Once
Refresher training	Biodiversity & Environmental Awareness Briefing	EMMP Consultant	Site Personnel including Sub-contractors	Monthly during construction phase
Toolbox meetings	Briefing to include reminders on wildlife encounters and environmental protection	CEMMP In-charge/ ECO	Construction Workers including Sub-contractors	Daily

## **7.6 Environmental Emergency Response Procedure**

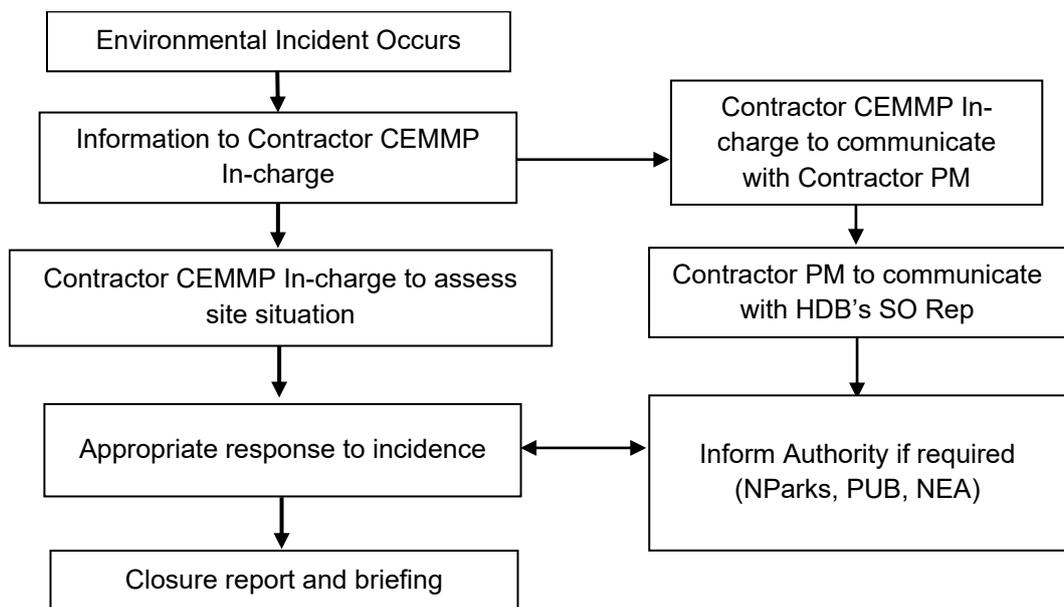
The regular and continual environmental monitoring may result in observations of failed or inadequate mitigation measures. Also, a public complaint/ observation may be received. Examples of environmental emergency are described below.

- Incident related to human – wildlife conflict
- Discovery of wildlife within construction site
- Incident of injury to wildlife due to work activity
- Damage to retained/ translocated flora
- Earth control measures (i.e., silt fence, cut-off drain, treatment) are ineffective
- Discharge of ECM does not meet regulatory limits
- Illegal water discharge from construction site
- Noise levels from construction activities exceed maximum permissible limits.
- Dust event due to dry weather conditions and high winds.
- Release of hazardous materials to land and watercourse
- Illegal disposal of waste into forested area.
- Community complaint relating to pollution

In the event that a failure is discovered, that failure must be reported to the CEMMP In-charge/ Project Manager within shortest possible time. The CEMMP In-charge/ Project Manager will be responsible for ensuring adequate follow-up activities. This may include:

- Consultation with the EMMP specialists/ QECP/ VCO/ PRO.
- Arranging an immediate appropriate response on guidance of EMMP Specialists/ QECP/ VCO as necessary.
- Reporting and consultation with the relevant authorities (i.e., NEA, NParks, PUB) as required.

The emergency response flowchart in handling environmental emergency is presented in Figure 7-1 Environmental Incidence Reporting Flowchart. In the event of violation of relevant standards/ regulations, it is recommended that site environmental management practices are reviewed immediately, and the appropriate mitigation action taken immediately to reduce impacts to acceptable levels.



**Figure 7-1** Environmental Incidence Reporting Flowchart

## 7.7 EMMP Reporting and Documentation

### *Site Environmental Control Report by Environmental Control Officer*

As per the Code of Practice for Environmental Control Officers for Construction Sites, the ECO shall prepare the Site Environmental Control Programme before work commences at the worksite. Further, the ECO shall submit the Site Environmental Control Report (SECR) to the Project Manager covering assessment of the environmental efforts carried out and review the effectiveness of these measures.

The ECO shall inspect the construction activities regularly and routinely to ensure that the appropriate environmental protection and pollution control mitigation measures are properly and timely implemented based on the CEMMP's recommendations. The ECO shall record all observations and actions taken to report them in the SECR. This SECR should form part of CEMMP monthly performance report described in next section.

### **Monthly Environmental Performance Report**

A monthly Environmental Performance Report is to be prepared by the EMMP Team with assistance from the ECO of each phase of works, and to be submitted to SO, project management team, NParks, and other relevant authorities. The Performance Report is to include the description of the project activities being carried out at site during the month and status of implementation of the CEMMP including information on environmental incidence if any. Table 7-3 provides the monthly environmental performance reporting framework.

**Table 7-3.** Monthly Environmental Performance Report Framework

<b>Sr. No.</b>	<b>Item</b>	<b>Description</b>
1.	Project Status	Update on project activities within Study Area
2.	CEMMP Implementation Status	Daily observations and actions taken, ECO report, ECM performance checklist, Biodiversity specialists' observations and recommendations, Physical monitoring results (Noise, Air, Surface water quality, ECM discharge) and assessment, Vector control report, Waste disposal record
3.	Environmental Awareness Training	Record of periodic biodiversity awareness training/ toolbox briefings
4.	Environmental Incident	Environmental Incident report and corrective actions, public feedback & response
5.	Authority Inspection & Findings	Record of Authority inspection visits (i.e., HDB, NParks, NEA, PUB) and corrective actions

### **Environmental Close-Off Report**

A final environmental close-off report should be prepared for each phase after construction work is completed to confirm that no residual impacts are observed.

## **7.8 Wildlife Management Plan**

Given the importance of this location as part of the BBNC, it is necessary to minimise impacts to fauna species on the site. The development of a proper Wildlife Response and Rescue Plan will help to reduce impacts to fauna, while also reducing the risk of human-wildlife conflict, which may pose a human health and safety issue if not managed.

Wildlife management should commence prior to construction works. This is to ensure that animals within the site are safely moved outside the working boundaries, either by passive shepherding or active relocation. A Wildlife Rescue and Response Plan should then be put in place for the duration of the construction period for animals that may get trapped or injured within the construction site.

All construction personnel are to be sufficiently trained on biodiversity issues on the site and how to respond to sightings of fauna.

Additionally, the Contractor shall engage an NParks Certified Animal Management

Specialist that can be mobilised immediately when the Consultant's CEMMP Specialist (Fauna)/ Ecologist recommends the relocation of fauna species at any stage during the project. The Animal Management Specialist must be a third-party contractor that has been given approval from the Director-General of Wildlife Management to conduct specific activities that are restricted by the Wildlife Act.

### **7.8.1 Biodiversity Awareness Training**

Prior to any construction activities, all construction personnel are to attend a biodiversity awareness training by the EMMP consultant. This training should impart important information on the ecological importance of the site, and the importance of minimising impacts to the natural environment. Also, they should be trained on the common fauna species they may encounter, and what to do should they have any wildlife encounters.

After the initial training, refresher trainings and toolbox briefings are to be conducted as specified in Section 7.5.

### **7.8.2 Wildlife Management during Clearance**

Wildlife management during tree clearance is a requirement for the project site. Directional clearance will allow for the passive shepherding of mobile fauna species, while active relocation of animals found within the project will be required for other non-volant species due to the Study Areas isolation from other forested areas. This is done in order to:

- Minimise the risk of road hazards and kills from the terrestrial fauna that are displaced from the project site onto adjacent roads.
- Minimise the risk of human-wildlife conflict from animals remaining within the project boundaries
- Encourage wildlife movement into designated forested areas (e.g. PRA)
- Ensure safe translocation of non-volant animals outside of the construction area.

Site clearance to be conducted in the following steps:

- Setting up of TPZs for trees to be maintained prior to the start of any works;
- Permanent hoarding along proposed working boundary starting along Bukit Batok Road, Bukit Batok West Ave. 5, Bukit Batok West Ave. 7 and internal PRA boundary to prevent entrance of fauna species into construction area and prevent animals from running onto the road;
- Inspection of trees and tree holes for arboreal fauna in phases, and relocation by qualified agencies and/or specialists;
- Felling of trees within each phase in one direction.

The overview of the phased clearance can be found in Section 7.8.5.

### **7.8.3 Target Species**

A list of target fauna species has been developed based on the findings of the EIA. Besides species encountered during the baseline surveys, other probable species that exist on the site were also included. This list was developed with the following

considerations:

- probable presence of species in the Study Area prior to construction;
- risks to species from being in close proximity to construction activities;
- practicality of relocating species from the construction site;
- conservation significance of species; and
- risk of road kills, road hazards, and/or human-wildlife conflict arising from uncontrolled species displacement from the Study Area.

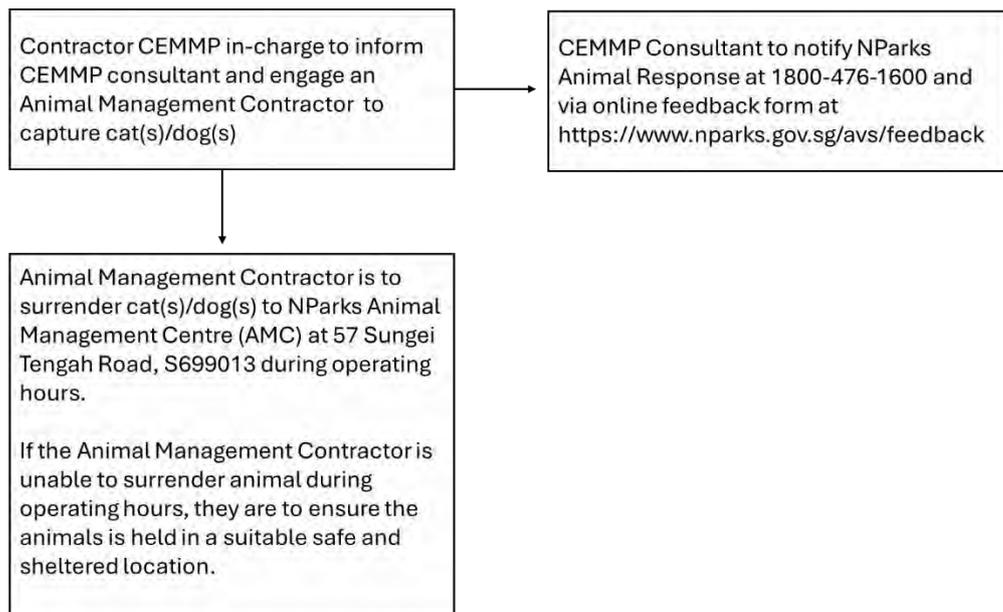
The target species in the list in Table 7-4 have been identified as suitable for capture-and-release as an approach required for wildlife shepherding. As opposed to fauna species that are highly mobile species in which a passive approach is recommended, the identified species are less mobile and would require a more active approach to shepherding.

**Table 7-4** List of identified target species

<b>Category</b>	<b>Species</b>	<b>Active Hours</b>
Capture-and-release	Clouded monitor	Diurnal
	Equatorial spitting cobra	Diurnal
	Reticulated python	Nocturnal
	Other snake species	Diurnal and nocturnal

For wild boars found at or around the site at any time during the project, NParks is to be informed as soon as possible at [nparks\\_wildlife\\_management@nparks.gov.sg](mailto:nparks_wildlife_management@nparks.gov.sg) for advice and subsequent action. An approved wild boar removal contractor must also be engaged to trap and remove the said animals, the process of which may take about 4–8 weeks.

As a feral cat was observed during the baseline surveys on site a trapping programme is to be implemented prior to the start of the construction activities. The programme is to adhere to following protocol show in the flowchart below.



**Figure 7-2** Trapping Programme Flowchart

#### **7.8.4 Methodology and Approach**

Phased tree clearance should only be conducted during scheduled daylight hours (8am to 6pm). It may include a combination of the following activities:

- Installation of hoarding along project boundaries, which would help to guide target terrestrial fauna in the intended direction of movement and as a barrier to prevent wildlife displacement onto adjacent roads;
- Installation of temporary hoarding to along width of cleared areas to prevent wildlife from re-entering the cleared areas;
- Systematic pattern of tree clearance in the site in order to encourage wildlife to encourage wildlife to move in an intended direction of movement towards adjacent refuge habitats, and;
- Careful survey to check for the presence of target fauna species and any active nests or dens.

As the Study Area is bounded by roads, permanent hoarding is to be installed prior to any clearance starting with boundaries along Bukit Batok Road, Bukit Batok West Ave. 5, Bukit Batok West Ave. 7. The area is to be divided into phases and clearly demarcated on site. Prior to tree-felling within a phase, undergrowth clearance is to be carried out with a fallow period of 3 day observed after. Tree felling should take place after the 3-day fallow period.

Prior to any tree felling, the site is to be inspected by an ecologist to ensure that no target fauna and active nests or dens remain. Cleared areas should be hoarded up to prevent target terrestrial fauna from returning to the site. The wildlife inspection prior to tree felling will check for any entrapped animals within the phase. This inspection will be valid for 7 days only, during which the trapped animals must be translocated away from the site and clearance must be conducted. If more than 7 days have passed and site clearance is not done yet, the inspection should be carried out again

In the event that any target fauna listed in Table 7-4 are encountered during this process, the following actions which have been developed with the consideration of reducing stress to fauna while ensuring the effectiveness of the exercise shall be taken:

- i) Passive Shepherding: These are highly mobile species such as birds, squirrels, and bats where passive shepherding is likely to be effective. When species in this category are encountered, personnel should allow the animal to move on its own accord. If necessary, personnel may talk loudly or make some noise by clapping their hands together to encourage the animal to move. If any individual fauna is injured or trapped, the EMMP team is to call NParks' Animal Response Centre or ACRES for the appropriate removal of the animal.
- ii) Capture-and-release: Species in this group are less mobile and/or venomous, and a passive shepherding approach is deemed to be ineffective and/or unsafe. A capture-and-release approach will be needed to ensure safe relocation of these fauna from the site prior to construction. In the event that these species are encountered, NParks' Animal Response Centre or ACRES should be called immediately for the next course of action. Capture-and release of animals encountered should be conducted by an NParks' licensed animal management company, with the relevant Letter of Approvals.

Should the team encounter a visibly injured animal, NParks' Animal Response Centre or ACRES should be called immediately for the next course of action.

No attempt should be made by the EMMP team, workers, or other unqualified personnel at any point to handle animals on site. Handling animals without appropriate certification is illegal under the recent Wildlife Act of June 2020.

For trees that are subjected to removal, it is necessary to check for the presence of fauna species before each individual tree is felled.

The ecologist shall inspect the tree for the presence of fauna, including birds, bats, arboreal mammals, and arboreal herpetofauna. The ecologist should do the following:

- Check the crown of the tree for bird nests
- Check along the trunk from the bottom up for holes in which animals could be nesting
- Scan the trunk and all the branches for animals using the tree
- Scan the ground for potential nests, eggs, or burrows

Photographs of all nests, tree holes, and burrows should be taken for recording purposes. In the event that the presence of birds, bats, arboreal mammals and herpetofauna, are found on the tree, tree felling, or transplanting must be postponed until the animal has left the tree on its own accord.

Tree felling or transplanting should not occur during prime breeding season for birds in Singapore, between the months of mid-March to July if possible. In the event that this

period is unavoidable for tree-felling, the frequency of pre-felling fauna inspections shall be increased as needed. Outside these months, if active nests are detected on the tree, nests shall be left undisturbed until the young birds have fledged. Inactive nests should be removed to minimize the possibility of a new nesting attempt. Tree felling or transplanting shall occur only when no active nests are present on the tree.

Once tree felling is completed, the tree should be inspected again for any animals that were not detected earlier. Should an animal be detected after felling, NParks Animal Response Centre or ACRES should be contacted immediately, especially since the animal might be injured.

Through the undertaking of general approach, a register shall be maintained to record:

- the activities that were carried out,
- the species, numbers, GPS locations, dates, timings, and actions taken (if any) for each target fauna which was identified, and
- the description, GPS location, and actions taken (if any) for each burrow, inhabited tree hole and nest that was identified.

#### Bee Hives and Wasp/Hornet Nest

If there is a presence of hornet and wasp nests within the Study Area, which may result in human-wildlife conflict during the construction phase. Prior to the commencement of works, the hornet and wasp nests should be removed. Bee hives are to be relocated out of the construction site to reduce the risk of any injury.

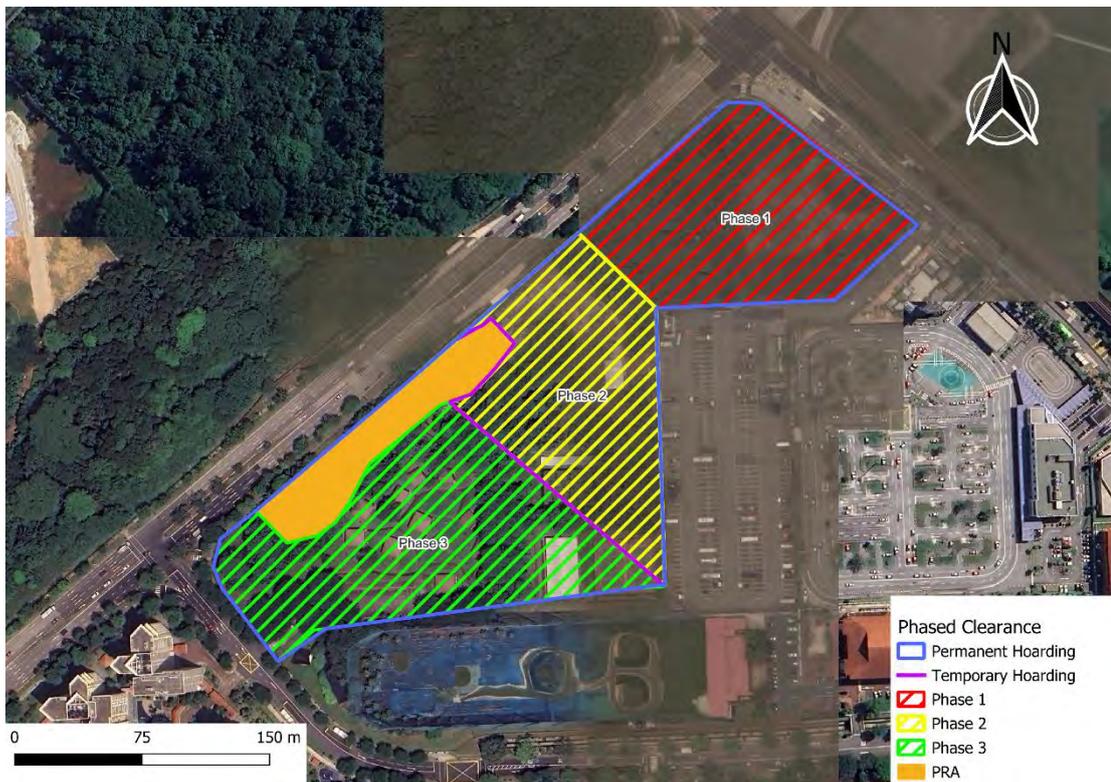
#### **7.8.5 Spatial Visualisation of Directional Clearance**

The figures below illustrate the overall scheduled phasing for directional clearance. These activities should take place during daylight hours only (i.e., 8am to 6pm) and a minimum of one rest day (i.e., Sunday) per week should be provided to reduce disturbance to wildlife.

This plan serves as a guide and shall be finalized prior to actual clearance works once the Contractor is on board to include a more detailed clearance regime. TPZs are to be set up before any works (including the installation of hoarding) to ensure there is no damage to the trees. Prior to vegetation clearance, permanent hoarding is to be installed around the Study Area as shown in Figure 7-4. Hoarding should have no gaps be embedded 300mm into the ground to prevent fauna from digging under the hoarding. An example of the permanent hoarding is illustrated in below.

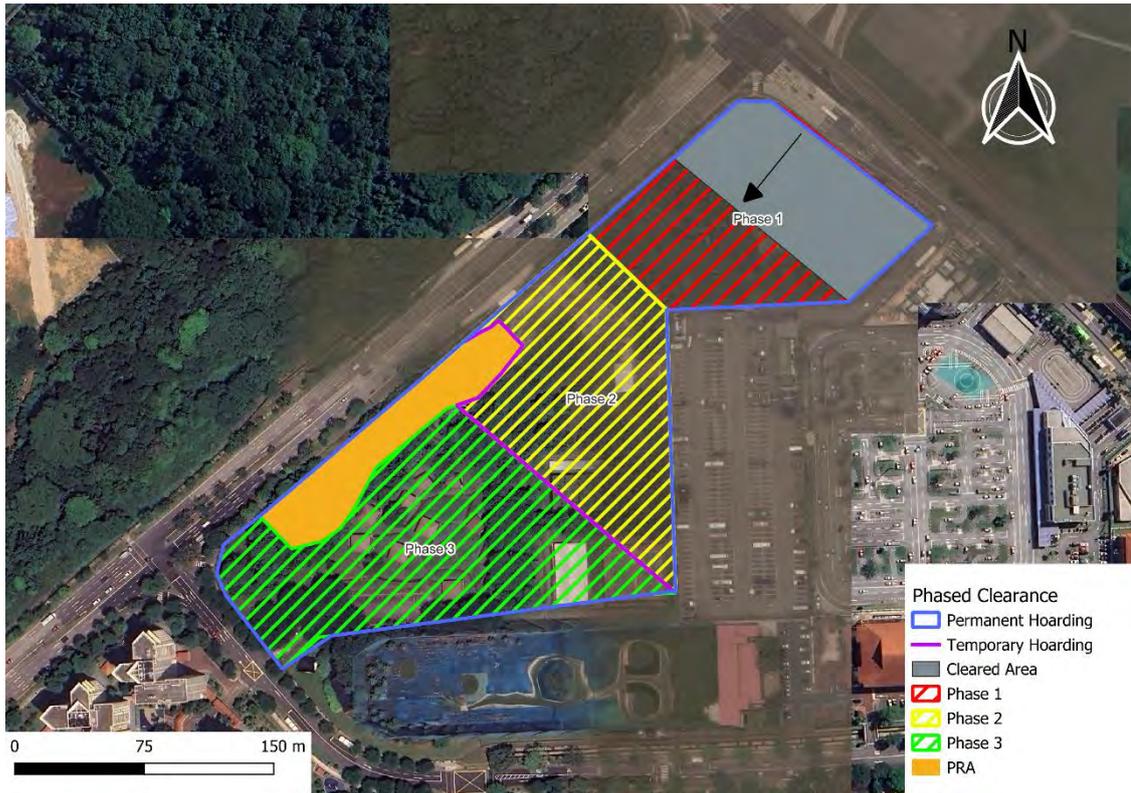


**Figure 7-3** Example of the permanent hoarding



**Figure 7-4** Phased Clearance Layout

Phased clearance is recommended to be conducted in at least 3 phases to allow better management of any non-volant species found on site (Figure 7-4). Prior to any vegetation clearance temporary hoarding is to be installed between the clearance zones to control the movement of wildlife to enable easier translocation of target non-volant fauna. General direction of clearance should be towards the PRA with an example shown in Figure 7-5.



**Figure 7-5** Example of clearance direction

For Phase 2 and Phase 3, the direction of the clearance and tree felling should be towards the PRA. As the clearance progresses to prevent fauna from re-entering these areas. Temporary hoarding is to be installed as the boundary shifts as the clearance proceeds. An example is shown in Figure 7-6 below.



**Figure 7-6** Temporary Hoarding Along Cleared Areas

Once phased clearance is carried out towards the PRA, the PRA is to be permanently hoarded up to prevent wildlife from re-entering the cleared areas.



**Figure 7-7** Permanent Hoarding After Completion of Clearance

### 7.8.6 Wildlife Response and Rescue Protocol

Even upon the completion of wildlife shepherding works, it is highly probable that animals might be able to enter the site and get trapped, particularly burrowing or climbing animals. Whenever fauna is encountered within the working areas, all construction activities should be stopped immediately, and the Wildlife Response and Rescue Plan should be followed (Table 7-5). Workers are to notify their supervisor, who will in turn contact the designated ecologist. The ecologist will then decide the next appropriate course of action.

All documentations of wildlife are to be captured in photographs, and a Wildlife Incident Form provided in **Appendix K** is to be filled.

**Table 7-5** Wildlife response and rescue plan

Particular	Within the project site					Outside project site
Timeframe	During working hours					Any time
Animal type	Highly mobile animals (e.g., wild boar, smooth-coated otters, and long-tailed macaques)		Non-large animals			Any
			Venomous / poisonous (e.g., king cobra, black spitting cobra)		Non-venomous / -poisonous (e.g., Malayan water monitor)	
Animal condition	Alive / Moving / Resting	Dead	Alive / Moving / Resting	Dead	Any	-
Risk To human	High	Low	High	Low	Low	-
Response	a. Stop work on work site b. Report to PM c. PM to report to CEMMP In-charge d. CEMMP In-charge to inform EMMP Specialist (Fauna), who will contact NParks/ ACRES for next steps if	a. Barricade affected area b. Report to PM c. PM to report to CEMMP In-charge d. CEMMP In-charge to inform EMMP Specialist (Fauna). e. If required,	a. Stop work at affected area; if possible, barricade affected area b. Report to PM c. PM to report to CEMMP In-charge d. CEMMP In-charge to inform EMMP Specialist (Fauna), who will contact	a. Barricade affected area b. Report to PM c. PM to report to CEMMP In-charge to inform EMMP Specialist (Fauna). e. If required, Contractor to assist with	a. Stop work at affected area; if possible, barricade affected area b. Report to PM c. PM to report to CEMMP In-charge to inform EMMP Specialist (Fauna), who will contact	Notify NParks Animal Response Centre/ ACRES hotline if necessary

Particular	Within the project site					Outside project site
	necessary	Contractor to assist with transporting of the Wild Animal to Disposal Location	NParks/ ACRES for next steps if necessary	transporting of Wild Animal to Disposal Location	NParks/ ACRES for next steps if necessary	
<b>Remarks</b>	<ul style="list-style-type: none"> <li>• No attempts shall be made by Contractors to handle the animal</li> <li>• Contractor to take photograph of the animal if possible.</li> <li>• Contractors shall allow the animal to leave the site without harassment / handling</li> <li>• If animal is trapped, notify NParks Animal Response Centre or ACRES hotline</li> <li>• For wild boar found at or around the site, NParks is to be informed as soon as possible at for advice and subsequent action. An approved wild boar removal</li> </ul>	<ul style="list-style-type: none"> <li>• Contractor to take photograph of the animal</li> </ul>	<ul style="list-style-type: none"> <li>• No attempts shall be made by Contractors to handle the animal</li> <li>• Contractor to take photograph of the animal if possible.</li> <li>• Contractors shall allow the animal to leave the site without harassment / handling</li> <li>• If animal is trapped, notify NParks Animal Response Centre or ACRES hotline</li> </ul>	<ul style="list-style-type: none"> <li>• Contractor to take photograph of the animal</li> </ul>	<ul style="list-style-type: none"> <li>• No attempts shall be made by contractors to handle the animal</li> <li>• Contractor to take photographs of the animal if possible.</li> <li>• Contractors shall allow the animal to leave the site without harassment / handling</li> <li>• If animal is trapped, notify NParks Animal Response Centre or ACRES hotline</li> </ul>	<ul style="list-style-type: none"> <li>• Contractor is encouraged to report</li> <li>• Reports could be from Public and/or Contractor's Staff</li> <li>• If required, CEMMP In-charge to contact PM for assistance of transferring Wildlife Animal Carcass to Disposal Location</li> </ul>

Particular	Within the project site					Outside project site
<div style="background-color: #cccccc; width: 100%; height: 100%;"></div>	contractor must also be engaged to trap and remove the animal.					

## 7.9 Flora Management Plan

The following Flora Management Plan lays out the details on salvaging plants, how to carry out tree protection works, the required components of tree assessments and monthly monitoring, etc. The tree protection and assessment duties should come under an ISA Certified Arborist.

Within the areas to be cleared, trees to be retained will be identified and confirmed during pre-construction phase. Protection of retained trees should be done through the establishment of appropriate TPZs. Additionally, permanent hoarding is to be set up around the adjacent areas of the project site to prevent unnecessary vegetation damage particularly along the PRA.

### 7.9.1 Salvaging Native Plants

The site has some plants that may be suitable for transplanting, including saplings or young plants of *Callicarpa longifolia*, *Ficus vasculosa*, *Glochidion zeylanicum* var. *zeylanicum*, *Lindera lucida*, *Litsea umbellata*, *Pavetta wallichiana*, *Rubus moluccanus* var. *angulosus* and *Trema tomentosum*. The Contractor will liaise with NParks so that they are informed at least eight weeks prior to vegetation clearance to facilitate plant salvaging, if required. These salvaged plants will be housed and maintained in NParks-approved locations.

It is important that all individuals involved in the salvaging works are qualified persons to conduct the required works (i.e., relevant experience and professional expertise in the landscaping industry). Preferably, they shall have good local flora (trees, shrubs) identification skills as well as hands on experience in the operational aspects such as transplanting techniques and nursery management knowledge to ensure a higher success rate in the transplanting process.

### 7.9.2 Assessment and Monitoring of Trees to be Protected

A basic arborist assessment matrix for all existing trees had been prepared during baseline survey period. Before any construction activity begins (including both planned and ad-hoc site clearance), the Arborist shall assess the trees listed in the arborist assessment matrix, record any new large trees with unique tree id number, and prepare an arborist assessment report for the retained tree, as well as a tree table for other trees to be removed for further consultation with NParks GDP. For the retained tree (*Ficus glandulifera*), the Arborist shall produce tree assessment report recording tree information such as site condition, tree photos, species, height, girth, crown spread, tree health, form, structure. He / She will then provide recommended mitigation measures to mitigate these impacts. This tree assessment report will then serve as a record as the pre-development tree condition, and the Arborist will have to refer to this report as benchmark when performing monthly monitoring for trees.

Mitigation actions such as crown cleaning to remove damaged and dead branches, as well as applying appropriate pest and disease control should be the first line of

measures. Tree Support Systems such as Tree Guying and Root Anchoring must be considered if the tree is deemed to be susceptible to wind throw. Furthermore, active regular monitoring of defects such cavity with wounded wood development by the Arborist will also be useful in early detection of hazardous trees.

### 7.9.3 Tree Protection Zones (TPZ)

It is possible to retain large and significant trees within construction footprint with a thorough and carefully thought-out pre-construction planning such as rerouting underground pipelines, altering footpath direction and repositing hardscape infrastructures etc. pavilion to avoid a native / mature tree within or at the border of such site. However, if these measures or plans proved to be impossible to put into place and works near / around a large, retained tree is unavoidable, a minimal TPZ needs to be demarcated to protect individual trees, so as to minimize the impacts of construction activities (including root cuts, mechanical trunk damage, branches breakage, damage due to soil compaction, etc.) on the tree. NParks (2018) has included some guidelines on TPZs in their Guidelines on Greenery Provision and Tree Conservation for Developments.

Trees identified for retention onsite or at the boundaries of the construction footprint of the working area and boundary of the PRA should be demarcated by Tree Protection Zones (TPZs) determined by an ISA-certified Arborist. TPZ size varies depending on tree size (Table 7-6). In general, the remaining space should be sufficient for implementation of design and required infrastructures. In the event the Contractor require extra spacing during the construction period for necessary works, the adjacent areas should be surveyed for native species / trees to be retained and possibly salvaged to interim nursery before any clearance. If any materials spill into TPZ, the spillage should be cleaned up immediately and the Arborist must be informed. The Contractor is also required to notify the Arborist immediately if retained trees are observed to have been damaged. If the tree suffers from substantial damage and are in a state of irreversible deterioration as determined by the Arborist, the Contractor should replace the tree of the same species at a minimum girth size of 0.2m with the default replacement ratio (Table 7-7).

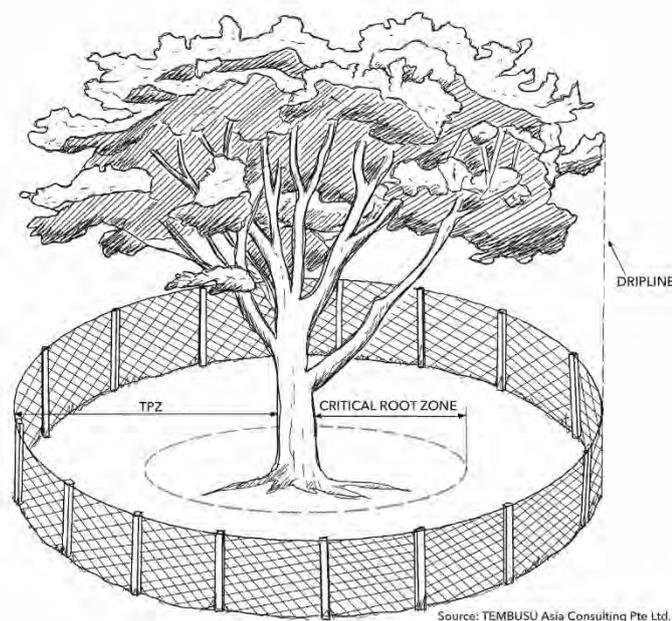
**Table 7-6** TPZ size required for different girth range

Girth	Recommended TPZ (radius)
<0.5m	1 m
>0.5m but less than 1m	2 m
>1m but less than 1.5m	3 m
>1.5m but less than 2m	4 m
>2m	5 m
Fig trees and Trees with Critically Endangered status	Prescribed individually by Arborist on a case-by-case basis

Girth	Recommended TPZ (radius)
Mangrove Trees	2m away from visible pencil, conical, or prop roots

**Table 7-7** Tree Replacement Ratio

Girth of Trees to be Replaced	Recommended Replacement (NO)
<0.4m	1
≥0.4m but ≤ 2m	3
>4m	5



**Figure 7-8.** Tree Protection Zone Diagram

The following specifies guidelines for construction activities within and outside the TPZ, extracted from NParks (2018).

**Inside TPZ**

- There must be no excavation, raising or lowering of soil level, compaction or any form of construction activities including temporary works within the hoarded area.
- Dumping of debris, excavated materials and/or storage of construction materials and equipment are not allowed within the TPZ.
- The demolition of drains, structures within the TPZ should be carried out manually and backfilled with Approved Soil Mixture (ASM) immediately.
- Trees are to be watered regularly if rainfall is inadequate.
- Trees are to be fertilised if soil tests or deficiency symptoms indicate they are nutrient stressed.

### Outside TPZ

- If major roots are encountered during excavation, the applicant may like to seek advice from a Certified Arborist, as cutting of major roots may affect the stability of the tree. Where possible, alternative proposals should be explored to avoid the need to cut the roots.
- In cases where the trees are managed by NParks (e.g., trees within the park connector planting verge), or are required by NParks to be conserved (e.g., trees with girth >1.0m within TCA or vacant land), approval from NParks must be obtained before the major root can be cut. If approval is granted by NParks to cut the roots, this must be done with a clean cut using a chainsaw.
- All building debris and chemical waste should not be burned or buried within green verges on the site.

#### **7.9.4 Tree Felling Within Forested Areas**

Before felling trees, the Arborist must ensure selected native saplings have already been tagged, identified, and transplanted. The Arborist must also survey, identify, and confirm the trees to be protected in the surrounding area and establish a tree felling protection distance based on site condition and tree crown spread.

The trees to be felled shall be inspected for any fauna as per guidelines provided in wildlife management plan (Section 7.8). Such trees will be marked with red & white tape and no tree felling operation shall be carried out within 5 m from the said tree until further instruction.

Prior to the any tree felling, HDB's Standard Operating Procedure (SOP) on tree felling must be implemented. This includes labelling each tree with laminated or weather protected A4 sheet to indicate if the tree is to be retained or translocated. This minimizes the risk of felling any trees that were supposed to be retained.

During tree felling operation works, the Contractor shall exercise all necessary precaution to ensure safety of workers and road users. Before commencing tree felling works, the supervisor, banksman, and foreman shall scout the area a final time to ensure that the tree felling protection zone is clear of human activities, while fauna specialist will inspect the tree felling protection zone if the site is free of wildlife activities. Once the areas are cleared, the banksman should signal the excavator operator to commence work for trees felling. The excavator operator should first clear off the shrubs and small trees (<5 m height) to create a clear line of sight for the whole area and to keep away blind spot areas which are blocked by small trees or tall shrubs. The excavator operator shall operate cautiously and fell all small trees and shrubs in a controlled manner, aware of the location of the locations of other trees to be protected.

When opening is completed, the excavator operator should clear off small trees and shrubs along the path into the site to mark the area that they are supposed to work within. When the paths are cleared, the operator should then move inward to fell trees within the area. If the operator faces a tree with height between 5 and 7 m, they should clear off shrubs in the surrounding area so that the foreman can move closer to the tree. The recommended tree cutting method should be the notch cut (Figure ). The foreman

shall determine the direction of falling and ensure the tree does not land on any property, cause injury, or damage nearby Trees to be Protected. To avoid trees leaning to an unintended direction when performing a third cut, the excavator should assist to prevent fall back and guide the tree to fall into the intended direction. Once the tree has been felled, the tree cutter shall cut the tree trunk into shorter lengths for easier loading during clearing of the debris from site.

If the tree has a height greater than 7 m, the tree height has to be reduced by using a lorry crane to perform crown reduction first. Before the lorry crane can enter the site, the Contractor has to prepare proper access for the lorry crane to enter the site and access the tree location. The Contractor must ensure that the access ground is firm enough to allow the lorry crane to deploy its outrigger. When the access is ready, the Contractor will then mobilize the lorry crane to enter the site to reduce tree height to 7 m in order to adopt the notch cut method for trees less than 7 m in height.

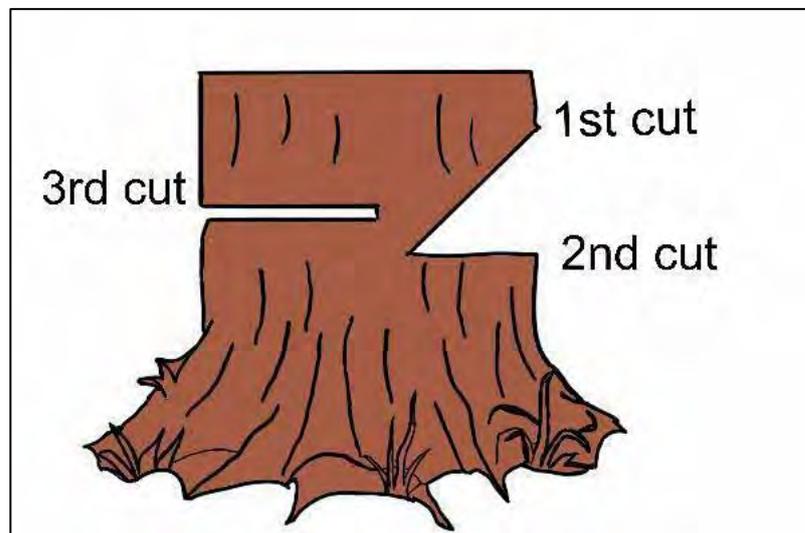


Figure 7-9 Illustration of a notch cut

#### 7.9.5 Flora monitoring at forest edges

For existing forest patch to be retained under the proposed PRA, engineering solutions can be provided to limit the amount of light entering forest edges to deter growth of invasive species at forest understorey, including but not limited to minimum 2m height hoarding with additional board at the top of hoarding angled towards the forest.

The Contractor will also need to engage a flora specialist to conduct monthly flora monitoring along forest edges of retained forest patch during the whole construction period. Some of the key monitoring parameters include:

- Identify any vegetation disturbance that are of natural causes (e.g. tree failure)
- Identify any vegetation disturbance that might be of manmade causes (e.g. machinery damage, soil erosion due to excavation)
- Along the forest edges of retained forest patches, regular weeding shall be conducted with help of the Contractor's workers to remove clusters of *Miconia crenata*, *Miconia dependens* and saplings of exotic species such as *Acacia auriculiformis*, *Cecropia pachystachya*, *Falcataria falcata* and *Leucaena leucocephala* to minimize disturbance to forest edge

## **7.10 Lighting Management Plan (LMP)**

In the event that night works are required, a Lighting Management Plan (LMP) shall be developed as part of the Construction EMMP.

## **7.11 Biodiversity Monitoring Requirements**

Specific monitoring requirements for biodiversity are detailed in this section. The other monitoring requirements for physical parameters are presented in Table 7-10.

### ***7.11.1 Fauna Monitoring***

There should be regular checks to ensure that the implementation of mitigation measures for fauna protection are in place and effective in the mitigation of impacts. Sensitive biodiversity should also be monitored to ensure that their presence has not been adversely affected by the works. The following section outlines visual site inspection and aquatic monitoring recommendations.

#### **Visual Site Inspection**

Monthly inspections of hoarding surrounding the worksite:

- There should be no clearance of vegetation outside the hoarding boundary. Additionally, the hoarding should be implemented with no gaps between, to ensure that animals are not able to enter the site. Specifications for hoarding should also follow directives from NParks.

Monthly inspection of habitats:

- Visual inspections should also be made of sensitive habitats, especially the PRA (if applicable). There should be no visible impacts to the PRA (if applicable), including, but not limited to, loss of vegetation, siltation, visible increased erosion, presence of chemicals, etc.

### ***7.11.2 Flora Monitoring***

Due to the presence of plant species of conservation value within and around the project site, there should be regular checks to ensure that the implementation of mitigation measures for flora and arboriculture protection are in place and effective in the mitigation of impacts. The following section outlines monitoring recommendations for flora protection.

For the monitoring of flora, the flora specialist and arborist should have access to the documents listed in Section 7.9.2.

#### **Monitoring of Retained Trees**

During the construction period, all retained trees will need to be protected from the side effects of major work activities. It is more vital for this project as a handful of trees i.e., heritage species, conservation valued species had been earmarked to be conserved

and remain as part of the future plans. Therefore, it is recommended for the Certified Arborist to conduct at least a Level 2 visual assessment (VTA), minimally on a six-month cycle to ensure that the retained trees are not gravely affected by ongoing construction activities. During the assessment, he/she will need to do a basic ground level assessment of every individual tree with general hand tools and produce an arborist report thereafter. The arborist report will document photo(s) of the specific tree and include information such as the general appearance, abnormalities and/or defects observed due to the construction activities, and follow-up recommendations to be taken (e.g., pruning/felling). The arborist report should generally cover 2 main components: (i) Overall tree health and (ii) TPZ condition with the criteria listed in the table below.

**Table 7-8** Parameters to take note during monthly tree inspections.

Tree Health	TPZ Condition
<ul style="list-style-type: none"> <li>• Foliage colour (Normal, Chlorotic, Necrotic)</li> <li>• Foliage density (Normal, Sparse, Dense)</li> <li>• Leaf size (Normal, Small)</li> <li>• Vigour (Good, Average, Poor)</li> <li>• Lean (Self corrected, Unnatural)</li> <li>• Diebacks and Dead branches (%)</li> <li>• Cracks</li> <li>• Cavities / Conks / Fungi</li> <li>• Roots collar buried / not visible</li> <li>• Pest / Disease Infestation</li> <li>• Damaged / Cut roots</li> <li>• Root plate lifting</li> <li>• Site Changes (None, Grade change, Site Clearing)</li> <li>• Soil Condition (Limited volume, Saturated, Compacted, Pavement over roots)</li> <li>• Wind Exposure (Protected, Partial, Full, Funnelling)</li> </ul>	<ul style="list-style-type: none"> <li>• TPZ barriers installed/good condition</li> <li>• Evidence of illegal encroachment</li> <li>• Evidence of damage to tree</li> <li>• Evidence of toxic splash</li> <li>• Evidence of illegal compaction</li> <li>• Evidence of materials storage</li> <li>• Evidence of machinery, equipment and vehicle storage</li> </ul>

It is critical for the Certified Arborist to be proactive in his / her inspection checks to manage the trees well, thus preventing the trees from consequential death and / or failure (i.e., snapping, uprooting). The Certified Arborist should also recommend routine maintenance such as deadwooding and formative pruning to be done periodically to keep the trees structurally safe and sound.

**Monitoring of Plants and Trees**

Fortnightly checks should be conducted by qualified persons (i.e., Flora specialist and / or Certified Arborist) to ensure that all the mitigation measures are implemented and effective in the protection of all plants and trees during the construction phase. Flora inspections shall be conducted within the worksite boundary.

The general criteria that the Flora Specialist can use to monitor the plants' condition during his / her periodic checks are presented in the table below.

**Table 7-9** Parameters to take note during for plants monitoring

<b>Signs of poor plant health</b>	<b>Signs of healthy plant</b>
Wilting	Vigorous growth
Change in colour	Uniform colour
Dropping leaves / needle without reason	Open and not curled growth
Brittle leaves	Upright appearance
Brown splotches or white powdery growth on leaves	
Uncharacteristic slow growth	

The Flora Specialist will need to pay attention to stressed plants within conserved areas, especially those infested by diseases and pests as such infestation may potentially spread fast and wide throughout the entire area or cluster.

### 7.11.3 Environmental Monitoring Plan

Table 7-10 provides the overview of recommended environmental monitoring plan and EMMP measures for this project which is to be incorporated into the CEMMP by the Contractor. The environmental monitoring locations are to be finalised by EMMP team during CEMMP formulation in consultation with relevant stakeholders.

**Table 7-10** Recommended Environmental Monitoring Plan for construction phase

Monitoring Category	Impact	Monitoring Parameters	Monitoring Method	Location	Standards / Criteria	Time / Duration / Frequency	Reporting	Implementation
<b>Biodiversity Monitoring</b>  <ul style="list-style-type: none"> <li>Avoiding clearance of vegetation outside working boundaries</li> <li>Avoiding human wildlife conflict</li> </ul>	<u>On-site Visual and Compliance Monitoring</u>							
	Habitat loss-Native Dominated Secondary Forest	<ul style="list-style-type: none"> <li>Implement hoarding around worksite boundary</li> <li>Implement hoarding around PRA</li> <li>No construction activity within the PRA</li> <li>No encroachment into the PRA by construction personnel</li> </ul>	<ul style="list-style-type: none"> <li>Visual monitoring</li> <li>Compliance check</li> </ul>	<ul style="list-style-type: none"> <li>Entire project site</li> <li>PRA boundary</li> </ul>	<ul style="list-style-type: none"> <li>Proper installation of hoarding</li> <li>Absence of construction works in PRA (if applicable)</li> <li>Absence of vegetation clearance outside working boundaries</li> </ul>	<ul style="list-style-type: none"> <li>Fortnightly during construction phase</li> </ul>	Monthly Environmental Performance Report	<ul style="list-style-type: none"> <li>Contractor PM</li> <li>Contractor ECO / CEMMP In-charge</li> <li>Ecologist</li> <li>Arborist</li> </ul>
	Species Mortality Due to Vegetation Clearance	<ul style="list-style-type: none"> <li>Implement hoarding around project boundaries.</li> <li>Minimise felling trees and clearing vegetation during the peak bird breeding season (March to July).</li> <li>Pre-felling fauna inspection should be conducted before felling any trees or removing any vegetation.</li> </ul>	<ul style="list-style-type: none"> <li>Visual monitoring</li> <li>Compliance check</li> </ul>	Entire project site	<ul style="list-style-type: none"> <li>Proper TPZ installation</li> <li>Retention of tree health</li> <li>Absence of mechanical damage on trees</li> <li>Absence of nesting birds</li> </ul>	<ul style="list-style-type: none"> <li>Prior to vegetation clearance (for wildlife translocation and fauna inspection)</li> <li>Monthly during construction phase</li> </ul>	Monthly Environmental Performance Report	<ul style="list-style-type: none"> <li>Contractor PM</li> <li>Contractor ECO / CEMMP In-charge</li> <li>Ecologist</li> <li>Arborist</li> </ul>

Monitoring Category	Impact	Monitoring Parameters	Monitoring Method	Location	Standards / Criteria	Time / Duration / Frequency	Reporting	Implementation
		<ul style="list-style-type: none"> <li>• Phased directional clearing to be adopted during vegetation clearance.</li> <li>• Active translocation target fauna species</li> <li>• Use only fully biodegradable erosion control blankets (ECB) to avoid trapping fossorial fauna such as snakes.</li> <li>• Check ECBs on a daily basis for entrapped fauna.</li> </ul>			<ul style="list-style-type: none"> <li>• Absence of entrapped fauna</li> </ul>	<ul style="list-style-type: none"> <li>• Daily for fauna entrapment</li> </ul>		
	Human-wildlife Conflict	<ul style="list-style-type: none"> <li>• Ensure good housekeeping controls such as provision of wildlife proof bins and eating areas.</li> <li>• Execute Wildlife Response and Rescue Plan when fauna is found on-site.</li> <li>• Train site personnel on biodiversity awareness and actions to take when encountering wildlife.</li> </ul>	<ul style="list-style-type: none"> <li>• Visual monitoring</li> <li>• Compliance check</li> </ul>	Entire project site (near forested area)	No injuries due to wild animals	<ul style="list-style-type: none"> <li>• Continuous</li> <li>• As and when required for Wildlife Response and Rescue Plan</li> </ul>	<ul style="list-style-type: none"> <li>• Monthly Environmental Performance Report</li> <li>• As and when a wildlife incident occurs</li> </ul>	<ul style="list-style-type: none"> <li>• Contractor PM</li> <li>• Contractor ECO / CEMMP In-charge</li> <li>• Ecologist</li> </ul>
	Disturbance To Flora and Fauna Species from Generated Light and Noise	<ul style="list-style-type: none"> <li>• Implementation of LMP</li> <li>• Installation of 4m noise barrier around boundary of PRA</li> </ul>	<ul style="list-style-type: none"> <li>• Visual monitoring</li> <li>• Compliance check</li> </ul>	PRA	<ul style="list-style-type: none"> <li>• Implementation of LMP developed with consultation with NParks</li> <li>• Proper installation of noise barriers around PRA boundary</li> </ul>	<ul style="list-style-type: none"> <li>• During nightworks</li> <li>• Continuous</li> </ul>	Monthly Environmental Performance Report	<ul style="list-style-type: none"> <li>• Contractor PM</li> <li>• Contractor ECO / CEMMP In-charge</li> </ul>

Monitoring Category	Impact	Monitoring Parameters	Monitoring Method	Location	Standards / Criteria	Time / Duration / Frequency	Reporting	Implementation
<b>Surface Water Quality Monitoring</b> <ul style="list-style-type: none"> <li>Minimization of impact to receiving watercourse due to contaminated site run-off</li> <li>Minimization of impact to receiving watercourse due to erosion of topsoil</li> </ul>	<u>On-site Visual and Compliance Monitoring</u>							
	ECM non-compliance	<ul style="list-style-type: none"> <li>Verify implementation of ECM Plan</li> <li>Perimeter cut-off drains, perimeter silt fence, silt traps, sedimentation basin and silt treatment system</li> </ul>	<ul style="list-style-type: none"> <li>Visual monitoring</li> <li>Compliance check</li> <li>ECM checklist</li> </ul>	Construction area with earthworks	ECM Plan designed by a Qualified Erosion Control Professional (QECP)	<ul style="list-style-type: none"> <li>Daily compliance monitoring</li> <li>During entire construction phase</li> </ul>	Monthly Environmental Performance Report	<ul style="list-style-type: none"> <li>Contractor PM</li> <li>Contractor ECO / CEMMP In-charge</li> <li>QECP</li> </ul>
	<u>On-site Water Quality Monitoring</u>							
	ECM discharge (sediment runoff)	Total Suspended Solids (TSS)	Implementation of TSS monitor and CCTV including a Silty Imagery Detection System (SIDS)	<ul style="list-style-type: none"> <li>Final ECM discharge points</li> </ul>	<ul style="list-style-type: none"> <li>Less than 30 mg/L for TSS</li> <li>Sewerage and Drainage (Surface Water Drainage) Regulation 2007</li> </ul>	Real-time continuous during entire construction phase	<ul style="list-style-type: none"> <li>TSS report</li> <li>Monthly Environmental Performance Report</li> </ul>	<ul style="list-style-type: none"> <li>Contractor PM</li> <li>Contractor ECO / CEMMP In-charge</li> </ul>
Contamination of water resources through trade effluent discharge	<ul style="list-style-type: none"> <li>All parameters identified in EPM (Trade Effluent) Regulations for Controlled Watercourse</li> </ul>	In-situ and ex-situ monitoring	<ul style="list-style-type: none"> <li>At every discharge outlet</li> </ul>	EPM (Trade Effluent) Regulations for Controlled Watercourse	<ul style="list-style-type: none"> <li>Monthly during construction phase</li> </ul>	Monthly Environmental Performance Report	<ul style="list-style-type: none"> <li>Contractor PM</li> <li>Contractor ECO / CEMMP In-charge</li> </ul>	

## 8 CONCLUSION

The section summarises the conclusions and recommendations from the assessed potential environmental impacts. A summary of the unmitigated and residual impacts of the assessed environmental aspects for both the pre-construction/ construction phase and operation phase, as well as the key mitigation measures to be implemented, are shown in Table 8-1 and Table 8-2 respectively.

**Table 8-1.** Summary of impact assessment

Environmental aspect	Impacts before mitigation	ES	Residual Impacts after mitigation	ES
<b>Pre-construction/Construction Phase</b>				
Biodiversity	Moderate Negative to Slight Negative	-108 to -14	Moderate Negative to Slight Positive	-81 to 9
Surface Water Quality	Slight Negative	-21 to -12	Slight Negative	-7
<b>Operation Phase</b>				
Biodiversity	Moderate Negative to Slight Positive	-81 to 27	Slight Negative to Slight Positive	-32 to 27

**Table 8-2.** Summary of key mitigation measures to be implemented

Environmental aspect	Key mitigation measures
<b>Pre-Construction/ Construction Phase</b>	
<b>Biodiversity</b>	<ul style="list-style-type: none"> <li>Proposed retained area (PRA)</li> <li>Incorporate native plant species such as those recommended in Table 5-18 into planned landscape planting palette</li> <li>Phased/directional clearance of vegetation</li> <li>Implement Light Management Plan (LMP) if night works are necessary</li> <li>Install hoarding around the work site</li> <li>Physically tag trees to be retained and transplanted on site</li> <li>Establish Tree Protection Zones (TPZ) for trees to be retained</li> <li>Identify plants to be transplanted</li> <li>Ensure Pre-felling fauna inspection of trees and burrows</li> <li>As far as practicable, avoid the commencement of tree felling during the peak bird nesting period (February to July)</li> <li>Monitor tree and vegetation health regularly</li> <li>Conduct daily checks of ECM blankets and pits</li> <li>Ensure ECM blankets are made of biodegradable material with no plastic mesh netting</li> <li>Conduct biodiversity awareness trainings for workers</li> <li>Install 6m noise barrier along boundary of the PRA during all construction stages</li> </ul>
<b>Surface Water Quality</b>	<ul style="list-style-type: none"> <li>Implement PUB-approved ECM Plan Emergency spill kits to be present to handle any chemical spillages</li> </ul>
<b>Operation Phase</b>	
<b>Biodiversity</b>	<ul style="list-style-type: none"> <li>Establish green link through future development to facilitate volant fauna movement</li> <li>Proposed wildlife bridge and animal culvert</li> </ul>

## 9 REFERENCES

- AECOM. (2021). *Specialist Consultancy Services for Environmental Impact Study (EIS) on Southern Tengah*. Singapore: Housing & Development Board.
- AECOM. (2024). *Specialist Consultancy Services at HDB Development (Western) - EMMP Addendum No. 03 (Area A)*.
- Agriculture and Resource Management Council of Australia and New Zealand. (2000). *Australian Guidelines for Urban Stormwater Management*. Canberra, Australian Capital Territory, Australia. Retrieved from <https://www.waterquality.gov.au/sites/default/files/documents/australian-guidelines-urbanstormwater.pdf>
- American Public Health Association. (2017). *Standard methods for the examination of water and wastewater* (23rd ed.). Washington, DC: American Public Health Association.
- Baker, M. E., Schley, M. L., & Sexton, J. O. (2019). Impacts of expanding impervious surface on specific conductance in urbanizing streams. *Water Resources Research*, 55(8), 6482-6498.
- Baker, N., & Lim, K. (2012). *Wild Animals of Singapore: A Photographic Guide to Mammals, Reptiles, Amphibians and Freshwater Fishes* (2nd ed.). Draco Pub and Distribution, Singapore.
- Bateman, H., & Merritt, D. (February, 2022). Complex riparian habitats predict reptile and amphibian diversity. *Global Ecology and Conservation*, 22(3). doi:10.1016/j.gecco.2020.e00957
- Bickford, D., Ng, T., Lan, Q., Kudavidanage, E., & Bradshaw, C. (2010). Forest Fragment and Breeding Habitat Characteristics Explain Frog Diversity and Abundance in Singapore. *Biotropica*, 42(1), 119-125.
- Bird Society of Singapore. (2024). *Singapore Bird Checklist, version 2024-1*. Retrieved 5 July, 2024, from Birds of Singapore: <https://singaporebirds.com/downloads/>
- Chiok, W. X., Miller, A. E., Pang, S. E., Eaton, J. A., Rao, M., & Rheindt, F. (2019). Regional and local extirpation of a formerly common Sundaic passerine, the Straw-headed Bulbul *Pycnonotus zeylanicus*. *Forktail*, 3-11.
- Chiok, W. X., Ng, E. Y., Tang, Q., Lee, J. G., & Rheindt, F. (2020). A distance sampling survey of the Critically Endangered Straw-headed Bulbul *Pycnonotus zeylanicus* in Singapore. *Bird Conservation International*, 1-13.
- Chong, K. Y., Tan, H. T., & Corlett, R. T. (2009). *A Checklist of the Total Vascular Plant Flora of Singapore: Native, Naturalised, and Cultivated Species*. (H. T. Tan, Ed.) Singapore: Raffles Museum of Biodiversity Research, National University of Singapore. Retrieved from [https://lknhm.nus.edu.sg/app/uploads/2017/04/flora\\_of\\_singapore\\_tc.pdf](https://lknhm.nus.edu.sg/app/uploads/2017/04/flora_of_singapore_tc.pdf)
- Corbet, A. S., Pendlebury, H. M., & Eliot, J. (1992). *The butterflies of the Malay Peninsula* (4 ed.). Kuala Lumpur, Malaysia: Malayan Nature Society.
- Cordier, J. M., Aguilar, R., Lescano, J. N., & Leynaud, G. C. (January, 2021). A global assessment of amphibian and reptile responses to land-use changes. *Biological Conservation*, 253(80). doi:10.1016/j.biocon.2020.108863
- Corlett, R. T. (July, 1992). The Ecological Transformation of Singapore, 1819-1990. *Journal of Biogeography*, 411-420.
- Davison, G., & Chew, P. T. (March, 2019). Historical review of Bukit Timah Nature Reserve, Singapore. *Gardens' Bulletin Singapore*, 19-40.
- Decena, S., Avorque, C., Decena, I., Asis, P., & Pacle, B. (2020). Impact of habitat alteration on amphibian diversity and species composition in a lowland tropical rainforest in

- Northeastern Leyte, Philippines. *Scientific Reports*, 10. doi:10.1038/s41598-020-67512-6
- Denzinger, A., & Schnitzler, H. (2013). Bat guilds, a concept to classify the highly diverse foraging and echolocation behaviors of microchiropteran bats. *Frontiers in Physiology*, 4(164), 1-15.
- Department of Geography, National University of Singapore. (2024). *Historical Maps of Singapore*. Retrieved 31 May, 2024, from Historical Maps of Singapore - NUS Libraries - Digitised by Department of Geography, National University of Singapore: <https://libmaps.nus.edu.sg/>
- Diong, C., Chou, L., & Lim, K. (1994). Calotes versicolor, the changeable lizard. *Nature Malaysiana*, 19(2), 46–54.
- Eaton, J., Shepherd, C. R., Rheindt, F., Harris, J. B., van Balen, B., & Wilcove, D. S. (2015). Trade-driven extinctions and near-extinctions of avian taxa in Sundaic Indonesia. *Forktail*, 31, 1-12.
- EnviroSolutions & Consulting. (2020). *Specialist Consultancy Services for Environmental Impact Study for Proposed Housing Development at Bukit Batok Hillside Park Area*. Singapore: Housing & Development Board.
- Fenton, M., & Bell, G. (1981). Recognition of species of insectivorous bats by their echolocation calls. *Journal of Mammalogy*, 62, 233–243.
- Figueroa, A., Low, M., & Lim, K. (2023). Singapore's herpetofauna: updated and annotated checklist, conservation, and distribution. *Zootaxa*, 5287(1), 1–378.
- Francis, C., & Barber, J. (2013). A framework for understanding noise impacts on wildlife: an urgent conservation priority. *Frontiers in Ecology and Environment*, 11(6): 305-313.
- Franklin, A. B., Noon, B. R., & George, T. L. (2002). What is habitat fragmentation? *Studies in Avian Biology*, 25, 20-29.
- Gan, C. W. (2022). *iNaturalist observation*. Retrieved 20 May, 2024, from iNaturalist.org: <https://www.inaturalist.org/observations/138831214>
- Ginal, P., Tan, W., & Rödder, D. (August, 2022). Invasive risk assessment and expansion of the realized niche of the. *Frontiers of Biogeography*, 14(3).
- Grantz, D., Garner, J., & Johnson, D. (2003). Ecological effects of particulate matter. *Environment International*, 29(2-3), 213 - 239.
- Greenery & Development Planning Branch. (2018). *Guidelines on Greenery Provision and Tree Conservation for Developments (Version 2 ed.)*. Singapore: National Parks Board. Retrieved from <https://www.nparks.gov.sg/-/media/nparks-real-content/partner-us/developers-architects-and-engineers/gdp-handbook-2018-apr-3.pdf>
- Groenewoud, D., & Law, I. S. (2016). First record of greenhouse frog in Singapore. *Singapore Biodiversity Records*, 2016, 59.
- Hamer, A. J., & McDonnell, M. J. (July, 2008). Amphibian ecology and conservation in the urbanising world: A review. *Biological Conservation*, 141.
- Heller K.G. (1989). Echolocation of Malaysian bats. *Zeitschrift für Säugetierkunde*, 54, 1–8.
- Ho, B., & Lua, H. (2022). Flora of Singapore precursors, 32: Discoveries in Mucuna (Leguminosae, subfamily Papilionoideae) with a review of the genus in Singapore. *Gardens' Bulletin Singapore*, 37-55.
- Ho, P. K. (25 July, 1999). SPEECH BY ASSOC. PROF. HO PENG KEE, MINISTER OF STATE (LAW & HOME AFFAIRS) AND PRESIDENT OF CIVIL DEFENCE ASSOCIATION FOR NATIONAL SERVICEMEN, AT THE GROUND BREAKING CEREMONY FOR THE 2ND PHASE DEVELOPMENT OF ITS BUKIT BATOK

- COUNTRY CLUB ON SATURDAY 17 JUL. Singapore: Media Division, Ministry of Information and The Arts. Retrieved 31 May, 2024, from National Archives Singapore: Archives Online: <https://www.nas.gov.sg/archivesonline/data/pdfdoc/1999071707.htm>
- Hughes A.C., S. C. (2011). Using echolocation calls to identify Thai bat species: Vespertilionidae, Emballonuridae, Nycteridae and Megadermatidae. *Acta Chiropterologica*, 13 (2), 447–455.
- iNaturalist. (n.d.). *Observations of Athyma reta from Singapore observed between 2000-01-01 and 2024-05-20*. Retrieved 20 May, 2024, from iNaturalist.org: [https://www.inaturalist.org/observations?place\\_id=6734&subview=map&taxon\\_id=446951](https://www.inaturalist.org/observations?place_id=6734&subview=map&taxon_id=446951)
- iNaturalist. (n.d.). *Observations of Taxila haquinus from Singapore observed between 2006-01-01 to 2024-05-20*. Retrieved 20 May, 2024, from iNaturalist.org: [https://www.inaturalist.org/observations?place\\_id=6734&subview=map&taxon\\_id=196819](https://www.inaturalist.org/observations?place_id=6734&subview=map&taxon_id=196819)
- Insyirah, N. (2023). *iNaturalist observation*. Retrieved from iNaturalist.org: <https://www.inaturalist.org/observations/176957995>
- International Union for Conservation of Nature and Natural Resources (IUCN). (2024). *The IUCN Red List of Threatened Species*. Retrieved 15 February, 2024, from <http://www.iucnredlist.org>
- Jackson, J. C. (July, 1965). Chinese Agricultural Pioneering in Singapore and Johore 1800-1917. *Journal of the Malaysian Branch of the Royal Asiatic Society*, 77-105.
- Jacobs. (3 November, 2021). *Tengah North EIA Report*. Retrieved from Housing Development Board: <https://www.hdb.gov.sg/-/media/doc/RPG/Tengah-North-EIS-Report.ashx>
- Khew, S. K. (6 November, 2007). *Saving the Harlequin - Part 1*. Retrieved from Butterflies of Singapore: <https://butterflycircle.blogspot.com/2007/11/saving-harlequin-part-1.html>
- Khew, S. K. (2015). *A field guide to the butterflies of Singapore*. . Ink On Paper Communications Pte Limited.
- Kingston , T., Lim, B., & Zubaid, A. (2009). *Bats of Krau Wildlife Reserve*. Penerbit Universiti Kebangsaan Malaysia.
- Kingston, T., Jones, G., Akbar, Z., & Kunz, T. (2003). Alternation of echolocation calls in 5 species of aerial-feeding insectivorous bats from Malaysia. *Journal of Mammalogy*, 84(1), 205-215.
- Kirton, L. G., Tan, H., Phon, C. K., & Khew, S. K. (2020). Discovery of the previously overlooked female of *Athyma reta* (Lepidoptera: Nymphalidae), and its taxonomic implications. *Raffles Bulletin of Zoology*, 68, 249–266.
- Kong, E., Khoo, M., Wong, J. W., Wong, S., & Low, B. W. (May, 2021). Observations on the behavior and diet of the Harlequin *Taxila haquinus haquinus* Fabricius 1793 (Lepidoptera: Riodinidae) in Singapore. *Tropical lepidoptera research*, 22-31.
- Kraus, F., & Campbell, E. W. (2002). Human-mediated Escalation of a Formerly Eradicable Problem: The Invasion of Caribbean Frogs in the Hawaiian Islands. *Biological Invasions*, 4(3), 327 - 332.
- Lane, D., Kingston, T., & Lee, B.-H. (2006). Dramatic decline in bat species richness in Singapore, with implications for Southeast Asia. *Biological Conservation*, 131, 584–593.
- Lee, S., Ting, W., Lian, F., Khoo, Y., & Kwek, L. (2021). GE3255 Aquatic, Coastal and Riparian Ecosystems: Conserving and Restoring the Dover Forest Stream. Wetland Delineation and Recommendations for Conserving and Restoring Dover Forest Stream 1: Appendix. *NUS Report*, 45.

- Legislation Division of the Attorney-General's Chambers. (n.d.). *Singapore Statutes Online*. Retrieved June, 2021, from Singapore Statutes Online: <https://sso.agc.gov.sg/>
- Legislation Division of the Attorney-General's Chambers. (n.d.). *Singapore Statutes Online*. Retrieved June, 2021, from Singapore Statutes Online: <https://sso.agc.gov.sg/>
- Leong, T. M., & Chou, L. M. (1999). Larval diversity and development in the Singapore Anura (Amphibia). *The Raffles Bulletin of Zoology*, 47(1), 81-137.
- Lewanzik, D., & Voigt, C. C. (10 April, 2014). Artificial light puts ecosystem services of frugivorous bats at risk. *Journal of Applied Ecology*, 51(2), 388-394. doi:<https://doi.org/10.1111/1365-2664.12206>
- Lim, K., & Chou, L. (1990). The herpetofauna of Singapore. In N. U. Singapore, & L. & Chou (Ed.), *Essays in Zoology: Papers commemorating the 40th anniversary of the Department of Zoology, National University of Singapore* (pp. 49-59). Singapore.
- Lindsay, S., Middleton, D., Ho, B., Chong, K., Turner, I., Ibrahim, A., . . . Er, K. (2022). Flora of Singapore: Checklist and bibliography. *Gardens' Bulletin Singapore*, 74(Suppl. 1), 3-860. doi:10.26492/gbs74(suppl.1).2022-01
- Lindsay, S., Middleton, D., Ho, B., Chong, K., Turner, I., Ibrahim, A., . . . Er, K. (2022). Flora of Singapore: Checklist and bibliography. *Gardens' Bulletin Singapore*, 74(Suppl. 1), 3-860. doi:10.26492/gbs74(suppl.1).2022-01
- Lok, A. F., Ang, W. F., Ng, B. Y., Leong, T. M., Yeo, C. K., & Tan, H. T. (2013). *Native fig species as a keystone resource for the Singapore urban environment*. Singapore: Raffles Museum of Biodiversity Research.
- Longcore, T., & Rich, C. (2004). Ecological Light Pollution. *Frontiers in Ecology and the Environment/ Volume 2, Issue 4*.
- McKenzie, N. L., & Bullen, R. D. (2019). What can echolocation recordings reveal about the foraging ecology of *Saccolaimus saccolaimus* (Emballonuridae) in north-western Australia? *Australian Journal of Zoology*, 66(6), 326-334. doi:<https://doi.org/10.1071/ZO19012>
- Murphy, D. H. (1997). Odonata Biodiversity in the Nature Reserves of Singapore. *Gardens' Bulletin Singapore*, 49, 333-352.
- Nakajima, T., Asaeda, T., Fujino, T., & Nanda, A. (2006). Coarse particulate organic matter distribution in the pools and riffles of a second-order stream. *Hydrobiologia*, 559, 275-283.
- National Environment Agency. (14 April, 2023). *Air Quality*. Retrieved from The National Environment Agency: <https://www.nea.gov.sg/our-services/pollution-control/air-pollution/air-quality>
- National Environmental Agency. (3 December, 2022). *Resources*. Retrieved from Pollutant Concentrations: <https://www.haze.gov.sg/resources/pollutant-concentrations>
- National Environmental Agency. (7 June, 2023). *Water Quality*. Retrieved from Allowable Limits for Trade Effluent Discharge to Watercourse or Controlled Watercourse: <https://www.nea.gov.sg/our-services/pollution-control/water-quality/allowable-limits-for-trade-effluent-discharge-to-watercourse-or-controlled-watercourse#:~:text=2%20Where%20two%20or%20more,if%20discharged%20into%20controlled%20watercourse.>
- National Parks Board. (27 May, 2017). *MEDIA FACTSHEET B Factsheet on species recovery programme*. Retrieved from Archives Online: <https://www.nas.gov.sg/archivesonline/data/pdfdoc/20170527001/3%20Factsheet%200B%20-%20Species%20recovery%20programme.pdf>
- National Parks Board. (26 September, 2022). *Checklist of Odonata present in Singapore and*

- Their National Status*. Retrieved 5 February, 2024, from National Parks Board: <https://www.nparks.gov.sg/biodiversity/wildlife-in-singapore/species-list/dragonfly>
- National Parks Board. (6 April, 2023). *List of butterfly species present in Singapore*. Retrieved 5 February, 2024, from National Parks Board: <https://www.nparks.gov.sg/biodiversity/wildlife-in-singapore/species-list/butterfly>
- National Parks Board. (1 August, 2023). *National Parks Board*. Retrieved 1 August, 2023, from Species List (Red Data Book List): <https://www.nparks.gov.sg/biodiversity/wildlife-in-singapore/species-list>
- National Parks Board. (2024). *About our parks, nature reserves and park connectors*. Retrieved 9 July, 2024, from National Parks Board: <https://beta.nparks.gov.sg/visit/when-visiting-parks/about-parks-nature-reserves-pcns/nature-corridors-ways>
- National Parks Board. (2024). *Biodiversity Impact Assessment (BIA) Guidelines*. National Parks Board, Singapore.
- National Parks Board. (2024). *Biodiversity Impact Assessment (BIA) Guidelines*. National Parks Board, Singapore.
- National Parks Board. (8 January, 2024). *Checklist of flora from Singapore*. Retrieved 20 May, 2024, from National Parks Board: <https://www.nparks.gov.sg/biodiversity/wildlife-in-singapore/species-list/flora>
- National Parks Board. (2024). *Light management in night works*. Singapore: National Parks Board.
- National Parks Board. (17 January, 2024). *Species List (Red Data Book List)*. Retrieved 6 February, 2024, from National Parks Board: <https://www.nparks.gov.sg/biodiversity/wildlife-in-singapore/species-list>
- Neo, L., Yee, A. T., Chong, K. Y., Kee, C. Y., Lim, R. C., Ng, W. Q., . . . Tan, H. T. (13 November, 2013). The Vascular Plant Flora of Bukit Batok, Singapore. *Nature in Singapore*, 6, 265–287.
- Ngiam, R., & Davison, G. (2011). A checklist of dragonflies in Singapore parks (Odonata: Anisoptera, Zygoptera). *Nature in Singapore*, 4, 349–353.
- Ngiam, R., & Ng, M. (2022). *A Photographic Field Guide to the Dragonflies and Damselflies of Singapore*. Oxford: John Beaufoy Publishing.
- NParks. (2020). *NParks (2020) Biodiversity Impact Assessment (BIA) Guidelines. Version 1*.
- NParks. (2024). *About our parks, nature reserves and park connectors*. Retrieved from National Parks Board: <https://beta.nparks.gov.sg/visit/when-visiting-parks/about-parks-nature-reserves-pcns/nature-corridors-ways>
- Ogden, L. J. (2002). Summary Report on the Bird Friendly Building Program: Effect of Light Reduction on Collision of Migratory Birds. *Special Report for the Fatal Light Awareness Program (FLAP)*, 2 - 16 .
- Pastakia, C., & Barber, J. R. (1998). The Rapid Impact Assessment Matrix (RIAM) for EIA. *Environmental Impact Assessment Review*, 461-482.
- Pottie, S., Lane, D., Kingston, T., & Lee, B.-H. (2005). The microchiropteran bat fauna of Singapore. *Acta Chiropterologica*, 7(2), 237-247.
- Pryke, J. S., Samways, M. J., & Saedeleer, K. D. (2015). An ecological network is as good as a major protected area for conserving dragonflies. *Biological Conservation*, 191, 537-545. doi:<https://doi.org/10.1016/j.biocon.2015.07.036>
- Rajwa-Kuligiewicz, A., Bialik, R. J., & Rowinski, P. M. (2015). Dissolved oxygen and water temperature dynamics in lowland rivers over various timescales. *Journal of Hydrology and Hydromechanics*, 63(4), 353-363.

- Robinson, G., Ackery, P., Kitching, I., Beccaloni, G., & Hernández, L. (March, 2023). HOSTS (from HOSTS - a Database of the World's Lepidopteran Hostplants) [Data set resource]. Natural History Museum. Retrieved 5 February, 2024, from <https://data.nhm.ac.uk/dataset/hosts/resource/877f387a-36a3-486c-a0c1-b8d5fb69f85a>
- Schnitzler, H.-U., Moss, C., & Denzinger, A. (2003). From spatial orientation to food acquisition in echolocating bats. *TRENDS in Ecology and Evolution*, 18(8), 386-394.
- Shepherd, C. R., Shepherd, L., & Foley, K.-E. (2013). Straw-headed Bulbul *Pycnonotus zeylanicus*: legal protection and enforcement action in Malaysia. *BirdingASIA*, 19, 92-94.
- Shilton, L. A., Altringham, J. D., Compton, S. G., & Whittaker, R. J. (1999). Old World fruit bats can be long-distance seed dispersers through extended retention of viable seeds in the gut. *Proceedings of the Royal Society B: Biological Sciences*, 266(1416), 219. doi:<https://doi.org/10.1098/rspb.1999.0625>
- Singapore Business Directory. (11 February, 2022). *Bukit Batok Driving Centre LTD*. Retrieved 31 May, 2024, from Singapore Business Directory: <https://www.sgpbusiness.com/company/Bukit-Batok-Driving-Centre-Ltd>
- Singapore Herbarium Online. (11 July, 2024). Retrieved from <https://herbaria.plants.ox.ac.uk/bol/sing>
- Soh, K. Y. (2024). *iNaturalist observation*. Retrieved from iNaturalist.org: <https://www.inaturalist.org/observations/198877246>
- Survey Department, Singapore. (1885). Map Of The Island Of Singapore And Its Dependencies. (S.-G. O.-G. Prepared and published by J. Von Cuylenburg, Compiler) National Archives of Singapore. Retrieved 31 May, 2024, from [https://www.nas.gov.sg/archivesonline/maps\\_building\\_plans/record-details/fba0dd42-115c-11e3-83d5-0050568939ad](https://www.nas.gov.sg/archivesonline/maps_building_plans/record-details/fba0dd42-115c-11e3-83d5-0050568939ad)
- Tan, G. (2024). *iNaturalist observation*. Retrieved from iNaturalist.org: <https://www.inaturalist.org/observations/207400624>
- Tan, H. T., Chou, L. M., Yeo, D. C., & Ng, P. K. (2007). *The Natural Heritage of Singapore (2nd edition)*. Singapore: Prentice Hall/Pearson Education South Asia Pte Ltd.
- Tan, H., & Khew, S. K. (2012). *Caterpillars of Singapore's Butterflies*. Singapore: National Parks Board.
- The Business Times. (16 September, 1981). New HDB estate. Singapore.
- The Straits Times. (22 November, 1975). Bukit Batok Will House 10,000. *The Straits Times*. Singapore. Retrieved 31 May, 2024, from <https://eresources.nlb.gov.sg/newspapers/digitised/article/straitstimes19751122-1.2.68>
- Tupaia glis (Diard, 1820) in GBIF Secretariat. (2023). *GBIF Backbone Taxonomy*. Retrieved from Checklist Dataset: <https://doi.org/10.15468/39omei>
- Tzi, M. L., Shunari, M., & Lim, K. K. (2010). THE NARROW-WINGED PIPISTRELLE, PIPISTRELLUS STENOPTERUS (DOBSON) IN SINGAPORE (MAMMALIA: CHIROPTERA: VESPERTILIONIDAE). *Nature in Singapore*, 3, 159-165.
- Urban Redevelopment Authority. (12 April, 2024). *Master Plan*. Retrieved from URA SPACE: <https://www.ura.gov.sg/maps/?service=MP>
- Vandermeulen, J. (2022). *iNaturalist Observation*. Retrieved from iNaturalist.org: <https://www.inaturalist.org/observations/141509403>
- Whitmore, T., Coode, M., & Hoffman, P. (2024). *Malesian Euphorbiaceae Descriptions*. Retrieved from Flora Malesiana:

[https://www.nationaalherbarium.nl/Euphorbs/specM/Macaranga.htm#Macaranga\\_grifithiana](https://www.nationaalherbarium.nl/Euphorbs/specM/Macaranga.htm#Macaranga_grifithiana)

- Wong, K. S. (24 April, 2005). SPEECH BY MR WONG KAN SENG, MINISTER FOR HOME AFFAIRS, AT LAUNCHING CEREMONY OF THE HOMETEAMNS, 24 APRIL 2005, 10.30 AM AT HOMETEAMNS BUKIT BATOK CLUBHOUSE, AUDITORIUM. Singapore. Ministry of Information, Communications and the Arts. Retrieved from <https://www.nas.gov.sg/archivesonline/speeches/record-details/79f2500c-115d-11e3-83d5-0050568939ad>
- Yao, G., Song, Z.-Q., Xue, B.-E., Shi, S., Li, Y.-L., & Luo, S.-X. (2020). Taxonomic revision of the genus *Glochidion* (Phyllanthaceae) in Taiwan, China. *Phytokeys*, 137-159.
- Yee, A. T., Chong, K. Y., Neo, L., & Tan, H. T. (2016). Updating the classification system for the secondary forests of Singapore. *Raffles Bulletin of Zoology*, 19.
- Yee, A. T., Corlett, R. T., Liew, S. C., & Tan, H. T. (2011). The vegetation of Singapore—an updated map. *Gardens' Bulletin Singapore*, 63(1&2), 205-212.
- Yee, A., Chong, K., Seah, W., & Lua, H. (October, 2019). Vegetation of Singapore. *FLORA OF SINGAPORE Volume 1 (pp.47-70)Chapter: 5, 1, 47-70*. doi:10.26492/fos1.2019-05
- Yoh N., K. T.-C., Lee, B., Mitchell, S., Bicknell, J., & Struebig, M. (2022). A machine learning framework to classify Southeast Asian echolocating bats. *Ecological Indicators*, 136, 108696.
- Yong, D. L., Lim, K. S., Lim, K. C., Tan, T., Teo, S., & Ho, H. C. (2018). Significance of the globally threatened Straw-headed Bulbul *Pycnonotus zeylanicus* populations in Singapore: a last straw for the species? *Bird Conservation International*, 28, 133-144.
- Yong, G. W., Soh, Z. W., Chui, S. X., Chan, A. A., & Ascher, J. S. (2019). Insect visitors to flowers of cultivated *Ardisia elliptica* Thunb. (Myrsinaceae) and *Memecylon caeruleum* Jack (Melastomataceae) in Singapore. *Nature in Singapore*, 75-80.
- Zhu, G., Chmura, A., & Zhang, L. (2012). Morphology, echolocation calls and diet of *Scotophilus kuhlii* (Chiroptera: Vespertilionidae) on Hainan Island, south China. *Acta Chiropterologica*, 14(1), 175-181. doi:<https://doi.org/10.3161/150811012X654394>

## **APPENDIX A**

### **List of Plant Species Recorded at Study Area**

S/N	Scientific Name	Common Name	Growth Form	Family	Origin	National Status
1	<i>Acacia auriculiformis</i>	Acacia-tree, Earleaf acacia	Tree	Fabaceae	Non-native	Naturalised
2	<i>Adenanthera pavonina</i>	Saga, Coral bean tree	Tree	Fabaceae	Non-native	Naturalised
3	<i>Adiantum latifolium</i>	Broadleaf maidenhair	Herb	Pteridaceae	Non-native	Naturalised
4	<i>Agelaea cf. macrophylla</i>	White weed	Herb	Connaraceae	Native	Naturalised
5	<i>Alocasia longiloba</i>	Keladi rimau, Keladi ular	Herb	Araceae	Native	Least Concern
6	<i>Alocasia macrorrhizos</i>	Giant taro, Greater alocasia	Shrub	Araceae	Non-native	Naturalised
7	<i>Alstonia angustiloba</i>	Common pulai, Pulai	Tree	Apocynaceae	Native	Least Concern
8	<i>Aphanamixis polystachya</i>	Pasak lingga, Amoor	Tree	Meliaceae	Native	Least Concern
9	<i>Ardisia elliptica</i>	Seashore ardisia, Mata pelandok	Tree, Shrub	Primulaceae	Native	Least Concern
10	<i>Arthropphyllum jackianum</i>	-	Tree	Araliaceae	Native	Least Concern
11	<i>Artocarpus altilis</i>	Breadfruit, Sukun	Tree	Moraceae	Non-native	Casual
12	<i>Artocarpus heterophyllus</i>	Jackfruit, Nangka	Tree	Moraceae	Non-native	Casual
13	<i>Asplenium nidus</i>	Bird's nest fern, Rumah langsuyar	Herb	Aspleniaceae	Native	Least Concern
14	<i>Axonopus compressus</i>	Tropical carpet grass, Wide-leaved carpet grass	Grass	Poaceae	Non-native	Naturalised
15	<i>Azadirachta indica</i>	Neem tree, Nim tree	Tree	Meliaceae	Non-native	Casual
16	<i>Bridelia stipularis</i>	Kenidai, Kernam	Climber, Vine & Liana, Shrub	Phyllanthaceae	Native	Least Concern
17	<i>Bridelia tomentosa</i>	Kenidai, Kernong	Tree, Shrub	Phyllanthaceae	Native	Least Concern
18	<i>Callicarpa longifolia</i>	Long leaved beauty berry, Nasi-nasi	Shrub	Lamiaceae	Native	Vulnerable
19	<i>Calophyllum soulattri</i>	Bintangor bunut, Malang-malang	Tree	Calophyllaceae	Non-native	Excluded
20	<i>Canavalia cathartica</i>	-	Climber, Vine & Liana	Fabaceae	Native	Least Concern
21	<i>Carica papaya</i>	Papaya, Betik	Herb	Caricaceae	Non-native	Casual
22	<i>Caryota mitis</i>	Fishtail palm, Common fishtail palm	Cluster Palm, Palm	Arecaceae	Native	Least Concern
23	<i>Cayratia mollissima</i>	-	Climber, Vine & Liana	Vitaceae	Native	Endangered
24	<i>Christella arida</i>	-	Fern	Thelypteridaceae	Native	Least Concern
25	<i>Cinnamomum iners</i>	Wild cinnamon, Clove cinnamon	Tree	Lauraceae	Native	Least Concern
26	<i>Cissus hastata</i>	-	Climber, Vine & Liana	Vitaceae	Native	Least Concern
27	<i>Claoxylon indicum</i>	Laping budak, Jarak kayu	Tree, Shrub	Euphorbiaceae	Native	Least Concern
28	<i>Clausena excavata</i>	Pink lime-berry, Cama	Tree, Shrub	Rutaceae	Native	Least Concern
29	<i>Clerodendrum disparifolium</i>	Swaddling flower, Celeguri	Shrub, Tree	Lamiaceae	Native	Least Concern

S/N	Scientific Name	Common Name	Growth Form	Family	Origin	National Status
30	<i>Clerodendrum villosum</i>	-	Shrub, Tree	Lamiaceae	Native	Least Concern
31	<i>Costus sp.</i>	-	Shrub/Herb	Costaceae	Non-native	Cultivated Only
32	<i>Cyrtophyllum fragrans</i>	Tembusu, Tembusu hutan	Tree	Gentianaceae	Native	Least Concern
33	<i>Dacryodes cf. rostrata</i>	Kedondong kerut, Kembayau	Tree	Burseraceae	Native	Vulnerable
34	<i>Dicranopteris linearis</i>	-	Fern	Gleicheniaceae	Native	Least Concern
35	<i>Dillenia suffruticosa</i>	Simpoh air, Simpoh air	Shrub	Dilleniaceae	Native	Least Concern
36	<i>Dimocarpus lichi</i>	Mata kucing	Tree	Sapindaceae	Native	Data Deficient
37	<i>Dioscorea bulbifera</i>	-	Climber, Vine & Liana	Dioscoreaceae	Uncertain	Cryptogenic
38	<i>Dracaena fragrans</i>	Corn palm, Palmillo	Shrub	Asparagaceae	Non-native	Casual
39	<i>Elaeis guineensis</i>	Oil palm, Macaw fat	Palm, Solitary Palm	Arecaceae	Non-native	Casual
40	<i>Embelia ribes</i>	-	Climber, Vine & Liana	Primulaceae	Native	Least Concern
41	<i>Embllica urinaria</i>	Shatterstone, Leaf flower	Shrub	Phyllanthaceae	Non-native	Naturalised
42	<i>Epipremnum pinnatum</i>	Dragon-Tail plant, Taro vine	Climber, Vine & Liana, Epiphyte, Creeper	Araceae	Non-native	Naturalised
43	<i>Erycibe tomentosa</i>	Akar pelandok	Climber, Vine & Liana	Convolvulaceae	Native	Least Concern
44	<i>Falcataria falcata</i>	Albizia, Kayu machis	Tree	Fabaceae	Non-native	Naturalised
45	<i>Ficus benjamina</i>	Weeping fig, Java willow	Shrub, Tree	Moraceae	Uncertain	Cryptogenic
46	<i>Ficus fistulosa</i>	Common yellow stem-fig, Ara serapat	Tree	Moraceae	Native	Least Concern
47	<i>Ficus glandulifera</i>	Gaping fig	Tree	Moraceae	Native	Endangered
48	<i>Ficus grossularioides</i>	Ara putih, White-leafed fig	Tree, Shrub	Moraceae	Native	Least Concern
49	<i>Ficus hispida</i>	Hairy Fig, devil fig, opposite-leaved fig-tree	Tree	Moraceae	Non-native	Casual
50	<i>Ficus microcarpa</i>	Malayan banyan, Jejawi	Tree	Moraceae	Native	Least Concern
51	<i>Ficus variegata</i>	Common red-stem fig, Variegated fig	Tree	Moraceae	Native	Least Concern
52	<i>Ficus vasculosa</i>	White fig, Ara nasi	Tree	Moraceae	Native	Vulnerable
53	<i>Flagellaria indica</i>	Common flagellaria, Rotan dini	Climber, Vine & Liana	Flagellariaceae	Native	Least Concern
54	<i>Glochidion zeylanicum</i> var. <i>zeylanicum</i>	-	Tree	Phyllanthaceae	Native	Vulnerable
55	<i>Guioa pubescens</i>	-	Tree	Sapindaceae	Native	Least Concern
56	<i>Gynochthodes cf. praetermissa</i>	-	Climber	Rubiaceae	Native	Vulnerable
57	<i>Gynochthodes rigida</i>	-	Climber, Vine & Liana	Rubiaceae	Native	Vulnerable
58	<i>Gynochthodes umbellata</i>	Akar ketang, Akar perut ayam	Climber, Vine & Liana	Rubiaceae	Native	Least Concern

S/N	Scientific Name	Common Name	Growth Form	Family	Origin	National Status
59	<i>Imperata cylindrica</i>	Lalang, cogon grass	Shrub, Grass	Poaceae	Native	Least Concern
60	<i>Ixonanthes reticulata</i>	Pagar anak, Ten men tree	Tree	Ixonanthaceae	Native	Least Concern
61	<i>Lansium domesticum</i>	Langsat, Duku	Tree	Meliaceae	Non-native	Casual
62	<i>Leea indica</i>	Bandicoot berry, Common tree-vine	Shrub, Tree	Vitaceae	Native	Least Concern
63	<i>Lindera lucida</i>	-	Tree	Lauraceae	Native	Vulnerable
64	<i>Litsea elliptica</i>	Medang, Perawas	Tree	Lauraceae	Native	Least Concern
65	<i>Litsea umbellata</i>	Blue laurel, Medang	Tree	Lauraceae	Native	Vulnerable
66	<i>Lygodium flexuosum</i>	Ribu-ribu gajah, Paku ribu-ribu gajah	Herb	Lygodiaceae	Native	Least Concern
67	<i>Macaranga bancana</i>	-	Tree	Euphorbiaceae	Native	Least Concern
68	<i>Macaranga cf. recurvata</i>	-	Tree	Euphorbiaceae	Native	Critically Endangered
69	<i>Macaranga conifera</i>	-	Tree	Euphorbiaceae	Native	Least Concern
70	<i>Macaranga gigantea</i>	Mahang gajah, Elephant's ear tree	Tree	Euphorbiaceae	Native	Least Concern
71	<i>Macaranga griffithiana</i>	Mahang bulan, Mahang tutup	Tree	Euphorbiaceae	Native	Vulnerable
72	<i>Macaranga heynei</i>	-	Tree	Euphorbiaceae	Native	Least Concern
73	<i>Macaranga hypoleuca</i>	-	Tree	Euphorbiaceae	Native	Least Concern
74	<i>Macrosolen cochinchinensis</i>	Common chinese mistletoe	Shrub	Loranthaceae	Native	Least Concern
75	<i>Mallotus paniculatus</i>	Turn-in-the-wind, Balik angin	Tree, Shrub	Euphorbiaceae	Native	Least Concern
76	<i>Mangifera indica</i>	Mango, Mangga	Tree	Anacardiaceae	Non-native	Casual
77	<i>Melastoma malabathricum</i>	Common sendudok, Singapore rhododendron	Shrub, Tree	Melastomataceae	Native	Least Concern
78	<i>Miconia crenata</i>	Koster's curse	Shrub	Melastomataceae	Non-native	Naturalised
79	<i>Microsorium cf. punctatum</i>	Fishtail fern, Crested fern	Epiphyte, Lithophyte, Herb	Polypodiaceae	Native	Least Concern
80	<i>Mimusops elengi</i>	Tanjong tree, Bunga tanjung	Tree	Sapotaceae	Non-native	Casual
81	<i>Morinda citrifolia</i>	Mengkudu besar, Inda	Tree	Rubiaceae	Native	Least Concern
82	<i>Morinda elliptica</i>	-	Tree	Rubiaceae	Native	Endangered
83	<i>Murraya paniculata</i>	Mock lime, China box	Shrub	Rutaceae	Non-native	Cultivated Only
84	<i>Neolitsea cassia</i>	Shore laurel, Tejur	Tree	Lauraceae	Native	Least Concern
85	<i>Nephrolepis biserrata</i>	Broad sword fern, Paku larat	Herb	Nephrolepidaceae	Native	Least Concern

S/N	Scientific Name	Common Name	Growth Form	Family	Origin	National Status
86	<i>Paederia foetida</i>	Lesser malayan stinkwort, Akar sekentut	Climber, Vine & Liana	Rubiaceae	Native	Least Concern
87	<i>Pavetta wallichiana</i>	-		Rubiaceae	Native	Vulnerable
88	<i>Planchonella obovata</i>	Sea gutta, Menasi	Tree	Sapotaceae	Native	Least Concern
89	<i>Premna serratifolia</i>	Buas-Buas, Bastard guelder	Tree, Shrub	Lamiaceae	Native	Least Concern
90	<i>Ptychosperma macarthurii</i>	MacArthur palm, Hurricane palm	Cluster Palm, Palm	Arecaceae	Non-native	Naturalised
91	<i>Rhodamnia cinerea</i>	Silver back tree, Mempoyan	Tree	Myrtaceae	Native	Least Concern
92	<i>Rubus moluccanus</i> var. <i>angulosus</i>	Tempu rengat, Broad-Leaf bramble	Shrub, Climber, Vine & Liana	Rosaceae	Native	Vulnerable
93	<i>Samanea saman</i>	Rain tree, Pukul lima	Tree	Fabaceae	Non-native	Casual
94	<i>Sandoricum koetjape</i>	Sentul, Santol	Tree	Meliaceae	Native	Vulnerable
95	<i>Scleria levis</i>	-	Sedge	Cyperaceae	Native	Least Concern
96	<i>Smilax setosa</i>	Bearded smilax	Climber	Smilacaceae	Native	Least Concern
97	<i>Spathodea campanulata</i>	African tulip tree, Panchot	Tree	Bignoniaceae	Non-native	Naturalised
98	<i>Stenochlaena palustris</i>	Climbing fern, Akar paku	Epiphyte, Herb	Blechnaceae	Native	Least Concern
99	<i>Syzygium cerasiforme</i>	Common kelat, Gelam tikus	Tree	Myrtaceae	Native	Least Concern
100	<i>Syzygium grande</i>	Sea apple, Jambu laut	Tree	Myrtaceae	Native	Least Concern
101	<i>Syzygium myrtifolium</i>	Kelat oil, Kelat paya	Shrub, Tree	Myrtaceae	Native	Critically Endangered
102	<i>Syzygium polyanthum</i>	Indonesian bayleaf, Salam	Tree	Myrtaceae	Native	Least Concern
103	<i>Tabebuia rosea</i>	Trumpet tree, Pink poui	Tree	Bignoniaceae	Non-native	Casual
104	<i>Terminalia catappa</i>	Sea almond, Ketapang	Tree	Combretaceae	Native	Least Concern
105	<i>Tetracera indica</i>	Mempelas, Akar mempelas	Climber, Vine & Liana	Dilleniaceae	Native	Least Concern
106	<i>Timonius wallichianus</i>	Silver timon, Triang	Tree	Rubiaceae	Native	Least Concern
107	<i>Trema tomentosum</i>	-	Tree	Cannabaceae	Native	Vulnerable
108	<i>Triadica cochinchinensis</i>	Mouse deer's delight	Tree	Euphorbiaceae	Native	Least Concern
109	<i>Uncaria</i> cf. <i>acida</i>	-	Climber, Vine & Liana	Rubiaceae	Native	Endangered
110	<i>Vitex pinnata</i>	Leban, Malayan teak	Tree	Lamiaceae	Native	Least Concern
111	<i>Xanthostemon chrysanthus</i>	Golden penda	Tree	Myrtaceae	Non-native	Cultivated Only

## **APPENDIX B**

### **Photographs of Plants Observed at Study Area**



1: *Callicarpa longifolia* (long leaved beauty berry); 2: *Cayratia mollissima*; 3: *Dimocarpus lichi* (mata kucing); 4: *Ficus glandulifera* (gaping fig); 5: *Ficus vasculosa* (white fig); 6: *Glochidion zeylanicum* var. *zeylanicum*; 7: *Gynochthodes rigida*; 8: *Lindera lucida*.



1: *Litsea umbellata* (blue laurel); 2: *Macaranga griffithiana* (mahang bulan); 3: *Morinda elliptica*; 4: *Pavetta wallichiana*; 5: *Rubus moluccanus* var. *angulosus* (tempu rengat); 6: *Sandoricum koetjape* (sentul); 7: *Syzygium myrtifolium* (kelat oil); 8: *Trema tomentosum*.



1: *Dacryodes* cf. *rostrata* (kedondong kerut); 2: *Gynochthodes* cf. *praetermissa*; 3: *Macaranga* cf. *recurvata*; 4: *Uncaria* cf. *acida*

## **APPENDIX C**

### **List of Fauna Species Recorded at Study Area**

BIRDS						
No.	Family	Species name	Common Name	Origin	SRDB3	IUCN status
1	Accipitridae	<i>Haliaeetus leucogaster</i>	White-bellied Sea Eagle	Native	LC	LC
2	Accipitridae	<i>Haliastur indus</i>	Brahminy Kite	Native	LC	LC
3	Aegithinidae	<i>Aegithina tiphia</i>	Common Iora	Native	LC	LC
4	Alcedinidae	<i>Halcyon smyrnensis</i>	White-throated Kingfisher	Native	LC	LC
5	Alcedinidae	<i>Todiramphus chloris</i>	Collared Kingfisher	Native	LC	LC
6	Caprimulgidae	<i>Caprimulgus macrurus</i>	Large-tailed Nightjar	Native	LC	LC
7	Cisticolidae	<i>Orthotomus atrogularis</i>	Dark-necked Tailorbird	Native	LC	LC
8	Cisticolidae	<i>Orthotomus sutorius</i>	Common Tailorbird	Native	LC	LC
9	Columbidae	<i>Chalcophaps indica</i>	Common Emerald Dove	Native	LC	LC
10	Columbidae	<i>Geopelia striata</i>	Zebra Dove	Native	LC	LC
11	Columbidae	<i>Spilopelia chinensis</i>	Spotted Dove	Native	LC	LC
12	Columbidae	<i>Treron vernans</i>	Pink-necked Green Pigeon	Native	LC	LC
13	Coraciidae	<i>Eurystomus orientalis</i>	Oriental Dollarbird	Native	LC	LC
14	Corvidae	<i>Corvus splendens</i>	House Crow	Introduced	-	LC
15	Cuculidae	<i>Eudynamis scolopaceus</i>	Asian Koel	Native	LC	LC
16	Dicruridae	<i>Dicrurus paradiseus</i>	Greater Racket-tailed Drongo	Native	LC	LC
17	Estrildidae	<i>Lonchura punctulata</i>	Scaly-breasted Munia	Native	LC	LC
18	Leiothrichidae	<i>Garrulax leucolophus</i>	White-crested Laughingthrush	Introduced	-	LC
19	Megalaimidae	<i>Psilopogon lineatus</i>	Lineated Barbet	Introduced	-	LC
20	Meropidae	<i>Merops viridis</i>	Blue-throated Bee-eater	Native	LC	LC
21	Motacillidae	<i>Anthus rufulus</i>	Paddyfield Pipit	Native	LC	LC
22	Muscicapidae	<i>Muscicapa dauurica</i>	Asian Brown Flycatcher	Native	LC	LC
23	Nectariniidae	<i>Anthreptes malacensis</i>	Brown-throated Sunbird	Native	LC	LC
24	Nectariniidae	<i>Cinnyris jugularis</i>	Olive-backed Sunbird	Native	LC	LC
25	Oriolidae	<i>Oriolus chinensis</i>	Black-naped Oriole	Native	LC	LC
26	Passeridae	<i>Passer montanus</i>	Eurasian Tree Sparrow	Native?	LC	LC
27	Phasianidae	<i>Gallus gallus</i>	Red Junglefowl	Native	NT	LC
28	Picidae	<i>Picus vittatus</i>	Laced Woodpecker	Native	LC	LC
29	Psittacidae	<i>Loriculus galgulus</i>	Blue-crowned Hanging Parrot	Native	LC	LC
30	Psittacidae	<i>Psittacula alexandri</i>	Red-breasted Parakeet	Introduced	-	NT
31	Psittacidae	<i>Psittacula krameri</i>	Rose-ringed Parakeet	Introduced	-	LC

32	Psittacidae	<i>Psittacula longicauda</i>	Long-tailed Parakeet	Native	NT	VU
33	Psittacidae	<i>Trichoglossus haematodus</i>	Coconut Lorikeet	Introduced	-	LC
34	Pycnonotidae	<i>Pycnonotus goiavier</i>	Yellow-vented Bulbul	Native	LC	LC
35	Pycnonotidae	<i>Pycnonotus jocosus</i>	Red-whiskered Bulbul	Introduced	-	LC
36	Pycnonotidae	<i>Pycnonotus plumosus</i>	Olive-winged Bulbul	Native	LC	LC
37	Pycnonotidae	<i>Pycnonotus zeylanicus</i>	Straw-headed Bulbul	Native	EN	CR
38	Rallidae	<i>Amaurornis phoenicurus</i>	White-breasted Waterhen	Native	LC	LC
39	Strigidae	<i>Otus lempiji</i>	Sunda Scops Owl	Native	LC	LC
40	Sturnidae	<i>Acridotheres javanicus</i>	Javan Myna	Introduced	-	VU
41	Sturnidae	<i>Aplonis panayensis</i>	Asian Glossy Starling	Native	LC	LC
42	Sturnidae	<i>Gracula religiosa</i>	Common Hill Myna	Native	NT	LC
43	Timaliidae	<i>Mixornis gularis</i>	Pin-striped Tit-babbler	Native	LC	LC
44	Zosteropidae	<i>Zosterops simplex</i>	Swinhoe's White-eye	Native + Introduced	VU	LC
45	Apodidae		Unidentified Swiftlet			
	Psittacidae		Unidentified Parakeet			
	Accipitridae		Unidentified Raptor			
	Cisticolidae		Unidentified Tailorbird			

## MAMMALS

No.	Family	Species name	Common Name	Origin	SRDB3	IUCN status
1	Felidae	<i>Felis catus</i>	Feral Cat		-	-
2	Pteropodidae	<i>Cynopterus brachyotis</i>	Lesser Dog-faced Fruit Bat	Native	LC	LC
3	Sciuridae	<i>Callosciurus notatus</i>	Plantain Squirrel	Native	LC	LC
4	Tupaiaidae	<i>Tupaia glis</i>	Common Malayan Treeshrew	Native	LC	LC
5	Emballonuridae	<i>Saccolaimus saccolaimus</i>	Pouched Tomb Bat	Native	LC	LC
6	Emballonuridae	<i>Taphozous melanopogon</i>	Black-bearded Tomb Bat	Native	LC	LC
7	Vespertilionidae	<i>Myotis muricola</i>	Whiskered Myotis	Native	LC	LC
8	Vespertilionidae	<i>Pipistrellus stenopterus</i>	Narrow-winged pipistrelle	Native	LC	LC
9	Vespertilionidae	<i>Scotophilus kuhlii</i>	Lesser Asian House Bat	Native	LC	LC
10	Muridae		Unidentified Rat			

## REPTILES

No.	Family	Species name	Common Name	Origin	SRDB3	IUCN status
-----	--------	--------------	-------------	--------	-------	-------------

1	Agamidae	<i>Bronchocelea cristatella</i>	Green Crested Lizard	Native	LC	LC
2	Agamidae	<i>Calotes versicolor</i>	Changeable Lizard	Introduced	-	LC
3	Agamidae	<i>Draco sumatranus</i>	Common Flying Dragon	Native	LC	LC
4	Colubridae	<i>Dendrelaphis pictus</i>	Painted Bronzeback	Native	LC	LC
5	Gekkonidae	<i>Gehyra mutilata</i>	Four-clawed Gecko	Native	LC	LC
6	Gekkonidae	<i>Gekko monarchus</i>	Spotted House Gecko	Native	LC	LC
7	Gekkonidae	<i>Hemidactylus brookii</i>	Brooke's House Gecko	Introduced	-	LC
8	Gekkonidae	<i>Hemidactylus frenatus</i>	Spiny-tailed House Gecko	Native	LC	LC
9	Gekkonidae	<i>Lepidodactylus lugubris</i>	Mourning Gecko	Introduced	LC	LC
10	Varanidae	<i>Varanus nebulosus</i>	Clouded Monitor	Native	LC	NT
11	Scincidae		Unidentified Skink			
	Varanidae		Unidentified Monitor Lizard			
			Unidentified Gecko			

## AMPHIBIANS

No.	Family	Species name	Common Name	Origin	SRDB3	IUCN status
1	Bufoidea	<i>Duttaphrynus bengalensis</i>	Asian Toad	Introduced	-	LC
2	Eleutherodactylidae	<i>Eleutherodactylus planirostris</i>	Greenhouse Frog	Introduced	-	LC
3	Microhylidae	<i>Kaloula pulchra</i>	Banded Bullfrog	Introduced	-	LC
4	Microhylidae	<i>Microhyla cf. heymonsi</i>	Dark-sided Chorus Frog	Native	LC	LC
5	Microhylidae	<i>Microhyla cf. mukhlesuri</i>	Mukhlesur's Narrow-mouthed Frog	Introduced	-	LC
6	Rhacophoridae	<i>Polypedates leucomystax</i>	Four-lined Tree Frog	Native	LC	LC

## BUTTERFLIES

No.	Family	Subfamily	Species name	Common Name	Origin	SRDB3	IUCN status
1	Butterflies	Hesperiidae	<i>Bibasis harisa consobrina</i>	Orange Awlet	Native	LC	-
2	Butterflies	Hesperiidae	<i>Iambrix salsala salsala</i>	Chestnut Bob	Native	LC	-
3	Butterflies	Hesperiidae	<i>Oriens gola pseudolus</i>	Common Dartlet	Native	LC	-
4	Butterflies	Hesperiidae	<i>Pelopidas mathias mathias</i>	Small Branded Swift	Native	LC	LC
5	Butterflies	Hesperiidae	<i>Potanthus omaha omaha</i>	Lesser Dart	Native	LC	-
6	Butterflies	Lycaenidae	<i>Arhopala centaurus nakula</i>	Centaur Oakblue	Native	LC	-
7	Butterflies	Lycaenidae	<i>Hypolycaena thecloides thecloides</i>	Dark Tit	Native	LC	-
8	Butterflies	Lycaenidae	<i>Loxura atymnus fuconius</i>	Yamfly	Native	LC	-

9	Butterflies	Lycaenidae	<i>Megisba malaya sikkima</i>	The Malayan	Uncertain	LC	-
10	Butterflies	Lycaenidae	<i>Prosotas dubiosa lumpura</i>	Tailless Line Blue	Native	LC	-
11	Butterflies	Lycaenidae	<i>Rapala pheretima sequeira</i>	Copper Flash	Native	LC	-
12	Butterflies	Lycaenidae	<i>Zizeeria maha serica</i>	Pale Grass Blue	Native	LC	-
13	Butterflies	Lycaenidae	<i>Zizina otis lampa</i>	Lesser Grass Blue	Native	LC	LC
14	Butterflies	Lycaenidae	<i>Zizula hylax pygmaea</i>	Pygmy Grass Blue	Native	LC	LC
15	Butterflies	Nymphalidae	<i>Amathusia phidippus phidippus</i>	Palm King	Native	NT	-
16	Butterflies	Nymphalidae	<i>Athyma reta moorei</i>	Malay Staff Sergeant	Native	NT	-
17	Butterflies	Nymphalidae	<i>Elymnias hypermnestra agina</i>	Common Palmfly	Native	LC	-
18	Butterflies	Nymphalidae	<i>Euthalia monina monina</i>	Malay Baron	Native	LC	-
19	Butterflies	Nymphalidae	<i>Ideopsis vulgaris macrina</i>	Blue Glassy Tiger	Native	LC	LC
20	Butterflies	Nymphalidae	<i>Junonia almana javana</i>	Peacock Pansy	Native	LC	LC
21	Butterflies	Nymphalidae	<i>Junonia atlites atlites</i>	Grey Pansy	Native	LC	-
22	Butterflies	Nymphalidae	<i>Junonia hedonia ida</i>	Chocolate Pansy	Native	LC	-
23	Butterflies	Nymphalidae	<i>Junonia orithya wallacei</i>	Blue Pansy	Native	LC	LC
24	Butterflies	Nymphalidae	<i>Lasippa tiga siaka</i>	Malayan Lascar	Native	LC	-
25	Butterflies	Nymphalidae	<i>Mycalesis perseoides perseoides</i>	Burmese Bush Brown	Uncertain	LC	-
26	Butterflies	Nymphalidae	<i>Mycalesis mineus macromalayana</i>	Dark-brand Bush Brown	Native	LC	-
27	Butterflies	Nymphalidae	<i>Phalanta phalantha phalantha</i>	Leopard	Native	LC	-
28	Butterflies	Nymphalidae	<i>Polyura schreiber tisamenus</i>	Blue Nawab	Native	LC	-
29	Butterflies	Papilionidae	<i>Graphium sarpedon luctatius</i>	Common Bluebottle	Native	LC	LC
30	Butterflies	Papilionidae	<i>Papilio polytes romulus</i>	Common Mormon	Native	LC	-
31	Butterflies	Pieridae	<i>Delias hyparete metarete</i>	Painted Jezebel	Native	LC	-
32	Butterflies	Pieridae	<i>Eurema blanda snelleni</i>	Three Spot Grass Yellow	Native	LC	-
33	Butterflies	Pieridae	<i>Eurema hecabe contubernalis</i>	Common Grass Yellow	Native	LC	LC
34	Butterflies	Riodinidae	<i>Abisara savitri savitri</i>	Malay Tailed Judy	Native	LC	-
35	Butterflies	Riodinidae	<i>Taxila haquinus haquinus</i>	The Harlequin	Native	CR	-

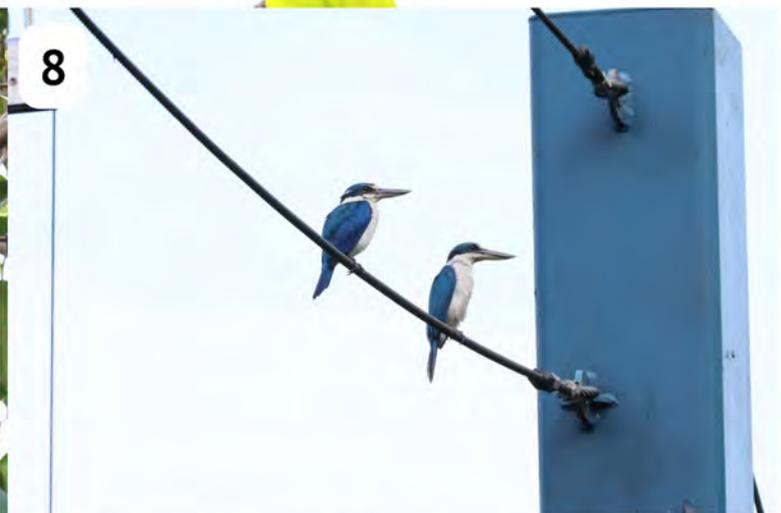
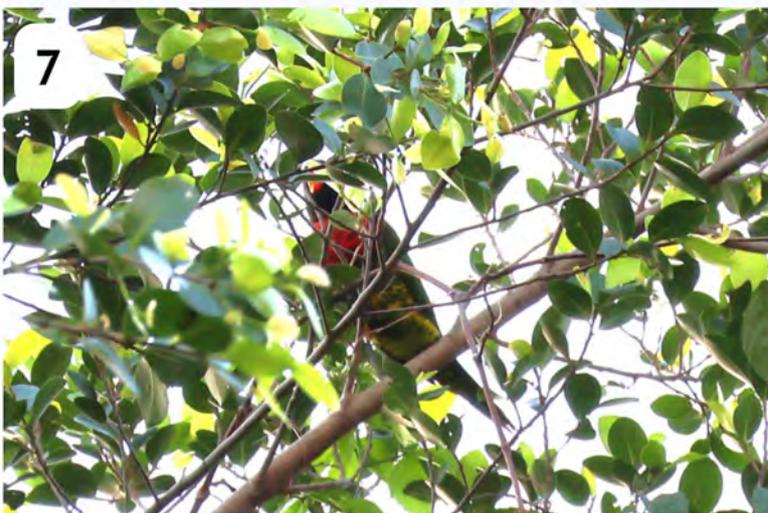
## ODONATES

No.	Family	Species name	Common Name	Origin	SRDB3	IUCN status
1	Aeshnidae	<i>Gynacantha dohrni</i>	Spear-tailed Duskhawker	-	LC	LC
2	Coenagrionidae	<i>Agriocnemis femina</i>	Variable Wisp	-	LC	LC
3	Coenagrionidae	<i>Teinobasis ruficollis</i>	Red-tailed Sprite	-	NT	NT
4	Libellulidae	<i>Agrionoptera insignis</i>	Grenadier	-	LC	LC

5	Libellulidae	<i>Lathrecista asiatica</i>	Scarlet Grenadier	-	LC	LC
6	Libellulidae	<i>Neurothemis fluctuans</i>	Common Parasol	-	LC	LC
7	Libellulidae	<i>Orthetrum testaceum</i>	Scarlet Skimmer	-	LC	LC
8	Libellulidae	<i>Pantala flavescens</i>	Wandering Glider	-	LC	LC
9	Libellulidae	<i>Rhyothemis phyllis</i>	Yellow-barred Flutterer	-	LC	LC
10	Libellulidae	<i>Tholymis tillarga</i>	White-barred Duskhawk	-	LC	LC

## **APPENDIX D**

### **Photographs of Animals Observed at Study Area**



1: Asian brown flycatcher (*Muscicapa dauurica*); 2: Asian glossy starling (*Aplonis panayensis*); 3: Asian koel (*Eudynamis scolopacea*); 4: Blue-throated bee-eater (*Merops viridis*); 5: Brahminy kite (*Haliastur indus*); 6: Brown-throated sunbird (*Anthreptes malacensis*); 7: Coconut lorikeet (*Trichoglossus haematodus*); 8: Collared kingfisher (*Todiramphus chloris*)



1: Common emerald dove (*Chalcophaps indica*); 2: Common hill myna (*Gracula religiosa*); 3: Eurasian tree sparrow (*Passer montanus*); 4: Greater racket-tailed drongo (*Dicrurus paradiseus*); 5: House crow (*Corvus splendens*); 6: Large-tailed nightjar (*Caprimulgus macrurus*); 7: Rose-ringed parakeet (*Psittacula krameri*); 8: Black-naped oriole (*Oriolus chinensis*)



1: Javan myna (*Acridotheres javanicus*); 2: Laced woodpecker (*Picus vittatus*); 3: Lineated barbet (*Psilopogon lineatus*); 4: Olive-winged bulbul (*Pycnonotus plumosus*); 5: Oriental dollarbird (*Eurystomus orientalis*); 6: Olive-backed sunbird (*Cinnyris jugularis*); 7: Paddyfield pipit (*Anthus rufulus*); 8: Pink-necked green pigeon (*Treron vernans*)



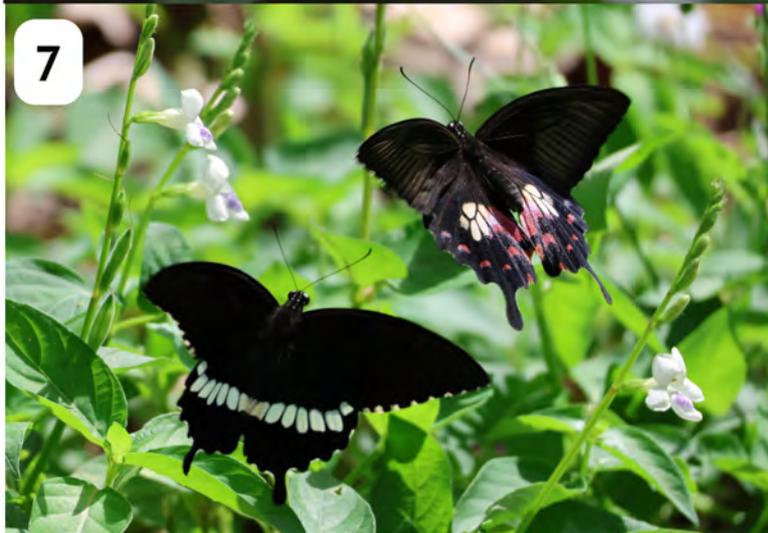
1: Red junglefowl (*Gallus gallus*); 2: Red-whiskered bulbul (*Pycnonotus jocosus*); 3: Scaly-breasted munia (*Lonchura punctulata*); 4: Spotted dove (*Spilopelia chinensis*); 5: Sunda scops owl (*Otus lempiji*); 6: Swinhoe's white-eye (*Zosterops simplex*); 7: White-bellied sea eagle (*Haliaeetus leucogaster*); 8: White-breasted waterhen (*Amauornis phoenicurus*)



1: White-crested laughingthrush (*Garrulax leucolophus*); 2: Yellow-vented bulbul (*Pycnonotus goiavier*); 3: Common Malayan treeshrew (*Tupaia glis*); 4: Plantain squirrel (*Callosciurus notatus*); 5: Changeable lizard (*Calotes versicolor*); 6: Clouded monitor (*Varanus nebulosus*); 7: Green crested lizard (*Bronchocela cristatella*); 8: Mourning gecko (*Lepidodactylus lugubris*)



1: Spiny-tailed house gecko (*Hemidactylus frenatus*); 2: Brooke's house gecko (*Hemidactylus brookii*); 3: Common flying dragon (*Draco sumatranus*); 4: Painted bronzeback (*Dendrelaphis pictus*); 5: Greenhouse frog (*Eleutherodactylus planirostris*); 6: Four-lined tree frog (*Polypedates leucomystax*); 7: Asian Toad (*Duttaphrynus bengalensis*); 8: Banded bullfrog (*Kaloula pulchra*)



1: Blue glassy tiger (*Ideopsis vulgaris macrina*); 2: Burmese bush brown (*Mycalesis perseoides perseoides*); 3: Chestnut bob (*Iambrix salsala salsala*); 4: Chocolate pansy (*Junonia hedonia ida*); 5: Common dartlet (*Oriens gola pseudolus*); 6: Common grass yellow (*Eurema hecabe contubernalis*); 7: Common mormon (*Papilio polytes romulus*); 8: Common palmfly (*Elymnias hypermnestra agina*)



1: Copper flash (*Rapala pheretima sequeira*); 2: Dark brand bush brown (*Mycalesis perseoides perseoides*); 3: Harlequin (*Taxila haquinus haquinus*); 4: Lesser grass blue (*Zizina otis lampa*); 5: Leopard (*Phalanta phalantha phalantha*); 6: Grey pansy (*Junonia atlites atlites*); 7: Palm king (*Amathusia phidippus phidippus*); 8: Malayan Lascar (*Lasippa tiga siaka*)



1: Tailless line blue (*Prosotas dubiosa lumpura*); 2: Centaur oakblue (*Arhopala centaurus nakula*); 3: Small branded swift (*Pelopidas mathias mathias*); 4: Dark tit (*Hypolycaena thecloides thecloides*); 5: Lesser dart (*Potanthus omaha omaha*); 6: Malay baron (*Euthalia monina monina*); 7: Malay staff sergeant (*Athyma reta moorei*); 8: Malay tailed Judy (*Abisara savitri savitri*)



1: Malayan (*Megisba malaya sikkima*); 2: Orange awlet (*Bibasis harisa consobrina*); 3: Pale grass blue (*Zizeeria maha serica*); 4: Peacock pansy (*Junonia almana javana*); 5: Pygmy grass blue (*Zizula hylax pygmaea*); 6: Three spot grass yellow (*Eurema blanda snelleni*); 7: Yamfly (*Loxura atymnus fuconius*); 8: Common parasol (*Neurothemis fluctuans*)



1: Scarlet skimmer (*Orthetrum testaceum*); 2: Scarlet grenadier (*Lathrecista asiatica*); 3: Grenadier (*Agrionoptera insignis*); 4: Wandering glider (*Wandering Glider*); 5: Yellow-barred flutterer (*Rhyothemis phyllis*); 6: Red-tailed sprite (*Teinobasis ruficollis*); 7: Spear-tail duskhawker (*Gynacantha dohrni*); 8: Variable wisp (*Agriocnemis femina*)

1



1: White-barred duskhawk (*Tholymis tillarga*)

## **APPENDIX E**

### **Surface Water Quality Laboratory Test Report**

**TEST REPORT NO: ASL-W0693-24**

Company Name : TEMBUSU Asia Consulting Pte. Ltd.  
 Company Address : 1 Commonwealth Ln, #06-06 One Commonwealth, Singapore 149544  
 Date Received : 17 May 2024  
 Date Tested : 17 May 2024 – 28 May 2024  
 Date Reported : 29 May 2024  
 Sample Description : One (1) sample of surface water.  
 Project Title : SPECIALIST CONSULTANCY SERVICES FOR ENVIRONMENTAL IMPACT ASSESSMENT (EIA) AT BUKIT BATOK (NParks/F/6/2023)

The sampling was done by our technical personnel (with reference to SOP-WAT-101) on 17 May 2024 which consists of 1 x 2L plastic bottle, 1 x 1L wide-mouth amber glass ,1 x 500ml sterilized plastic bottle and marked as:

**PROJECT CODE: P23123**  
**SURFACE WATER – SW01**

On analysis, the following results were obtained:

Test	Method	Result	Specification
<b>In-Situ Analysis</b>			
pH value	APHA 4500-H B	7.06	6 - 9
Temperature, °C	APHA 2550 B	30.27	45
Turbidity, NTU	APHA 2130 B	0.35	-
Conductivity, µS/cm	APHA 2510 B	506	-
Dissolved Oxygen, mg/L	APHA 4500-O-G	5.45	-
<b>Ex-Situ Analysis</b>			
Biological Oxygen Demand (BOD <sub>5</sub> ), mg/L	APHA 5210 B	3	20
Chemical Oxygen Demand (COD), mgO <sub>2</sub> /L	APHA 5220 C	8	60
Salinity, mg/L	APHA 2520 B	240	-
Total Suspended Solids, mg/L	APHA 2540 D	<1	30
Total Dissolved Solids, mg/L	APHA 2540 C	314	1000
Orthophosphate (PO <sub>4</sub> -P), mg/L	APHA 4110 B	<0.10	2
Total Phosphorus, mg/L	APHA 3120 B	<0.10	-
Nitrate (NO <sub>3</sub> as N), mg/L	APHA 4110 B	0.40	20
Total Nitrogen, mg/L	SOP-WAT-048	6.7	-

"The report shall not be reproduced except in full, without the written approval of the laboratory.

The results reported herein have been performed in accordance with the terms of accreditation under the Singapore Accreditation Council."

Test	Method	Result	Specification
Total Alkalinity, mgCaCO <sub>3</sub> /L	APHA 2320 B	273	-
Total Organic Carbon (TOC), mg/L	APHA 5310 D	2.68	-
Ammoniacal Nitrogen, mg/L	APHA 4500-NH <sub>3</sub> E	<0.10	-
Arsenic (As), mg/L	APHA 3120 B	<0.01	0.01
Barium (Ba), mg/L	APHA 3120 B	<0.01	1
Beryllium (Be), mg/L	APHA 3120 B	<0.01	0.5
Boron (B), mg/L	APHA 3120 B	<0.01	0.5
Iron (Fe), mg/L	APHA 3120 B	<0.10	1
Manganese (Mn), mg/L	APHA 3120 B	<0.01	0.5
Tin (Sn), mg/L	APHA 3120 B	<0.10	5
*Cadmium (Cd), mg/L	APHA 3120 B	<0.003	0.003
*Chromium (CrIII), mg/L	APHA 3120 B	<0.01	0.05
*Copper (Cu), mg/L	APHA 3120 B	<0.01	0.1
*Lead (Pb), mg/L	APHA 3120 B	<0.01	0.1
*Mercury (Hg), mg/L	APHA 3120 B	<0.001	0.001
*Nickel (Ni), mg/L	APHA 3120 B	<0.01	0.1
*Silver (Ag),mg/L	APHA 3120 B	<0.10	0.1
*Selenium (Se), mg/L	APHA 3120 B	<0.01	0.01
*Zinc (Zn), mg/L	APHA 3120 B	<0.01	0.5
*Total Metal, mg/L	APHA 3120 B	<0.001	0.50
Oil and Grease (Total), mg/L	APHA 5520 B/F	<b>2.0</b>	1
Oil and Grease (Hydrocarbon), mg/L	APHA 5520 B/F	<1	1
<i>Enterococcus</i> , CFU/100mL	APHA 9230 C	166	-

- Remarks:**
- 1) The above results are tested as per sample received by the laboratory.
  - 2) Specification is based on NEA's allowable limits to trade effluent discharge in a controlled watercourse.
  - 3) < = Less than
  - 4) TOC not an accredited test



**Ling Kai Sin**  
**Laboratory Chemist**



**Izzatul Adhwa Akashah**  
**Microbiologist**

**TEST REPORT NO: ASL-W0694-24**

Company Name : TEMBUSU Asia Consulting Pte. Ltd.  
 Company Address : 1 Commonwealth Ln, #06-06 One Commonwealth, Singapore 149544  
 Date Received : 17 May 2024  
 Date Tested : 17 May 2024 – 28 May 2024  
 Date Reported : 29 May 2024  
 Sample Description : One (1) sample of surface water.  
 Project Title : SPECIALIST CONSULTANCY SERVICES FOR ENVIRONMENTAL IMPACT ASSESSMENT (EIA) AT BUKIT BATOK (NParks/F/6/2023)

The sampling was done by our technical personnel (with reference to SOP-WAT-101) on 17 May 2024 which consists of 1 x 2L plastic bottle, 1 x 1L wide-mouth amber glass ,1 x 500ml sterilized plastic bottle and marked as:

**PROJECT CODE: P23123**  
**SURFACE WATER – SW02**

On analysis, the following results were obtained:

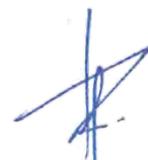
Test	Method	Result	Specification
<b>In-Situ Analysis</b>			
pH value	APHA 4500-H B	7.20	6 - 9
Temperature, °C	APHA 2550 B	29.96	45
Turbidity, NTU	APHA 2130 B	9.7	-
Conductivity, µS/cm	APHA 2510 B	470	-
Dissolved Oxygen, mg/L	APHA 4500-O-G	5.54	-
<b>Ex-Situ Analysis</b>			
Biological Oxygen Demand (BOD <sub>5</sub> ), mg/L	APHA 5210 B	3	20
Chemical Oxygen Demand (COD), mgO <sub>2</sub> /L	APHA 5220 C	8	60
Salinity, mg/L	APHA 2520 B	220	-
Total Suspended Solids, mg/L	APHA 2540 D	9	30
Total Dissolved Solids, mg/L	APHA 2540 C	295	1000
Orthophosphate (PO <sub>4</sub> -P), mg/L	APHA 4110 B	<0.10	2
Total Phosphorus, mg/L	APHA 3120 B	<0.10	-
Nitrate (NO <sub>3</sub> as N), mg/L	APHA 4110 B	0.24	20
Total Nitrogen, mg/L	SOP-WAT-048	1.1	-

Test	Method	Result	Specification
Total Alkalinity, mgCaCO <sub>3</sub> /L	APHA 2320 B	242	-
Total Organic Carbon (TOC), mg/L	APHA 5310 D	3.11	-
Ammoniacal Nitrogen, mg/L	APHA 4500-NH <sub>3</sub> E	<0.10	-
Arsenic (As), mg/L	APHA 3120 B	<0.01	0.01
Barium (Ba), mg/L	APHA 3120 B	<0.01	1
Beryllium (Be), mg/L	APHA 3120 B	<0.01	0.5
Boron (B), mg/L	APHA 3120 B	<0.01	0.5
Iron (Fe), mg/L	APHA 3120 B	<0.10	1
Manganese (Mn), mg/L	APHA 3120 B	0.23	0.5
Tin (Sn), mg/L	APHA 3120 B	<0.10	5
*Cadmium (Cd), mg/L	APHA 3120 B	<0.003	0.003
*Chromium (CrIII), mg/L	APHA 3120 B	<0.01	0.05
*Copper (Cu), mg/L	APHA 3120 B	<0.01	0.1
*Lead (Pb), mg/L	APHA 3120 B	<0.01	0.1
*Mercury (Hg), mg/L	APHA 3120 B	<0.001	0.001
*Nickel (Ni), mg/L	APHA 3120 B	<0.01	0.1
*Silver (Ag),mg/L	APHA 3120 B	<0.10	0.1
*Selenium (Se), mg/L	APHA 3120 B	<0.01	0.01
*Zinc (Zn), mg/L	APHA 3120 B	<0.01	0.5
*Total Metal, mg/L	APHA 3120 B	<0.001	0.50
Oil and Grease (Total), mg/L	APHA 5520 B/F	<b>3.6</b>	1
Oil and Grease (Hydrocarbon), mg/L	APHA 5520 B/F	<b>1.1</b>	1
<i>Enterococcus</i> , CFU/100mL	APHA 9230 C	357	-

- Remarks:**
- 1) The above results are tested as per sample received by the laboratory.
  - 2) Specification is based on NEA's allowable limits to trade effluent discharge in a controlled watercourse.
  - 3) < = Less than
  - 4) TOC not an accredited test



**Ling Kai Sin**  
**Laboratory Chemist**



**Izzatul Adhwa Akashah**  
**Microbiologist**

**TEST REPORT NO: ASL-W0551-24**

Company Name : TEMBUSU Asia Consulting Pte. Ltd.  
 Company Address : 1 Commonwealth Ln, #06-06 One Commonwealth, Singapore 149544  
 Date Received : 17 April 2024  
 Date Tested : 17 April 2024 – 23 April 2024  
 Date Reported : 24 April 2024  
 Sample Description : One (1) sample of surface water.  
 Project Title : SPECIALIST CONSULTANCY SERVICES FOR ENVIRONMENTAL IMPACT ASSESSMENT (EIA) AT BUKIT BATOK (NParks/F/6/2023)

The sampling was done by our technical personnel (with reference to SOP-WAT-101) on 17 April 2024 which consists of 1 x 2L plastic bottle, 1 x 1L wide-mouth amber glass, 1 x 500ml sterilized plastic bottle and marked as:

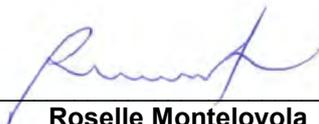
**PROJECT CODE: P23123**  
**SURFACE WATER – SW01**

On analysis, the following results were obtained:

Test	Method	Result	Specification
<b>In-Situ Analysis</b>			
pH value	APHA 4500-H B	7.54	6 - 9
Temperature, °C	APHA 2550 B	30.65	45
Turbidity, NTU	APHA 2130 B	1.2	-
Conductivity, µS/cm	APHA 2510 B	637	-
Dissolved Oxygen, mg/L	APHA 4500-O-G	2.11	-
<b>Ex-Situ Analysis</b>			
Biological Oxygen Demand (BOD <sub>5</sub> ), mg/L	APHA 5210 B	12	20
Chemical Oxygen Demand (COD), mgO <sub>2</sub> /L	APHA 5220 C	35	60
Salinity, mg/L	APHA 2520 B	300	-
Total Suspended Solids, mg/L	APHA 2540 D	5	30
Total Dissolved Solids, mg/L	APHA 2540 C	318	1000
Orthophosphate (PO <sub>4</sub> -P), mg/L	APHA 4110 B	<0.01	2
Total Phosphorus, mg/L	SOP-WAT-020	<0.01	-
Nitrate (NO <sub>3</sub> as N), mg/L	APHA 4110 B	0.67	20
Total Nitrogen, mg/L	SOP-WAT-048	0.80	-

Test	Method	Result	Specification
Total Alkalinity, mgCaCO <sub>3</sub> /L	APHA 2320 B	234	-
Total Organic Carbon (TOC), mg/L	APHA 5310 D	1.42	-
Ammoniacal Nitrogen, mg/L	APHA 4500-NH <sub>3</sub> E	1.58	-
Arsenic (As), mg/L	APHA 3120 B	<0.01	0.01
Barium (Ba), mg/L	APHA 3120 B	<0.01	1
Beryllium (Be), mg/L	APHA 3120 B	<0.01	0.5
Boron (B), mg/L	APHA 3120 B	<0.01	0.5
Iron (Fe), mg/L	APHA 3120 B	<0.01	1
Manganese (Mn), mg/L	APHA 3120 B	<0.01	0.5
Tin (Sn), mg/L	APHA 3120 B	<0.01	5
*Cadmium (Cd), mg/L	APHA 3120 B	<0.003	0.003
*Chromium (CrIII), mg/L	APHA 3120 B	<0.01	0.05
*Copper (Cu), mg/L	APHA 3120 B	<0.01	0.1
*Lead (Pb), mg/L	APHA 3120 B	<0.01	0.1
*Mercury (Hg), mg/L	APHA 3120 B	<0.001	0.001
*Nickel (Ni), mg/L	APHA 3120 B	<0.01	0.1
*Silver (Ag),mg/L	APHA 3120 B	<0.01	0.1
*Selenium (Se), mg/L	APHA 3120 B	<0.01	0.01
*Zinc (Zn), mg/L	APHA 3120 B	<0.01	0.5
*Total Metal, mg/L	APHA 3120 B	<0.001	0.50
Oil and Grease (Total), mg/L	APHA 5520 B/F	<1	1
Oil and Grease (Hydrocarbon), mg/L	APHA 5520 B/F	<1	1
<i>Enterococcus</i> , CFU/100mL	APHA 9230 C	282	-

- Remarks:**
- 1) The above results are tested as per sample received by the laboratory.
  - 2) Specification is based on NEA's allowable limits to trade effluent discharge in a controlled watercourse.
  - 3) < = Less than
  - 4) TOC not an accredited test

  
 \_\_\_\_\_  
**Roselle Monteloyola**  
**Laboratory Manager**

**TEST REPORT NO: ASL-W0552-24**

Company Name : TEMBUSU Asia Consulting Pte. Ltd.  
 Company Address : 1 Commonwealth Ln, #06-06 One Commonwealth, Singapore 149544  
 Date Received : 17 April 2024  
 Date Tested : 17 April 2024 – 23 April 2024  
 Date Reported : 24 April 2024  
 Sample Description : One (1) sample of surface water.  
 Project Title : SPECIALIST CONSULTANCY SERVICES FOR ENVIRONMENTAL IMPACT ASSESSMENT (EIA) AT BUKIT BATOK (NParks/F/6/2023)

The sampling was done by our technical personnel (with reference to SOP-WAT-101) on 17 April 2024 which consists of 1 x 2L plastic bottle, 1 x 1L wide-mouth amber glass ,1 x 500ml sterilized plastic bottle and marked as:

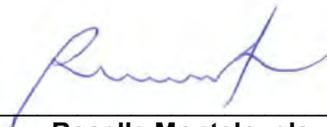
**PROJECT CODE: P23123**  
**SURFACE WATER – SW02**

On analysis, the following results were obtained:

Test	Method	Result	Specification
<b>In-Situ Analysis</b>			
pH value	APHA 4500-H B	7.59	6 - 9
Temperature, °C	APHA 2550 B	30.46	45
Turbidity, NTU	APHA 2130 B	4.7	-
Conductivity, µS/cm	APHA 2510 B	611	-
Dissolved Oxygen, mg/L	APHA 4500-O-G	2.88	-
<b>Ex-Situ Analysis</b>			
Biological Oxygen Demand (BOD <sub>5</sub> ), mg/L	APHA 5210 B	11	20
Chemical Oxygen Demand (COD), mgO <sub>2</sub> /L	APHA 5220 C	35	60
Salinity, mg/L	APHA 2520 B	290	-
Total Suspended Solids, mg/L	APHA 2540 D	<1	30
Total Dissolved Solids, mg/L	APHA 2540 C	306	1000
Orthophosphate (PO <sub>4</sub> -P), mg/L	APHA 4110 B	<0.01	2
Total Phosphorus, mg/L	SOP-WAT-020	<0.01	-
Nitrate (NO <sub>3</sub> as N), mg/L	APHA 4110 B	0.26	20
Total Nitrogen, mg/L	SOP-WAT-048	1.40	-

Test	Method	Result	Specification
Total Alkalinity, mgCaCO <sub>3</sub> /L	APHA 2320 B	236	-
Total Organic Carbon (TOC), mg/L	APHA 5310 D	1.48	-
Ammoniacal Nitrogen, mg/L	APHA 4500-NH <sub>3</sub> E	1.55	-
Arsenic (As), mg/L	APHA 3120 B	<0.01	0.01
Barium (Ba), mg/L	APHA 3120 B	<0.01	1
Beryllium (Be), mg/L	APHA 3120 B	<0.01	0.5
Boron (B), mg/L	APHA 3120 B	0.12	0.5
Iron (Fe), mg/L	APHA 3120 B	0.28	1
Manganese (Mn), mg/L	APHA 3120 B	0.31	0.5
Tin (Sn), mg/L	APHA 3120 B	0.12	5
*Cadmium (Cd), mg/L	APHA 3120 B	<0.003	0.003
*Chromium (Cr), mg/L	APHA 3120 B	<0.01	0.05
*Copper (Cu), mg/L	APHA 3120 B	<0.01	0.1
*Lead (Pb), mg/L	APHA 3120 B	<0.01	0.1
*Mercury (Hg), mg/L	APHA 3120 B	<0.001	0.001
*Nickel (Ni), mg/L	APHA 3120 B	<0.01	0.1
*Silver (Ag),mg/L	APHA 3120 B	<0.01	0.1
*Selenium (Se), mg/L	APHA 3120 B	<0.01	0.01
*Zinc (Zn), mg/L	APHA 3120 B	<0.01	0.5
*Total Metal, mg/L	APHA 3120 B	<0.001	0.50
Oil and Grease (Total), mg/L	APHA 5520 B/F	<1	1
Oil and Grease (Hydrocarbon), mg/L	APHA 5520 B/F	<1	1
<i>Enterococcus</i> , CFU/100mL	APHA 9230 C	570	-

- Remarks:**
- 1) The above results are tested as per sample received by the laboratory.
  - 2) Specification is based on NEA's allowable limits to trade effluent discharge in a controlled watercourse.
  - 3) < = Less than
  - 4) TOC not an accredited test



**Roselle Monteloyola**  
**Laboratory Manager**

**TEST REPORT NO: ASL-W0678-24**

Company Name : TEMBUSU Asia Consulting Pte. Ltd.  
 Company Address : 1 Commonwealth Ln, #06-06 One Commonwealth, Singapore 149544  
 Date Received : 14 May 2024  
 Date Tested : 14 May 2024 – 21 May 2024  
 Date Reported : 22 May 2024  
 Sample Description : One (1) sample of surface water.  
 Project Title : SPECIALIST CONSULTANCY SERVICES FOR ENVIRONMENTAL IMPACT ASSESSMENT (EIA) AT BUKIT BATOK (NParks/F/6/2023)

The sampling was done by our technical personnel (with reference to SOP-WAT-101) on 14 May 2024 which consists of 1 x 2L plastic bottle, 1 x 1L wide-mouth amber glass ,1 x 500ml sterilized plastic bottle and marked as:

**PROJECT CODE: P23123**  
**SURFACE WATER – SW03**

On analysis, the following results were obtained:

Test	Method	Result	Specification
<b>In-Situ Analysis</b>			
pH value	APHA 4500-H B	6.61	6 - 9
Temperature, °C	APHA 2550 B	26.69	45
Turbidity, NTU	APHA 2130 B	27	-
Conductivity, µS/cm	APHA 2510 B	91	-
Dissolved Oxygen, mg/L	APHA 4500-O-G	5.05	-
<b>Ex-Situ Analysis</b>			
Biological Oxygen Demand (BOD <sub>5</sub> ), mg/L	APHA 5210 B	<2	20
Chemical Oxygen Demand (COD), mgO <sub>2</sub> /L	APHA 5220 C	8	60
Salinity, mg/L	APHA 2520 B	40	-
Total Suspended Solids, mg/L	APHA 2540 D	7	30
Total Dissolved Solids, mg/L	APHA 2540 C	23	1000
Orthophosphate (PO <sub>4</sub> -P), mg/L	APHA 4110 B	<0.10	2
Total Phosphorus, mg/L	SOP-WAT-020	<0.10	-
Nitrate (NO <sub>3</sub> as N), mg/L	APHA 4110 B	0.63	20
Total Nitrogen, mg/L	SOP-WAT-048	1.7	-

"The report shall not be reproduced except in full, without the written approval of the laboratory.

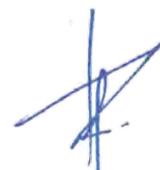
The results reported herein have been performed in accordance with the terms of accreditation under the Singapore Accreditation Council."

Test	Method	Result	Specification
Total Alkalinity, mgCaCO <sub>3</sub> /L	APHA 2320 B	36.5	-
Total Organic Carbon (TOC), mg/L	APHA 5310 D	5.47	-
Ammoniacal Nitrogen, mg/L	APHA 4500-NH <sub>3</sub> E	<0.10	-
Arsenic (As), mg/L	APHA 3120 B	<0.01	0.01
Barium (Ba), mg/L	APHA 3120 B	<0.01	1
Beryllium (Be), mg/L	APHA 3120 B	<0.01	0.5
Boron (B), mg/L	APHA 3120 B	<0.01	0.5
Iron (Fe), mg/L	APHA 3120 B	<0.10	1
Manganese (Mn), mg/L	APHA 3120 B	<0.01	0.5
Tin (Sn), mg/L	APHA 3120 B	<0.10	5
*Cadmium (Cd), mg/L	APHA 3120 B	<0.003	0.003
*Chromium (Cr), mg/L	APHA 3120 B	<0.01	0.05
*Copper (Cu), mg/L	APHA 3120 B	<0.01	0.1
*Lead (Pb), mg/L	APHA 3120 B	<0.01	0.1
*Mercury (Hg), mg/L	APHA 3120 B	<0.001	0.001
*Nickel (Ni), mg/L	APHA 3120 B	<0.01	0.1
*Silver (Ag),mg/L	APHA 3120 B	<0.10	0.1
*Selenium (Se), mg/L	APHA 3120 B	<0.01	0.01
*Zinc (Zn), mg/L	APHA 3120 B	0.04	0.5
*Total Metal, mg/L	APHA 3120 B	0.04	0.50
Oil and Grease (Total), mg/L	APHA 5520 B/F	<b>3.4</b>	1
Oil and Grease (Hydrocarbon), mg/L	APHA 5520 B/F	1.0	1
<i>Enterococcus</i> , CFU/100mL	APHA 9230 C	151	-

- Remarks:**
- 1) The above results are tested as per sample received by the laboratory.
  - 2) Specification is based on NEA's allowable limits to trade effluent discharge in a controlled watercourse.
  - 3) < = Less than
  - 4) TOC not an accredited test



**Ling Kai Sin**  
**Laboratory Chemist**



**Izzatul Adhwa Akashah**  
**Microbiologist**

## **APPENDIX F**

### **Arborist Assessment Matrix**

Date	Tag	Latitude	Longitude	Scientific.Name	Common.Name	Girth (m)	Height (m)	Canopy (m)	Health	Structure	Arborist Comments	Mitigation
3/20/2024	T0004	1.36773	103.748719	<i>Ficus variegata</i>	Common red-stem fig, Variegated fig	1.5	13	10	good	good	root flare intact, no injuries observed on trunk, some minor deadwood	NIL
3/20/2024	T0010	NA	NA	<i>Spathodea campanulata</i>	African tulip tree, Panchot	1.3	13	13	good	fair	well developed root flare, no injury on trunk, dead twigs in crown	Deadwooding
3/20/2024	T0013	1.367899	103.748949	<i>Adenanthera pavonina</i>	Saga, Coral bean tree	1	12	12	good	fair	leaning with self correction, tension roots observed dead twigs on crown	Deadwooding
3/20/2024	T0014	1.367879	103.748979	<i>Falcataria falcata</i>	Albizia, Kayu machis	2.9	15	15	good	poor	multiple attachment at base , two main leaders observed. One leader has cavity at 2m height facing west. climber strangling the tree. Decay observed in some roots . Termite trail observed at tree base.	Removal
3/20/2024	T0016	1.367969	103.749075	<i>Mangifera indica</i>	Mango, Mangga	1	14	11	good	fair	root intact, no injury on trunk, slightly asymmetrical crown	NIL
3/20/2024	T0018	1.368041	103.749167	<i>Spathodea campanulata</i>	African tulip tree, Panchot	3.5	10	16	fair	poor	multiple attachments at base , decay at trunk failure point and root flare, cavity at tree base	Removal
3/20/2024	T0020	1.367888	103.749181	<i>Terminalia catappa</i>	Sea almond, Ketapang	1.5	14	15	good	good	root flare well developed, multiple climbers on tree crown , some dead twigs on crown	Deadwooding

Date	Tag	Latitude	Longitude	Scientific.Name	Common.Name	Girth (m)	Height (m)	Canopy (m)	Health	Structure	Arborist Comments	Mitigation
3/20/2024	T0021	1.367986	103.749266	<i>Clausena excavata</i>	Pink lime-berry, Cama	1	14	12	fair	poor	multiple attachments at 2m height, previous branch failure, decayed wood on branches	Removal
3/20/2024	T0023	1.367986	103.74928	<i>Spathodea campanulata</i>	African tulip tree, Panchot	1.2	12	10	good	poor	decay at root base	Removal
3/20/2024	T0024	1.368081	103.749382	<i>Spathodea campanulata</i>	African tulip tree, Panchot	1.3	12	12	good	fair	root flare intact, multiple dead branch on crown, ant nest observed 1m from ground suggesting potential cavity	Removal
3/26/2024	T0025	1.36772	103.748572	<i>Terminalia catappa</i>	Sea almond, Ketapang	1.2	11	12	Good	Fair	Root flare intact, tree leaning with asymmetrical crown. Hanging dead branch	Crown reduction
3/26/2024	T0026	1.367878	103.748538	<i>Spathodea campanulata</i>	African tulip tree, Panchot	1.3	13	10	Good	Poor	Basal decay, codominant leaders	Removal
3/26/2024	T0027	1.367779	103.748544	<i>Ficus vasculosa</i>	White fig, Aransi	1	12	10	Good	Fair	Root flare intact, dead branch with 0.2m girth at 10m above tree	Deadwooding
3/26/2024	T0034	1.367842	103.748365	<i>Cyrtophyllum fragrans</i>	Tembusu, Tembusu hutan	2.6	18	10	Fair	Fair	Multiple attachments at base, root flare intact, multiple climbers on tree	NIL
3/26/2024	T0038	1.368124	103.748143	<i>Alstonia angustiloba</i>	Common pulai, Pulai	1.4	18	10	Fair	Poor	Root flare intact, tree growing in close vicinity to T0039, leaf chlorotic	NIL
3/26/2024	T0039	1.368098	103.748171	<i>Alstonia angustiloba</i>	Common pulai, Pulai	2.5	20	12	Good	Fair	Tree in close vicinity to T0038, root flare intact, termite trail on trunk	NIL

Date	Tag	Latitude	Longitude	Scientific.Name	Common.Name	Girth (m)	Height (m)	Canopy (m)	Health	Structure	Arborist Comments	Mitigation
3/26/2024	T0040	1.368443	103.748434	<i>Ficus variegata</i>	Common red-stem fig, Variegated fig	1.3	13	12	Good	Fair	Root flare intact, tree leaning with self-correction	NIL
3/26/2024	T0041	1.368516	103.748486	<i>Syzygium cerasiforme</i>	Common kelat, Gelam tikus	1	14	12	Good	Fair	Root flare intact, dead branch at 5m height, hanging dead twig on crown, multiple witch brooms	Deadwooding
3/26/2024	T0045	1.368512	103.748632	<i>Bridelia tomentosa</i>	Kenidai, Kernong	1	7	7	Fair	Poor	Root flare intact, tree leaning, multiple branch failure, cross branch, multiple attachment at base	Removal
3/26/2024	T0046	1.368513	103.748603	<i>Bridelia tomentosa</i>	Kenidai, Kernong	2.2	10	10	Fair	Poor	Multiple branch failure, some occurring at 1m height, termite trail on failure point suggests decay, root flare intact, adventitious roots	Removal
3/26/2024	T0050	1.368402	103.748466	<i>Claoxylon indicum</i>	Laping budak, Jarak kayu	1	12	10	Fair	Poor	Multiple cankers on tree with exposed decayed wood, multiple epicormic shoots, previous failure point with decayed wood at 3m height	Removal
3/26/2024	T0051	1.368389	103.748469	<i>Spathodea campanulata</i>	African tulip tree, Panchot	2	12	10	Good	Poor	Root flare intact, codominant leaders, open wound with decay at 2m height on one of the leaders	Removal
4/4/2024	T0053	1.368215	103.748372	<i>Falcataria falcata</i>	Albizia, Kayu machis	1.8	16	14	Good	Fair	Termite trail and hanging branch on tree	Removal

Date	Tag	Latitude	Longitude	Scientific.Name	Common.Name	Girth (m)	Height (m)	Canopy (m)	Health	Structure	Arborist Comments	Mitigation
4/4/2024	T0054	1.368206	103.748259	<i>Dillenia suffruticosa</i>	Simpoh air, Simpoh air	1.3	8	10	Good	Fair	Multiple attachments at base	NIL
4/4/2024	T0055	1.368174	103.748248	<i>Dillenia suffruticosa</i>	Simpoh air, Simpoh air	1	7	10	Good	Poor	Multiple attachments at base, previous branch failure with decayed wood	Removal
4/4/2024	T0056	1.368116	103.748216	<i>Cinnamomum iners</i>	Wild cinnamon, Clove cinnamon	1	12	10	Good	Good	Dead twigs on crown	Deadwooding
4/4/2024	T0057	1.368127	103.74818	<i>Falcataria falcata</i>	Albizia, Kayu machis	2.5	12	14	Poor	Poor	Previous trunk failure with decayed stump	Removal
4/4/2024	T0059	1.36804	103.748452	<i>Dead tree</i>	NA	1.4	12	8	Poor	Poor	Dead tree	Removal
4/4/2024	T0062	1.367242	103.747975	<i>Ficus microcarpa</i>	Malayan banyan, Jejawi	3	12	12	Good	Good	NA	NIL
4/4/2024	T0063	1.367179	103.747949	<i>Spathodea campanulata</i>	African tulip tree, Panchot	1	14	12	Fair	Fair	Tree with epicormic shoot grown to height 8m and canopy 6m from tree root flare, dead hanging branch on tree crown	Removal
4/4/2024	T0064	1.367171	103.747959	<i>Spathodea campanulata</i>	African tulip tree, Panchot	1.2	15	10	Good	Fair	Root flare intact	NIL
4/4/2024	T0065	1.367134	103.747956	<i>Spathodea campanulata</i>	African tulip tree, Panchot	1	13	10	Good	Fair	Root flare intact, minor dead twigs	NIL
4/4/2024	T0067	1.367141	103.74797	<i>Spathodea campanulata</i>	African tulip tree, Panchot	1	12	8	Poor	Poor	Decay at tree base	Removal

Date	Tag	Latitude	Longitude	Scientific.Name	Common.Name	Girth (m)	Height (m)	Canopy (m)	Health	Structure	Arborist Comments	Mitigation
4/4/2024	T0068	1.367123	103.748035	<i>Cinnamomum iners</i>	Wild cinnamon, Clove cinnamon	2.4	14	12	Good	Poor	Root flare intact, multiple attachments at 1m height with included bark, crown asymmetrical heavy towards East	Removal
4/4/2024	T0069	1.367089	103.748023	<i>Spathodea campanulata</i>	African tulip tree, Panchot	1.5	13	10	Fair	Poor	Root flare intact, crown sparse, one epicormic shoot deriving from tree base reaching 8m height, termite trail with cavity at 3m height facing North	Removal
4/4/2024	T0070	1.367006	103.748028	<i>Ficus benjamina</i>	Weeping fig, Java willow	2.2	13	12	Good	Fair	Multiple epicormic shoots	NIL
4/4/2024	T0071	1.366754	103.748052	<i>Spathodea campanulata</i>	African tulip tree, Panchot	2.4	18	12	Fair	Poor	Exposed dead wood with decay in between multiple flares	Removal
4/4/2024	T0073	1.366634	103.748076	<i>Claoxylon indicum</i>	Laping budak, Jarak kayu	1	12	10	Good	Poor	Large lateral branch derived from tree base	NIL
4/4/2024	T0074	1.366522	103.748039	<i>Claoxylon indicum</i>	Laping budak, Jarak kayu	1	12	10	Good	Poor	Cavity at 2m height with wasp nest	Removal
4/4/2024	T0075	1.3665	103.748092	<i>Spathodea campanulata</i>	African tulip tree, Panchot	1.8	15	10	Good	Fair	Root flare intact	NIL
4/4/2024	T0076	1.36649	103.748083	<i>Spathodea campanulata</i>	African tulip tree, Panchot	1.6	15	10	Good	Poor	Root flare intact, more than 30 degree lean with self correction, pronounced tension root	NIL
5/7/2024	T0078	1.366465	103.74804	<i>Spathodea campanulata</i>	African tulip tree, Panchot	1	14	10	Good	Fair	Root flare intact, tree leaning with tension roots present	NIL

Date	Tag	Latitude	Longitude	Scientific.Name	Common.Name	Girth (m)	Height (m)	Canopy (m)	Health	Structure	Arborist Comments	Mitigation
5/7/2024	T0079	1.366479	103.748029	<i>Spathodea campanulata</i>	African tulip tree, Panchot	1	12	10	Fair	Fair	Tree leaning with asymmetrical crown; crown heavy towards south, tension roots pronounced	NIL
5/7/2024	T0080	1.366516	103.748029	<i>Spathodea campanulata</i>	African tulip tree, Panchot	3	16	12	Fair	Poor	Root flare intact, large lateral branch bifurcating 0.5m above ground forming a V-shaped crotch, previous failure wound 10m above ground, cavity 3m above ground, canopy arising from lateral branch heavy towards south	Removal
5/7/2024	T0081	1.366507	103.747976	<i>Claoxylon indicum</i>	Laping budak, Jarak kayu	1.2	10	10	Good	Poor	Decay at tree base with cavity extending inwards and upwards towards trunk	Removal
5/7/2024	T0082	1.366509	103.747961	<i>Spathodea campanulata</i>	African tulip tree, Panchot	1.9	14	10	Good	Fair	Root flare intact, crown asymmetrical and heavy towards south	NIL
5/7/2024	T0083	1.366554	103.747935	<i>Spathodea campanulata</i>	African tulip tree, Panchot	1.8	14	12	Fair	Fair	Root flare intact, crown sparse, several dead twigs in crown	NIL
5/7/2024	T0084	1.366603	103.747932	<i>Spathodea campanulata</i>	African tulip tree, Panchot	2.3	15	12	Good	Fair	Root flare intact, codominant leaders with V-shaped crotch	NIL
5/7/2024	T0085	1.366569	103.747845	<i>Spathodea campanulata</i>	African tulip tree, Panchot	1.4	16	10	Fair	Good	Root flare intact, termite trail on trunk, some dead twigs on canopy	NIL

Date	Tag	Latitude	Longitude	Scientific.Name	Common.Name	Girth (m)	Height (m)	Canopy (m)	Health	Structure	Arborist Comments	Mitigation
5/7/2024	T0086	1.366592	103.74787	<i>Spathodea campanulata</i>	African tulip tree, Panchot	1.3	12	9	Fair	Fair	Large lateral branch bifurcating 1m above ground forming V-shaped crotch, root flare intact, dead branch 6m from ground	NIL
5/7/2024	T0087	1.366603	103.747901	<i>Spathodea campanulata</i>	African tulip tree, Panchot	1.3	15	12	Good	Fair	Root flare intact	NIL
5/7/2024	T0088	1.366666	103.747912	<i>Spathodea campanulata</i>	African tulip tree, Panchot	1.4	16	12	Fair	Good	Root flare intact, some dead wood on canopy	NIL
5/7/2024	T0089	1.366763	103.747894	<i>Spathodea campanulata</i>	African tulip tree, Panchot	1	12	9	Fair	Good	Root flare intact, canopy overgrown by climbers, some dead twigs on crown	NIL
5/7/2024	T0090	1.366758	103.747902	<i>Spathodea campanulata</i>	African tulip tree, Panchot	1	10	6	Fair	Poor	Cavity with wasp nest at 3m height, tree trunk bent towards east with poor taper	Removal
5/7/2024	T0091	1.366819	103.747865	<i>Spathodea campanulata</i>	African tulip tree, Panchot	1	12	9	Good	Fair	Root flare intact, previous injury at 1.5m height	NIL
5/7/2024	T0094	1.366502	103.747762	<i>Spathodea campanulata</i>	African tulip tree, Panchot	5.5	15	15	Good	Poor	Root flare intact, tree with multiple attachments at base with accumulation of leaf litter and humus preventing further inspection, some decayed branches extending from multiple attachment point	Removal
5/7/2024	T0095	1.366521	103.747654	<i>Spathodea campanulata</i>	African tulip tree, Panchot	1.3	12	10	Good	Fair	Root flare intact, lateral branch bifurcating 1m above ground forming a V-shaped crotch	NIL
5/7/2024	T0096	1.366504	103.747623	<i>Spathodea campanulata</i>	African tulip tree, Panchot	1	7	5	Poor	Poor	Large decay on trunk	Removal

Date	Tag	Latitude	Longitude	Scientific.Name	Common.Name	Girth (m)	Height (m)	Canopy (m)	Health	Structure	Arborist Comments	Mitigation
5/7/2024	T0097	1.366513	103.747628	<i>Spathodea campanulata</i>	African tulip tree, Panchot	2.5	14	12	Fair	Poor	Large decay wound from 2m height extending to 3m height facing east,	Removal
5/7/2024	T0098	1.366548	103.747597	<i>Spathodea campanulata</i>	African tulip tree, Panchot	2.8	14	10	Fair	Poor	Codominant leaders bifurcating 0.5m above getting, bifurcation point with included bark, bifurcation point with accumulation of leaf litter and humus preventing further inspection, liontailing on smaller leader, decayed wood observed on larger leader at 5m height	Removal
5/7/2024	T0099	1.36657	103.747572	<i>Spathodea campanulata</i>	African tulip tree, Panchot	3.6	16	12	Fair	Poor	Multiple attachments at base with one branch fallen	Removal
5/7/2024	T0100	1.36657	103.747532	<i>Spathodea campanulata</i>	African tulip tree, Panchot	1.3	12	10	Fair	Fair	Previous codominant leader failure at 5m height resulting in a large wound	Removal
5/7/2024	T0101	1.366542	103.747532	<i>Spathodea campanulata</i>	African tulip tree, Panchot	1.1	12	9	Fair	Fair	Root flare intact, decayed branch at 1m above ground, tree leaning with crown asymmetrical	Removal
5/7/2024	T0102	1.367121	103.747788	<i>Spathodea campanulata</i>	African tulip tree, Panchot	1	12	10	Fair	Fair	Root flare intact, self corrected lean with pronounced tension root	NIL
5/7/2024	T0105	1.367101	103.747881	<i>Spathodea campanulata</i>	African tulip tree, Panchot	1	12	8	Fair	Fair	Root flare intact, some dead twigs on crown	NIL

Date	Tag	Latitude	Longitude	Scientific.Name	Common.Name	Girth (m)	Height (m)	Canopy (m)	Health	Structure	Arborist Comments	Mitigation
5/7/2024	T0107	1.366928	103.747816	<i>Spathodea campanulata</i>	African tulip tree, Panchot	3	14	10	Fair	Poor	Multiple attachments at base with accumulation of leaf litter and humus preventing further inspection, some previous branch failure wounds	Removal
5/7/2024	T0108	1.366958	103.747661	<i>Spathodea campanulata</i>	African tulip tree, Panchot	1	12	9	Fair	Fair	Root flare intact, previous failure wound at 8m height facing south	Removal
5/21/2024	T0109	1.367486	103.746999	<i>Arthrophyllum jackianum</i>		1	10	6	Fair	Fair	Tree leaning with pronounced tension root, crown asymmetrical due to competition with neighbouring trees, some exposed dead wood on branch	NIL
5/21/2024	T0110	1.366968	103.746552	<i>Syzygium polyanthum</i>	Indonesian bayleaf, Salam	1	12	8	Poor	Fair	Root flare intact and well developed, crown overgrown with climbers	NIL
5/21/2024	T0116	1.367139	103.746904	<i>Cinnamomum iners</i>	Wild cinnamon, Clove cinnamon	1	10	10	Fair	Fair	Low bifurcation with included bark at 0.5m above ground, root flare intact and well developed,	NIL
5/21/2024	T0117	1.367334	103.746978	<i>Ficus variegata</i>	Common red-stem fig, Variegated fig	1.2	12	10	Good	Fair	Root flare intact and well developed, crown overgrown by climbers.	NIL

Date	Tag	Latitude	Longitude	Scientific.Name	Common.Name	Girth (m)	Height (m)	Canopy (m)	Health	Structure	Arborist Comments	Mitigation
5/21/2024	T0118	1.367306	103.746949	<i>Ficus variegata</i>	Common red-stem fig, Variegated fig	1.1	12	6	Fair	Fair	Root flare intact and well developed, crown small compared to neighbouring tree.	NIL
5/21/2024	T0119	1.367416	103.747051	<i>Vitex pinnata</i>	Leban, Malayan teak	1	10	14	Good	Fair	Root flare intact, bifurcation at 3m above ground with slight included bark.	NIL
5/21/2024	T0120	1.367433	103.747075	<i>Vitex pinnata</i>	Leban, Malayan teak	1	14	14	Fair	Good	Root flare intact and well developed, an <i>Embelia ribes</i> climber with 10cm girth subsumed between trunk and lateral branch at 4m height.	NIL
5/21/2024	T0122	1.367533	103.747167	<i>Cinnamomum iners</i>	Wild cinnamon, Clove cinnamon	1.2	11	10	Good	Fair	Root flare intact, tree leaning with self correction.	NIL
5/21/2024	T0124	1.367375	103.747201	<i>Ficus microcarpa</i>	Malayan banyan, Jejawi	2.8	14	14	Good	Fair	Root zone partially restricted by foot path.	NIL
5/29/2024	T0126	1.3672	103.747103	<i>Spathodea campanulata</i>	African tulip tree, Panchot	2.5	12	13	Fair	Poor	Tree has low bifurcation. Tree has exposed root with 15cm diameter at tree base, likely due to failure of one scaffold branch. Exposed dead root was observed at the crotch. Two scaffold branches also cross at each other at 2-3m above ground.	Removal

Date	Tag	Latitude	Longitude	Scientific.Name	Common.Name	Girth (m)	Height (m)	Canopy (m)	Health	Structure	Arborist Comments	Mitigation
5/29/2024	T0127	1.367133	103.746925	<i>Syzygium polyanthum</i>	Indonesian bayleaf, Salam	1.1	15	12	Good	Fair	Root flare intact. Co-dominant leaders with U-shaped crotch at 6m height. Hanging dead branch and hanging branch observed on crown canopy.	Deadwooding
5/29/2024	T0129	1.367159	103.746981	<i>Spathodea campanulata</i>	African tulip tree, Panchot	1.5	14	12	Fair	Fair	Most root flare intact. Exposed deadwood observed in 1 major root flare. Co-dominant leaders with U-shaped crotch at 8m above ground. Heavy climber growth on crown.	Removal
5/29/2024	T0133	1.367337	103.747348	<i>Spathodea campanulata</i>	African tulip tree, Panchot	1.4	16	8	Poor	Fair	Root flare intact. Sparse crown and low live crown ratio. Heavy climber growth on crown.	NIL
5/29/2024	T0135	1.367359	103.747413	<i>Spathodea campanulata</i>	African tulip tree, Panchot	1	15	8	Fair	Poor	Live crown ratio low. Tree has previous trunk failure at 7m above ground.	Removal
5/29/2024	T0139	1.366939	103.7471	<i>Syzygium polyanthum</i>	Indonesian bayleaf, Salam	1	14	8	Good	Fair	Bifurcation with U-shaped crotch. Side lateral branch originating at 1.5m above ground forming V-shaped crotch from main trunk with obvious included bark.	Structural pruning
5/29/2024	T0140	1.366964	103.747062	<i>Ficus benjamina</i>	Weeping fig, Java willow	4	16	18	Good	Fair	Exposed deadwood on trunk.	NIL

Date	Tag	Latitude	Longitude	Scientific.Name	Common.Name	Girth (m)	Height (m)	Canopy (m)	Health	Structure	Arborist Comments	Mitigation
5/29/2024	T0141	1.366982	103.747018	<i>Spathodea campanulata</i>	African tulip tree, Panchot	1.4	15	12	Fair	Fair	Root flare is intact. Side lateral branch with U-shaped crotch at 10m above ground. Several dead branches found.	NIL
5/30/2024	T0144	1.36704	103.747107	<i>Spathodea campanulata</i>	African tulip tree, Panchot	1.2	16	10	Good	Fair	Root flare intact. Lean with self-correction and tension roots are observed. Decay at previous pruning wound.	NIL
5/30/2024	T0145	1.367095	103.747236	<i>Spathodea campanulata</i>	African tulip tree, Panchot	1.1	16	8	Fair	Good	Root flare intact with straight trunk and 1 main leader. Some dead twigs on crown.	NIL
5/30/2024	T0146	1.367268	103.747311	<i>Falcataria falcata</i>	Albizia, Kayu machis	4	20	18	Fair	Poor	Multiple attachments originating at 1m above ground. Decay at tree base on one of the root flares facing North. Decay is more than 15cm deep and advancing into inner tree base.	Removal
5/30/2024	T0147	1.367328	103.747391	<i>Ficus variegata</i>	Common red-stem fig, Variegated fig	1.2	18	12	Good	Fair	Root flare intact. Tree has multiple suspected cankers. Side branch forming a U-shaped crotch from main trunk at 3m above ground.	NIL
5/30/2024	T0150	1.367242	103.747431	<i>Spathodea campanulata</i>	African tulip tree, Panchot	1.2	18	10	Good	Fair	Root flare intact. Side branch bifurcating at main trunk at 0.5m height above ground with some included bark observed.	NIL

Date	Tag	Latitude	Longitude	Scientific.Name	Common.Name	Girth (m)	Height (m)	Canopy (m)	Health	Structure	Arborist Comments	Mitigation
5/30/2024	T0151	1.36733	103.747444	<i>Spathodea campanulata</i>	African tulip tree, Panchot	1.7	18	18	Good	Fair	Root flare intact. Side branch forming V-shaped crotch at main trunk at 3m height above ground. Minor termite trail present. Dead branches on crown observed.	NIL
5/30/2024	T0152	1.367323	103.747431	<i>Spathodea campanulata</i>	African tulip tree, Panchot	1	14	10	Fair	Fair	Tree bowing until 5m above ground before leader is self-corrected.	NIL
5/30/2024	T0154	1.367345	103.747534	<i>Spathodea campanulata</i>	African tulip tree, Panchot	1.2	14	10	Good	Fair	Tree heading different directions from base to 6m above ground. Exposed deadwood and decay from previous branch failure.	Removal
5/30/2024	T0156	1.367288	103.747516	<i>Spathodea campanulata</i>	African tulip tree, Panchot	1.3	13	10	Fair	Poor	Co-dominant leaders forming V-shaped crotch at 5m above ground with included bark observed.	Removal

Date	Tag	Latitude	Longitude	Scientific.Name	Common.Name	Girth (m)	Height (m)	Canopy (m)	Health	Structure	Arborist Comments	Mitigation
5/30/2024	T0160	1.3674	103.747557	<i>Falcataria falcata</i>	Albizia, Kayu machis	3.6	22	24	Fair	Poor	Root flare intact. Heavy lateral branch forming U-shaped crotch at 3m height above ground. Cavity with diameter of 10cm and more than 30cm in depth observed on trunk 1.5m above ground, facing 135 degree SE direction with evidence of fauna nesting (Laced Woodpecker nest). Several previous failure wounds observed.	Removal
5/30/2024	T0161	1.367424	103.747624	<i>Spathodea campanulata</i>	African tulip tree, Panchot	1	14	8	Fair	Fair	Side branch forming U-shaped collar with trunk at 3m above ground. Heavy climber growth on trunk that obstructed inspection.	NIL
5/30/2024	T0163	1.367454	103.747494	<i>Spathodea campanulata</i>	African tulip tree, Panchot	1.2	16	10	Fair	Fair	Termite trail observed on trunk. Low side branch forming V-shaped crotch with main trunk at 0.5m above ground.	NIL
5/30/2024	T0166	1.367201	103.747624	<i>Spathodea campanulata</i>	African tulip tree, Panchot	2.5	16	8	Fair	Poor	Multiple attachments at base originating from previous cut at the trunk. Decayed wood observed at the point of multiple attachment at 0.5m above ground.	Removal

Date	Tag	Latitude	Longitude	Scientific.Name	Common.Name	Girth (m)	Height (m)	Canopy (m)	Health	Structure	Arborist Comments	Mitigation
5/30/2024	T0167	1.36711	103.74758	<i>Spathodea campanulata</i>	African tulip tree, Panchot	3.5	18	12	Good	Poor	Multiple attachments from tree base.	Removal
5/30/2024	T0169	1.36711	103.747481	<i>Spathodea campanulata</i>	African tulip tree, Panchot	1.4	18	12	Fair	Fair	Crown slightly chlorotic. Co-dominant leaders with U-shaped crotch at 5m above ground.	NIL
6/6/2024	T0170	1.367107	103.747458	<i>Spathodea campanulata</i>	African tulip tree, Panchot	1	13	10	good	fair	tree bowing, root flares intact, termite trails on trunk	NIL
6/6/2024	T0171	1.367076	103.747335	<i>Spathodea campanulata</i>	African tulip tree, Panchot	3	16	12	good	poor	several branch failures with decay and a lot of hanging dead branches. decayed wood close to tree base-suspected cavity indicated by ant nest. Multiple attachments at base.	Removal
6/6/2024	T0173	1.367053	103.747235	<i>Falcataria falcata</i>	Albizia, Kayu machis	2	20	20	good	poor	suspect tree has dead root flares or that it is growing on a dead tree	Removal
6/6/2024	T0174	1.366983	103.747253	<i>Spathodea campanulata</i>	African tulip tree, Panchot	2.2	20	12	good	fair	cavity of diameter 8cm on trunk facing south and 4m above ground. Codominant leaders with U-shape crotch. Root flares intact.	NIL
6/6/2024	T0175	1.366929	103.747353	<i>Spathodea campanulata</i>	African tulip tree, Panchot	1.2	18	10	good	good	heavy climber growth on canopy	NIL
6/6/2024	T0176	1.366987	103.747348	<i>Spathodea campanulata</i>	African tulip tree, Panchot	2.8	18	12	good	poor	low bifurcation with V-shaped crotch from 0.5m above ground. Some decayed wood near root flare	Removal

Date	Tag	Latitude	Longitude	Scientific.Name	Common.Name	Girth (m)	Height (m)	Canopy (m)	Health	Structure	Arborist Comments	Mitigation
6/6/2024	T0177	1.366972	103.747297	<i>Spathodea campanulata</i>	African tulip tree, Panchot	1.1	18	10	fair	fair	root flares intact, tree trunk bowing, low live crown ratio.	NIL
6/6/2024	T0180	1.367025	103.747489	<i>Spathodea campanulata</i>	African tulip tree, Panchot	1.8	17	12	fair	fair	root flares intact, heavy climber growth on canopy	NIL
6/6/2024	T0183	1.366972	103.747421	<i>Spathodea campanulata</i>	African tulip tree, Panchot	1	12	12	fair	fair	tree trunk bowing heavily. heavy climber growth on canopy	NIL
6/6/2024	T0184	1.366774	103.747267	<i>Cinnamomum iners</i>	Wild cinnamon, Clove cinnamon	1.2	12	12	good	fair	decay at previous peripheral branch failure wound.	NIL
6/6/2024	T0187	1.366817	103.747174	<i>Spathodea campanulata</i>	African tulip tree, Panchot	2.4	20	16	good	poor	cavity 10cm diameter 3m above ground facing northwest. codominant leaders with V-shape crotch forming pronounced included bark (elephant ear).	Removal
6/6/2024	T0188	1.366892	103.747087	<i>Spathodea campanulata</i>	African tulip tree, Panchot	2.8	18	12	good	poor	root flares intact. multiple attachments at 4m above ground. some dead branches at canopy.	Removal
6/6/2024	T0191	1.366915	103.747133	<i>Spathodea campanulata</i>	African tulip tree, Panchot	1.2	18	8	good	fair	root flares intact. low live crown ratio. tree in close proximity to T0190.	NIL
6/6/2024	T0192	1.366899	103.747115	<i>Spathodea campanulata</i>	African tulip tree, Panchot	1.2	20	10	good	fair	root flares intact. low live crown ratio	NIL

Date	Tag	Latitude	Longitude	Scientific.Name	Common.Name	Girth (m)	Height (m)	Canopy (m)	Health	Structure	Arborist Comments	Mitigation
6/6/2024	T0193	1.366966	103.747118	<i>Spathodea campanulata</i>	African tulip tree, Panchot	3	20	12	good	poor	multiple attachments at tree base. large decay at tree base with presence of honeybee nesting.	Removal
6/6/2024	T0194	1.36691	103.747193	<i>Spathodea campanulata</i>	African tulip tree, Panchot	2.2	20	18	good	fair	large girdling root. minor dead branches on crown.	NIL
6/6/2024	T0198	1.366714	103.746292	<i>Vitex pinnata</i>	Leban, Malayan teak	1.1	16	12	fair	poor	codominant leaders with V-shape crotch and included bark. large lateral branch bifurcating from trunk at 0.5m above ground.	NIL
6/27/2024	T0200	1.366754	103.746907	<i>Vitex pinnata</i>	Leban, Malayan teak	1	10	10	Good	Poor	Large cavity at tree base	Removal
3/20/2024	T0202	1.368198	103.749174	<i>Alstonia angustiloba</i>	Common pulai, Pulai	1.3	20	11	Good	Fair	Co dominant leaders, Dead branches	Deadwooding
3/20/2024	T0203	1.368192	103.749098	<i>Spathodea campanulata</i>	African tulip tree, Panchot	1	16	9	Fair	Poor	Dead branches, Snapped branches, Exposed deadwood	Removal
3/20/2024	T0204	1.368264	103.74907	<i>Ficus variegata</i>	Common red-stem fig, Variegated fig	1.1	16	9	Fair	Fair	Well defined trunk flare, Diebacks, Smothered by dead creepers, Slight asymmetrical	Crown balancing, Removal dead creepers
3/20/2024	T0205	1.368295	103.749051	<i>Dillenia suffruticosa</i>	Simpoh air, Simpoh air	2	4	10	Good	Fair	Nil	Crown thinning

Date	Tag	Latitude	Longitude	Scientific.Name	Common.Name	Girth (m)	Height (m)	Canopy (m)	Health	Structure	Arborist Comments	Mitigation
3/20/2024	T0206	1.368383	103.74895	<i>Ficus variegata</i>	Common red-stem fig, Variegated fig	2.2	18	11	Fair	Fair	Diebacks, Dense crown. To recommend reduce 25% of the crown	Crown reduction
3/20/2024	T0208	1.368571	103.748761	<i>Spathodea campanulata</i>	African tulip tree, Panchot	2	16	9	Fair	Poor	Multiple trunk attachments, Diebacks, Storm vulnerable	Removal
3/20/2024	T0209	1.36863	103.748711	<i>Spathodea campanulata</i>	African tulip tree, Panchot	1.6	14	8	Fair	Poor	Storm Vulnerable species , Growing on a slope edge	Removal
3/20/2024	T0210	1.368525	103.748438	<i>Adenanthera pavonina</i>	Saga, Coral bean tree	1.5	18	12	Fair	Fair	Bowing branches, Fused branches, Diebacks	Formative pruning
3/20/2024	T0211	1.368405	103.748186	<i>Dillenia suffruticosa</i>	Simpoh air, Simpoh air	1.2	7	10	Fair	Fair	Dead branches	NIL
3/20/2024	T0213	1.368419	103.748184	<i>Dillenia suffruticosa</i>	Simpoh air, Simpoh air	2.5	5	10	Fair	Fair	Fused branches	Crown thinning
3/20/2024	T0216	1.368264	103.748051	<i>Dillenia suffruticosa</i>	Simpoh air, Simpoh air	1	5	9	Fair	Fair	Fused branches. Previous branch failure with exposed deadwood	NIL
3/20/2024	T0218	1.368207	103.747898	<i>Dillenia suffruticosa</i>	Simpoh air, Simpoh air	1.1	6	8	Fair	Fair	Fused branches, Dead branches	Crown thinning and Deadwooding
3/20/2024	T0219	1.36812	103.747856	<i>Dillenia suffruticosa</i>	Simpoh air, Simpoh air	1.2	7	7	Fair	Fair	Fused branches, Previous failure with exposed deadwood	NIL
3/20/2024	T0220	1.368023	103.747826	<i>Arthropodium jackianum</i>		1	16	8	Fair	Fair	Tight trunk union	Removal
3/20/2024	T0221	1.368007	103.747807	<i>Dillenia suffruticosa</i>	Simpoh air, Simpoh air	1.2	7	6	Fair	Fair	Cluster of 9	NIL

Date	Tag	Latitude	Longitude	Scientific.Name	Common.Name	Girth (m)	Height (m)	Canopy (m)	Health	Structure	Arborist Comments	Mitigation
3/20/2024	T0222	1.367905	103.747744	<i>Ficus variegata</i>	Common red-stem fig, Variegated fig	1.3	15	NA	Fair	Poor	Tree already uprooted ( snapped at flare )	NIL
3/26/2024	T0228	1.367909	103.748108	<i>Macaranga conifera</i>		1.4	12	9	Good	Poor	Multiple attachments at tree base with included bark and many V shaped crotch, large decay at previous pruning cut	Removal
3/26/2024	T0230	1.367928	103.748114	<i>Macaranga conifera</i>		1	12	7	Good	Poor	Multiple attachments at tree base, likely forming from epicormic shoots of previous fallen tree	Removal
3/26/2024	T0234	1.367797	103.748036	<i>Dillenia suffruticosa</i>	Simpoh air, Simpuh air	1	3	8	Good	Fair	Multiple attachments at base	NIL
3/26/2024	T0235	1.367849	103.747898	<i>Falcataria falcata</i>	Albizia, Kayu machis	1.5	18	124	Fair	Poor	Codominant leaders with included bark, large open wounds on one of the leader	Removal
3/26/2024	T0237	1.367866	103.747892	<i>Ficus glandulifera</i>	Gaping fig	1.2	16	10	Good	Fair	Root flare intact, trunk slight lean with self correction	Retain
3/26/2024	T0239	1.367789	103.747876	<i>Ficus variegata</i>	Common red-stem fig, Variegated fig	4	18	16	Good	Fair	Well developed root flare	NIL
3/26/2024	T0248	1.367756	103.748413	<i>Macaranga conifera</i>		1.1	12	8	Good	Poor	Multiple attachments at base, heavy climber growth, exposed deadwood on one of the attachments	Removal

Date	Tag	Latitude	Longitude	Scientific.Name	Common.Name	Girth (m)	Height (m)	Canopy (m)	Health	Structure	Arborist Comments	Mitigation
3/26/2024	T0249	1.367817	103.748264	<i>Cinnamomum iners</i>	Wild cinnamon, Clove cinnamon	1.4	16	10	Fair	Fair	Multiple attachments on trunk at 8m height, heavy climber growth	NIL
3/26/2024	T0252	1.367765	103.748077	<i>Spathodea campanulata</i>	African tulip tree, Panchot	2	18	12	Good	Poor	Previous branch failure with cavity at 4m above ground, low bifurcation with V shaped crotch	Removal
3/26/2024	T0253	1.367715	103.747974	<i>Spathodea campanulata</i>	African tulip tree, Panchot	1.2	17	12	Good	Fair	Exposed deadwood on one root flare with strong wound wood growth, though the exposed deadwood might predispose tree to further decay	Removal
3/26/2024	T0254	1.367722	103.748002	<i>Spathodea campanulata</i>	African tulip tree, Panchot	1	16	10	Fair	Poor	Tree has large previous failure wound with suspected decay. Tree bowing slightly	Removal
3/26/2024	T0255	1.367451	103.747964	<i>Spathodea campanulata</i>	African tulip tree, Panchot	1	18	12	Good	Poor	Adventitious roots growing from a decay at tree base	Removal
3/26/2024	T0256	1.367517	103.747989	<i>Spathodea campanulata</i>	African tulip tree, Panchot	1.6	17	12	Good	Fair	Root flare intact, large epicomic shoots at tree base, large lateral branch forming U shaped crotch with trunk	NIL
3/26/2024	T0257	1.366857	103.746947	<i>Vitex pinnata</i>	Leban, Malayan teak	1	10	8	Good	Poor	Large decay at tree base	Removal
3/26/2024	T0258	1.366678	103.746453	<i>Cyrtophyllum fragrans</i>	Tembusu, Tembusu hutan	1	18	10	Good	Fair	Codominant leader with V-shaped crotch	NIL

Date	Tag	Latitude	Longitude	Scientific.Name	Common.Name	Girth (m)	Height (m)	Canopy (m)	Health	Structure	Arborist Comments	Mitigation
3/26/2024	T0260	1.36627	103.746543	<i>Acacia auriculiformis</i>	Acacia-tree, Earleaf acacia	2	16	8	Good	Poor	decay and large open cavity at tree base of trunk facing East	Removal
3/26/2024	T0261	1.366013	103.747086	<i>Samanea saman</i>	Rain tree, Pukulima	3.8	18	18	Good	Fair	codominant leaders with U-shaped crotch. root partially restricted by roadside drain. several big dead branches above footpath.	Deadwooding
3/26/2024	T0262	1.366051	103.746983	<i>Samanea saman</i>	Rain tree, Pukulima	4	20	20	Good	Fair	wasp nest 10m aboveground within a branch cavity, facing security kiosk. Root partially restricted by drain curb	Prune away branch with decay and wasp nest
3/26/2024	T0263	1.366013	103.746457	<i>Samanea saman</i>	Rain tree, Pukulima	3	16	18	Good	Fair	a few hanging dead branches over carpark. Severely restricted root zone. Multiple attachments at 3m aboveground.	Deadwooding
3/26/2024	T0264	1.365987	103.746324	<i>Samanea saman</i>	Rain tree, Pukulima	3	18	16	Fair	Fair	Large hanging dead branch above carpark area, Highly restricted root zone by carpark kerb and drain	NIL

Date	Tag	Latitude	Longitude	Scientific.Name	Common.Name	Girth (m)	Height (m)	Canopy (m)	Health	Structure	Arborist Comments	Mitigation
3/26/2024	T0265	1.366013	103.746078	<i>Samanea saman</i>	Rain tree, Pukulima	4.5	20	20	Good	Fair	Heavy epiphytes with ficus, multiple attachments, ants nest at root flares indicating potential cavity, dead and hanging branches, Restricted root zone by drain	Deadwooding
3/26/2024	T0266	1.366113	103.746204	<i>Samanea saman</i>	Rain tree, Pukulima	4.5	18	16	Fair	Poor	Restricted root zone by roadside kerb and drain, multiple attachments where two scaffold branches crossing, poor taper, poor live crown ratio, open decay at previous branch failure wound with cavity	NIL
3/26/2024	T0267	1.366168	103.74632	<i>Samanea saman</i>	Rain tree, Pukulima	4.3	18	18	Fair	Poor	Severely restricted root zone by roadside curb. Dead stump above carpark lot. Codominant leader with U-shaped crotch.	Deadwooding
6/27/2024	T0274	1.366646	103.746132	<i>Ficus variegata</i>	Common red-stem fig, Variegated fig	2	18	15	Good	Good	Root flare intact	NIL
6/27/2024	T0275	1.366688	103.746184	<i>Litsea elliptica</i>	Medang, Perawas	1.1	20	14	Good	Good	Root flare intact	NIL
6/27/2024	T0284	1.366523	103.746136	<i>Cinnamomum iners</i>	Wild cinnamon, Clove cinnamon	1.2	16	12	Good	Fair	Root flare intact. Tree leaning slightly but tension root was observed. Epicormic shoots at tree base.	NIL

Date	Tag	Latitude	Longitude	Scientific.Name	Common.Name	Girth (m)	Height (m)	Canopy (m)	Health	Structure	Arborist Comments	Mitigation
6/27/2024	T0285	1.366548	103.746097	<i>Syzygium polyanthum</i>	Indonesian bayleaf, Salam	1.3	18	14	Good	Poor	Multiple attachments from 7m above ground with wasp nest suggesting cavity presence.	Removal
6/27/2024	T0286	1.366647	103.746135	<i>Terminalia catappa</i>	Sea almond, Ketapang	1	18	12	Fair	Poor	Tree leaning slightly but root flare well developed	NIL
6/27/2024	T0287	1.366529	103.746007	<i>Dillenia suffruticosa</i>	Simpoh air, Simpuh air	1.5	9	8	Good	Fair	Multiple attachments at base. High live crown ratio	NIL
6/27/2024	T0289	1.366496	103.745946	<i>Spathodea campanulata</i>	African tulip tree, Panchot	1.6	16	14	Good	Fair	Root flare intact. Codominant leader with U-shaped crotch. Dead branch on canopy.	NIL
6/27/2024	T0291	1.366317	103.745841	<i>Falcataria falcata</i>	Albizia, Kayu machis	2	18	18	Good	Poor	Cavity at 2m height with 10cm diameter, at least 20cm deep, facing northwest. Bifurcation with U-shaped crotch. Root flare well developed.	Removal
6/27/2024	T0293	1.366397	103.746031	<i>Terminalia catappa</i>	Sea almond, Ketapang	2.2	20	16	Good	Fair	Root flare generally well developed though many have mechanical injury. Tree leaning with self-correction	NIL
6/27/2024	T0294	1.366339	103.746056	<i>Aphanamixis polystachya</i>	Pasak lingga, Amora	1	18	12	Good	Fair	Tree bowing due to phototropism	NIL
6/27/2024	T0296	1.36645	103.746135	<i>Macaranga gigantea</i>	Mahang gajah, Elephant's ear tree	1.1	16	15	Good	Good	Tree in good condition	NIL
6/27/2024	T0297	1.366594	103.746315	<i>Ficus benamina</i>	Weeping fig, Java willow	5	14	20	Good	Poor	Previous failure wounds at 3m and 5m aboveground	Removal

Date	Tag	Latitude	Longitude	Scientific.Name	Common.Name	Girth (m)	Height (m)	Canopy (m)	Health	Structure	Arborist Comments	Mitigation
6/27/2024	T0298	1.366495	103.746353	<i>Spathodea campanulata</i>	African tulip tree, Panchot	1.3	15	10	Good	Poor	Tree has low branching which bends towards the ground. Tree trunk bowing followed by corrected lean.	Removal
6/27/2024	T0299	1.366474	103.746307	<i>Cinnamomum iners</i>	Wild cinnamon, Clove cinnamon	1	14	10	Good	Good	Tree in good condition, slight minor lean	NIL
6/27/2024	T0300	1.366424	103.74628	<i>Syzygium cerasiforme</i>	Common kelat, Gelam tikus	1	12	12	Poor	Fair	Canopy overgrown with <i>Uncaria acida</i> climbers. Some cross branching	NIL
6/27/2024	T0301	1.366308	103.746136	<i>Spathodea campanulata</i>	African tulip tree, Panchot	1.1	5	10	Good	Poor	Tree has uprooted and rested on ground	Removal
6/27/2024	T0302	1.366296	103.746084	<i>Spathodea campanulata</i>	African tulip tree, Panchot	1.3	16	12	Good	Fair	Asymmetrical crown, root flare intact, bifurcation forming U-shaped crotch	NIL
6/27/2024	T0303	1.366304	103.745982	<i>Spathodea campanulata</i>	African tulip tree, Panchot	5	20	12	Good	Poor	Multiple attachments at base with unusual prop root-like growth. Large decay at tree base measuring 30cm in size	Removal
6/27/2024	T0304	1.366254	103.746059	<i>Spathodea campanulata</i>	African tulip tree, Panchot	5	20	24	Good	Poor	Multiple attachments at base, root flare generally okay. Some open wounds on trunk	Removal
7/4/2024	T0309	1.36679	103.746488	<i>Alstonia angustiloba</i>	Common pulai, Pulai	2.5	18	14	Good	Poor	Thick level of debris at the root zone obstructing assessment. Tree has good vigour. Multiple attachments at 12m above ground.	NIL

Date	Tag	Latitude	Longitude	Scientific.Name	Common.Name	Girth (m)	Height (m)	Canopy (m)	Health	Structure	Arborist Comments	Mitigation
7/4/2024	T0310	1.366735	103.746471	<i>Cyrtophyllum fragrans</i>	Tembusu, Tembusu hutan	3	18	12	Good	Poor	Co-dominant leaders with V-shaped crotch near tree base with pronounced included bark protruding roughly 15cm from the bifurcation. Some dead twigs on crown.	Removal
7/4/2024	T0312	1.366613	103.746464	<i>Cyrtophyllum fragrans</i>	Tembusu, Tembusu hutan	1	16	6	Fair	Fair	Tree has low live crown ratio. Large wound wood reponse near tree base implying large previous injury.	NIL
7/4/2024	T0313	1.366589	103.746463	<i>Cyrtophyllum fragrans</i>	Tembusu, Tembusu hutan	1	14	10	Good	Poor	Large cavity at tree base. Tree leaning with a bow at 4m above ground, followed by self-correction. Some dead branches observed.	Removal
7/4/2024	T0314	1.366701	103.746474	<i>Triadica cochinchinensis</i>	Mouse deer's delight	1	18	10	Good	Fair	Tree has slight bowing followed by self-correction	NIL
7/4/2024	T0316	1.366822	103.746649	<i>Elaeis guineensis</i>	Oil palm, Macaw fat	3	14	10	Good	Fair	Spear is healthy. Stem covered by multiple dead frond petiole.	NIL
7/4/2024	T0317	1.366755	103.746666	<i>Spathodea campanulata</i>	African tulip tree, Panchot	1.4	12	12	Good	Poor	Tree leaning with well-developed root flare and large tension root. Large previous failure wound at 2m and 4m above ground with cavities that are likely to be connected. Asymmetrical crown.	Removal

Date	Tag	Latitude	Longitude	Scientific.Name	Common.Name	Girth (m)	Height (m)	Canopy (m)	Health	Structure	Arborist Comments	Mitigation
7/4/2024	T0319	1.366703	103.746585	<i>Syzygium grande</i>	Sea apple, Jambu laut	1	18	10	Fair	Fair	Root flare intact. Tree crown and trunk covered by heavy climber growth, obstructing assessment.	NIL
7/4/2024	T0320	1.366858	103.746712	<i>Spathodea campanulata</i>	African tulip tree, Panchot	1.2	16	10	Fair	Fair	Root flare intact. Co-dominant leaders with U-shaped crotch. Overgrown climber growth on crown	NIL
7/4/2024	T0321	1.366884	103.746777	<i>Spathodea campanulata</i>	African tulip tree, Panchot	1.8	16	8	Fair	Poor	Root flare intact. Trunk leaning with self-correction. Canopy overgrown with climbers. Downward angling branch that may indicate partial failure.	Removal
7/4/2024	T0322	1.366985	103.746778	<i>Spathodea campanulata</i>	African tulip tree, Panchot	1.2	12	8	Fair	Poor	Previous large failure wound at 4m above ground. Strongly fluted bark formation at tree base which suggests a wound that has been compartmentalised completely. Tree has heavy lean.	Removal
7/4/2024	T0323	1.36686	103.746949	<i>Spathodea campanulata</i>	African tulip tree, Panchot	1	10	8	Poor	Poor	Low bifurcation on ground. Very low live crown ratio for main stem.	Removal
7/4/2024	T0324	1.366109	103.747393	<i>Spathodea campanulata</i>	African tulip tree, Panchot	4	12	14	Good	Poor	Multiple attachments at base resulting in failure at tree base. Multiple dead branches above footpath.	Removal

Date	Tag	Latitude	Longitude	Scientific.Name	Common.Name	Girth (m)	Height (m)	Canopy (m)	Health	Structure	Arborist Comments	Mitigation
7/4/2024	T0325	1.366086	103.747262	<i>Spathodea campanulata</i>	African tulip tree, Panchot	1	14	8	Good	Poor	Previous failure wounds at 0.5m above ground with some incipient decay	Removal
7/4/2024	T0326	1.36622	103.747246	<i>Spathodea campanulata</i>	African tulip tree, Panchot	1.1	16	12	Good	Good	Root flare intact, slight bowing on trunk with self correction	NIL
7/4/2024	T0327	1.36642	103.747265	<i>Cinnamomum iners</i>	Wild cinnamon, Clove cinnamon	1.1	10	10	Good	Fair	Tree leaning with well developed root flare. Some dead branches and decay on one of the lateral branch	NIL
7/4/2024	T0328	1.366335	103.747284	<i>Claoxylon indicum</i>	Laping budak, Jarak kayu	1	12	5	Fair	Poor	One of the codominant leaders has failed 7m from ground, unusual trunk taper due to multiple burl growth	Removal
7/4/2024	T0329	1.366399	103.747252	<i>Falcataria falcata</i>	Albizia, Kayu machis	4	22	20	Good	Poor	Fruiting bodies on tree base. Codominant leaders with elephant ear.	Removal
7/4/2024	T0330	1.366361	103.747337	<i>Spathodea campanulata</i>	African tulip tree, Panchot	1	18	7	Fair	Fair	Root flare intact. Dead branches. Low live crown ratio	NIL
7/4/2024	T0331	1.366447	103.747377	<i>Spathodea campanulata</i>	African tulip tree, Panchot	1.2	20	10	Fair	Fair	Root flare intact, low live crown ratio, several dead twigs. Leaves slightly chlorotic	NIL
7/4/2024	T0332	1.366459	103.747328	<i>Spathodea campanulata</i>	African tulip tree, Panchot	1	18	9	Good	Fair	Root flare intact, bowing slight, small dead branches	NIL
7/4/2024	T0333	1.36647	103.747285	<i>Spathodea campanulata</i>	African tulip tree, Panchot	1.2	18	8	Fair	Poor	Large area of decay at tree base. Multiple dead branches on canopy.	Removal

Date	Tag	Latitude	Longitude	Scientific.Name	Common.Name	Girth (m)	Height (m)	Canopy (m)	Health	Structure	Arborist Comments	Mitigation
7/4/2024	T0334	1.366483	103.74722	<i>Cinnamomum iners</i>	Wild cinnamon, Clove cinnamon	2	12	12	Good	Poor	Multiple attachments at base, open decay on one of the attachments. Asymmetrical crown.	Removal
7/4/2024	T0335	1.366546	103.74728	<i>Falcataria falcata</i>	Albizia, Kayu machis	5	22	22	Good	Poor	Multiple attachments at base with suspected cavity. Some dead branches on crown. Multiple mechanical injuries on tree branch	Removal
7/4/2024	T0336	1.366509	103.747371	<i>Ficus vasculosa</i>	White fig, Aransi	1	20	10	Good	Good	Tree has good structure and health with multiple fauna present feeding on figs	Retain
7/4/2024	T0338	1.366514	103.74744	<i>Spathodea campanulata</i>	African tulip tree, Panchot	2	16	10	Fair	Poor	Root flare intact, large lateral branch bifurcate from tree base	NIL
7/4/2024	T0339	1.366564	103.747367	<i>Spathodea campanulata</i>	African tulip tree, Panchot	1.2	20	10	Good	Poor	Small cavity on trunk likely due to previous branch failure.	Removal
7/4/2024	T0340	1.366592	103.747333	<i>Spathodea campanulata</i>	African tulip tree, Panchot	1	18	8	Fair	Good	Root flare intact, some minor dead twigs on crown	NIL
7/4/2024	T0341	1.36664	103.747371	<i>Spathodea campanulata</i>	African tulip tree, Panchot	1.2	16	10	Fair	Poor	Root flare intact. Heavy climber growth. Codominant leader with V-shaped crotch, included bark.	Removal
7/4/2024	T0342	1.366667	103.74734	<i>Spathodea campanulata</i>	African tulip tree, Panchot	2.5	22	16	Good	Poor	Cavity and open decay on trunk	Removal
7/4/2024	T0343	1.366731	103.74738	<i>Spathodea campanulata</i>	African tulip tree, Panchot	1.2	16	14	Good	Poor	Large previous failure wound	Removal

Date	Tag	Latitude	Longitude	Scientific.Name	Common.Name	Girth (m)	Height (m)	Canopy (m)	Health	Structure	Arborist Comments	Mitigation
7/4/2024	T0344	1.366738	103.747224	<i>Spathodea campanulata</i>	African tulip tree, Panchot	2.2	16	14	Good	Poor	Large lateral branch bifurcating from trunk 1m above ground. some dead trees on canopy	Removal
7/4/2024	T0345	1.366682	103.747255	<i>Spathodea campanulata</i>	African tulip tree, Panchot	1	16	12	Fair	Fair	Codominant leader with U-shaped crotch	NIL
7/4/2024	T0346	1.366625	103.747275	<i>Spathodea campanulata</i>	African tulip tree, Panchot	1.2	18	12	Fair	Fair	Heavy climber growth on canopy. Girdling roots.	NIL
7/4/2024	T0347	1.366597	103.747253	<i>Spathodea campanulata</i>	African tulip tree, Panchot	1.4	12	12	Good	Poor	Multiple attachments at tree base with decay. Main trunk leaning. Multiple dead branches at canopy.	Removal
7/4/2024	T0348	1.366571	103.747436	<i>Spathodea campanulata</i>	African tulip tree, Panchot	1	15	10	Good	Fair	NA	NIL
7/4/2024	T0349	1.366174	103.747424	<i>Syzygium polyanthum</i>	Indonesian bayleaf, Salam	1	16	12	Fair	Fair	Heavy climbers on crown	NIL
7/4/2024	T0350	1.36621	103.747395	<i>Spathodea campanulata</i>	African tulip tree, Panchot	1	12	8	Fair	Poor	Multiple cavities at trunk and tree base	Removal
7/4/2024	T0351	1.366208	103.747376	<i>Spathodea campanulata</i>	African tulip tree, Panchot	1.4	10	8	Fair	Poor	Multiple attachments with biggest trunk 0.6m girth	Removal