

The top half of the cover features a photograph of a lush tropical forest. Large, ancient-looking trees with thick trunks and dense green foliage dominate the scene. Sunlight filters through the canopy, creating dappled light on the ground. In the foreground, there is a grassy clearing with some ferns and other tropical plants.

Specialist Consultancy Services for Environmental Impact Assessment (EIA) for Redevelopment of the Former Turf Club at Bukit Timah

Final Report

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<u>Prepared by</u>	<u>Checked by</u>	<u>Verified by</u>	<u>Approved by</u>
AECOM Environment Team*	Dr. Liang Liang (Project Manager) Derek Yap (Biodiversity Team Lead)	Dr. Liang Liang (Project Manager)	Jagriti Dawra (Project Director)

*Note: the AECOM Environment Team include Hanisah Binte Sukarji, Jaypee Bautista, Samuel Neo, Hanzel Lalitan, Leela Guvvala, Tiffany Tan, Kameshwari Ravi, Shayok Ghosh, and Biodiversity Specialist Team (including Sheryl Seet, Sherry Hung and Wan Ting Chan).

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Distribution List

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Prepared for:

Urban Redevelopment Authority
45 Maxwell Road
The URA Centre
Singapore, 069118

Prepared by:

AECOM Singapore Pte Ltd
300 Beach Road, #23-00
The Concourse
Singapore, 199555
aecom.com

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List of Acronyms

Acronym	Definition
ABC	Active, Beautiful, Clean
ACMV	Air Conditioning and Mechanical Ventilation
AECOM	AECOM Singapore Pte. Ltd.
AHU	Air Handling Unit
ALAN	Artificial lighting at night
ALARP	As Low As Reasonably Practicable
APCP	Air Pollution Control Plan
APHA	American Public Health Association
ASEAN	Association of Southeast Asian Nations
ASR	Air sensitive receptors
BAT	Best Available Technology
BCA	Building Construction Authority
BEP	Best Environmental Practice
BIA	Biodiversity Impact Assessment
BOD₅	Biochemical Oxygen Demand
BS	British Standard
BTNR	Bukit Timah Nature Reserve
BTO	Build to order
CAD	Computer-Aided Design
CBD	Central Business District
CCNR	Central Catchment Nature Reserve
CCS	Central Control System
CCTV	Closed-Circuit Television
CFU	Colony Forming Units
CITES	Convention on International Trade in Endangered Species
COD	Chemical Oxygen Demand
COPC	Chemicals of Potential Concern
COP	Code of Practice
COPPC	Code of Practice for Pollution Control
CRL2	Cross Island Line Phase 2
CS	Conservation Significance
CT	Contractor
CUGE	Centre for Urban Greenery and Ecology
CVES	Commercial Vehicle Emissions Scheme
CVPA	Control of Vector and Pesticide Act
DBP	Dibutylphthalate
DDD	Dichlorodiphenyldichloroethane
DDE	Dichlorodiphenyldichloroethylene
DDT	Dichlorodiphenyltrichloroethane
DEHP	Di(2-ethylhexyl)phthalate
DGPS	Differential Global Positioning System
DIV	Dutch Intervention Values
DO	Dissolved Oxygen
DOE	Department of Environment
EBS	Environmental Baseline Study
ECB	Erosion Control Blankets
ECM	Earth Control Measures
ECO	Environmental Control Officer
ECP	Erosion Control Plan
EEAI	EV Early Adoptive Incentive
EHS	Environmental, Health and Safety
EIA	Environmental Impact Assessment
EIS	Environmental Impact Study

Acronym	Definition
EMMP	Environmental Management and Monitoring Plan
cEMMP	Contract-Specific EMMP
EPM	Environmental Protection and Management
ERSS	Earth Retaining and Stabilising Structures
ERT	Emergency Response Team
ESA	Environmental Site Assessment
EU	European Union
EV	Electric Vehicle
GIS	Geographic Information System
GPS	Global Positioning System
HASP	Health and Safety Plan
HCH	Hexachlorocyclohexane
HDV	Heavy Duty Vehicle
HK EIAO TM	Hong Kong Environmental Impact Assessment Ordinance - Technical Memorandum
IAQM	Institute of Air Quality Management
ICE	Internal Combustion Engine
ISA	International Society of Arboriculture
IUCN	International Union for the Conservation of Nature
JTC	Jurong Town Corporation
LCV	Light Commercial Vehicle
LOR	Limit of Reporting
LTA	Land Transport Authority, Singapore
MEP	Mechanical / Electrical / Plumbing
MND	Ministry of National Development
MRT	Mass Rapid Transit
MSDS	Material Safety Data Sheet
mSHD	Horizontal Deviation
MSS	Meteorological Service Singapore
NA	Not Applicable
NAAQS	National Ambient Air Quality Standards
NAS	National Archives of Singapore
NBSAP	National Biodiversity Strategy and Action Plan
NEA	National Environment Agency, Singapore
NG	Nature Group
NIA	Noise Impact Assessment
NMDS	Non-Metric Multidimensional Scaling
NParks	National Parks Board, Singapore
NSR	Noise Sensitive Receptor
NSS	Nature Society (Singapore)
NSSF	Nee Soon Swamp Forest
NTU	Nephelometric Turbidity Unit
NUS	National University of Singapore
NUSLHMSG	NUS Libraries Historical Maps of Singapore
PAH	Polycyclic / Polynuclear Aromatic Hydrocarbon
PCO	Pest Control Operator
PCP	Professional Certification Programme
PERMANOVA	Permutational Multivariate Analysis of Variance
PHILMINAQ	Philippines Mitigating Impact from Aquaculture
PID	Photoionization Detector
PIE	Pan Island Expressway
PM	Particulate Matter
PME	Powered Mechanical Equipment
POC	Potential of Contamination
PRO	Public Relations Officer
PSI	Pollution Standard Index
PUB	Public Utilities Board, Singapore

Acronym	Definition
QP	Qualified Professionals
QECPP	Qualified Erosion Control Professional
RAC	Recommended Area of Conservation
RTO	Resident Technical Officer
RWH	Restricted Working Hours
SAC	Special Area of Conservation
SAC	Singapore Accreditation Council
SCDF	Singapore Civil Defence Force
SDS	Safety Data Sheet
SHE	Safety, Health and Environment
SIDS	Silty Imagery Detection System
SING	Singapore Botanic Gardens' Herbarium
SINGLAS	Singapore Laboratory Accreditation Scheme
SLM	Sound Level Meter
SO	Superintending Officer
SOP	Standard Operation Procedure
SPL	Sound Power Level
SPA	Special Protection Area
SRDB	Singapore Red List Data Base
SS	Singapore Standards
STATS	Specialist Testing and Technical Services Asia Pacific Pte Ltd
STC	Sound Transmission Class
SWL	Stabilised Water Level
TAN	Total Ammonia Nitrogen
TAQMMS	Telemetric Air Quality Monitoring and Management System
TDS	Total Dissolved Solids
TIW	Toxic Industrial Waste
TN	Total Nitrogen
TNIA	Traffic Noise Impact Assessment
TOC	Total Organic Carbon
TP	Total Phosphorus
TPH	Total Petroleum Hydrocarbons
TPZ	Tree Protection Zones
TSS	Total Suspended Solids
UHI	Urban Heat Island
UK	United Kingdom
UNECE	United Nations Economic Commission for Europe
URA	Urban Redevelopment Authority, Singapore
US	United States of America
USCS	Unified Soil Classification System
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
VOC	Volatile Organic Compound
WHO	World Health Organisation
WSHO	Workplace Safety and Health Officer
WSQ	Workplace Skills Qualifications

1 Executive Summary

AECOM Singapore Pte Ltd was appointed by Urban Redevelopment Authority (URA) to carry out the *Environmental Baseline Study (EBS) and Environmental Impact Assessment (EIA) for Former Turf Club at Bukit Timah*. The Study Area, located in central region of Singapore, has an area of approximately 193 hectares (ha), including the Project Site area which is approximately 176.4ha and adjacent vegetated areas outside of the Project Site. The Project Site has been mainly zoned for “Residential”, with some supporting amenities. Ecologically rich patches of forests such as Eng Neo Avenue Forest and Bukit Tinggi sit within the site. Additionally, the site is located adjacent to Central Catchment Nature Reserve (CCNR) and Bukit Timah Nature Reserve (BTNR), making it a potential ecological connectivity corridor.

With the current proposed developments within the Study Area, there is a need to: (1) understand the baseline ecological and environmental conditions of the Site; (2) assess potential impacts on the local biodiversity and environment associated with and/or caused by the Project during both construction and operational phases; (3) recommend mitigation measures to safeguard the existing ecological and avian connectivity, and incorporate them into the future development; and (4) to develop an Environmental Monitoring and Management Plan (EMMP).

Environmental Baseline Findings

Baseline studies on biodiversity, hydrology and water quality, soil and groundwater, air quality and airborne noise were conducted for the Study Area, and a summary of the findings is provided below. More information can be obtained from Sections 7, 8, 9, 10 and 11 of the report, respectively.

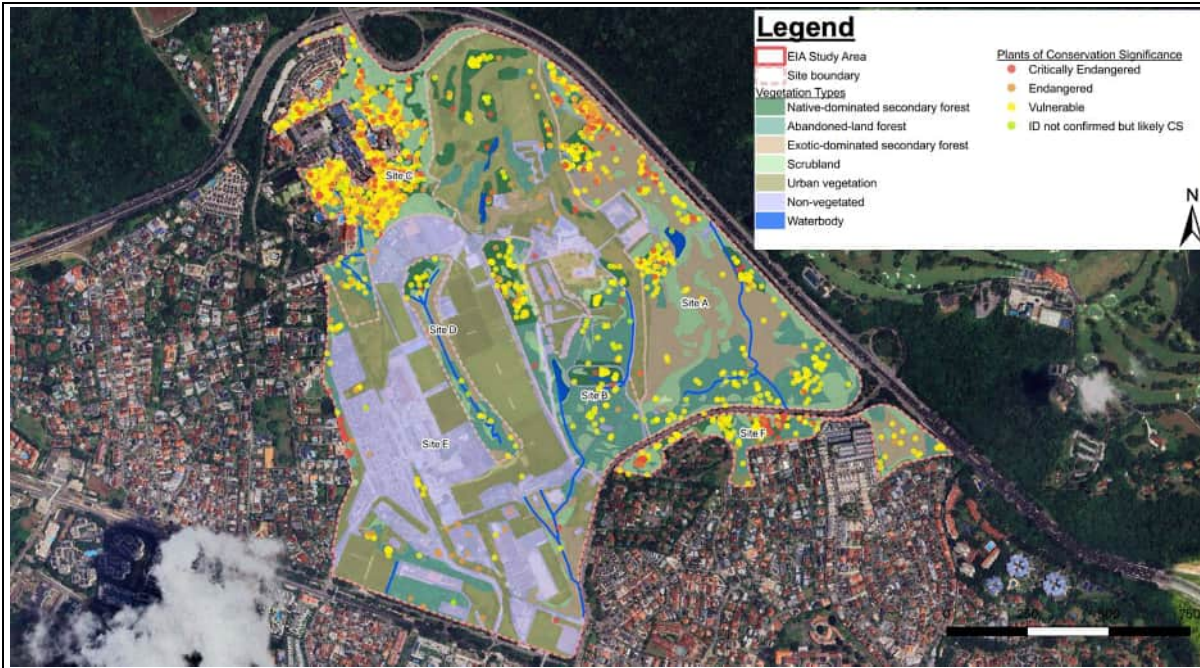


Figure 1-1 Distribution of habitats, vegetation, plant specimens of conservation significance

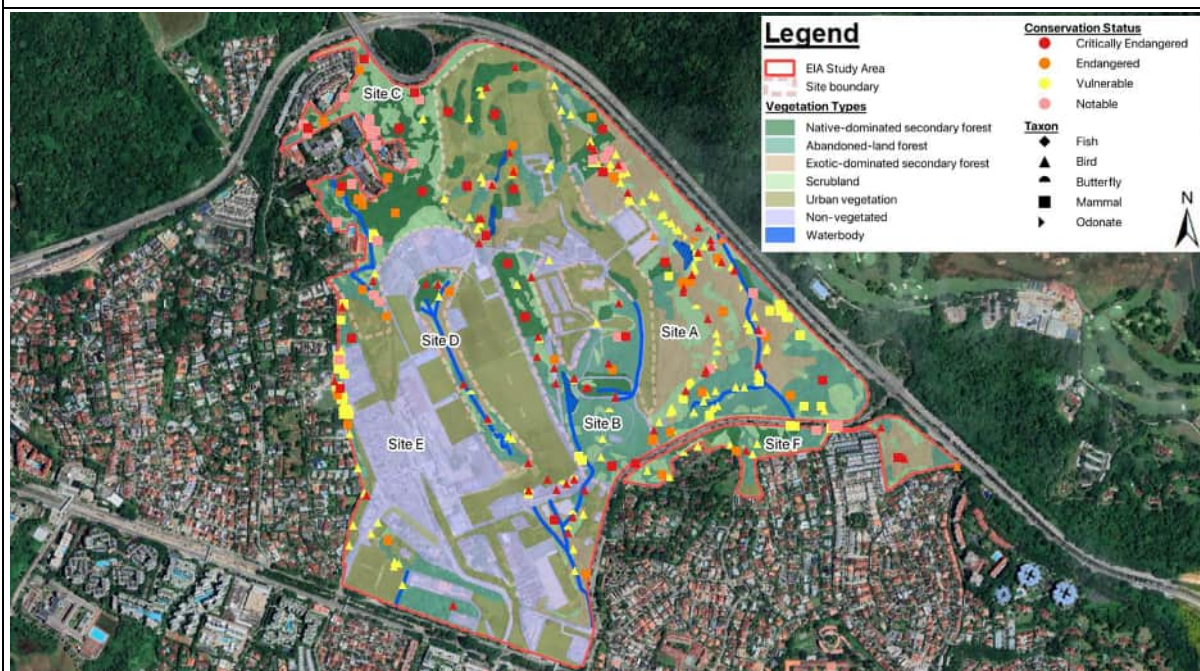


Figure 1-2 Distribution of terrestrial fauna of conservation significance

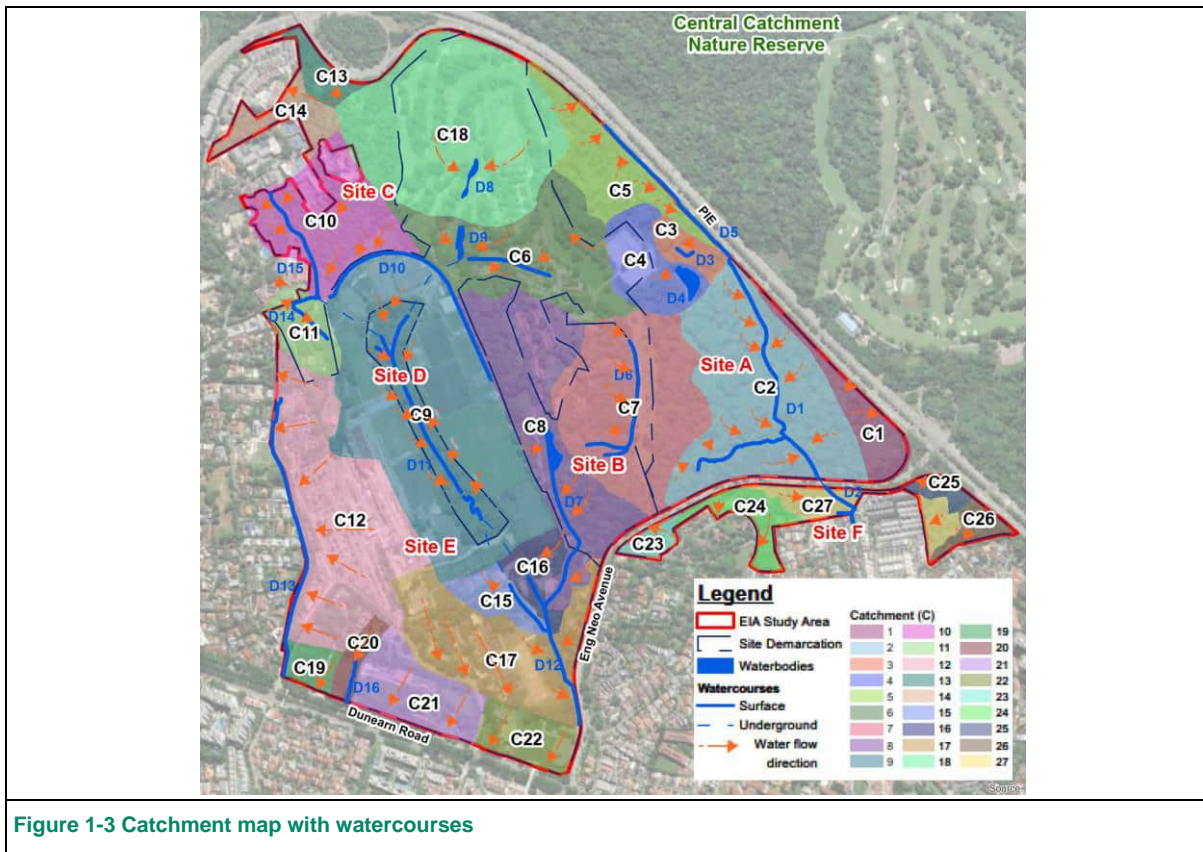


Figure 1-3 Catchment map with watercourses

- Study Area Division** (see Figure 1-1) – The Study Area is divided into six (6) Sites based on the past studies conducted in the area. Site A is largely made of Eng Neo Avenue Forest, Site B covers the forested areas adjacent to Fairways Quarters, Site C comprises of the forest adjacent to British club and Swiss club, also known as Bukit Tinggi, Site D is represented by the forested area within Racecourse Oval, Site E comprises of most of the urbanised area in the study area and some vegetated areas and lastly, Site F includes the forest adjacent to Linden Drive.
- Habitats and Vegetation Distribution** (see Figure 1-1) – The Study Area is largely non-vegetated and/or occupied by urban vegetation. These comprise more than 50% of the total area. One of the key findings from the present Study is the rich and diverse native-dominated secondary forest. The largest continuous patch was recorded in Site C, but scattered fragments of equally diverse native patches were also recorded in all other sites. Altogether, native forest makes up close to 10% of the total area. The other habitat types recorded in the Study Area are abandoned-land forest, exotic-dominated secondary forest, scrubland, and waterbodies.
- Biodiversity Flora** (see Figure 1-1) – A total of 646 plant species was recorded, of which 177 are species of conservation significance. Many plant species recorded in the native patches can also be found in the Central Catchment Nature Reserve (CCNR) and are less commonly encountered in other disturbed secondary forests outside the nature reserves in Singapore. Some plant species associated with older forests and are rare even in the Nee Soon Swamp Forest (NSSF) were recorded in the Study Area. This has contributed to the high overall native species richness, a feature characteristic of late-successional forests in Singapore. Nationally threatened species are widespread and occur in high numbers, and large parent trees also occur in the forested areas. While most plants of conservation significance were concentrated in the native fragments, several specimens were also recorded in the adjacent abandoned-land and exotic-dominated secondary forests, a positive indication that native propagules are dispersing into latter.
- Biodiversity Fauna** (see Figure 1-2) – Field survey from 2019 to 2024 documented 407 fauna species, dominated by birds (111 species) and butterflies (101 species). Species of conservation significance are distributed across the Sites, including the globally threatened straw-headed bulbul (*Pycnonotus zeylanicus*) and Sunda pangolin (*Manis javanica*). In total 25 fauna species of conservation significance was recorded. Both species was found across the Study Area, and the Sunda Pangolin (*Manis javanica*) showed signs of breeding activity. A higher number of species of conservation significance were found in Site A likely due to its size and intact natural habitats. It is also noteworthy that Site A is a hotspot for the fiery coral-tail (*Ceragrion chaoi*), which were found in relatively high densities than commonly observed in other sites in Singapore. Site

C recorded the highest number of Sunda colugo (*Galeopterus variegatus*) sighting (15 recorded), making it a colugo stronghold of the Former Turf Club area. Overall, the Study Area's proximity to the BTNR and CCNR, and the presence of good habitat, there is a high chance of expecting rare fauna species here.

- **Hydrological Conditions** (see Figure 1-3) – Twenty-seven (27) water catchment areas and sixteen (16) watercourses/bodies were identified within the Study Area. Three separate catchments contribute to ponds D4, D8 and D9. One main natural stream (D1) lies in Site A, and is served by roadside drain D5 and earth drain D3, both of which have ephemeral flow. The water from the natural stream in Site A flows via an underground culvert into the canal in Site F (D2). In Site B, one roadside drain (D6) and one naturalised stream D7 is identified. The naturalised stream D7 flows out of Site B into Site E, and merges with naturalised stream D12-B, which together with naturalised stream D12-A are tributaries of naturalised stream D12. The water in D12 flows out of the Site along Eng Neo Avenue. One naturalised stream D15 and one earth cum concrete drain D14 flows in Site C. They merge before flowing out via an underground structure. The ravine of Site D is served by one man-made earth drain, which flows southwards. Other watercourses in Site E include a concrete drain D13, which collects runoff from the urban vicinity including the Grandstand, a naturalised stream D16 which has a small catchment, and an ephemeral roadside drain D10 along Turf Club Road.
- **Surface Water Quality** – Thirty-five (35) sampling stations were identified for the Study Area. Site A has overall good water quality, although phosphorus content normally exceeds the international aquatic life criteria. Aluminium, iron and manganese occasionally exceeds but are common exceedances and likely due to natural sources from the soil. Unmanaged pond D4 notably has very low dissolved oxygen (DO) and high total organic carbon (TOC), and is likely due to the decomposing organic matter within the pond. In Site B, roadside drain D6 has good water quality, but naturalised stream D7 has poorer water quality. DO is low in D7 due to stagnation, especially in dry weather. Orange films, presumably iron bacteria, are visible in multiple locations along D7, which causes high turbidity. Upstream of D7 also recorded arsenic exceedance in dry weather, likely due to anthropogenic sources nearby. Site C has relatively good water quality in dry weather, although low DO and high iron is recorded at earth drain D14. In wet weather, water quality is poorer with copper, nickel and lead exceedances recorded, and may be from the urban infrastructure nearby. Aluminium and iron exceedances were detected in some locations in Site C, but are likely due to natural leaching from soil. Water quality in Site D is generally good in dry weather. In wet weather, high sediment runoff from the steep slopes of the ravine causes high TSS. Water quality in Site E varies with different watercourses. Aluminium and iron exceeds at some of the locations but are likely due to natural leaching from soil. Phosphate is high throughout the site except for the golf course ponds (D8 and D9) and the roadside drains (D10 and D13). Consequently, some locations with high phosphate have high total phosphorus. DO is low at predominantly stagnant locations, especially in dry weather. The waters in Site F are clear but record exceedance of arsenic in both dry and wet weather, along with iron and phosphate. Aluminium only exceeds in dry weather.
- **Soil and Groundwater Quality** – Nine (9) soil samples were collected from three (3) boreholes advanced in Site A and Site E. The soil profile generally consisted of clayey silt with layers of silt and silty sand. The soil samples were analysed for parameters listed in the Dutch Environmental Guidelines Soil Remediation Circular as well as for sulphides. The laboratory analytical results reported metals, total petroleum hydrocarbons (TPH), fluoranthene and phthalates (dibutylphthalate and di(2-ethylhexyl)phthalate) above the laboratory reporting limits. None of the soil detections exceeded the Dutch Intervention Values (DIV). Groundwater was encountered during advancement of the boreholes but no sample was collected. Information on groundwater quality was obtained from a previous environmental report [R-2, R-4], which reported detections of metals and TPH. Groundwater collected from two pre-existing monitoring wells exceeded the DIV. The sources of the detected analytes could not be conclusively ascertained, as they can be due to historic anthropogenic activities or of background levels (in case of metals).
- **Air Quality** – Baseline air quality monitoring included primary baseline monitoring and secondary data from previous EIS Study for LTA [R-4]. Air Monitoring was conducted at a total of twelve (12) representative locations for Site A – F. All measured pollutant concentrations were well below the Singapore Ambient Air Quality Long Term Targets for both PM₁₀ and PM_{2.5} except for the maximum concentration of 24-hour average PM_{2.5} at AQ01, AQ04, AQ05 and AQ07 exceeded the Singapore Ambient Air Quality Long Term Targets. Overall, the baseline air quality within the Sites A, B, C and D is of good quality as there is no major air pollution sources and exceedances found within the Sites A, B, C and D. Whereas, the baseline air quality within Sites E and F are relatively good, with exceedance at some monitoring locations (AQ01, AQ04, AQ05, AQ07).

- Airborne Noise** – Baseline monitoring was carried out at eleven (11) locations within the Study Area. By integrating the noise measurements from previous studies [R-2,R-3,R-4], the baseline noise levels within the Project Site were established. In Site E, monitoring points NN01 and NN05 exhibited noise levels exceeding 60 dB(A), whereas other locations (NN02, NN04, and NN08) showed noise levels less than 60 dB(A). NN01 experienced elevated noise levels due to heavy traffic on the PIE, while NN05 was impacted by traffic from Dunearn Road, Bukit Timah, and Eng Neo Avenue. For Site A, monitoring location NM02 recorded noise levels above 60 dB(A) attributed to PIE traffic, while other monitoring points (NM01 and N09) recorded noise levels lower than 60 dB(A). Noise levels captured by other noise monitoring points located in other Sites (B,C,D,F) didn't exceed 60 dB(A).

Impact Assessment Methodology

Sections 7, 8, 9, 10 and 11 of the EIA report discuss the methodologies used for impact identification, prediction and assessment on environmental parameters including biodiversity, hydrology, water quality, soil and groundwater, air quality and airborne noise during the construction and operational phases of the development.

Key Mitigation Measures

Table 1-1 summarises the key mitigation measures that have been developed to minimise the adverse impacts throughout the course of the Project. More details can be found in Sections 7, 8, 9, 10 and 11 of the report.

Table 1-1 Summary of key mitigation measures and best management practices

Environmental Parameter	Recommended Key Mitigation Measures and Best Management Practices	
	During Pre-construction & Construction Phase	During Operational Phase
Biodiversity	<ul style="list-style-type: none"> Retain and create a 100m forested corridor at the periphery of the former Champions Golf Course for ecological connectivity between Eng Neo Avenue Forest and Bukit Tinggi Begin habitat enhancement and creation before development where possible Avoid plant removal or salvage if unavoidable Consider the retention of large trees as part of design where possible Design for urban greenery such as street scape trees, flowering shrubs and roof top garden where possible Keep building height near forested area low where possible Bird friendly building designs Study and build connectivity structures (e.g. culverts, colugo poles, grade separated crossing, potential ecolink) to facilitate the safe movement of wildlife across roads Implement road calming measures Use lighting strategies to reduce light spill into retained forest Avoid night works and keep working hours to 0800h – 1800h where possible Restrict entry to TPZ and retained forested area outside of worksite Biodiversity awareness training for site personnel Conduct site inspection to ensure no vegetation clearance occurs outside the agreed working space Pre-felling fauna inspection should be conducted before felling any trees or removing any vegetation Wildlife shepherding via directional clearing should be adopted 	<ul style="list-style-type: none"> Incorporate urban greenery such as street scape trees, flowering shrubs and roof top garden where possible Regular park maintenance and signages to remind park visitors of the common park etiquette Road calming measures near retained forested areas Conduct random patrols to deter undesirable behaviours in parks Employ lighting strategies to minimise light disturbance

Environmental Parameter	Recommended Key Mitigation Measures and Best Management Practices	
	During Pre-construction & Construction Phase	During Operational Phase
Hydrology and Water Quality	<ul style="list-style-type: none"> • Redirect clean water into retained ecologically sensitive watercourses/bodies with significant catchment loss (i.e. pond D4, naturalised stream D7, and earth drain D14) • Prohibit any discharges from construction site into retained ecologically sensitive watercourses/bodies (i.e. D1, D4, D7, D14 and D15) • Build a berm structure or equivalent at the upstream of tributary of natural stream D1 and earth drain D14 prior to construction works (e.g. backfilling) • Complete drain diversion construction prior to connection with naturalised stream D7 • Provide silt curtains or equivalent when connecting naturalised stream D7 to the drain diversion • Coverage of all bare/erodible surfaces are to be done as soon as possible when works are complete or at the start of heavy rain and cessation of works are necessary, implying that tarp or other coverage material should always be on standby next to bare soil 	<ul style="list-style-type: none"> • Redirect clean water into retained ecologically sensitive watercourses/bodies with significant catchment loss (i.e. pond D4, naturalised stream D7, earth drain D14) to increase the flow into these watercourses/bodies. If possible, the water can be from ABC Waters Design features
Soil and Groundwater	<ul style="list-style-type: none"> • <u>No mitigation measures to be proposed</u>, provided that the minimum control measures during the construction phase are in place (refer to Section 9.6.1). 	<ul style="list-style-type: none"> • <u>No mitigation measures to be proposed</u>, provided that the minimum control measures during the operational phase are in place (refer to Section 9.6.2).
Air Quality	<ul style="list-style-type: none"> • Implement dust control measures e.g. dust screens, equipment with dust suppression etc. • Install hard surfaced haul routes. • Only use cutting, grinding and sawing equipment with dust suppression water spray mechanisms. • Erect hoarding around dusty activities and site boundary. • Impose and signpost maximum speed-limit of 25km/hr on paved roads and 15 km/hr on unpaved roads and work areas. • No burning of waste allowed on site. • Closed turfing to the exposed areas where possible and maintain proper storage of soil stockpiles. 	<p><u>No mitigation measures to be proposed</u> as the predicted increase in air quality pollutant levels is likely to be insignificant, due to:</p> <ul style="list-style-type: none"> • Current large traffic volume along existing roads, and thus, any increase in traffic due to the development will not lead to a significant change in air quality. • Continued implementation of increasingly stringent Euro emission standards on new vehicles.
Airborne Noise	<ul style="list-style-type: none"> • Staggered building heights should be considered to reduce duration of noisy activities near receptors; • Access routes should avoid facing receptors; • Use equipment with lower noise levels; and • Noise barriers should be installed along boundary of worksites facing noise sensitive receptors (where necessary). 	<ul style="list-style-type: none"> • Utilize noise attenuators and other Best Available Technology (BAT) and Best Environmental Practice (BEP) to mitigate potential noise from air conditioning and mechanical ventilation (ACMV) systems; • Utilize low speed postings, speed humps, speed limit signages at drop-off points and parking areas to mitigate noise from increased road traffic; and • Consider alternative siting of roads away from areas with noise sensitive receptors.

Summary of Impact Assessment

With the implementation of mitigation measures, the overview of impact evaluation for both construction and operational phases are summarised in Table 1-2.

Table 1-2 Summary of impact significance for construction and operational phases

Environmental Parameter	Impact Significance (with minimum controls/best practices)	Residual Impact Significance (with mitigation measures)
Construction Phase		
Biodiversity	Negligible to Major	Negligible to Major ¹
Hydrology and Surface Water Quality <ul style="list-style-type: none"> Humans Receptors Ecological Receptors 	<ul style="list-style-type: none"> Negligible Negligible to Major 	<ul style="list-style-type: none"> N.A. Negligible to Moderate
Soil and Groundwater <ul style="list-style-type: none"> Human Receptors Ecological Receptors 	Negligible to Minor	N.A.
Air Quality <ul style="list-style-type: none"> Ecological Receptors Human Receptors 	<ul style="list-style-type: none"> Major Moderate to Major 	<ul style="list-style-type: none"> Minor Minor
Airborne Noise <ul style="list-style-type: none"> Ecological Receptors Human Receptors 	<ul style="list-style-type: none"> Moderate to Major Negligible to Major 	<ul style="list-style-type: none"> Moderate to Major² Negligible to Major²
<p>Note: As current means of noise impact assessment were only performed qualitatively, AECOM recommends that quantitative noise impact assessment with and without barrier through noise modelling by a 3D simulating software such as SoundPLAN and CadnaA conducted by Noise Consultant(s) appointed by Contractor (s) be it roadworks/ earthworks/ construction contractor prior to commencement of construction works as required by NEA regulations for human impacts for residents, but also for ecological receptors and embed that part in the contract-specific EMMP for this site to be submitted to NParks before commencement of construction works.</p>		
Operational Phase		
Biodiversity	Negligible to Major	Negligible to Moderate
Hydrology and Surface Water Quality <ul style="list-style-type: none"> Humans Receptors Ecological Receptors 	<ul style="list-style-type: none"> Negligible to Minor Negligible to Major 	<ul style="list-style-type: none"> N.A. Negligible to Minor
Soil and Groundwater <ul style="list-style-type: none"> Human Receptors Ecological Receptors 	Negligible to Minor	N.A.
Air Quality <ul style="list-style-type: none"> Ecological Receptors Human Receptors 	<ul style="list-style-type: none"> Minor Minor 	<ul style="list-style-type: none"> N.A. N.A.
Airborne Noise <ul style="list-style-type: none"> Ecological Receptors Human Receptors 	<ul style="list-style-type: none"> Negligible to Minor Negligible to Minor 	<ul style="list-style-type: none"> N.A. N.A.
<p>Note: As current means of noise impact assessment were only performed qualitatively, quantitative noise impact assessment must be conducted by the developer/ developing agent at a later stage to assess</p>		

Environmental Parameter	Impact Significance (with minimum controls/best practices)	Residual Impact Significance (with mitigation measures)
	noise impacts arising from the operational phase related activities as mandated by law at later stages of the Project.	
<p>Note:</p> <ul style="list-style-type: none"> (1) Biodiversity impact during construction phase: some biodiversity impact remains as Major after mitigation as there are impacts (e.g. habitat loss) that cannot be mitigated. For more details refer to Section 7.11. (2) Noise impact during construction phase: due to the close proximity of the project sites to sensitive receptors, impact intensity will remain Moderate – Major even after the mitigation measures (see Section 11.7 to 11.9). 		

A set of Environmental Monitoring and Management Plan (EMMP) has also been developed for each environmental parameter, which will be updated and implemented during construction and operational phases, to ensure the effectiveness of the proposed mitigation measures. The EMMP is described in Section 12 of the EIA report.

2 Introduction

AECOM Singapore Pte. Ltd. Was appointed by the Urban Redevelopment Authority (URA), through the Letter of Acceptance dated 7 March 2023 (Contract Number URA/T/22/031), to provide Environmental Baseline Study (EBS) and Environmental Impact Assessment (EIA) for Redevelopment of the Former Turf Club at Bukit Timah ('the Study'). An EIA is required to be undertaken to assess the potential environmental impacts arising from, and associated with, the construction and operation of the future township with ancillary facilities and infrastructural development such as drainage, sewerage and road network etc. in the Former Turf Club area ('the Project'). It should be noted that the EIA for the development of Cross Island Line Phase 2 (CRL2) has been completed by LTA [R-2, R-3, R-4] and will not be included in this report.

The Project Site located in the central region of mainland Singapore spans across approximately 176.4 hectares (ha) and is bounded by the Pan Island Expressway (PIE) to the north, Eng Neo Avenue to the east and Dunearn Road to the south and residential areas to the west. The Site was occupied by sports and recreational facilities, service and commercial areas, pre-schools and a golf course, which have since stopped operations in December 2023. Central Catchment Nature Reserve (CCNR) and Bukit Timah Nature Reserve (BTNR) sits north of the Project Site, which also comprises of managed turf vegetation and ecologically sensitive forested areas such as the Eng Neo Avenue Forest and Bukit Tinggi. This makes the Site potentially important for ecology and its connectivity, and therefore the Study Area for the Project includes the forest northwest of the Site and south of Eng Neo Avenue, in addition to the Project Site itself.

The Client understands that AECOM has been involved with Land Transport Authority (LTA)'s completed environmental studies, such as the Environmental Impact Study (EIS) for CRL2 (CR2005), which has study locations overlapping with this Study. AECOM will be using information gathered from the previous study – LTA's EIS [R-2, R-3, R-4] where applicable, to assist this EIA.

Findings of the environmental baseline studies as well as the predicted environmental impacts resulting from this Project have been included in this EIA Report. This section will serve as a brief introduction of this EIA Report in terms of the scope of EIA, report structure as well as study limitations, assumptions and constraints.

2.1 Scope of Work

Prior to the commission of EIA, environmental consultation was undertaken by URA to the relevant technical agencies (i.e. NEA and NParks) and an EIA was assessed to be required. The scope of EIA was documented in the form of an Inception Report submitted to URA. This EIA proceeded upon acceptance of the Inception Report by URA and the relevant technical agencies.

The services under this EIA shall include, but are not limited to the following:

- Field survey including topography survey, floral survey, faunal survey, hydrological, soil and groundwater, surface water quality survey, air quality monitoring and noise monitoring;
- Formulation of biodiversity inventory and distribution maps;
- Environmental Impact Assessment;
- Mitigation measures and EMMP; and
- Preparation of the EIA Report.

This EIA has assessed the development plan, design elements, construction methodology, project components, and operational activities available at the time of writing. Understanding of the project construction methods and operational activities has been clearly stated in Section 3.3 and Section 3.4 respectively. Detailed assumptions, if any, are described in individual assessment sections thereafter. Should the detailed design conducted at a later stage require material modifications to these assumptions/approaches, a revised environmental impact assessment shall be undertaken by developer/developing agent to address these changes.

2.2 Report Structure

The structure of the Report is as follows:

- **Section 1 – Executive Summary** of the Project provides an overview of the planned developments, summarised baseline findings as well as EIA findings;
- **Section 2 – Introduction** of the Project provides detailed scope, report structure, study limitations, assumptions and constraints;
- **Section 3 – Project Overview** provides a general description of the Project components, construction activities, operational activities, and schedule of the Project;
- **Section 4 – Description of the Environment** provides a general description of the site setting, land use, historical features, geology, water catchment and climate of the Project;
- **Section 5 – Environment Legislation, Policies, Plans, Standards and Criteria** provides the legislative requirements relevant to the Project;
- **Section 6 – EIA Approach and Methodology** provides the overview of the methodology used for the assessment;
- **Section 7 – Biodiversity** presents the methodology, baseline environment, sensitive receptors, and potential sources of impacts, minimum controls and evaluation of impacts to biodiversity within the Study Area, along with recommendations for mitigation measures;
- **Section 8– Hydrology and Water Quality** presents the methodology, baseline environment, sensitive receptors, potential sources of impacts, minimum controls and evaluation of impacts to hydrology and surface water quality within the Study Area, along with recommendations for mitigation measures;
- **Section 9 – Soil and Groundwater** presents the methodology, sensitive receptors, potential sources of impacts, minimum controls and evaluation of impacts from construction and operational activities to soil and hydrogeological conditions of the Study Area, and also to ascertain the presence of possible pollutants in the underlying soil and groundwater that may impact the local vegetation and downstream waterbodies, along with recommendations for mitigation measures;
- **Section 10 – Air Quality** presents the methodology, baseline environment, sensitive receptors, potential sources of impacts, minimum controls and evaluation of impacts from the Project to air quality on the ecologically sensitive sites within the Study Area, along with recommendations for mitigation measures;
- **Section 11 – Airborne Noise** presents the methodology, baseline environment, sensitive receptors, potential sources of impacts, minimum controls and evaluation of noise impacts on the ecologically sensitive sites within the Study Area, along with recommendations for mitigation measures;
- **Section 12 – Environmental Monitoring and Management Program (EMMP)** details the organisational framework, stakeholder roles and responsibilities, monitoring program requirements and detailed EMMP; and
- **Section 13 – Conclusion** provides a conclusive summary of the EIA's outcomes.

2.3 Study Limitations, Assumptions and Constraints

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During this study, there will be inherent limitations associated with data acquisition in flora surveys due to the variability of vegetation communities across a site and changes to the detectability and presence of species with time (i.e. inaccessible areas due to the nature of arduous terrain that might be present). Therefore, it may be possible that some flora species occurring within the Project site, or perhaps not visibly present during the survey period, were not recorded. However, the surveys will be considered to be comprehensive as survey routes were strategically planned to cover ecologically and geographically representative samples of the Project site, and all plant species sighted will be identified and recorded to the best of the team members' abilities. Project team members who will carry out the survey and identify the species post-survey have prior experience in conducting such flora assessments in Singapore.

As for the fauna surveys conducted, not all species present within the site could be captured via fauna field surveys due to the rapid nature of this study, as well as the activity patterns, weather conditions, seasonal variations and other factors. Species that were highlighted in the literature review were therefore considered to be potentially present in the site and were included in the baseline assessment. Professionals who carried out the fauna surveys are experienced field biologists and familiar with the local fauna.

It should be noted that the EIA for the development of CRL2 has been completed by LTA [R-2, R-3, R-4], and its development timeline will not overlap with the development of this Project in CRL2's vicinity, thus CRL2's EIA will not be included in this report.

Due to the above, the statements, conclusions and opinions contained in this report are approximations of the existing environmental conditions within the Project site, based on available literature, expert observations and opinion at the time of reporting. Reliance on the report after the date of issuance as an accurate representation of current site conditions shall be at the user's sole risk.

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3 Project Overview

This section will provide a background overview of the Project in terms of its location, current land uses, conceptual development plan, proposed construction activities and operational activities.

3.1 Project Location

The 176.4 ha Project Site for developments (i.e. Former Turf Club) is located in the central region of mainland Singapore. It is bounded by the Pan Island Expressway (PIE) to the north, Eng Neo Avenue to the east, Dunearn Road to the south, residential developments to the west, and educational institutions (Chatsworth International School) and clubs (Swiss Club and The British Club) to the northwest. Nearby the Project Site is the Central Catchment Nature Reserve (CCNR), which is the largest nature reserve and one of the two main water catchments in Singapore, and Bukit Timah Nature Reserve (BTNR). The EIA Study Area is slightly larger than the Project Site as it includes adjacent vegetated areas. The Project Site, EIA Study Area and its surroundings are shown in Figure 3-1.

The Study Area has been demarcated into six (6) different sites, labelled Sites A to F (refer to Figure 3-1), for easier reference to specific areas within the Study Area. The demarcation of the sites largely follows the remaining forest patches within the Study Area. The largest site, Site E, is the only site predominantly made up of urbanised land, while Sites A, B, C, D and F, are forested patches.



Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community

Legend

- EIA Study Area
- Site Demarcation
- Project Site

N

Rev.	Date	By	Description	Chk'd	App'd
-	MAY 2024	HBS	Turf Club EIA	LAL	JAG

Qualified Person Endorsement : NA

URA Endorsement : NA

Consultant : **AECOM**

Project Title : **CONTRACT URA/T/22/031 ENVIRONMENTAL IMPACT ASSESSMENT (EIA) FOR FORMER TURF CLUB AT BUKIT TIMAH**

Designed HBS	Checked LAL	Approved JAG
Drawn HBS	Date MAY 2024	

Client: **URBAN REDEVELOPMENT AUTHORITY**

Figure Title : **Project Site and EIA Study Area**

Figure No. : 3 - 1	Rev. : -	Sheet : 1 of 1
CAD File Name : NA		A3

Note: Source of basemap - Google Earth Map

3.2 Project Description

Based on the proposed preliminary land use plan, the Project Site has been proposed to be used mainly for "Residential", with some supporting amenities (refer to Figure 3-2). Eng Neo Avenue Forest and Bukit Tinggi will largely be retained as forests with trails, together with the small patches of forest towards the centre of the Project Site. The ravine will be backfilled and part of the Racecourse Oval currently surrounded by Turf Club Road will be kept as an open area potentially as a park or for sports and recreation use while the strip of forest on the western boundary of the Project Site will be converted to a linear park.

Main township facilities planned will be centred around the 4 heritage / community clusters. Developments will range from high-rise near the MRT stations, stepping down to low rise at areas close to existing heritage buildings and low-rise residential development. For the purpose of this Study, the remaining Study Area outside of the Project Site will be assessed in its current condition with the assumption that there are no plans for developments in the near-term.



Legend

- EIA Study Area
- Heritage/Community Clusters
- Residential with supporting amenities
- Retained Buildings
- Retained Forest with Trails
- Urban Vegetation
- ↔ Pedestrian Routes/Green Fingers
- ↔ Transport Network
- MRT Entrance
- MRT

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Designed HBS	Checked LAL	Approved JAG
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Client: **URBAN REDEVELOPMENT AUTHORITY**

Figure Title : **Proposed preliminary land use plan of the Project Site**

Figure No. : 3 - 2	Rev. : -	Sheet : 1 of 1
CAD File Name : NA		A3

Note: Source of basemap - Google Earth Map

3.3 Proposed Activities During Construction Phase

At this stage of Report writing, limited information is available regarding the construction activities planned during the development of the proposed Project as the Project is under master planning stage only. Hence, this section only provides description of general activities to be involved, and it will be subject to changes during detailed design or construction stages, which will not be covered by this EIA. The potential future activities that are expected to occur during the construction phase of the Project are further categorised into land preparation activities and construction activities. However, for the proposed future Retained Forest with Trails, refer to Figure 3-2, Client has confirmed that no major construction works are expected within the plots. If there are any construction works within these plots, it would be only light touches with minimal disturbance.

Land preparation activities will take place first. The main objective of these activities is to prepare the land so that the main development and construction activities (i.e. building construction) can be carried out. These activities will entail site clearance (i.e. demolition of existing buildings/structures that are not identified for retention and removal of resulting debris, removal of existing trees and vegetation) and earthworks (e.g. soil excavation and filling within the site to achieve desirable platform levels, utilities diversion, etc.) and for which future developments can take access from. Furthermore, access roads and other required infrastructure for construction work machinery will be established within the site as part of pre-construction activities. It should be noted that activities such as site surveying, utilities surveying, trial trenching and other site investigations (e.g. soil investigations, trial trenches) are commonly carried out as a part of pre-construction activities.

The construction activities will take place only after the land parcel is staged for development and will entail civil engineering activities such as foundation works, superstructure works, utilities/services laying, landscaping works and habitat creation. In addition, activities such as earth works, site surveying, trial trenching and other site investigation work etc. will also be carried out during the construction phase. Before the site becomes operational, temporary structures and facilities will be removed.

It is to note that the future individual development within the Project Site will be carried out in phases, tied in with the timeline for the Turf City MRT construction completion. Occupants will move into completed phases while construction is ongoing for the later phases. However, any demolition of any existing structures will be carried out in Phase 1. The tentative location of the development works occurring during each phase is presented in Figure 3-3.

A tentative schedule of construction phase is presented in a form of chart in Figure 3-4, and also summarised in Table 3-1.



Figure 3-3 Development phases of Project Site

Table 3-1 Typical Project construction activities and tentative timeline for each of the activities

Pre-Construction and Construction Activity	Related Activities	Construction Machinery and Equipment	Timeline
Land Preparation Activities			
Site Clearance & Preliminary Works	<ul style="list-style-type: none"> • Delivery of steel plates, scaffoldings and hoarding boards for safety nets and dust control curtains; • Surveying and Soil Investigation work • Demolition of existing structures and accompanying infrastructure within the Project Site which are not intended to be retained; • Hacking of minor and major structures; • Removal of abandoned steel elements, debris (e.g. damaged windows, frames, doors, internal & external building furniture, etc); • Removal of foundation, spoils and debris; and • Removal of vegetation (e.g. trees, bushes, etc.) 	<ul style="list-style-type: none"> • Soil Investigation Rigs • Lorry cranes; • Hand-held breakers; • Excavators; • Excavators mounted with breaker; and • Dump trucks 	Land preparation will begin in phases. It is assumed that works in different phases are not concurrent.
Earthworks	<ul style="list-style-type: none"> • Soil dewatering • Soil excavation, cut and fill; • Site levelling to obtain planned platform levels; • Utility laying • Construction of drainage and sewage infrastructure • Soil excavation for foundations (i.e. excavation of soil to depth at which the foundations of the future structures will be placed); • Utilities diversion; • Construction of access roads (for both final and temporary access) and other infrastructure required for construction activities 	<ul style="list-style-type: none"> • Temporary water Pumps; • Excavators; • Lorries; • Generators; • Concrete vibrators; and • Air compressor 	
Construction Activities			
Foundation and Earthworks	<ul style="list-style-type: none"> • Soil excavation, cut and fill; • Site levelling to obtain planned platform levels; • Delivery and erection of construction machinery (i.e. crawler crane for lifting operations and boring rig for soil drilling); • Soil dewatering; • Installation of bore casings; • Soil boring work; 	<ul style="list-style-type: none"> • Temporary water pump; • Mobile crane; • Crawler cranes; • Bore pilling machine; • Ready-mix concrete truck • Breakers • Welding equipment 	From approximately the 7th to the 16th month after land parcel is staged for development (10 months)

Pre-Construction and Construction Activity	Related Activities	Construction Machinery and Equipment	Timeline
	<ul style="list-style-type: none"> • Installation of rebar cage and tremie pipe; • Concreting works – construction of piles and pile caps; • Pile head hacking/removal; • Delivery of steel sections; • Hot works – welding of steel beams, brackets, etc.; • Stage excavation; • Hoisting of walers and struts; • Stage excavation with walers and struts; and • Spoil and slurry removal 	<ul style="list-style-type: none"> • Trailers • Excavators (with and without lifting appliance); • Mini Excavators; • Dump trucks; • Lorries; • Generators • Concrete vibrators; and • Air compressor 	
Superstructure Works (Prefabricated Installation)	<ul style="list-style-type: none"> • Soil dewatering (i.e. groundwater extraction and pumping of rainwater); • Establishment of power supply (e.g. for lighting, pumps, temporary ventilation fans); • Excavation below ground surface (e.g. for working platform, for preparing of lean concrete); • Spoil removal; • Formwork construction and cleaning before casting; • Rebar handling and positioning; • Hoisting of falsework; • Casting of concrete; • Scaffolding; and • Finishing works (e.g. plastering, waterproofing, tiling, etc.) 	<ul style="list-style-type: none"> • Temporary water pumps; • Generators; • Excavators; • Mini excavators; • Cranes • Mobile crane; • Air compressor; • Dump trucks • Ready-mix concrete truck; and • Concrete pump 	<p>From approximately the 16th to the 55th month after land parcel is staged for development</p> <p>(40 months/ 3 years and 4 months)</p>
Landscape Works	<ul style="list-style-type: none"> • General landscaping activities • Construction of landscape amenities/ constructions (e.g. gazebos, pathways) 	<ul style="list-style-type: none"> • Generators • Excavators mounted sheet pile vibrator; • Mobile cranes; and • Welding and cutting equipment 	<p>From approximately the 37th to the 56th month after land parcel is staged for development</p> <p>(20 months/ 1 year and 8 months)</p>
Removal of Temporary Structures and Reinstatement	<ul style="list-style-type: none"> • Removal of Earth Retaining and Stabilising Structures (ERSS) • Reinstatement of the area to original (or required) condition 	<ul style="list-style-type: none"> • Generators • Excavators mounted sheet pile vibrator; • Mobile cranes; • Welding and cutting equipment; and • Trucks 	<p>From approximately the 46th to the 55th month after land parcel is staged for development</p> <p>(10 months)</p>

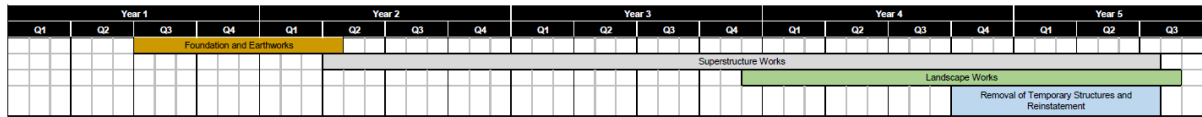


Figure 3-4 Tentative Project's construction schedule for each development phase

The detailed description of each of the identified activities during the construction phase of the Project is provided in the following sub-sections.

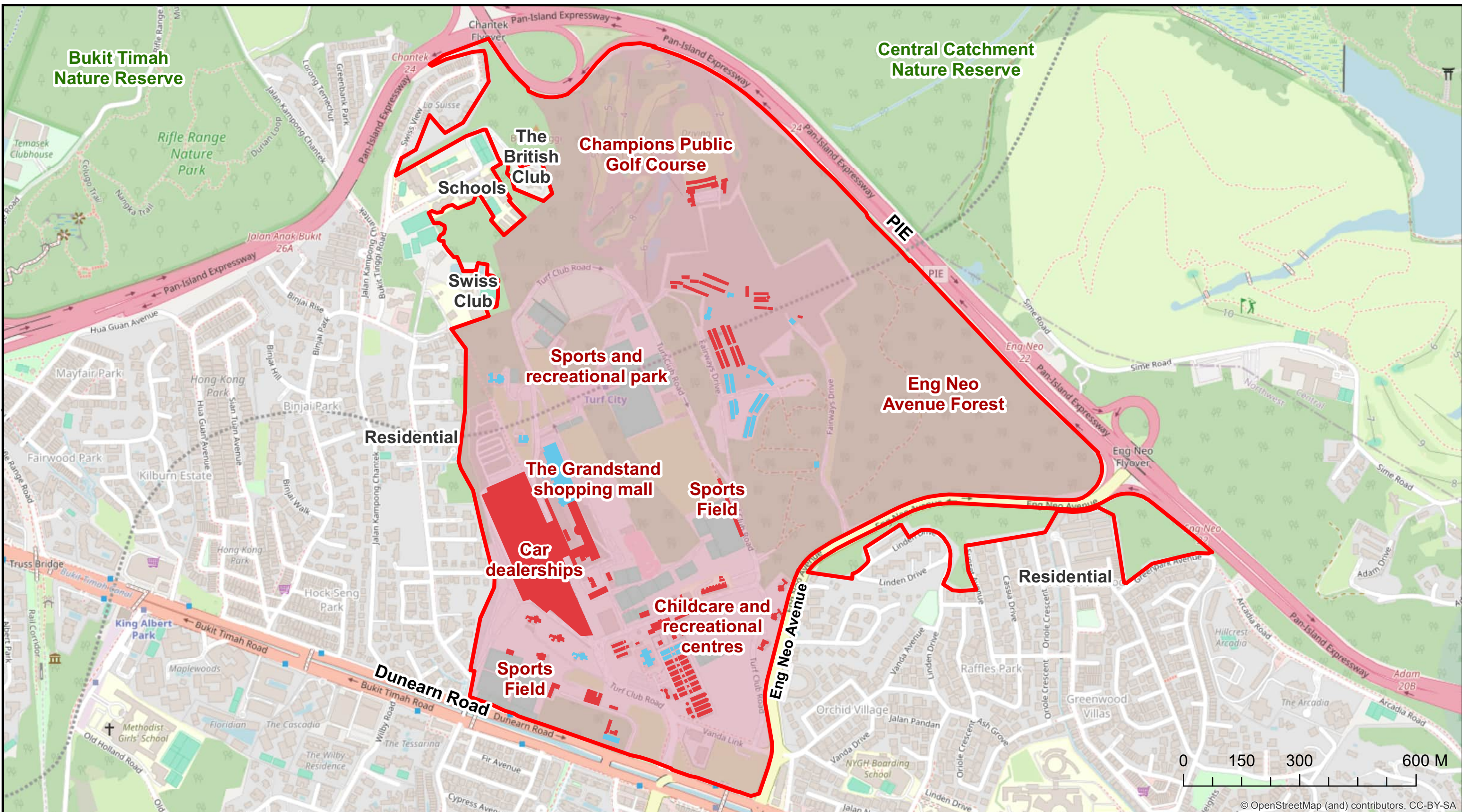
3.3.1 Land Preparation Activities

Land Preparation activities will be carried out in three phases (refer to section above) and their goal is to prepare land parcels so that they are ready for future development and building construction. During the site clearance, buildings, facilities and infrastructure within the Study Area that are not intended to be preserved will be demolished and resulting debris will be removed. Following this, earthworks including soil excavation, utility diversion and ground levelling will be carried out.

3.3.1.1 Site Clearance

Site clearance is the first activity to be carried out as a part of site preparation for construction works. It involves the demolition of buildings, facilities and infrastructure currently present on the site that are not identified for retention, as well as removal of vegetation and topsoil.

Demolition of larger buildings present on the site (refer to Figure 3-5 for overview of structures to be demolished or retained based on proposed preliminary land use plan) is done by excavators mounted with breakers. Hacking of smaller structures can be done with hand-held breakers. Explosives will not be used for demolition purposes. Some removal of trees, shrubs and other vegetation from the site is also planned to be carried out to facilitate redevelopment works within the Project Site. Solid waste generated from demolition activities is collected and removed from the site by dump trucks and lorry cranes. Site clearance works generally generate substantial amount of waste, besides dust and noise in their activities. Potential environmental impacts arising from site clearance have been assessed in the relevant sections of this Report.



Legend

- EIA Study Area
- Project Site

Demolished/Retained

- Demolished
- Retained

N

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Qualified Person Endorsement : NA

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Consultant : **AECOM**

Project Title : **CONTRACT URA/T/22/031 ENVIRONMENTAL IMPACT ASSESSMENT (EIA) FOR FORMER TURF CLUB AT BUKIT TIMAH**

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Client: **URBAN REDEVELOPMENT AUTHORITY**

Figure Title : **Existing structures to be demolished or retained**

Figure No. : 3 - 5

CAD File Name : NA

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Note: Source of basemap - Google Earth Map

3.3.1.2 Earthworks

Following the demolition of existing buildings and structures and removal of existing vegetation, earthworks will be carried out. This will include activities during which the soil will be excavated, transported, placed at the new location, and compacted. The excess soil which is not used for filling will be permanently removed from the site.

3.3.1.2.1 Civil Engineering Earthworks

Civil engineering earthworks will be carried out prior to or concurrently with civil engineering works and they will include utilities diversion, foundation works (refer to Section 3.3.2.1), as well as construction of accompanying infrastructure (e.g. temporary and permanent roads, sewerage, etc.).

Existing utilities which are shallow and likely to cause impedance to excavation works will be diverted first, so that there is no disruption in usage of utilities to nearby receptors. If required, some of the utilities will be reinstated after the whole construction works are completed and the utilities need to be restored at the same place.

Temporary access will be constructed to provide controlled and safe access for vehicles carrying materials and equipment as well as for other machinery. Temporary roads are generally constructed from aggregate/soil which is placed on the required location and compacted. For the final road locations, they will be constructed as part of the land preparation phase together with the laying of utilities such as sewage, drainage and water infrastructure, telco and electrical cables etc. This includes the new planned sewer under Eng Neo Avenue that will serve Turf City, which will be constructed during the Eng Neo Avenue widening works. The sewer is expected to be deep and constructed via pipe-jacking method.

3.3.1.2.2 Site Levelling

Following the site clearance, demolition of existing structures and utility diversion, some terrain will be levelled for construction activities to start. Currently, the Project Site has undulating terrain, with areas of much lower relative elevation compared to its surroundings, such as the ravine and parts of the golf course. The proposed final road levels would vary throughout the site, with elevations generally decreasing southwards, from over 30 mSHD in the golf course to approximately 5 mSHD at the southern tip of the Project Site. This may involve cutting the areas of Project Site where proposed platform levels are lower than existing terrain levels (e.g. the higher elevations within the golf course) and filling and stabilising of slopes in areas which are currently lower than the proposed future platform levels (e.g. the ravine in Site D). In this case geotechnical engineers will develop Earth Retaining Stabilisation Structures (ERSS) schemes to stabilise the exposed slopes in their engineering design. Environmental Control Officer (ECO) considers measures to prevent erosion of soil into any watercourses. This may accompany ground improvement works depending on the nature of the soil in the area. One example of site levelling in a construction site is shown in Figure 3-6. Site levelling would involve large machineries such as excavator, lorry, concrete vibrator, grader, roller, etc.

The earthworks as described above may cause potential biodiversity impact due to reduced habitats and indirect impact from air, noise and water, potential surface water impact due to increased surface runoff and contaminants from construction activities, potential noise impact due to operation of machineries, as well as potential air quality impact due to dust emissions from hacking activities. These potential impacts have been assessed in the relevant sections of this Report.



Figure 3-6 An example of site levelling at construction worksite in Singapore (AECOM©)

3.3.2 Construction Activities

Once the site clearance and earthworks have been completed, construction activities are carried out through the foundation works, superstructure works, general landscaping works as well as reinstatement of the Project Site (including the removal of temporary structures). As no detailed design information is available for proposed buildings, the following sections will only describe general works required.

3.3.2.1 Foundation and Earthworks

Once the land preparation works are completed and the respective sites are staged for development, developers can enter and complete their final site clearance and establish their temporary worksites to carry out the foundation and earthworks for substructures. These works including piles and pile caps will last approximately 10 months.

To begin the foundation piling process, erection of crawler crane and boring rig is required, and mobile crane may be used for lifting and transporting actions. After setting up the pile position, a temporary guide casing with an internal diameter same as pile diameter is installed using crawler crane to the pile centre of the marked position to prevent collapse of the surrounding soil. The temporary casing also serves as a guide in forming a uniform basis for the following boring works until the designed depth using a bored piling machine. This can be very intensive and generate noise and vibration. Thereafter, the reinforced bars (rebar) are installed using a crawler crane to enhance the strength of concrete pile, followed by the tremie pipe installation to better support the concreting works. The ready-mix concrete, transported by a concrete truck, is poured into the borehole using crawler crane. During circumstances when there is extra pile head after the completion of bored piling, pile head hacking is conducted using breaker and excavator.

To seal the pile foundation, a pile cap is necessary. For this, steel waler and struts are required to hold the temporary formworks to proceed with pile cap concreting. The steel is delivered with a 40-foot trailer where hot works (e.g.

welding of steel beams, brackets, etc.) may be required with the usage of welding equipment. Hoisting of water and struts is carried out using an excavator with lifting appliance.

3.3.2.2 Superstructure Works

Following the completion of foundation works, superstructures will be constructed for this Project. Firstly, generators provide the power supply on site for lighting, pumps and temporary ventilation fans operation. Before the installation of superstructures, temporary water pumps are positioned to pump the water from ground or collected rain in order to prevent it from affecting the quality of concrete. To form the working platform, excavation below surface is conducted using an excavator, followed by the formation of lean concrete as the first ground layer for waterproofing purposes. Cranes are used for the spoil removal as well. To construct building until the designated height, temporary formwork is necessary at each level before casting, where air compressor will be used for cleaning. During this process, mobile crane is used to transport rebar and for the hoisting of falsework, formwork, scaffolding and the construction of temporary working platforms. A concrete truck is used to transport ready mix concrete to the site and concrete pump is used for the superstructure's concreting works.

The completion of superstructure is generally followed by finishing works, such as interior plastering, exterior plastering, waterproofing and tiling, mechanical/ electrical/ plumbing (MEP) rough-in an ceiling installation, painting, lift installation, exterior glass walls, windows and doors installation, as well as setting up building systems (i.e. electrical, plumbing, air-conditioning, etc.).



Figure 3-7 An example of superstructure construction works in Singapore (AECOM ©)

3.3.2.3 General Landscaping Works

Open spaces and parks with water features are proposed as part of future developments within the Project Site. They are envisioned to refresh and enhance the site's varied landscapes to form a green network of recreational spaces and to also provide buffer for the surrounding nature areas. In order to maintain, enhance and present the

proposed landscape and other visual amenities of the site to future users (i.e. future residents, general public) landscaping works will be conducted. Generators provide the power supply for lightning and running of machineries during landscaping works. If needed, excavator and mobile crane will be used to remove patches of soil and relocate them or transport from the site. Welding and cutting equipment are commonly used to form landscape structures. The potential environmental impacts associated with the general landscaping works will be assessed and incorporated as a whole in the relevant sections of the Report.

3.3.2.4 Removal of Temporary Structures and Reinstatement of the Study Area

As the final step towards completion of construction activities, the developer and/or contractor shall remove all the temporary structures for the reinstatement of working area to its original condition and/or required conditions. A well-reinstated and stabilised land will also enhance the landscape and visual amenity values to create a better living environment for the public and residents of this Project development. Therefore, the potential environmental impacts associated with the removal of temporary structures and reinstatement of the Project Site will be assessed and incorporated as a whole in the relevant sections of the Report.

3.4 Proposed Activities During Operational Phase

Following the reinstatement period, human activity will increase as the development area becomes operational. The Project Site will see an associated increase in human activity such as traffic movement, lighting, and general human activities. During the operational stage, the vehicular traffic volume within the site and its vicinity is predicted to increase when the proposed residential housing and amenities, and its associated road network start operating.

These abovementioned activities may cause potential noise nuisance, air and water pollution and disturbance to biodiversity and human receptors within and in the vicinity of the development. In addition, more impervious surfaces are expected due to the potential change of natural landscape to urbanised area which will reduce stormwater infiltration into the ground and increase flooding potential.

4 Description of the Environment

This section will describe the historical land use, existing land use and environment, topographical condition, as well as geological and soil characteristics of the Project.

4.1 Historical Land Use

The changes in historical land use of an area can give insight into the influence of historical processes on contemporary habitat. By looking into the type, intensity, extent and duration of past land use, present-day richness in biodiversity at the identified ecologically sensitive sites and the history of human activities in such area can be better understood. It is also notable to discuss any potential heritage value of the Study Area.

As far as possible, a chronological account of the changes in land use of the Study Area is provided in following paragraphs, with inferences drawn from historical resources (maps, sea charts, and aerial photographs) contained within the NUS Libraries Historical Maps of Singapore (NUSLHMSG) [M-3], unless otherwise mentioned.

The earliest map of the area showing urban development (from 1911) indicated that Swiss Rifle Club had established itself in the Study Area and there were records of roads, and a railway station in the south that connects to other parts of Singapore (Figure 4-1A). The 1914 map (Figure 4-1B) shows that the Study Area was characterised mostly by hilly terrain such as Bukit Tinggi, Lalang Hill and other smaller hills, as well as streams which eventually merged around the location of the current Eng Neo Avenue, and swampy habitats in the south.

In the early 20th century, most parts of Singapore became rubber plantations (Yee et al., 2016 [P-67]), including Khoo Chong Seng Estate near present-day Eng Neo Avenue and the Chasseriau Estate which stretched to Bukit Tinggi (National Heritage Board, 2018 [P-68]). An exception was the Swiss Rifle Club area (Site C), which has been left relatively untouched since the extensive deforestation that occurred during the colonial period in the 19th century (Figure 4-1C). Rubber processing factories that complemented the rubber plantations also operated in the area, particularly west of Singapore Turf Club (Figure 4-1C). These factories took advantage of the proximity to the railway in Bukit Timah that facilitated the transport of goods and materials. Around the same period, the northern part of Eng Neo Avenue Forest became a part of the Municipal Water Catchment (later gazetted as Central Catchment Nature Reserve).

The Singapore Turf Club was one of the main recreational infrastructures built in the area and was constructed by 1933 (Tan, 2019 [W-23]), purchasing about 99 hectares of land from the previous Bukit Timah Rubber Estate. During its construction, some 30,000 rubber trees were cleared and hilly areas flattened to create space and build facilities for hosting horse racing (National Heritage Board, 2018 [P-68]). Later during the Japanese Occupation in the 1940s, the racecourse was used as a prisoner-of-war camp and open grounds were planted with banana, papaya, tapioca and vegetables in response to food shortages (National Heritage Board, 2018 [P-68]).

Based on an aerial photograph from 1950, the centre of Study Area appears to be relatively open and barren or with limited vegetation cover (Figure 4-1D). By 1974, the PIE had been constructed on the east of the Study Area (Figure 4-1E) and in 1978, the rest of the PIE construction had been completed, along with Eng Neo Avenue, fragmenting the remaining patch of forest north of Eng Neo Avenue Forest (Figure 4-1F). The map also shows that majority of the Study Area was marked out as sundry tree cultivation (Figure 4-1F). Additionally, a school was established close to the northwest boundary of the Study Area, and more residential areas were developed to the west and south of the Study Area. In 1999, the Turf Club moved to Kranji and the racecourse was converted to interim lifestyle and recreation uses. Nonetheless, the Former Turf Club still figures prominently in the history of horse racing in Singapore (National Heritage Board, 2018 [P-68]). After the relocation of the racecourse, some of the land was not put to interim uses, and the forest likely developed with a canopy layer of mainly exotic species. Presently, all vegetated areas are covered by secondary forests of varying successional stages, occasionally interspersed with shrublands.

Small forest patches in Singapore, such as this Study Area, provide stepping stones for forest-dependent wildlife to move across the fragmented landscape. Landscape-level habitat connectivity is crucial in maintaining the long-term viability of populations and important ecological processes (Nor et al., 2017 [P-69]). The Study Area is located within 1 km of key biodiversity hotspots like BTNR and CCNR (Figure 3-1) and provides important habitats for wildlife across the landscape. Although the site is separated from the CCNR by the PIE to its north, volant species

may still be able to cross the expressway and move between these patches. The Study Area is hence potentially ecologically sensitive in its own right, and important in a regional context. Besides its biodiversity values, the centre of the Study Area also serves as recreational and service and commercial amenity for human beings.

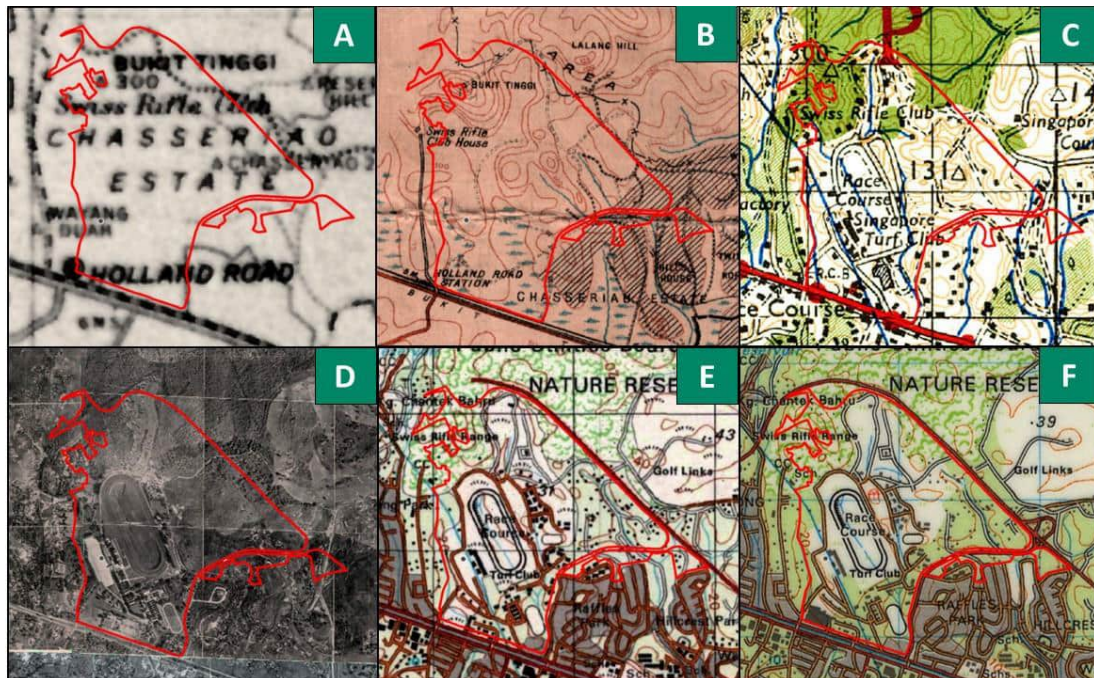
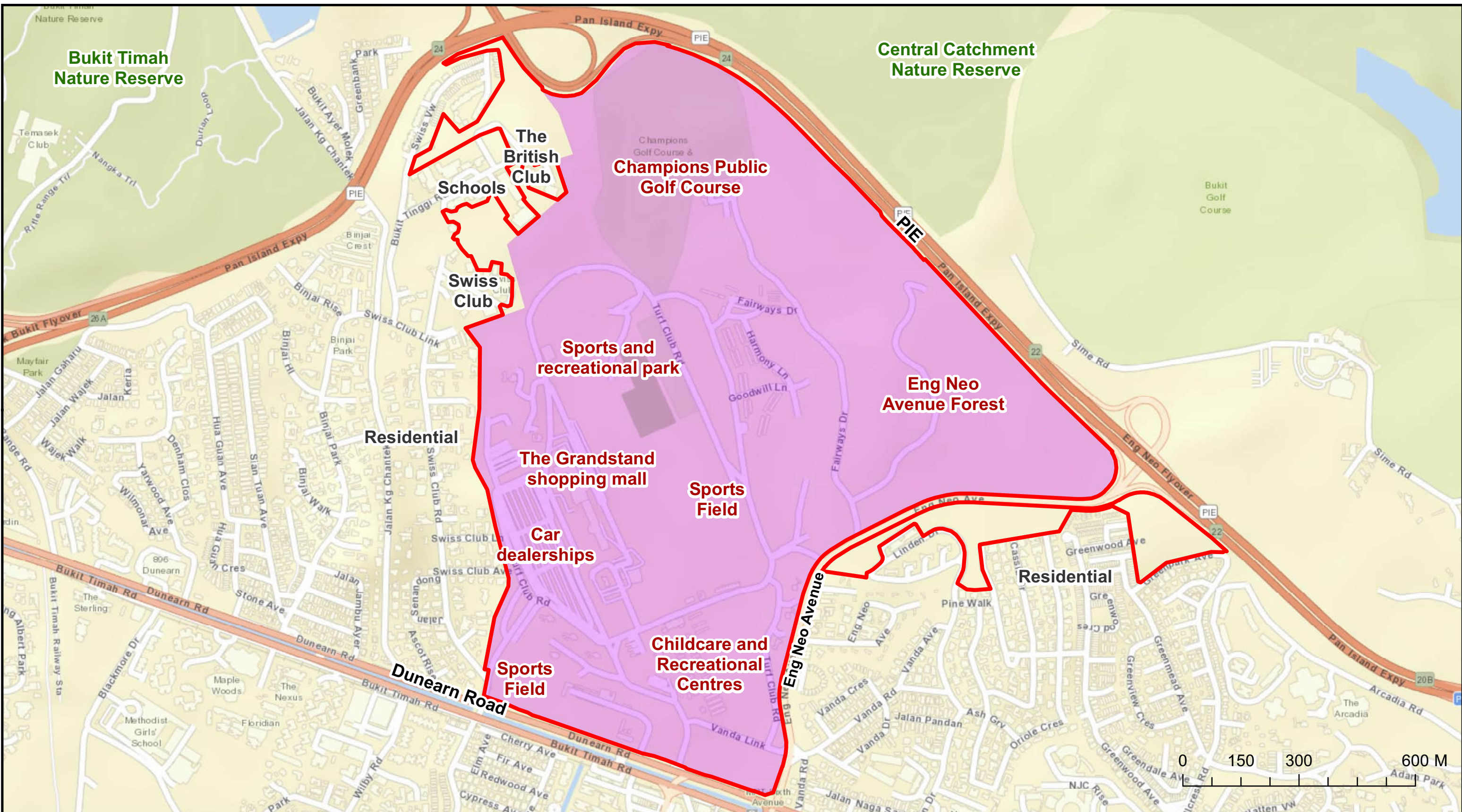


Figure 4-1 Maps showing the chronological land use of the area in (A) 1911, (B) 1914, (C) 1945, (D) 1950, (E) 1974 and (F) 1978

4.2 Recent Land Uses of Project Site

Currently, the Project Site consists of a mix of urban and forested areas. Majority of the urban uses of the land were for recreational facilities, including a golf course on the north-eastern side of the area, outdoor sports parks in the central of the area surrounded by Turf Club Road, and multiple sports fields spread across the southwestern half of area. Businesses including car dealerships, The Grandstand shopping mall and other stand-alone service centres such as pre-schools also occupied the western half of the area. Due to the redevelopment plan of the area, these urban areas have been largely vacated since end 2023. On the other hand, the eastern half of the Project Site is primarily occupied by densely forested area with a few buildings such as the Fairways Quarters and stables, and other structures which used to serve the former Turf Club. Residential and institutional buildings surround the Project Site. The Project Site and its recent land uses are shown in Figure 4-2.



Legend
 EIA Study Area
 Project Site



Rev.	Date	By	Description	Chk'd	App'd
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Qualified Person Endorsement : NA

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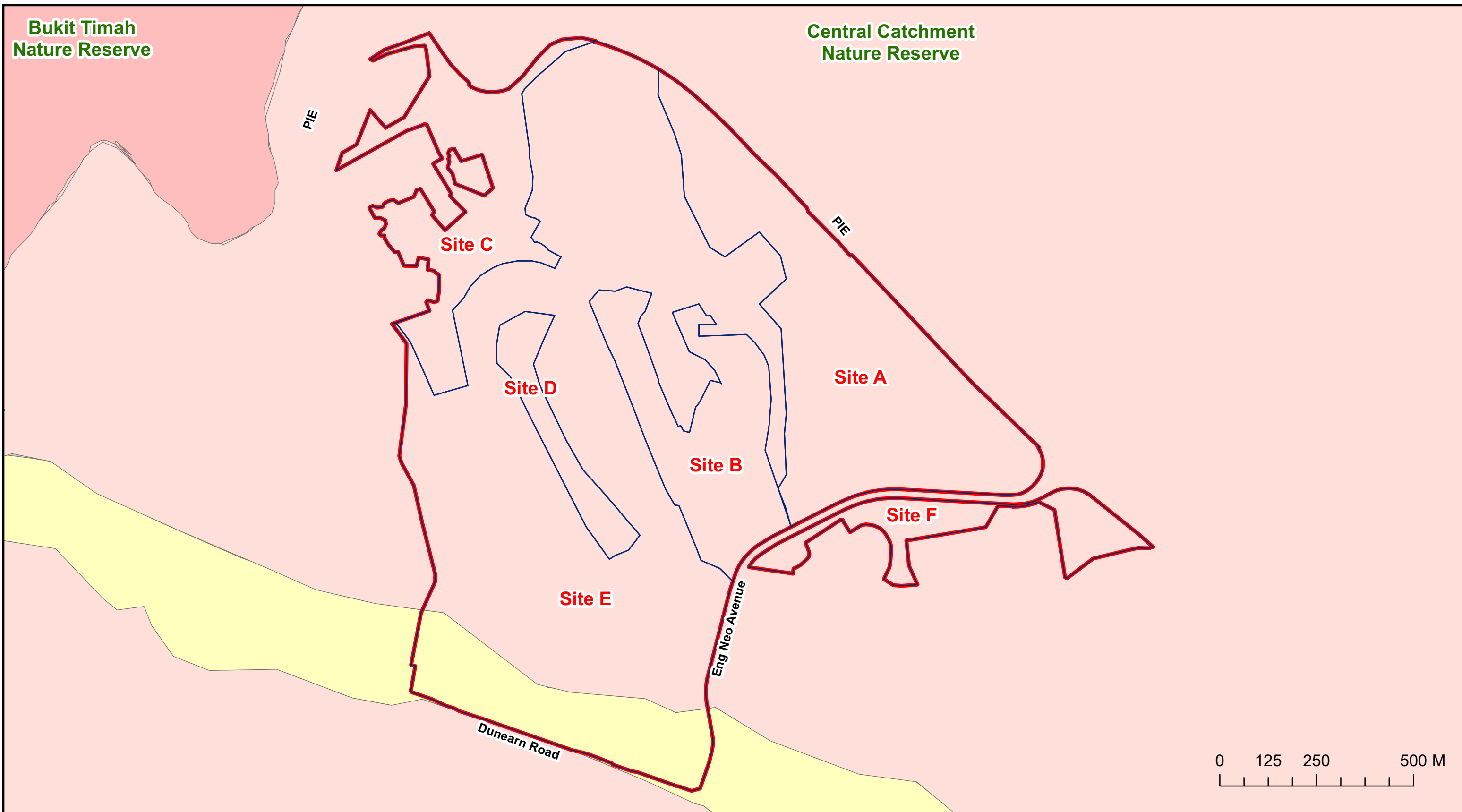
Client: **URBAN REDEVELOPMENT AUTHORITY**
 Figure Title :
Recent land uses of Project Site
 Figure No. : 4 - 2
 Rev. -
 Sheet 1 of 1
 CAD File Name : NA
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4.3 Geology

Based on the Geological Map of Singapore (see Figure 4-3), the Study Area's bedrock is dominated by Bukit Timah Granite (Rengam Facies), which is an array of acid rocks including granite, adamellite, granodiorite and the acid and intermediate hybrids which resulted from the assimilation of basic rock within the granite. However, the southern tip of the Study Area parallel to Dunearn Road is made of the Jurong Formation (Tengah Facies), which is composed of Muddy marine sandstone with occasional grit beds and conglomerate.

Bukit Timah Nature Reserve

Central Catchment Nature Reserve



Legend

- EIA Study Area
- Demarcated sites
- Bukit Timah Granite - Rengam Facies (red variant)
- Bukit Timah Granite - Rengam Facies
- Jurong Formation - Tengah Facies



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ENVIRONMENTAL IMPACT
ASSESSMENT (EIA) FOR
FORMER TURF CLUB AT BUKIT TIMAH**

Designed HBS	Checked LAL	Approved JAG
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Client: **URBAN REDEVELOPMENT AUTHORITY**

Figure Title :
Geological map of the Study Area

Figure No. : 4 - 3	Rev. -	Sheet 1 of 1
CAD File Name : NA		A3

Note: Source of basemap - Google Earth Map

4.4 Topography

The topography of the Study Area is provided in Figure 4-4. As seen from the figure, the elevation within the Study Area generally decreases from north to south, with a few dips within the terrain.

Site A has undulating terrain with a valley that runs from the north to the south of the site. There are two local high points within Site A, one located in the south at 46.0 mSHD and one in the north at 50.0 mSHD. The lowest point in Site A occurs in the south, nearby Eng Neo Avenue, at 10.4 mSHD.

Similarly, in Site B, there are two local high points within the site, occurring one in the north (42.3 mSHD) and one in the south (32.5 mSHD). There is a central low-lying region between these two high points, which continues southwards on the western edge of the site.

In Site C the highest point of elevation in the Study Area occurs in Bukit Tinggi in Site C, (90.9 mSHD) and decreases radially outwards from that point. The elevation decreases to its lowest point at the southwest-central section of the site, before increasing again.

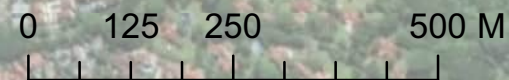
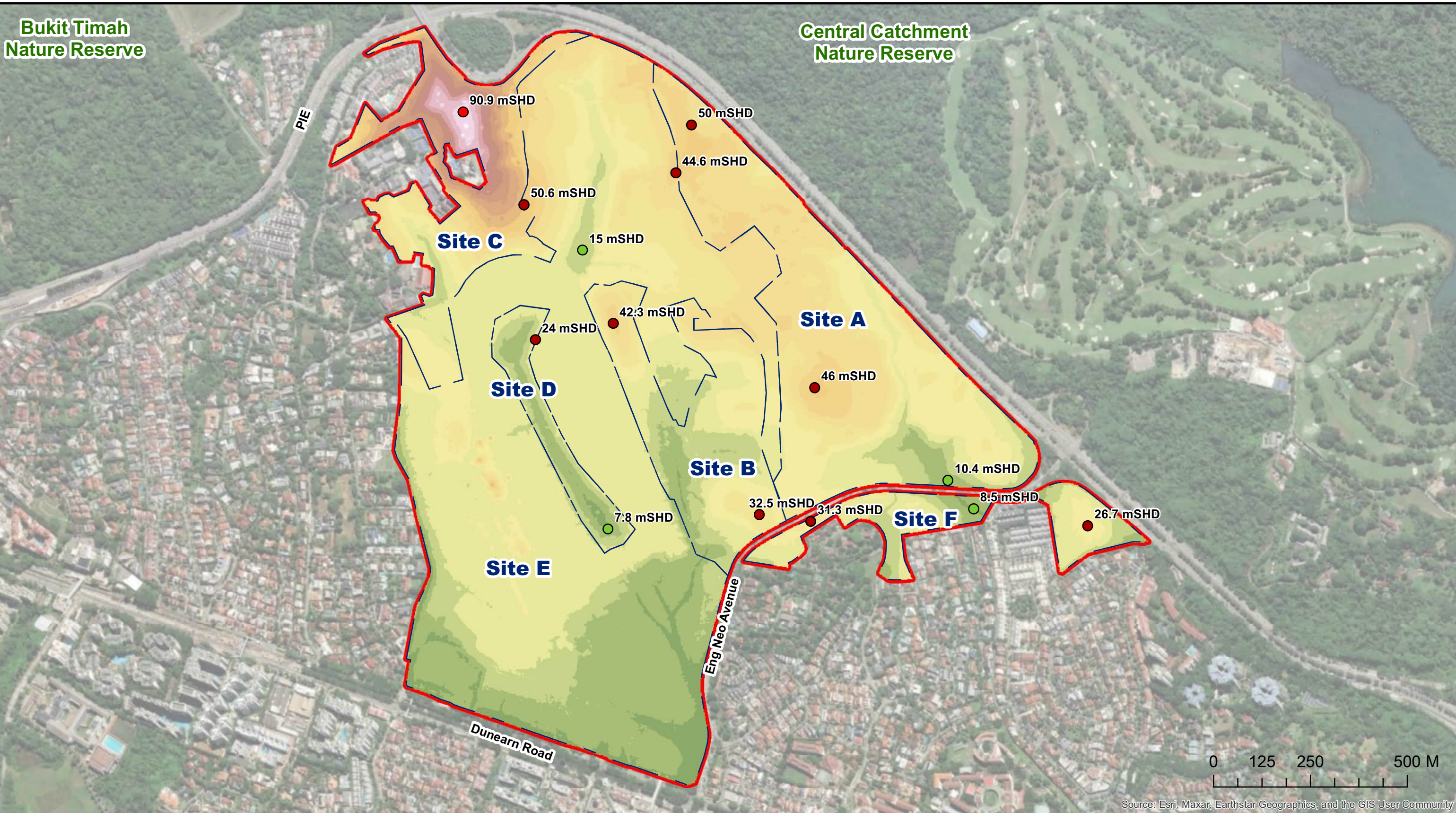
The elevation in Site D decreases inward towards the centre of the site, and also southwards. Consequently, the lowest elevation within the site is near the southern edge of Site D at 7.8 mSHD, while the highest elevation on the northern edge of Site D at 24.8 mSHD.

Site E has the highest elevations in the north running along the shared boundaries with Site A and Site C at 44.6 mSHD and 50.6 mSHD respectively. The elevation decreases between these two boundaries as well as southwards, to a minimum of 15.2 mSHD. The elevation then increases just south of this local minimum point, but gradually decreases southwards from there.

Site F has two high points, one in the west (31.3 mSHD) and one in the east (26.7 mSHD). The elevation generally decreases from these two points. The lowest lying area lies in the centre of Site F, at 8.5 mSHD.

Bukit Timah Nature Reserve

Central Catchment Nature Reserve



Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community

Legend

EIA Study Area	Elevation (mSHD)	45 - 50
Site Demarcation	< 5	50 - 55
Local Maximum	5 - 10	55 - 60
Local Minimum	10 - 15	60 - 65
Overall Maximum	15 - 20	65 - 70
	20 - 25	70 - 75
	25 - 30	75 - 80
	30 - 35	80 - 85
	35 - 40	85 - 90
	40 - 45	> 90



Rev.	Date	By	Description	Chk'd	App'd
-	MAY 2024	HBS	Turf Club EIA	LAL	JAG

Qualified Person Endorsement : NA

URA Endorsement : NA

Consultant : **AECOM**

Project Title : **CONTRACT URA/T/22/031 ENVIRONMENTAL IMPACT ASSESSMENT (EIA) FOR FORMER TURF CLUB AT BUKIT TIMAH**

Designed HBS	Checked LAL	Approved JAG
Drawn HBS	Date MAY 2024	

Client: **URBAN REDEVELOPMENT AUTHORITY**

Figure Title : **Digital elevation map of the Study Area**

Figure No. : 4 - 4	Rev. -	Sheet 1 of 1
CAD File Name : NA		A3

Note: Source of basemap - Google Earth Map

4.5 Catchment Area

As Singapore does not have extensive natural aquifers or lakes and has limited land to store collected stormwater, it aims to maximise stormwater harvesting. Stormwater is collected through a network of rivers, canals and drains and channelled to seventeen (17) reservoirs, after which it is treated, filtered and disinfected at the water treatment plants. Stormwater is one of Singapore’s main sources of drinking and industrial water. As shown Figure 4-5, majority of the Study Area sits on the Bukit Timah sub catchment, which eventually drains into Marina Reservoir through the Rochor River, while a small part of the northern site drain surface runoff to the MacRitchie Reservoir. All the reservoirs are used for drinking water purposes and for recreation (e.g. kayaking). The detailed hydrology baseline information will be further discussed in Section 8.

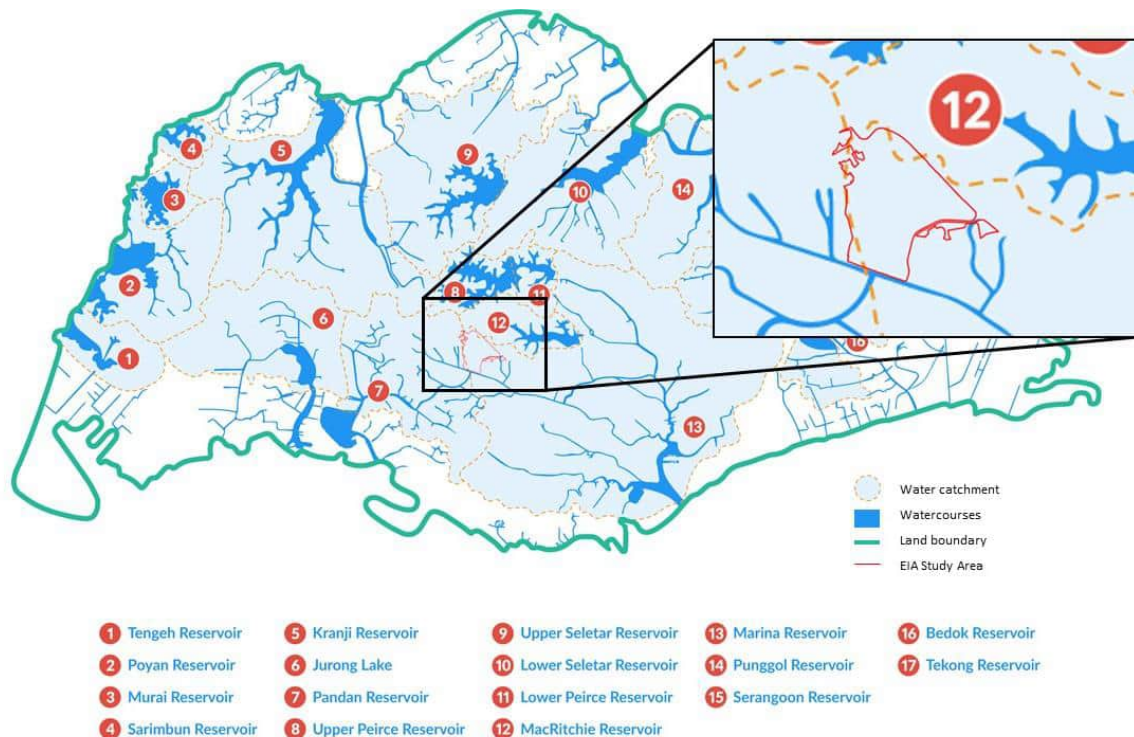


Figure 4-5 Singapore water catchment (sourced from PUB, 2020 [W-1])

4.6 Climate

4.6.1 Rainfall

Singapore is situated near the equator and has typically tropical climate. Singapore’s year-to-year rainfall is highly variable. Based on the 30-years long-term climate information (1981 – 2010) by the Meteorological Service Singapore (MSS), it rained an average of 167 days of the year [W-4]. The long-term mean annual rainfall total is 2534.3 millimetres (mm) when averaged across island-wide stations with long-term records [W-5]. Based on the findings from MSS, the annual rainfall total has increased at an average rate of 75.2 mm per decade, and hourly rainfall increased at the rate of 0.8 days per decade for heavy rain (>40 mm) and 0.2 days per decade for very heavy rain (>70 mm) from Year 1980 to 2019 (refer to Figure 4-6) [W-6].

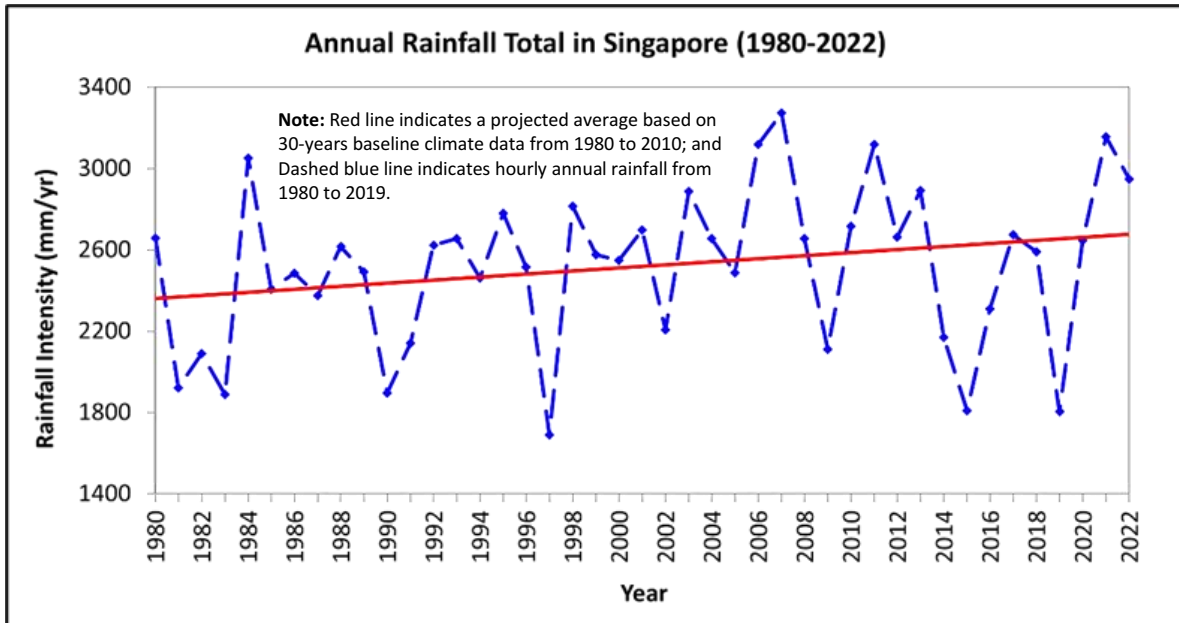


Figure 4-6 Annual rainfall total in Singapore from 1980 to 2022 (sourced from: MSS [W-6])

In terms of spatial distribution, rainfall is higher over the northern and western parts of Singapore and decreases towards the eastern part of the island (Figure 4-7) [W-4]. The figure also shows that the Central Catchment possibly receives the maximum rainfall in Singapore. The annual average rainfall in the Project site is anticipated to be approximately 2,800 mm to 3,000 mm. Furthermore, the recent findings from MSS had shown an overall upward trend in total annual rainfall at increased average rates ranging from 0.3 mm/ year to 15.3 mm/year, during the period from 1980 to 2022 (refer to Figure 4-8) if compared to the 30-years long-term basis, except for the areas near Queenstown climate station at the south of Singapore [W-6].

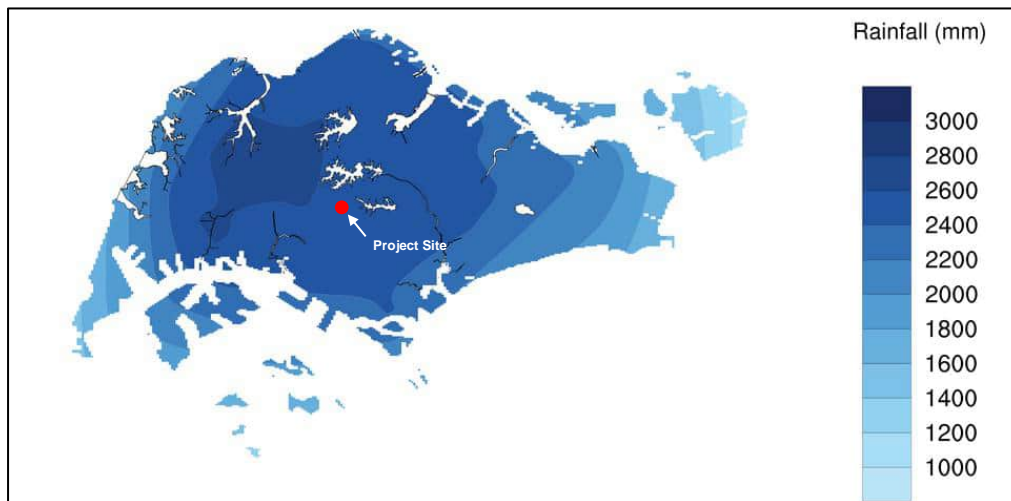


Figure 4-7 Annual average rainfall spatial distribution (1981 - 2010) (Source: MSS [W-4])

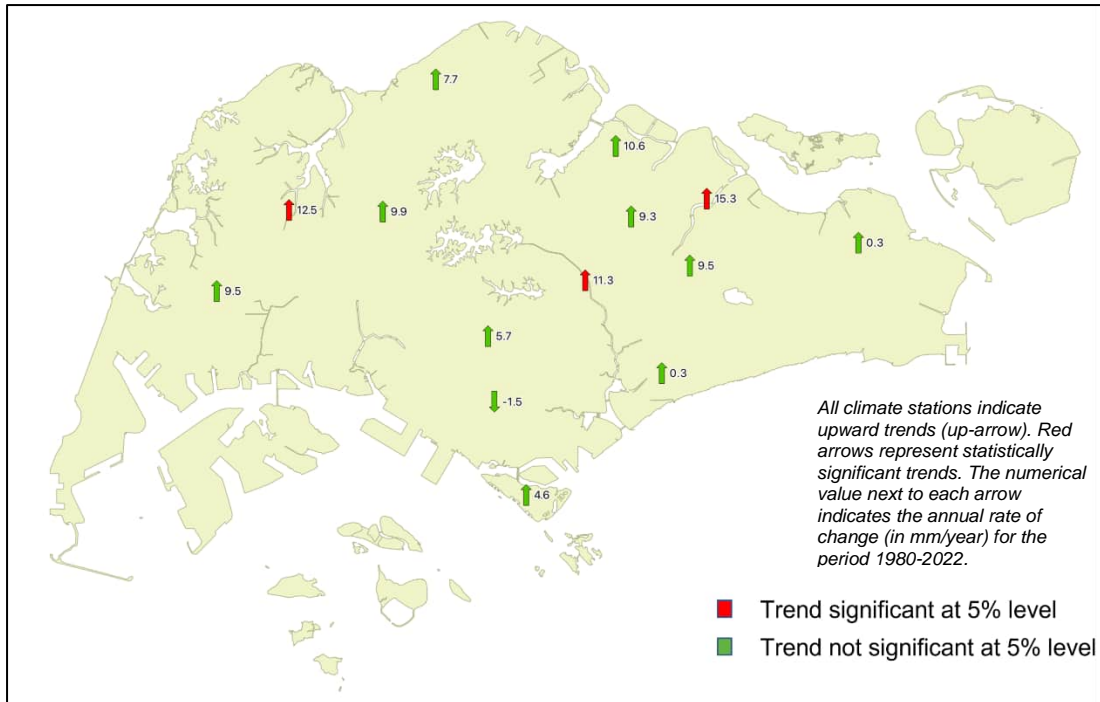


Figure 4-8 Past trends of annual rainfall total at indicative stations (1981-2022) [W-6].

Singapore has two monsoon seasons separated by inter-monsoonal periods, where the Northeast Monsoon occurs from December to early March and the Southwest Monsoon from June to September. It also has abundant rainfall all the year round with relatively higher mean rainy days (more than thirteen [13] days) and mean rainfall amount (more than 202 mm) from November to January every year (refer to Figure 4-9). The average rainfall in Singapore is approximately 202 mm and 138 mm during Northeast and Southwest Monsoon, respectively. Most months in 2023 had rainfall that was above average (refer to Figure 4-9).

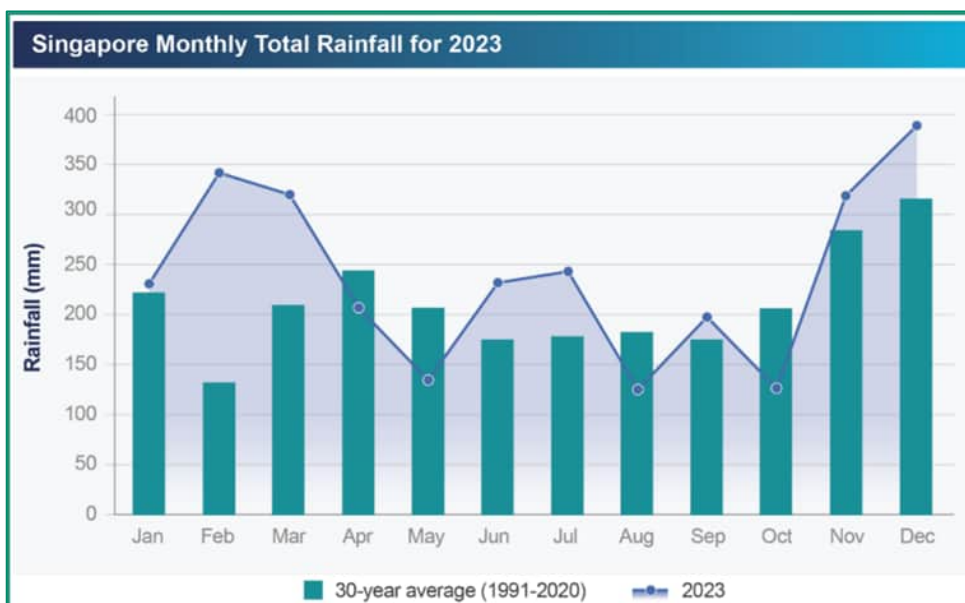


Figure 4-9 Monthly total rainfall in Singapore for 30-year average over island-wide stations with long-term records (bars, 1991 – 2020) compared to 2023 (solid line) (sourced from MSS [W-5])

4.6.2 Temperature

Singapore’s continuous temperature records since 1948 show that the island has warmed by an average of 0.25°C per decade, with a visible and sudden rapid increase after the mid-1970s (see Figure 4-10). This may have been due to the rapid economic development and urbanization that took place after Singapore’s political reformation, as well as due to the influence of anthropogenic global warming effects. Eight (8) out of the ten (10) warmest years recorded in Singapore have occurred in the 21st century and all ten (10) occurred after 1997. This increasing trend has led to an increase in warm days and warm nights, and a decrease in cool days and cool nights.

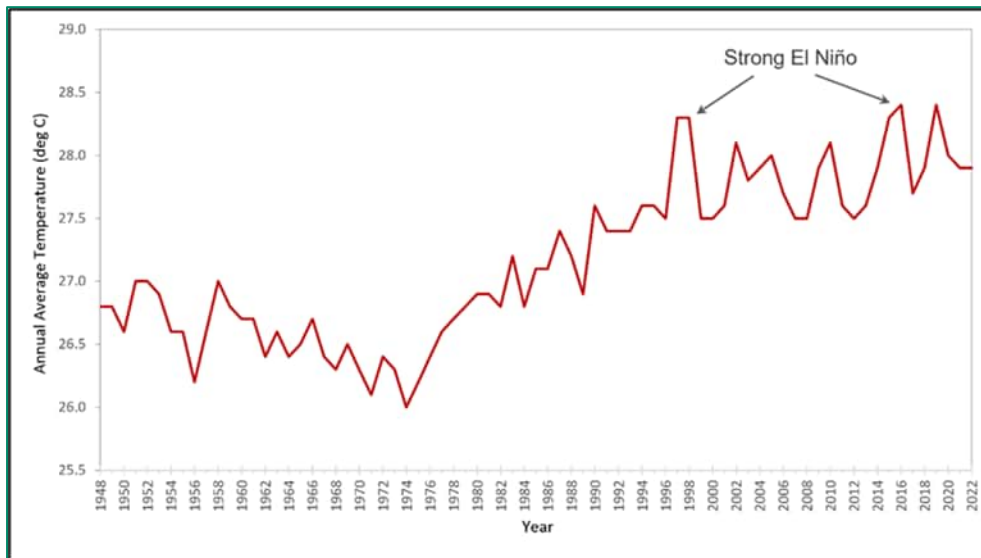


Figure 4-10 Annual mean temperature in Singapore from 1948 to 2022 (sourced from MSS [W-6])

Generally, the temperature variation throughout the year is relatively small as compared to the mid-latitude regions [W-7]. The mean temperature from 2013 to 2022 was 28.01°C, which is 0.04°C higher than the previous record of 27.97°C for the decade from 2012 to 2021. In Year 2023, the annual mean temperature was 28.2°C, with May 2023 being the warmest month at 29.5°C and December 2023 being the coolest month at 26.5°C.

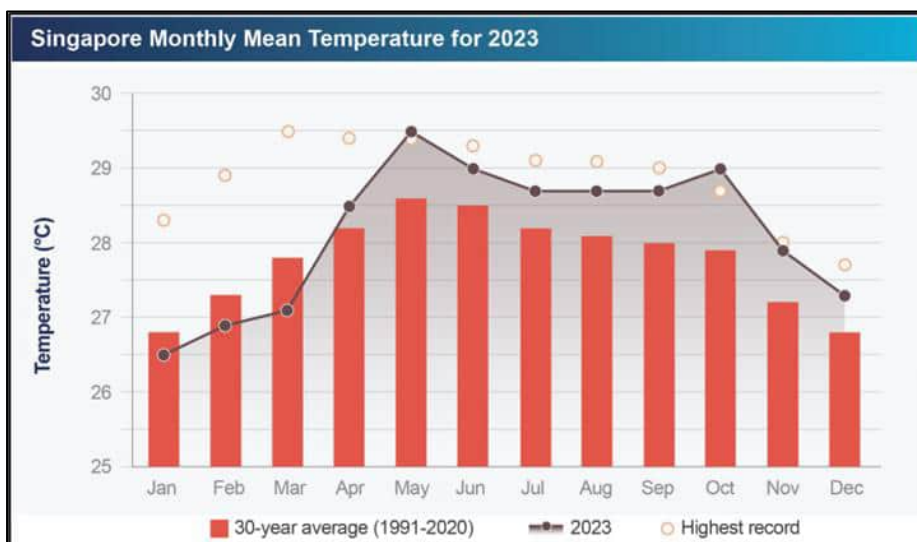


Figure 4-11 Singapore monthly mean temperature for 30-years average from Changi Climate Station with comparison to Year 2023 monthly mean temperature [W-5]

Although there is no distinct borderline between “urban” and “rural” areas in Singapore, maximum temperature difference of 4.01°C was observed between well-planted area, such as Lim Chu Kang area, and the Central Business District (CBD) area [P-26]. This shows the presence of an Urban Heat Island (UHI) effect in Singapore. Green areas in cities have been considered as potential measure in mitigating the UHI effect. This finding is also supported by a study conducted by Jusuf et al (2007), which shows different daytime temperature at different type of land use areas in Singapore. As observed in Figure 4-12, the daytime temperature in park areas is considerably lower compared to other type of land use areas [P-25].

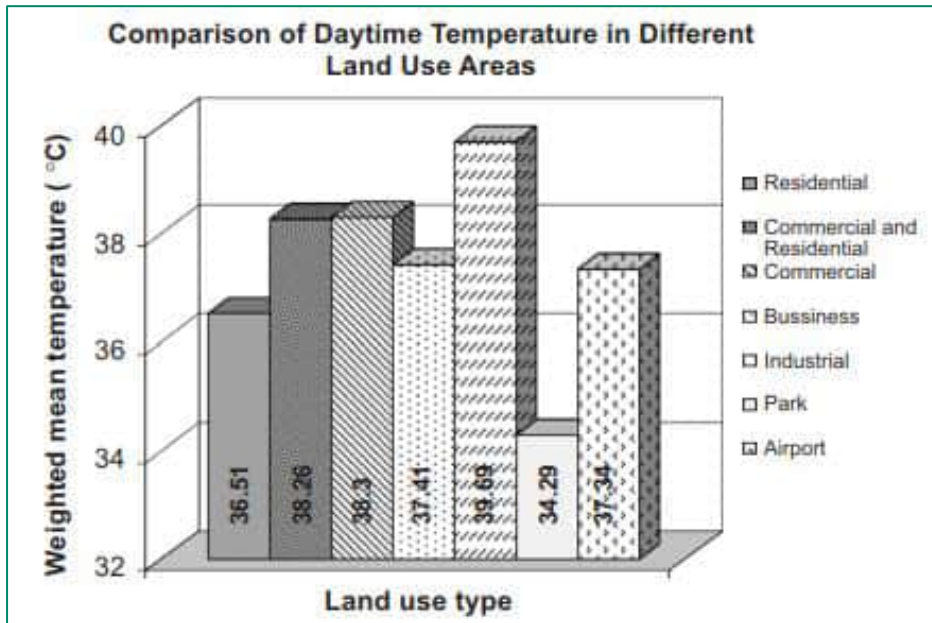


Figure 4-12 Comparison of daytime and night time temperature in different land use areas [P-25]

4.6.3 Relative Humidity

Relative humidity shows a fairly uniform pattern throughout the year and does not vary much from month to month (refer to Figure 4-13). Its daily variation is more marked, varying from more than 90% before sunrise to around 60% in the mid-afternoon on days when there is no rain. While the mean annual relative humidity is 83.9%, the relative humidity frequency reaches 100% during prolonged periods of rain.

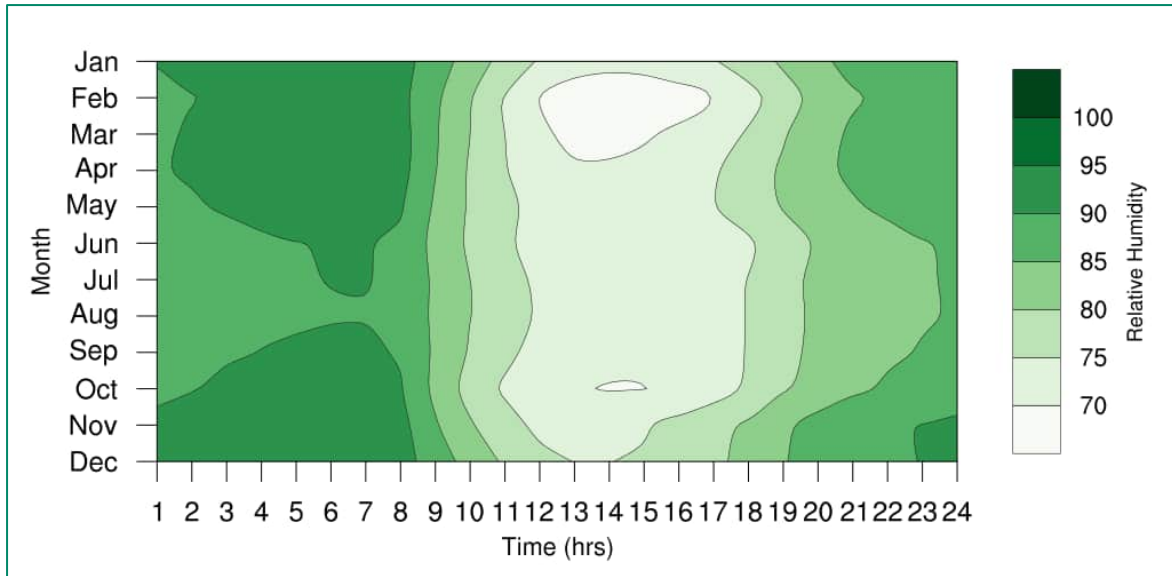


Figure 4-13 Hourly variation of relative humidity for each month from 1981 to 2010 (sourced from MSS [W-4])

4.6.4 Surface Wind

Winds in Singapore are generally light, with the mean surface wind speed normally less than 2.5 m/s. An exception to this is during the presence of a Northeast Monsoon surge, where mean speeds of 10 m/s or more have been observed. Strong winds also occur during thunderstorms. Surface wind gusts are produced from thunderstorm downdrafts and from the passage of Sumatra Squall Lines. As shown in Figure 4-14, the most prominent winds in Singapore are from northeast and the south, occurring during the Northeast and Southwest Monsoon, respectively. The mean monthly wind speeds ranges from 1.5 m/s to 3 m/s [W-4].

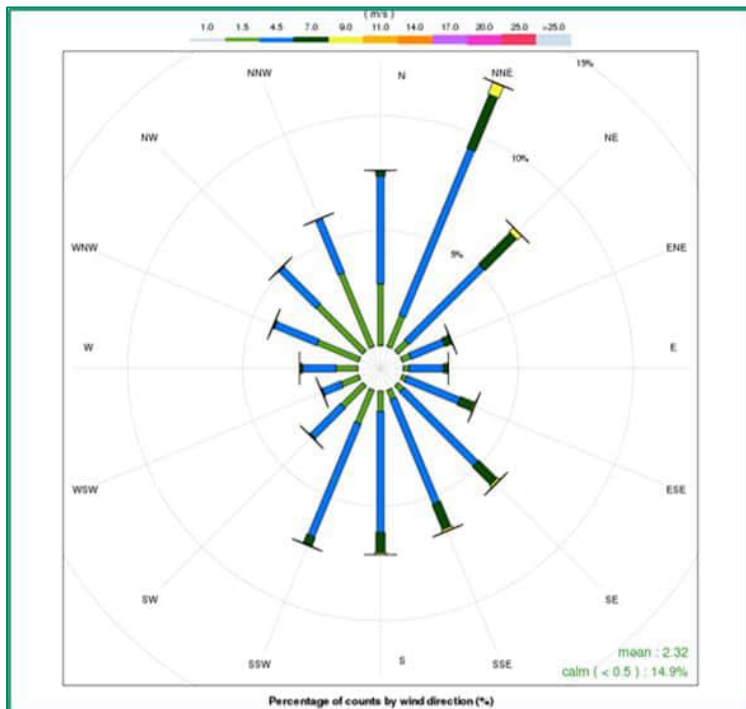


Figure 4-14 Annual wind rose of Singapore (1991 – 2020) (sourced from MSS [W-4])

5 Relevant Regulatory Framework, International Standards and Guidelines

A list of relevant legislative requirements, international benchmarks, and/or guidelines applicable to the Project has been provided in Table 5-1.

Table 5-1 Relevant regulatory framework in Singapore

Environmental Parameter	Applicable Legislation / Guidelines	Key Points
General	Environmental Protection and Management Act, 1999 (2020 Revised Edition) [R-42]	An Act to consolidate the laws relating to environmental pollution control, to provide for the protection and management of the environment and resource conservation, and for purposes connected therewith. For surface water, it regulates the discharge of trade effluent, oil chemical, sewage or other pollution onto land and drains.
	Environmental Public Health Act, 1987 (2020 Revised Edition) [R-66]	An Act to consolidate the law relating to environmental public health and to provide for matters connected therewith. With regards to waste management, it regulates removal of refuse, disposal and treatment of industrial waste, disposal facilities and general health requirements for buildings.
	Energy Conservation Act, 2012 (2020 Revised Edition) [R-65]	An Act to mandate energy efficiency requirements and energy management practices to promote energy conservation, improve energy efficiency and reduce environmental impact.
	Code of Practice (COP) on Environmental Health (2021 Edition) [R-64]	The COP on Environmental Health provides the guidelines for Qualified Professionals (QP) (e.g. architects, engineers, developers) on the environmental health concerns and requirements in the design of the buildings. It defines the objectives to be met and sets out the minimum design criteria. It stipulates the design requirements for various aspects of developments such as refuse storage and collection system, public toilets, ventilation, cooling towers, aquatic facilities, storage and anti-mosquito breeding.
	Singapore Biodiversity Impact Assessment (BIA) Guidelines, 2021 [R-41]	This document is published by National Parks Board (NParks) and was revised in 2021 to provide a framework guiding biodiversity baseline study in Singapore. It recommends methods for conducting baseline survey. Section 2 of this BIA Guidelines detailed the baseline study methods recommended for vegetation mapping, habitat mapping, hydrology (including watercourse mapping, water conditions, water quantity and water quality)
Biodiversity	Singapore National Biodiversity Strategy and Action Plan (NBSAP), 2019 [R-74]	This document provides a framework to guide biodiversity conservation efforts in Singapore. It intends to establish both policy frameworks and specific measures to ensure better planning and co-ordination in the sustainable use, management and conservation of biodiversity.

Environmental Parameter	Applicable Legislation / Guidelines	Key Points
		A holistic approach has been adopted where the input of various public sector agencies and nature groups have been taken into consideration in the preparation of the document.
	Wildlife Act, 2021[R-75]	An Act for the protection, preservation and management of wildlife for the purposes of maintaining a healthy ecosystem and safeguarding public safety and health, and for related matters. The Director-General may direct a person to implement, in respect of any development or works being carried out, or to be carried out, by or on behalf of the person, any wildlife-related measure that the Director-General considers necessary to safeguard the health, welfare or safety of any wildlife or class of wildlife; public health in relation to wildlife or health of ecosystem.
	Parks and Trees Act, 2006 [R-76]	An Act to provide for the planting, maintenance and conservation of trees and plants within national parks, nature reserves, tree conservation areas, heritage road green buffers and other specified areas, and for matters connected therewith. No tree with a girth exceeding one meter (when measured 1-m from the ground) located within tree conservation areas and vacant lands should be cut or damaged without the prior approval of the relevant authorities; and No tree or plant will be cut or damaged if located within the heritage road green buffer. Prohibitions and regulations on trees and animals within national park, nature reserve or public park.
	Singapore Parks and Trees (Heritage Road Green Buffers) Order, 2006 [R-77]	Lists the areas designated as heritage road green buffers.
	Singapore Parks and Trees (Preservation of Trees) Order, 1998 [R-78]	Lists the designated tree conservation areas
	Species List (Red Data Book List) by the National Parks Board, 2022 [W-20]	Lists the endangered plants and animals in Singapore. Published by Singapore's Nature Society. Provides the scientific name, common name, status, description, habitat, distribution, threats, scientific interest and potential value, as well as conservation measures for each plant and animal listed.
Hydrology and Surface Water Quality	Singapore Sewerage and Drainage Act, 1999 (2020 Revised Edition) [R-54]	An Act to provide for and regulate the construction, maintenance, improvement, operation and use of sewerage and land drainage systems, and to regulate the discharge of sewage and trade effluent. Regulates the protection, maintenance and provision of sewerage and stormwater drainage systems.
	Singapore Sewerage and Drainage (Surface Water Drainage) Regulations, 1999 (2007 Revised Edition) [R-55]	Regulations that limit TSS concentration of water to be discharged into stormwater drainage system and to put into effect COP on Surface Water Drainage (specifies

Environmental Parameter	Applicable Legislation / Guidelines	Key Points
		minimum engineering requirements and control measures for surface water drainage).
	Singapore Sewerage and Drainage (Trade Effluent) Regulations, 1999 (2007 Revised Edition) [R-56]	Regulations that specify nature and type of trade effluent as well as allowable limits of certain chemicals in trade effluent to be discharged into public sewers. Any discharge of effluent into public sewer must comply with these regulations.
	Singapore Environmental Protection and Management (Trade Effluent) Regulations, 1999 (2008 Revised Edition) [R-43, R-50]	Regulations that specify nature and type of trade effluent as well as allowable limits of certain chemicals in trade effluent to be discharged into controlled watercourses and other watercourses in Singapore. Any discharge of effluent into a watercourse and/ or controlled watercourse must comply with the regulatory standards established in these regulations.
	Singapore SS 593: 2013 – Code of Practice for Pollution Control (COPPC) [R-52]	Provides guidelines for the appropriate discharge of any effluent into public sewer or watercourse. Provides guidelines for the appropriate storage and accidental release of oils & chemicals.
	Singapore PUB COP on Surface Water Drainage, 2018 (2021 Addendum) [R-57]	Provides guidelines for measures to be implemented to protect the stormwater drainage system and manage surface water drainage (e.g. development and implementation of an Earth Control Measures [ECM] plan).
	Singapore Biodiversity Impact Assessment (BIA) Guidelines, 2020 [R-41]	Provides standards for water quality in the context of biodiversity conservation in marine water.
	Singapore PUB Circular on Preventing Muddy Water from the Construction Site, October 2015 [R-58]	All new construction sites with site area of 0.2ha and above, sites with problematic ECM, and sites within sensitive areas are required to implement closed-circuit television (CCTV) including a Silty Imagery Detection System (SIDS) at the public drain to monitor the surface run-off discharges from the sites.
Soil and Groundwater	Environmental Protection and Management Act 1999 [R-83]	Regulates the discharge of trade effluent, oil chemical, sewage or other pollution onto land.
	SS 593:2013 Code of Practice for Pollution Control (COPPC) [R-52]	Provides guidelines for the control of land pollution and remediation of contaminated sites. Provides guidelines for the appropriate storage and accidental release of oils & chemicals.
	Environmental Protection and Management (Trade Effluent) Regulations [R-84]	Regulates the discharge of trade effluent into any watercourse or onto land.
	Sewerage and Drainage Act 1999 [R-85]	Regulates the construction, maintenance, improvement, operation and use of sewerage and land drainage systems.
	Sewerage and Drainage (Surface Water Drainage) Regulations [R-86]	Regulates measures to be implemented to protect the storm water drainage system and avoid flooding. Regulates the provision and maintenance of ECM in accordance with the Code of Practice on Surface Water Drainage.
	JTC Guideline on Environmental Baseline Study, 2024 Edition [R-87]@	Provide the responsible parties necessary guidance for conducting EBS for assessing contamination of a site.

Environmental Parameter	Applicable Legislation / Guidelines	Key Points
	Section 7 of SS 593:2013 Code of Practice for Pollution Control (COPPC) [R-52]	Provides the necessary guidance for conducting Environmental Site Assessment (ESA) for assessing contamination of a site and the respective standards to be followed.
Air Quality	Singapore Environmental Protection and Management (Air Impurities) Regulations 2015 [R-61]	Regulates air emissions and impurities in Singapore.
	Singapore Ambient Air Quality Targets (Long Term Targets) [R-71]	Stipulates the recommended limit values for ambient concentrations of NO ₂ , SO ₂ , PM ₁₀ , PM _{2.5} , CO and O ₃ . Target values are based on World Health Organisation (WHO) 2005 Air Quality Guidelines.
	Singapore Environmental Protection and Management (Off-Road Diesel Engine Emissions) Regulations 2012 [R-62]	Stipulates that all off-road diesel engines (including construction equipment with diesel engines) imported for use in Singapore from July 2012 must comply with the EU Stage II, US Tier II or Japan Tier I off-road diesel engine emission standards.
Airborne Noise	Singapore Environmental Protection and Management (Control of Noise at Construction Sites) Regulations, 2008 [R-68]	Stipulates a set of maximum allowable noise limits for construction sites for different time periods of the day and for different types of premises affected by construction noise. Stipulates the correction factor that needs to be applied to the applicable noise criteria based on background noise levels.
	Singapore SS 593: Code of Practice for Pollution Control (COPPC), 2013 [R-52]	Specifies recommended pollution control requirements and good practices for prevention of impacts to noise.
	Singapore SS602:2014 Code of Practice for Noise Control on Construction and Demolition Sites [R-79]	Specifies recommendations and good practices for prevention of noise impacts from construction and demolition activities.
	Singapore Technical Guideline for Land Traffic Noise Impact Assessment from National Environment Agency (NEA) [R-70]	Provides the necessary guidance to conduct land traffic Noise Impact Assessment (NIA) for designated projects.
	Singapore Technical Guideline on Boundary Noise Limit for Air Conditioning and Mechanical Ventilation Systems in Non-Industrial Buildings by National Environment Agency (NEA); Code of Practice on Pollution Control by National Environment Agency [R-69]	Legislative requirements for boundary noise due to noise emissions from mechanical ventilation systems for non-industrial buildings.

Table 5-2 Relevant international standards and guidelines

Environmental Parameter	Applicable Legislation / Guidelines	Key Points
General	UK Biodiversity 2020: A strategy for England's wildlife and ecosystem services [R-28]	<p>"Theme 3: reduce environmental pressures - integrate consideration of biodiversity within the sectors which have the greatest potential for direct influence and reduce direct pressures."</p> <p>The guide serves as a reference that sets out biodiversity policies and strategies to conserve biodiversity for AECOM to consider and implement in the EIA.</p>
Biodiversity	The International Union for Conservation of Nature and Natural Resources (IUCN) Red List of Threatened Species [R-6]	Provides taxonomic, conservation status and distribution information on plants, fungi and animals that have been globally evaluated.
	The Hong Kong Environmental Impact Assessment Ordinance - Technical Memorandum (HK EIAO TM) ¹ [R-82]	Sets out the principles, procedures, guidelines, requirements and criteria for deciding whether the Project is environmentally acceptable.
Hydrology and Surface Water Quality	United States Environmental Protection Agency (USEPA) Water Quality Standards Handbook, 2017 [R-45]	Provides standards for water quality assessment relating to aquatic life for surface watercourses.
	Strategic Plan of Action on Water Resources Management ASEAN (2005) [R-53]	Provides a consolidated framework for the classification of water resources and associated water quality standards for each class.
	Australian & New Zealand Guidelines for Freshwater and Marine Water Quality, 2000 [R-46]	Provides standards for water quality assessment relating to aquatic life for surface watercourses.
	Canadian Water Quality Guidelines for the Protection of Aquatic Life, 2007 [R-47]	Provides standards for water quality assessment relating to aquatic life for surface watercourses.
	World Health Organisation (WHO) Water Quality Requirements [R-44]	Provides standards for water quality assessment relating to aquatic life for surface watercourses.
	United Nations Economic Commission for Europe (UNECE) Standard Statistical Classification of Surface Freshwater Quality for the Maintenance of Aquatic Life, New York and Geneva 1994 [R-59]	Provides standards for water quality assessment relating to aquatic life for surface watercourses.
	Philippines Mitigating Impact from Aquaculture (PHILMINAQ) [R-48]	Provides standards for water quality assessment relating to aquatic life for surface watercourses.

¹ The HK EIAO TM was added as an applicable legislation for biodiversity because: (1) Singapore does not have an established standard for biodiversity assessment yet; (2) Singapore and Hong Kong share similar urban development setting; and (3) HK EIAO TM has previously been used for other environmental impact studies in Singapore.

Environmental Parameter	Applicable Legislation / Guidelines	Key Points
	Malaysia Department of Environment (DOE) National Water Quality Standards [R-49]	Provides standards for water quality assessment relating to aquatic life for surface watercourses.
Soil and Groundwater	<i>Soil Remediation Circular</i> , 2013 [R-88]	The soil remediation Dutch Intervention Values (DIV) indicate when the functional properties of the soil for humans, plant and animal life, is seriously impaired or threatened. They are representative of the level of contamination above which there is a serious case of soil contamination.
Air Quality	UK Institute of Air Quality Management (IAQM) Guidance on the Assessment of Dust from Demolition and Construction [R-60]	The document provides guidance for developers, their consultants and environmental health practitioners on how to undertake a construction impact assessment (including demolition and earthworks).

6 EIA Approach and Methodology

This section outlines the approach and methodology followed for this EIA.

6.1 Approach

The overall EIA workflow is shown in Figure 6-1, and the general approach to the EIA is listed as follows:

- Scoping of EIA (Section 6.2);
- Data Collection and Analysis (Section 6.3);
- Prediction of Impacts (Section 6.4.1);
- Evaluation of Impacts (Section 6.4.2);
- Recommendations of Mitigation Measures (Section 6.5); and
- Environmental Monitoring and Management Plan (EMMP) (Section 6.5).

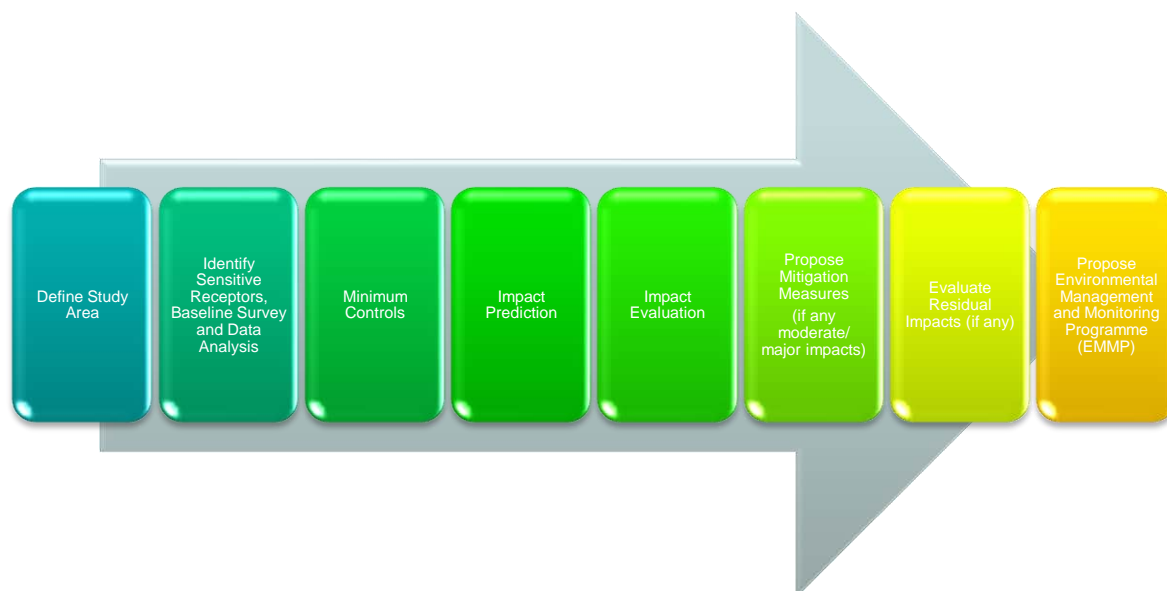


Figure 6-1 Overall EIA workflow

6.2 Scoping of Project

Referring to the Inception Report Rev 04 [R-5], the environmental impacts resulting from the construction and operational activities of this Project are assessed in this EIA report as follows:

- Biodiversity;
- Hydrology, and Water Quality;
- Soil Quality and Groundwater Level;
- Air Quality; and
- Airborne Noise.

6.2.1 Identification of Environmental Impact Assessment Area

The Study Area for this EIA is presented in Figure 3-1 which is an area of total 193 ha, including the Project Site. Both these areas were determined in consultation with the Client and define the scope of works of this report. The assessment extent of potential environmental impacts on nearby sensitive receptors depended on each technical discipline and is presented in Table 6-1. More details on the assessment scope will be described respectively for each impact in the following chapters.

Table 6-1 Assessment scope for different environmental parameters

Environmental Parameter	Scope of Assessment	Key Impacted Parameters	Impact(s) Assessed for
Biodiversity	Habitats, flora and fauna within the Sites A to F.	<ul style="list-style-type: none"> • Habitats; • Flora; and • Fauna 	<ul style="list-style-type: none"> • Construction Phase; and • Operational Phase
Hydrology and Surface Water Quality	Watercourses with direct impact from the proposed development.	<ul style="list-style-type: none"> • Surface hydrology; and • Surface water quality 	<ul style="list-style-type: none"> • Construction Phase; and • Operational Phase
Soil and Groundwater	Soil and groundwater within the Study Area.	<ul style="list-style-type: none"> • Soil Quality; and • Soil type 	<ul style="list-style-type: none"> • Construction Phase; and • Operational Phase
Air Quality	<p><u>Construction Phase</u></p> <ul style="list-style-type: none"> • 50 m (ecological receptors) and 350 m (human receptors) planned development area. <p><u>Operational Phase</u></p> <ul style="list-style-type: none"> • 250 m from operational footprint. 	Ambient Air Quality	<ul style="list-style-type: none"> • Construction Phase; and • Operational Phase
Airborne Noise	<p><u>Construction Phase</u></p> <ul style="list-style-type: none"> • 150 m around the Project Site. <p><u>Operational Phase</u></p> <ul style="list-style-type: none"> • Immediate boundary of the operational footprint and 70 m from roads (if available). 	Airborne Noise	<ul style="list-style-type: none"> • Construction Phase; and • Operational Phase

6.2.2 Identification and Categorisation of Sensitive Receptors

Sensitive receptors are those receptors within or in the vicinity of the Study Area which may potentially be impacted by the Project's construction and operational activities. Environmentally sensitive receptors are categorised into

three categories: Priority 1, Priority 2 and Priority 3 (from the most sensitive to the least) as shown in the following table. The identification of sensitive receptors for each environmental parameter will be developed based on the findings of the environmental reconnaissance surveys, baseline surveys and review of the proposed Project Study Area.

Table 6-2 Receptor sensitivity classification

Environmental Parameter	Receptor Sensitivity		
	Priority 1	Priority 2	Priority 3
Biodiversity	Flora, fauna species and habitats of high ecological value. (i.e., presence of conservation significant flora and fauna species; identified keystone species; flora species that is essential for the survival of threatened fauna species).	Flora, fauna species and habitats of moderate ecological value. (i.e., mainly native species of flora, fauna and habitats).	Flora, fauna species and habitats of low ecological value. (i.e., mainly exotic or cryptogenic flora, fauna and habitats; managed vegetation which can provide habitat for significant species).
Surface Water Resources (Hydrology)	Ecological Receptors		
	<ul style="list-style-type: none"> Aquatic habitats and/ or biocenosis of high ecological value that are highly dependent on surface water flow conditions and/ or quantities. Examples of fauna include fish, amphibians, odonates in aquatic or semi-aquatic habitats. Aquatic habitats and/ or biocenosis of high ecological value which would be permanently impacted by changes in surface water flow conditions. 	<ul style="list-style-type: none"> Aquatic habitats and/ or biocenosis of high ecological value that are resilient of changes in water quantities and water flow conditions. Terrestrial habitats of high ecological value that obtain water from multiple sources. 	<ul style="list-style-type: none"> Habitats and/ or biocenosis that are not of high ecological value Habitats and/ or biocenosis that will not be disturbed due to changes in existing hydrology
Surface Water Resources (Surface Water Quality)	Human Receptors		
	<ul style="list-style-type: none"> Humans within and in the vicinity of the Project Site whose activities would be permanently altered or prevented by changes in hydrology. Humans within and in the vicinity of the Project Site whose safety would be largely compromised. 	<ul style="list-style-type: none"> Humans within and in the vicinity of the Project Site whose activities would be temporarily altered or prevented. Humans within and in the vicinity of the Project Site whose safety would be moderately compromised. 	<ul style="list-style-type: none"> Humans within and in the vicinity of the Project Site whose activities would not be altered or prevented. Humans within and in the vicinity of the Project Site whose safety would not be compromised.
Surface Water Resources (Surface Water Quality)	Ecological Receptors		
	Aquatic or semi-aquatic habitats and its biocenosis of high ecological value with	Aquatic or semi-aquatic habitats and its biocenosis of medium ecological value with medium to high	<ul style="list-style-type: none"> Aquatic or semi-aquatic habitats and its biocenosis of low ecological value with high tolerance to

Environmental Parameter	Receptor Sensitivity		
	Priority 1	Priority 2	Priority 3
	low tolerance ² to changes in surface water quality.	tolerance to changes in surface water quality.	changes in surface water quality. • All terrestrial habitats
	Human Receptors		
	<ul style="list-style-type: none"> Protected waterbodies or waterbodies used for drinking water supply or aquaculture farms 	<ul style="list-style-type: none"> Waterbodies used for recreational purposes Waterbodies used for industrial and/ or agricultural water supply 	<ul style="list-style-type: none"> Waterbodies not used for beneficial purposes
Soil and Groundwater	Ecological Receptors		
	Flora species and its biocenosis of high ecological value with low tolerance to changes in soil and groundwater quality.	Flora species and its biocenosis of medium ecological value with moderate to high tolerance to changes in soil and groundwater quality.	Flora species and its biocenosis of low ecological value with high tolerance to changes in soil and groundwater quality.
	Human Receptors		
	Humans within and in the vicinity of the Project Site who may come into frequent direct contact with potentially contaminated soil, for short or prolonged durations, potentially causing harm to their health. Receptors of particular concern include on-site outdoor construction workers during site redevelopment and future on-site intrusive workers undertaking excavations.	Humans within and in the vicinity of the Project Site who may come into infrequent direct contact with potentially contaminated soil, potentially causing harm to their health.	Humans within and in the vicinity of the Project Site who comes into minimal to no direct contact with soil, thus not developing any health issues as a result of soil conditions.
Air Quality (Construction)	Ecological Receptors³		
	<ul style="list-style-type: none"> Flora, Fauna Species and Habitats of High Ecological Value within 20 m of construction worksite area 	<ul style="list-style-type: none"> Flora, Fauna Species and Habitats of High Ecological Value within 20 m to 50m of construction worksite area. 	<ul style="list-style-type: none"> Ecological sites having known sensitive communities within 20 m to 50 m of construction worksite area

² Tolerance to changes in surface water quality for identified ecological receptors will be determined with biodiversity specialists

³ As per UK IAQM [R-60], ecological receptor refers to any sensitive habitat affected by dust soiling. This includes direct impacts on vegetation or aquatic ecosystems of dust deposition, and the indirect impacts on fauna (e.g. on foraging habitats) if any. In terms of air quality impact assessment of this Project, only the direct impacts on flora of conservation significance or sensitive plant communities of large specimens which are the key species affected by dust deposition will be emphasised.

Environmental Parameter	Receptor Sensitivity		
	Priority 1	Priority 2	Priority 3
		<ul style="list-style-type: none"> Ecological sites⁴ having known sensitive communities within 20 m of construction worksite area. 	<ul style="list-style-type: none"> Any other ecological sites within the Study Area of 50 m.
	Human Receptors		
	<ul style="list-style-type: none"> Sensitive receptors⁵ (more than 100 receptors) within 50m of the construction area. Sensitive receptors (1-100 receptors) within 20m of the construction area. Office, industrial facilities, or shops (more than 10 receptors) within 20m of the construction area. 	<ul style="list-style-type: none"> Sensitive receptors (more than 100 receptors) between 50m to 100m of the construction area. Sensitive receptors (1-100 receptor) between 20m to 50m of the construction area. Office, industrial facilities, or shops (more than 10 receptors) within 20m to 50m of the construction area. Office, industrial facilities, or shops (1-10 receptors) within 20m of the construction area. 	<ul style="list-style-type: none"> Public footpath, playing fields and parks within 20m from the construction area. All other buildings within the 350m study boundary.
Air Quality (Operational)	Schools and education buildings, hospitals and medical centres, nursing homes, residential buildings, ecological sensitive site	Sport and recreation areas (outdoor)	Commercial, religious, infrastructure, industrial
Airborne Noise⁶	Ecological Receptors		
	Areas inhabited by fauna Conservation Significance (CS)/ non-CS species that use sound for communication, foraging and breeding, and are known to have their behaviours disrupted by increase in baseline noise (e.g., due to immobility from impacted area such as raptor nests).	Areas inhabited by species of Conservation Significance (CS) that are less affected by airborne noise; or CS species which have the ability to move away temporarily to neighbouring areas which are not impacted by the construction noise.	Area inhabited by species that are less affected by airborne noise and are not of Conservation Significance.

⁴ As per UK IAQM [R-60], ecological site refers to a site with international statutory designation (i.e. Special Conservation Areas (SACs), Special Protection Areas (SPAs) designated internationally under the Habitats Directive (92/43/EEC) and RAMSAR sites. Non-statutory sites (i.e. local wildlife sites) can be considered if appropriate.

⁵ Sensitive receptors for air impact assessment include residential blocks, hospitals, medical centre, schools and education and residential care home. This is according to classification made in the IAQM's guidance. Hawker centres shall also be checked.

⁶ The fact is that different species are likely to react differently to disturbance and that will be influenced by various other factors such as how percussive the noise is (e.g. from blasting and piling), how far away the receptor is generally, behaviour of the fauna, and other factors such as whether the species is feeding or breeding/nesting and in particular from the complication of visual disturbance (particularly humans on foot nearby).

Environmental Parameter	Receptor Sensitivity		
	Priority 1	Priority 2	Priority 3
	Human Receptors		
	Schools and Education Buildings, Place of Worship, Hospitals and Medical Centres, Nursing Homes.	Residential buildings	Other Buildings (Industrial, Commercial, Infrastructure, Sport & Recreation Areas, etc.).

6.3 Data Collection and Analysis

Collection of pre-construction environmental baseline data within the Study Area was conducted both from primary sources and secondary sources.

6.3.1 Primary Data Collection

The sampling and survey locations for baseline data collection were selected based on their proximity to the project and receptor priority. These locations were confirmed during a site reconnaissance survey. Information on sample collection and survey locations, timing and parameters are provided in Section 7 (Biodiversity), Section 8 (Hydrology and Surface Water Quality), Section 9 (Soil and Groundwater), Section 10 (Air Quality), and Section 11 (Airborne Noise).

6.3.2 Secondary Data Collection

Additional secondary data was collected from sources including, but not limited to, the following:

- Proposed Preliminary Land Use Plan of the Study Area
- Historical, current and future land uses
- Construction/operational boundary/footprint/phasing (e.g. CAD drawing format)
- Construction/operational schedule
- Aerial photographs
- Geological Map
- Existing biodiversity information in Study Area
- Any planned developments on the waterbodies in Study Area
- Weather data (rainfall, wind, humidity, evaporation)
- Existing topographical maps
- Existing catchment and drainage maps
- Previous environmental site assessment/ soil and groundwater investigation report (s) prepared for the site [including the ones prepared for CRL2 study completed by LTA [R-2, R-3, R-4]

Further information on secondary data collection is provided in Section 7 (Biodiversity), Section 8 (Hydrology and Surface Water Quality), Section 9 (Soil and Groundwater), Section 10 (Air Quality), and Section 11 (Airborne Noise).

6.4 Assessment Criteria

6.4.1 Prediction of Impacts

Key potential environmental impacts arising from the Project's construction and operational activities were assessed within the project scope. The methodology for the prediction of impacts is as given in Table 6-3

Table 6-3 Methodology for prediction of impacts

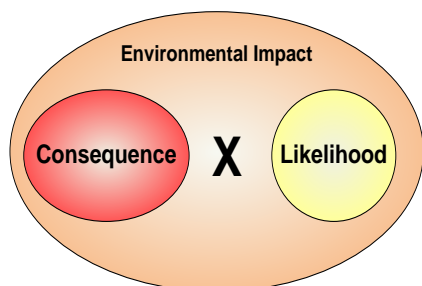
Environmental Parameter	Predictive Methods	Assessment Criteria	EIA Section
Biodiversity	Qualitative assessment to evaluate the ecological value of the habitats, floral and faunal species recorded within the Study Area. Sensitive receptors within the Study Area and within the immediate surrounding area (if any) which may be impacted by the Project's construction and operational activities will be identified. Sensitive receptors will be sub-categorised into three priority levels according to the Sensitive receptor classification in Table 6-2, depending on their ecological value. Thereafter, a qualitative impact assessment to evaluate the potential impacts (Table 6-7) from the Project's construction and operational activities on the identified sensitive receptors, taking into consideration the likelihood (Table 6-6) of impact occurrence will be conducted; where the likelihood depends on factors such as duration of impact. Suitable mitigation measures will then be recommended based on the assessed potential impacts.	Applicable legislation detailed in Table 5-1 and Table 5-2, more specifically the Wildlife Act [R-75] and the Parks and Trees Act [R-76].	Section 7
Surface Water Resource	Qualitative and analytical methods will be applied to assess hydrological and water quality impacts of the proposed development's construction and operational phases. For qualitative and analytical methods, the impact assessment on hydrology will be carried out using water catchment analysis approach (e.g. catchment delineation, etc.) on land use change of the Project Site. Impacts related to the stream alignment, potential runoff and water pollution will be identified. Qualitative water quality impact assessment will be carried out with the assumption that the related standard minimum controls have been implemented.	<ul style="list-style-type: none"> • Singapore Environmental Protection and Management (Trade Effluent) regulations [R-9]; • Singapore PUB Code of Practice on Surface Water Drainage, 2018 [R-13] • Singapore NParks Biodiversity Impact Assessment (BIA) Guidelines [R-7]; • Water Quality Criteria for Aquatic Life from other countries including ASEAN Strategic Plan of Action on Water Resources Management 2005 [R-53], United Nations Economic Commission for Europe [R-59], World Health Organization (WHO) [R-44], United States Environmental Protection Agency [R-45], Mitigating Impact from Aquaculture in the Philippines [R-48], Canadian Water Quality Guidelines for the Protection of Aquatic Life [R-47] and Australian & New Zealand Guidelines for Freshwater and Marine Water Quality [R-46] 	Section 8
Soil and Groundwater	Qualitative and analytical assessment to identify and evaluate the potential impact of construction and operation phases to the	The soil laboratory analytical results will be compared against the DIV of the Dutch Environmental Guidelines Soil Remediation Circular.	Section 9

Environmental Parameter	Predictive Methods	Assessment Criteria	EIA Section
	<p>existing soil quality, that may impact the local vegetation and downstream waterbodies within the Study Area.</p>	<p>The EIA will be supplemented by the soil analytical results from previous environmental impact assessment carried out by LTA if available.</p>	
<p>Air Quality</p>	<p><u>Construction Phase</u> Qualitative Assessment following dust risk assessment methodology focusing on fugitive particulate emissions (dust) from the construction site. Dust Risk Assessment will be conducted for earthworks, construction, trackout and demolition (if any) activities during the construction. Study will be conducted using parameters like volume of spoil, volume of concrete used, area of construction site, number of vehicles and access routes for construction, and soil type of the construction worksite area. <u>Operational Phase</u> Qualitative assessment will be conducted to assess air quality impacts of the development operational phases due to increased traffic in the vicinity of the Project. Criteria pollutants, such as NO₂, CO, SO₂, PM₁₀, and PM_{2.5} will be assessed qualitatively.</p>	<p><u>Construction Phase</u> Assessment broadly follows “Guidance on the Assessment of Dust from Demolition and Construction” which was published by the UK Institute of Air Quality Management (IAQM) in 2014. <u>Operational Phase</u> Compare the change in predicted increase in traffic volume to the Project and access routes in the vicinity of the Project if data is available.</p>	<p>Section 10</p>
<p>Airborne Noise</p>	<p><u>Construction Phase</u> Qualitative assessment of noise in Decibels (dB) generated from construction activities within the Project Site based on the Singapore standard SS602:2014 “Code of Practice (CP49) for Noise Control on the Construction and Demolition Sites; and British Standard BS5228-1:2009 , given the detailed equipment list of construction activities is not available at master planning stage. Qualitative assessment of the cumulative impacts from nearby activities surrounding the proposed Project. <u>Operational Phase</u> Qualitative assessment will be conducted to assess operational airborne noise impacts due to increased traffic and potential operational noise emissions from utility/ commercial buildings in the vicinity of the Project.</p>	<p><u>Construction Phase</u> Environmental Protection and Management (Control of Noise at Construction Sites) Regulations, 2008. There are local and international policies in place to address the impacts of airborne noise on human health and well-being. It is not possible to infer the impacts of noise on biodiversity from the impacts on human. This is because the auditory sensitivities for fauna are very different from those of humans. Currently, noise criteria for human is based on a listening frequency range of 20Hz to 20 kHz and the human threshold for audibility, whereas, depending on the species that is being studied, it may have comparable, better or worst hearing capabilities compared to human. The assessment will be conducted on identified species which have sufficient evidence to indicate that noise is causing significant impacts on their behaviour and movement patterns. Baseline noise for weekdays shall be used as the criteria to be maintained preferably for the fauna in the intact non disturbed areas of the development. A no</p>	<p>Section 11</p>

Environmental Parameter	Predictive Methods	Assessment Criteria	EIA Section
		<p>worse off criteria step change of 3 dB similar to humans shall be used to devise the criteria for low, medium, and high impacts for impact intensity.</p> <p><u>Operational Phase</u></p> <p>Guideline on Boundary Noise Limit for Air Conditioning and Mechanical Ventilation Systems in Non-Industrial Buildings by National Environmental Agency (NEA)</p> <p>Traffic noise with the NEA Technical Guideline for Land Traffic Noise Impact Assessment, 2023 [R-34] for noise sensitive and residential building receptors.</p>	

6.4.2 Evaluation of Impacts

Impacts were evaluated based on their significance, which is a measure of the weight that should be given to each impact in decision making and if it warrants impact management. It was assessed using the following two factors in the Impact Significance Assessment Matrix (refer to Table 6-7) as detailed below and in the following sections.



- **Impact Consequence:** The consequence of an impact is a function of a range of considerations including impact spread, impact duration, impact intensity and nature, legal and guideline compliance;
- **Likelihood of Occurrence:** The likelihood of the impact occurring in life of the project.

6.4.2.1 Impact Consequence

In evaluating the consequence of environmental impacts, the following aspects were taken into consideration:

- **Receptor Sensitivity:** categorises receptors according to their susceptibility to adverse impacts from the Projects construction and operational phases (refer to Table 6-2);
- **Impact Intensity:** defines the magnitude of the impact and the status of the impact in relation to environmental parameters of interest, based on regulations (e.g. discharge limits), standards (e.g. environmental quality criteria) and guidelines. The criteria presented in Table 6-4 were used to categorise the impact intensity.

Table 6-4 Evaluation of impact intensity for construction and operational phases

Environmental Parameters	Impact Intensity			
	Negligible	Low	Medium	High
Biodiversity-Habitats	Potential impacts with no detectable changes to viability/function of habitats	Potential impacts with small temporal and spatial (localised) scale changes that could affect part of the habitat but does not cause the loss of viability/function of the habitat	Potential impacts with moderate duration and/or over a considerable spatial scale changes that could affect part of the habitat but does not threaten the long-term viability/function of the habitat	Potential impacts with extensive duration and large spatial scale that affects the entire habitat, or a significant proportion of it, and could affect the long-term viability/function of the habitat
Biodiversity – Flora and Fauna	No expected changes to the ecologically sensitive receptors and/or individuals	Short duration and small-scale localised spatial changes that could cause minimal changes to the ecologically sensitive receptors and/or individuals	Moderate duration and medium-scale spatial changes that could cause moderate effects on the ecologically sensitive receptors but would not threaten long-term viability	Extended duration and large-scale spatial changes that could cause substantial effects on the ecologically sensitive receptors and threaten long-term viability

Environmental Parameters	Impact Intensity			
	Negligible	Low	Medium	High
Hydrology	Very minor change to existing hydrology and flow.	Small scale localised changes to existing hydrology or flow.	Medium scale changes to existing hydrology or flow.	Major changes to existing hydrology or flow.
Surface Water Quality	No contamination; or Likely to be well within regulatory limits.	Small scale localised contamination within regulatory limits.	Medium scale contamination to just exceeding regulatory limits.	Large scale contamination exceeding regulatory limits.
Soil and Groundwater	No contamination; or minimal detection of analysed parameters below the values of the adopted screening criteria. No decrease in observed groundwater levels.	Small scale localised contamination, which is unlikely to extend beyond the Study Area. Exceedance of analysed parameters within the values of secondary screening criteria. Small scale localised decrease in groundwater levels, which is unlikely to extend beyond the Study Area.	Medium scale contamination, which is likely to extend beyond the Study Area. Exceedance of analysed parameters within the values of a Tier 2 study. Medium scale decrease in groundwater level that possibly extends beyond the Study Area.	Large scale contamination which is likely to extend beyond the Study Area. Exceedance of analysed parameters exceeds both secondary screening criteria and Tier 2 study. May require remediation to be conducted. Large scale decrease in groundwater level that is likely to extend far beyond the Study Area
Air Quality (Construction Phase) ¹	-	For Earthworks: <ul style="list-style-type: none"> Total site area <2,500 m² Soil type with large grain size (e.g. sand) <5 heavy earth moving vehicles active at any one time Formation of bunds <4 m in height Total material moved <20,000t Earthworks during wetter months 	For Earthworks: <ul style="list-style-type: none"> Total site area 2,500 m³ – 10,000 m³ Moderately dusty soil type (e.g. silt) 5-10 heavy earth moving vehicles active at any one time Formation of bunds 4 m - 8 m in height Total material moved 20,000-100,000t 	For Earthworks: <ul style="list-style-type: none"> Total site area >10,000 m² Potentially dusty soil type (e.g. clay, which will be prone to suspension when dry due to small particle size) >10 heavy earth moving vehicles active at any one time Formation of bunds >8 m in height Total material moved >100,000t
	-	For Construction: <ul style="list-style-type: none"> Total building volume <25,000 m³ Construction material with low potential for dust release (e.g. 	For Construction: <ul style="list-style-type: none"> Total building volume 25,000-100,000 m³ Potentially dusty construction 	For Construction: <ul style="list-style-type: none"> Total building volume >100,000 m³ On-site concrete batching Sandblasting

Environmental Parameters	Impact Intensity			
	Negligible	Low	Medium	High
		metal cladding or timber)	material (e.g. concrete) • On-site concrete batching	
	-	For Trackout: • <10 HDV (>3.5t) outward movements in any one day • Surface material with low potential for dust release • Unpaved road length <50 m	For Trackout: • 10-50 HDV (>3.5t) outward movements in any one day • Moderately dusty surface material (e.g. high clay content) • Unpaved road length 50-100 m	For Trackout: • >50 HDV (>3.5t) outward movements in any one day • Potentially dusty surface material (e.g. high clay content) • Unpaved road length >100 m
	-	For Demolition: • Total building volume <20,000 m ³ • Construction material with low potential for dust release (e.g. metal cladding or timber) • Demolition activities <10m above ground • Demolition during wetter months	For Demolition: • Total building 20,000 – 50,000 m ³ • Potentially dusty construction material • Demolition activities 10-20 m above ground level	For Demolition: • Total building >50,000 m ³ • Potentially dusty construction material (e.g. concrete) • On-site crushing and screening • Demolition activities >20m above ground level
Air Quality (Operational Phase)	No increase in air quality pollutant levels in the vicinity of stations due to Project operation	Small scale increase in air quality pollutant levels in the vicinity of stations due to Project operation	Medium scale increase in air quality pollutant levels in the vicinity of stations due to Project operation	Large scale increase in air quality pollutant levels in the vicinity of stations due to Project operation
Airborne Noise (Construction and Operational Phase)	<u>Human Receptor:</u> Just noticeable, non-intrusive, increase in noise levels: • Noise can be heard but does not result in any change in behaviour or attitude. • Can slightly affect the character of the area but not such that there is a perceived change in quality of life.	<u>Human Receptor:</u> Noticeable, mildly intrusive, increase in noise levels: • Noise can be heard and may cause small changes in behaviour and/or attitude. Potential for non-awakening sleep disturbance. • Can slightly affect the character of the area but not such that there is a perceived	<u>Human Receptor:</u> Noticeable, disruptive, increase in noise levels: • Causes an important change in behaviour and/or attitude during periods of intrusion. • Potential for sleep disturbance resulting in difficulty in getting to sleep, premature awakening, and difficulty in	<u>Human Receptor:</u> Noticeable, very intrusive, increase in noise levels: Significant changes in behaviour and/ or an inability to mitigate effect of noise leading to psychological stress or psychological effects.

Environmental Parameters	Impact Intensity			
	Negligible	Low	Medium	High
		change in quality of life.	getting back to sleep. <ul style="list-style-type: none"> Quality of life diminished due to change in character of area. 	
	<u>Ecological Receptor:</u> No detectable change to fauna.	<u>Ecological Receptor:</u> Potential impacts last a short duration, are reversible and/or of a small magnitude for species with low auditory sensitivity level.	<u>Ecological Receptor:</u> Potential impacts last for a moderate duration, are reversible with significant input and compensatory measures, and/or of a moderate magnitude for species with medium auditory sensitivity level.	<u>Ecological Receptor:</u> Potential impacts last for a long time, are non-reversible, and/or of a significant magnitude for species with high auditory sensitivity level.
Notes: <ol style="list-style-type: none"> (1). This impact intensity criterion is equivalent to the Emission Magnitude as defined in IAQM's Guidance [R-60]. (2). Heavy duty vehicles (HDV) defined as vehicles with a gross weight greater than 3.5 tonnes. (3). The Flora & Fauna Specialist will be consulted to identify the species sensitivity to the potential change to their habitat, conservation status and foraging regime. 				

A consequence category is then derived based on receptor sensitivity and impact intensity, as shown in Table 6-5. The air quality impact assessment uses matrices specific to the Institute of Air Quality Management (IAQM) Guidance on the assessment of dust from demolition and construction [R-26] and these are provided in Section 10.2.

Table 6-5 Impact consequence matrix

Sensitivity	Priority 3	Priority 2	Priority 1
Impact Intensity			
Negligible	Imperceptible	Imperceptible	Very Low
Low	Very Low	Very Low	Low
Medium	Very Low	Low	Medium
High	Low	Medium	High

6.4.2.2 Likelihood

Likelihood is estimated on the basis of experience and/or evidence that such an outcome has previously occurred. Impacts resulting from routine/planned events (normal operations) are classified under High Likelihood.

Table 6-6 Likelihood criteria

Likelihood Criteria	Definition for All Environmental Parameters	Definition for Airborne Noise (Construction)
Unlikely/ Remote	Would be unlikely or not expected to occur during construction and operational activities.	Frequency of exposure of less than 5% to active duration of equipment over daily working period.
Less Likely/ Rare	Would less likely/ rarely occur during construction and operational activities.	Frequency of exposure of 5% and up to 15% to active duration of equipment over daily working period.
Possible/ Occasional	Would possibly/ occasionally occur during construction and operational activities.	Frequency of exposure of 15% and up to 25% to active duration of equipment over daily working period.
Likely/ Regular	Would likely to occur or would occur on a regular basis during construction and operational activities.	Frequency of exposure of 25% and up to 50% to active duration of equipment over daily working period.
Certain/ Continuous	Would be certain to occur or would occur continuously during construction and operational activities.	Frequency of exposure of more than 50% to active duration of equipment over daily working period.
References:		
<ol style="list-style-type: none"> 1. Ecological Impact Assessment (EclA). EIANZ Guidelines for use in New Zealand: terrestrial and freshwater ecosystems. 2nd Edition. May 2018. [R-29] 2. CIEEM (2018). Guidelines for ecological impact assessment in the UK and Ireland: Terrestrial, Freshwater and Coastal. September 2018. [R-30]. 		

6.4.2.3 Impact Significance

The significance of each impact will be determined by assessing the impact consequence against the likelihood of the impact occurring using the Impact Significance Assessment Matrix. A simple risk-based matrix will be used for summation of consequence and likelihood, a sample of which is shown below.

Table 6-7 Impact significance matrix

Consequence Likelihood	Imperceptible	Very Low	Low	Medium	High
Unlikely/ Remote	Negligible	Negligible	Negligible	Negligible	Negligible
Less Likely/ Rare	Negligible	Negligible	Minor	Minor	Minor
Possible/ Occasional	Negligible	Minor	Minor	Moderate	Moderate
Likely/ Regular	Negligible	Minor	Moderate	Moderate	Major
Certain/ Continuous	Negligible	Minor	Moderate	Major	Major

Positive impacts are classified under a single category. Impacts assessed as negligible or minor will require no additional management or mitigation measures (on the basis that the magnitude of the impact is sufficiently small, or that the receptor was of low sensitivity and/or that adequate controls were already included in the Project design). Negligible and minor impacts are therefore deemed to be “Insignificant”. Impacts evaluated as moderate or major require the adoption of management or mitigation measures. Major impacts are therefore deemed to be “Significant” and moderate impact as “Relatively Significant”. Major impacts always require further management or mitigation measures to minimise or reduce the impact to an acceptable level.

An “acceptable level” is the reduction of a major impact to a moderate one after mitigation. In seeking to mitigate moderate impacts, the emphasis is on demonstrating that the impact has been reduced to a level that is as low as reasonably practicable. It will not always be practical to reduce moderate impacts to minor ones in consideration of the cost-ineffectiveness of such an approach (due to the diminishing return of a reduction of impact versus cost). Residual impact assessment shall be conducted for those parameters where impact from the activity is identified to be significant and additional mitigation measures are recommended. Positive impacts were not assessed for significance. Assessment of residual impact shall follow similar risk approach as outlined above.

6.5 Mitigation of Impacts and Environmental Monitoring and Management Plan (EMMP)

Where implemented minimum controls are insufficient in alleviating significant environmental construction and operational impacts (i.e. ‘significant impacts’ are defined as ‘moderate’ or ‘major’ impacts), Project-specific mitigation measures will be proposed in consultation with the URA. Where applicable and practical, engineering control measures will be accompanied by specifications (product brochures), estimated cost and source of supply. In addition, mitigation measures at receptors’ end will also be recommended on a case-by-case basis. For example, if the unmitigated construction noise levels are found to exceed the relevant criteria, practical direct mitigation measures such as the use of noise barriers, enclosures, quieter powered mechanical equipment (PME) and construction methods, etc, will be recommended. Effective dust control measures will be recommended to minimise dust emission from the site, where necessary. Mitigation measures will be proposed in accordance with the following hierarchy in line with Biodiversity Impact Assessment (BIA) Guidelines published by NParks in 2020 [R-7]:

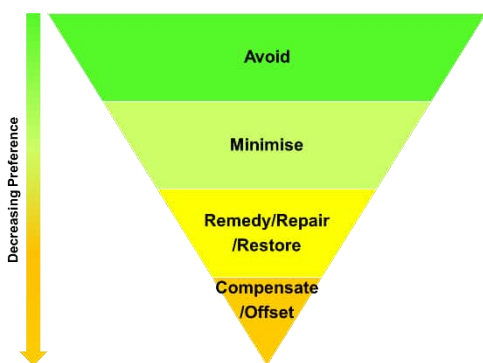


Figure 6-2 Mitigation hierarchy

- **Avoid** – Where changes to the Project design and construction/ operation methodology can be made to eliminate or avoid an identified impact (e.g. through optimisation or reduction of construction footprint, shifting or elimination of construction site in critical areas, etc.). Baseline findings and impact assessment (both quantitative and qualitative) will aim to assess the extent of impacts and critical pathways and subsequently inform the decision making in construction/ operational approaches which could potentially reduce the adverse impact. If a full elimination is not possible, the next level of mitigation is to minimise the identified impact.

- **Minimise** – Where changes to the Project design and construction/ operation methodology cannot affect impact elimination or avoidance, use of alternative construction methodology or any enhancement measures can be adopted to

minimise for identified impacts. For example, a wildlife shepherding plan and wildlife corridor will be proposed to ensure that animals trapped within the site can escape into the surrounding vegetation.

- **Remedy/ Repair/ Restore** – Where changes to the Project design and construction/ operation is unable to result in impact avoidance and impact minimisation, restoration methodology can be applied after construction is completed to remedy/ repair/ restore the ecological habitat as much as possible. For example, after construction, appropriate trees and shrubs can be replanted in appropriate locations within the impacted site to restore part of the habitat.
- **Compensation/ Offset** – Where measures taken to compensate or offset the residual impacts after implementing the first three steps of the mitigation hierarchy, wherever technically and financially feasible. An example would be the transplanting of rare shrubs or trees to other suitable sites in consultation with government authorities, etc.

Subsequently, a construction and operational phase EMMP will be formulated to specify mitigation measures, monitoring scope, methodology and locations, and triggers to report and escalate irregularities in the environmental conditions during construction and operational stages. An additional vector and waste management plan generated by contractor will also be included in the EMMP, as construction activities tend to contribute to the occurrence and breeding of vectors (e.g. mosquitoes, rats, etc), leading to the spread of vector-borne disease.

6.6 Baseline Approach and Methodology

A baseline study aims to establish the extent and conditions of the existing environment that may be potentially affected by the execution of the proposed Project. The baseline study provides the basis for the prediction of potential impacts of the Project across each environmental parameter. The collection of baseline environmental status at the Study Area will be conducted using both primary and secondary sources and will help to identify sensitive receptors.

The primary data will be collected via:

- Review of the future development plan provided by relevant Agencies;
- Site reconnaissance to confirm existing conditions of baseline environment, including site accessibility; and
- Site surveys, sampling and monitoring to assess the existing environmental conditions.
- Additional secondary data will be collected for the following aspects:
 - Review of other available environmental surveys (if any) previously carried out within or in the vicinity of the Project site (e.g. ecological surveys, topography surveys, environmental site investigation/ environmental site assessment/ environmental baseline study, etc.);
 - Proposed site infrastructure installation methodology and layout, including the Project schedule and construction equipment used;
 - Existing topographical data of the site;
 - Catchment and drainage maps;

- Commercial and recreational activities (within and surrounding the Project site);
- Aerial photographs and satellite images;
- Weather data (rainfall, wind, temperature, humidity);
- Historical and current land uses;
- Information of ongoing developments in the vicinity;
- Interviews and consultations with various agencies; and
- Publicly available data, existing literature, books (e.g. online sources)
- Online databases;
- Regional and local drainage maps of the catchment area; and
- Geological maps.

6.6.1 Safety Contingency Plan

All on-site personnel shall be in general compliance with the requirements of the Health and Safety Plan (HASP) and Job Safety Risk Assessment developed for this site and which are respectively presented in Appendix A and Appendix B. All field surveys shall be conducted in accordance with AECOM safety procedures and requirements as documented in the HASP and Job Safety Risk Assessment.

All personnel completing the onsite baseline surveys shall be formally inducted with the HASP and Job Safety Risk Assessment. Subcontractors may follow the HASP and Job Safety Risk Assessment prepared by AECOM but it is expected that they have their internal policies and procedures in terms of health and safety. The subcontractors may adopt the HASP and Job Safety Risk Assessment prepared by AECOM at their own risk. To note that biodiversity team has developed its own safety plan which is presented in Appendix C for the biodiversity surveys.

Potential hazards that may be encountered during the field surveys are enumerated in the HASP and Job Safety Risk Assessment. Appropriate mitigation measures are included to lower the identified risk as low as reasonably practicable (ALARP). The AECOM Project Manager shall coordinate activities and meetings with AECOM subcontractors in order to ensure that tasks associated with the Projects are completed smoothly.

6.7 Stakeholder Engagement

It is known that effective communication and cooperation between various expert groups, the Client and other stakeholders can minimise risks throughout the project delivery process. During this Study, three (3) dialogue sessions were conducted with Nature Group representatives. The purpose of these sessions were to share the environmental study findings, the proposed plans for the area, the associated environmental impact assessment and the proposed environmental monitoring and management plan (EMMP) to mitigate the environmental impact. Feedback from Nature Group representatives were taken into consideration as part of the study.

7 Biodiversity

7.1 Introduction

The biodiversity baseline study aims to establish baseline biodiversity information of the Study Area. Baseline information was first gathered through reviews of past and present biodiversity records, published literature, and in consultation with taxonomic experts. Field surveys were then carried out. Through desktop and field assessments, important habitats, species of flora and fauna of conservation significance were identified. The information was then used to identify core conservation areas and key potential ecological corridors for wildlife. The baseline information was also used to evaluate the extent of impacts that may arise from the proposed development, as well as to recommend mitigation measures to address these impacts.

7.2 Methodology

The biodiversity study areas add up to a total of 193 ha (Figure 3-1). They comprise six zones (Sites A–F) within the Former Turf Club.

7.2.1 Desktop Assessment

7.2.1.1 Land Use History

Historical and present-day land use of the Study Area was reviewed. Information on land use history was primarily gathered from old maps in the online collection of the National Archives of Singapore (NAS) [M-2], historical maps on the OneMap [M-6], and the NUS Libraries portals [M-3].

7.2.1.2 Taxonomy and Nomenclature

Past and present floristic as well as faunistic species composition was examined using relevant key references that include books, scientific publications, unpublished literature, and online databases.

Key local and/or regional references for the various taxonomic groups are listed in Table 7-1.

Table 7-1 Key references for the nomenclature and taxonomy for each taxonomic group

Taxon	Key References
Plants	Red Data Book 3 [W-20]; Lindsay et al. (2022) [P-52]; Chong et al. (2009) [P-2]
Odonates	Red Data Book 3 [W-20].
Butterflies	Red Data Book 3 [W-20].
Aculeate hymenopterans	Ascher and Pickering (2018) [P-82]; Ascher et al (2022) [P-55].
Herpetofauna	Red Data Book 3 [W-20].
Birds	Gill et al. (2022) [P-65]
Mammals (including bats)	Red Data Book 3 [W-20].
Freshwater fish	Kottelat (2013) [P-61]; Ho et al. (2016) [P-63]; Suzuki et al. (2015) [P-62]
Freshwater decapod crustaceans and molluscs	Ng (1997) [P-59], Cai et al. (2007) [P-60], Tan et al. (2012) [P-64]
Spiders	Koh et al. (2022) [P-71]

7.2.1.3 Preliminary Species List

A list of species of fauna likely to occur at the Study Area (termed “species of probable occurrence”) was compiled using information on the existing habitat types and past records of fauna up to 2 km from the Study Area.

7.2.1.4 Species of Conservation Significance

The assessment of whether certain species are of conservation significance is important for highlighting the need and priorities for conservation. Threatened species of flora—i.e., listed in the Singapore Red Data Book 3 [W-20] and Lindsay et al. (2022) [P-52] as nationally Vulnerable, Endangered, Critically Endangered, or Presumed Extinct (which indicates a rediscovery)—was assessed to determine whether they are of conservation significance. While

the national conservation status of threatened species is true of wild populations that originate in an area without direct or indirect human intervention, some populations may be relics that persist from past cultivation or escapees from present-day cultivation that do not belong to native genetic stock.

The assessment of whether a threatened species is of conservation significance was based on, but not limited to, information on the following: (1) land use history, (2) presence of large parent tree(s), (3) commercial availability, (4) data from previous environmental impact assessments, (5) reforestation efforts, (6) natural range, and (7) importance for associated fauna. Where the origin of a threatened species population was disputable or difficult to determine, findings from field surveys of fauna and/or the more conservative approach were considered and the species of interest were considered to be of conservation significance. In carrying out such assessments, conservation needs can then be prioritised and resources focused on conserving them.

Faunal species of conservation significance include both threatened species, as well as non-threatened species of interest. Threatened species of fauna are native species listed as nationally or globally Vulnerable, Endangered, Critically Endangered, or Extinct. The national conservation statuses referenced the Singapore Red Data Book 3 [W-20], and other more updated local checklists, where available. The global conservation status referenced the Red List of Threatened Species by the International Union for Conservation of Nature (IUCN, 2023) [R-6].

Information on Sunda pangolin (*Manis javanica*) roadkill, sightings, and rescues were obtained from the Singapore Pangolin Working Group and ACRES to aid in the analysis of existing gaps in ecological connectivity (unpublished data).

7.2.2 Field Surveys

7.2.2.1 Site Reconnaissance

Site reconnaissance surveys were conducted to obtain an initial understanding of the existing habitats and biodiversity. Field observations were then used for planning and execution of the actual surveys. The main objectives of the reconnaissance survey were:

- Determine site accessibility and terrain
- Conduct a preliminary assessment to determine the dominant vegetation types
- Identify locations of existing natural permanent waterbodies, such as streams, ponds, and swampy areas (if any)
- Mark out survey sampling routes and points, and potential locations for camera traps

7.2.2.2 Floristic Field Assessment

The field assessment for flora comprised: (1) habitat and vegetation mapping; (2) general walking floristic surveys; (3) vegetation plot sampling; and (4) tree mapping.

7.2.2.2.1 Habitat Mapping

A preliminary vegetation map was first prepared based on visual interpretations of satellite images from Google Earth 7.1.2.2041 [O-1]. Preliminary classification of the vegetation types—for example, forests, grasslands, or urban vegetation—was determined using visual features, such as textures and colours, observed in the satellite images. Adjustments were then made to the preliminary maps according to actual observations during ground truthing. Ground truthing was conducted throughout the survey area with the aid of a GPS receiver (Garmin GPSMap® 64s). Photographs of the vegetated areas were also taken. The boundaries of each vegetation type were tracked on the GPS receiver and mapped out on Google Earth 7.1.2.2041 [O-1]. The classification of vegetation types referenced NParks [R-41].

7.2.2.2.2 General Walking Surveys

All plants observed within the Study Area during floristic surveys were identified to species whenever possible. A checklist of all the plant species recorded from the present floristic surveys was compiled. The nomenclature and national conservation status follow that of the Singapore Red Data Book 3 [W-20], Lindsay et al. (2022) [P-52], and/ or other published papers with updated information.

For plants that could not be immediately identified with certainty in the field, photographs and/ or voucher specimens were taken. They were then identified using identification keys, taxonomic descriptions, online plant

photo databases, with the help of taxonomic experts, and/ or by matching the pressed and dried collected specimens with existing specimens in the Singapore Botanic Gardens' Herbarium (SING).

For very tall unidentifiable trees with leaves that are too high in the canopy to photograph, dried leaves matching these trees were collected from the forest floor and used to aid in species identification.

7.2.2.2.1 Species of Conservation Significance

The geographic locations of plants of conservation significance—as defined in Section 7.2.1.4—were marked using a Global Positioning System (“GPS”) receiver (Garmin GPSMap® 64s). Where there were clusters of plants of conservation significance—i.e., more than one individual occurring within 5 m or less of another individual—the approximated centre of the area will be marked using the GPS receiver.

7.2.2.2.2 Large Plant Specimens

Similarly, the GPS receiver was used to record locations of all trees of ≥ 3 m girth, as well as bamboo clusters, palm clusters, and strangling *Ficus* species of ≥ 3 m spread. Individuals were identified to species whenever possible. The girth (for trees) and spread (for bamboo clusters, palm clusters, and strangling *Ficus* species) were measured and estimated, respectively. The height of all specimens was also estimated.

7.2.2.2.3 Other Plant Specimens of Value

Locations of other plants that are of value but do not meet the minimum size requirement, as detailed above, were also recorded using the GPS receiver. Examples of such include bamboo clusters of < 3 m spread that may be important refugia for rare bamboo bats, exotic albizia trees (*Falcataria falcata*) with raptor nests, amongst others.

7.2.2.2.3 Vegetation Plot Sampling

In addition to the thirteen 20×20 m vegetation plots completed during the concurrent studies [R-1], five additional plots of the same size were set up at the new sites. The number of plots in each site was determined based on the sampling density of one plot for every 5 ha of spontaneous vegetation. Hence, the number of vegetation plots is proportionate to the relative size of the spontaneous vegetation within the site, i.e., vegetation that occurs naturally and is neither manicured nor managed by humans.

Locations of the vegetation plots was first randomly generated. The actual locations were then adjusted on-site based on accessibility and suitability, i.e., not covered in dense vegetation and/or tree falls that would render the site inaccessible. All tree specimens of ≥ 0.05 m girth were identified to species and the girths measured. The number of tree specimens of < 0.05 m girth were also counted. All other vascular plant species observed in the plots were also recorded.

7.2.2.2.4 Tree Mapping

Tree mapping was carried out for the entire Study Area. All trees, single-stemmed palms (i.e., defined as having one obvious and erect stem), and strangling *Ficus* species of ≥ 1.0 m girth or spread were tagged with a unique serial number. Specimens listed as nationally threatened and of ≥ 0.3 m girth were also tagged. All geographic locations, girth/spread and height of the tagged specimens were recorded.

A Differential Global Positioning System (DGPS) receiver (Hi-Target Qmini A5 handheld data controller with the V-90 GNSS receiver and Leica DISTO™ D510 touch rangefinder or CHC® Navigation HCE320 GNSS data controller with the CHC® Navigation i90 Pro GNSS receiver and Leica DISTO™ D810 touch rangefinder) were used to record the geographic locations of the specimens using the SVY21 plane coordinate system.

Specimens that could not be assessed owing to physical obstructions such as fallen branches were not tagged with a physical tag, but their locations were still recorded using the DGPS.

7.2.2.3 Faunistic Field Assessment

Field surveys of fauna were carried out for the following taxa: (1) butterflies, (2) odonates (damselflies and dragonflies), (3) hymenopterans (bees and wasps), (4) herpetofauna (amphibians and reptiles), (5) birds, (6) mammals (including bats), (7) freshwater aquatic fauna (fish, decapod crustaceans and molluscs), and (8) spiders. Opportunistic sightings of species of conservation significance from the aforementioned taxa were also recorded.

The routes, locations and number of sampling units (Figure 7-1) were finalised upon completion of all site reconnaissance surveys. Table 7-2 summarises all the surveys that were carried out. The sampling efforts are consistent with the previous baseline study [R-1], except for spider surveys which were not carried out then. Each cycle of surveys was conducted twice, at least two weeks apart, unless otherwise stated. Each survey was performed by at least two surveyors. All fauna encountered were identified to species, or to the next lowest taxonomic level possible, and the location of each individual recorded using a handheld GPS (Garmin GPSMAP 64s). The number of individuals observed was also recorded.

Table 7-2 Summary of fauna surveys

Survey Type	Taxon	Timing (h)	Duration	Sampling Unit*	Replicates per sampling unit	Technique
Transect surveys	Butterflies	0900–1600	20–30 minutes per transect	200-m continuous transects along a sampling route	2	Visual only; up to 10 m left, right, and front of surveyor
	Odonates (damselflies and dragonflies)	0900–1600	20–30 minutes per transect	200-m continuous transects along a sampling route	2	Visual only; up to 10 m left, right, and front of surveyor
	Hymenopterans (bees and wasps)	0900–1600	20–30 minutes per transect	200-m continuous transects along a sampling route	2	Visual only; up to 10 m left, right, and front of surveyor
	Herpetofauna (amphibians and reptiles)	0700–1000; 2000–2300	20–30 minutes per transect	200-m continuous transects along a sampling route	2	Visual and auditory; up to 50 m left, right, and front of surveyor
	Birds	0700–1000; 2000–2300	20–30 minutes per transect	200-m continuous transects along a sampling route	2	Visual and auditory; up to 50 m left, right, and front of surveyor
	Mammals (non-volant)	0700–1000; 2000–2300	20–30 minutes per transect	200-m continuous transects along a sampling route	2	Visual and auditory; up to 50 m left, right, and front of surveyor

Survey Type	Taxon	Timing (h)	Duration	Sampling Unit*	Replicates per sampling unit	Technique
	Mammals (bats)	2000–2300	20–30 minutes per transect	200-m continuous transects along a sampling route	2	Visual only; up to 25 m left, right, and front of surveyor
Aquatic point counts	Odonates (damselflies and dragonflies)	0900–1600	20 minutes per point (following the previous baseline study [R-1])	Sampling points at waterbodies (at 100-m intervals along the lengths or perimeters for streams and ponds, respectively, following the previous baseline study [R-1])	2	Visual only; up to 10 m from sampling point or the extent of waterbodies, whichever is smaller
	Herpetofauna (amphibians and reptiles)	0900–1600; 2000–2300	5 minutes per point (following the previous baseline study [R-1])	Sampling points at waterbodies (at 100-m intervals along the lengths or perimeters for streams and ponds, respectively, following the previous baseline study [R-1])	2	Visual and auditory; up to 25 m from sampling point or the extent of waterbodies, whichever is smaller
	Aquatic fauna (fish, decapod crustaceans, and molluscs)	0900–1600; 2000–2300	5 minutes per point (following the previous baseline study [R-1])	Sampling points at waterbodies (at 100-m intervals along the lengths or perimeters for streams and ponds, respectively, following the previous baseline study [R-1])	2	Visual only; up to 25 m from sampling point or the extent of waterbodies, whichever is smaller
Camera trapping	Mammals (non-volant)	24 hr/day for forest camera traps, 1900–	60 days per camera trap	24-h continuous period of recording on a camera trap;	–	Infrared motion sensing

Survey Type	Taxon	Timing (h)	Duration	Sampling Unit*	Replicates per sampling unit	Technique
		0700h for road camera traps		12-h continuous period of recording on a road camera trap (for connectivity study)		
Bioacoustics surveys	Mammals (bats)	2000–2300	20–30 minutes per transect	200-m continuous transects along a sampling route	2	Auditory only
Roost emergence surveys	Mammals (bamboo bats only)	1830–2100	Once per bamboo cluster	Bamboo clusters (if any)	–	Visual and auditory
Harp Trapping	Mammals (bats)	1930 on Day 1 to 0800 on Day 2	Overnight	Harp trap	–	Live trapping
Mist netting	Mammals (bats)	1930-2100	–	Mist net	–	Live trapping
Push, scoop, and cast netting	Aquatic fauna (fish, decapod crustaceans, and molluscs)	0900–1600	5 minutes per netting event (following the previous baseline study [R-1])	Sampling points at waterbodies (at 100-m intervals along the lengths or perimeters for streams and ponds, respectively and where feasible, following the previous baseline study [R-1])	2	Live trapping
Minnow trapping	Aquatic fauna (fish and decapod crustaceans)	1930–1200	Overnight	Sampling points at waterbodies (at 100-m intervals along the lengths or perimeters for streams and ponds, respectively and where feasible,	1	Live trapping

Survey Type	Taxon	Timing (h)	Duration	Sampling Unit*	Replicates per sampling unit	Technique
				following the previous baseline study [R-1])		
Visual point count	Spiders	2000–2300	10 minutes per point	Terrestrial sampling points at suitable forested locations	1	Visual only; up to 10 m from the sampling point
Leaf litter sifting	Spiders	0900–1200	20–30 minutes per quadrat	50 x 50 cm quadrat at suitable forested locations	1	–
Umbrella beating	Spiders	0900–1200	20–30 minutes per location	20 “shakes” at each location	1	–
<p>Note: *A sampling unit is the basic building block of the dataset that was used for statistical analyses. For example, a sampling route of a few kilometres would consist of several 200 m transects.</p>						



Legend

- EIA Study Area
- Site boundary
- Vegetation Types**
- Native-dominated secondary forest
- Abandoned-land forest
- Exotic-dominated secondary forest
- Scrubland
- Urban vegetation
- Non-vegetated
- Waterbody

Fauna Survey

- Terrestrial Transect
- Camera trap
- Aquatic sampling point



Rev.	Date	By	Description	Chk'd	App'd
-	MAY 2024	CWT	Turf Club EIA	LAL	JAG

Qualified Person Endorsement : NA

URA Endorsement : NA

Consultant :



Project Title :
**CONTRACT URA/T/22/031
 ENVIRONMENTAL IMPACT
 ASSESSMENT (EIA) FOR
 FORMER TURF CLUB AT BUKIT TIMAH**

Designed CWT	Checked LAL	Approved JAG
Drawn	Date MAY 2024	

Client:



Figure Title :
**BIODIVERSITY TERRESTRIAL SAMPLING
 ROUTE,CAMERA TRAPS AND AQUATIC
 SAMPLING POINTS**

Figure No. : 7-1	Rev. : -	Sheet 1 of 1
CAD File Name : NA		A3

Note: Source of basemap - Google Earth Map

7.2.2.3.1 Butterflies

Diurnal transect surveys were carried out for adult butterflies along 200-m continuous transects on a sampling route between 0900h and 1600h. Butterfly caterpillars, pupae, eggs, and host plants were also recorded when observed. Adult butterflies were identified visually (with binoculars where necessary), photographed, or caught using insect nets, if required. Captured individuals were released immediately after identification.

7.2.2.3.2 Odonates (Dragonflies and Damselflies)

Diurnal transect surveys were carried out for adult damselflies and dragonflies along 200-m continuous transects on a sampling route between 0900h and 1600h. Five-minute point counts were also conducted at aquatic sampling points during the same survey window. Adult odonates were identified visually (with binoculars where necessary), photographed, or caught using insect nets, if required. Captured individuals were released immediately after identification.

7.2.2.3.3 Aculeate hymenopterans (Bees and Stinging Wasps)

Diurnal transect surveys were carried out for aculeate hymenopterans along 200-m continuous transects on a sampling route between 0900h and 1600h. Aculeate hymenopterans were identified visually (with binoculars where necessary), photographed, or caught using insect nets, if required. Captured individuals were released immediately after identification. When identification in the field is not possible, live specimens were collected and examined under a microscope. The specimens were identified to the lowest taxonomic level using relevant references, identification keys, or in consultation with taxonomic experts.

7.2.2.3.4 Herpetofauna (Amphibians and Reptiles)

Diurnal (0700h–1000h) and nocturnal (2000h–2300h) surveys were carried out for amphibians and reptiles along 200 m continuous transects on a sampling route. Five-minute point counts were also conducted at aquatic sampling points during the same survey window. As herpetofauna occupy a wide range of habitat types, both the diurnal and nocturnal surveys involved active searches for individuals on the ground, below rocks, logs, leaf litter and debris, in the water, and/or on vegetation. Rocks, logs, and other structures were returned to their original positions if moved during the searches. Torches and/or headlamps were used to elicit eyeshine during nocturnal surveys. Vocalising fauna were also located or identified by call recognition, whenever possible. For species that are capable of quick retreats and escapes, the individuals were captured by hand, or using hooks, tongs, or dip nets for identification. Captured individuals were released immediately after identification.

7.2.2.3.5 Birds

Diurnal (0700h–1000h) and nocturnal (2000h–2300h) surveys were carried out for birds along 200 m continuous transects on a sampling route. Birds were identified visually (with binoculars where necessary) and photographed. Torches and/or headlamps were used to elicit eyeshine during nocturnal surveys. Vocalising birds were also located or identified by call recognition, whenever possible.

Additional diurnal (0700h–1000h) surveys were carried out for migratory birds when the actual bird surveys could not be carried out during the migratory season between September and February [P-72].

7.2.2.3.6 Mammals (Non-Volant)

Diurnal (0700h–1000h) and nocturnal (2000h–2300h) surveys were carried out for non-volant mammals along 200 m continuous transects on a sampling route. Both the diurnal and nocturnal surveys involved searches in burrows and tree holes. Tracks and scats were also recorded. Mammals were identified visually (with binoculars where necessary) and photographed. Torches and/or headlamps were used to elicit eyeshine during nocturnal surveys. Vocalising mammals, such as the squirrels, were also located or identified by call recognition, whenever possible.

In addition to transect surveys, mammals were also surveyed via camera trapping. This method is useful for the survey of terrestrial (mostly ground dwelling) mammals because it is non-invasive (i.e., does not require capturing and handling of live animals), not labour-intensive, and can be programmed to operate 24 hours a day. This allows for both diurnal and nocturnal species to be recorded, especially if their peak activity periods do not overlap with the timings of transect surveys.

A total of 47 terrestrial camera traps (one camera trap for every 4 ha) were deployed (Table 7-3). The camera traps were deployed at least 200 m apart within the Study Area and kept at least 20 m away from the transects, whenever possible. They were also stratified across sites to cover all vegetation types.

Table 7-3 Number of camera traps deployed

Site	No. of camera traps
Site A	10
Site B	5
Site C	7
Site D	2
Site E	15
Site F	5
Road	3
Total	47

To investigate the ecological connectivity between the Study Area and surrounding green areas (i.e., CCNR and BTNR through Rifle Range Nature Park), additional camera traps were also deployed at strategic locations (e.g., culverts and potential future crossings deemed feasible for faunal usage). To determine if non-volant mammals were crossing Jalan Kampong Chantek to move between the Study Area and Rifle Range Nature Park, one camera trap was deployed along the road and two along Eng Neo Avenue (Figure 7-1).

Each camera trap was set up approximately 20–30 cm above ground (Figure 7-2). The camera traps in the forest operated 24 hours a day, while those deployed specifically for the study on connectivity operated 12 hours at night (1900–0700h) and were programmed to record 10-second footage per motion trigger with a 10-second quiet period following each trigger. All camera traps were deployed for at least 60 days.

Camera trap locations, species identity, and the number of individuals were recorded for each video with a positive capture (i.e., with fauna recorded on the video). An independent detection constitutes video(s) of one or a group of individuals of the same species occurring within 60 minutes at each camera trap. The number of independent detections was used to calculate detection rate of all species of mammals.



Figure 7-2 A terrestrial camera trap set up

7.2.2.3.7 Mammals (Bats Only)

Visual and acoustic surveys were carried out for bats along 200 m continuous transects on a sampling route between 2000h and 2300h. For acoustic surveys, the Echo Meter Touch 2 Pro (Wildlife Acoustics, Inc.) was used to record, stream, and attenuate ultrasonic calls between 18 and 192 kHz at a sampling frequency of 384 kHz to low frequency signals below 20 kHz, a range that is audible to the human ear.

Bats were also sampled via live trapping. Harp traps and mist nets were deployed strategically at 12 locations. Mist nets targeted the larger-sized fruit/nectar bats (Yinpterochiroptera), while harp traps targeted the smaller insectivorous bats (Yangochiroptera).

Each pair of one ground mist net and one harp trap were placed near each other. The traps and nets were set up between 1730–1930h and the actual trapping occurred between 1930–2100h, during which the traps and nets were repeatedly checked every 30 mins. Mist nets were disassembled by 2100h, while harp traps were left overnight and checked the following morning (0800–0900h) and removed. Bats caught in the traps were handled safely by trained personnel and released immediately upon identification, sexing and aging. Where identification was difficult, photographs, weight and forearm length were taken. Ultrasonic recordings were also taken when releasing the bats to aid in species identification.

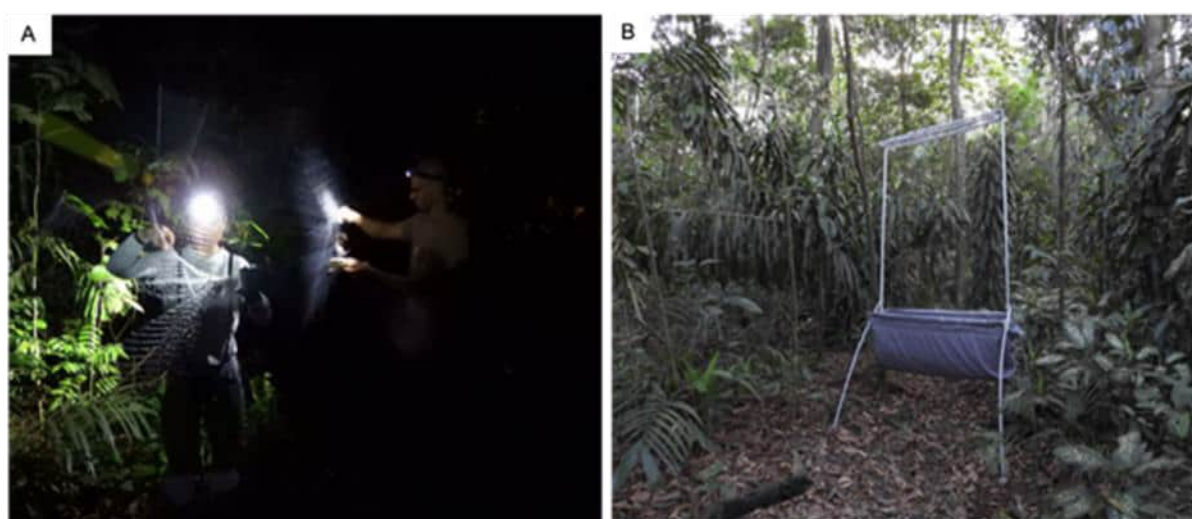


Figure 7-3 Set up of (A) mist net and (B) harp trap for bat trapping

Roost emergence surveys were carried out between 1830h and 2100h specifically for bamboo bats at bamboo clusters. Bamboo bats were identified visually, photographed, and their calls recorded using the Echo Meter Touch 2 Pro detector. Bamboo slits that were at least 1 cm wide and actively used for entry and exit, as well as the number of bats residing within each internode were recorded.

Bat recordings were processed using Kaleidoscope v.4.5.4 (Wildlife Acoustics, Inc.) to separate extraneous noise from files with bat echolocation calls. The signal parameters for recognising a potential bat echolocation call were configured as follows: frequency range of 20–200 kilohertz (kHz), duration of 2–500 millisecond (ms), maximum inter-syllable gap of 500 ms and a minimum of 2 pulses. These files will then be visually processed to identify bat species based on call structures, peak frequency, minimum frequency and call duration [P-73]. They will be identified with reference to those in Pottie et al. (2005) [P-73], which provide echolocation signatures for bats in Singapore, and other relevant references, namely, Collen (2012) [P-74] and Hughes et al. (2011) [P-75].

7.2.2.3.8 Freshwater Fauna (Fishes, Decapod Crustaceans, and Molluscs)

Diurnal (0900–1600h) and nocturnal (2000–2300h) five-minute point counts were conducted at aquatic sampling points in natural or naturalised permanent waterbodies (streams and ponds). Torches and/or headlamps were used to elicit eyeshine during nocturnal surveys.

Push and/or scoop netting were carried out for freshwater fish, decapod crustaceans, and molluscs at sampling points inside waterbodies during the day. Push netting was carried out, usually in deeper waters, using a rigid-frame tray net (61 × 49 cm; 5 mm mesh) to catch specimens on the banks or the streambed (Figure 7-4A). Scoop netting was carried out, usually in shallower waters, using hand nets (net size 25 × 18 cm; 2-mm mesh) to catch

specimens within the stream column (Figure 7-4B). Captured individuals were released immediately after identification.

Minnow traps baited with halal meat (e.g., sausage or liver) were be deployed within the streams and ponds, where feasible (e.g., sufficient water depth) (Figure 7-4D). The traps were left overnight, checked and removed the following morning. This was only done once at each sampling point. All caught individuals were released immediately upon identification.



Figure 7-4 Freshwater fauna survey methods: (A) push netting; (B) scoop netting; (c) minnow trapping deployed in streams and ponds

7.2.2.3.9 Spiders

The following surveys of spiders were carried out: (1) visual point counts, (2) leaf litter sifting, and (3) umbrella beating.

Nocturnal (2000–2300h) 10-min visual point count surveys were carried out at suitable forested locations. Torches and/or headlamps were used to elicit eyeshine during nocturnal surveys.

Diurnal (0900–1200h) leaf litter sifting was carried out for spiders at forested locations deemed suitable for this method. At each location, one heap of leaf litter within a 50 x 50-cm quadrat will be sifted on-site (Figure 7-5). The leaf litter was returned to the quadrat after sifting.

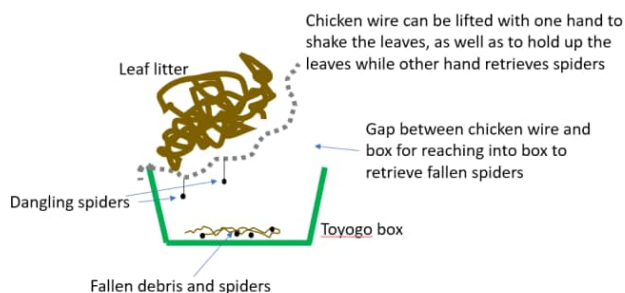


Figure 7-5 Photograph and diagram of leaf litter sifting

Diurnal (0900–1200h) umbrella beating was carried out at suitable locations. This was done by holding an umbrella upside down below some vegetation. The vegetation was shaken and disturbed 20 times (Figure 7-6). Spiders that fell onto the umbrella were then identified or collected.



Figure 7-6 Umbrella beating

All spiders were identified visually or photographed. Specimens that could not be identified in the field were collected and examined under a microscope, before being deposited at the Lee Kong Chian Natural History Museum. All specimens were identified to the lowest taxonomic level using relevant references, identification keys, or in consultation with taxonomic experts.

7.2.3 Data Analyses

7.2.3.1 Floristic Data Analyses

7.2.3.1.1 Community Data Analyses

All statistical analyses for this Study were carried out in the statistical programming environment R version 3.4.3 [O-2]. Community data analyses were conducted using the “iNEXT” package 2.0.20 [P-78].

A taxon sampling curve was plotted using data on floristic diversity from the vegetation plots. Species richness was plotted against sample coverage, as opposed to survey effort, to estimate sample completeness/ survey adequacy, i.e., how extensively we have sampled the species in the community. According to Chao and Jost (2012) [P-79], sample coverage refers to “the proportion of the total number of individuals in a community that belong to the species represented in the sample”. The curve was then extrapolated to provide an estimation of species richness and sample coverage if the sample size was theoretically doubled.

As some species will always remain undetected after sampling all the vegetation plots, total species richness was estimated using the Chao estimator [P-78]. The associated standard error and 95% confidence interval were also computed. Standard error represents the range of uncertainty of the estimate, while the 95% confidence interval is the interval in which there is a 0.95 probability of containing the estimated true species richness.

To visualise the differences among vegetation types based on species composition, non-metric multidimensional scaling (NMDS) ordination was used. The Bray–Curtis dissimilarity index was used to quantify dissimilarities between the observed communities. Permutational Multivariate Analysis of Variance (PERMANOVA) via bootstrapping with 999 permutations was then used to test for statistical significance. This was performed using the ‘adonis’ function in the “vegan” package 2.5-6 [P-80]. The ordination was also tested to ensure that the assumption of homogeneity of multivariate dispersion holds true.

7.2.3.2 Faunistic Data Analyses

7.2.3.2.1 Taxon Sampling Curves

Taxon sampling curves were plotted for all taxa – Namely mammals, birds, reptiles, amphibians, butterflies, odonates, aculeata, fish and molluscs - with sufficient occurrences as large sample sizes are required for the estimation of sample coverage to be robust [P-76]. The analysis for each taxon was the same as that carried out for the floristic baseline data, as detailed above.

7.3 Baseline Findings

7.3.1 Habitats

Site A

Site A, mostly consisting of Eng Neo Avenue Forest, is made up of five vegetation types (Table 7-4, Figure 7-7). The three dominant vegetation types comprise, in descending order, (1) exotic-dominated secondary forest, (2) scrubland, and (3) abandoned-land forest. In particular, exotic-dominated secondary forest occupies 15.0 ha, which is more than one-third of Eng Neo Avenue Forest. These large patches of exotic-dominated secondary forest are distributed across the entirety of Site A. On the other hand, abandoned-land forest is concentrated in the southern half of Eng Neo Avenue Forest and takes up almost a quarter of Site A, making up the third largest habitat type. These exotic-dominated secondary forest and abandoned-land forest areas are interspersed with patches of scrubland (10.3 ha; 26.5%), which is the second largest vegetation type in Site A. Native-dominated secondary forest (1.9 ha; 4.9%) is the next largest habitat type, consisting of three relatively smaller patches situated in the north and mid-section of Eng Neo Avenue Forest. About 1.9 ha (4.9%) of Site A is non-forested and/or planted up with urban vegetation, typically occurring along the edge. A single and natural forested stream, D/S14, runs through the eastern edge while a 0.3 ha anaerobic pond sits in the middle of Site A.

Site B

Site B covers the forested areas adjacent to Fairways Quarters, which comprise two vegetated zones located to the west and east of an unnamed road and collectively consist of six habitat types (Table 7-4, Figure 7-7). Abandoned-land forest is the largest vegetation type at 8.3 ha, which takes up nearly half of Site B. It occupies the majority of the southwestern and eastern areas of Site B, both of which are bordered by roads and other infrastructure. The native-dominated secondary forest and scrubland vegetation types make up roughly 3.0 ha each. There are three patches of native forest, with the largest occupying the northwest of Site B. Scrubland occurs in several small patches either along forest edges or within the forest. Urban vegetation is the next largest habitat type at 1.5 ha, represented by two patches located in the northeast taking up 8.5% of Site B. The combined area of the remaining habitat types makes up approximately 10%, namely, in descending order, infrastructure and two waterbodies. The two naturalised streams, D6 and D7, run along the edges of Site B, with a concrete drain connecting upstream of D6 and a waterlogged/swampy ground located in the north of D7.

Site C

Site C comprises the forested areas adjacent to the British and Swiss clubs, which are mostly occupied by scrubland as well as native-dominated secondary forest (Table 7-4, Figure 7-7). Both habitat types take up almost three-quarters of Site C and are mostly present in the northern side. The native-dominated secondary forest is mainly represented by a large continuous patch in the mid-section, while scrubland intersperse small strips of native forest, predominantly in the area west of the golf course. Abandoned-land forest (2.9 ha; 15.4%) and urban vegetation (1.8 ha; 9.6%) make up the rest of the vegetated areas. Both occur in the southern side of Site C. The remaining 0.5% of the Study Area is occupied by infrastructure, which is also located in the southern side.

Site D

Site D is represented by the forested area within Racecourse Oval and comprises four vegetation types (Table 7-4, Figure 7-7). Exotic-dominated secondary forest is the largest at 1.8 ha (33.3%), followed by abandoned-land forest at 1.7 ha (31.5%), and scrubland at 1.2 ha (22.2%). Exotic-dominated secondary forest can be found throughout the site, of which, the largest continuous swathe runs from the centre to the north of Site D. Abandoned-land forest is largely concentrated towards the south of Site D. While, scrubland occurs in small fragments throughout the forest edges and within the forest interior. Native-dominated secondary forest occupies 0.6 ha (11.1%) and only occupies the northern portion of Site D. Infrastructure makes up 0.1 ha (1.9%) and is located in the northwest.

Site E

Site E includes the vegetated and non-vegetated areas surrounding the former Champion's Golf Course, Horsecity, Grandstand, and residential areas around Vanda Link, and consists of five vegetation types (Figure 7-4, Figure 7-7). The largest vegetation type is urban vegetation at 47.9 ha, which makes up nearly half of Site E and mostly occurs as turf and other planted vegetation in the golf course and Grandstand. The forest vegetation types each

comprise about 5% of Site E, in descending order, (1) abandoned-land forest, (2) exotic-dominated secondary forest, and (3) native-dominated secondary forest. Abandoned-land forest was encountered as small patches in the golf course and along the southwestern edge of Site E. While, exotic-dominated forest occur as small patches in the south of the golf course and the southeast corner of Site E. Patches of native-dominated secondary forest was mostly present in the northern side of the golf course. The last vegetation type, scrubland (1.1 ha; 1.1%), occur as small fragments throughout the forest edges. The combined area of the remaining habitat types makes up approximately 40%, namely, in descending order, infrastructure (40.1 ha; 38.5%) and two ponds in the golf course.

Site F

Site F includes the forest adjacent to Linden Drive and is made up of five vegetation types (Table 7-4, Figure 7-7). Abandoned-land forest is distributed across the site and makes up the majority with 2.5 ha (30.5%). Scrubland (2.0 ha; 24.4%) occur in large patches across Site F, making up the second largest vegetation type. This is followed by exotic-dominated secondary forest (1.6 ha; 19.5%) which was found mainly in the eastern portion of Site F. Urban vegetation and native-dominated secondary forest each comprise about 1.0 ha, with the former lining the southern borders of Site F abutting residential areas, and the latter occurring as two patches in the middle of Site F. No non-vegetated areas nor waterbodies were encountered in Site F.

Table 7-4 Absolute (ha) and relative (%) sizes of each vegetation type

	Site A		Site B		Site C		Site D		Site E		Site F	
	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%
Native-dominated Secondary Forest	1.9	4.9	2.9	16.5	6.2	33.0	0.6	11.1	4.2	4.0	1.0	12.2
Abandoned-land Forest	9.5	24.4	8.3	47.2	2.9	15.4	1.7	31.5	6.2	5.9	2.5	30.5
Exotic-dominated secondary forest	15.0	38.6	–	–	–	–	1.8	33.3	4.3	4.1	1.6	19.5
Scrubland	10.3	26.5	2.7	15.3	7.8	41.5	1.2	22.2	1.1	1.1	2.0	24.4
Urban vegetation	1.1	2.8	1.5	8.5	1.8	9.6	–	–	47.9	45.8	1.1	13.4
Non-vegetated	0.8	2.1	1.9	10.8	0.1	0.5	0.1	1.9	40.1	38.5	–	–
Waterbody	0.3	0.8	0.3	1.7	–	–	–	–	0.3	0.3	–	–
Total Area	38.9	100.0	17.6	100.0	18.8	100.0	5.4	100.0	104.1	100.0	8.2	100.0



Legend

Site boundary

Vegetation plot

Vegetation Types

- Native-dominated secondary forest
- Abandoned-land forest
- Exotic-dominated secondary forest
- Scrubland
- Urban vegetation
- Non-vegetated
- Waterbody

Rev.	Date	By	Description	Chk'd	App'd
-	MAY 2024	SHMX	Turf Club EIA	LAL	JAG

Qualified Person Endorsement : NA

URA Endorsement : NA

Consultant : **AECOM**

Project Title :
**CONTRACT URA/7/22/031
 ENVIRONMENTAL IMPACT
 ASSESSMENT (EIA) FOR
 FORMER TURF CLUB AT BUKIT TIMAH**

Designed SHMX	Checked LAL	Approved JAG
Drawn SHMX	Date MAY 2024	

Client: **URBAN REDEVELOPMENT AUTHORITY**

Figure Title :
**Habitat map and
 locations of vegetation plots**

Figure No. : 7-7	Rev. : -	Sheet 1 of 1
CAD File Name : NA		A3



Note: Source of basemap - Google Earth Map

7.3.1.1 Native-dominated Secondary Forest

Native-dominated secondary forest was found in all the sites A–F. The characteristics of these native patches are mostly similar across sites A, B, C, and F.

There are three patches of native-dominated secondary forest in Site A. Altogether, they occupy about 5% of Site A (Table 7-4). This habitat type is the second largest in Site B, where three separate patches cover 2.9 ha in total. The largest continuous patch was recorded in Site C, where native forest comprises one-third (6.2 ha) of the site. Two patches of native-dominated secondary forest totalling 1.0 ha were identified in Site F. The features of the native patches across Sites A, B, C, and F are similar in that they comprise a diverse pool of common and rare native species characteristic of mature secondary forest. Site D and E is frequently used for recreational activities, such as mountain biking and golfing; as such, the native forest present within this site was noticeably more disturbed and sparsely vegetated compared to those in the other sites.

Site A

Firstly, the floristic assemblage of the native-dominated secondary forest in Site A largely comprised of both common and rare native species. Many species found in these areas can also be found in the CCNR [P-161] and are less commonly encountered in other secondary forests in Singapore. In addition, species associated with older growth forest and/or are known to be rare in the Nee Soon Swamp Forest (NSSF)—Singapore’s last remaining tract of primary freshwater swamp forest—such as the nationally Critically Endangered *Prunus arborea* var. *stipulacea* (Figure 7-42B), were also recorded in the Study Area. The presence of these species contributes to the habitat’s high native species richness. The species composition and high native species richness encountered within this habitat parcel are typical features characteristic of late-successional forests in Singapore [P-67]. The complete flora inventory is in Appendix D.

Secondly, native specimens are widespread and occur in high numbers in the area. For example, *Piper baccatum* (previously recorded as *Piper flavimarginatum*), a nationally Critically Endangered climber species (Figure 7-8E), was found throughout the forests. Most of them are concentrated in the northern-most native-dominated forest patch. Another example that highlights this feature unique to the forest type is a population of nationally Vulnerable *Calophyllum tetramerum* var. *tetramerum* specimens found in high numbers, also mostly in the northern-most native-dominated forest patch. The specimens include several seedlings (Figure 7-8D), saplings, and trees. The trees are between 0.3–0.7 m girth range and 70% of those assessed during arboriculture surveys have good health with no visible structural defects. This species is neither known to be cultivated locally nor sold in commercial markets. Hence, the specimens belong to the native genetic stock. The presence of seedlings and trees in such high numbers suggests that the population is reproducing and self-replacing.

Thirdly, large parent trees are present in the area. Four large *Cyrtophyllum fragrans* trees with girths exceeding 3 m were also all found in the northern-most native dominated secondary forest patch (Figure 7-8A). Although trees of this species are planted locally, it is unlikely that the large trees in the Study Area are cultivated propagules as this common native tree species is known to be very slow-growing. For the specimens to attain their present size, it is almost certain that they have been at the site for a long time before this species was available in commercial markets and planted locally. A large *Archidendron jiringa* tree of 2.4 m girth was also found in the native-dominated forest patch south of the horse training stable (Figure 7-8B). Seedlings and saplings of this species growing in the understorey near the large tree were also in very high concentration (Figure 7-8C). As this species is known to be widely cultivated in Singapore, many propagules present in the secondary forest are suspected to have spread from cultivation. However, the presence of a large tree in the Study Area suggests a likelihood that young specimens could belong to the native genetic stock. In this Study, a conservative approach was adopted; specimens of this species were included as those of conservation significance (Appendix E).

Lastly, many native species listed as nationally Least Concern were also widespread within the patches. They include *Prunus polystachya*, *Morella esculenta*, *Aporosa frutescens*, *Gironniera nervosa*, and *Elaeocarpus mastersii*, amongst others. Some of which are characteristic of late-successional secondary forest [P-67]. The widespread distribution of these species is uncommon across the secondary forests of Singapore.



Figure 7-8 Species found in the native-dominated secondary forest in Site A. (A) A large *Cyrtophyllum fragrans* tree of more than 3.0 m girth; (B) A large *Archidendron jiringa* parent tree of 2.4 m girth; (C) Seedlings and saplings of *Archidendron jiringa* in the forest understorey near the parent tree; (D) *Calophyllum tetrapterum* var. *tetrapterum* seedlings; (E) *Piper baccatum* growing on the forest floor; (F) *Oncosperma tigillarum* palm cluster; (G) *Horsfieldia polyspherula* seedling.

Site B

Unique to the largest patch in the western zone is the presence of fairly large trees of rare native species. For example, at least one nationally Endangered *Ficus glandulifera* and two recently rediscovered Critically Endangered *Actinodaphne maingayi* (previously recorded as *Actinodaphne macrophylla*) trees of at least 1.0 m girth were recorded during floristic surveys. The *Ficus glandulifera* tree was also observed to be producing figs at the time of survey (Figure 7-45D). These mature specimens play an important role in ensuring a constant supply

of native propagules for the continued survival of these threatened species. Hence, these forested patches may serve as key additional refuge for rare species, allowing them to be able to persist in other areas in Singapore beyond the CCNR.

Also present in this large hotspot of native diversity are nationally Vulnerable and common native species in the understory, such as the Vulnerable *Xylopia malayana* and *Elaeocarpus ferrugineus*, and common *Gironniera nervosa* and *Morella esculenta* (Figure 7-9A–D). These species are not typically found in the young and disturbed secondary forests of Singapore. Instead, their presence tends to be characteristic of more mature native secondary forests. Additionally, a few *Rhodamnia cinerea* trees were present in the area; this tree species—as well as other species belonging to other genera—typically characterise forests in the post-*adinandra* belukar successional stage [P-67].

Another feature that distinguishes this large patch from the other native patches in Site B is the greater population of nationally Vulnerable *Alsophila latebrosa* at the wetter areas in the north. This tree fern species has often been observed to grow near streams and in areas with wet/poor-draining soils.

The second largest patch of native forest in Site B is within the circular horse track (Figure 7-7). This patch is mostly surrounded by abandoned-land forest, where planted exotic trees have grown to very large sizes and host a wide diversity of epiphytes and climbers. One of the epiphytic plants found to be widespread in the area is the nationally Vulnerable orchid species *Bulbophyllum vaginatum* (Figure 7-46B). The orchids were found to be widespread and abundant throughout the area; many of which were growing on the exotic trees alongside other epiphytes. Outside this central patch, the orchids were no longer observed in Site B. Another interesting finding in this native area is the presence of large nationally Endangered *Ficus kerkhovenii* stranglers. One spanned a staggering 14 m in width (Figure 7-54A–B). The specimen was observed to be strangling two large exotic rain trees (*Samanea saman*). This rare strangler species is more commonly associated with coastal areas, but even in coastal habitats, such large specimens are exceedingly rare in Singapore. Therefore, records of such specimens in the Study Area, which is much further inland, are very valuable and noteworthy. Other surprising finds in this patch are the nationally Critically Endangered *Baccaurea pyriformis* (Figure 7-45C) and *Aporosa nigricans* (Figure 7-46A) (refer to Section 7.3.2.2 for the description of these species of conservation significance).

The third and smallest native patch is located northeast of Site B, surrounded by scrubland, urban vegetation, a road, and abandoned-land forest. Although small, fragmented and surrounded by areas with human disturbances, some species more commonly found in old growth secondary forests still persist here, such as *Gironniera nervosa* (Figure 7-9A). Large tembusu trees (*Cyrtophyllum fragrans*) were also recorded here, as well as throughout Site B. Although currently planted in streetscapes, this slow-growing species would take a long time to attain their present-day large sizes and are likely present before they were sold in commercial markets for streetscape planting. This implies that these specimens are probably of native stock and belong to the native forest that was present before human disturbance.



Figure 7-9 Nationally Vulnerable and common native plant species in the native-dominated secondary forest in Area B. (A) *Gironniera nervosa*; (B) *Xylopia malayana*; (C) *Elaeocarpus ferrugineus*; (D) *Morella esculenta*.

Site C

The largest and most extensive patch of native-dominated secondary forest recorded in this study was at Site C. Within Site C, this habitat type occupies one-third of the total area (Table 7-4). Floristically, the native forest in Site C was even more species-rich than in sites A and B.

The native forest of Site C also largely comprised both common and rare native species, many of which occur more commonly in the CCNR than secondary forest fragments elsewhere in mainland Singapore. Furthermore, a high abundance of native plant specimens was recorded. For example, areas dominated by *Calophyllum* trees were recorded in Site C, which is similar to Site A. Species of this genus are often associated with late successional forests, where the tree canopy layer is dominated by this genus [P-67]. Large parent trees were also recorded in the Site C, some of which are rare native species. A few of the large rare tree species recorded exclusively at Site C and not sites A and B include the nationally Critically Endangered *Daphniphyllum griffithianum*, where at least one mature tree of 2.4 m girth was tagged. Lastly, the northern portion of the native forest surrounded by scrubland and infrastructure is still able to host large and rare native plant species, despite being narrow, fragmented, and/or surrounded by areas with human disturbances. Examples of such native species found here include the nationally Critically Endangered *Parastemon urophyllus* with specimens of at least 1.5 m girth and at least one tree of the nationally common but less widespread *Sloetia elongata* (previously recorded as *Streblus elongatus*) of 3.0 m girth.

The collation of the aforementioned observations suggests that the native forest patches across sites A–C could be remnants of a continuous native-dominated secondary forest connected to the CCNR. Considering the extent of disturbance and fragmentation the area has experienced, the native forests at these sites are unusually species-rich. Hence, it is likely that the close proximity of the sites to the CCNR has allowed for continued dispersal of propagules among the native patches. If left undisturbed, the entire forested area may eventually regenerate into a late-successional native-dominated forest.

Site D

Native-dominated secondary forest occupies 0.6 ha and is located mainly at the north of the forested area within Racecourse Oval. This habitat type mainly comprises native common species, such as Malayan banyan (*Ficus microcarpa*), *Syzygium cerasiforme* (previously recorded as *Syzygium lineatum*), tembusu (*Cyrtophyllum fragrans*), and *Ixonanthes reticulata*, as well as native pioneer species, such as *Macaranga gigantea*. Similar to Site B, some native species recorded here are uncommon in other disturbed secondary forests in Singapore. These include *Aporosa frutescens*, *Timonius wallichianus*, *Gironniera nervosa*, and *Prunus polystachya* (Figure 7-10B–E). Species of conservation significance found within this habitat type include the nationally Vulnerable *Macaranga griffithiana* (Figure 7-10F) in the forest understory (Section 7.3.2.2).

While the native patch in Site D is noticeably more disturbed and of lower floristic richness, it is interesting to note that native species still persist in this disturbed site. The lack of large-scale vegetation removal has most likely prevented large changes in the species composition at this site, despite the level of disturbance that is occurring. If the current conditions remain and connectivity is sustained for faunal movements, this native patch has the potential to regenerate into a more diverse native-dominated forest.

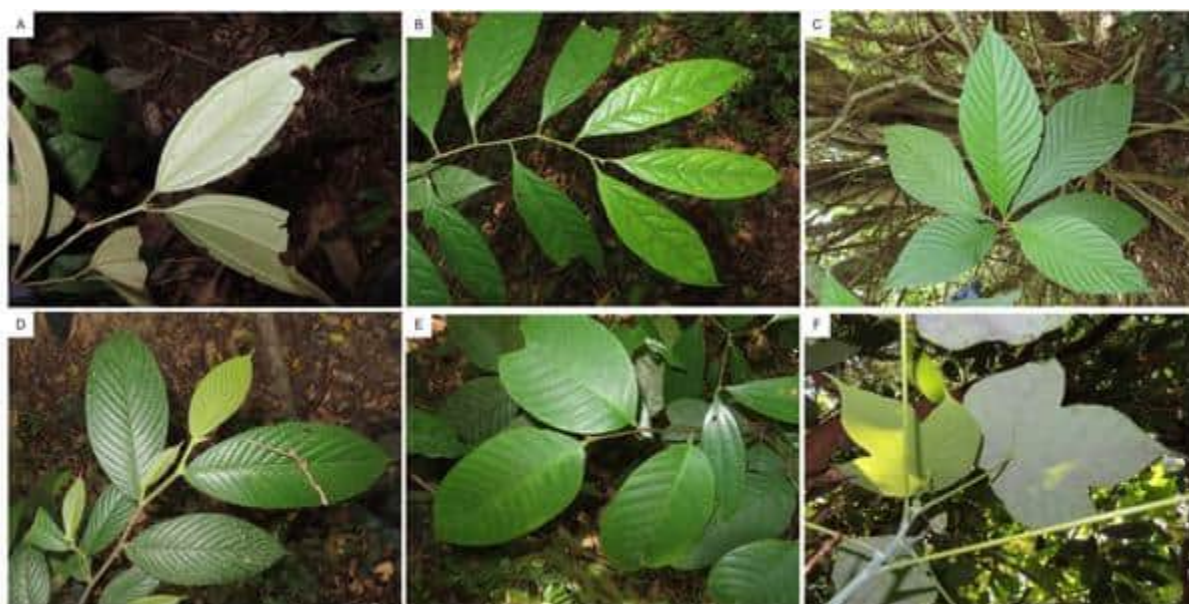


Figure 7-10 Native species found in Site D. (A) *Rhodamnia cinerea*; (B) *Aporosa frutescens*; (C) *Timonius wallichianus*; (D) *Gironniera nervosa*; (E) *Prunus polystachya*, and; (F) Nationally Vulnerable *Macaranga griffithiana*.

Site E

Small strips of native-dominated secondary forest can be found between turf and planted urban vegetation in the north and east of the Champion's golf course, occupying a total of 4.2 ha. These forest strips mainly comprise native common species, including *Vitex pinnata*, *Cinnamomum iners*, *Syzygium polyanthum*, and tembusu (*Cyrtophyllum fragrans*), as well as native pioneer species, such as *Camptosperma auriculatum* and *Macaranga gigantea*. Populations of uncommon native species were also recorded here, including the nationally Vulnerable *Calophyllum tetrapterum* var. *tetrapterum* and *Aporosa benthamiana*, as well as the nationally Endangered *Calophyllum inophyllum* and *Ficus virens* (Section 7.3.2.2).

Similar to Site D, the native forest patches in Site E are noticeably more disturbed and of lower floristic richness, but are still able to support native species. The retention of pre-existing forest for forested features of the golf course has most likely prevented drastic changes in the native species composition of this site. If the current conditions remain and connectivity is sustained for faunal movements, these native patches also have the potential to regenerate into a more diverse native-dominated forest.

Site F

Like sites A–C, the two adjacent native-dominated forest patches at the mid-section of Site F (Figure 7-7) are rich and abundant in native species, with both common and rare species that can be found in CCNR and not outside

the nature reserves in Singapore. Native species found in abundance include common *Cinnamomum iners*, *Ficus variegata*, *Litsea elliptica*, *Syzygium grande*, and the nationally Vulnerable *Horsfieldia polyspherula* var. *polyspherula*. Mature trees and saplings of species associated with late-successional native secondary forests were also recorded in these patches, namely the nationally Endangered *Calophyllum rubiginosum*, represented by a tree of 0.4 m girth, as well as Vulnerable *C. tetrapterum* var. *tetrapterum* and *Aporosa benthamiana*, with trees of up to 1.5 m and 0.6 m girth, respectively.

Particularly, rarer native species, such as the nationally Critically Endangered *Piper baccatum*, *Xanthophyllum ellipticum*, Endangered *Knema conferta*, *Gymnacranthera farquhariana*, and Vulnerable *Knema communis*, were recorded in these patches (Section 7.3.2.2). As with sites A–C, these forest patches are adjacent to human disturbance, such as roads, yet are able to support rich native populations with parent trees and sapling recruitment. This can also be explained by the possibility that native forest patches across sites A, B, C, and F were previously contiguous to the CCNR and the close proximity of these sites to native populations in the CCNR allow for continued recruitment of their propagules. If further disturbance is prevented or reduced, the entire forested area can potentially regenerate into a late-successional native-dominated forest.

7.3.1.2 Abandoned-land Forest

Abandoned-land forest was recorded in all sites A–F, and is largely similar across the fragments.

Site A

Large abandoned-land forest patches (9.5 ha) located towards the south make up the third-largest habitat type in Site A (Table 7-4, Figure 7-7). These forests are dominated by fruit trees such as cempedak (*Artocarpus integer*) and rambutan (*Nephelium lappaceum*) (Figure 7-11). Some areas were found to be dominated by ornamental plants such as *Heliconia* sp. and *Dieffenbachia seguine*.



Figure 7-11 Abandoned-land forest in Site A. (A) Cempedak (*Artocarpus integer*) (red arrow), one of the fruit crop species commonly found in this forest type; (B) understorey with rambutan (*Nephelium lappaceum*) saplings (red circle).

Site B

Abandoned-land forest (8.3 ha; 47.2%) is the largest habitat type in the forested area adjacent to Fairways Quarters, covering most of the centre, south, and east of Site B (Table 7-4, Figure 7-7). Old topographical maps dating between 1974 and 1983 (see Section 4.1) and by Gaw et al. (2009) [P-97] indicate that these areas were used for “sundry tree cultivation” [P-67] or used to be “Vegetation with structure dominated by human management”. For the former, remnant trees from such past cultivation occupy the canopy layer, represented mostly by the African tulip (*Spathodea campanulata*), mango (*Mangifera* sp.; Figure 7-12C), rambutan (*Nephelium lappaceum*; Figure 7-12A), and durian (*Durio zibethinus*; Figure 7-12B). The understorey is largely dominated by rambutan saplings (*N. lappaceum*), with African oil palms (*Elaeis guineensis*; Figure 7-12D), amongst some native common trees such as *Cinnamomum iners* and *Aphanamixis polystachya*.

In the latter, the areas consisted of overgrown past streetscape and urban plantings with native recruits that are likely propagules from the nearby native patches. Resulting in a mix of large exotic trees in the canopy, with native epiphytes growing on them, and young native saplings and treelets in the understorey. In addition, a few native *Ficus*

microcarpa stranglers were observed growing over abandoned infrastructure, such as concrete walls (Figure 7-13A). Most of the exotic trees, which are relics from past urban plantings in the sites, are rain trees (*Samanea saman*) (Figure 7-13B) which naturally host epiphytic plants and provide a diverse range of microhabitats for fauna.

The understorey was relatively species-poor and dominated by dense and overgrown *Baphia nitida*, a shrub species commonly planted as hedges (Figure 7-13D). Nonetheless, some signs of recruitment of native propagules were observed, including rare and nationally threatened native species. Particularly, the nationally Endangered epiphytic orchid species, *Bulbophyllum vaginatum*, was found to be widespread and abundant in this habitat type. Other rare native species recorded here include the nationally Critically Endangered fern species, *Asplenium nitidum*, which was thought to be nationally Extinct but was rediscovered in recent years, as well as the nationally Vulnerable tree species *Calophyllum tetrapterum* var. *tetrapterum* and *Litsea umbellata* (Section 7.3.2.2). Some signs of present-day human disturbance, such as furniture and small farm plots, were observed in these forests as well (Figure 7-13C–D).



Figure 7-12 Common crop plant species in the abandoned-land forest that were used for “sundry tree cultivation” in Site B. (A) Rambutan (*Nephelium lappaceum*); (B) Durian (*Durio zibethinus*); (C) Mango (*Mangifera* sp.); (D) Oil palm (*Elaeis guineensis*).



Figure 7-13 Abandoned-land forest in Site B. (A) A Large *Ficus microcarpa* strangler growing over a concrete wall (arrowed); (B) A large rain tree (*Samanea saman*) of 4.6 m girth; (C–D) Some human disturbances and usage inside the forest.

Site C

Abandoned-land forest was mostly identified in the southern half of Site C and is the third-largest habitat type (Table 7-4, Figure 7-7). It is surrounded by urban vegetation to the south and native-dominated secondary forest to the north. This habitat is also partially interspersed by abandoned infrastructure and scrubland (Figure 7-7). Unlike abandoned-land in sites A, B, and D, the tree canopy for this habitat in Site C is dominated by rubber trees (*Hevea brasiliensis*), which are likely relics of past plantation. Other tree species found in this habitat type include the exotic African tulip (*Spathodea campanulata*) and rain tree (*Samanea saman*). The understorey was sparsely vegetated and occupied by a mix of exotic and native plants, such as exotic oil palm (*Elaeis guineensis*) and *Baphia nitida*, and native common fish tail palms (*Caryota mitis*), *Ficus fistulosa*, and *Aphanamixis polystachya*. A few species of conservation significance were recorded in the understorey, namely the nationally Vulnerable *Aporosa benthamiana* and *Chassalia curviflora*.



Figure 7-14 Abandoned-land forest in Site C, next to (A) the former Paddington preschool, (B) a soccer field, and (C–D) around the former junkyards.

Site D

Within the forested area of the Racecourse Oval, a contiguous patch of abandoned-land forest was observed at the southern portion, while a smaller fragmented patch occupies the northern portion beside the native-dominated secondary forest (Figure 7-7). Majority of the canopy is dominated by the exotic tree species, African tulip (*Spathodea campanulata*), interspersed with some native common trees, such as Indonesian bayleaf (*Syzygium polyanthum*). Within the understorey, crop and edible cultivated plants such as oil palm (*Elaeis guineensis*; Figure 7-15A), *Andira inermis*, rambutan (*Nephelium lappaceum*), banana (*Musa* sp.), and giant taro (*Alocasia macrorrhizos*; Figure 7-15B) that had persisted from past cultivation were observed alongside native saplings such as *Cinnamomum iners* and *Leea indica*. Strips of vegetation within this habitat type have been cleared to create the existing cycling dirt track for mountain biking (Figure 7-15C).

Within the smaller patch of abandoned-land forest located at the northern portion, two specimens of the native strangling fig, *Ficus microcarpa*, occupy the canopy. The pillar trunks of these specimens were observed to be strangling remnants of a dilapidated wooden fence that was often seen along the old racecourse within the vicinity of Turf City (Figure 7-15D).



Figure 7-15 Abandoned-land forest in Site D. (A) Oil palm (*Elaeis guineensis*); (B) Giant taro (*Alocasia macrorrhizos*) (red circle); (C) Area cleared for the mountain biking track; (D) *Ficus microcarpa* growing over the dilapidated wooded fence.

Site E

Narrow strips of abandoned-land forest were recorded within the former golf course and along the western and southern edge of Grandstand Car Mall. A small patch was also identified to the west of Turf Club Road (Figure 7-7). Due to different levels and types of human disturbances, the floristic assemblage of abandoned-land forest in these three areas differ slightly.

Within the former golf course, a relatively greater native composition was observed, with some common species such as tembusu (*Cyrtophyllum fragrans*), *Cinnamomum iners*, *Ficus microcarpa*, and *Syzygium grande*. These were surrounded by exotic spontaneous species, such as *Acacia auriculiformis*, and previously cultivated and planted species including oil palm (*Elaeis guineensis*), jackfruit (*Artocarpus heterophyllus*), mango (*Mangifera indica*), and *Baphia nitida*. The trees in this area were comparatively larger, providing more canopy cover. Notably, rare nationally Endangered *Ficus virens* stranglers were observed in these patches (Section 7.3.2.2).

Contrastingly, the abandoned-land forest strips along the western and southern edge Grandstand Car Mall had a much greater exotic species composition. Species recorded here in abundance include exotic spontaneous species such as earleaf acacia (*Acacia auriculiformis*) and albizia (*Falcataria falcata*), and relics from past cultivation including coconut (*Cocos nucifera*), mango (*Mangifera indica*), jackfruit (*Artocarpus heterophyllus*), giant taro (*Alocasia macrorrhizos*), African tulip tree (*Spathodea campanulata*), and rain tree (*Samanea saman*). Some common native species were occasionally recorded along this strip, such as *Ficus variegata* and *Syzygium polyanthum*. Additionally, possibly due to the steep terrain and extensive disturbance, the tree sizes and canopy cover in this abandoned-land forest were observed to be small and sparse, respectively. Furthermore, these strips were flanked by infrastructure and urban vegetation, with a narrow corridor of turf grass cutting through the middle of the forest at some sections, and were often littered with rubbish and abandoned infrastructure, indicating that there could be constant human traffic and disturbance in these forest strips (Figure 7-16). Nevertheless, a few species of conservation significance were encountered in abundance here, such as the nationally Critically

Endangered *Cyclea laxiflora*, which was observed to be flowering and fruiting, large Endangered *Ficus kerkhovenii* stranglers, and Vulnerable *Ficus vasculosa* trees (Section 7.3.2.2).

The small abandoned-land forest patch abutting the west of Turf Club Road sits on the northeast corner of a larger exotic-dominated forest habitat. It is characterised by a closed canopy dominated by large *Ficus microcarpa* stranglers and interspersed with previously planted species such as yellow flame tree (*Peltophorum pterocarpum*), saga tree (*Adenanthera pavonina*), and African tulip tree (*Spathodea campanulata*). No species of conservation significance were observed in this forest patch.



Figure 7-16 Abandoned-land forest in Site E with (A–D) trails and (B) an abandoned stone well.

Site F

Abandoned-land forest is the largest habitat type in Site F, consisting of a large continuous patch in the centre and small fragments in the east and west that add up to one-third of the site area (Table 7-4, Figure 7-7). All forest patches show a similar species composition in the canopy, which is mostly dominated by oil palm (*Elaeis guineensis*) and interspersed with fruit and streetscape trees from past cultivation, which is similar to the abandoned-land forests described in Site B. Specimens of conservation significance belonging to native threatened species were recorded across this habitat type, most of which belong to the nationally Vulnerable *Horsfieldia polyspherula* var. *polyspherula*. Notably, a small group of nationally Critically Endangered *Xanthophyllum ellipticum* saplings were concentrated in the western abandoned-land forest patch (Section 7.3.2.2).

7.3.1.3 Exotic-dominated Secondary Forest

Exotic-dominated secondary forest was recorded in Sites A and D–F. This habitat type is usually comprised of fast-growing exotic species that establish themselves on areas that have been cleared recently. This vegetation type usually regenerates from scrublands dominated by sun-loving herbs and shrubs, and is fairly common amongst secondary forests in Singapore, especially where vegetation was removed before [P-67]. Depending on the conditions of underlying substrates and tree propagule dispersal, forest succession can occur at varying levels.

Site A

Exotic-dominated secondary forest occupies the largest area in Site A, taking up almost 40% of the total area (Table 7-4). This forest type generally does not form a large forest patch, but is interspersed with other vegetation types, especially scrubland (Figure 7-7). The dominant tree species established in Site A is the exotic albizia (*Falcataria falcata*), which was historically commonly planted as a wayside tree (Figure 7-17B) [P-160]. *Cecropia pachystachya* was also observed in the exotic-dominated secondary forest, but in relatively lower numbers (Figure 7-17A). Some areas within the exotic-dominated secondary forest have been cleared, presumably to make pathways for horses moving around the training stables (Figure 7-17C–D).



Figure 7-17 Exotic-dominated secondary forest in Site A with (A) *Cecropia pachystachya* trees (red arrow) and (B) *Albizia (Falcataria falcata)* trees forming canopies over areas dominated by herbaceous vegetation; (C–D) Areas within the exotic-dominated secondary forest cleared for pathways.

Site D

Within the forested area within Racecourse Oval, this habitat type occupies the largest area (1.8 ha), making up exactly one-third of Site D (Table 7-4, Figure 7-7). The northern patch is dominated by African tulip (*Spathodea campanulata*) (Figure 7-18A), interspersed with other fast-growing exotic species, such as *Leucaena leucocephala* (Figure 7-18B) and *Acacia auriculiformis*. Within the understorey, some common native species, such as *Claoxylon indicum* and *Syzygium grande*, were also observed. In the central and southern portion, the canopy is largely dominated by large specimens of albizias (*Falcataria falcata*) (Figure 7-18C) which were growing above the other trees, forming the forest emergent strata, as they are known to be fast-growing and reach much greater heights (Figure 7-18D). Although they are an exotic species, albizia trees provide important potential nesting locations for raptors and other bird species.

Some infrastructure were also observed within the exotic-dominated secondary forest, such as an abandoned pump room (Figure 7-18E), and a swing structure as part of the obstacle courses for the jungle cross trail that was still in use until recently (Figure 7-18F).



Figure 7-18 Exotic-dominated secondary forest in Site D. (A) African tulip tree (*Spathodea campanulata*); (B) *Leucaena leucocephala*; (C) *Albizia (Falcataria falcata)*. (D) *Albizia* trees towering above other trees; (E) Abandoned pump room, and; (F) Swing.

Site E

Two strips of exotic-dominated secondary forest were identified in Site E, one in the golf course and another south of the Grandstand (Figure 7-7). The forest strip within the golf course was largely dominated by *albizia (Falcataria falcata)* and had a sparse understorey surrounded by the turf area of the golf course which was regularly maintained. Very few specimens of conservation significance were encountered in this forest, of which a notable record would be the large specimen of the nationally Endangered *Ficus virens* strangler (Section 7.3.2.2).

South of the Grandstand, the floristic assemblage was dominated by a few spontaneous and fast-growing exotic trees, mostly African tulip (*Spathodea campanulata*), followed by *Cecropia pachystachya*, and *Leucaena leucocephala*. Some common native trees could still be found in this forest as well, such as *Ficus microcarpa* and *Syzygium grande*, but species of conservation significance were also seldomly encountered.

Site F

The large exotic-dominated secondary forest patch that covers the eastern segment of Site F (Figure 7-7) has an especially low native species composition and is heavily dominated by African tulip (*Spathodea campanulata*) and *Albizia (Falcataria falcata)* in the canopy and understorey. Other trees include exotic fruit trees from past sundry cultivation, including rambutan (*Nephelium lappaceum*) and coconut (*Cocos nucifera*). Only a handful of common native species and species of conservation significance which were widespread across Site F were recorded in this patch, such as *Ficus variegata* and the nationally Vulnerable *Horsfieldia polyspherula* var. *polyspherula* (Section 7.3.2.2). A small fragment of this habitat type was also found in the western tip of Site F (Figure 7-7), comprised of a few exotic trees, such as *Ficus hispida* and rain tree (*Samanea saman*), in the canopy and a sparse understorey with some exotic fruit tree species and a low native species composition as well.

7.3.1.4 Scrubland

Scrubland habitat was recorded across all sites from A–F. The features characterising this habitat type include an open-canopy with a high incidence of sunlight and a uniform vegetated stratum occupied by grasses and herbaceous plants.

Site A

Scrubland occupies the second largest area (10.3 ha) in Site A and can be found throughout the site (Table 7-4, Figure 7-7). Most patches are interspersed within exotic-dominated secondary forest parcels (Figure 7-19A); this is likely due to the fact that trees are yet to colonise these highly disturbed areas of land [P-67]. Many of the scrubland patches in Site A could have been previously cleared and subsequently colonised by sun-loving

herbaceous species (Figure 7-19B). With time, available seed sources, and reduction in disturbance, it is highly likely that these areas will eventually be succeeded by tree species that will form closed canopies. At the time of this survey, this scrubland vegetation is largely dominated by the native common grass *Isachne globosa* as well as exotic mile-a-minute climber (*Mikania micrantha*) and elephant grass (*Cenchrus purpureus*).



Figure 7-19 Scrubland in Site A. (A) Scrubland with an open canopy contrasted with the closed canopy of the exotic-dominated secondary forest in the background; (B) Spontaneous herbs and shrubs that have colonised a previously cleared area.

Site B

Scrubland occupy 15.3% (2.7 ha) of the forested area adjacent to Fairways Quarters (Table 7-4, Figure 7-7). Numerous patches of scrubland are scattered across the forested area, and various different sub-types of this vegetation were observed. One of which is scrubland that has remained as semi-open canopy patches within the forested area for a long period of time (Figure 7-20A). Based on satellite images dating the early 2000s, these scrubland patches most likely formed from the time of vegetation clearance in the past but still persist today even though the area was most likely left untouched since then. These scrublands are dominated and densely covered by the broad sword fern (*Nephrolepis biserrata*) and *Ottochloa nodosa* grass, which thrive best in environments with open canopy and high incidence of sunlight.

The other sub-type is mostly located at the northwest, within open-canopy gaps in the native dominated forest. These patches of scrubland are dominated by resam fern (*Dicranopteris linearis*) (Figure 7-20B), which is a sun-loving species that could have established themselves following tree falls which create gaps in the canopy (Figure 7-20C). Such scrublands may progressively decrease in size as they are shaded out by adjacent forest trees which are growing and proliferating.

Scrubland dominated by a dense layer of camwood (*Baphia nitida*) shrub (Figure 7-20D) was also identified as a sub-type. This sub-type was recorded in the southeast, in proximity to Eng Neo Avenue. Camwood (*Baphia nitida*) is a shrub species commonly planted as hedges along streetscapes, including the nearby Eng Neo Avenue. If not maintained and pruned regularly, this species is able to overgrow and encroach into adjacent forested areas. This would result in extensive patches of scrubland dominated by camwood, which was observed for this site.



Figure 7-20 Scrubland in Site B. (A) Scrubland dominated by broad sword fern (*Nephrolepis biserrata*) within a forested patch; (B) Resam fern (*Dicranopteris linearis*) possibly shaded out by larger trees; (C) Open-canopy formed by tree falls; (D) Dense camwood (*Baphia nitida*) shrubs.

Site C

In Site C, scrubland is the largest vegetation type and was mostly found surrounding the native-dominated secondary forest in the north, adjacent to the golf course, as well as in the south as small scattered patches surrounding abandoned-land forest (Table 7-4, Figure 7-7). The extensive stretch of scrubland in the north was dominated by lalang (*Imperata cylindrica*) (Figure 7-21A), broad sword fern (*Nephrolepis biserrata*) (Figure 7-21B), as well as resam fern (*Dicranopteris linearis*), which is similar to what was observed for forest canopy gaps in Site B (Figure 7-21B).



Figure 7-21 Scrubland in Site C, dominated by (A) lalang (*Imperata cylindrica*) and (B) *Nephrolepis biserrata*.

Site D

Scrubland occupies approximately 20% (1.2 ha) of the forested area within Racecourse Oval (Table 7-4, Figure 7-7). Similar to Site B, numerous patches of scrubland are scattered within the forest edges and the forest interior. Within the forest interior, this habitat consists of grasses, such as *Ottochloa nodosa*, *Ischaemum* sp., and other species, such as broad sword fern (*Nephrolepis biserrata*), as well as climbers, such as morning glory (*Ipomoea cairica*) (Figure 7-22A). Some patches of this habitat type were also observed to occur along steep terrains (Figure 7-22B).

Another scrubland sub-type was also observed at the southern portion, along the waterbody. Within this area, the scrubland is mostly dominated by elephant grass (*Cenchrus purpureus*) (Figure 7-22C) and crepe ginger (*Cheilocostus ebracteatus*). As majority of these scrubland patches are adjacent to abandoned-land forest, herbaceous crop plants persisting from past cultivation, such as banana (*Musa* sp.) (Figure 7-22D) and giant taro (*Alocasia macrorrhizos*) (Figure 7-22E) were interspersed within this habitat type. Along the forest edge, small *Leucaena leucocephala* saplings were also observed in the open-canopy environment (Figure 7-22F).



Figure 7-22 Scrubland in Site D. (A) Within the forest interior; (B) Steep terrain; (C) A scrubland dominated by elephant grass (*Cenchrus purpureus*) and some crop plants: (D) Banana (*Musa* sp.); (E) Giant taro (*Alocasia macrorrhizos*); (F) Saplings of *Leucaena leucocephala* growing along the forest fringe.

Site E

Scrubland is the smallest vegetation type in Site E and is made up of small patches scattered along the edges of the exotic-dominated forest and abandoned-land forest in the south (Table 7-4, Figure 7-7). These scrubland patches were dominated by elephant grass (*Cenchrus purpureus*) and broad sword fern (*Nephrolepis biserrata*), with a few scattered African tulip (*Spathodea campanulata*) trees and saplings.

Site F

Scrubland patches in Site F make up one-quarter of the site, comprised of large patches surrounding the forested areas and a few small patches in canopy gaps within the central abandoned-land forest patch (Table 7-4, Figure 7-7). Similar to Site D, these scrubland patches were dominated by sun-loving grasses and shrubs as well as herbaceous crop species and saplings of exotic trees that are found in the adjacent forests. Notably, specimens of the nationally Vulnerable *Horsfieldia polyspherula* var. *polyspherula* found in abundance across Site F were also present in these scrubland patches (Section 7.3.2.2).

7.3.1.5 Urban Vegetation

Urban vegetation was recorded in all sites except Site D.

Site A

Two small areas with urban vegetation in Site A include (1) a managed turf of 5–10 m width with some planted streetscape trees southeast of the horse training stable (Figure 7-23A) and (2) *Bougainvillea glabra* hedges, planted trees, and turf along a bend of Eng Neo Avenue leading to the PIE (Figure 7-23B, Figure 7-7). All urban vegetation comprised planted exotic species.



Figure 7-23 Urban vegetation in Site A. (A) Managed turf with planted streetscape trees on one side of the horse training stable; (B) Planted trees, managed lawn, and *Bougainvillea glabra* hedges along a bend of Eng Neo Avenue leading to the PIE.

Site B

There are two small patches of urban vegetation in Site B (Table 7-4, Figure 7-7). The larger patch is located at the northeast and consists of managed turf and scattered trees, bordering the premises north of the Bukit Timah Saddle Club where equestrian training was often held (Figure 7-24A). Some of the commonly planted streetscape trees recorded here include angkana (*Pterocarpus indicus*; Figure 7-24B), rain trees (*Samanea saman*), and tembusu (*Cyrtophyllum fragrans*). These trees are periodically pruned and maintained as they are located in close proximity to the training areas and other amenities, such as carparks. *Syzygium myrtifolium* hedges are also planted in these areas and are regularly maintained as well (Figure 7-24B).

The second patch of urban vegetation is located south of the Bukit Timah Saddle Club. Here, clusters of *Syzygium grande* trees with few specimens of exotic trees, such as *Acacia auriculiformis*, saga (*Adenantha pavonina*) and African tulip (*Spathodea campanulata*) were planted on turf (Figure 7-24C). A Malayan colugo (*Galeopterus variegatus*) (Figure 7-24D) was also opportunistically sighted on one of the *Syzygium grande* trees during floristic surveys.



Figure 7-24 Urban vegetation in Site B. (A–B) Near the Bukit Timah Saddle Club; (C–D) South of the Bukit Timah Saddle Club, where a Malayan colugo was opportunistically sighted.

Site C

Urban vegetation is the smallest vegetation type recorded only in the south of Site C (Table 7-4, Figure 7-7) and comprise the landscaping around a large private house (Figure 7-25A) which is separated from the adjacent forest by a chain link fence (Figure 7-25B).



Figure 7-25 Private housing and urban vegetation photographed from inside the forest in Site C

Site E

Urban vegetation is the largest vegetation type in Site E, comprising vegetation in the former Champion's golf course, Grandstand, Horsecity, Junkie's Corner, and buildings near 700 Dunearn Road, which make up nearly half

of the site (Table 7-4, Figure 7-7). Although the species composition differs amongst urban vegetation due to the diverse land use, the species that comprise urban vegetation are largely exotic and can commonly be found at many urban areas in Singapore.

The former golf course consists of managed turf and commonly planted trees, such as rain tree (*Samanea saman*), angkana (*Pterocarpus indicus*), and tembusu (*Cyrtophyllum fragrans*), which make up the fairway (Figure 7-26). Larger tembusu trees are likely to have been retained from the native vegetation present before clearance. Some waterbodies with exotic ornamental aquatic vegetation such as lotus (*Nelumbo nucifera*) were also present within the managed turf as part of the features for the golf course (Figure 7-26). Species of conservation significance, including the nationally Endangered *Ficus virens* and Vulnerable *Litsea umbellata*, were sparsely recorded along the fairway and rough beside the waterbodies (Section 7.3.2.2).

The rest of the urban vegetation in Site E, namely at the Grandstand (Figure 7-27), Horsecity, Junkie's Corner, and buildings near 700 Dunearn Road (Figure 7-28), can be found along roads, paths, and buildings and are largely comprised of managed turf and common streetscape trees and hedges, such as African mahogany (*Khaya* sp.) and red lip tree (*Syzygium myrtifolium*). A few small and scattered areas, especially near Junkie's Corner, were cultivated by ex-tenants with ornamental and edible vegetation, such as common bamboo (*Bambusa vulgaris*) and banana (*Musa* sp.). Abandoned areas, mostly represented by buildings at 700 Dunearn Road, were observed to be overgrown with spontaneous weedy species, such as *Hyptis capitata*, *Lindernia antipoda*, and *Legazpia polygonoides*, and other hardy vegetation such as *Ficus microcarpa* which are usually found sprouting on roofs.

Species of conservation significance were occasionally recorded throughout the urban vegetation, most of which were large strangling figs (e.g. *Ficus virens* and *Ficus kerkhovenii*) that have established themselves amongst the streetscape. Additionally, clusters of *Ficus vasculosa* trees and *Cyclea laxiflora* climbers were encountered in the vegetated patches located south of the Grandstand, as well as epiphytes, such as the nationally Vulnerable *Bulbophyllum vaginatum* and *Goniophlebium percussum*, that were found thriving on streetscape trees (Section 7.3.2.2).



Figure 7-26 The former Champions Golf Course in Site E, which was mostly managed turf with large tembusu (*Cyrtophyllum fragrans*) trees, remnant strips of forests, and waterbodies



Figure 7-27 Urban vegetation around the Grandstand in Site E. (A) Planted bamboos, trees, and turf; (B) Steep slope with planted turf near Swiss Club Road; (C) Street scape next to Turf Club Road



Figure 7-28 Urban vegetation and abandoned buildings at 700 Dunearn Road in Site E

Site F

Similar to Site A, managed turf and streetscape trees along roads and buildings constitute the urban vegetation in Site F. These areas were found mostly along Eng Neo Avenue, Sunset Avenue, Greenpark Avenue, and along the PIE (Figure 7-7; Figure 7-29). Remarkably, a specimen of the nationally Endangered *Plegmariurus phlegmaria* (Figure 7-29D) was spotted on a roadside rain tree (*Samanea saman*) along Eng Neo Avenue (Section 7.3.2.2).



Figure 7-29 Urban vegetation in Site F along (A) Sunset Avenue , (B) Greenpark Avenue, (C) PIE, and (D) *Plegmariurus phlegmaria*

7.3.1.6 Non-vegetated

Non-vegetated areas, such as infrastructure and cleared areas, were recorded in sites A–E.

Site A

Infrastructure found in Site A mostly comprise small roads branching east of Fairway Drive and the golf course as well as scattered abandoned buildings similar to Site B (Figure 7-7). The roads were lightly used and mostly overgrown with vegetation from the adjacent scrubland and forests.

Site B

Infrastructure within Site B include concrete roads and sand pathways that are now used by horses (Figure 7-30A-B). There are also abandoned water pump rooms Figure 7-30C). These buildings are located within the forested areas, some of which were enclosed within dilapidated green chain-linked fences (Figure 7-30D). Multiple concrete culverts and drains were also present (Figure 7-30E).



Figure 7-30 Infrastructure in Site B. (A–B) Concrete and sand pathways for horses; (C–D) Abandoned buildings within green chain-linked fences and with overgrown vegetation; (E) A Culvert; (F) Abandoned amenities.

Site C

Non-vegetated areas in Site C include a private road stretching around the British Club. Unlike the other sites, cleared area also makes up the non-vegetated areas in Site C (Figure 7-7). An area of < 1% of Site C near Turf Club Road was observed to be cleared at the time of survey. The space was mostly cleared of vegetation and appeared to be used temporarily as storage space for large cargo containers and tentages (Figure 7-31).



Figure 7-31 Cleared areas in Site C

Site D

Infrastructure in the forested area within Racecourse Oval include areas that were cleared to make way for the amenities for various sports activities (Figure 7-32A) and soccer fields (Figure 7-32B) that are located beside the forest fringe. Large containers and sheds were also found adjacent to forest fringe and were used as storage

facilities (Figure 7-32C). Slopes that were created using compacted soil and sand were also observed to create ramps for the mountain biking activity within the site (Figure 7-32D). Within the forest interior, different obstacle courses for the jungle cross trail, such as monkey bars (Figure 7-32E) and other climbing structures (Figure 7-32F), were placed across the existing waterbodies and within the open areas.



Figure 7-32 Infrastructure in Site D. Areas that were previously cleared to make way for (A) Sports amenities; and (B) Soccer field; (C) Ramps created with soil and sand for the mountain biking activity; (D) Container storage and sheds used to store logistics; different obstacles courses found beside the existing waterbody and within the forest interior; (E) Monkey bars; (F) Other climbing structures.

Site E

Non-vegetated areas make up the second-largest area in Site E, taking up about 40% of the site (Table 7-4). These areas are buildings and roads in the former Grandstand, golf course, Horsecity, and along Vanda Link and Turf Club Road (Figure 7-7). Some ornamental vegetation could still be found amongst these infrastructures, but are too sparse to form a vegetated habitat (Figure 7-33).



Figure 7-33 Part of the former Grandstand, which was mostly non-vegetated and sparsely planted with trees

7.3.1.7 Waterbodies

Site A

Within Site A, waterbodies, ponds and waterlogged/swampy ground areas are present. The locations and alignment of the waterbodies is shown in Figure 7-7.

There is a single stream system that runs from north to south on the eastern edge of the Study Area. Though most of the stream flows directly from north to south, there is a minor tributary that flows towards the west. The waterway flowing through the site encompasses both forest streams and open-country streams (Figure 7-34A-D).

Some smaller waterbodies are also present on site. Man-made shallow waterbodies are present parallel to the old road (Figure 7-34E), which was likely formed from water accumulation in channels left behind after construction of the old road. Some swampy sections were also observed around the stream, particularly in the southern and western part. There is a large unmanaged pond (D4, ~20m by 20m) present in the centre part of the site (Figure 7-34F). The pond is filled with wood debris and covered by algae. It is located within the open scrubland.



Figure 7-34 Waterbodies in Site A. (A) Upstream of outflow from culvert under the PIE; (B) Semi-open country stream; (C–D) Forested streams with canopy cover; (E) Man-made shallow waterbodies along the old road; (F) A large unmanaged pond (D4) in the centre part of the Study Area.

Site B

Within the forested area adjacent to Fairways Quarters, naturalised and concretised ponds and streams were present. The locations and alignment of the waterbodies is shown in Figure 7-7.

There is a single stream system that runs from north to south on the western edge of Site B (Figure 7-35A–D). The waterway flowing through the site encompasses narrower, slow flowing streams where parts of the old concrete drain has been filled with soil and leaf debris, naturalising these areas while other sections of the stream remained concrete-bottomed. Some parts of the stream flow overland.

In addition, parts of the old concrete drain system within the forested area remain inundated and forms shallow streams within the eastern part of Site B (Figure 7-35E-F). This is located within a horse track oval found in the middle of Site B within the forest habitat.



Figure 7-35 Waterbodies in the forested area adjacent to Fairways Quarters. (A–D) Waterbody D7 with different microhabitats from upstream (A) to downstream (D); (E–F) Waterbody D6 Located within the horse track oval found in the middle of Site B.

Site C

Within Site C, a forest stream and a short naturalised concrete canal are present. The locations and alignment of the waterbodies is shown in Figure 7-7.

There is a single stream system that runs from north to south on the western edge of the Study Area. The waterway flowing through the site is narrow and encompasses both forest streams with higher canopy cover and open-country streams with lower canopy cover. The streambed alternates between being manmade and concretised, and natural at different sections.

A man-made and concretised canal that has since been naturalised can also be found on the western section of the Study Area, south of the forest stream.

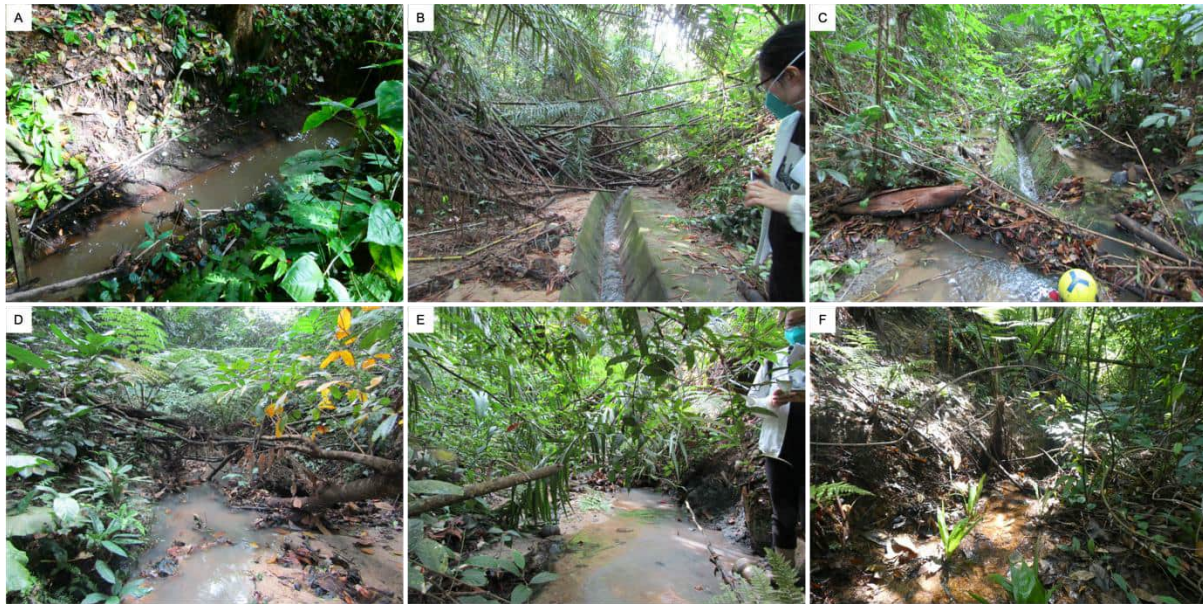


Figure 7-36 Waterbodies in the forested area adjacent to Swiss Club and British Club. (A–F) Waterbody with different microhabitats from downstream (A) to upstream (F).

Site D

In contrast to Site B, a wider stream with a much deeper flow was present in the forested area within Racecourse Oval that ran north to south through the centre of the forested area. The waterbody was mostly naturalised with substrate bottom and well-shaded sections (Figure 7-37). Since the stream was located within a Racecourse Oval that in recent years has been used as part of a mountain biking and jungle cross trail, there were obvious signs of human disturbance with parts of the stream deepened and the presence of concrete structures found within various parts of the stream. Despite this and the clear daily use of stream by mountain bikers and trail runners, stream flow remained clear.



Figure 7-37 Waterbodies in in the forested area within racecourse oval. (A) naturalised concrete canal south of waterbody and Study Area; (B) steep banks and concrete structures along stream; (C) forested stream with canopy cover north of waterbody and Study Area.

Site E

Site E has three main waterbodies – canals and drains near Swiss Club Road, managed ponds at the former golf course area and a naturalised streams in the southern forest.

The forest patch at the south of Site E near 700 Dunearn (Figure 7-38), the drain that separates the forest from the former Merlion Sports City Field had a number of aquatic fauna. This includes a large number of the Nationally Threatened common walking catfish (*Clarias batrachus*), guppies (*Poecilia reticulata*) and oriental swamp eel (*Monopterus javanensis*). There is also a large concrete high wall canal that borders the west most forest patch in Site E.

The managed ponds in the former golf course area (D8 and D9) are relatively stagnant, however aquatic fauna such as the Malayan giant frog (*Limnonectes blythii*) and field frog (*Fejervarya limnocharis*) were frequently encountered near the edge of the pond. Within the pond, guppies (*Poecilia reticulata*) and the Indochinese spotted barb (*Barbodes rhombeus*) were also commonly recorded. The shallow region of pond D9 tend to attract a large number of dragonfly, such as the variable sprite (*Agriocnemis rubescens*), sapphire flutterer (*Rhyothemis triangularis*) and sultan (*Camacinia gigantea*).

The naturalised stream on the south of Site E (D12) is connected to the stream at Site B (D7). The stream width varies and ends as a concrete culvert. The stream bed and bank has areas that were naturalised with sandy substrate, as well as areas which were purely concrete. There is generally a canopy cover over the stream, however, some parts of the stream was observed to be highly polluted and would require clean-ups as part of enhancement if it were to be retained.



Figure 7-38 Waterbodies at the area near Swiss Club Road



Figure 7-39 Waterbodies near the former horse gallop stable

Site F

At Site F, there is a concrete canal that connects to Site A from underneath Eng Neo Avenue (Figure 7-40). No other permeant water body is present, however occasionally natural shallow ponds are observed. These are likely ephemeral and no other aquatic fauna or riparian vegetation was recorded.



Figure 7-40 (A) A natural ponding area within Site F; (B) An existing concrete canal that runs from Site A to Site F

7.3.2 Flora

7.3.2.1 Overall

A total of 591 species and 55 species groups (i.e., plants that could not be identified to species with certainty) belonging to at least 132 families were recorded from the Study Area (Appendix D). Almost half of all recorded plant species from this Study are native, of which approximately half are listed as nationally threatened. About one-third are non-native species, while the remaining are either cryptogenic, not listed in Chong et al. (2009) [P-2], Lindsay et al. (2022) [P-52] and the Red Data Book 3 [W-20] and are likely non-native, or could not be identified with certainty.

Native threatened species comprise species that have been accorded the following statuses: Vulnerable, Endangered, Critically Endangered, or Presumed Extinct. For overall findings, however, a distinction was not made as to whether threatened species are from native wild populations or are cultivated locally and/or relics from past cultivation. Species belonging to the latter category are not of conservation significance even though they have been accorded with a threatened status (Sections 7.2.1.4).

Table 7-5 Number of recorded plant species

Origin	Status	Count	%
Native		337	52.2
	Critically Endangered	44	6.8
	Endangered	50	7.7
	Vulnerable	66	10.2
	Least Concern	173	26.8
	Data Deficient	4	0.6
Exotic		215	33.3
	Cultivated only	67	10.4
	Casual	61	9.4
	Naturalised	87	13.5
Cryptogenic		22	3.4
Not listed*		16	2.5
Unidentified species		55	8.7
Total		646	100.0

*Note: Not listed in Chong et al. (2009) [P-2], Lindsay et al. (2022) [P-52] and the Red Data Book 3 [W-20] and are likely non-native

7.3.2.2 Plant Species of Conservation Significance

A total of 177 species across are considered of conservation significance (Table 7-6). Some species, though listed as nationally threatened, were not considered of conservation significance in this Study because they are most likely escapees from present-day cultivation or relics that has persisted from past cultivation. The assessment on whether a threatened plant species is of conservation significance was carried out based on the criteria detailed in Section 7.3.2.1.

Overview

Up to 560 individuals and clusters of specimens of conservation significance were recorded from Site A (Appendix E). A large number of these specimens are concentrated in the northern half of the Study Area, especially within the native-dominated secondary forest patch (Figure 7-41). Beyond these areas, the specimens appear to be sparsely distributed within the abandoned-land forest, especially in the south, near Site F.

Altogether, about 130 specimens and/or clusters of specimens belonging to these species of conservation significance were recorded in Site B (Appendix E). Majority of the specimens are concentrated within the native-dominated secondary forest, followed by the abandoned-land forest (Figure 7-41).

More than 1,400 plant specimens of conservation significance were recorded in Site C (Appendix E). This is the highest concentration amongst all the sites surveyed in this Study. Most of the plant specimens occupy the native-dominated secondary forest—which is also the largest and most extensive continuous native forest patch in the

combined Study Area—with several other scattered specimens occurring within the adjacent and smaller patch of abandoned-land forest and scrubland (Figure 7-41).

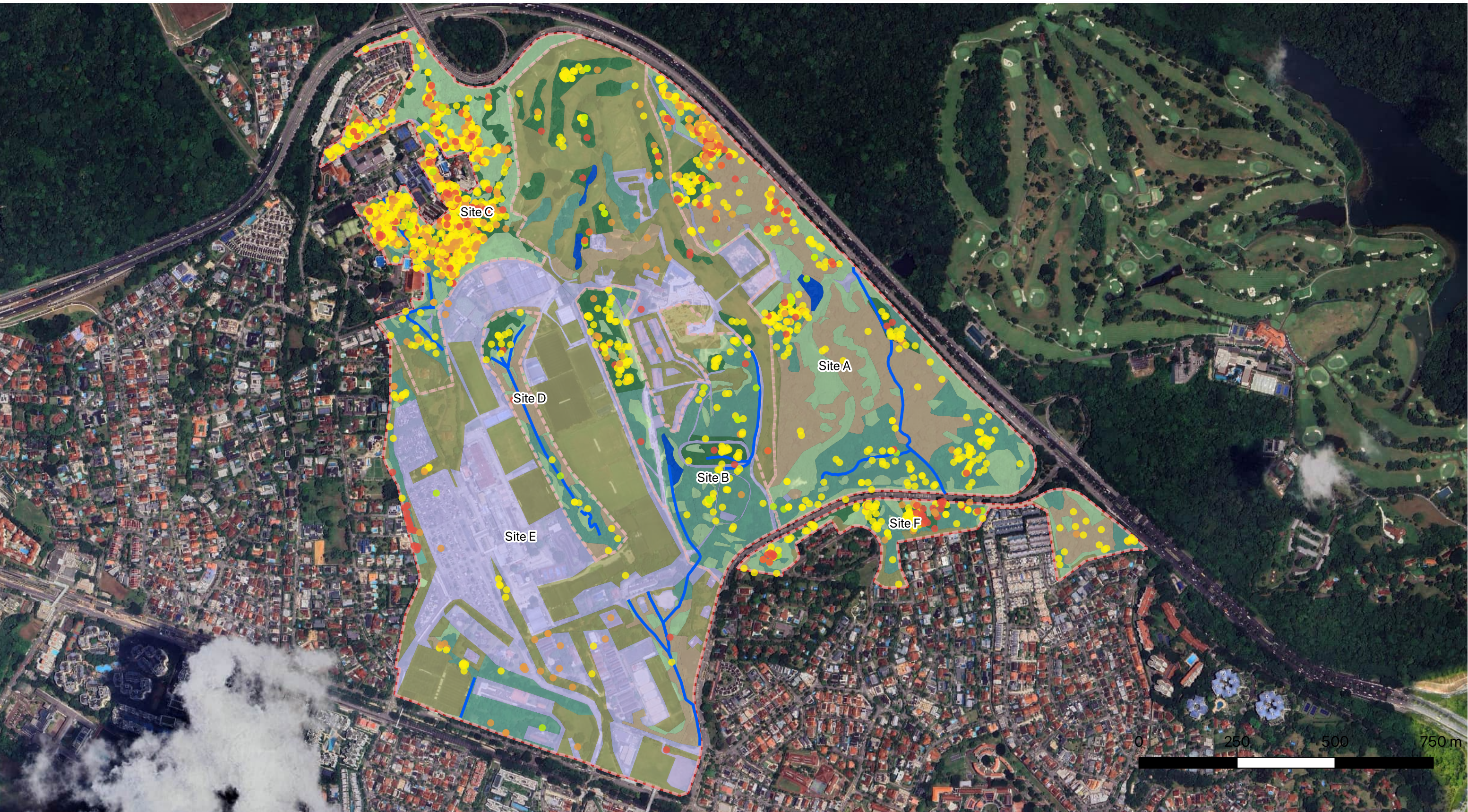
About 20 specimens and/or clusters of specimens belonging to these species of conservation significance were recorded in Site D (Appendix E). The majority of the specimens are concentrated within the native-dominated secondary forest (Figure 7-41). This is the lowest count as Site D, being the smallest site, also had the smallest native forest patch relative to the other sites.

Approximately 160 specimens and/or clusters of specimens of conservation significance were recorded in Site E (Appendix E). Although this site is mostly built-up, several threatened plants still persist in the remnant forest fragments within the former Grand Stand and Champions Golf Course (Figure 7-41).

Although Site F is a forest fragment isolated from the rest of the sites by Eng Neo Avenue, close to 150 plants of conservation significance were recorded here (Appendix E). Most of them were recorded within the native-dominated secondary forest, but the specimens were generally well-distributed across all habitat types throughout Site F (Figure 7-41).

Table 7-6 Number of species of conservation significance

Status	Count	%
Critically Endangered	32	18.1
Endangered	47	26.6
Vulnerable	64	36.2
Unidentified species*	34	19.2
Total	177	100.0
*Note: species that could not be identified with certainty, but are most likely native and threatened		



Legend

- EIA Study Area
 - Site boundary
 - Vegetation Types**
 - Native-dominated secondary forest
 - Abandoned-land forest
 - Exotic-dominated secondary forest
 - Scrubland
 - Urban vegetation
 - Non-vegetated
 - Waterbody
-
- Plants of Conservation Significance**
 - Critically Endangered
 - Endangered
 - Vulnerable
 - ID not confirmed but likely CS



Rev.	Date	By	Description	Chk'd	App'd
-	MAY 2024	SHMX	Turf Club EIA	LAL	JAG

Qualified Person Endorsement : NA

URA Endorsement : NA

Consultant : **AECOM**

Project Title : **CONTRACT URA/T/22/031 ENVIRONMENTAL IMPACT ASSESSMENT (EIA) FOR FORMER TURF CLUB AT BUKIT TIMAH**

Designed SHMX	Checked LAL	Approved JAG
Drawn SHMX	Date MAY 2024	

Client: **URBAN REDEVELOPMENT AUTHORITY**

Figure Title : **Distribution of Plant Specimens of Conservation Significance**

Figure No. : 7-41	Rev. -	Sheet 1 of 1
CAD File Name : NA		A3

Note: Source of basemap - Google Earth Map

Site A

At least nineteen species listed as nationally Critically Endangered are considered of conservation significance in Site A. Some of the rarer species include *Memecylon floridum* and *Prunus arborea* var. *stipulacea* (Figure 7-42).

As with many other species, a cluster of *Prunus arborea* var. *stipulacea* seedlings and trees up to 0.2 m girth were only recorded in a vegetation plot located within the northern-most native-dominated forest patch. *Prunus arborea* var. *stipulacea* is more often associated with more mature secondary forests. It was noted by taxonomic experts that this species is fairly rare and not commonly encountered even in the NSSF (pers. comms.).

In addition to native-dominated secondary patches, some of the rare species were also found beyond those areas, such as *Xanthophyllum ellipticum*. In this Study, at least 20 specimens were found throughout Site A, both in and outside the native-dominated patches. Previous records of this species include the pristine forests NSSF, CCNR, and BTNR, as well as outside the protected areas (Ang Mo Kio and Tanglin Barracks) [P-137]. Similarly, small- to medium-sized clusters of *Memecylon floridum* were distributed only within the northern half of the Study Area.

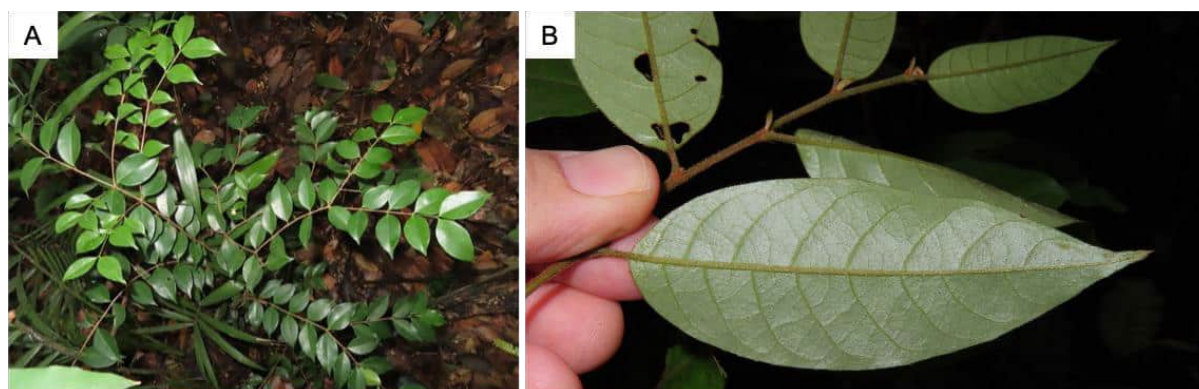


Figure 7-42 Nationally Critically Endangered plant species recorded at Site A. (A) *Memecylon floridum*; (B) *Prunus arborea* var. *stipulacea*.

Twenty species recorded as nationally Endangered are considered of conservation significance in Site A. Some of the less frequently encountered species include *Artocarpus dadah*, *Uncaria cordata*, *Canthiumera robusta*, and *Koompassia malaccensis* (Figure 7-43).

One specimen each of *Koompassia malaccensis* and *Uncaria cordata* were both encountered in the northern-most native-dominated forest patch.

On the other hand, a cluster of about 20 *Artocarpus dadah* specimens was found in one of the vegetation plots outside but in close proximity to the northern-most native dominated forest patch (Figure 7-7). The girth ranges from < 0.05 m to 0.2 m. The forest type in which these specimens were found was classified as abandoned-land forest as several rubber trees form the canopy layer. However, the forested patch hosts a mix of native and crop plants species.

Two specimens of *Canthiumera robusta* were also encountered outside the native-dominated, within an exotic-dominated secondary forest patch and at the border between a native-dominated patch and exotic-dominated secondary forest, respectively.

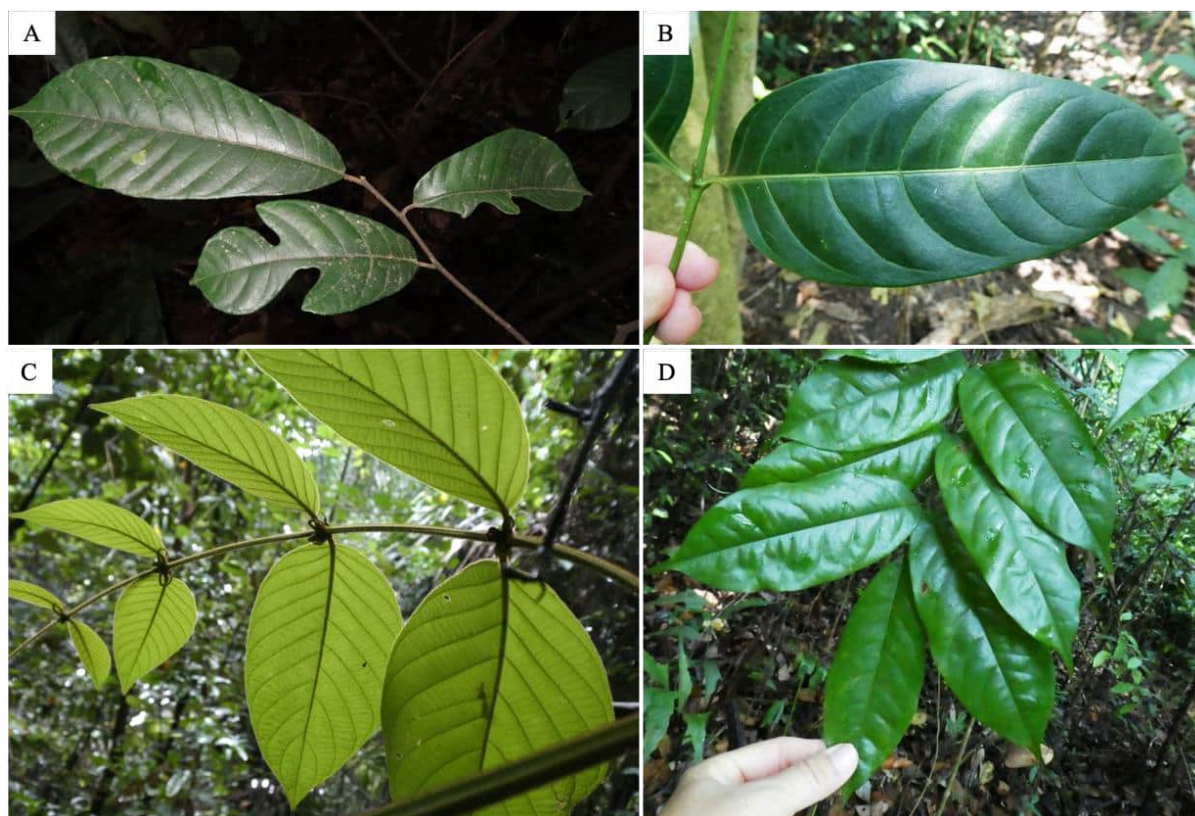


Figure 7-43 Nationally Endangered plant species recorded at Site A. (A) *Artocarpus dadah*; (B) *Canthiumera robusta*; (C) *Uncaria cordata*; (D) *Koompassia malaccensis*.

Thirty-one nationally Vulnerable species were recorded from Site A, some of which are commonly encountered in some secondary forests in Singapore, such as *Macaranga griffithiana* and *Litsea umbellata*. The rarer and less commonly encountered species include *Flacourtia rukam*, *Hornstedtia scyphifera* var. *scyphifera*, *Pternandra coerulescens*, and *Sterculia rubiginosa*, amongst others (Figure 7-44).

Two specimens of *Aporosa lucida* var. *lucida* were encountered in the abandoned-land forest south of the Study Area, one of which is a fairly large tree of 0.4 m girth found inside one of the vegetation plots.

Flacourtia rukam was found in the vegetation plot located within the northern-most native-dominated forest patch, from which the rare and nationally Critically Endangered *Prunus arborea* var. *stipulacea* was also recorded.

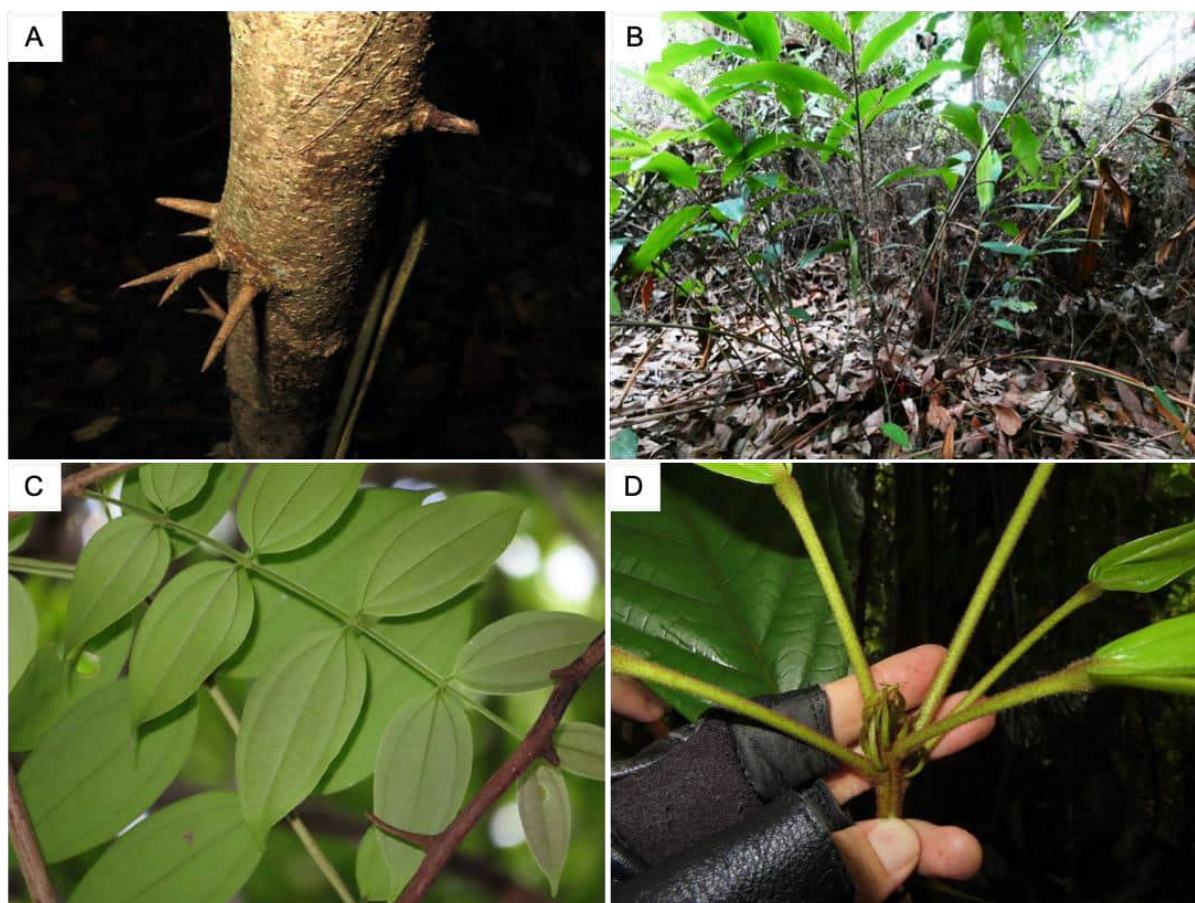


Figure 7-44 Nationally Vulnerable plant species In Site A. (A) *Flacourtia rukam*; (B) *Hornstedtia scyphifera* var. *scyphifera*; (C) *Pternandra coerulescens*; (D) *Sterculia rubiginosa*.

Site B

Several nationally threatened species were found in Site B. A key species of interest is the pteridophyte *Phlegmariurus carinatus* (Figure 7-45A). Two small clusters of this species were spotted on a rain tree (*Samanea saman*) near the Rider's Café carpark in Oct 2021. Based on the distinct morphological feature of the cord-like shoots and assuming the specimens are native, *P. carinatus* is the only plausible species of this genus in the region (Lindsay S., pers. comms., 2022). This species was previously classified as Extinct in the Singapore Red Data Book 2 [P-96] and by Chong et al. (2009) [P-2]. The recent collection at MacRitchie as well as this finding from the present Study likely indicated a rediscovery of this rare species. Since then, its national conservation status has been updated to Critically Endangered in the Red Data Book 3 [W-20].

Another noteworthy species is the fern, *Asplenium nitidum* (Figure 7-45B). One specimen was encountered on 11 Nov 2021. It was growing on a rain tree, near Fairways Drive. The specimen was relatively large with fronds measuring up to 50 cm long. As the specimen was too high to reach, photographs were taken and used to match against identification keys and books. Characters observed in the photographs match those in Piggott (1996) [P-123]. No spores were observed during surveys. This species was thought to be nationally Extinct based on Davison et al. (2008) [P-96], Chong et al. (2009) [P-2], and Ho et al. (2019) [P-100]. Three specimens catalogued in the SING date all the way back to the 19th century, where the specimens were collected between 1906 and 1907. Thereafter, no voucher specimens were collected until about a century later, in 2012, where one specimen was collected from Jalan Jelutong at Pulau Ubin. This species may have been under-detected and thus thought to be nationally extinct. Findings from this Study as well as previous surveys in other forested patches of Singapore (unpublished data) is evidence that the population may still be persisting on mainland Singapore. In the latest Red Data Book 3 [W-20], this species is listed as nationally Critically Endangered.

A total of three findings of *Baccaurea pyriformis* were recorded. Their locations are restricted to the native-dominated forest patches. This species is characterised by the visible marginal glands on both leaf surfaces, which are covered with hairs, especially on the venations on the abaxial side of the leaves. It was previously thought to

be nationally extinct, as listed in Davison et al. (2008) [P-96] and Chong et al. (2009) [P-2]. Most of the voucher specimens' collection catalogued in the SING date back to 1984, except for the latest one which was collected in 2015 at MacRitchie Reservoir. This species could be "exceedingly rare", as noted by a taxonomic expert that it was only recently re-discovered in the Nee Soon Swamp Forest (NSSF) and another individual observed in an old secondary patch in MacRitchie [P-109]. Apart from these, there is very little information to-date on the distribution and habitats of *B. pyriformis* in Singapore. It is now listed as nationally Critically Endangered in the Red Data Book 3 [W-20].

Calophyllum inophyllum, listed as Endangered in the Red Data Book 3 [W-20], is a native coastal species. Currently, the only known area in Singapore where mature individuals of this species still persist is the natural coastal forest southwest of St. John's Island, where a population was found to be widespread [P-100]. This species is also commonly planted in local streetscapes; as such it is likely that propagules from cultivated stocks have spread into some secondary forests in Singapore. However, one large *Calophyllum inophyllum* tree of 3.3 m girth was recorded from the present floristic surveys. Given that it would take a long time for the slow-growing species to attain the present size, it is almost certain the large specimen has been at the site for a long time. The individual is likely a remnant of the original native population there before human disturbance and could still be persisting in spite of the surrounding human developments and forest fragmentation.

A few nationally threatened species of relatively large girth were also documented in this present Study. For example, one specimen of the fig tree species nationally Endangered *Ficus glandulifera* was at least 1.1 m girth. It was also producing figs at the time of observation (Figure 7-45D). Two Critically Endangered *Actinodaphne maingayi* (previously recorded as *Actinodaphne macrophylla*) trees of at least 1 m girth were also recorded in close proximity to the large *Ficus glandulifera* tree. These were recorded in the largest native-dominated secondary forest patch in the western zone.

Other nationally threatened species recorded in the Study Area include *Psychotria maingayi* (previously recorded as *Psychotria sarmentosa*), *Aporosa lucida* var. *lucida*, *Gymnacranthera farquhariana* var. *farquhariana*, and *Strophanthus caudatus*. As some plants are climbers or epiphytes by nature, it is equally important to preserve them and the trees on which they grow. Although exotic, the value of these trees increases as they get nativised by more and more rare climbers and epiphytes overtime.

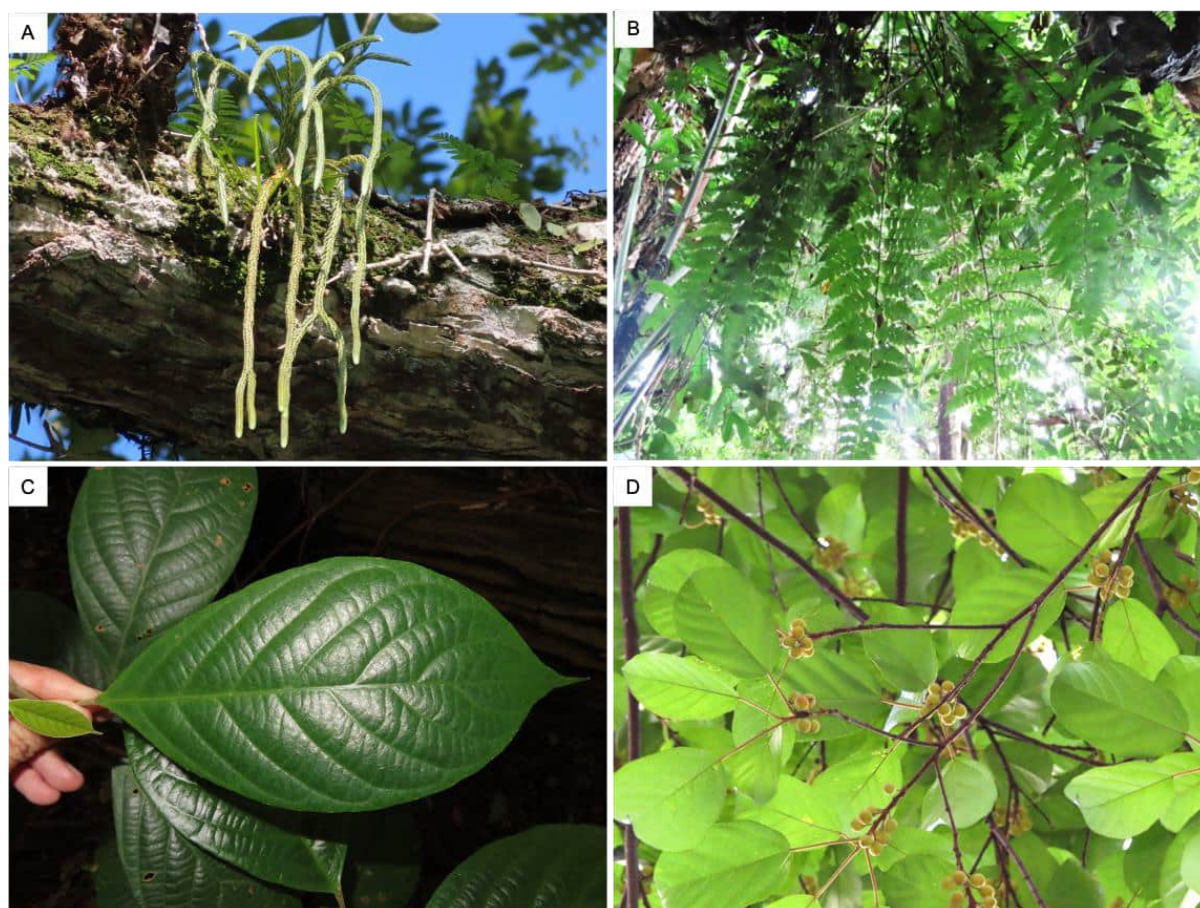


Figure 7-45 (A) *Phlegmariurus carinatus*, (B) cf. *Asplenium nitidum*; and (C) *Baccaurea pyriformis*; (D) *Ficus glandulifera*.

Other findings of non-widespread species of conservation significance include a single sapling of nationally Critically Endangered *Aporosa nigricans* that was encountered beside a drain outlet, within the native-dominated forest surrounded by the circular horse track in the eastern zone. This species is characterised by prominent glands at the base of the leaves, with whitish twigs and leaves that dry with a distinct blackish colour. This species was a surprising find at Site B as it is exceedingly rare. There have only been three records of this species in the recent years – one voucher specimen collected from the MacRitchie Reservoir in 2014 at the SING, and recorded from the Bukit Timah Nature Reserve (BTNR) by Ho et al. (2019) [P-100] and the NSSF [P-109]. Similar to *B. pyriformis*, *A. nigricans* is uncommon even in the NSSF and other nature reserves, with low densities of population found only in undisturbed and old forest patches [P-109]. Therefore, the forest should be retained so that these species can continue to grow and flourish in Singapore.

There were a few rare epiphyte species found as well, including *Bulbophyllum vaginatum*, a nationally Vulnerable orchid. According to Yam and Thame (2005) [P-142], this is an “unusual species” that is able to grow naturally on the branches of rain trees (*Samanea saman*) and sea apple (*Syzygium grande*), and in areas that are fairly exposed. This is consistent with the observations of *B. vaginatum* from the present Study, where this orchid was observed to be abundant and growing extensively on the branches of the rain trees. This species was recorded in the abandoned-land forest. This species appears to be well established in Site B.

Other nationally threatened species recorded in this Study had only a few specimens, such as *Calophyllum rubiginosum* with only one record (Figure 7-46D) and *Symplocos fasciculata* with two specimens in the Study Area (Figure 7-47B). Others had slightly different distribution pattern; for example, *Aporosa benthamiana* specimens (Figure 7-47A) were found in small clusters within the same area.



Figure 7-46 (A) *Aporosa nigricans*; (B) *Bulbophyllum vaginatum*; (C) *Amblovenatum opulentum* (previously nationally threatened, but now Least Concern); (D) *Calophyllum rubiginosum* (leaf underside).



Figure 7-47 (A) *Aporosa benthamiana* (large stipules); (B) *Symplocos fasciculata*.

Site C

The native forest in Site C, was by far, the most diverse and concentrated with nationally threatened plants. Several species are rare in Singapore and are mostly restricted to the nature reserves. Close to 100 threatened species were recorded in this site alone, making the native forest patches the most valuable across the entire Study Area.

Some of the more widespread species include the nationally Vulnerable *Calophyllum tetrapterum* var. *tetrapterum* (Figure 7-48F), *Chassalia curviflora* (Figure 7-48C) and the Endangered *Strophanthus caudatus* (Figure 7-48D). These species, amongst others, were observed to be occurring in high concentrations, where most specimens were close to another.

While the native forest in Site C resembles that of the other sites at A and B, there were still several species that were found exclusively in the former. The rarer species include *Daphniphyllum griffithianum* and *Vanilla griffithii* (Figure 7-48A–B). Mature specimens of *Daphniphyllum griffithianum* were recorded fruiting and flowering during surveys. *Vanilla griffithii* was an interesting find as this species, listed as nationally Endangered, is difficult to encounter as it occupies mainly primary rainforests and freshwater swamp forests, which only occur in the CCNR on mainland Singapore [W-29]. In this Study, at least two fairly large and healthy populations were observed during floristic surveys. Past unpublished data from our surveys also suggest that this species could be exceedingly rare, where there are a very few locations this species had been recorded. Other rare species found exclusively in this site include *Garcinia celebica* (previously *Garcinia hombroniana*), *Phaeanthus intermedius* (Figure 7-48E), and *Porterandia anisophylla*.

These findings and observations demonstrate the value of such remnant forest fragments, like the one in Site C, as additional refugia and stronghold for rare species to occur outside of the CCNR.



Figure 7-48 Plant species of conservation significance recorded in Site C. (A) *Daphniphyllum griffithianum*; (B) *Vanilla griffithii*; (C) *Chassalia curviflora*; (D) *Strophanthus caudatus*; (E) *Phaeanthus intermedius*; (F) *Calophyllum tetrapterum* var. *tetrapterum*.

Site D

Majority of the species of conservation significance that were recorded in the forested area within Site D were also found in Site B. Some rarer and important species are *Asplenium nitidum* (Critically Endangered), *Calophyllum tetrapterum* var. *tetrapterum* (Vulnerable) and *Aporosa benthamiana* (Vulnerable).

A small specimen of nationally Critically Endangered fern, *Asplenium nitidum*, was growing at the base of an oil palm, located near a waterbody (Figure 7-49A). Given that both specimens from Sites B and D were found in different habitat types, it suggests that the species can exist in a range of habitats and it is likely that more individuals could be discovered as more environmental studies are conducted.

A single specimen of the Vulnerable *Calophyllum tetrapterum* var. *tetrapterum* was recorded within the native-dominated secondary forest. One other nationally Vulnerable species of conservation significance was also recorded. A single specimen of *Aporosa benthamiana* was recorded in the middle of the native-dominated secondary forest (Figure 7-49B). It is likely that the native propagules in Site D dispersed from the adjacent larger and more mature native forests nearby.



Figure 7-49 (A) *Asplenium nitidum*; (B) *Aporosa benthamiana*

Site E

Site E is the largest of the six sites in the Study Area. The site is predominantly urbanised with little to no spontaneous vegetation, comprising buildings, carparks, roads, and other infrastructure. Most of the specimens of conservation significance were found in the remnant forest fragments that make up only approximately 15% of the site.

One of the notable species recorded in Site E is the nationally Critically Endangered climber, *Cyclea laxiflora*. Vegetative specimens of *Cyclea laxiflora* are typically challenging to recognise in the field owing to its sprawly growth habit and non-distinct leaves. During surveys in this Study, however, several mature specimens of this species were observed to be fruiting and flowering throughout the abandoned-land forest near Swiss Road in Site E (Figure 7-50A–B). The forest fragment was the only site in the entire Study Area where the species was recorded and widespread. It was also in this forest fragment that large strangling figs of the nationally Endangered *Ficus kerkhovenii* were recorded. Elsewhere in the Study Area, the only other large strangling fig of this species were only recorded in Site B, where it was found to be strangling two large rain trees (Section 7.3.2.3) and had a very large spread of 14 m.

Besides this area, the former Champions Golf Course was another area in which several plants of conservation significance were recorded in Site E. Such species include the nationally vulnerable *Calophyllum tetrapterum* var. *tetrapterum* and *Pternandra coerulescens*, as well as the Critically Endangered *Xanthophyllum ellipticum*. Although the golf course has been largely cleared and replaced by managed turf, small scattered patches of native-dominated secondary forest remain. It is likely that sites A and C, the present-day golf course, and the forests across the PIE all used to be one contiguous forest patch until human development took place and fragmented it. Even so, relics of what used to be in the larger continuous forest continue to persist in the small fragments that were not removed completely within the golf course. Such specimens belonging to the native genetic stock are valuable to conserve, especially in light of rapid urbanisation in land-scarce Singapore.

While the forested areas naturally host many more plants owing to the presence of natural pollinators and dispersers, many plants of conservation significance were also recorded in the urban environment of Site E. Examples of such plants are the nationally Endangered *Ficus virens* (Figure 7-50D), and the nationally Vulnerable epiphytic orchid *Bulbophyllum vaginatum*, which was only recorded in Site B and site E. These plants are typically bird-dispersed and/or epiphytic, which could have contributed to their wider distribution range in the Study Area. These observations suggest that forest fragments surrounded by built-up areas could still contribute as important refugia for plants. In areas that were once built-up but have since been abandoned, such as the compound at 700 Dunearn Road, rare plants like the nationally Endangered *Geophila herbacea* were recorded (Figure 7-50C).

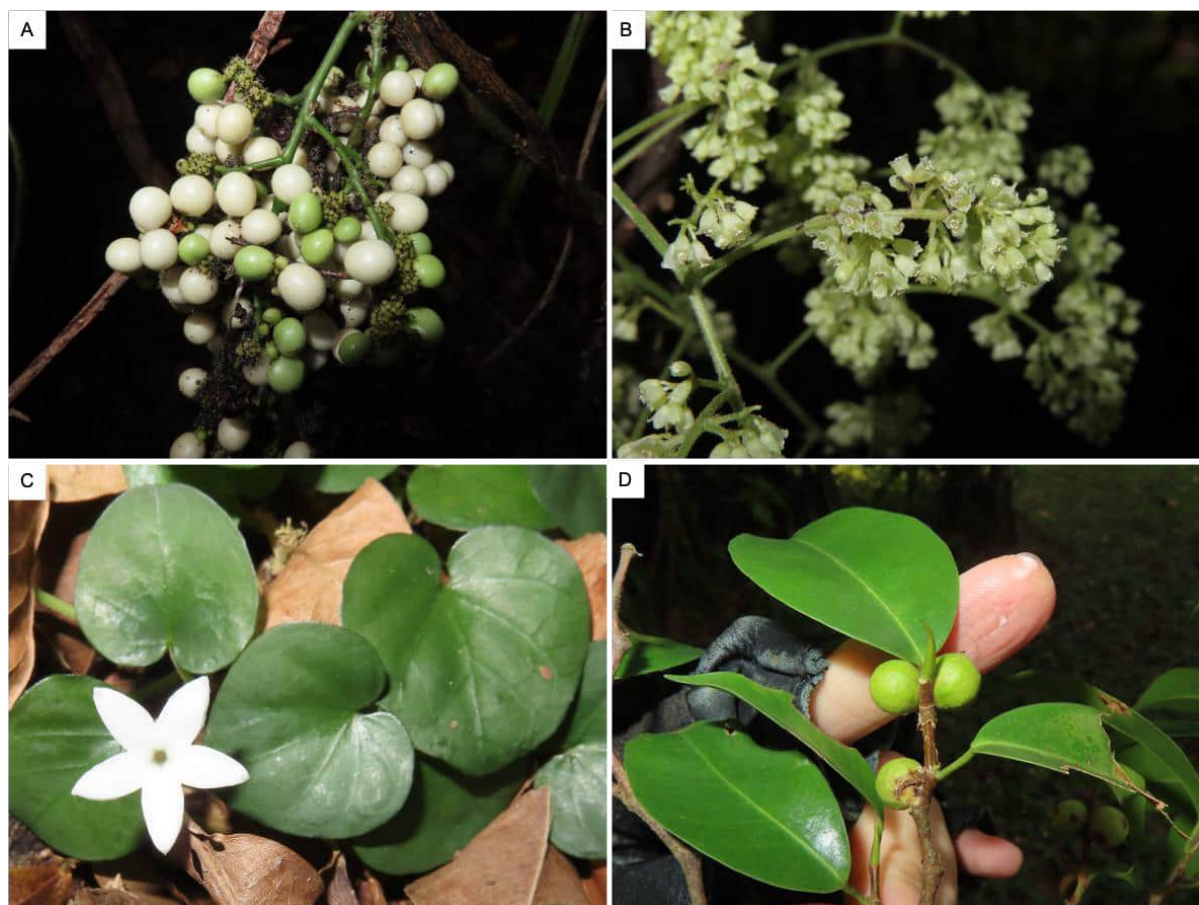


Figure 7-50 Plants of conservation significance in Site E. (A–B) *Cyclea laxiflora* fruits and flowers; (C) *Geophila herbacea*; (D) *Ficus virens*

Site F

Site F is separated from the other five sites by Eng Neo Avenue to its north and is mostly surrounded by residential areas to its south. A forest fragment in the middle of a built-up environment, Site F hosts several plants of conservation significance.

A cluster of the nationally Endangered pteridophyte *Phlegmariurus phlegmaria* was spotted on one of the rain trees (*Samanea saman*) planted along Eng Neo Avenue during floristic surveys (Figure 7-51). A new record of another rare epiphyte in an urban environment in this Study, this species belongs to the same genus as the nationally Critically Endangered pteridophyte *P. carinatus* recorded near the former Riders' Café carpark in Site B. Both species are epiphytic, capable of establishing themselves on tree branches. Such findings suggest that urban vegetation can also contribute as additional refugia for plants outside the natural forested habitats. Native rare epiphytes growing on exotic street trees increase the conservation value of the latter by 'nativising' them.

Within the forested area of Site F, most plants of conservation significance were concentrated in the native-dominated secondary forest. Similar to that of other sites in this Study, the native forests in Site F hosts several mature trees, including that of rare species such as *Knema communis* (Figure 7-52C) and *Knema conferta* (Figure 7-52D), which are nationally Vulnerable and Endangered, respectively. Within the same area, specimens of the nationally Critically Endangered *Aglaia lowii* subsp. *oligocarpa* (Figure 7-52A) and *Xanthophyllum ellipticum* (Figure 7-52B) were also recorded. A detailed survey of the area via vegetation plot sampling revealed more rare plants such as *Calophyllum rubiginosum*, *Gymnacranthera farquhariana* var. *farquhariana*.

While most plants were concentrated within the native forest patches, signs of dispersal into the adjacent exotic-dominated forest and abandoned-land forest were observed. This is especially true for pioneer species that are more tolerant of disturbances, such as *Macaranga griffithiana*. *Horsfieldia polyspherula* var. *polyspherula* was one of the species observed to be more widespread, where like treelets and saplings have been recorded across the forest of Site F.



Figure 7-51 *Phlegmariurus phlegmaria* on a rain tree (*Samanea saman*) along Eng Neo Avenue

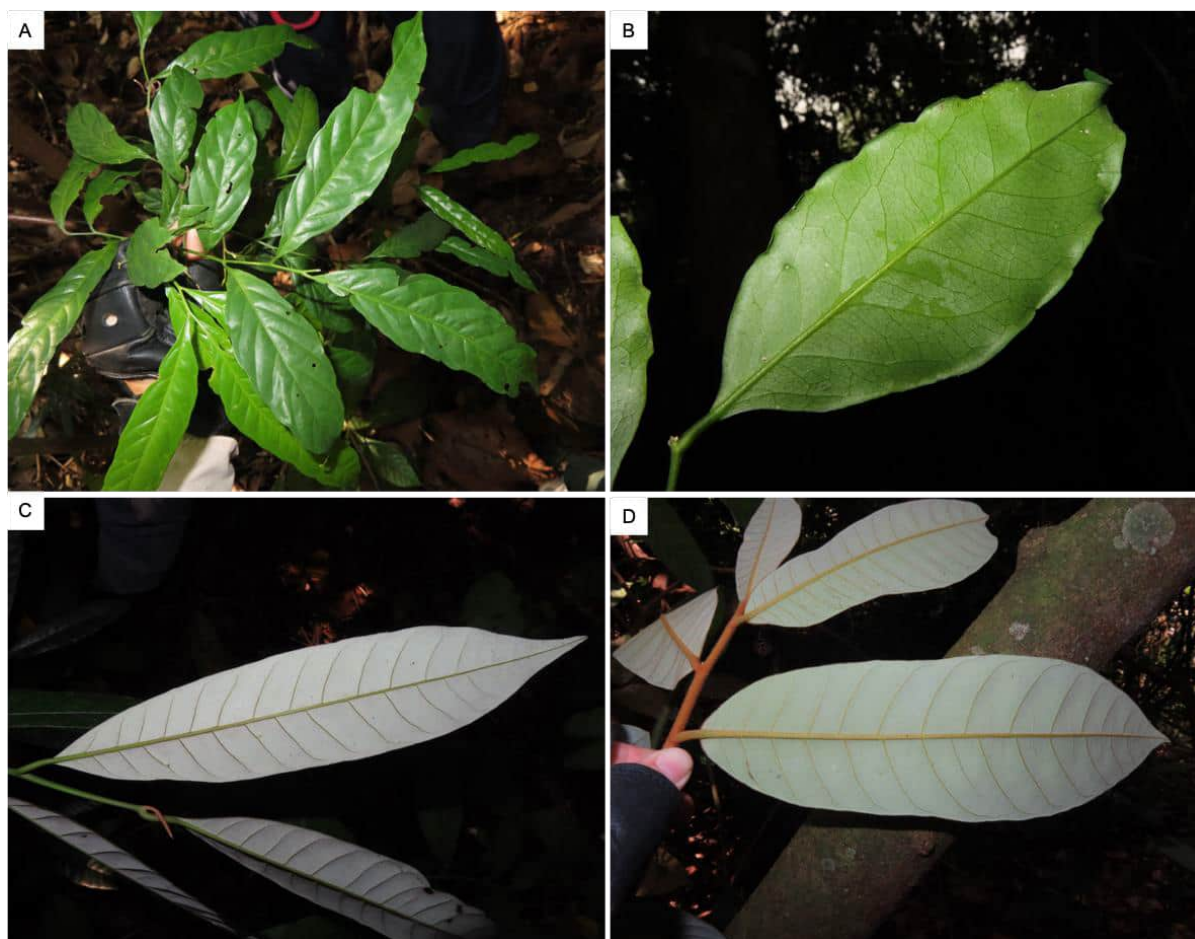


Figure 7-52 Plants of conservation significance recorded in Site F. (A) *Aglaia lowii* subsp. *oligocarpa*; (B) *Xanthophyllum ellipticum*; (C) *Knema communis*; (D) *Knema conferta*.

7.3.2.3 Large Plant Specimens

There is a total of 553 large plant specimens, comprising 41 species recorded in all sites A–F. Of the 41 species, 21 are exotic, 18 are native and two are cryptogenic (i.e., of unknown origin) (Appendix F). The distribution of all large plant specimens is shown in Figure 7-56.

Site A

A total of 115 large plant specimens were recorded during floristic surveys in Site A, of which 85 specimens (73.9%) are exotic, 21 (18.3%) are native and the remaining nine (7.8%) are cryptogenic (Figure 7-56; Appendix F). These specimens are distributed throughout the entire area, and the density tapers off towards the northern portion of Site A. Half the number of specimens (58 specimens) are albizia (*Falcataria falcata*) trees. The largest recorded tree specimen was also an albizia, with a girth of 5.4 m and height of 22 m. Some large native trees were also established in Site A, such as tembusu (*Cyrtophyllum fragrans*) (Figure 7-53A), *Alstonia angustiloba* (Figure 7-53B), and *Ficus variegata* (Figure 7-53C).

Several large bamboo specimens were also found in Site A. Eight bamboo clusters of the same species, *Bambusa vulgaris* with spreads that range from 3 to 15 m, were recorded (Figure 7-53E). Of these, five are clustered in the eastern portion of Site A, adjacent to the PIE.



Figure 7-53 Large specimens in Site A. (A) *Cyrtophyllum fragrans*; (B) *Alstonia angustiloba*; (C) *Ficus variegata*; (D) *Ficus benjamina*; (E) *Bambusa vulgaris*.

Site B

A total of 129 large plant specimens were recorded during floristic surveys in Site B, of which 59 specimens (45.7%) are exotic, 54 (41.9%) are native and the remaining 16 (12.4%) cryptogenic (i.e., of unknown origin) (Appendix F).

Of 129 large plant specimens, 78 are trees belonging to 15 species. Majority of them (24 specimens) are rain trees (*Samanea saman*). Forty-four large specimens are stranglers comprising five fig species. The Malayan banyan (*Ficus microcarpa*) is the most abundant, with 26 specimens. The remaining six specimens are shrubs comprising two bamboo species, including two *Bambusa vulgaris* and four *Thyrsostachys siamensis* clusters.

The largest specimen recorded in Site B was a nationally Endangered strangler, *Ficus kerkhovenii*, with a spread of up to 14 m (Figure 7-54A). At the point of encounter, this specimen was also producing figs (Figure 7-54B). The largest tree specimen recorded was a rain tree with a girth of 7.8 m (Figure 7-54C), while the largest bamboo specimen, *Bambusa vulgaris*, had a spread of 4 m (Figure 7-54D).



Figure 7-54 Large specimens in Site B. (A–B) *Ficus kerkhovenii* of 14 m spread; (C) *Samanea saman* of 7 m girth; (D) *Bambusa vulgaris* of 4 m spread.

Site C

A total of 47 large plant specimens from 16 species were recorded within Site C (Appendix F). Of these large plant specimens, 17 (36.2%) are exotic, 28 (59.6.3%) are native, and two (0.04%) are cryptogenic. These specimens are distributed throughout the entire area, with majority of the specimens found in the native-dominated secondary forest followed by the abandoned-land forest. The large tree specimens are dominated by tembusu *Cyrtophyllum fragrans* (10 specimens), a native tree species that is very slow-growing. The largest recorded tree specimen was a native *Alstonia angustiloba*, with a girth of 5.4 m and estimated height of 30 m.

Several large bamboo specimens were also found in Site C, including one *Bambusa heterostachya* and nine *B. vulgaris* clusters with spread ranging from 5 to 10 m.

Site D

A total of 54 large plant specimens from nine species were recorded during floristic surveys in the forested area within Site D, of which 34 specimens (63.0%) are exotic, 10 (18.5%) are native and the remaining 10 (18.5%) are cryptogenic (i.e., of unknown origin) (Appendix F).

Of 54 large plant specimens, 21 specimens are albizias (*Falcataria falcata*). Twelve large specimens are stranglers comprising two fig species, most of which were *Ficus benjamina* (10 specimens) and the remaining were *F. microcarpa* specimens. Additionally, six large specimens of the Critically Endangered *Peltophorum pterocarpum* were also recorded.

The largest plant specimen recorded here was a *Ficus microcarpa* with a spread of up to 15 m (Figure 7-55A). The largest tree specimens recorded include a specimen of albizia (*Falcataria falcata*) and a specimen of *Ficus benjamina* both with girths of 6 m (Figure 7-55B).



Figure 7-55 Large specimens in Site D. (A) *Ficus microcarpa* of 15 m spread; (B) *Ficus benjamina* of 4 m spread.

Site E

Floristic surveys throughout Site E yielded 112 large plant specimens in total, consisting of 49 exotic (43.8%), 47 (42.0%) native, and 16 (14.3%) cryptogenic (i.e., of unknown origin) specimens (Appendix F). Trees from 16 species comprised 99 specimens, with most of them (24 specimens) being tembusu trees (*Cyrtophyllum fragrans*). Stranglers from six fig species made up 68 specimens and Malayan banyan (*Ficus microcarpa*) is the majority with 33 specimens. The rest of the 12 large specimens are shrubs from three bamboo species, mostly *Bambusa vulgaris* (eight specimens).

The largest plant specimens recorded in Site E are exotic stranglers, *Ficus microcarpa*, with spreads of up to 20 m. Meanwhile, the largest tree specimens recorded measure 6 m in girth and include trees from five species. The largest bamboo specimen belongs to *Bambusa vulgaris*, which formed a grove with a spread of 80 m (Appendix F).

Site F

A total of 29 large plant specimens were recorded during floristic surveys in Site F, almost all of which were exotic specimens (28 specimens), with only one cryptogenic (i.e., of unknown origin) specimen (Appendix F). These large specimens are mostly located in the exotic-dominated secondary forest towards the east of Site F (Figure 7-56). Twenty-one of these specimens are trees belonging to three species, most of which (nine specimens) are albizia trees (*Falcataria falcata*). Two large stranglers, a *Ficus benjamina* and a *F. maclellandii*, measuring 3 m in spread were recorded. The remaining six specimens are shrubs comprising two bamboo species, including four *Bambusa vulgaris* and two *B. heterostachya* clusters.

The largest specimen recorded in Site F was a *Bambusa vulgaris* cluster with a spread of up to 6 m, while the largest tree specimen was an albizia with a girth of 4 m.



Legend

- EIA Study Area
- Site boundary
- Vegetation Types**
- Native-dominated secondary forest
- Abandoned-land forest
- Exotic-dominated secondary forest
- Scrubland
- Urban vegetation
- Non-vegetated
- Waterbody
- Large Plant Specimens**
- ◆ Tree
- ◆ Strangler
- ◆ Bamboo



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Figure Title :
Distribution of Large Plant Specimens

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Note: Source of basemap - Google Earth Map

7.3.2.4 Other Plant Specimens of Value

In total, 22 other plant specimens of value were recorded and identified across all sites A–F (Appendix G). These specimens contribute to ecosystem functions by providing habitats for fauna, e.g., they either contain active raptor nests and/or are bamboo clusters that could be roost sites for bamboo bats (*Tylonycteris* sp.). The location of all other plant specimens of value is reflected in Figure 7-59.

Site A

Eleven other plant specimens of value comprising two albizia trees (*Falcataria falcata*) and nine bamboo clusters (*Bambusa vulgaris*) were recorded in Site A (Figure 7-57; Appendix G). Two raptor nests were recorded on the two separate albizia trees.

All nine bamboo clusters were identified as potential roost sites for bamboo bats. Bamboo clusters with confirmed roost sites were determined during roost emergence surveys (refer to Section 7.3.3.10).



Figure 7-57 Other specimens of value in Site A: a raptor and its nest on an albizia tree

Site B

One other plant specimens of value was recorded in Site B (Appendix G). The bamboo specimen, *Bambusa vulgaris*, had a 0.5 m spread (Figure 7-58A–B). Despite its small size, it is located among a larger cluster of bamboos, which were found to be the roost sites of bamboo bats (*Tylonycteris* sp.) during roost emergence surveys and is a potential roost site as well (refer to Section 7.3.3.10).



Figure 7-58 Other specimens of value in Site B. (A–B) *Bambusa vulgaris* of 0.5 m spread.

Site C

One other specimens of value was recorded in Site C (Appendix G). The specimen was a 1 m spread *Bambusa heterostachya* cluster which is a potential roost site for bamboo bats (*Tylonycteris* sp.) (Section 7.3.3.10).

Site D

An albizia tree, hosting Goffin's cockatoos (*Tanimbar corella*), was the only recorded other specimen of value in Site D (Appendix G).

Site E

Four other specimens of value were encountered in Site E (Appendix G). They include a *Bambusa vulgaris* cluster which is a potential roost site for bamboo bats (*Tylonycteris* sp.) (Section 7.3.3.10) and three specimens planted but healthy red sealing wax palms (*Cyrtostachys renda*). The latter were included as other specimens of value as they can be considered for conservation and integration into future design.

Site F

Floristic surveys in Site F yielded four other specimens of value, all of which were bamboo clusters which are potential roost sites for bamboo bats (*Tylonycteris* sp.) (Section 7.3.3.10). These bamboo clusters, consisting of three *Bambusa vulgaris* and one *Thyrsostachys siamensis* cluster, were situated in the western and central abandoned land forest patches in Site F (Figure 7-59; Appendix G).



Legend

- Site boundary
- Vegetation Types**
- Native-dominated secondary forest
- Abandoned-land forest
- Exotic-dominated secondary forest
- Scrubland
- Urban vegetation
- Non-vegetated
- Waterbody
- Other specimen of value**
- raptor nest
- bird habitat
- bamboo
- nice specimen



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Figure Title :
Distribution of other plant specimens of value

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Note: Source of basemap - Google Earth Map

7.3.2.5 Tree Mapping Findings

Altogether, 6955 trees were tagged and assessed during the tree mapping surveys of sites A–F (Appendix H). Majority of these trees (3968 trees; 57.1%) belong to exotic species, while 38.6% (2684 trees) belong to native species, 4.3% (296 trees) belong to cryptogenic species (i.e., of unknown origin), and the remaining 0.1% (7 unidentified trees or trees that could not be identified with certainty) are unassessed. The locations of all trees are reflected in Figure 7-61.

The top three species with the highest count are the albizias (*Falcataria falcata*) with a total count of 1385 trees, followed by African tulip tree (*Spathodea campanulata*) with a total count of 874 trees, and lastly, oil palm (*Elaeis guineensis*) with 329 specimens.

Note that there were more specimens assessed than tagged as some specimens occur in clusters, i.e., within 1–2 m of each other. All the specimens within clusters were assessed, but only one specimen was tagged (refer to Appendix H).

Site A

A total of 2482 trees were tagged and assessed during the tree mapping surveys, of which, 77.5% (1924 trees) are exotic, 20.1% (499 trees) are native, and the remaining 2.4% are cryptogenic (58 trees) and unassessed (one tree) (Appendix H).

The trend of tree species with highest count within this area is mostly similar to the consolidated finding mentioned above, where albizia (*F. falcata*) has the highest total count with 1208 trees, followed by African tulip tree (*S. campanulata*) with a total count of 259 trees. The species with the third highest count differs from the consolidated findings, as *Ficus variegata* is the third most abundant tagged tree in Site A, with a total count of 227 trees. Also, Site A contributed most (35.7%) to the total tree counts across all sites, probably due to this site having the largest vegetated area compared to all other sites. Remarkably, Site A has the highest count of native trees compared to all other sites.

Site B

A total of 723 trees were tagged and assessed during the tree mapping surveys, of which, approximately half (351 trees; 48.5%) are native, 322 (44.5%) are exotic, 48 (6.6%) are cryptogenic, and two (0.3%) are unassessed (Appendix H).

The tree species with highest count is African tulip (*S. campanulata*; 103 specimens) followed by *Cinnamomum iners* (64 specimens), raintree (*Samanea saman*; 41 specimens), tembusu (*C. fragrans*; 39 specimens) and Malayan banyan (*Ficus microcarpa*; 34 specimens). Altogether, 281 specimens from these five species make up about 40% of the total number of trees. Notably, there were two specimens that are rare and of uncommonly large size. The first is the nationally Endangered Johor Fig, *Ficus kerkhovenii*, which was observed to be in the process of strangling a large rain tree. The second is a large nationally Endangered *Calophyllum inophyllum* of 3.3 m girth, and as mentioned in Section 7.3.2.2, the slow growth and large size of this specimen suggests that it is a remnant of the original native forest and has managed to avoid removal through years of development in the vicinity.

Site C

A total of 1153 trees were tagged in the forested area within Site C, of which 73.3% (845 trees) are native, 23.5% (271 trees) are exotic, 2.9% (34 trees) are cryptogenic, and 0.3% (three unidentified trees) are unassessed (Appendix H).

The tree species with the highest count is tembusu (*Cyrtophyllum fragrans*) with 206 specimens, followed by *Calophyllum tetrapterum* var. *tetrapterum* with 134 specimens, and *Syzygium grande* with 96 specimens. All three species are native. Altogether, the specimens of these three species accounted for almost 40% of the total number of trees mapped at this site. The site also had several large exotic tree specimens, such as rain tree (*Samanea saman*) and angsana (*Pterocarpus indicus*), with girths ranging from 3.2 m to 5.2 m. Several large specimens of native trees, including tembusu (*C. fragrans*) and *S. grande*, of girths exceeding 3.0 m were also found.

Other notable specimens include the nationally Critically Endangered *Daphniphyllum griffithianum* tree, which was recorded with a girth of 2.4 m within the site. Multiple specimens of *Xanthophyllum ellipticum* and *Radermachera quadripinnata* subsp. *lobbii*, both of nationally Critically Endangered status, were also recorded. In addition, many specimens of large native trees with girths of or exceeding 3.0 m were recorded, including the nationally

Endangered *Artocarpus lanceifolius*, Vulnerable *Litsea umbellata*, *Sloetia elongata* (previously recorded as *Streblus elongatus*), tembusu (*C. fragrans*), and *S. grande*.

Site D

A total of 344 trees were tagged in the forested area within Site D, of which 25.9% (89 trees) are native, 70.6% (243 trees) are exotic, and 3.5% (12 trees) are cryptogenic (Appendix H).

Tree species with highest counts are mostly exotic species. African tulip tree (*S. campanulata*) accounted for 96 specimens, followed by albizia (*F. falcata*; 46 specimens), *Leucaena leucocephala* (43 specimens), and *Acacia auriculiformis* (17 specimens). Altogether, the specimens of these four species accounted for more than half (58.7%) of the total number of trees mapped at this site. The site also had 15 large *F. microcarpa* and *F. benjamina* specimens, of which, some had interesting pillar root architecture (Figure 7-60). Yellow-flame trees (*Peltophorum pterocarpum*) that were tagged on site (16 specimens) were also observed to be relatively large with many exceeding 2.0 m in girth. These specimens were likely planted in past settlements and have persisted since then.



Figure 7-60 (A–D) Pillar root architecture of *F. benjamina* and *F. microcarpa*. (D) This particular specimen has an almost spider-like appearance and it is interesting given that this suggests a negative geotactic growth of the roots at some point.

Site E

Altogether, 1614 trees were tagged in Site E, of which 42.6% (687 trees) are native, 50.0% (807 trees) are exotic, 7.4% (119 trees) are cryptogenic, and 0.1% (one tree) is not assessed as they could not be identified with certainty (Appendix H).

Exactly half of the tagged trees belong to exotic species, most of which are African tulip trees (*Spathodea campanulata*) accounting for 228 specimens. The next most abundant species is the native common *Syzygium grande* with 137 specimens, followed by the exotic rain tree (*Samanea saman*) with 99 specimens.

Remarkably, specimens of the nationally Critically Endangered *Xanthophyllum ellipticum*, as well as many large specimens of the Endangered *Ficus virens* and Endangered *Calophyllum inophyllum*, were also recorded. In addition, multiple specimens of large common native trees with girths of or exceeding 3.0 m, including tembusu (*Cyrtophyllum fragrans*), *Ficus microcarpa*, *Syzygium grande*, and *Terminalia catappa*, were also recorded.

Site F

Tree mapping surveys across the forests in Site F recorded 639 trees. More than half (401 specimens; 62.8%) belong to exotic species, one-third (213 specimens) are native, and the remaining (25 specimens; 3.9%) are cryptogenic (Appendix H).

The three most abundant species are all exotic species, represented mostly by African tulip tree (*S. campanulata*) with 138 tagged trees, followed by oil palm (*Elaeis guineensis*) with 56 specimens, then albizia (*F. falcata*) with 46 specimens. Notable findings from this site include one specimen of the nationally Critically Endangered *Sterculia parviflora* and Endangered *Calophyllum rubiginosum*. In addition, many large exotic trees, such as African tulip and albizia trees, and some large native trees, such as *Alstonia angustiloba* and *Ficus variegata*, were encountered throughout the site.



Legend

- EIA Study Area
- Site boundary
- Vegetation Types**
- Native-dominated secondary forest
- Abandoned-land forest
- Exotic-dominated secondary forest
- Scrubland
- Urban vegetation
- Non-vegetated
- Waterbody
- Mapped tree



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Distribution of Mapped Trees

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Note: Source of basemap - Google Earth Map

7.3.2.6 Community Data Results

A coverage-based rarefaction curve was plotted using data from the vegetation plots in sites A–D [R-1]. From the 13 vegetation plots, the sampling coverage was 81.7%, which refers to the proportion of the total number of species in the community belong to those represented in the vegetation plots [P-153].

In this Study, five additional plots were sampled in the other un-surveyed portion of Site C and forested areas of sites E and F. With additional data from five more vegetation plots, the overall sampling coverage increased from 81.7% to 86.9%. Upon extrapolation, i.e., sample size was theoretically doubled using the statistical programme, the sample coverage increased to 95.3%. This implies that even with increased survey effort via vegetation plot sampling, a portion of plant species in the community, i.e., around 5%, will remain undetected in the vegetation plots.

The Chao estimator was used to predict the total number of species in the species pool of the combined Study Area. Using the 'ChaoRichness' function in the iNEXT 2.0.20 package in R [W-33], the total species richness of the entire Study Area was estimated to be 292.91 ± 25.13 (standard error). The 95% confidence interval is between 255.76 and 357.26.

Additional sampling of the new sites increased the total species richness in the Study Area by 30%, from 494 to 647. This total count far exceeds—and is more than double—the total number of species predicted using the Chao estimator. This is likely because many species were undetected or absent in the vegetation plots but were documented during general floristic surveys, especially in the very rich and diverse native-dominated secondary forests. Additionally, urban vegetation was not surveyed via vegetation plot sampling; hence, the numbers reported above are only representative of the forested areas. Overall, the combined survey effort of general floristic surveys and vegetation plot sampling were sufficient in documenting the floristic composition of the Study Area.

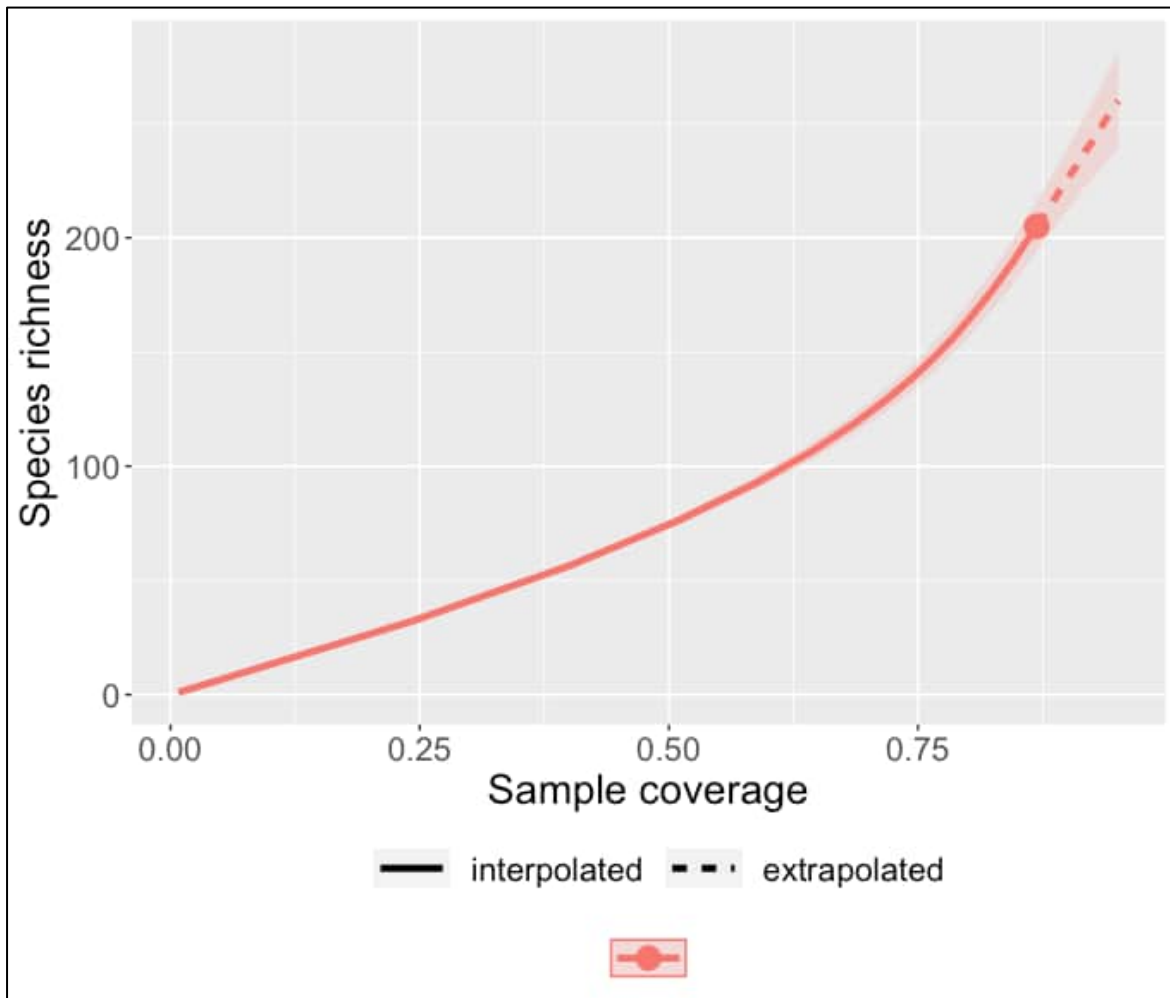


Figure 7-62 Coverage-based sampling curve from eighteen 20 × 20 m vegetation plots in sites A–F

An NMDS ordination was plotted for the 18 vegetation plots representing native-dominated secondary forest, abandoned-land forest, exotic-dominated secondary forest, and scrubland (Figure 7-63). The ordination shows that the four habitat types found in the Study Area are floristically distinct, as indicated by the non-overlapping polygons. This result is interesting. In Singapore where forests are heavily fragmented and disturbed, it is rarely the case where the vegetation types are clearly distinct from each other. More often than not, the plant composition of each vegetation type would overlap to some extent as propagules disperse from source forests to the nearby forested patches. From the ordination, scrubland is the most distinct from the other three forest sub-types. However, the most noteworthy habitat type in the Study Area is the native-dominated secondary forest.

Unlike other native forests in disturbed sites outside the nature reserves in Singapore, that in the Study Area is highly diverse with several native and threatened plants. The floristic assemblage overlaps with that of the CCNR which it was once contiguous with. Even after fragmentation from the CCNR by the PIE, the forest continues to sustain the native plant population as trees have attained maturity and become seed sources. Presently, the forest serves as a refuge for rare plant species, in addition to the old growth forests of the CCNR. Besides tree species, the forest understory is also rich in ferns, herbaceous plants, and climbers. It is also in the native forest where important fauna such as the Sunda pangolins, Sunda colugos, *Lexias* sp. butterflies, and the Asian red-eyed bulbuls were recorded in this Study (Section 7.3.3).

These are indicative of a healthy forest ecosystem that, if left untouched to regenerate, will gain greater species diversity, structural complexity and even increase its stored carbon in the long run. Considering the general positive relationship between plant and animal diversities, the forest would be able to support an even richer animal community in the future than it does presently if it is left to continue to regenerate. This regeneration trajectory can be aided by creating greater ecological connectivity with the nearby old growth secondary forests – Rifle Range Nature Park and Bukit Timah Nature Reserve to its northwest, as well as the Central Catchment Nature Reserve to its northeast. The proximity to these mature forests provides nearby sources for the arrival of propagules.

This also applies for the abandoned-land and exotic-dominated secondary forests in the Study Area. With constant and steady rates of dispersal of propagules from the native patches and nearby old growth forests, the adjacent abandoned-land and exotic-dominated forests could also regenerate into native forests over time. There are already positive signs of this happening as nationally threatened plant species are dispersing and getting recruited in them. Ideally, they should be left to further accumulate more species.

Considering that majority of the spontaneous vegetation presently found in Singapore are secondary forests [P-1], the forests in the Study Area have conservation value and should be retained. This is especially so for the distinct native forest patches. Collectively, the forests also serve as important refugia for forest-dependent animal species within the larger urban-dominated landscape in Singapore [P-17], in addition to other ecosystem functions and services they provide.

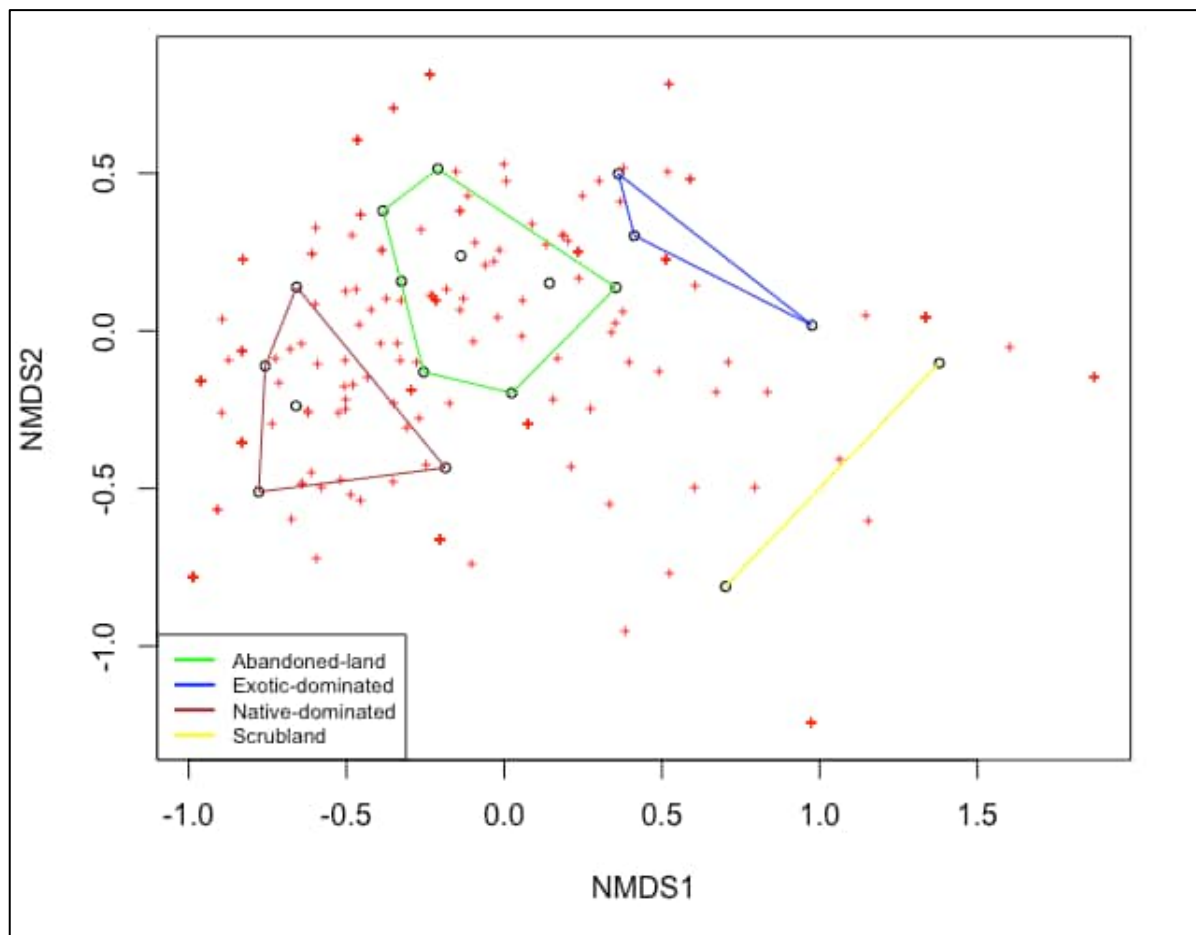


Figure 7-63 NMDS ordination of the 18 vegetation plots (open circles) based on species composition. Red crosses represent the plant species found in the plots. Stress value = 0.11, k = 2.

7.3.3 Fauna

7.3.3.1 Overall

The desktop assessment identified 463 species of probable occurrence across the study area. The field survey across the study area from 2019 to 2024 documented 407 species, dominated by birds (111 species) and butterflies (101 species). Of these, 25 were of conservation significance and one notable species was identified. The Sunda colugo (*Galeopterus variegatus*) was considered a notable species for its dependence on trees located within its gliding distance for effective movement. The findings for each faunal group are described later in this section. The list of probable and recorded species is available in Appendix J and summarised in Table 7-7. The list of faunal species of conservation significance and their conservation statuses is available in Appendix I. The faunal survey data and camera trap data are provided in Appendix J.

Table 7-7 Summary of probable and recorded faunal species

Faunal Group	No. of Probable Species		No. of Recorded Species	
	All Species	CS Species	All Species	CS Species
Aculeate hymenopterans	70	7	63	0
Bees	33	6	27	0
Stinging wasps	37	1	36	0
Odonates	60	15	46	1
Dragonflies	38	4	34	0
Damselflies	22	11	12	1

Faunal Group	No. of Probable Species		No. of Recorded Species	
	All Species	CS Species	All Species	CS Species
Butterflies	114	15	101	2
Freshwater decapod crustaceans	0	0	0	0
	9	0	9	0
Freshwater fish	14	1	14	1
Herpetofauna	42	4	38	0
Amphibians	11	0	11	0
Reptiles	31	4	27	0
Birds	127	31	111	15
Mammals	26	6	25	5
Non-volant mammals	15	3	15	3
Bats	11	3	10	2
Total	462	80	407	25

Note: 'CS species' refers to species of conservation significance

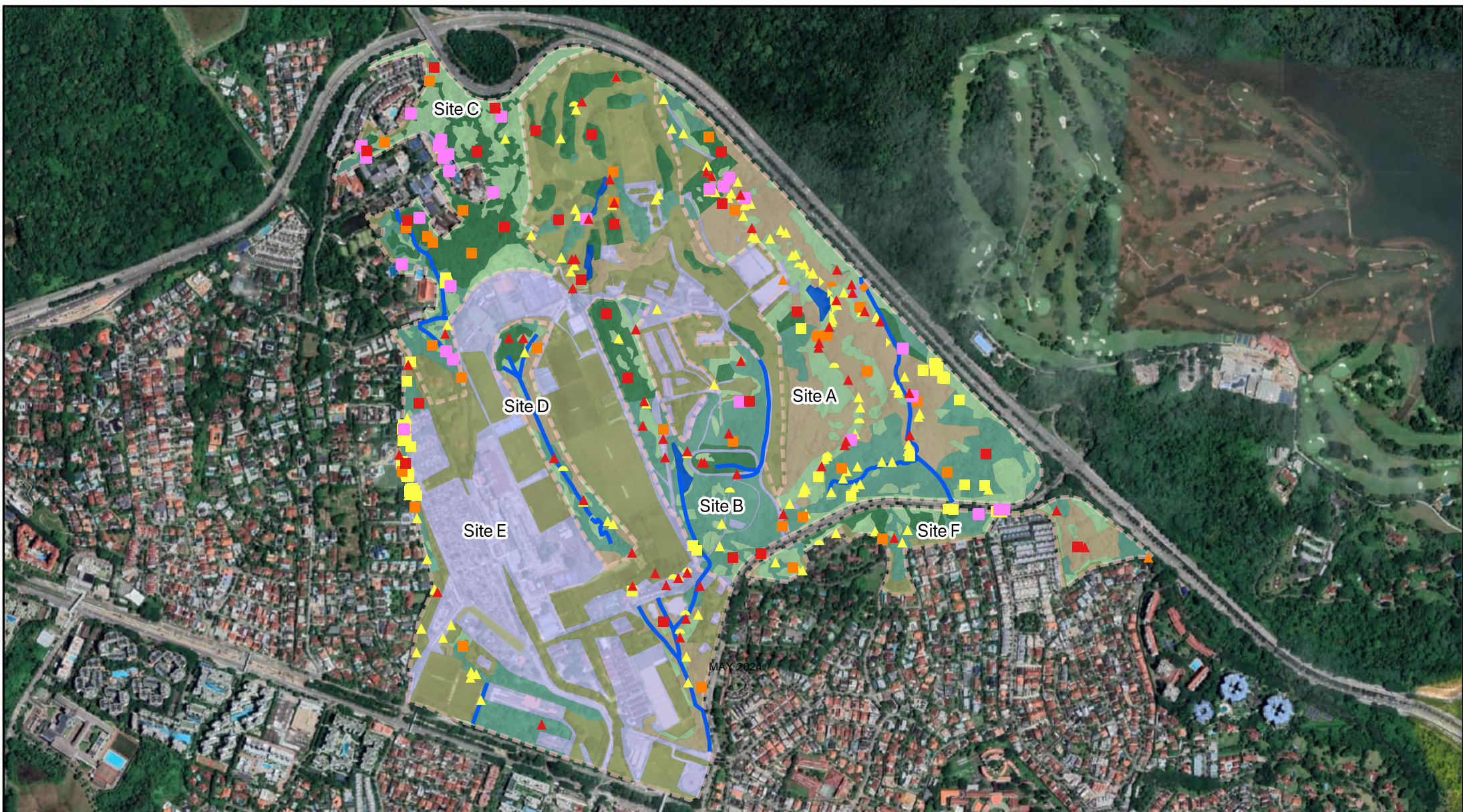
Table 7-8 List of faunal species of conservation significance recorded

Taxon	Species	Common Name	Local Status	Global Status	Sites of Records
Bird	<i>Ardea purpurea</i>	Purple heron	Endangered	Least Concern	A
Bird	<i>Collocalia affinis</i>	Plume-toed swiftlet	Vulnerable	Least Concern	A, C, E, F
Bird	<i>Copsychus malabaricus</i>	White-rumped shama	Endangered	Least Concern	F
Bird	<i>Copsychus saularis</i>	Oriental magpie-robin	Vulnerable	Least Concern	A, D, E
Bird	<i>Corvus macrorhynchos</i>	Large-billed crow	Vulnerable	Least Concern	D
Bird	<i>Ketupa ketupu</i>	Buffy fish owl	Vulnerable	Least Concern	E
Bird	<i>Lanius cristatus</i>	Brown shrike	Vulnerable	Least Concern	A, E
Bird	<i>Nisaetus cirrhatus</i>	Changeable hawk-eagle	Vulnerable	Least Concern	A, E, F
Bird	<i>Psittacula longicauda</i>	Long-tailed parakeet	Near Threatened	Vulnerable	A, B, C, D, F
Bird	<i>Ptilinopus jambu</i>	Jambu fruit dove	Vulnerable	Near Threatened	C
Bird	<i>Pycnonotus brunneus</i>	Asian red-eyed bulbul	Vulnerable	Least Concern	C
Bird	<i>Pycnonotus zeylanicus</i>	Straw-headed bulbul	Endangered	Critically Endangered	All
Bird	<i>Strix seloputo</i>	Spotted wood owl	Vulnerable	Least Concern	B
Bird	<i>Treron curvirostra</i>	Thick-billed green pigeon	Vulnerable	Least Concern	A
Bird	<i>Zosterops simplex</i>	Swinhoe's white-eye	Vulnerable	Least Concern	A, B, E, F
Butterfly	<i>Astictopterus jama jama</i>	Forest hopper	Endangered	Not Listed	A
Butterfly	<i>Troides helena cerberus</i>	Common birdwing	Vulnerable	Not Listed	A, B, D, E, F
Fish	<i>Betta imbellis</i>	Crescent betta	Endangered	Least Concern	A
Mammal	<i>Eonycteris spelaea</i>	Cave nectar bat	Vulnerable	Least Concern	A
Mammal	<i>Lutrogale perspicillata</i>	Smooth-coated otter	Endangered	Vulnerable	E
Mammal	<i>Macaca fascicularis</i>	Long-tailed macaque	Least Concern	Endangered	All

Taxon	Species	Common Name	Local Status	Global Status	Sites of Records
Mammal	<i>Manis javanica</i>	Sunda pangolin	Critically Endangered	Critically Endangered	A, B, C, E, F
Mammal	<i>Tylonycteris sp.</i>	Unidentified bamboo bat	Vulnerable	Least Concern	A, B, C, D, E
Mammal	Unidentified <i>Sciuridae (flying)</i>	Flying squirrel	Endangered	Least Concern	A
Odonata	<i>Ceriagrion chaoi</i>	Fiery coraltail	Vulnerable	Least Concern	A

Given the Study Area's proximity to the BTNR and CCNR, there remains a high chance of expecting rare species here. Species of conservation significance are distributed across the Sites, including the globally threatened straw-headed bulbul (*Pycnonotus zeylanicus*) and Sunda pangolin (*Manis javanica*). A higher number of species of conservation significance were found in Site A likely due to its size and intact natural habitats. Species of conservation significance that were found only in Site A include the forest hopper (*Astictopterus jama jama*), crescent betta (*Betta imbellis*), fiery coraltail (*Ceriagrion chaoi*) and thick-billied green pigeon. It is also noteworthy that Site A is a hotspot for the fiery coraltail (*Ceriagrion chaoi*), which were found in relatively high densities than commonly observed in other sites in Singapore. At Site B, the spotted wood owl (*Strix seloputo*) was uniquely recorded in this Study. At Site C, the nationally Vulnerable Asian red-eyed bulbul (*Pycnonotus brunneus*) and jambu fruit dove (*Ptilinopus jambu*), among other rare migratory birds, was uniquely recorded. In addition, Site C also recorded 15 Sunda colugo (*Galeopterus variegatus*) sightings – the highest across all sites in the Study Area, making it a colugo stronghold of the Former Turf Club area. The only exclusive find at Site D was the large-billed crow (*Corvus macrorhynchos*), on top of high butterfly species richness, including an abundant common birdwing (*Troides helena cerberus*) population.

Among the waterbodies, the waterbodies, D1, D7 and D14 in Sites A, B and C respectively, recorded fish species of interest, such as the common walking catfish (*Clarias cf. batrachus*) and, in the case of Site A only, the crescent betta (*B. imbellis*) as well. The unnamed linear pond along terrestrial sampling route A1 has seen a high diversity of odonates, including a thriving uncommon fiery coraltail (*Ceriagrion chaoi*) population. The forested area within the racecourse oval (D11) in Site D recorded mainly non-native fish, alongside common amphibians and odonates.



Legend

- Site boundary
- Vegetation Types**
- Native-dominated secondary forest
- Abandoned-land forest
- Exotic-dominated secondary forest
- Scrubland
- Urban vegetation
- Non-vegetated
- Waterbody

- Conservation status**
- Critically Endangered
- Endangered
- Vulnerable
- Notable
- Taxon**
- Fish
- Bird
- Butterfly
- Mammal
- Odonate



Rev.	Date	By	Description	Chk'd	App'd
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Qualified Person Endorsement : NA

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Consultant : **AECOM**

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Note: Source of basemap - Google Earth Map

7.3.3.2 Taxon Sampling Curves

Along the terrestrial sampling route, the sample coverage for each taxon were all above 95%. Sample coverage for aquatic sampling points was above 94% for all four taxa (amphibian, fish, mollusc and odonate). Sample coverage was not calculated for faunal groups with less than two species recorded. This included the bats for terrestrial and reptiles for aquatic. For camera trapping, the sample coverage was a high 99.0% indicating sufficient sampling.

Table 7-9 Result summary of taxon sampling analysis

Faunal Group	Sample Coverage (%)	Observed Richness	Estimated Richness (\pm Standard Error)	95% Confidence Interval For Estimated Richness	Estimated Coverage With Doubled Effort (%)
Terrestrial Sampling Routes					
Aculeate Hymenopteran	92.3	44	44 \pm 10.5	48.9 – 95.6	97.2
Odonate	95.5	38	38 \pm 17.3	42.6 – 124.3	97.4
Butterfly	93.7	85	85 \pm 9.5	92.2 – 132.9	98.4
Amphibian	99.1	12	12 \pm 2.3	12.1 – 26.0	99.9
Reptile	92.5	23	23 \pm 14.7	26.7 – 96.8	95.9
Bird	97.5	104	104 \pm 17.3	117.7 – 191.6	98.9
Mammal	97.6	18	18 \pm 10.2	19.9 – 70.3	98.5
Aquatic Sampling Points					
Odonate	94.4	27	32 \pm 4.8	28 - 51.5	98.7
Freshwater Fish	98.9	14	18 \pm 7.1	14.5 - 54.7	99.4
Amphibian	98	9	10 \pm 2.2	9.1 - 22.9	99.7
Mollusc	98.2	10	10 \pm 0.4	10 - 12.9	99.7
Camera Trapping					
Non-Volant Mammal	99	11	12 \pm 2.2	11.1 - 24.8	99.9

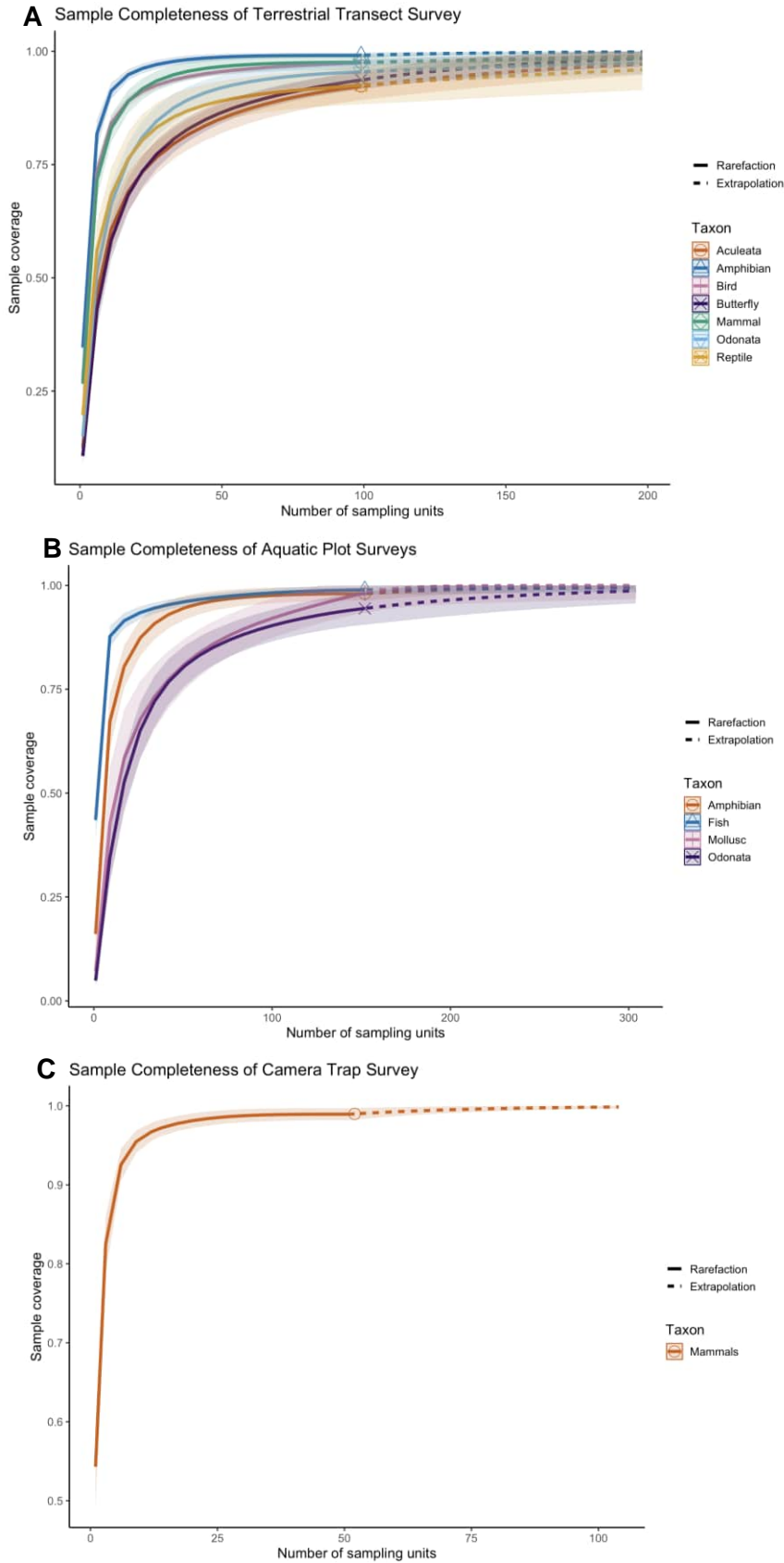


Figure 7-65 Taxon sampling curves for (A) terrestrial surveys; (B) aquatic surveys; (C) camera trapping

7.3.3.3 Butterflies

Butterflies are important pollinators and biological indicators of a healthy ecosystem, particularly because they are one of the most well-known insect groups and are sensitive to environmental changes. In the early stages of their lives, butterflies rely on a small range of specific host plants for survival. If changes in the habitat and canopy cover occur, butterflies become vulnerable quicker than other fauna groups [P-107]. In highly urbanised Singapore, it was estimated that almost half of the butterflies species (236 species) found locally have been lost over the last 160 years to habitat destruction [P-139]. The findings below reveal the importance of certain sites for the conservation of uncommon and rare butterflies.

A total of 101 butterfly species (Appendix I), were recorded during this field assessment, including two species of conservation significance: the nationally Endangered forest hopper (*Astictopterus jama jama*) in Site A and the nationally Vulnerable common birdwing (*Troides helena cerberus*) in most of the sites (A, B, D, E, F). The hostplant of the common birdwing is the Dutchman's pipe (*Aristolochia acuminata*). This is a climber recorded in Site B and D. When growing in a forest, leaves only sprout at the canopy level when mature [P-115]. This plant is also frequently planted in the urban landscape for its ornamental value. The largest family recorded was naturally the brush-footed butterflies, Nymphalidae, with 40 species, followed by Lycaenidae (24 species) and the skipper family, Hesperidae (23 species). Due to the diversity of habitats and restricted distribution of host plants found, only 3 species were shared across all 5 Sites. Overall Site A has the highest butterfly species richness, with 73 species recorded.

Site A

At Site A, a total of 37 butterfly species were recorded, of which most were categorised as common to moderately common. Two species of conservation significance were recorded. The open country and forest edge habitats may attract many butterfly species to gather here for foraging and basking, although it may not apply to strict forest specialists. The open habitats may also allow for easier detection of species as well. Due to the presence of scrubland and herbaceous vegetation present, grassland-associated species such as the bush browns (*Mycalesis* sp.), grass yellows (*Eurema* sp.) and rings (*Ypthima* sp.) were frequently recorded. The two species of conservation significance recorded were the forest hopper (*A. jama jama*), and Singapore's largest butterfly - common birdwing (*Troides helena cerberus*) (Figure 7-66). Both species were recorded at the edge of the central area of Site A. Of the entire Study Area, only Site A recorded the forest hopper. While not listed as threatened, the Malayan jester (*S. hippoclus selangorana*) was observed once along terrestrial sampling route A1. It was first discovered in 2012 in the western part of Singapore and was regarded as a very rare seasonal migrant [P-106]. Recent sightings in the northern (Admiralty Park) and central (Dairy Farm area; Bukit Timah Hill) parts of Singapore suggest a breeding population locally [P-106]. Therefore, the record of this species here is of significance. Other species of interest recorded on site are the rare great orange awlet (*Bibasis etelka*), and moderately rare common redeye (*Matapa aria*) and palm king (*Amathusia phidippus phidippus*).

Site B

At Site B, 26 species of butterflies were recorded, with most categorised as common to moderately common. The bush browns (*Mycalesis* sp.) and common cerulean (*Jamides celeno aelianus*) were the most encountered species across open pockets of shrubland. Among the 26 species, one species of conservation significance can be identified – common birdwing (*T. helena cerberus*) (Figure 7-66). Some species were observed foraging on flowering plants. For example, chocolate pansy (*Junonia hedonia ida*), common five-ring (*Y. baldus newboldi*) and common bluebottle (*Graphium Sarpedon luctatus*) were seen feeding on the nectar of flowering shrubs such as *Leea indica*.

Site C

At Site C, 26 species of butterflies were recorded. No species of conservation significance was recorded, however one rare butterfly – the yellow flash (*Rapala domitia domitia*) (Figure 7-66E) was recorded. The yellow flash is a forest-dependent butterfly found mostly in the nature reserves [P-4]. It was sighted at the native-dominated secondary forest in the north of Site C and was not recorded in other Sites of the Study Area. Four other moderately rare butterflies were also recorded – orange awlet (*Bibasis harisa consobrina*), full stop swift (*Caltoris cormasa*), Malay tailed judy (*Abisara savitri Savitri*) Figure 7-66D) and blue spotted crow (*Euploea midamus singapura*). The blue spotted crow is uncommon in Singapore and usually only seen in the nature reserves where its host plant (Apocynaceae family: *Strophanthus* species) is located [P-58]. The forest habitat and proximity to CCNR are probable reasons why forest species like the yellow flash, Malay tailed judy and cruiser (*Vindula dejone erotella*)

and Malayan (*Megisba malaya sikkima*) were found only in Site C of the Study Area. This is a good indication of Site C as a habitat extension for threatened forest butterflies that exist largely in the CCNR.

Site D

At Site D, while diversity of butterflies found here was lower than the other sites with 21 species recorded, 23 other species were also recorded in a recent study conducted by NSS [P-115]. In this Study, the only species of conservation significance encountered was the common birdwing (*T. helena Cerberus*). A thriving population of this species can be noted due to the presence of its host plant, the Dutchman's pipe (*Aristolochia acuminata*), supported by the sighting of its caterpillar by NSS in early 2021 [P-115]. This suggests that this forest is likely a stronghold for the common birdwing. Moreover, the rare Malay dartlet (*Oriens paragola*) and Burmese lascar (*Lasippa heliodore dorelia*), and moderately rare Semanga superba deliciosa were found unique to this site. These species are infrequently encountered as they are often associated with forested areas, particularly nature reserves, and their surrounding habitats. The NSS study [P-115] also revealed other rare species, including the silver forget-me-not (*Catochrysops panormus exiguous*) and Ancyra blue (*Catopyrops ancyra aberrans*), recorded onsite. Given the rich diversity of butterflies found in such a small forest patch, Site D remains particularly important for the conservation of butterflies in Singapore.



Figure 7-66 Butterflies recorded at Sites A, B, C and D. (A) common birdwing (*Troides helena cerberus*), (B) formosan swift (*Borbo cinnara*), (C) common faun (*Faunis canens arcesilas*), (D) yellow flash (*Rapala domitia domitia*) and (E) Malay tailed judy (*Abisara savitri savitri*).

Site E

At Site E, 37 butterfly species are recorded. One of which is of conservation significance, the nationally Vulnerable common birdwing (*Troides helena cerberus*). Other notable species found at E includes nationally Near Threatened tawny palmfly (*Elymnias panthera panthera*), Blue spotted crow (*Euploea midamus singapura*) and common rose (*Pachliopta aristolochiae asteris*). A very rare seasonal migrant, the great orange tip (*Hebomoia glaucippe aturia*) was also recorded at the south of Site E.

Site F

At Site F, 25 species of butterflies are recorded. One species is of conservation significant, the common birdwing (*Troides helena cerberus*) which is nationally Vulnerable. The nationally Near Threatened common rose (*Pachliopta*

aristolochiae asteris), moderately rare Malayan six-ring (*Ypthima fasciata torone*) and orange awlet (*Bibasis harisa consobrina*) were also sighted.



Legend

- EIA Study Area
 - Site boundary
- Vegetation Types**
- Native-dominated secondary forest
 - Abandoned-land forest
 - Exotic-dominated secondary forest
 - Scrubland
 - Urban vegetation
 - Non-vegetated
 - Waterbody

- Butterfly of conservation significance**
- Astictopterus jama jama*
 - Troides helena cerberus*



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-	MAY 2024	CWT	Turf Club EIA	LAL	JAG

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Note: Source of basemap - Google Earth Map

7.3.3.4 Odonates

Dragonflies and damselflies serve as good biological indicators for the assessment of aquatic environments as they are highly sensitive to environmental changes and are taxonomically well-known. Odonates are mostly encountered near their aquatic breeding sites, which can be many habitats, ranging from suburban drains to streams. As odonate species differ greatly in their eco-physiological requirements, their distribution can be an indicator of the characteristics and quality of the aquatic habitat that they are found in [P-130]. Being predators of several types of insects, dragonflies and damselflies serve an important role within food webs [P-172]. Additionally, they provide humans with the ecosystem service of mosquito control [P-173].

Given the diverse habitats present across the Study Area, and its proximity to CCNR and BTNR, 60 species of odonates were expected. Of which, 15 species were of conservation significance from the field survey, 46 species of odonates were recorded: 12 damselflies and 34 dragonflies. One unexpected species of conservation significance, the uncommon fiery coraltail (*Ceriagrion chaoi*) was also recorded in Site A. Out of the 10 families observed, the family with the highest number of species found with 29 species was the largest dragonfly family of skimmers and their relatives, Libellulidae. The most abundantly recorded species was the widespread common parasol (*Neurothemis fluctuans*), found across all sites.

Site A

Overall, Site A had the highest diversity of odonates, with 38 species found, including the only odonate species of conservation significance. While most species observed at Site A are considered widespread and common, rare and uncommon species were also found here. The sheer diversity of odonates can be attributed to the natural waterbodies unique to the site. In the case of forested pools and streams (D1 and D4), the nationally Near Threatened and rare red-tailed sprite (*Teinobasis ruficollis*), and uncommon sapphire flutterer (*Rhyothemis triangularis*) were recorded. The former species is very localised and can be found mainly in marshes and forested pools at BTNR and CCNR. The latter species, on the other hand, inhabits ponds and sluggish streams [P-136], and can be observed outside of CCNR, such as Marina East and Bishan Park. Moreover, several nymphs of the yellow featherlegs (*Copera marginipes*), orange-striped threadtail (*Prodasineura humeralis*), and treehugger (*Tyriobapta torrida*) were also found throughout the forested stream, indicating clear utilisation of and dependence on the Area. Along a linear pond beside the terrestrial sampling route, a thriving population of the fiery coraltail (*C. chaoi*) exists, with at least eight mating pairs and one teneral observed. This is a nationally Vulnerable species, and is uncommon in Singapore, inhabiting only ponds and slow-flowing streams with submerged water plants. [P-118] reported this species at five location records, but the population at Bishan Park no longer exists, reducing the distribution records of this species. The sighting of this species at Site A, is therefore, considered significant. Moreover, other uncommon species like the shorttail (*Onychargia atrocyana*) was also seen mating here, among high numbers of the uncommon sultan (*Camacinia gigantea*). Terrestrially, the large *Gynacantha* sp. were occasionally encountered throughout the forest, including the uncommon dingy duskhawker (*G. subinterrupta*). In a concurrent study, five other species such as the uncommon spear-tail duskhawker (*G. dohrni*) and uncommon shadowdancer (*Idionyx yolanda*) were also recorded at Site A. The waterbodies at Site A are hence a stronghold for many odonate species and have very high potential to grow and stabilise populations of rare and uncommon species should it be allowed to remain undisturbed.

Site B

At Site B, 22 species of odonates were recorded, of which many can be considered widespread and common. Unlike at Site A, the waterbodies here (D6 and D7) are mainly naturalised lined drains, which may explain the assemblage of odonate sightings. Nonetheless, both the uncommon sultan (*C. gigantea*) and dingy duskhawker (*G. subinterrupta*), were recorded. Moreover, forest-associated damselflies like the crescent threadtail (*P. notostigma*) and orange-striped threadtail (*P. humeralis*) were also found, with the latter observed mating, thereby suggesting the suitability of the habitat for breeding.

Site C

At Site C, 12 species of odonates were recorded. They are either common or uncommon species and not of conservation significance. The recorded species are typical of disturbed secondary forest with open forest edges and degraded waterbodies. However, there is potential to rehabilitate the existing stream into a forest stream, especially with the presence of crescent threadtail (*Prodasineura notostigma*).

Site D

At Site D, odonate diversity was significantly lower than the other sites with waterbodies. A total of 9 species was recorded, none was of conservation significance. Other than the sultan (*C. gigantea*), species recorded are classified as common. As many species require strict environmental conditions to survive, the poor richness here could indicate less-than-ideal microhabitats present. This observation was apparent from the highly disturbed forested area within the racecourse oval (D11), with anthropogenic structures deposited along it.

Site E

At Site E, 32 species are recorded, which is the second highest species richness among the six sites. There is no species of conservation significance and species recorded are typically common in a regenerative secondary forest containing open lentic and disturbed stream habitats. Nonetheless, the variety of habitats in this Site, where there are open ponds in the golf course (D8 and D9) and naturalised forest streams (D7), has proven to be conducive for a more diverse odonate community. Indeed, the presence of violet sprite (*Archibasis viola*), a species associated with natural flowing stream in forest or semi forest, and orange-striped threadtail (*Prodasineura humeralis*) are indicative of the rehabilitative potential of the existing streams.

Site F

At site F, 7 species of odonates are recorded, none of conservation significance. This finding is not alarming as there are no permanent major waterbodies on site. Other than the sultan (*C. gigantea*), species recorded are considered common.



Figure 7-68 Odonates recorded at Sites A, B, C and D. (A) male sultan (*Camacinia gigantea*); (B) dingy duskhawker (*Gynacantha subinterrupta*); (C) treehugger (*Tyriobapta torrida*); (D) crescent threadtail (*Prodasineura notostigma*); (E) orange-striped threadtail (*Prodasineura humeralis*); (F) fiery coraltail (*Ceriagrion chaoi*).



Legend

- EIA Study Area
- Site boundary
- Vegetation Types**
- Native-dominated secondary forest
- Abandoned-land forest
- Exotic-dominated secondary forest
- Scrubland
- Urban vegetation
- Non-vegetated
- Waterbody

Odonate of conservation significance

- ▶ Ceriagrion chaoi



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**DISTRIBUTION OF ODONATE OF
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Note: Source of basemap - Google Earth Map

7.3.3.5 Aculeate Hymenopterans

Aculeata is a subclade of Hymenoptera containing bees, stinging wasps and ants. They are known for their stinger which is a modified ovipositor. The stingers are used for killing or paralysing prey and serve as a defence mechanism against predators [P-174]. In this study, only bees and stinging wasps were assessed.

Bees and wasps play vital roles in supporting biodiversity in ecosystems. As pollinators, bees and wasps assist in the reproduction process of plants which ensures that they produce sufficient seed sets. The pollination process by bees and wasps also results in the production of fruits, which supports frugivorous fauna including bats and birds [P-175]. Additionally, certain species of wasps also serve to control pest populations [P-176]. A good diversity of aculeate hymenopterans is hence essential for and indicative of a healthy ecosystem.

A total of 63 aculeate hymenopteran species were recorded: 27 bees and 36 stinging wasps, from nine families. Of which, six can be classified as Near Threatened – *Liostenogaster nitidipennis* and *Liostenogaster varipicta*, due to their inclination for forest habitats [P-177], lesser paper wasp (*Parapolybia varia*), *Nomia fuscipennis*, *Tetragonula laeviceps*, and *Homotrigona apicalis*. Nonetheless, none of the species recorded were of conservation significance.

Overall, the family with the highest number of species found with 21 species belonging to the wasp family, Vespidae, which is a wide and diverse group comprising of both social and solitary species [P-135]. The most abundantly recorded species was the eastern honey bee (*Apis cerana*). The bees and wasps were clustered mostly around open pockets of scrubland with wildflowers and flowering trees in forested areas.

Overall Site C and E have a higher species richness compared to Site F. This may be attributed to the larger area of the adjoining two sites which support a greater variety of habitats. The findings are elaborated specific to the three sites below.

Site A

At Site A, 40 species of aculeate hymenopterans were found, including three Near Threatened species - *Liostenogaster nitidipennis*, *Liostenogaster varipicta* and *Nomia fuscipennis*. Among all the Sites, Site A has the highest species richness, likely a result of a large heterogenous landscape [P-113], alongside abundant foraging and nesting opportunities. For example, the eastern honey bee (*Apis cerana*) was observed feeding on flowering plants such as *Leea indica* and *Asystasia gangetica*. Active nests of the near Threatened *Liostenogaster nitidipennis*, giant honey bee (*A. dorsata*) and Sumatran paper wasp (*Ropalidia sumatrae*) were also found, confirming the use of the Site by these species. It is noteworthy that the nest of the Sumatran paper wasp is a few years old.

Site B

At Site B, 17 species of aculeate hymenopterans and two of the Near Threatened species, *Liostenogaster varipicta* and *Nomia fuscipennis*, were observed. All species found were native. Similarly, the site provides foraging opportunities for numerous species such as the Eastern honey bee (*A. cerana*), Andrew's blue-banded digger bee (*Amegilla andrewsi*) and *Sphex subtruncatus*. Active nests of *R. jacobsoni*, *Tetragonula valdezi* and *R. sumatrae* were also found, with the latter on a large Critically Endangered *Ficus kerkhovenii* specimen.

Site C

At Site C, 26 species of aculeate hymenopterans were recorded. This includes five of the Near Threatened species – *Liostenogaster varipicta*, *Liostenogaster nitidipennis*, lesser paper wasp (*Parapolybia varia*), *Homotrigona apicalis*, and *Tetragonula laeviceps*. Additionally, three species were found only at Site C, viz. lesser paper wasp (*Parapolybia varia*), Malaysian stingless bee (*Heterotrigona itama*) where a nest was observed, and a wasp *Liris* species. All the recorded species are considered native except for the unidentified *Liris* species which cannot be assessed.

Site D

Site D had the lowest species diversity across the Study Area with only 7 species recorded despite the presence of open and favourable habitats. Nonetheless, all species recorded were native. The near threatened species *Liostenogaster varipicta* was recorded as well as one nesting *Parischnogaster mellyi*. The low species diversity could be attributed to the fact that the site is highly disturbed by regular maintenance and biking activity.

Site E

At Site E, 32 species are recorded with no species of conservation significance. Two Near Threatened species were recorded. They were the *Liostenogaster nitidipennis* and *Tetragonula laeviceps*, which was sighted with a nest. The nest of three other species were also recorded from *Parischnogaster mellyi*, *Ropalidia stigma* and, *Ropalidia sumatrae*.

Site F

At Site F, 13 species of aculeates were recorded with no species of conservation significance. Recorded species were all native and two observations of a *Ropalidia jacobsoni* nest were made. This species tends to build its nest on urban structure such as traffic lights and in this case, the nest was made on the road sign.



Figure 7-70 Aculeate hymenopterans at Sites A, B and D. (A) *Sphex subtruncatus* feeding on *Leea indica*; (B) *Ropalidia sumatrae* nesting in a large Critically Endangered *Ficus kerkhovenii* specimen in Site B; (C) *Ropalidia jacobsoni* in their nest in Site B; (D) *Parischnogaster mellyi* in its nest in Site D.

7.3.3.6 Amphibians

Amphibians carry significant ecological importance in forest and aquatic ecosystems [P-178]. They can be important consumers in both aquatic and terrestrial habitats and may represent an important energetic link between the two, particularly in the tropics, where amphibian species richness and abundance are high [P-178]. They also play an important role in nutrient cycling in both aquatic and terrestrial habitats, in addition to helping control pest populations and potentially acting as pollinators and seed dispersers [P-180]. Despite being such important assets to the ecosystem, amphibians are also unfortunately one of the most sensitive taxa to habitat loss and fragmentation [P-179]. As such, they face a serious threat due to the increasing rates of these phenomena happening in Singapore's forests [P-179].

The field assessment recorded 11 amphibian species, none were of conservation significance and all are commonly occurring in open waterbodies and disturbed secondary forests. Of the recorded species, there were three non-natives and these were the greenhouse frog (*Eleutherodactylus planirostris*), banded bull frog (*Kaloula pulchra*) and East Asian ornate chorus frog (*Microhyla mukhlesuri*).

Site A

Site A recorded 10 species and was dominated by chorus frogs (*Microhyla* sp.), in particular the dark-sided chorus frog (*Microhyla heymonsi*). The green paddy frog (*Hylarana erythraea*), was only recorded at two of the sites, one of it being Site E. Tadpoles of several amphibian species were also observed along the waterbodies. For example, tadpoles of the chorus frogs, four-lined tree frog (*Polypedates leucomystax*) and *Limnonectes* sp. were found along the streams in Site A (D15).

Site B

Site B recorded 9 species and was dominated by the non-native greenhouse frog (*Eleutherodactylus planirostris*).

Site C

At Site C, 8 species was recorded, dominated by the Malayan giant frog (*Limnonectes blythii*) and non-native greenhouse frog (*Eleutherodactylus planirostris*). The only record of the copper-cheeked frog (*Chalcorana labialis*) was found at Site C at aquatic sample FW4_02. This is noteworthy as this species has a restricted distribution in forested streams [P-3].

Site D

Site D recorded 8 five species and was dominated by the Malayan giant frog and Asian toad (*Duttaphrynus melanostictus*).

Site E

At site E, 10 species are recorded, dominated by the greenhouse frog (*Eleutherodactylus planirostris*), Malayan giant (*Limnonectes blythii*) and dark-sided chorus frog (*Microhyla heymonsi*).

Site F

Despite the lack of permanent waterbodies, 5 species of amphibians are recorded at Site E. Sightings were dominantly the greenhouse frog (*Eleutherodactylus planirostris*) which does not depend on water for its reproduction.

7.3.3.7 Reptiles

Reptiles are an important part of the ecosystem as they fill up key niches in the food chain by preying on a wide range of invertebrates and vertebrates, hence enhancing the flow of nutrients in the ecosystem through energy transfer in food chains [P-180].

Overall, 27 species of reptiles were recorded (Appendix I) none of conservation significance. Most of the recorded reptiles have a widespread distribution except for four Near Threatened Wagler's pit viper (*Tropidolaemus wagleri*), lowland dwarf gecko (*Hemiphyllodactylus typus*), red-necked bronzeback (*Dendrelaphis kopsteini*), and banded malayan coral snake (*Calliophis intestinalis*). All of which can be found in Site A and the Wagler's pit viper was encountered multiple times in Site C. Although not of conservation status, it is noteworthy that more individuals of the native and uncommon green crested lizard (*Bronchocela cristatella*) were sighted across the Sites than the

changeable lizard (*Calotes versicolor*), a non-native species that has been displacing the green crested lizard [P-3].

Site A

Site A had the highest species richness for reptiles, with 17 recorded species. The nationally Near Threatened lowland dwarf gecko (*Hemiphyllodactylus typus*), an incidental record from Site A, was a rare encounter and had not been previously documented from the site. This species is usually known from CCNR, the Western Catchment and Mandai Mangroves [P-3]. Other Near Threatened species recorded on site are the banded Malayan coral snake (*Calliophis intestinalis*), red-necked bronzeback (*Dendrelaphis kopsteini*) and the Wagler's pit viper (*Tropidolaemus wagleri*). Besides that, two snakes were also uniquely found in Site A: the common Malayan racer (*Coelognathus flavolineatus*) and white-spotted slug snake (*Pareas margaritophorus*). The widespread but rare common Malayan racer was recorded only from its moult along a linear pond beside terrestrial sampling route A1, where many odonate species were also found. The non-native, white-spotted slug snake was observed on two separate occasions, one on the forest floor and one as a roadkill, along with two other roadkills: equatorial spitting cobra (*Naja sumatrana*) and unidentified bronzeback (*Dendrelaphis* sp.), along Fairways Drive. Most notably, the habitats located along the western terrestrial sampling route appears favourable for painted bronzebacks (*Dendrelaphis pictus*), with up to 63 individuals being recorded in a single night. This observation may be attributed to the presence of waterbodies and grasslands that the bronzebacks prefer.

Site B

Site B recorded 9 reptile species, all of which can be found in other parts of the Study Area.

Site C

There are 13 species of reptiles are recorded at Site C. Notably, the Near Threatened Wagler's pit viper (*Tropidolaemus wagleri*) was recorded all across this Site, with as many as 5 encounters in a single night. This species typically inhabits mature secondary forests more common in the nature reserves) [P-181].

Site D

At Site D, 9 species were recorded. Of which, two snake species were found only in Site D, paradise gliding snake (*Chrysopelea paradisi*) and reticulated python (*Malayopython reticulatus*).

Site E

Site E recorded 12 reptile species. The Brooke's house gecko (*Hemidactylus brookii*) and Bowring's agile skink (*Subdoluseps bowringii*) are only recorded in Site E. Similar to Site A, the painted bronze back (*Dendrelaphis pictus*) was a common encounter with up to 16 seen in a single night.

Site F

At Site F, 9 species of reptiles was recorded. Located adjacent to Eng Neo Avenue, two reptile road kills were recorded – a painted bronzeback (*Dendrelaphis pictus*) and a house wolf snake (*Lycodon capucinus*). The latter being an exclusive record together with the non-native long-tailed sun skink (*Eutropis longicaudata*).

7.3.3.8 Birds

Through foraging, many bird species provide important ecological functions such as nutrient cycling, seed dispersal, pollination, pest control and removal of carcasses [P-182]. Some of these services help support vegetation succession, thus averting forest degradation through time [P-183].

In total, 111 species of birds were recorded, 15 were of conservation significance (Appendix I). This comprise of 83 residents (71 native and 12 introduced), 24 are migrant/visitor and 2 introduced species. Two other species were not identified to species level hence not classified by its native status.

The highest species richness is recorded at Site A, which is unsurprising since it contains a larger tract of forest. However, conservation significant birds are recorded across the Study Area. This highlights the connectivity function of the entire Study Area which are supporting birds that may disperse from the nature reserve across the PIE. The findings are elaborated specific to the sites below. The long-tailed parakeet (*P. longicauda*) remains globally Vulnerable, and its population is threatened mainly by pet bird trade [W-31]. It is currently protected under

the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) as an Appendix II species with international trade of the species controlled. Locally, this bird is relatively common, but faces competition from the introduced red-breasted parakeet (*P. alexandri*) as they both nest in tree holes [P-93]. The straw-headed bulbul (*P. zeylanicus*) seen across the sites is globally Critically Endangered as a result of rampant poaching for the songbird trade. In Singapore, although it is listed as nationally Endangered, the population is showing an increasing trend [P-111]. Singapore is now a global stronghold for this species. All forested habitats in Singapore that support the species like the Study Area play a critical role in its global conservation.

Site A

Site A recorded the highest 88 species of birds and has the highest diversity amongst the Study Area. Of which, 9 were species of conservation significance. Within Site A, the nationally Vulnerable changeable hawk-eagle (*Nisaetus cirrhatus*) was uniquely present. The changeable hawk-eagle has been observed flying at low heights on several occasions and was captured once on a camera trap, indicating the utilisation of the site by the species. The nationally Vulnerable thick-billed green pigeon (*Treron curvirostra*) was also found at Site A. This species is often an indicator of forest quality in Singapore and is also a seed disperser that helps to maintain tree populations [W-29]. Migratory species recorded from Site A consisted of four uncommon species, the yellow-rumped flycatcher (*Ficedula zanthopygia*) and dark-sided flycatcher (*Muscicapa sibirica*), green-backed flycatcher (*Ficedula elisae*) and Sakhalin leaf warbler (*Phylloscopus borealoides*) were also noted. The Sakhalin leaf warbler is considered a rare accidental visitor, with the first wintering record confirmed in 2014 [P-143]. The green-backed flycatcher has also been sighted in CCNR [P-148]. Additionally, the uncommon winter visitor, crested honey buzzard (*Pernis ptilorhynchus*), was previously recorded incidentally feeding on the hive of giant honeybee (*Apis dorsata*). While the hive was sighted again in this Study, the buzzard was not observed.

Site B

At Site B, 60 bird species and 4 species of conservation significance was recorded. The spotted wood owl (*Strix seloputo*) was a species of conservation significance recorded exclusively at this Site, perched on a large rain tree (*Samanea saman*) specimen at night. Three uncommon migrant species, including the forest wagtail (*Dendronanthus indicus*), yellow-rumped flycatcher (*Ficedula zanthopygia*) and Eastern crowned warbler (*Phylloscopus coronatus*), were observed.

Site C

Site C recorded 57, of which 5 are of conservation significance. At Site C, the nationally Vulnerable Asian red-eyed bulbul (*Pycnonotus brunneus*) and nationally Vulnerable jambu fruit dove (*Ptilinopus jambu*) is uniquely present. The latter is more associated with primary or mature secondary forests, which suggests that the native-dominated forest in this Site serves as a refuge for this species. At Site C, uncommon visitors include yellow-rumped flycatcher, Indian cuckoo (*Cuculus micropterus*), orange-headed thrush (*Geokichla citrina*) and the rare streaked bulbul (*Ixos malaccensis*) were also recorded. The latter three species are especially noteworthy as they were recorded only at Site C. The orange-headed thrush is dependent on forests as wintering grounds while the streaked bulbul is forest dependent and Near Threatened [P-184].

Site D

There were 48 species of birds recorded at Site D, three of which are of conservation significance. The nationally Near Threatened oriental pied hornbill (*Anthracoceros albirostris*) was frequently observed on the tall albizia trees (*Falcataria falcata*), which are also likely nesting habitats for the Tanimbar corella (*Cacatua goffiniana*). The Hodgson's hawk-cuckoo (*Hierococcyx nasicolor*), an uncommon winter visitor is a notable sighting. While none are of conservation significance, both Site C and D are important for providing habitats for uncommon and rare migratory species.

Site E

At Site E, 68 species are recorded. There are eight species of conservation significance (Appendix I). This includes the nationally Endangered straw-headed bulbul (*Pycnonotus zeylanicus*), globally Vulnerable long-tailed parakeet (*Psittacula longicauda*) and nationally Vulnerable brown shrike (*Lanius cristatus*) which is a common wintering migrant in Singapore from September till May (Yong et al 2016). The nationally Vulnerable buffy fish owl (*Ketupa ketupu*) was also recorded on Site within Champions golf course. This is an uncommon bird usually found in primary and mature secondary forests near reservoirs or streams (Yong et al 2016). Most of the conservation significant

birds are found along the transect which cuts through the golf course and is also closest to Site A and the nature reserve across the PIE.

Site F

Site F recorded 47 species of birds. Six species are of conservation significant: the nationally Endangered white-rumped shama (*Copsychus malabaricus*), and straw-headed bulbul (*Pycnonotus zeylanicus*); nationally Vulnerable plume-toed swiftlet (*Collocalia affinis*), changeable hawk-eagle (*Nisaetus cirrhatus*) and swinhoe's white-eye (*Zosterops simplex*); and long-tailed parakeet (*Psittacula longicauda*). The straw-headed bulbul is also globally Critically Endangered due to rampant poaching for the songbird trade. However, Singapore is a global stronghold for this bird (Yong et al 2016). Hence habitats in Singapore supporting the bird are crucial for its global conservation. Caught on the camera trap is the Siberian blue robin (*Larvivera cyane*), a Near Threatened passage migrant.



Figure 7-71 Bird species recorded at the Study Area: (A) yellow-rumped flycatcher (*Ficedula zanthopygia*); (B) pale morph changeable hawk-eagle (*Nisaetus cirrhatus*) caught on camera trap; (C) Hodgson's hawk-cuckoo (*Hierococcyx nasicolor*); (D) a pair of oriental pied hornbills (*Anthracoceros albirostris*).



Legend

- EIA Study Area
 - Site boundary
- Vegetation Types**
- Native-dominated secondary forest
 - Abandoned-land forest
 - Exotic-dominated secondary forest
 - Scrubland
 - Urban vegetation
 - Non-vegetated
 - Waterbody

Birds of conservation significance

- Ardea purpurea
- Collocalia affinis
- Copsychus malabaricus
- Copsychus saularis
- Corvus macrorhynchos
- Ketupa ketupu
- Lanius cristatus
- Nisaetus cirrhatu
- Pittacula longicauda
- Ptilinopus jambu
- Pycnonotus brunneus
- Pycnonotus zeylanicus
- Strix seloputo
- Treron curvirostra
- Zosterops simplex



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-	MAY 2024	CWT	Turf Club EIA	LAL	JAG

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DISTRIBUTION OF BIRD OF CONSERVATION SIGNIFICANCE

Figure No. : 7-72	Rev. : -	Sheet : 1 of 1
CAD File Name : NA		A3

Note: Source of basemap - Google Earth Map

7.3.3.9 Non-volant mammals

A total of 15 species of non-volant mammals were deemed of probable occurrence and 4 of which are of conservation significance. Of note, the globally and nationally Endangered Sunda slow loris (*Nycticebus coucang*), and nationally Endangered Horsfield's flying squirrel and lesser mousedeer were included in the list due to their presence in the Sime Forest across the PIE (O'dempsey, pers comm.). Faunistic findings via visual surveys and camera trapping revealed a total of 15 mammalian species, including 4 species of conservation significance globally and nationally Critically Endangered Sunda pangolin (*Manis javanica*), globally Endangered Long-tailed macaque (*Macaca fascicularis*), nationally Endangered smooth-coated otter (*Lutrogale perspicillata*) and an unidentified flying squirrel. While not of conservation significance, the Near Threatened Malayan colugo (*Galeopterus variegatus*) is also a species of interest, that may require additional protection measures during any future development.

The Sunda pangolin (*Manis javanica*) was detected 45 times on camera traps across the Study Area. All Sites recorded this species except Site D. For such a small area, these findings can be considered remarkable. Moreover, the sighting of a mother and its baby clinging on its tail at CT23 and CT34 denotes breeding activity in Site B and the forest strip in the West of Site E. The vegetation-type where pangolins were detected comprises of a mixture of native-dominated forest and mixed-forest. While Sunda pangolins are known to reside mainly in both CCNR and Bukit Batok, fragmented patches of forest such as those within the Study Area can serve as a habitat for dispersing animals to reside or travel, contributing to the overall genetic health of the pangolin population.

The nationally widespread and common long-tailed macaque (*Macaca fascicularis*) was recently up-listed as a globally Endangered species as a result of human persecution across the rest of Southeast Asia (Eudey et al., 2020). This species was detected at all Sites of the Study Area, mainly through camera trapping. The highest number of long-tailed macaque recorded was 29 individuals during a diurnal survey at Champions golf course (Site E).

The forest-dependent Malayan colugo (*Galeopterus variegatus*) was observed at all Sites except Site D. A total of 28 colugo encounters was recorded, 15 of which were from Site C. A colugo was also seen climbing the trees along Eng Neo Avenue through camera trapping. The Sunda colugo is largely restricted to the CCNR and its surrounding forests, although it has been sighted in discrete forest patches [P-88]. In Singapore, colugos have been observed to glide across Pan Island Expressway (PIE), despite the heavy traffic and street lamps, using mature trees as far as 63.5m apart [P-112]. Therefore, it is probable that the observed individuals are a result of dispersal from the main source population at CCNR; or part of a small population already residing within the Study Area; or stray individuals. There are also signs of colugo breeding activity in the west forest patch of Site E, where a mother child pair was recorded. It is likely that a small population exists within and is moving around the Study Area. Therefore, it is important to maintain and facilitate forest connectivity to allow for the safe movement of this species.

Other common species also contributed to the list of faunistic findings. The slender squirrel (*Sundasciurus tenuis*) and common palm civet (*Paradoxus musangus*) were recorded both visually and captured via camera traps. The common palm civet can be found in both urban and forested regions in Singapore and plays an ecological role as a seed disperser [W-29]. While the plantain squirrel (*Callosciurus notatus*) and common treeshrew (*Tupaia glis*) occur in forest, adjacent scrubland and parkland, the slender squirrel is confined mostly to forested regions of Singapore [P-3]. Presence of Eurasian wild boar (*Sus scrofa*) was detected during both transect surveys and camera trap detection. This species is widespread across Singapore and able to persist in large patches of mixed secondary forest-abandoned plantation [P-149].



Figure 7-73 Mammals at Sites A, B, C and D: (A) long-tailed macaque (*Macaca fascicularis*); (B) Sunda colugo (*Galeopterus variegatus*); (C) Sunda pangolin (*Manis javanica*) mother and young captured on camera trap



Legend

- EIA Study Area
 - Site boundary
- Vegetation Types**
- Native-dominated secondary forest
 - Abandoned-land forest
 - Exotic-dominated secondary forest
 - Scrubland
 - Urban vegetation
 - Non-vegetated
 - Waterbody

Mammal of conservation significance

- Eonycteris spelaea
- Galeopterus variegatus
- Lutrogale perspicillata
- Macaca fascicularis
- Manis javanica
- Tylonycteris sp.
- Flying squirrel



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Figure Title :
DISTRIBUTION OF MAMMAL OF CONSERVATION SIGNIFICANCE

Figure No. : 7-74	Rev. : -	Sheet : 1 of 1
CAD File Name : NA		A3

Note: Source of basemap - Google Earth Map

The camera traps yielded 2582 independent detections and 12 species of mammals (Table 7-10). The list of camera trap data is available in Appendix J. The most commonly recorded was the common treeshrew (*Tupaia glis*) with 996 independent detections. Notably, the Critically Endangered Sunda pangolin (*Manis javanica*) was recorded over ten occasions at 20 locations across The Study Area.

Table 7-10 Locations and number of independent detections of mammalian species

Species	Common Name	CT Location	No. Of Independent Detections
<i>Callosciurus notatus</i>	Plantain squirrel	CT1, CT2, CT4, CT5 – CT10, CT12 – CT18, CT20 – CT27, CT30, CT31, CT33, CT35, CT36, CT38, CT41 – CT45	637
<i>Canis lupus familiaris</i>	Feral dog	CT14, CT36, CT44, R01	6
<i>Felis catus</i>	Feral cat	CT17, CT24, CT31, CT38, CT42	5
<i>Galeopterus variegatus</i>	Sunda colugo	R03	1
<i>Lutrogale perspicillata</i>	Smooth-coated otter	CT31	1
<i>Macaca fascicularis</i>	Long-tailed macaque	CT1, CT2, CT5, CT7 – CT9, CT11, CT12, CT14, CT17, CT18, CT20, CT24, CT25, CT33, CT34, CT37, CT40, CT41, R01, R02	129
<i>Manis javanica</i>	Sunda pangolin	CT11 – 13, CT16, CT17, CT20, CT21, CT22, CT23, CT25, CT27, CT28, CT30, CT31 – CT34, CT39, CT45, R02	39
<i>Paradoxurus musangus</i>	Common palm civet	CT3, CT4, CT6, CT8, CT9, CT11, CT14, CT16, CT17, CT21, CT25 – CT28, CT31, CT32, CT34, CT40, CT42, CT44, R01	43
<i>Rattus sp.</i>	Rat	CT1, CT4 – CT9, CT11 – CT18, CT21 – CT30, CT33 – CT38, CT40 – CT45	639
<i>Sundasciurus tenuis</i>	Slender squirrel	CT4 – CT8, CT11	8
<i>Sus scrofa</i>	Eurasian Wild Boar	CT1, CT3, CT7 - CT11, CT16 – CT18, CT45	78
<i>Tupaia glis</i>	Common treeshrew	CT1 – CT 9, CT11 – CT18, CT20 – CT31, CT33, CT35, CT36, CT37, CT41 – CT45	996
Total			2582

7.3.3.10 Bats

During field assessment, 10 species of bats were detected, all of which are native. The frugivorous lesser short-nosed fruit bat (*Cynopterus brachyotis*) and bamboo bat (*Tylonycteris sp.*) was detected visually while the glossy horseshoe bat (*Rhinolophus refulgens*) and cave nectar bat (*Eonycteris spelaea*) were caught during bat trapping. The remaining bats were insectivorous bats and were detected acoustically. The bamboo bat and cave nectar bat were bat species of conservation significance detected during the field assessment (Figure 7-75). Two species of bamboo bats are found in Singapore: the lesser bamboo bat (*T. fulvida*) and the greater bamboo bat (*T. malayana*). The acoustic signatures of the two species overlap, thus making it difficult to distinguish the species without handheld specimens. As both species are nationally Vulnerable, the bamboo bat species was considered a species of conservation significance.

Bamboo bats were recorded at all Sites other than Site D. All bamboo clusters were identified in the Study Area and they were examined for its use by bamboo bats, as the species roosts in bamboo internodes. Bamboo bat activity was also detected acoustically around bamboo clusters during roost emergence surveys. From the roost emergence survey, shows the distribution of bamboo clusters where bamboo bats were detected. Despite the lack of bamboo bat detection in some bamboo clusters, these bamboos still serve as a potential roost site. Notably, Site A and the forest patch in the west of Site E has the highest number of active roosts and bamboo bats detected via bioacoustics survey.



Legend

- EIA Study Area
 - Site boundary
- Vegetation Types**
- Native-dominated secondary forest
 - Abandoned-land forest
 - Exotic-dominated secondary forest
 - Scrubland
 - Urban vegetation
 - Non-vegetated
 - Waterbody
- Roost emergence survey**
- Roost confirmed
 - Bamboo bat detected but roost not confirmed
 - Bamboo bat not detected
- Bat trapping**
- Eonycteris spelaea



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Figure Title :
**BATS OF CONSERVATION SIGNIFICANCE
 DETECTED THROUGH ROOST EMERGENCE
 SURVEY AND TRAPPING**

Figure No. : 7-75	Rev. : -	Sheet 1 of 1
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Note: Source of basemap - Google Earth Map

Areas adjacent to the Study Area have been converted for anthropogenic use, and in keeping with this, the majority of species recorded are highly adaptable species capable of utilising urban as well as forested habitats. However, the Study Area is still able to support forest-specialists such as the glossy horseshoe bat (*Rhinolophus refulgens*). Highly adapted to hunting in cluttered environments, the glossy horseshoe bat has been recorded in CCNR and BTNR, and has been recorded hunting in forest canopies. Acoustic recordings of the glossy horseshoe bat were recorded from native-dominated secondary forests and abandoned-land forests within the Study Area. It was also caught in harp traps that were deployed in Site C, E and F. Another forest-specialist expected in the Study Area is the cave nectar bat (*Eonycteris spelaea*). Considered nationally Vulnerable, this nectarivores species is a key pollinator within forests. The cave nectar bat was detected via live trapping at Site A Figure 7-75. The species resembles the lesser short-nosed fruit bat when in flight, as well as its preference for foraging in the forest canopy, may have allowed it to evade detection. Although the PIE separates the Study Area from CCNR forests in the northeast, both the cave nectar bat and glossy horseshoe bat are likely able to overcome this barrier, allowing them to utilise the landscape as a contiguous habitat for its survival. The number of bats detected in each Site is largely similar. The highest number of bats species was detected at Site A with nine (9) species, Site C recorded six (6) species while the other Sites recorded eight (8) species each. Five bat species was recorded in all the Sites, these are the black-bearded tomb bat (*Taphozous melanopogon*), the lesser short-nose fruit bat (*Cynopterus brachyotis*), glossy horseshoe bat (*Rhinolophus refulgens*), Asian whiskered myotis (*Myotis muricola*) and lesser Asian house bat (*Scotophilus kuhlii*).

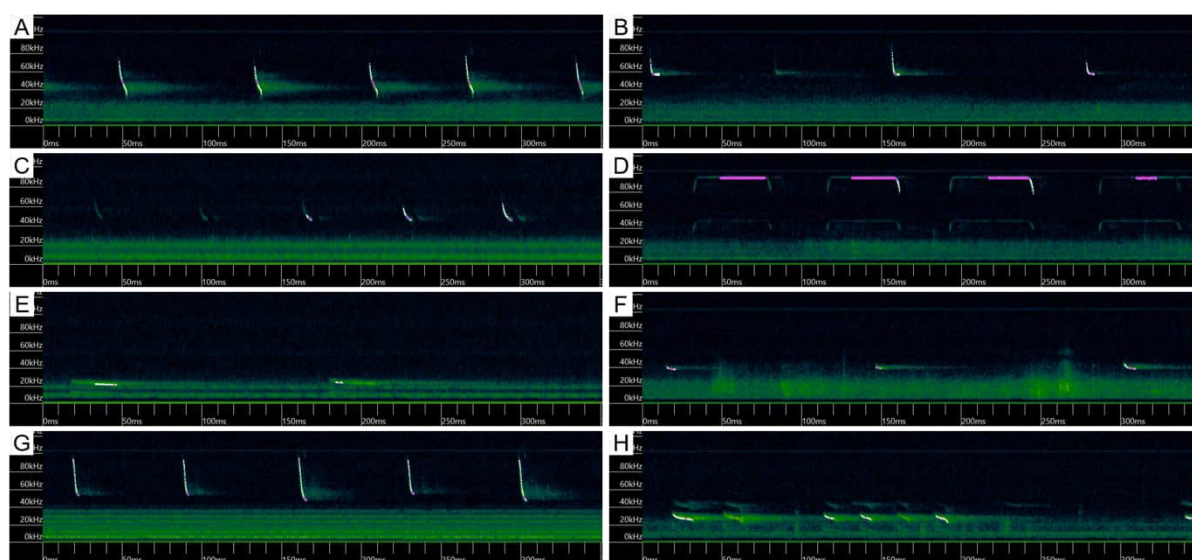


Figure 7-76 Spectrogram of bat echolocation calls at Sites A, B, C and D. (A) Horsfield's myotis (*Myotis horsfieldii*); (B) whiskered myotis (*Myotis muricola*); (C) Javan pipistrelle (*Pipistrellus javanicus*); (D) glossy horseshoe bat (*Rhinolophus refulgens*); (E) pouch bearing bat (*Saccolaimus saccolaimus*); (F) lesser Asian house bat (*Scotophilus kuhlii*); (G) bamboo bat (*Tylonycteris sp.*); (H) black-bearded tomb bat (*Taphozous melanopogon*).

7.3.3.11 Freshwater Fish and Molluscs

There were 14 fish species and 9 molluscs recorded, one fish of conservation significance which is the nationally Endangered crescent betta (*Betta imbellis*) (Figure 7-77). Of the recorded fish species, 5 are native and 9 are non-native. The common walking catfish (*Clarias batrachus*) and guppy (*Poecilia reticulata*) was recorded across the Study Area. The fish community is typical of waterbodies on sites that have a history of land use change. This results in an exotic community dominated by highly adaptable species like guppy (*Poecilia reticulata*) and Indochinese spotted barb (*Barbodes rhombeus*) which are the most abundant fishes in these sites.

Only one mollusc species, *Melanoides tuberculata*, is considered native to Singapore. The remaining seven species are exotic with some introduced to Singapore via the aquarium trade [P-185]. Majority of the mollusc are found in Site E at the golf course ponds and stream at transect F3a.

Site A

At Site A, 9 fish species was recorded. Species richness was intermediate throughout the stream, with lowest richness at the end of the channel, where the channel was shallower and only two species were found. Both species

of interest were recorded here, with the common walking catfish (*C. cf. batrachus*) in mid-channel and crescent betta (*B. imbellis*) in the upstream. While not listed to be threatened nationally or globally, the presence of the common walking catfish is noteworthy. Though a previously widespread species in the non-forested waterways of Singapore, it has seen a marked decline in its populations outside of the central reserves due to competition and displacement from the invasive African sharp-toothed walking catfish (*C. gariepinus*) [P-117] which was recorded in the waterbodies in other Areas. In D1 the common walking catfish was recorded thrice separately, rendering the existing stream habitat valuable in supporting the populations of the species in Singapore. The crescent betta is also a species of interest, given that it has a rare and restricted distribution. Aside from the other common species found, the native croaking gouramy (*Trichopsis vittata*) and Sunda swamp-eel (*Monopterus albus*) were also found upstream and mid-channel respectively. These sections of the stream are relatively deeper and as such have sufficient volume to host larger-bodied, predatory species like the common walking catfish and Sunda swamp-eel. Two other non-native species, Hasselt's bony-lipped barb (*Osteochilus vittatus*) and Barcheek goby (*Rhinogobius similis*) were recorded towards the end of the stream.

The native *Melanooides tuberculata* was the only mollusc recorded.

Site B

At Site B, six species of fish were found along D7 and none in D6, likely as the former stream is more naturalised with riparian vegetation than the latter. The common walking catfish was observed twice in mid-channel, unfortunately alongside the invasive African sharp-toothed walking catfish (*C. gariepinus*). The waterbody was generally dominated by three non-native species including the guppy (*P. reticulata*), Indochinese spotted barb (*B. rhombeus*) and pearl danio (*Brachydanio albolineata*). No mollusc was recorded.

Site C

Only 3 fish species were recorded from Site C. Two are non-native: the guppy and pearl danio (*Brachydanio albolineata*). The third is the nationally Near Threatened common walking catfish (*Clarias batrachus*) recorded at aquatic sampling point FW4_01. No mollusc was recorded.

Site D

At Site D, 7 species of fish were also found along D11, with five of them being non-native. The two native fish species found here was the common snakehead (*C. striata*) and common walking catfish (*C. batracus*). The fish assemblage here might be attributed to human activity in the area, with high levels of disturbance such as anthropogenic structures deposited along and built around the forested area within the racecourse oval. Signs of slope erosion was also observed. No mollusc was recorded.

Site E

At Site E, 11 species of fish and 8 mollusc species are recorded. Of the recorded fish species, 8 were non-native, such as the sharp-tooth walking catfish (*Clarias gariepinus*), pearl danio (*Danio albolineatus*), Nile tilapia (*Oreochromis niloticus*), and two goby species (*Rhinogobius similis* and *Rhinogobius giurinus*).

Site F

There were no records of fish and molluscs in Site F.



Legend

- EIA Study Area
- Site boundary
- Vegetation Types**
- Native-dominated secondary forest
- Abandoned-land forest
- Exotic-dominated secondary forest
- Scrubland
- Urban vegetation
- Non-vegetated
- Waterbody

Fish of conservation significance

- ◆ Betta imbellis



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Note: Source of basemap - Google Earth Map

7.3.3.12 Spiders

A total of 145 species were recorded across 25 families. Most of the species were recorded from the diurnal umbrella beatings (89 species), followed by nocturnal visual searches (79 species), and the diurnal leaf litter sifting (28 species).

During umbrella beatings, the most commonly encountered species are the comb-footed spiders (Family Theridiidae). During the night visual searches, orb weavers (Family Araneidae) and comb-footed spiders (Family Theridiidae) were the most commonly encountered species. Within the leaf litter, spiders from the Pholcidae family were the most commonly recorded. Being thin and delicate, these spiders have very long legs that helps them to navigate through the densely packed forest floor easily.

In the third edition of the Singapore Red Data Book, the national conservation statuses of spider species were included in the assessment process. While none of the recorded species were of conservation significance, it is worth noting that many recorded specimens were not identified to species level and many species have yet to be evaluated under the Singapore Red Data Book. As such, this section highlights five notable records based on the specialists' observations, in spite of the lack of a national conservation status.

For morphologically distinct specimens that could not be identified to a species level, a two-lettered code was assigned following the genus or family (e.g., *Belisana* CS) = *Belisana* "Carapace Stripe".

Tapponia micans is a species of lynx spider (Family Oxyopidae) which was recorded during a night visual survey, and it is the sole representative of the genus *Tapponia*. It is rare in Singapore, with records in only Pulau Ubin and Bukit Brown. As such, this record within the project site is significant, as it marks the first record of the species beyond previously documented locations.

Singaporemma singulare is an armoured spider from the Tetrablemmidae family. Previous records of this species have only been within CCNR, making this the first record in other parts of Singapore. Most species from the Tetrablemmidae family are typically found within leaf litter and soil, and the single specimen recorded in the surveys was observed during leaf litter sifting.

Gamasomorpha insomnia, a species of goblin spider (Family Oonopidae), was recorded during leaf litter sifting. This species has mainly been recorded within BTNR and is uncommonly observed outside the nature reserve. Species of the Oonopidae family tend to be very small (between 1–4 mm) and are found in leaf litter, subterranean habitats, as well as forest canopies [P-170]. As such, this species could be easily overlooked, and could be more widespread in Singapore than expected.

Aff. Reductoonops SE was also recorded during leaf litter sifting surveys, and the genus similarly falls under the Oonopidae family. The genus *Reductoonops* has only been recently described, with its members usually having only two eyes as opposed to six (which is typical of the family), and are found only in the Americas [P-171]. While more research is required to elucidate the identity of the collected specimens, and the existence of this genus in Singapore, it is likely that members of this genus have been introduced to Singapore.

Faiditus MR is an uncommon species which was recorded in both umbrella beating and nocturnal visual surveys. This comb-footed spider (Family Theridiidae) is typically observed in CCNR, with only a few records outside the nature reserve. As species belonging to the genus *Faiditus* are known to be food stealers that parasitise the webs of other spiders [P-71], it is unsurprising that specimens were only recorded during umbrella beating and nocturnal surveys, and none were recorded via leaf litter sifting.

Site A

At Site A, 51 species of spiders across 16 families were recorded. Notable records include the uncommon *Faiditus MR*, which was recorded in this site during both diurnal umbrella beating and nocturnal visual surveys, as well as the potentially non-native *aff. Reductoonops SE*, as the genus *Reductoonops* is native to the Americas.

Site B

A total of 42 species of spiders from 15 families were recorded at Site B. Of note is the record of *Tapponia micans*, which is rarely observed in Singapore, and only known from a few specimens collected from Bukit Brown and Pulau Ubin. This record within the site was thus significant.

Site C

At Site C, 60 species of spiders from 18 families were recorded. There are several notable records, including the first record of *Singaporemma singulare* outside the Central Catchment Nature Reserve (CCNR). There have also been records of two species which are rarely seen outside nature reserves, namely *Stergusa KB* (typically in BTNR and CCNR) and *Gamasomorpha insomnia* (typically in BTNR). Both *Plynnon CL* and *Ordgarius sexpinosus*, which are uncommonly seen in Singapore, have also been recorded within the site. Finally, *aff. Reductoonops SE* was also recorded at Site C.

Site D

At Site D, 25 species across 10 families were recorded. There are no notable records from the species observed in this site.

Site E

Site E is the most diverse site, with 84 species recorded across 21 families. Notable records include *Gasteracantha cf. diadesmia* and *Angaeus rhombifer*, which are both uncommonly seen outside of BTNR and CCNR. There is also one species of uncertain identification, *cf. Thorelliola RE*, which could be a non-native species.

Site F

A total of 47 species of spiders across 13 families were recorded at Site F. The only notable record from this site is *Dipoenura FT*, which is not commonly seen, but recorded one specimen during umbrella beating surveys.

7.4 Assessment of Ecological Value

Habitats and species within the Study Area were assessed for their ecological value based on the criteria described in Table 7-11 (habitat) and Table 7-12 (plant species) [R-34, R-35] and write up below (fauna species). Those of high ecological value were assigned the Priority 1 sensitivity level, while those of moderate or low ecological value were assigned the Priority 2 or 3 sensitivity levels, respectively.

Habitats and species accorded with higher ecological value were regarded of greater importance for conservation relative to other habitats and species, respectively, within the Study Area. The assessment was carried out using biodiversity baseline findings.

Table 7-11 Criteria for assessing the ecological value of habitats

Criterion	Definition	Classification			
		High (3)	Medium (2)	Low (1)	Zero (0)
Flora and fauna species richness	The number of flora (vascular aquatic plants including submerged, partially submerged, and floating species) and water-dependent fauna (bird, odonate, amphibian, reptile, mammal, decapod crustacean, fish, mollusc) species that can be expected to occur in the habitat, excluding introduced fauna species.	High flora and fauna species richness (> 135 species)	Moderate flora and fauna species richness (90 to 135 species)	Low flora and fauna species richness (45 to 89 species)	Very low flora and fauna species richness (< 45 species)
Irreplaceability	The difficulty of recreating or replacing the habitat to its ecologically optimal structure and species composition, with reference to known localities where such habitats have been successfully recreated in Singapore.	Impossible to recreate/replace within 50 years (e.g., quarry lake)	Difficult to recreate/replace (e.g., freshwater swamp forest, hill stream, freshwater marsh, mangrove forest, forest/rural stream, forest/rural river, reservoir)	Easy to recreate/replace (e.g., naturalised river, naturalised stream, managed soft-bank pond, unmanaged soft-bank pond, rain garden, swale, biotope)	Not ideal to recreate/replace for biodiversity (e.g., concrete drain, hard-bank pond)
Local rarity of habitat	Rarity of the habitat in Singapore.	Habitat is rare in Singapore (e.g., freshwater swamp forest, hill stream, freshwater marsh, mangrove forest)	Habitat is uncommon in Singapore (e.g., forest/rural river, forest/rural stream, unmanaged soft-bank pond, quarry lake)	Habitat is common in Singapore (e.g., naturalised river, naturalised stream, managed soft-bank pond, hard-bank pond, reservoir, rain garden, swale, biotope)	Habitat is ubiquitous in Singapore (e.g., concrete drain).
Unique flora and fauna species	The total number of unique flora (vascular aquatic plants including submerged, partially submerged and floating species) and fauna (bird, butterfly, odonate, amphibian, reptile, mammal) species that can be expected to occur in the habitat. Unique species are those that are not typically found in other habitats.	Supports a high number of unique flora and fauna species (> 34 species)	Supports some unique flora and fauna species (23 to 34 unique species)	Supports few unique flora and fauna species (< 23 species)	Does not support any unique flora and fauna species

All plant species were first accorded with a tentative ecological value, i.e., high, medium, or low, based on the following basic framework:

- High ecological value (Priority 1): Species of conservation significance
- Medium ecological value (Priority 2): All other native species
- Low ecological value (Priority 3): Exotic and cryptogenic species

Species are then further evaluated individually based on association with important fauna (Table 7-12).

The ecological value of plant species that directly support the growth and survival of important fauna at one or various life cycle stages were raised to high, irrespective of the plant species origin and conservation status. Examples of such plant species include caterpillar host plants for rare butterfly species and bamboos that are refugia for nationally threatened bamboo bats. The ecological value of plant species without associations with important fauna was maintained at the original level, i.e., medium or low.

There are, however, a few exceptions in which the highest ecological value was automatically assigned to species regardless of the criteria listed below. They are (1) species endemic to Singapore, and (2) keystone fig (*Ficus* sp.) and mangrove species as they fruit all year round and provide a steady source of food for frugivores [P-18]. Additionally, the exotic rain tree (*Samanea saman*) was also automatically raised from low to medium ecological value given that it often supports the growth of epiphytes that provide habitats for fauna.

Table 7-12 Criteria for assessing the ecological value of plant species

Criterion	Definition
Conservation Significance	Listed as nationally threatened, i.e., Vulnerable, Endangered, Critically Endangered, or Extinct, and are considered of conservation significance in this study
Association with Important Fauna	Directly associated with the survival of important fauna at one or various life cycle stages

For the fauna ecological assessment framework, every recorded faunal species was provided an ecological value based on the conservation significance and species origin:

- High ecological value (Priority 1): Species of conservation significance
- Medium ecological value (Priority 2): All other native species
- Low ecological value (Priority 3): Exotic and cryptogenic species

7.4.1 Habitats

The ecological value of five (5) terrestrial habitats, and five (5) aquatic habitats within the Study Area were assessed. Habitats with distinctiveness scoring >7 are considered High ecological value, 6-7 are Medium ecological value, and <6 are Low ecological value.

One terrestrial habitat (native-dominated secondary forest) was assessed to have high ecological value. Two terrestrial habitats (exotic-dominated secondary forest and abandoned-land forest) and two aquatic habitats (unmanaged soft-bank pond and forest or rural stream) were assessed to have medium ecological value. Two terrestrial habitats (scrubland/grassland and urban vegetation) and three aquatic habitats (managed soft-bank pond, naturalised stream, concrete drain / canal) were assessed to have low ecological value. A summary of the assessment of each habitat is shown in Table 7-13.

I. Native-dominated Secondary Forest (High Ecological Value; Priority 1)

Native-dominated secondary forests are regrowth forests that are dominated by native plant species. This habitat type is generally high in flora and fauna species richness (Score 3), although it does not host many unique species (Score 1). Such forests are difficult to replace, due to the length of time required for such forests to re-establish (Score 3). Within Singapore, this habitat type is decreasing, and hence it is assigned a high score for local rarity (Score 3). This habitat type thus has a total score of 10 and is assessed to have high ecological value across all terrestrial habitats in Singapore.

II. Exotic-dominated Secondary Forest (Medium Ecological Value; Priority 2)

Exotic-dominated secondary forests are forests that have previously undergone land clearance and are dominated by exotic tree species such as albizia (*Falcataria falcata*). This habitat generally has moderate flora and fauna species richness (Score 2), and supports few unique flora and fauna species (Score 1). It is also able to support certain species of conservation significance. It is possible to recreate and replace this habitat type via both natural and human-assisted succession, and thus it is given a low score in irreplaceability (Score 1). Nonetheless, this habitat type has been diminishing across Singapore in the recent years due to increasing urbanisation (Score 2). This habitat type thus has a total score of six, and is assessed to have medium ecological value across all terrestrial habitats in Singapore.

III. Abandoned-land Forest (Medium Ecological Value; Priority 2)

Abandoned-land forests are forests that have regrown on abandoned villages, orchards, or plantations, and are usually dominated by cultivated fruit trees and crops, or ornamental plants. Abandoned-land forests generally have moderate flora and fauna species richness (Score 2), supporting few unique flora and fauna species (Score 1). Even though it is possible to recreate and replace this habitat type by means of natural and human-assisted succession, rendering it a low score in irreplaceability (Score 1), this habitat type is uncommon in Singapore (Score 2) due to increasing urbanisation. This habitat type thus has a total score of six and is assessed to have medium ecological value across all terrestrial habitats in Singapore.

IV. Unmanaged soft-bank pond (Medium Ecological Value; Priority 2)

Unmanaged soft-bank ponds refer to waterbodies that are not managed by people. Such a waterbody generally supports a few flora and fauna species (Score 3), although only a few of these species are unique to this habitat type (Score 1). In Singapore, this habitat type is moderately common (Score 2) and can be easily recreated (Score 1) over a short duration (i.e., 5 years or less). This habitat type thus has a total score of seven and is assessed to have medium ecological value across all aquatic habitats in Singapore.

V. Forest or rural stream (Medium Ecological Value; Priority 2)

Forest or rural streams refer to waterbodies that are formed naturally, and usually flow through areas of spontaneous vegetation. Such a waterbody generally supports several flora and fauna species (Score 3), although no species are considered unique to this habitat type (Score 0). In Singapore, this habitat type is moderately common (Score 2), but it is also moderately difficult to recreate (Score 2). This habitat type thus has a total score of seven and is assessed to have medium ecological value across all aquatic habitats in Singapore.

VI. Scrubland / Grassland (Low Ecological Value; Priority 3)

Scrublands and grasslands are open-canopy, level, and continuous areas dominated by grasses (Family Poaceae). Both these habitats are generally low in flora and fauna species richness (Score 1), although it is able to host species that are scrubland and grassland specialists (Score 2). Scrublands and grasslands are generally the first habitat types to establish when land is cleared (Score 1), as most flora species in grasslands are fast-growing, and these two habitat types are hence easily replaced (Score 1). This habitat type thus has a total score of five and is assessed to have low ecological value across all terrestrial habitats in Singapore.

VII. Urban Vegetation (Low Ecological Value; Priority 3)

Urban vegetation refers to areas that are created by and maintained by humans, and may include streetscape vegetation, urban parks and gardens, vegetation within golf courses, and turfed areas. Such areas generally have low flora and fauna species richness (Score 1), with few unique flora and fauna species recorded (Score 0). This habitat type is often encountered within Singapore (Score 1) and can be easily reconstructed, giving it a low score in irreplaceability (Score 1). This habitat type thus has a total score of three and is assessed to have low ecological value across all terrestrial habitats in Singapore.

VIII. Managed soft bank pond (Low Ecological Value; Priority 3)

Managed soft-bank ponds refer to man-made ponds that are usually maintained by people. Such waterbodies may be able to support a number of flora and fauna species (Score 2), but the species it hosts are not unique to such a waterbody (Score 1). This habitat type is common across Singapore (Score 1), and is not difficult to replace (Score 1). This habitat type thus has a total score of five and is assessed to have low ecological value across all aquatic habitats in Singapore.

IX. Naturalised stream (Low Ecological Value; priority 3)

Naturalised streams may have previously been concrete-lined drains, but the concrete base of the drain may have eroded over time, and a layer of substrate is now deposited atop the concrete. The layer of substrate thus facilitates the establishment of vegetation on it, allowing both flora and fauna species to utilise it (Score 2), although not many of these species can be considered specialists of such a habitat (Score 1). Naturalised streams can be recreated (Score 1), and can be observed in multiple places within Singapore (Score 1). This habitat type thus has a total score of five and is assessed to have low ecological value across all aquatic habitats in Singapore.

X. Concrete drain / canal (Low Ecological Value; Priority 3)

Concrete drains and canals are usually fully-lined and are built to meet stormwater drainage needs of the area, and may periodically be dry. Such a habitat type does not host many flora and fauna species (Score 1), although there are species that rely on it (Score 1). As the habitat is man-made, it is easily replaceable (Score 0), and is common throughout Singapore (Score 0). This habitat type thus has a total score of two and is assessed to have low ecological value across all aquatic habitats in Singapore.

Table 7-13 Habitat ecological assessment table

Criterion	Terrestrial Habitats					Aquatic Habitats				
	Native-dominated secondary forest	Exotic-dominated secondary	Abandoned-land forest	Scrubland / Grassland	Urban Vegetation	Unmanaged soft bank pond	Forest or rural stream	Managed soft bank pond	Naturalised stream	Concrete drain / canal
Flora and fauna species richness	3	2	2	1	1	3	3	2	2	1
Irreplaceability	3	1	1	1	1	1	2	1	1	0
Local rarity of habitat	3	2	2	1	1	2	2	1	1	0
Unique flora and fauna species	1	1	1	2	0	1	0	1	1	1
Total score	10	6	6	5	3	7	7	5	5	2
Ecological value	High	Medium	Medium	Low	Low	Medium	Medium	Low	Low	Low

7.4.2 Flora

The ecological value of the 646 plant species and species groups in the Study Area were assessed (Appendix K). Of these, 177 are of high value, 196 of medium value, and 273 of low value.

Altogether, 19 species had their ecological value raised after assessment. One species was raised from low to medium ecological value, while that of 18 species were raised to high from low (11 species) and from medium (7 species).

The sole species raised to medium ecological value from an initial low level is the rain tree (*Samanea saman*). It was given an initial priority level of low before assessment as it is an exotic tree. Rain trees support the growth of many epiphytes which provide different microhabitats for a variety of fauna. Hence, it was raised by one level to medium ecological value.

The ecological value of three bamboo species was raised from low to high. Albeit of exotic origin, *Thyrsostachys siamensis*, *Bambusa heterostachya*, and *Bambusa vulgaris* may be inhabited by bamboo bats that are known to reside within the bamboo internodes, where they roost for long hours. Such bamboo clusters play an important role in the survival of these nationally threatened bat species. Therefore, retaining bamboo clusters in the Study Area is essential in safeguarding local populations that continually face the threat of habitat loss.

The remaining 27 species that had their ecological value raised to high are fig species. Twelve are native threatened species and were therefore accorded an initial level of high, seven are native non-threatened (listed as Least Concern) and were originally accorded medium ecological value, while the remaining eight are of non-native origin and were originally accorded low ecological value. The ecological value of these fig species was raised to or maintained at high as they are keystone species important for the health of entire ecosystems; they produce figs year-round that provide a steady source of food for frugivores [P-18].

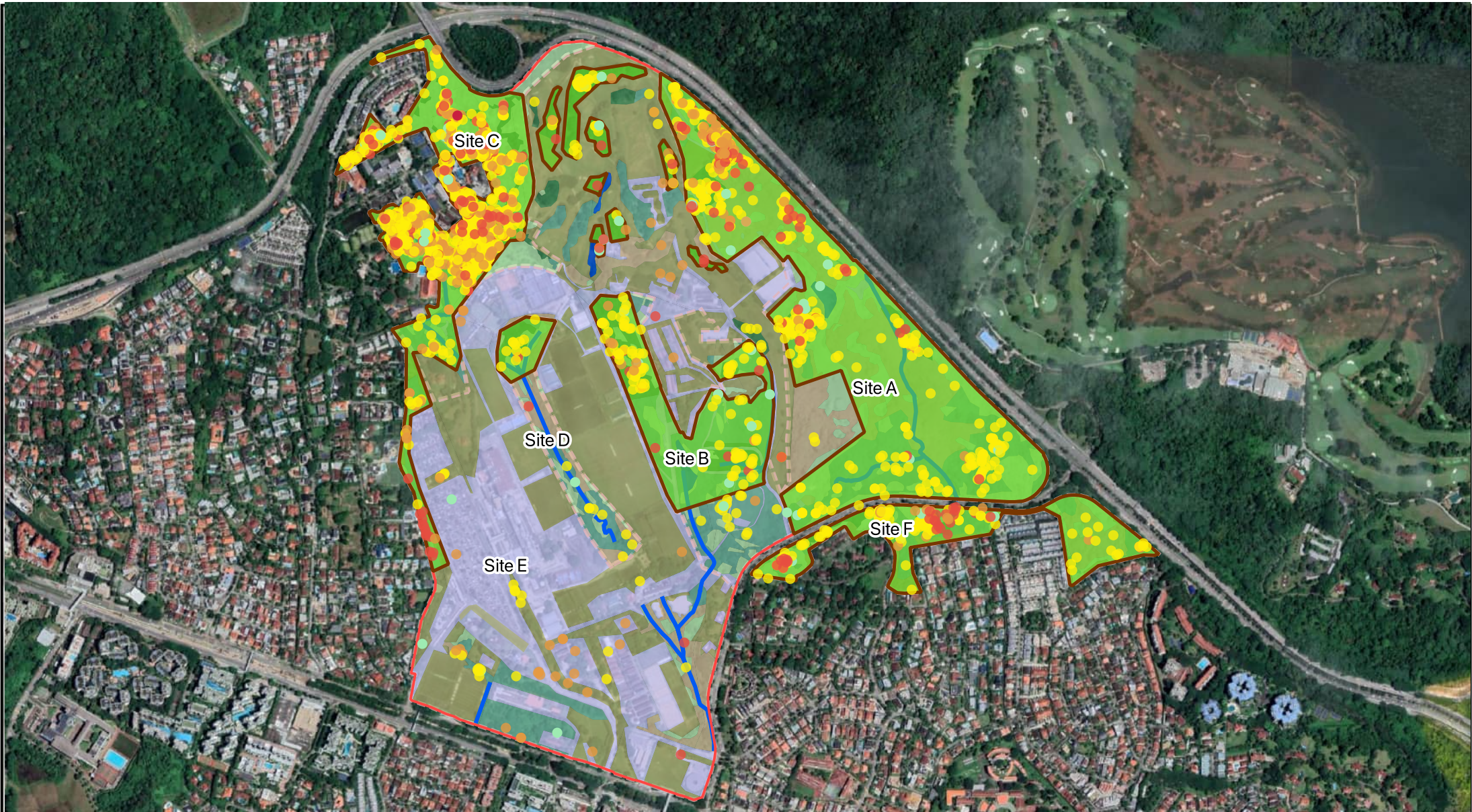
7.4.3 Fauna

The ecological value of 462 species were assessed. Of these, 81 species of conservation significance (recorded and probable) were assessed to be of high ecological value. Both bamboo bat species (*Tylonycteris fulvida* and *T. malayana*), which are nationally Vulnerable, were also identified as sensitive receptors as species level identification is not possible for the bamboo bat recorded during survey. Of the 81 sensitive receptors identified, 25 were recorded during field survey and the remaining 65 were deemed probable in the Study Area. Breaking down the sensitive receptors by taxon, there are 31 birds, 15 odonates, 15 butterflies, 7 aculeate hymenopterans, 7 mammals, 4 herptofauna and 1 fish.

7.5 Areas of High Biodiversity Value

Based on the findings from the biodiversity baseline study, areas of high biodiversity value within the Project Area were identified. An overview of these areas is shown in Figure 7-78 and the justifications for their selection are provided in the following sections.

This area contains plant specimens of conservation significance, large plant specimens, other plant specimens of value (bamboo clusters, trees with raptor nests, keystone species), and/or sensitive habitats such as streams and native-dominated secondary forest. Any construction or habitat enhancement/rehabilitation works within these areas should be carried out sensitively.



Legend

- EIA Study Area
- Site boundary
- Area of high biodiversity value

Vegetation Types

- Native-dominated secondary forest
- Abandoned-land forest
- Exotic-dominated secondary forest
- Scrubland
- Urban vegetation
- Non-vegetated
- Waterbody

Plants of conservation significance

- Critically Endangered
- Endangered
- Vulnerable
- ID not confirmed but likely CS

Rev	Date	By	Description	Chk'd	App'd
-	MAY 2024	CWT	Turf Club EIA	LAL	JAG



Qualified Person Endorsement : NA

URAE endorsement : NA

Consultant : **AECOM**

Project Title :
**CONTRACT URA/T/22/031
 ENVIRONMENTAL IMPACT
 ASSESSMENT (EIA) FOR
 FORMER TURF CLUB AT BUKIT TIMAH**

Designed CWT	Checked LAL	Approved JAG
Drawn	Date MAY 2024	

Client: **URBAN REDEVELOPMENT AUTHORITY**

Figure Title :
IDENTIFIED AREA OF HIGH BIODIVERSITY VALUE

Figure No. : 7-78	Rev. -	Sheet 1 of 1
CAD File Name : NA		A3

Note: Source of basemap - Google Earth Map

Site A

Drawing conclusions from the EIS previously conducted of Site A [R-4], the significance of Site A for both flora and fauna were of paramount importance, not as a habitat but also in facilitating connectivity within the area. This was eventually why LTA ultimately decided to shift all Cross Island Line works out of the site. A summary of reasons for selection of Site A as an area of high biodiversity value (Figure 7-41, Figure 7-74) include:

1. Forest in the south consisting of the native-dominated secondary forest was observed to comprise of late-successional secondary forest species with a cluster of threatened plant species, many of which were suspected to be remnants of the CNNR.
2. Several fauna species of conservation and forest dependent species were recorded, such as the Sunda pangolin (*Manis javanica*), Sunda colugo (*Galeopterus variegatus*), Wagler's pit viper (*Tropidolaemus wagleri*) and red-necked bronzeback (*Dendrelaphis kopsteini*).
3. Waterbodies within the site have been found to support several uncommon/rare faunal such as the firey coraltail (*Ceriagrion chaoi*), emperor (*Anax imperator*) and sapphire flutterer (*Rhyothemis triangularis*).

Site B

Drawing conclusions from the EIS previously conducted of Site B [R-4], other than being important in providing forest connectivity between the larger forest patches to the north (Site C) and the east (Site A), a summary of the reasons for the selection of areas high biodiversity value in Site B (Figure 7-56, Figure 7-74) include:

1. The native-dominated secondary forest and mixed forest were found to contain late-successional secondary forest species and be rich in floral species of conservation significance, some of which are rarely found outside of CCNR.
2. High number of large tree specimens, many of which are host trees to rare epiphytes.
3. Several fauna species of conservation and forest dependent species were recorded utilising the whole site, such as the straw-headed bulbul (*Pycnonotus zeylanicus*), Sunda pangolin (*Manis javanica*) and Sunda colugo (*Galeopterus variegatus*).
4. Natural waterbodies are increasingly uncommon habitats in Singapore—especially natural and naturalised stream-types found such as those within Site A. These waters have been found to support several uncommon/rare fauna such as the common walking catfish (*Clarias cf. batrachus*).

Site C

The reasons for selection of the whole of Site C as an area of high biodiversity value (Figure 7-74) include:

1. The native-dominated secondary forest recorded remarkably high densities of plant specimens of conservation significance. Additionally, observation of plant specimen composition, indicate that the forest is likely to hold remnants of CNNR.
2. Several fauna species of conservation and forest dependent species were recorded utilising the whole site, such as the straw-headed bulbul (*Pycnonotus zeylanicus*), Sunda pangolin (*Manis javanica*), Sunda colugo (*Galeopterus variegatus*) and Wagler's pit viper (*Tropidolaemus wagleri*).

Site D

The reasons for the selection of the areas of high biodiversity value in Site D (Figure 7-78) include:

1. The native-dominated secondary forest with plant specimens of conservation significance.
2. Facilitate as a stepping stone for connectivity and buffer between the areas of high biodiversity in Site C and Site B.

Site E

The reasons for the selection of the areas of high biodiversity value in Site E (Figure 7-78) include:

1. The native-dominated secondary forest within the golf course with high densities of plant specimens of conservation significance and Tembusu trees (*Cyrtophyllum fragrans*) which are suspected to be remnants from CNNR due to large sizes observed.
2. Thin strip of forest outlining the project area on the west contains rare native climber—*Cyclea laxiflora*.
3. Presence of conservation significant fauna species such as Sunda pangolin (*Manis javanica*) utilising the area, indicated by data from camera trap.

Site F

The reasons for the selection of the areas of high biodiversity value in Site F (Figure 7-78) include:

1. The native-dominated secondary forest with high densities of plant specimens of conservation significance.
2. Connectivity for Sunda colugo (*Galeopterus variegatus*) and Sunda pangolin (*Manis javanica*) that have been observed to crossing Eng Neo Avenue to utilise forest patches both in the north and south of the Project Area.

7.6 Identification of Biodiversity Sensitive Receptors

As exact construction worksite and the boundaries of cleared areas cannot be determined at this stage of master planning, it is assumed that all areas apart from those labelled "Forested area with trails" in Figure 3-2 were cleared.

7.6.1 Habitats

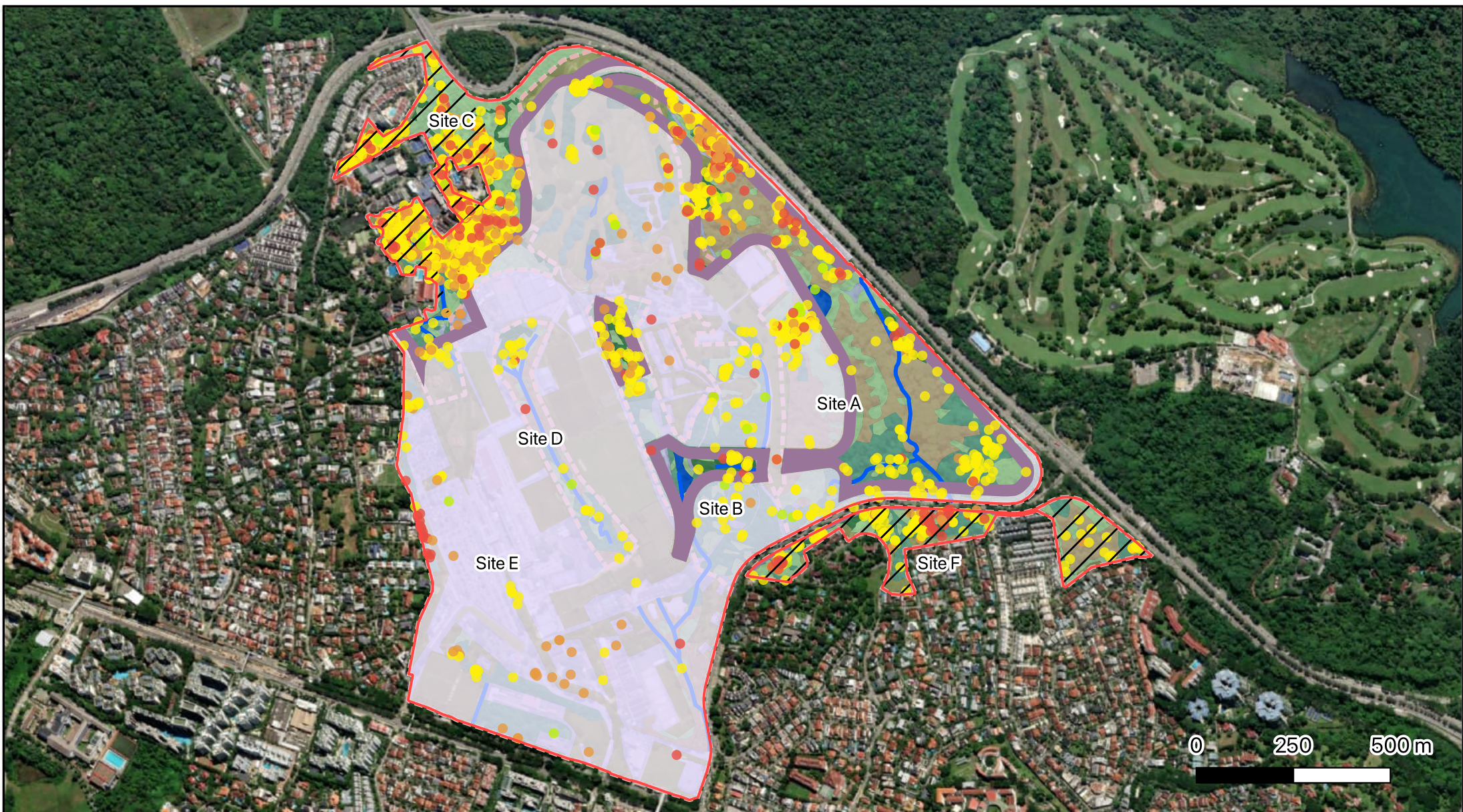
Following the assessment of ecological value of the habitats within the Study Area (Section 7.4.1), all habitats within the worksite and within 30 m from the proposed worksite area were identified as the sensitive habitat receptors (Figure 7-79). As the exact construction worksite and boundaries of cleared areas cannot be determined at this stage of master planning, the conservative approach was taken and it is assumed that all areas apart from those labelled as "Retained Forest with Trails" in Figure 3-2 were cleared.

7.6.2 Flora

Following the assessment of ecological value for all plant species (Section 7.4.2), all plants with high ecological value located inside and within 30 m from the worksites were selected as sensitive receptors for the assessment of ecological impacts (Figure 7-79).

7.6.3 Fauna

Following the assessment of ecological value of faunal species (Section 7.4.3), all species with high ecological value in this study were identified as the sensitive receptors.



Legend EIA Study Area Site boundary Surrounding vegetation outside Turf City Proposed development footprint 30m Impact zone	Plants of Conservation Significance Critically Endangered Endangered Vulnerable ID not confirmed but likely CS Vegetation Types Native-dominated secondary forest Abandoned-land forest Exotic-dominated secondary forest Scrubland Urban vegetation Non-vegetated Waterbody				Qualified Person Endorsement : NA		Consultant : AECOM		Client:				
					URAEndorsement : NA		Project Title : CONTRACT URA/T/22/031 ENVIRONMENTAL IMPACT ASSESSMENT (EIA) FOR FORMER TURF CLUB AT BUKIT TIMAH		Figure Title : IMPACT ZONE FOR HABITAT AND FLORA RECEPTORS				
		Rev.	Date	By	Description	Chk'd	App'd	Designed CWT	Checked LAL	Approved JAG	Figure No. : 7-79	Rev. -	Sheet 1 of 1
			MAY 2024	CWT	Turf Club EIA	LAL	JAG		Drawn CWT	Date MAY 2024	CAD File Name : NA		A3

Note: Source of basemap - Google Earth Map

7.7 Potential Sources of Biodiversity Impacts

Potential impacts to biodiversity arising from construction (Section 3.2) and operational (Section 3.4) activities are assessed in this section.

Some of the existing forested habitats in the northern part of the development boundary will be retained, and lightly developed for recreation (e.g. nature trails). However, most of the existing habitat types will be removed due to the construction. Habitats adjacent to the development boundary are not expected to be directly impacted through loss of vegetation/habitat, indirect impacts, such as habitat degradation and changes in species composition, may also occur.

At the operational phase, the development will be predominantly residential, with supporting amenities. As retained areas will also be developed for recreation, albeit lightly, vehicular and human foot traffic is hence expected to increase, resulting in impacts such as habitat degradation, light disturbance, and human-wildlife conflict.

The impacts were separately assessed for habitats, plant and faunal species. There are two main categories in which the impacts fall into, namely, (1) direct, i.e., impacts to habitats and species within the worksites and (2) indirect, i.e., impacts to habitats and species outside the worksites but within the impact zone. Impact zones for habitat and species receptors are defined as areas within 30 m from worksites of the proposed development, even though there are some studies that found edge effects affecting vegetation up to 150 m from forest boundaries [P-21, P-22, P-23, P-24]. The 30 m impact zone is based on the assumption that edge effects in the forests adjacent to worksites are the greatest within 30 m from the worksites.

Table 7-14 List of ecological impacts

Receptor	Impact Type	Description	Impact Category
Construction Phase			
Habitats	Loss of habitat	Terrestrial habitats: Direct removal of vegetation (with extensive underground root systems that protect against soil erosion) to create space for construction activities Aquatic habitats: Changes in waterbody due to canalisation and diversion activities, and/or changes in hydrology	Direct
	Habitat degradation	Terrestrial habitats: Improper disposal of construction waste, accidental release of hazardous materials (such as construction slurry, paint, and/or solvents) Aquatic habitats: Changes in surface water quality	Indirect
	Formation of edge effects	Changes in microclimatic conditions (such as direct sunlight, temperature, humidity and wind exposure) of the habitat due to vegetation removal.	Indirect
Plant Species	Mortality	Direct removal of vegetation to create space for construction activities	Direct
	Decline in plant health and survival	Changes in microclimatic conditions (i.e., dust, noise, and light, temperature, and humidity) and hydrology or surface water quality	Indirect
Faunal Species	Loss of/reduction in habitats and food sources	Terrestrial habitats: Direct removal of vegetation, nests or roost sites to create space for construction activities Aquatic habitats: Changes in waterbody due to canalisation and diversion activities, and/or changes in hydrology	Direct
	Accidental injury or mortality	Collisions with machineries, entrapments in construction materials (such as non-biodegradable erosion control blankets) and structures (such as exposed pits or drains), and accidental kills by construction personnel, including roadkills	Direct

Receptor	Impact Type	Description	Impact Category
	Human-wildlife conflict	Negative consequences of human-wildlife interactions, such as deliberate killing and depopulation of faunal species perceived as nuisances or threats by construction personnel	Indirect
	Loss/reduction of ecological connectivity for faunal movement	Terrestrial habitats: Habitat fragmentation from the removal of vegetation Aquatic habitats: Changes that impedes connectivity of waterbody	Indirect
	Light disturbances	Increase in light levels from construction activities	Indirect
	Human disturbances	Increase in human traffic flow, such as workers and site personnel	Indirect
Operational Phase			
Habitat	Introduction of exotic species	Accidental and/or intentional release of exotic animals by humans into waterbodies or terrestrial habitats	Indirect
	Changes in microclimatic condition	Changes in microclimatic conditions (such as temperature, light and humidity) of the habitat due to operational activities and/or micro urban heat island from the adjacent development.	Indirect
	Habitat degradation	Terrestrial habitats: Trampling on vegetation or pollution (e.g., litter) from increased human activities Aquatic habitats: Changes in surface water quality	Indirect
Faunal Species	Accidental injury or mortality	Navigation failures into the wrong areas and entrapment in facility structures, including bird collision into buildings (distorted perceptions of reflective surfaces on buildings as flyways, greenery, and/or water) and roadkills	Direct/Indirect
	Human-wildlife conflict	Negative consequences of human-wildlife interactions, such as deliberate killing and depopulation of faunal species perceived as nuisances or threats by members of the public	Direct
	Poaching	Poaching of fauna by humans	Direct
	Loss of ecological connectivity for faunal movement	Terrestrial habitats: Impediment to faunal movement by presence of buildings, infrastructure, and human activity Aquatic habitats: Changes that impedes connectivity of waterbody	Indirect
	Light disturbances	Increase in light levels from development	Indirect
	Human disturbances	Increase in human traffic flow, such as residents and visitors	Indirect

7.8 Minimum Control Measures

This section lists biodiversity-specific minimum control measures that are commonly implemented in Singapore for construction activities. These are assumed to be implemented for the impact assessment and should be proposed in tandem with the measures proposed for other environmental receptors (e.g., water quality, air quality, noise). Minimum controls for each potential impact occurring from the construction and operational phases are listed in Table 7-15.

Table 7-15 Minimum control measures for the construction phase

Work activities	Minimum controls
Construction Phase	
General	<ul style="list-style-type: none"> Install hoarding to delineate and enclose the working area prior to the start of works Environmental Manager to conduct daily checks on site

Work activities	Minimum controls
	<ul style="list-style-type: none"> Execute Wildlife Response Plan when a trapped/ injured/ dead/ dangerous animal is encountered around or within the worksite, according to Section 10 of Wildlife Act Restricted Working Hours (RWH): The Contractor shall ensure that general construction activities are confined to daylight hours (0800—1800 hours) only
Vegetation Clearance	<ul style="list-style-type: none"> Set up Tree Protection Zones (TPZs) around trees or other plant specimens to be retained within the worksites and ensure that no construction works are allowed inside the TPZs. This should be executed by certified Arborists and in accordance with NParks' guidelines Soil erosion control measures are to be implemented once vegetation has been removed and soil is exposed, as described in Section 8.6 under Hydrology and Surface Water Quality and Section 9.6 under Soil and Groundwater
Earthworks	<ul style="list-style-type: none"> Implement soil erosion control measures as described in Section 8.6 under Hydrology and Surface Water Quality Implement dust control measures as described in Section 10.6 under Air Quality Implement noise barrier as described in Section 11.6 under Airborne Noise
Below and Above Ground Construction	<ul style="list-style-type: none"> Ensure proper storage of materials that are likely to leach harmful chemicals and fuel-powered equipment away from waterbodies or sensitive habitats as described in Section 9.6 under Soil and Groundwater (and Waste)
Operational Phase	
General	<ul style="list-style-type: none"> Ensure noise levels are within approved limits (refer to Section 11.6 under Airborne Noise) Ensure dust levels are within approved limits (refer to Section 10.6 under Air Quality) Avoid fogging by implementing preventive measures for mosquito to remove sources of stagnant water or water-bearing receptacles (e.g., provide well-maintained pitched roof, clear discarded items daily, store materials appropriately, level up ground depression/uneven surfaces, ensure effective drainage flow) The Wildlife Act, Section 5, 2020. "A person must not intentionally release any wildlife in any place unless the person has the Director-General's written approval to do so". "A person who contravenes (the above) shall be liable on conviction to a fine not exceeding \$5,000" The Wildlife Act, Section 5, 2020. "A person must not intentionally kill, trap, take or keep any wildlife in any place unless the person has the Director-General's approval to do so". "A person who contravenes (the above) shall be liable on conviction – <ul style="list-style-type: none"> in the case where the offence is committed in respect of a protected wildlife, to a fine not exceeding \$50,000 or to imprisonment for a term not exceeding 2 years or to both; and in any other case – <ul style="list-style-type: none"> for a first offence, to a fine not exceeding \$10,000 or to imprisonment for a term not exceeding 6 months or to both; and for a second or subsequent offence, to a fine not exceeding \$20,000 or to imprisonment for a term not exceeding 12 months or to both."

7.9 Prediction and Evaluation of Biodiversity Impacts

In this section, the identified biodiversity sensitive receptors were evaluated based on impact intensity and likelihood, which eventually gives the impact significance.

The various levels of impact intensity and likelihood for each impact type during construction and operation were specifically defined for the ecologically sensitive receptors. Some assumptions were made in defining the levels of impact intensity.

7.9.1 Construction Phase

The three assumptions made in defining the levels of impact intensity (Table 7-16) and likelihood (Table 7-17) for habitat receptors during the construction phase are:

- Habitats within 30 m from the worksites are assumed to experience the greatest extent of edge effects, although some studies have shown that edge effects could be up to 150 m (refer to Section 7.7 for the definition of the impact zone).
- The likelihood of habit degradation, i.e., improper disposal of construction waste, accidental release of hazardous materials (such as construction slurry, paint, and/or solvents), increase in dust, noise, and light levels, changes in forest hydrology, is presumed to be **Less Likely** for all habitat receptors, based on the assumption that all minimum controls (Section 7.8) are adequately and properly implemented.

- Formation of edge effects is not assessed for scrublands and grasslands, as these habitats are typical to an edge habitat.

Table 7-16 Definitions of each level of impact intensity for all three impact types during construction for habitat receptors

Impact Type	Negligible	Low	Medium	High
Loss of habitat	The habitat does not overlap with the worksites	≤ 10% of the habitat overlaps with the worksites	10–40% of the habitat overlaps with the worksites	> 40% of the habitat overlaps with the worksites
Formation of edge effects	The habitat does not overlap with the worksites	≤ 10% increase in perimeter to area ratio of the habitat due to the worksites	10–40% increase in perimeter to area ratio of the habitat due to the worksites	> 40% increase in perimeter to area ratio of the habitat due to the worksites
Habitat degradation	Terrestrial habitat The habitat type does not overlap with areas 30 m from the worksites	Terrestrial habitat ≤ 10% of the habitat type overlaps with areas 30 m from the worksites	Terrestrial habitat 10–40% of the habitat type overlaps with areas 30 m from the worksites	Terrestrial habitat > 40% of the habitat type overlaps with areas 30 m from the worksites
	Aquatic habitat No change in surface water quality	Aquatic habitat Some changes in surface water quality	Aquatic habitat Considerable changes in surface water quality	Aquatic habitat Extensive changes in surface water quality

Table 7-17 Definitions of each level of likelihood for all three impact types during construction for habitat receptors

Likelihood	Loss of habitat	Formation of edge effects	Habitat degradation
Unlikely/Remote	The habitat does not overlap with the worksites	The habitat does not overlap with the worksites	N.A.
Less Likely/Rare	N.A.	The worksites are small (e.g., trails, boardwalks) and/or is not expected to change vegetation structure significantly to effect changes in microclimatic conditions (e.g., minimal tree or vegetation removal)	N.A. (see assumption above)
Possible/Occasional	N.A.	The worksites are of considerable size (e.g., single lane roads) and/or is expected to change some vegetation structure significantly to effect changes in microclimatic condition (e.g., some tree or vegetation removal)	N.A.
Likely/Regular	N.A.	The worksites are large (e.g., buildings, multiple lane roads) and/or is expected to change vegetation structure significantly to effect changes in microclimatic	N.A.

Likelihood	Loss of habitat	Formation of edge effects	Habitat degradation
		conditions (e.g., extensive tree or vegetation removal)	
Certain/ Continuous	The habitat overlaps with the worksites	N.A.	N.A.

Assumptions made in defining the levels of impact intensity (Table 7-18) for plant species receptors during the construction phase:

- Habitats within 30 m from the worksites are assumed to experience the greatest extent of edge effects, though some studies have shown that edge effects could be up to 150 m (refer to Section 7.7 for the definition of the impact zone). The effects of forest edges may be experienced by species more sensitive to microclimatic changes more than 30 m away from the worksites; these are considered during species-specific impact evaluations.
- For some fig species (i.e., native species that are not considered of conservation significance, exotic, or cryptogenic species) that are known to be locally widespread, it was assumed that the intensity of impacts of work activities on them is **Negligible**. The impacts, however, will still be considered specifically for each species during evaluation (e.g., *Ficus heteropleura* and *Ficus punctata*).

Table 7-18 Definitions of each level of impact intensity for all four impact types during construction for plant species receptors

Impact Type	Negligible	Low	Medium	High
Mortality	No plant specimens of this species are within the worksites	Less than 50% of all plant specimens of this species are within the worksites	More than or exactly 50% of all plant specimens of this species are within the worksites	All plant specimens of this species are within the worksites
Decline in plant health and survival	No specimens of this species are within 30 m from the worksites	Less than 50% of all plant specimens of this species are within 30 m from the worksites	More than or exactly 50% of all plant specimens of this species are within 30 m from the worksites	All specimens of this species are within 30 m from the worksites

Table 7-19 Definitions of each level of likelihood during construction for plant species receptors

	Mortality	Decline In Plant Health And Survival
Unlikely/Remote	No plant specimens of this species are within the worksites	No formation of forest edges (i.e., construction activities are fully underground and/or in existing built-up areas outside the forest)
Less Likely/ Rare	N.A.	Formation of scrubland edges in scrubland areas only
Possible/ Occasional	No count data and/or locations of specimens of this species is available, but specimens could possibly be within the worksites	Formation of some forest and scrubland edges in a mix of urban vegetation, scrubland and forested areas
Likely/ Regular	N.A.	Formation of new forest edges (i.e., complete clearance within forested areas)
Almost Certain/ Continuous	Plant specimens of this species are within the worksite	N.A.

The definitions for impact intensity and likelihood for faunal species at construction phase are presented in Table 7-20 and Table 7-21, respectively.

Table 7-20 Definitions of level of impact intensity for all five impact types during construction for faunal species receptors

Impact Type	Negligible	Low	Medium	High
Loss of/reduction in habitats and food sources	No loss of original habitat, raptor nests, or roosts	Loss of <10% of original habitat, or roosts	Loss of 10–40% of original habitat, or roosts	Loss of >40% of original habitat or roosts; loss of any raptor nests
Injury or mortality	Species with negligible susceptibility to accidental injury/mortality from construction activities (large vehicles, excavation, piling, etc.) and roadkills	Species with low susceptibility to accidental injury/mortality from construction activities (large vehicles, excavation, piling, etc.) and roadkills: – Volant species (e.g., odonates, butterflies, highly volant birds, most bats) – Aquatic species (most fishes, crabs, shrimps)	Species that are mobile but possibly susceptible to accidental injury/mortality from construction activities (large vehicles, excavation, piling, etc.) and roadkills: – Less volant birds – All amphibians – Some mammals (e.g., squirrels, shrews)	Species with high susceptibility to accidental injury/mortality from construction activities (large vehicles, excavation, piling, etc.) and roadkills: – Reptiles – Some mammals (e.g., Sunda pangolin, long-tailed macaque, smooth otter)
Loss/reduction of ecological connectivity for faunal movement	<u>Terrestrial habitat</u> Not dependent on connected habitats for dispersal and able to traverse urban infrastructure <u>Aquatic habitat</u> No change to waterbody	<u>Terrestrial habitat</u> Slightly dependent on connected habitats for dispersal and adaptable to traverse urban infrastructures if needed <u>Aquatic habitat</u> Minimal changes in waterbody that may affect connectivity for aquatic species	<u>Terrestrial habitat</u> Dependent on connected habitats for dispersal <u>Aquatic habitat</u> Some changes in waterbody that may affect connectivity for aquatic species	<u>Terrestrial habitat</u> Highly dependent on connected habitats for dispersal <u>Aquatic habitat</u> Considerable changes in waterbody that may affect connectivity for aquatic species
Light disturbances	Species that are not sensitive to changes in light levels: aculeate hymenopterans, most aquatic and marine species	Species that are slightly sensitive to changes in light levels: odonates, butterflies	Species that are sensitive to changes in light levels: diurnal birds, reptiles and mammals	Species that are extremely sensitive to changes in light levels: nocturnal, crepuscular fauna and migratory birds

Impact Type	Negligible	Low	Medium	High
Human disturbances	Species that are not sensitive to human presence	Species that are slightly sensitive to human presence	Species that are sensitive to human presence	Species that are extremely sensitive to human presence

Table 7-21 Definitions of each level of likelihood for all five impact types during construction for faunal species receptors

Impact Type	Loss of/ reduction in habitats and food sources	Accidental injury or mortality	Human-wildlife conflict	Loss of/ reduction in ecological connectivity for faunal movement	Light disturbances	Human disturbances
Unlikely/ Remote	Impact is not expected to happen during the construction phase of the project					
Less Likely/ Rare	Impact is not likely to happen during the construction phase of the project					
Possible/ Occasional	Impact could possibly happen or known to occur during the construction phase of the project					
Likely/ Regular	Impact is a common occurrence during the construction phase of the project					
Almost Certain/ Continuous	Impact is a continual or repeated process during the construction phase of the project					

7.9.1.1 Habitats

Three construction phase impacts were identified and assessed for habitat receptors: (1) loss of habitat, (2) habitat degradation, and (3) formation of edge effects. The impact significance ranged from **Negligible** to **Major**. Only the most substantive impact for each impact type is presented. Calculations required for the assessment of impact intensity is given in Table 7-22, and a summary of habitat receptors impacted during the construction phase is shown in Table 7-23. For the full habitat impact assessment, refer to Appendix L.

7.9.1.1.1 Loss of habitat

Vegetation clearance will impact all habitat types except the unmanaged soft-bank ponds at Site A. Based on the size of site clearance, the impact significance will be **Major** for native-dominated secondary forests, abandoned-land forests within the Study Area. The impact significance will also be **Moderate** for exotic-dominated secondary forests, managed ponds (D7, D8, D9), naturalised stream (D11, D12, D14, D15), and concrete drain / canals (D16) within the Study Area. Notably, the managed ponds at the golf course (D8, D9) will be completely cleared for construction.

7.9.1.1.2 Habitat degradation

The likelihood of habitat degradation occurring is taken as **Less likely** for all habitat types, assuming the key minimum controls are followed. This includes the proper storage of materials which are likely to leach harmful chemicals and storing them away from waterbodies and/or sensitive habitats. Hoarding or silt fence should also be constructed and maintained to prevent accidental vegetation clearance. With that, the impact significance of this impact is **Negligible to Minor**.

7.9.1.1.3 Formation of edge effects

The likelihood of the formation of edge effects for habitat receptors was deemed to be **Likely**, as there will be extensive vegetation removal during the construction phase. Based on the proposed preliminary land use plan footprint, less than 10% increase in exposed forest edges is expected. Therefore, **Moderate** impact significance to

native-dominated secondary forests and **Minor** impact significance is expected for the remaining habitats in the Study Area.

Table 7-22 Summary of calculations to assess the direct and indirect impact intensity experienced by habitat receptors within the Study Area during construction phase

Habitat receptor	Direct impact	Indirect impact
	$\left(\frac{\text{Habitat directly cleared (ha)}}{\text{Original habitat size (ha)}}\right)$	$\left(\frac{\text{Habitat 30m from worksite (ha)}}{\text{Original habitat size (ha)}}\right)$
Native-dominated secondary forest	5.2 ha (30.7%)	4.2 ha (35.8%)
Abandoned-land forest	17.2 ha (54.9%)	5.3 ha (37.2%)
Exotic-dominated secondary forest	8.8 ha (38.6%)	2.9 ha (20.8%)
Scrubland / Grassland	8.7 ha (34.8 %)	5.4 ha (32.9 %)
Urban vegetation	48.3 ha (90.4%)	3.6 ha (69.2%)
Unmanaged pond (D4)	0 ha (0%)	0.06 ha (21.3 %)
Managed pond (D8, D9)	0.29 ha (100 %)	0 ha (0 %)
Forest stream (D1)	0.02 ha (7.5 %)	0.02 ha (8.1 %)
Naturalised stream (D7, D11, D12, D14, D15)	0.25 ha (39.5%)	0.07 ha (19.3 %)
Concrete drain / canal (D16)	0.05 ha (52.9%)	0.04 ha (91.7%)

Table 7-23 Summary of construction phase impacts to habitat receptors

Impact Type	Impact Significance			
	Major	Moderate	Minor	Negligible
Loss of habitat	<ul style="list-style-type: none"> Native-dominated secondary forest Abandoned-land forest 	<ul style="list-style-type: none"> Exotic-dominated secondary forest Managed pond (D8, D9) Concrete drain / canal (D16) Naturalised stream (D7, D11, D12, D14, D15) 	<ul style="list-style-type: none"> Scrubland / Grassland Forest or rural stream (D1) Urban vegetation 	<ul style="list-style-type: none"> Unmanaged pond (D4)
Habitat degradation	<ul style="list-style-type: none"> N.A. 	<ul style="list-style-type: none"> N.A. 	<ul style="list-style-type: none"> Native-dominated secondary forest Abandoned-land forest Exotic-dominated secondary forest Urban vegetation Unmanaged pond (D4) Concrete drain / canal (D16) 	<ul style="list-style-type: none"> Scrubland / Grassland Forest or rural stream (D1) Naturalised stream (D7, D11, D12, D14, D15) Managed pond (D8, D9)
Formation of edge effects	<ul style="list-style-type: none"> N.A. 	<ul style="list-style-type: none"> Native-dominated secondary forest 	<ul style="list-style-type: none"> Exotic-dominated secondary forest Abandoned-land forest Forest or rural stream (D1) Naturalised stream (D7, D11, D12, D14, D15) Managed pond (D8, D9) Concrete drain / canal (D16) 	<ul style="list-style-type: none"> Scrubland / Grassland Urban vegetation

7.9.1.2 Flora

In the assessment of the two impact types for individual species during the construction phase—(1) mortality, and (2) decline in plant health and survival—the impact significance was negligible, low, moderate, or major. Only the most severe impact for each species from the assessment of the two impact types is presented.

A total of 108 sensitive plant species receptors recorded in the Study Area were selected for the assessment of ecological impacts (refer to Section 7.6.2 on how the sensitive receptors were selected). The significance of the impacts is **Major** for 37 species, **Moderate** for 34 species, and **Minor** for 37 species (Appendix M).

The 37 species are likely to experience **Major** impacts owing to mortality.

- 1) Of the 37 species, 16 have 100% of all recorded specimens located within the proposed worksite, giving an impact intensity of **High**. All 16 have high ecological value (**Priority 1**) as they are species of conservation significance. As it is **Almost Certain** (likelihood) that these specimens would be removed for construction activities, the resulting impact significance is therefore **Major**.
- 2) The other 21 species likely to experience **Major** impacts have 50% or more of all specimens located within the proposed worksite, which gives an impact intensity of **Medium**. All of these species have high ecological value (**Priority 1**), i.e., are species of conservation significance, keystone *Ficus* species, and/or bamboo species associated with bamboo bats. As it is **Almost Certain** (likelihood) that the specimens would be removed for construction activities, the resulting impact significance is also **Major**.

The 34 species likely to experience **Moderate** impacts are owing mortality.

- 1) All 34 species likely to experience **Moderate** impacts as a result of mortality have less than 50% of all specimens for each species recorded within the worksite, which gives an impact intensity of **Low**. They are also all of conservation significance (32 species) and/or bamboo species (2 species) with high ecological value (**Priority 1**). Since it is **Almost Certain** (likelihood) that these specimens would be removed for construction activities, the impact significance for all 33 species is **Moderate**.

The remaining 37 species are likely to experience **Minor** impacts owing to decline in plant health and survival as the likelihood of the impacts occurring is **Unlikely** or **Less Likely**, respectively. Hence, the impact significance for these species is **Minor**, respectively.

7.9.1.3 Fauna

Six (6) construction phase impacts were identified and assessed for faunal receptors: (1) loss of or reduction in ecological connectivity for faunal movement, (2) accidental injury or mortality, (3) human disturbances, (4) human-wildlife conflict, (5) light disturbance, and (6) loss of or reduction in ecological connectivity for faunal movement. The impact significance ranges from Negligible to Major. The key impacts arising from each impact type are briefly summarised below. A summary of the impacts to fauna receptors is given in Table 7-24 and the detailed assessment in Appendix N.

Table 7-24 Summary of construction phase impacts to fauna receptors

Impact type	No. of Species			
	Major	Moderate	Minor	Negligible
Loss of/ reduction in habitats and food sources	67	13	1	-
Accidental injury or mortality	-	9	72	-
Human disturbance	-	38	35	8
Human-wildlife conflict	-	9	7	65
Light disturbance	20	53	-	8
Loss of/reduction of ecological connectivity	-	48	23	10

7.9.1.3.1 Loss of or reduction in habitat or food source

Site clearance for the development of the Study Area will lead to habitat loss. With the exception of Retained Forest with Trails, everything within the proposed preliminary land use plan is assumed to be fully cleared. This includes Urban Vegetation which, while the intentions are to retain as much vegetation as possible, given that these areas are expected to have more construction activity, a conservative assumption of zero retention was made for the sake of this study. Areas outside of the proposed preliminary land use plan footprint (North of Site C and Site F) are assumed to be fully retained. Therefore, likelihood of this impact is **Certain**. With more than 30% habitat loss across all habitat types, 67 fauna species is expected to have **Major** impact significance and 13 will have **Moderate** impact significance. Species with Major impact significance are mostly species with more than 40% loss of suitable habitat or roost. The two (2) species with Minor impacts are the will-o-wisp and spoon-tailed duskhawker which utilises the unmanaged soft-bank pond, a habitat in Site A that will not be cleared under the current proposed preliminary land use plan.

7.9.1.3.2 Accidental injury or mortality

Accidental injury or mortality of fauna during construction phase was deemed **Moderate** for nine (9) species. This include reptiles that are unable to quickly move away from danger, such as the black-headed collared snake (*Sibynophis melanocephalus*) and Malayan box terrapin (*Cuora amboinensis*). Mobile species like the long-tailed macaque (*Macaca fascicularis*), smooth otter (*Lutrogale perspicillata*) and Sunda pangolin (*Manis javanica*) may enter the worksite and risk being trapped. Therefore, they are susceptible to accidental injury. With the minimum control measure of conducting fauna inspections before any vegetation clearance, the impact significance for these species is **Moderate**. Clear demarcation of working area is required as part of the minimum control measure to avoid damaging any retained bamboo clusters which may house bamboo bats (*Tylonycteris* spp.). Impact significance is **Moderate** for bamboo with the minimum controls in place.

7.9.1.3.3 Human disturbance

Human disturbance at the construction phase has **Negligible** to **Moderate** impacts. Species not adversely impacted by human presence such as butterflies, odonates, and long-tailed macaques (*Macaca fascicularis*) have Negligible to Low impact intensity, hence the overall impact significance is **Minor** (38 species). Aculeate hymenopterans are not sensitive to human presence, the impact significance is **Negligible** (5 species). Species with Moderate (38 species) impact range from slightly sensitive species like the smooth otter (*Lutrogale perspicillata*) to extremely sensitive species like the greater green leafbird (*Chloropsis sonnerati*) and Sunda slow loris (*Nycticebus coucang*).

7.9.1.3.4 Human-wildlife conflict

Human-wildlife conflict between faunal species and construction site personnel is deemed to be **Negligible** for species not perceived as nuisances or threats to construction personnel, such as butterflies, odonates, birds and some reptiles that would normally avoid human presence. Human-wildlife interactions may escalate into conflicts for nuisance species, such as long-tailed macaques (*Macaca fascicularis*), which may be attracted to food waste or other materials within the worksite. A lack of understanding regarding how to safely interact with wildlife like the smooth otter (*Lutrogale perspicillata*) may also lead to conflict. The black-headed collared snake (*Sibynophis melanocephalus*) is a species that may elicit fear in construction personnel when encountered, inviting conflict. Aculeate hymenopterans which include bees and stinging wasps may run into conflict especially when its nests are disturbed. Therefore, the impact significance is **Moderate** for these nine (9) species and wildlife response plan should be in plan as part of the minimum control.

7.9.1.3.5 Light disturbance

Disturbance from light is likely to result in **Major** impact for 20 species and **Moderate** impact for 53 species. With the occurrence of night works, species extremely sensitive to changes in light levels such as the Sunda slow loris (*Nycticebus coucang*), spotted wood owl (*Strix seloputo*), buffy fish owl (*Ketupa ketupu*), bats and Malayan box terrapin (*Cuora couro*) will experience high impact intensity and hence **Major** impacts. Species that migrate at night such as the violet cuckoo (*Chrysococcyx xanthorhynchus*) is also expected to experience **Major** impact significance. Other species less sensitive to light level includes diurnal birds, reptiles and mammals which are expected to experience **Moderate** impact significance.

7.9.1.3.6 Loss of or reduction of ecological connectivity

Loss of or reduction of ecological connectivity is predicted to result in **Negligible to Moderate** impact significance. Ground dwelling animals such as the Sunda pangolin (*Manis javanica*) and black-headed collared snake (*Sibynophis melanocephalus*) are expected to experience High impact intensity from the development of the Study Area. Through the construction of infrastructures, widening of roads and removal of connecting habitats, animals that are unable to travel across vegetated areas will experience **Moderate** impact (48 Species). Aquatic species such as the crescent betta (*Betta imbellis*) will also experience **Moderate** impact due to its high dependency on connected habitats for dispersal. Fauna species with higher mobility such as bees, wasps, some birds and butterfly, as well as the smooth otter (*Lutrogale perspicillata*) and long-tailed macaque (*Macaca fascicularis*) are still able to travel across infrastructure, therefore impact significance is **Minor** (23 species). Lastly species like the plume-toed swiftlet (*Collocalia affinis*) and plain palm dart (*Cephrenes acalle niasicus*) are not dependent on connected habitats for dispersal and are able to traverse through urban spaces. Therefore, they experience **Negligible** (10 species) impact significance.

7.9.2 Operational Phase

The tables below state the definitions of impact intensity and likelihood of the respective impact types on the habitat and species receptors, respectively.

Table 7-25 Definitions of each level of impact intensity for all three impact types during operational phase for habitat receptors

Impact type	Negligible	Low	Medium	High
Habitat degradation	<u>Terrestrial habitat</u> The habitat type does not overlap with areas 30 m from the development	<u>Terrestrial habitat</u> ≤ 10% of the habitat type overlaps with areas 30 m from the development	<u>Terrestrial habitat</u> 10–40% of the habitat type overlaps with areas 30 m from the development	<u>Terrestrial habitat</u> > 40% of the habitat type overlaps with areas 30 m from the development
	<u>Aquatic habitat</u> No change in surface water quality	<u>Aquatic habitat</u> Some changes in surface water quality	<u>Aquatic habitat</u> Considerable changes in surface water quality	<u>Aquatic habitat</u> Extensive changes in surface water quality
Introduction of exotic species	The habitat is already exotic-dominated such that introduction of exotic species has no impact on the habitat	The habitat is already exotic-dominated such that introduction of exotic species has some impact on the habitat	Introducing exotic species will change the balance of exotic vs native species within the habitat	Introducing exotic species will be detrimental to the native-dominated habitat
Change in microclimatic conditions	The habitat type does not overlap with areas 30 m from the development	≤ 10% of the habitat type overlaps with areas 30 m from the development	10–40% of the habitat type overlaps with areas 30 m from the development	> 40% of the habitat type overlaps with areas 30 m from the development

Table 7-26 Definitions of each level of likelihood for all three impact types during operational for habitat receptors

Likelihood	Habitat degradation	Introduction of exotic species	Change in microclimatic conditions
Unlikely/ Remote	Developed area is not accessible to public. Surrounding natural habitats are not accessible to public	Developed area is not accessible to public. Aquatic habitats are not accessible to public	Development is largely green and human activity is limited (e.g., Thomson Nature Park)

Likelihood	Habitat degradation	Introduction of exotic species	Change in microclimatic conditions
Less likely/ Rare	Developed area is designed with the intention for the public to use or visit. Surrounding natural habitats are accessible but public use is restricted/controlled	Developed area is designed with the intention for the public to use or visit. Aquatic habitats are accessible but public use is restricted/controlled	Development involves the building of urban structures but will be heavily landscaped (e.g., Gardens by the Bay)
Possible/ Occasional	Developed area is designed for members of the public to visit. Surrounding natural habitats are accessible and have infrastructure for the public to use, such as boardwalks (but people can still stray off track)	Developed area is designed for members of the public to visit. Aquatic habitats are accessible	Development involves the building of structures that are designed to release heat, light, noise or dust (e.g., ventilation shafts)
Likely/Regular	Developed area and surroundings are designed for large groups of people to live or work in the long run. Surrounding natural habitats are easily accessible and do not have infrastructure for the public to use, such as boardwalks (thus public are off track)	Developed area and surroundings are designed for large groups of people to live or work in the long run. Aquatic habitats are easily accessible	Development involves the building of extensive pavements, structures, and other infrastructure with surfaces that absorb and retain heat, constantly produce dust and noise disturbances (e.g., residential estate)
Certain/ Continuous	N.A.	N.A.	N.A.

Table 7-27 Definitions of each level of impact intensity for all four impact types during operational phase for faunal species receptors

Impact Type	Negligible	Low	Medium	High
Accidental injury or mortality	Species with negligible susceptibility to accidental injury/mortality from operation activities, roadkills, and collision with buildings	Species with low susceptibility to accidental injury/mortality from operation activities, roadkills, and collision with buildings: <ul style="list-style-type: none"> Birds with low susceptibility to collision with buildings Volant species (e.g., odonates, butterflies, raptors and frugivorous bats) Aquatic species (most fishes, crabs, shrimps)	Species that are mobile but possibly susceptible to accidental injury/mortality from operation activities and roadkills, and collision with buildings: <ul style="list-style-type: none"> Birds that are possibly susceptible to collision with buildings (e.g., resident species with known records of bird-building collisions) All amphibians 	Species with high susceptibility to accidental injury/mortality from operation activities and roadkills, and collision with buildings: <ul style="list-style-type: none"> Birds with high susceptibility to collision with buildings (e.g., forest-edge frugivores, migratory species) Reptiles Some mammals (e.g., Sunda pangolin, long-tailed macaque, smooth otter)

Impact Type	Negligible	Low	Medium	High
			<ul style="list-style-type: none"> Some mammals (e.g., squirrels, shrews) Insectivorous bats (susceptible to roadkills as they are attracted to insects that are attracted to street lamps) 	
Human disturbance	Species that are not sensitive to human presence	Species that are slightly sensitive to human presence	Species that are possibly sensitive to human presence	Species that are sensitive to human presence
Human-wildlife conflict	<p>Species that are not perceived as nuisances or threats by members of the public:</p> <ul style="list-style-type: none"> Odonates Butterflies Most birds Aquatic species 	<p>Species that are possibly perceived as both nuisances and threats by members of the public, less tolerant of human presence and urban environments:</p> <ul style="list-style-type: none"> Some reptiles Most amphibians Most bats 	<p>Species that are typically perceived as nuisances and possibly as threats by members of the public, highly tolerant of human presence and urban environments, and frequently implicated in human-wildlife conflict:</p> <ul style="list-style-type: none"> Smooth otter Red junglefowl <p>Aculeate hymenopterans</p>	<p>Species that are typically perceived as both nuisances and threats by members of the public, highly tolerant of human presence and urban environments, and are frequently implicated in human-wildlife conflict:</p> <ul style="list-style-type: none"> Long-tailed macaque Some snakes
Light disturbances	Species that are not sensitive to changes in light levels: aculeate hymenopterans, aquatic and marine species	Species that are slightly sensitive to changes in light levels: odonates, butterflies	Species that are sensitive to changes in light levels: diurnal birds, reptiles, and mammals	Species that are highly sensitive to changes in light levels: nocturnal, crepuscular fauna
Loss of/ reduction of ecological connectivity for fauna movement	<p><u>Terrestrial habitat</u> Not dependent on connected habitats for dispersal and able to traverse urban infrastructure</p> <p><u>Aquatic habitat</u> No change to waterbody</p>	<p><u>Terrestrial habitat</u> Slightly dependent on connected habitats for dispersal and adaptable to traverse urban infrastructures if needed</p> <p><u>Aquatic habitat</u> Minimal changes in waterbody that may affect connectivity for aquatic species</p>	<p><u>Terrestrial habitat</u> Dependent on connected habitats for dispersal</p> <p><u>Aquatic habitat</u> Some changes in waterbody that may affect connectivity for aquatic species</p>	<p><u>Terrestrial habitat</u> Highly dependent on connected habitats for dispersal</p> <p><u>Aquatic habitat</u> Considerable changes in waterbody that may affect connectivity for aquatic species</p>

Impact Type	Negligible	Low	Medium	High
Poaching	Species with negligible susceptibility to poaching	Species with low susceptibility to poaching; not commonly known to be traded as pets	Species that are possibly susceptible to poaching; commonly traded as pets	Species that are highly susceptible to poaching; listed on CITES Appendix I or II

Table 7-28 Definitions of each level of likelihood for all five impact types during operational for faunal species receptors

Impact Type	Injury or Mortality	Loss of Ecological Connectivity for Faunal Movement	Light Disturbances	Human Disturbances
Unlikely/Remote	Impact is not expected to happen during the operational phase of the project			
Less Likely/Rare	Impact is not likely to happen during the operational phase of the project			
Possible/Occasional	Impact could possibly happen or known to occur during the operational phase of the project			
Likely/Regular	Impact is a common occurrence during the operational phase of the project			
Certain/Continuous	Impact is a continual or repeated process during the operational phase of the project			

7.9.2.1 Habitats

Three operational phase impacts were identified and assessed for habitat receptors: (1) habitat degradation, (2) introduction of exotic species, and (3) change in microclimatic conditions. The impact significance ranged from **Negligible** to **Major**. Only the most substantive impact for each impact type is presented. Calculations required for the assessment of impact intensity is given in Table 7-29. During operation phase, due to the complete removal of managed ponds (D8, D9), this habitat type is not assessed. For the full habitat impact assessment, refer to Appendix L.

7.9.2.1.1 Habitat degradation

The likelihood of habitat degradation is **Possible** as the retained area is designed for members of the public to visit. Based on the size of the area affected, the impact is **Moderate** impact on native-dominated secondary forest and **Minor** impacts are expected for the other habitat type in the Study Area.

7.9.2.1.2 Introduction of exotic species

The likelihood of exotic species being introduced is expected to be **Likely**, as the future development will bring large groups of people near the retained habitat receptors, and aquatic habitats would be accessible. A **Major** impact significance is expected for native-dominated secondary forests, and **Moderate** for the unmanaged pond (D4) and forest stream (D1) within the Study Area as habitat types are currently dominated by native species, and the introduction of exotic species may outcompete the native biodiversity. The scrubland, concrete drain / canal (D16) and naturalised stream (D11, D12, D14, D15) are expected to have **Minor** impact.

7.9.2.1.3 Change in microclimatic conditions

Changes to the microclimatic conditions for habitat receptors was deemed to be **Likely**, as there would be an increase in infrastructure and disturbance from constant dust and noise production from the future development. The impact significance for native-dominated secondary forests, abandoned-land forests, exotic-dominated secondary forests, urban vegetation, unmanaged pond (D4) and concrete drain / canal (D16) are expected to be **Moderate**. **Minor** impact is expected for the remaining habitat types.

Table 7-29 Summary of calculations to assess the indirect impact intensity experienced by habitat receptors within the Study Area during operational phase

Habitat receptor	Indirect impact (% of total habitat type within study area)
Native-dominated secondary forest	4.2 ha (35.8%)
Abandoned-land forest	5.3 ha (37.2%)
Exotic-dominated secondary forest	2.9 ha (20.8%)
Scrubland / Grassland	5.4 ha (32.9 %)
Urban vegetation	3.6 ha (69.2 %)
Unmanaged pond (D4)	0.06 ha (21.3 %)
Managed pond (D8, D9)	0 ha (0%)
Forest stream (D1)	0.02 ha (8.1 %)
Naturalised stream (D7, D11, D12, D14, D15)	0.07 ha (19.3 %)
Concrete drain / canal (D16)	0.04 ha (91.7 %)

Table 7-30 Summary of operational phase impacts to habitat receptors

Impact Type	Impact Significance			
	Major	Moderate	Minor	Negligible
Habitat degradation	<ul style="list-style-type: none"> • NA 	<ul style="list-style-type: none"> • Native-dominated secondary forest 	<ul style="list-style-type: none"> • Abandoned-land forest • Exotic-dominated secondary forest • Forest or rural stream (D1) • Scrubland / Grassland • Urban vegetation • Unmanaged pond (D4) • Concrete drain / canal (D16) • Naturalised stream (D7, D11, D12, D14, D15) 	<ul style="list-style-type: none"> • NA
Introduction of exotic species	<ul style="list-style-type: none"> • Native-dominated secondary forest 	<ul style="list-style-type: none"> • Unmanaged pond (D4) • Forest or rural stream (D1) 	<ul style="list-style-type: none"> • Scrubland / Grassland • Concrete drain / canal (D16) • Naturalised stream (D7, D11, D12, D14, D15) • 	<ul style="list-style-type: none"> • Abandoned-land forest • Exotic-dominated secondary forest • Urban vegetation
Change in microclimatic conditions	<ul style="list-style-type: none"> • NA 	<ul style="list-style-type: none"> • Native-dominated secondary forest • Abandoned-land forest • Exotic-dominated secondary forest • Urban vegetation • Unmanaged pond (D4) • Concrete drain / canal (D16) 	<ul style="list-style-type: none"> • Scrubland / Grassland • Forest or rural stream (D1) • Naturalised stream (D7, D11, D12, D14, D15) • 	<ul style="list-style-type: none"> • NA

7.9.2.2 Flora

There are no potential impacts to plants at the operational phase. Decline in plant health and mortality are not assessed during operational phase, as multiple events not relating to this development could have an effect on these factors. Since the cause of impacts cannot be narrowed down unlike in construction phase where a more direct link can be made, it is not conclusive to make this assessment.

7.9.2.3 Fauna

Six (6) operational phase impacts were identified and assessed for faunal receptors: (1) accidental injury or mortality, (2) human disturbances, (3) human-wildlife conflict, (4) Light disturbances and (5) loss of or reduction in ecological connectivity for faunal movement, and (6) poaching. impact significance ranged from **Negligible** to **Major**. Only the most substantive impact for each impact type is presented below. A summary of the impact to fauna receptors is given in Table 7-31 and detailed in Appendix N.

Table 7-31 Summary of operational phase impacts to fauna receptors

Impact type	No. of Species			
	Major	Moderate	Minor	Negligible
Accidental injury or mortality	-	33	48	-
Human disturbance	-	38	35	8
Human-wildlife conflict	-	10	7	64
Light disturbance	54	19	-	8
Loss of/reduction of ecological connectivity	-	48	20	13
Poaching	-	22	32	27

7.9.2.3.1 Accidental injury or mortality

This development is expected to include road widening works, constructing of new roads and building of high-rise infrastructures such as residential blocks. This exposes fauna in the vicinity to the risk of accidental injury or mortality. There are 33 species identified to have **Moderate** impact significance. This includes species with high susceptibility to roadkills such as the smooth otter (*Lutrogale perspicillata*), Sunda pangolin (*Manis javanica*) and black-headed collared snake (*Sibynophis melanocephalus*). Birds such as the thick-billed green pigeon (*Treron curvirostra*), jambu fruit dove (*Ptilinopus jambu*) and straw-headed bulbul (*Pycnonotus zeylanicus*) are also exposed to the risk of collision with infrastructures. Aculeates, bees, butterflies and Odonates and aquatic species have lower susceptibility to these impacts hence are predicted to have **Minor** (48 species) impact significance.

7.9.2.3.2 Human disturbance

The increase in human traffic from residents and park visitors results in **Negligible to Moderate** impact on fauna. Fauna that are highly sensitive to human presence such as the brown-chested jungle flycatcher (*Cyornis brunneatus*), Sunda slow loris (*Nycticebus coucang*) and greater green leafbird (*Chloropsis sonnerati*) are predicted to have **Moderate** impacts due to the increased proximity to infrastructures and increased visitorship in retained forests with trails. Butterflies, Odonates and some birds like the house swift (*Apus nipalensis*) are less sensitive to human presence hence are likely to have **Minor** impacts. Bees, wasps and fish are not expected to experience human disturbance and have **Negligible** impact significance.

7.9.2.3.3 Human-wildlife conflict

With the increased proximity of residential area to forested area, as well as the opening of parks in retained forest, human-wildlife conflict will likely result in **Negligible to Moderate** impact. Species typically perceived as nuisance or a threat by members of public such as bees, wasps, long-tailed macaque (*Macaca fascicularis*), and black-headed collared snake (*Sibynophis melanocephalus*) are likely to have **Moderate** impact. A lack of understanding regarding how to safely interact with wildlife like the smooth otter (*Lutrogale perspicillata*) may also lead to conflict.

Birds, butterflies, fish and odonate that are not perceived as a nuisance have **Negligible** impact significance during the operational phase.

7.9.2.3.4 Light disturbance

Higher light levels around the residential areas are expected to result in **Major** impact for 54 species, **Moderate** impact for 19 species. For diurnal species, higher light levels from human activities may affect their rhythmic patterns and may reduce the suitability of habitats for roosting and resting at night. Similarly, the higher light levels may reduce the suitability of habitats for nocturnal species, resulting in less-than-optimal condition for nocturnal species to forage and move around. With the construction of residential building and installation of street lights, species extremely sensitive to changes in light levels such as the spotted wood owl (*Strix seloputo*), buffy fish owl (*Ketupa ketupu*), bats and Malayan box terrapin (*Cuora couro*) will experience high impact intensity and hence **Major** impacts. Species that migrate at night such as the violet cuckoo (*Chrysococcyx xanthorhynchus*) is also expected to experience **Major impact** significance. Other species less sensitive to light level includes diurnal birds, reptiles and mammals which are expected to experience **Moderate** impact significance.

7.9.2.3.5 Loss of or reduction of ecological connectivity

Loss of or reduction of ecological connectivity is predicted to result in **Negligible to Moderate** impact significance. Ground dwelling animals such as the Sunda pangolin (*Manis javanica*) and black-headed collared snake (*Sibynophis melanocephalus*), as well as arboreal animals like the Sunda slow loris (*Nycticebus coucang*), are expected to experience High impact intensity from the development of the Study Area. Through the construction of infrastructures, widening of roads and removal of connecting habitats, animals that are unable to travel across vegetated areas will experience **Moderate** impact (48 Species). Aquatic species such as the crescent betta (*Betta imbellis*) will also experience **Moderate** impact due to its high dependency on connected habitats for dispersal. Fauna species with higher mobility such as bees, wasps, some birds, butterfly, and the smooth otter (*Lutrogale perspicillata*) are still able to travel across infrastructure, therefore impact significance is **Minor** (20 species). Lastly, species like the plume-toed swiftlet (*Collocalia affinis*) and plain palm dart (*Cephrenes acalle niasicus*) are not dependent on connected habitats for dispersal. They can traverse through urban infrastructure and would be least affected by the development. Hence, they would experience **Negligible** (13 species) impact significance.

7.9.2.3.6 Poaching

Twenty-two (22) species are susceptible to poaching with the increased accessibility of the Study Area to members of the public. Examples include straw-headed bulbul (*Pycnonotus zeylanicus*), white-rumped shama (*Copsychus malabaricus*), Sunda pangolin (*Manis javanica*¹), and common birdwing butterfly (*Troides helena cerberus*). Despite Singapore's stance of zero-tolerance towards illegal wildlife trade, the likelihood is still Possible given known occurrences of such activities, and the impact significance is Moderate for the CITES-listed species and species commonly traded as pets. The likelihood of poaching for the remaining species is considered Unlikely, and impact significance for these species range from **Negligible** to **Moderate**.

7.10 Recommended Mitigation Measures

In this section, mitigation measures for the future residential developments are discussed. Mitigation measures are implemented in the following order: 1) avoidance; 2) minimisation; 3) compensation and enhancement. Avoidance of the impact is first attempted. If avoidance is not possible, the construction impacts will be minimised. Finally, if habitat loss must occur, compensation and enhancement of remaining/nearby habitats will be suggested as a form of impact mitigation.

It is important to note that the successful implementation of mitigation measures requires the commitment of contractors, arborists and biodiversity specialists. Some of the major concerns around this proposed project include habitat loss, ecological connectivity and human-wildlife interactions/conflict.

7.10.1 Design Phase and Pre-construction Phase

The design of a development should be considered in the mitigation as it has the most potential to influence the extent and types of impacts that can influence any sensitive biological receptors at the operational phase.

7.10.1.1 Avoid

It is evident and imperative that areas of high biodiversity are avoided to reduce the impact from the incoming development. However, due to the nature of the plans at Turf Club, there is little chance to avoid major site

clearance and habitat loss within the Project Area. As a result of the topography, there would be major cut and fill works carried out across the Project Area. Therefore, other than consideration to safeguard areas of high biodiversity value (Figure 7-80) it is important to ensure ecological connectivity within the Project Area and with nearby green networks such as CCNR and BTNR, to allow for steady dispersal of threatened and rare flora and fauna. This will thereby further enhance the ecological integrity and viability of habitats in the Project Area and the surrounding green network as part of futureproofing for the incoming development.

Taking into consideration the proposed preliminary land use plan—where development of residential and related amenities is expected—it is more feasible to prioritise:

1. Securing larger patches of area to ensure better forest quality for refugia.
2. Ensuring connectivity between retained forest as much as possible.
3. Creating a contiguous ecological connection with at least 100 m width between the two largest forest patches (Site A and Site C) to aid fauna movement.
4. Ensuring connectivity to other key nature areas outside of the Project Area for future proofing.

This results in a Recommended Area of Conservation (RAC) that mainly sits on the periphery of the Project Area as indicated in Figure 7-80. If there is a need to develop within the RAC, development should be in less sensitive habitats such as scrublands and forest with less flora and fauna of conservation significance. There should also be a buffer of at least 50-m from waterbodies.



- Legend**
- EIA Study Area
 - Site boundary
 - Recommended area for conservation
 - Surrounding vegetation outside Turf City
- Plants of conservation significance**
- Critically Endangered
 - Endangered
 - Vulnerable
 - ID not confirmed but likely CS

Vegetation Types

 Native-dominated secondary forest
 Abandoned-land forest
 Exotic-dominated secondary forest
 Scrubland
 Urban vegetation
 Non-vegetated
 Waterbody

Rev.	Date	By	Description	Chk'd	App'd
-	MAY 2024	CWT	Turf Club EIA	LAL	JAG

Qualified Person Endorsement : NA

URA Endorsement : NA

Consultant : **AECOM**

Project Title :
**CONTRACT URA/T/22/031
 ENVIRONMENTAL IMPACT
 ASSESSMENT (EIA) FOR
 FORMER TURF CLUB AT BUKIT TIMAH**

Designed CWT	Checked LAL	Approved JAG
Drawn	Date MAY 2024	

Client: **URBAN REDEVELOPMENT AUTHORITY**

Figure Title :
RECOMMENDED AREA FOR CONSERVATION

Figure No. : 7-80	Rev. : -	Sheet 1 of 1
CAD File Name : NA		A3

Note: Source of basemap - Google Earth Map

With more than 50% of the green areas lost, it is important to ensure that the existing flora and fauna have sufficient habitat within the Project Area. Therefore, it is crucial to select the larger patches of areas of high biodiversity value to be retained over smaller patches within the Project Area (i.e., Area A and C over patches in Area B and Area D). However, in the long run, with more than 50% of the green area lost, there is a need to cater for the displacement of fauna and dispersal of flora.

Connectivity study of the Project Area revealed areas both within and outside the Project Area where connectivity can be improved or enhanced.

7.10.1.1.1 Recommended connectivity within Project Area

7.10.1.1.1.1 Ecological corridor in the periphery

Building an ecological corridor in the northern periphery of the Study Area (Figure 7-82) could help to connect two of the biggest and best forest patches (Site A and Site C). In setting out the recommendations for corridor sizes, an extensive literature review was carried out to determine parameters that will best suit the site context. The USDA National Agroforestry Centre recommends as a guideline that a corridor will generally need to be wider in landscapes that provide limited habitat or that are dominated by human use. While most of the literature review studied had a temperate context and the reviewed literature yielded no papers that could fit concisely to the context at this Study Area, it is important to note that the fundamental considerations still apply. These considerations are highlighted below:

- Target species: In general, the larger the focal species, the wider the corridor needed. Singapore's species diversity composes of few large mammal species and in Eng Neo context, the focal species of birds and small mammals require at least 60 m [P-36]. Refer to Figure 7-81.
- Edge effects: Literature review indicate that changes in temperature, light intensity and soil moisture happens between 20–30 m (on average) from the edge. While at least 32 m of heavily forested vegetation will be required to buffer for noise. Hence for a corridor with two edges, it would require at least 60 m width for the reduction of edge effects.
- Temporal considerations: Corridors that need to function for decades and are situated in landscapes that are dominated by human use need to be wider [P-36]. The corridor will also need time to establish, evolve and mature into an effective connection. It is estimated that it will take at least ten years for the canopy of trees to merge and for a sufficient microclimate to establish. This will in turn create conditions suitable to sustain interior species while the corridor (trees) matures.

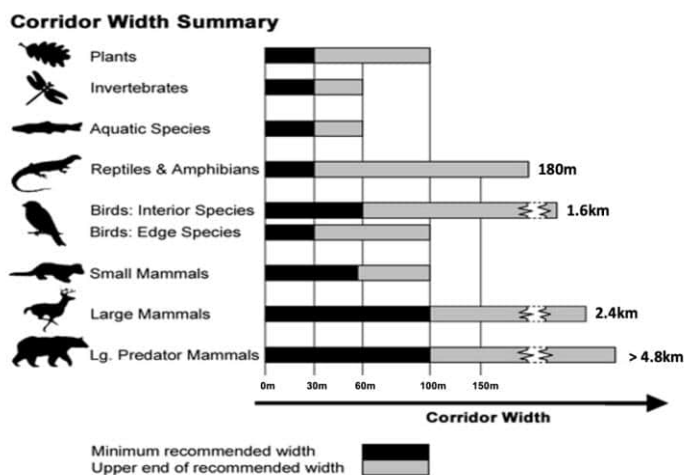


Figure 7-81 Corridor width of different fauna groups [P-36]. Extracted from USDA National Agroforestry Centre Guidelines

Table 7-32 Summary of literature review of edge effects and buffers

Factors	Impact threshold	Species/subject	Study findings	References
Light, temperature, litter moisture, vapour pressure deficit, humidity and shrub cover.	50 m	Abiotic	Significant edge effects were detected in light, temperature, litter moisture, vapor pressure deficit, humidity, and shrub cover, affecting the forest microenvironment up to 50 m from the edge.	[P-37]
Temperature	10 - 30 m	Abiotic	10-30 m of native forest riparian buffer necessary to maintain aquatic habitat temperature control	[P-38]
Temperature	≥ 30 m	Abiotic	A minimum 30 meters required to provide temperature and microclimate regulation	[P-48]
Microclimate	8 m	Abiotic	Microclimatic differences were limited to the first 8 m in the forest fragments.	[P-39]
Light intensity and soil moisture	20 m	Abiotic	In a study of 22 mature upland forest fragments, increases in light intensity and reductions in soil moisture extended up to 20m from the edge, irrespective of forest fragment size.	[P-40]
Light	<ul style="list-style-type: none"> - Separate street lights at least 50 m from ecological corridors - Avoid vertical light trespass beyond 0.1 lx for light sensitive bats 	Bats	Negative effect from artificial lights on <i>Myotis</i> sp. and <i>E. serotinus</i> detected up to 50 m away from streetlights. Even after streetlights were turned-off, negative effect persisted in <i>Myotis</i> sp.	[P-41]
Shade	> 30 m	Riparian buffer	Minimum 30 m required to control water temperature via shading	[P-42]
Shade	> 30 m	Riparian buffer	Buffer required to protect floodplain and	[P-43]

Factors	Impact threshold	Species/subject	Study findings	References
			riparian vegetation from exposure to light and wind which could cause succession to shrub communities	
Shade	> 30 m	Riparian buffer	Riparian buffer of >30 m provided 50 – 100% shading	[P-49]
Shade	28 – 38 m	Riparian buffer	Riparian buffer of 28-38 m provided 80% shading	[P-48]
Seedlings recruitment	65 m	Plants	Populations in forest remnants within 65 m of forest clear-cut edges have almost no recruitment of young plants.	[P-48]
Predation and parasitism.	50 m	Birds	Predation and parasitism rates are often significantly greater within 50 m of an edge.	[P-44]
Noise (industrial)	700 m	Birds (boreal forest)	Areas up to a distance of 700 m from compressor stations resulted in lower abundance of forest birds.	[P-35]
Road traffic noise	Effects strongest at 200 m, but detected at 2000 - 3000 m (in forested wetlands)	Amphibian species diversity and abundance	Species richness negatively correlates to road density. The effects of adjacent land use were strongest at 200 m.	[P-46]
Road traffic noise	> 600 m	Birds - forest-interior species	The effects of road-effect zone extends >100 m from the road. The average width of the road-effect zone for a suburban highway exceeded 600 m	[P-47]

Therefore, to buffer for edge effects as well as disturbance from noise, the ecological buffer surrounding the parameter for the study area should be at least 100m for it to be effective. The corridor can be achieved through planting native species at north of the former golf course area, with the eventual goal of creating a native forest. This new connection would allow fauna to move between Site A and Site C. However, it is important to note that while the newly planted trees take time to grow, there is a need to **facilitate intermediate connectivity** to allow arboreal fauna such as the Sunda colugo to cross.

7.10.1.1.1 Grade-separated crossing

At areas where roads sit between retained forest patches, grade-separated crossing is a way to ensure connectivity. There are two areas where this is recommended for implementation: (1) the road in the north leading from PIE to the former Turf Club area; (2) between Site A and Site B in the south (Figure 7-82). In both areas, having a ground level road would result in a forest disconnection, which also increases the risk of roadkill. An elevated road would allow fauna to safely pass beneath and ensure that there is still ecological connectivity. For area (1), after constructing the grade-separated road, the area under the road should be re-planted for the native forest to be connected.

7.10.1.1.2 Urban greenery

Urban greenery such as rooftop gardens and streetscape are useful as intermediate habitats to connect retained forest patch. In addition, planting of flowering plants will attract the pollinators such as butterflies, bees, wasps can potentially improve ecological processes in the region. Therefore, where possible, developers should look into incorporating urban greenery into the planning designs. At Site B where there is a gap between the northern and southern forest patch (Figure 7-82) it is important for lush greenery and other connectivity features to be in place as part of ensuring canopy and ground connectivity.

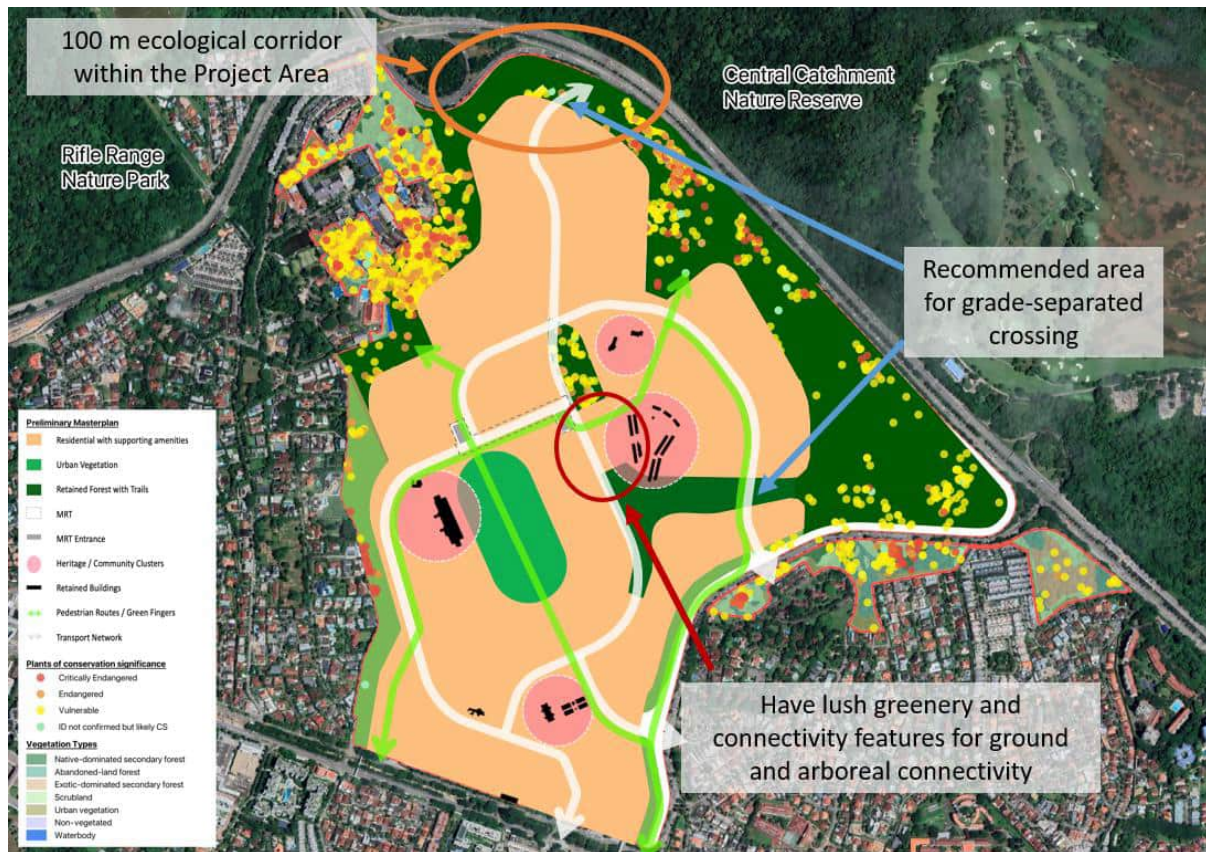


Figure 7-82 Recommended connectivity within Project Area

7.10.1.1.2 Recommended connectivity outside Project Area

Two possible connectivity routes have been identified as a means to improve connectivity outside the project area as shown in Figure 7-83.



Figure 7-83 Possible connectivity outside Project Area

7.10.1.1.2.1 Via Jalan Kampong Chantek to Rifle Range Nature Park

With the proximity of the Study Area (Site C) and Rifle Range Nature Park, it is worth exploring the possibility of connecting these two forest patches. Subsequently, this could also connect further down to Bukit Timah Nature Reserve (BTNR). Jalan Kampong Chantek is currently the most viable location for this connection to be built. Road camera traps observed activities of ground dwelling mammals such as the Long-tailed macaques (*Macaca fascicularis*) and common palm civet (*Paradoxurus musangus*) along this road, indicating the potential of Jalan Kampong Chantek as a crossing point to Rifle Range. This connectivity should not involve fauna crossing the road, to prevent future roadkill incidents. It is suggested that a culvert can be pipe jacked under PIE to create a safe passage for fauna to cross (Figure 7-84).

However, there are currently some challenges that needs to be overcome for this connectivity:

- Fence along Swiss View Road blocking wildlife exit (Figure 7-85)
- Steep slope from Swiss View Road (Figure 7-85)
- Risk of roadkill when crossing Swiss View Road
- Creating a culvert under the PIE – will require detailed technical studies

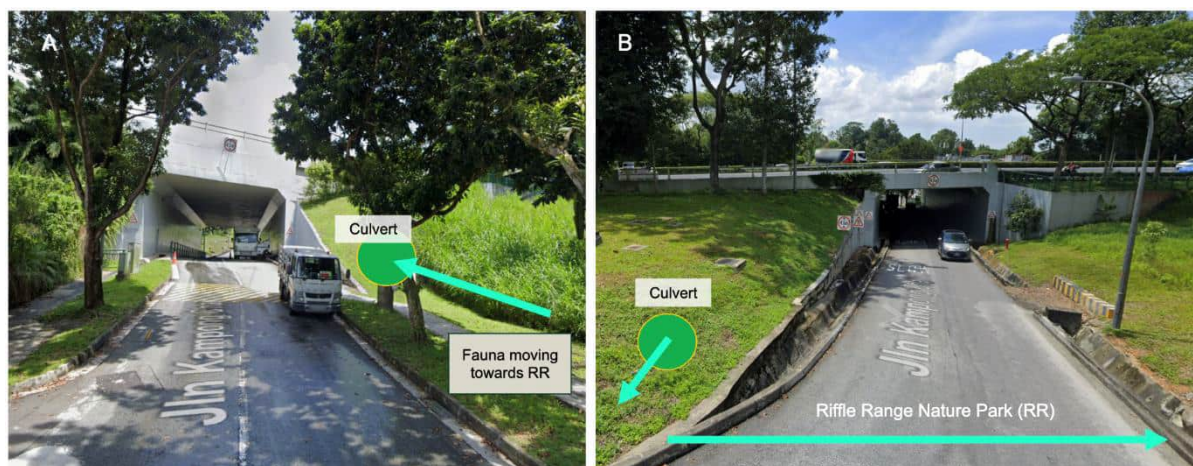


Figure 7-84 Suggested culvert location along Jalan Kampung Chantek

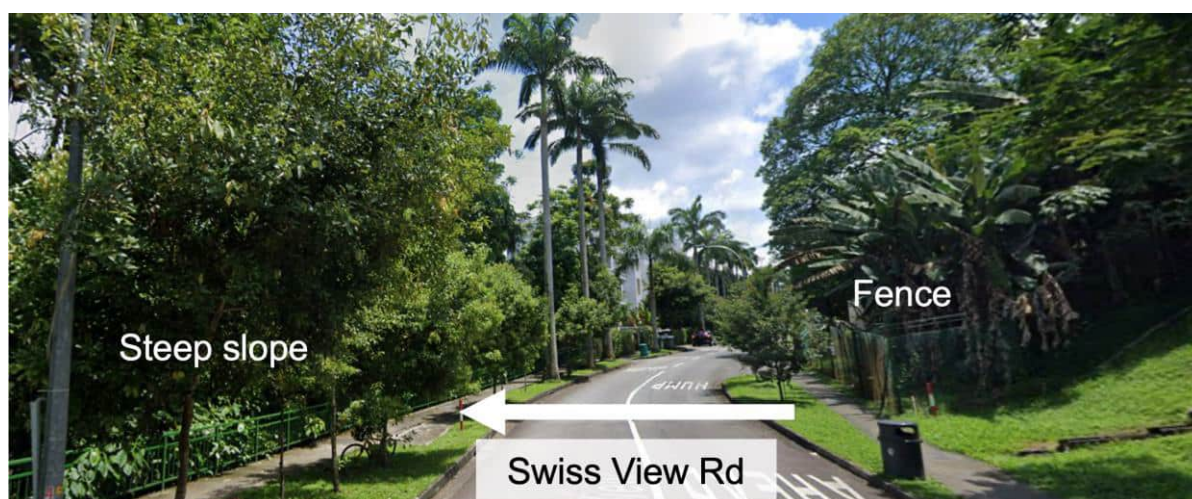


Figure 7-85 Swiss View Road fence and slope

7.10.1.1.2.2 Via ecolink across PIE to Central Catchment Nature Reserve

An ecolink across PIE would serve to connect the Project Area with the larger green network outside. The Project Area, especially at Site A and Site C is highly biodiverse. However, the Pan Island Expressway currently separates the connectivity of this area. Therefore, if connectivity can be re-established in this area, it would bring about the following benefits:

- Reconnects isolated forest patch
- Allow safe movement of displaced wildlife during development
- Increase fauna access to alternative habitats
- Reduced risk of roadkill
- Targets all taxon (flora, arboreal & terrestrial fauna)
- Future proofing for upcoming development in the area

However, it is recognised that the implementation of a new ecolink would require detailed technical and environmental studies of its own to determine technical feasibility as well as environmental impact, given that its construction would also likely require habitat clearance. Vegetation and topography survey at Sime Forest (CCNR), along with other technical considerations for spanning across the PIE, the necessary height clearance, and the underground pipelines in the area, should be studied as part of implementation studies for the eco-link..

Subsequently, retaining large trees as much as possible can also be considered as part of the 'avoidance' strategy. This can include:

- Retention of existing keystone plants such as *Ficus benjamina*, *Ficus microcarpa*, *Ficus religiosa* as much as possible. If such plants are unable to be retained, enhancement efforts can be carried out with the planting of keystone flora such as fig trees. These trees have uncoordinated fruiting periods but fruit abundantly over the year as a community, forming an important food source for avian fauna and small mammals. In addition, planting of flowering plants will attract the pollinators such as butterflies, bees, wasps can potentially improve ecological processes in the region.
- Retention of the large specimens such as the large tembusu trees in Site B and E that were likely to have been retained from the native vegetation present before clearance. These large trees can provide shelter and habitat for fauna species.
- When constructing parks, design trails and footprint (entrances, boardwalks, etc) to avoid Priority 1 Plant specimens.
- In areas demarcated as parks, avoid clearing vegetation where possible, especially in areas of high conservation value.

7.10.1.2 Minimise

7.10.1.2.1 Bird friendly building designs

Major impacts arising from injury or mortality at the operational stage is a concern that can be addressed using impact minimisation via design—the unnecessary deaths of birds, which tend to collide with glass windows due to their inability to perceive these structures. The frequency of these events can be reduced by substituting aspects of the building design with bird-friendly designs [P-20]:

- Minimise the quantity or surface area of glass. This could be achieved by reducing the amount of glass façade or installing a decorative cladding over the glass façade so that the reflections on the glass facades are broken up.
- Incorporate features that increase the visibility of glass (including mirrored and non-mirrored reflective glass, and transparent glass) or dampen reflections to reduce the appearance of clear passage to sky or vegetation. Possible strategies include film coating (e.g., CollidEscape; <http://www.collidescape.org>), angled glass, interior or exterior shades, decals, fenestration patterns, grilles, sunshades, screens, blinds and netting. Exterior shades confer the freedom of choosing to only use it during periods where bird collisions are expected to be most frequent, such as during the migratory seasons.
- When decals or patterns are added to increase the visibility of the glass, it is advised that the pattern should be as dense as possible as it will appear more clearly as a solid object to birds and thus be more effective [R-33]. For example, for WindowAlert decals, it is recommended for decals to be 5cm apart horizontally and 10cm apart vertically [W-3].
- Avoid interior vegetation near windows as birds may confuse this with exterior vegetation and fly towards them. This can include adding balconies to help prevent reflections on windows.
- Avoid planting vegetation close to glass so that reflection of vegetation would not confuse birds that may fly into the building. If there are sides which are close to the natural vegetation, the façade should have shades installed or netting that are a short distance away from the glass to prevent birds from crashing into it.
- Buildings should not have courtyards or corridors that are enclosed by glass as these may confuse birds to fly through.

7.10.1.2.2 Lighting strategies

While light disturbance impacts at the operational stage can be minimised by incorporating proper lighting strategies, any level of artificial light above that of moonlight masks the natural rhythms of lunar sky brightness and thus, can disrupt patterns of foraging, mating, as well as the circadian rhythm [P-30]. Artificial lighting at night (ALAN) can disorient birds, bats and insects, altering their behaviour that results in them being more vulnerable to predation and other risks. For example, ALAN may repel light-adverse bats from lit areas and restrict their use of commuting or feeding space. It is recommended to adopt the following framework:

- Minimise areas from being artificially lit — lighting should only be installed when necessary.
- Limit the duration of lighting, where peak nocturnal fauna activity is avoided.

- Reduce the trespass of lighting. This can be done via the use of a minimal number of luminaires, at low positions in relation to the ground, directed and shielded to provide the least amount of spill to adjacent habitats while achieving the necessary lighting levels for working safely (Figure 7-86). Accessories such as baffles, hoods or louvres can be used to reduce light spill and direct it only to where it is needed [P-31].
- Change the spectrum of lighting. Lights with reduced or filtered blue, violet and ultra-violet wavelengths should be used. Short wavelength light (blue) scatters more readily in the atmosphere and therefore contributes more to sky glow than longer wavelength light. Furthermore, most wildlife is sensitive to short wavelength (blue/violet) light. Therefore, as a general rule, only lights with little or no short wavelength (400–500 nm) violet or blue light should be used to avoid unintended effects. Where wildlife is sensitive to longer wavelength light (e.g., some bird species), consideration should be given to wavelength selection on a case-by-case basis. It is also recommended that warm colour temperature light sources to be employed preferably at < 2,700 K.
- Set dark buffers and illuminance limits of < 100 lux to minimise effects on animal behaviour due to light pollution and zonation.
- Employ species-specific strategy.
- Minimise noise levels at night.

Finally, adopting road calming measures such as speed bumps, and other mitigation measures such as restriction on speed of vehicles can help potentially to minimise roadkill accidents at the operational stage.

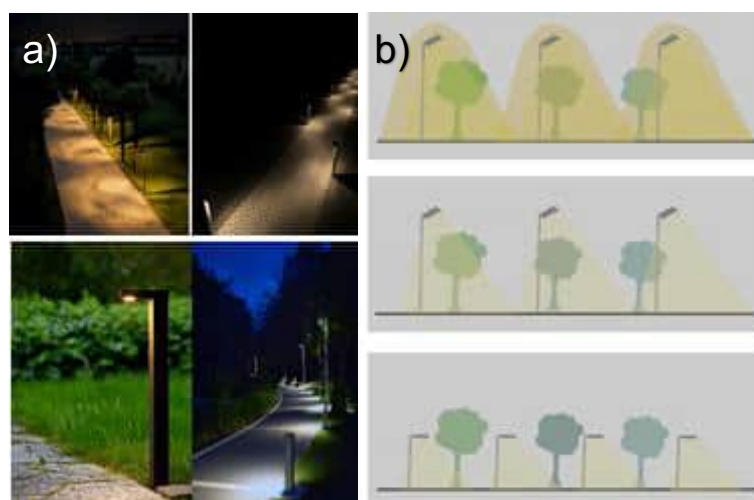


Figure 7-86 (a) Low level bollards directed downwards and shielded to limit lighting to only the area intended. Combined effect of shielded luminaires and short poles on reducing light trespass. (b) First picture—unshielded luminaires, second—luminaires with shield, third—shielded luminaires on short poles which cut-off light trespass and keep adjacent areas dark.

7.10.1.2.3 Installation of connectivity structures to facilitate fauna movement

7.10.1.2.3.1 Across Eng Neo Avenue

In view of road expansion plans along Eng Neo Avenue, there will be an increased risk of roadkill in the area. During the baseline study, road cameras traps recorded activities of both the Sunda colugo and Sunda pangolin along Eng Neo Avenue. Coupled with pangolin sighting data from ACRES and Singapore Pangolin Working Group, it is likely these animals transverse between Site A and Site F via the Eng Neo Avenue. Sunda colugo require a certain proximity of trees to be able to glide between spaces. A widened road would decrease the number of viable glide paths, hence increasing the chance of colugo road kills. There have also been several past sightings of pangolins roadkill along this road. Hence, a further widening of Eng Neo Avenue would inevitably increase the risk of road kills in the area. Therefore, there is a strong need to facilitate the movement of colugos and other ground dwelling animals in view of this development.

Therefore, we recommend for culverts and colugo poles to be installed as part of roadkill mitigation:

- Steep/vertical-walled canals or large drains, such as the one that runs under Eng Neo Avenue from Site A towards Site E (Figure 7-87, position 1), can be modified to potentially serve as a walkway for ground-dwelling mammals moving between these two Sites. The presence of obstacles to fauna movement (e.g. vertical drop-offs) along this canal is currently unknown. The detailed architecture of the canal should be examined to identify these obstacles, and strategies to address them (e.g. installation of ladders) can be formulated. Constructing an elevated wildlife friendly walkway above the high-water mark will allow wildlife to continue using these pathways when the water level in the drain is high (Figure 7-88)
- On top of the wildlife friendly passage, a culvert under Eng Neo Avenue (Figure 7-87), west of the canal is recommended to facilitate the movement of more ground dwelling animals across.
- The culverts can be constructed concurrently with the road widening works to provide for another fauna underpass crossing for small terrestrial ground dwelling mammals. Further technical studies are required for proper and effective implementation of this recommendation.
- Colugo poles can also be installed along the road and road divider of the expanded road to decrease the glide path of colugos. Further details on the location and number of poles or culvert to be installed is to be further discussed with the aid of connectivity models in [Appendix DD](#).



Figure 7-87 Suggested culvert location under Eng Neo Avenue

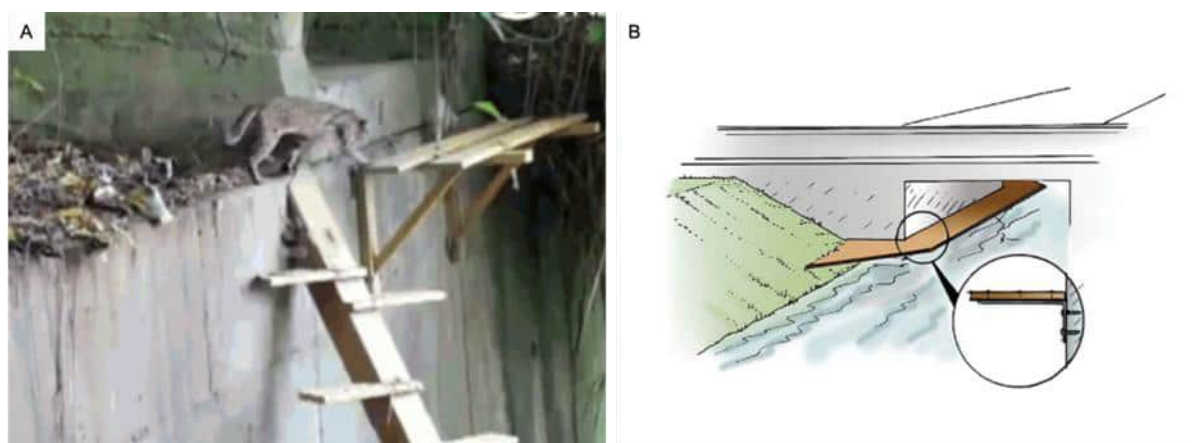


Figure 7-88 Examples of installations on canal walls to facilitate wildlife movement. (A) Ladder; (B) Elevated walkway above high-water mark (Kruidering et al., 2005)

7.10.1.2.3.2 Between Site A and Site C, through the former golf course

Trees are to be planted between Site A and Site C at the former golf course area to facilitate ecological connectivity. However, planted trees are usually not at a size that is big enough to facilitate the movement of arboreal animals such as the Sunda colugos (*Galeopterus variegatus*). Therefore, the installation of colugo poles can act as an intermediate mitigation for the connectivity gap. Arising from the Nature Group engagement sessions, a collaborative study was undertaken together with several Nature Group representatives to evaluate the impact of the proposed development on colugo movement using a glide-ratio model, and to propose the optimisation of

colugo poles as a mitigating measure. Further details on the location and number of poles to be installed is further discussed with the aid of connectivity models in Appendix DD.

7.10.1.3 Remedy/Repair/Restore and Compensate

This section lists the strategies to enhance and further compensate for developmental works.

1. Enhance existing scrublands into native forests within the golf course.
2. Enhance the conditions of the retained abandoned-land and exotic-dominated secondary forests in Site A and the park at the west of the Study Area via infill plantings.
3. Create new habitats (e.g., replace the existing turf and non-vegetated areas with native forests, create urban greenery along streetscapes and on rooftops and buildings, create freshwater habitats to compensate for the loss of existing waterbodies in the Study Area).
4. Enhance the conditions of the retained naturalised waterbodies.

7.10.1.3.1 Creation and Enhancement of freshwater habitats

Creating and enhancing freshwater habitats is a way to compensate for the loss of existing waterbodies at the Study Area due to development. Habitats such as ponds and marshes would support a wide array of species, including fish, amphibians, invertebrates like dragonflies and various plants. It is recommended to study the creation of freshwater habitats in some of the proposed new parks.

Habitat enhancement is a way to compensate for the loss of aquatic habitat by improving existing ones. This can come in the form of cleaning up streams through the removal of litter, or reintroduction of native aquatic fauna. Common native species such as the croaking gurami (*Trichopsis vittata*) can be reintroduced carefully at strategic locations. This would preferably be at a waterbody less accessible to the public as there is a tendency for people to release unwanted pets into parks such as the invasive red-eared slider (*Trachemys scripta*).

7.10.2 Construction Phase

7.10.2.1 Avoid

7.10.2.1.1 Flora and Habitat

1. Ensure there are no works and disturbances to areas outside of work site, especially into areas of high conservation value.
2. Ensure any associated slope stabilisation and grading works will not impact topography of areas outside work site and, water quality and hydrology of the waterbodies within the Study Area. Care should be taken to prevent siltation into ecologically sensitive areas such as the native forests. Works should not encroach on these areas, nor should there be clearance, trampling or vegetation damage to these areas. Overall, these areas should have no or minimal impacts.
3. Consider engaging arborists and flora specialists to clearly mark out areas and plants with conservation value before the start of works. This would avoid clearing unnecessary working space, eliminate the need of removing specimens of value and plants of conservation significance as much as possible.

7.10.2.2 Minimise

7.10.2.2.1 Flora and Habitat

1. Transplant or harvest trees/saplings of conservation significance instead if they are to be cleared.
2. Erect Tree Protections Zones (TPZs) to prevent encroachment of construction activities and excessive vegetation clearance around retained trees or areas (if any).
3. Conduct regular inspections to ensure contractor compliance and identify any impacts to the adjacent forest areas.

7.10.2.2.2 Fauna

1. Minimise felling trees and clearing vegetation during the peak bird breeding season (March to July).

2. Before vegetation removal, a pre-felling check should be conducted by an Ecologist to identify any nesting structures that are being actively used (e.g., bird nests, tree hollows, burrows and bamboos clusters); if such structures are observed, no works should be conducted in the area of the nesting structure until it is confirmed that there is no activity at the nesting structure.
3. Wildlife shepherding via directional clearing should be adopted over the usual site clearance. This should be planned and overseen by an ecologist.
4. Quieter construction machinery/equipment should be used over loud and noisy machinery/equipment whenever possible.
5. Night-time works should be avoided to prevent disturbance to nocturnal fauna; recommended to restrict working hours to 0700–1800h. Animals perceive light differently from humans.
6. Retain ground cover for as long as possible before removal. When ground cover is removed, earth control measures (ECM) are to be in place. Use only fully biodegradable erosion control blankets (ECB) to avoid trapping fossorial fauna such as snakes.
7. Adopt road calming measures such as speed bumps, and other mitigation measures such as restriction on speed of vehicles and working time, to minimise roadkill accidents.
8. Train site personnel on biodiversity awareness and actions to take when encountering wildlife.
9. Ensure good housekeeping controls such as provision of wildlife proof bins and eating areas.
10. Execute fauna response and rescue protocol when fauna is found on-site.
11. Monitor the water quality and aquatic faunal community in retained streams and streams adjacent to the construction areas.
12. Ensure silt fences or other silt control measures along the site hoarding are installed and maintained properly.
13. Practise due diligence in proper storage and handling of machinery to prevent leaching of oil or harmful materials such as bentonite slurry. Store and handle harmful materials well away from water bodies.
14. Engage a Qualified Erosion Control Professional (QECP) to formulate and implement ECM plan in accordance with PUB requirements.
15. Implement dust control measures such as dust screens and water suppression systems.
16. Implement acoustic barriers to reduce noise pollution outside worksites.
17. Conduct regular site inspections to ensure contractor compliance and to identify potential fauna entrapments.
18. Fogging is not recommended; to implement preventive measures against mosquito breeding by removing sources of stagnant water or water-bearing receptacles. Examples include:
 - a. Providing a well-maintained pitched roof
 - b. Clearing discarded items daily
 - c. Store materials appropriately
 - d. Level ground depressions and uneven surfaces
 - e. Ensure effective drainage flow

General guidelines for sequence of site clearance:

- i. Priority phase:
 1. Establish connectivity via culverts, poles and corridors (golf course, Eng Neo Avenue).
 2. Enhance existing forest (Site A abandon land & exotic).
 3. Habitat creation.
- ii. Subsequent phase:
 1. Develop existing built-up areas and those with urban vegetation (except the golf course).
 2. Directional vegetation clearance to shepherd animals towards forested habitats. Otherwise, consider animal translocation.

In general, given the overall loss of habitat in the development of the project area, a key problem is ensuring that this transition occurs with minimal fauna mortality. One key measure to achieve this is the implementation of ecological connectivity to allow fauna to safely move outwards towards other green areas. However, at the same

time, it is recommended to implement these ecological connectivity measures to dovetail with planned infrastructure works, to minimise ecological and human disruption (e.g. implement culvert crossings with Eng Neo Avenue widening works). Other ecological connectivity measures may also require complicated technical studies (e.g. pipejacking of culvert along Jalan Kampong Chantek, proposed eco-link and thus should not be implemented hastily. Hence, while earlier implementation of ecological connectivity is theoretically preferred, in practice, the timing of the implementation of these measures is one that has to be given more careful thought and consideration when the detailed implementation, including construction details, of these connectivity measures are being studied. Plant specimens that have the potential to be salvaged should be transplanted into suitable locations throughout the development phase. This should be carried out in consultation with a Flora Specialist.

7.10.3 Operational Phase

Mitigation measures stated here should be relevant for the Project Area and enforced if applicable. However, most of the strategies for enhancement should have been considered during the design phase. Avoidance, restoration and compensation measures would be the most applicable at the operational phase.

Soil that was dug up should be returned to the ground and replanted if possible. The planting scheme should be as similar in forest species composition to the adjacent forest patches and include as many native species as possible. Other than minimising edge effects, these replanted areas can serve as a natural barrier to light, noise and dust to reduce disturbance. Subsequently, barriers can be places to prevent entry into more sensitive area.

Fogging should also be minimised by implementing measures preventing mosquito breeding as the first line of defence, such as removing sources of stagnant water or water-bearing receptacles. Examples include:

- Providing well-maintained pitched roof
- Clearing discarded items daily
- Store materials appropriately
- Level ground depressions and uneven surfaces
- Ensure effective drainage flow

A final concern for the proposed development works is human-wildlife conflict. Due to the proximity and ecological role played by this area, wildlife such as macaques and otters can potentially pass through this area. Some of the suggestions can include:

- Placing educational signboards within or near green areas across the entire estate, particularly along the green corridors. The content of these signboards can include:
 - a. General advisories on what to do when the public encounters wildlife;
 - b. Advising/cautioning against feeding wildlife; and
 - c. Hotlines to call in the event of an emergency/injury as a result of human-wildlife interactions.
- Mitigation measures related to the design and landscaping of the estate such as
 - f. Using specific rubbish bins to prevent wildlife access to rubbish;
 - g. Planting tall trees facing the retained forested areas to encourage bird roosting away from the estates;
 - h. Planting shorter native shrubs in estate to avoid attracting bird roosting;
 - i. Ensure the window grills resistant to monkey entry; and
 - j. Planting fruit trees away from the residential areas;
 - k. Incorporate bird friendly building designs;
 - l. Otter-proofing housing premises using adequate fencing, particularly in areas with fishponds.

In continuity with the educational sign boards created to educate the public on how to interact with wildlife that could be passing through the area, active outreach can also be carried out by local interest groups or relevant authorities. Government agencies, when sharing plans for the area, should stress a need for harmonious co-existence with nature. This will help manage the residents' expectations and hopefully aid the management of human-wildlife interactions.

Finally, regular site inspections in the initial few months of the operational phase are recommended to be conducted to ensure that the proposed flora and fauna mitigating measures are effective. These site inspections also serve to identify any impacts to the adjacent forest areas. Key species such as the straw-headed bulbul, spotted wood owl, and crested goshawk should be monitored for their distribution, abundance, food resource use, and breeding behaviour. This information will contribute to evaluating the actual impact of the developments.

7.10.4 Mitigation Measures for Specific Fauna

Several threatened faunal species were recorded at multiple sites in the Study Area. These included the straw-headed bulbul (*Pycnonotus zeylanicus*) and smooth-coated otter (*Lutrogale perspicillata*). Broadly, mitigation measures that target these threatened faunal species include retaining habitats and food sources, maintenance/enhancement of ecological connectivity and the adoption of wildlife-friendly building designs. The mitigation measures for specific faunal species are listed below and should be applied at areas where they were recorded on top of the mitigation measures stated at design, construction, and operational.

7.10.4.1 Straw-headed Bulbul

- Retain fruit and fig trees, which are known food sources. Some examples are *Leea indica*, *Bridelia tomentosa*, *Clausena excavata*, *Dillenia suffruticosa* and *Ficus* sp.
- Include fruit and fig trees, which are their known food sources, as part of the native planting palette when replanting the area in the operational phase.
- Avoid felling trees and clearing vegetation during the bird breeding season for this species (January to September).

7.10.4.2 Long-tailed Macaques

The long-tailed macaques (*Macaca fascicularis*) are edge species and are highly adaptable in urban environments. The chance of human-macaque encounters, and therefore, human-macaque conflict in the proposed development is high. Minimising human-macaque conflict requires site-specific recommendations. However, the general guidelines below can be considered:

- 1) The landscaping and infrastructure should keep in mind the capabilities and behaviour of the macaques. For instance:
 - Macaques are primarily arboreal and have a mean leaping distance of 2.2 m [P-32] and a maximum leaping distance of 5 m [P-33]. Thus, there should be a 6m buffer between the building façade and the tree line as well as any potential climbing structures (e.g., lamppost).
 - To prevent scaling, the walls and pillars should be smooth and any projections that could potentially be used as handholds should be spaced greater than 1.5 m apart (i.e., larger than the arm span of an adult male long-tailed macaque) [P-34].
 - There should also be a canti-levered section of the building to prevent them from scaling to the higher residential levels of the building.
 - Addition of invisible grills to balconies will prevent macaques from entering and if these grills are spaced less than 10 cm apart (vertically), they will also prevent birds from entering the residential areas.
 - Macaques are avid swimmers and would enter outdoor swimming pools accessible to them. Thus, the swimming pools should be placed indoors or at a height that is beyond reach to them.
- 2) Proper waste-management techniques are extremely crucial within the residential districts. Key features include:
 - Macaque-proof bins, i.e., inaccessible to macaques either through being enclosed, with secured ropes or ties, or complex opening/closing mechanisms [P-34].
 - Waste management centres should be enclosed and inaccessible to macaques, including vents.
- 3) Education—reducing human-macaque conflict also involves behavioural change on the public's part. It is important to educate the public to not feed the macaques and indicate proper behaviours to avoid conflict with macaques (e.g., Dos and Don't; [P-34]). Educational signages are cost-effective methods that can be implemented.
- 4) Others [P-34]

- Enclosed carparks; owners can cover cars if concerned with damage.
- Walkways/bridges: wide enough for people to pass a macaque at >1 m.
- Gardens: enclosed; motion-triggered water spurts.

7.10.4.3 Otters

The otter's population in Singapore had a bounce back in recent years and were recorded in the Study Area during the baseline survey. Otters are mobile and have adapted to the urban environment. There have been past incidents of human wildlife conflicts with otters, often involving pet fishes. Therefore, it is recommended to otter-proof housing premises using adequate fencing, particularly in areas with fishponds to reduce the likelihood of such incidents.

7.11 Residual Impacts

7.11.1 Construction Phase

7.11.1.1 Habitats

For the full habitat impact assessment, refer to Appendix L.

7.11.1.1.1 Loss of habitat

Despite the proposed mitigation measures, the residual impact from loss of habitat remains the same as Section 7.9.1.1. This is largely because the proposed preliminary land use plan already concentrates infrastructures on non-vegetated areas and urban vegetation, conserving some of the peripheral forest patches as parks. Residual impact significance from this impact ranges from **Moderate** to **Major**. The native-dominated secondary will experience **Major** impact despite a medium impact intensity, as it is a habitat with high sensitivity. The abandoned-land forest will also experience **Major** impact due to high impact intensity, where >40% of the habitat overlaps with the proposed worksite.

7.11.1.1.2 Formation of edge effects

The likelihood of forming edge effects can be reduced to **Less Likely** if in-fill planting is conducted at the edges of retained forest to create a buffer against the urbanised areas. Therefore, residual impact can be reduced to **Minor** to **Negligible**.

7.11.1.1.3 Habitat degradation

With the minimum control measures and regular compliance inspection and monitoring, the likelihood of degrading retained habitats is still deemed **Less Likely**. Impact significance is hence **Negligible** to **Minor**.

Table 7-33 Summary of residual construction phase impacts to habitat receptors

Impact Type	Impact Significance			
	Major	Moderate	Minor	Negligible
Loss of habitat	NA	NA	NA	NA
Habitat degradation	NA	NA	NA	<ul style="list-style-type: none"> • Native-dominated secondary forest • Scrubland / Grassland • Unmanaged pond (D4) • Managed pond (D8, D9) • Concrete drain / canal (D16) • Abandoned-land forest • Urban vegetation • Forest or rural stream (D1) • Exotic-dominated secondary forest • Naturalised stream (D7, D11, D12, D14, D15)
Formation of edge effects	NA	NA	<ul style="list-style-type: none"> • Native-dominated secondary forest 	<ul style="list-style-type: none"> • Scrubland / Grassland • Unmanaged pond (D4) • Managed pond (D8, D9) • Concrete drain / canal (D16) • Abandoned-land forest • Urban vegetation • Forest or rural stream (D1)

Impact Type	Impact Significance			
	Major	Moderate	Minor	Negligible
				<ul style="list-style-type: none">• Exotic-dominated secondary forest• Naturalised stream (D7, D11, D12, D14, D15)

7.11.1.2 Flora

Out of the 106 plant species selected for ecological impact assessment, 37 and 34 species are assessed to have **Major** and **Moderate** impacts, respectively, before mitigation measures were theoretically implemented.

With the appropriate mitigation measures discussed above for the Study Area, i.e., set up TPZs (for trees), avoid plant removal, and/or transplant where suitable, the impact intensity would be reduced to **Negligible** and likelihood to **Less Likely**. This results in a **Negligible** impact significance for all 71 species.

7.11.1.3 Fauna

A summary of the residual impacts to fauna receptors is given in Table 7-34 and detailed in Appendix N.

Table 7-34 Summary of construction phase residual impacts to fauna receptors

Impact type	No. of Species			
	Major	Moderate	Minor	Negligible
Loss of/ reduction in habitats and food sources	67	13	1	-
Accidental injury or mortality	-	-	81	-
Human disturbance	-	-	73	8
Human-wildlife conflict	-	-	16	65
Light disturbance	-	-	73	8
Loss of/reduction of ecological connectivity	-	1	67	13

7.11.1.3.1 Loss of or reduction in habitat or food source

The residual impact from reduction in habitat and food source remains the same despite mitigation measures because the design of the development would inevitably lead to habitat loss. Forested areas to be conserved in the RAC (Figure 7-80) is similar to the proposed preliminary land use plan, therefore residual impact ranges from **Minor** to **Major**.

7.11.1.3.2 Accidental injury or mortality

The likelihood of accidental injury or mortality and human-wildlife conflict can be reduced if mitigation measures in Section 7.10.1 such as conducting biodiversity awareness training and having a wildlife response plan are followed, thus reducing the impact significance for all species to **Minor**.

7.11.1.3.3 Human disturbance

The likelihood of human disturbances can be reduced if site personnel are not allowed to access areas beyond the agreed working boundaries and into the retained forest. The reduction in human presence results in a residual impact ranging from **Negligible** to **Minor**.

7.11.1.3.4 Human-wildlife conflict

Biodiversity awareness training, as well as other mitigation measures mentioned in Section 7.10.1 can reduce the impact of human-wildlife conflict. With the knowledge of how to safely interact with long-tail macaque (*Macaca fascicularis*), smooth otter (*Lutrogale perspicillata*), black-headed collared snake (*Sibynophis melanocephalus*), and aculeates, the impact significance to these species can be reduced to **Minor**.

7.11.1.3.5 Light disturbance

Avoiding night works where possible and restricting construction work hours can reduce the impact of light disturbance on fauna. Along with the other mitigation measures to prevent light spillage into forested areas, the **Major** and **Moderate** impact significance of light disturbance can be reduced to **Minor**.

7.11.1.3.6 Loss of or reduction of ecological connectivity

With the clearance of vegetation, connecting habitats are removed. Movement between remaining forested patch can be facilitated through planting and deliberate installation of infrastructures. During construction, the installation of colugo poles and construction of culverts would facilitate the safe movement of fauna out of affected areas. The creation of a 100m forested corridor at the periphery of the former Champions Golf Course would also allow fauna to move between the retained forest patches. Planting flowering shrubs along the streets for butterflies and aculeata would help connect species highly dependent on connected habitat for dispersal to retained vegetated areas, therefore reducing impact from **Moderate** to **Minor** for species such as common three-ring (*Ypthima pandocus corticaria*). Culverts would facilitate the movement of ground dwelling animals like the Sunda pangolin (*Manis javanica*), reducing impact significance to **Minor**.

7.11.2 Operational Phase

7.11.2.1 Habitats

For the full habitat impact assessment, refer to Appendix L.

7.11.2.1.1 Habitat degradation

Regular park maintenance and signages reminding park visitors of the appropriate park etiquette reduces the likelihood of habitat degradation to **Less likely**. Consequently, impact significance is reduced to **Negligible to Minor**.

7.11.2.1.2 Introduction of exotic species

With the proposed signages, regular patrols, and design measures to deter visitors from venturing off-trail and accessing the aquatic habitats, the likelihood of exotic species is reduced to **Less Likely**. Consequently, the residual impact significance ranges from **Minor** to **Negligible**.

7.11.2.1.3 Change in microclimatic conditions

Due to the nature of the developmental works for this project, the likelihood of altering microclimatic condition remains as **Likely** and residual impact significance remains as **Minor** to **Moderate**.

Table 7-35 Summary of operational phase impacts to habitat receptors

Impact Type	Impact Significance			
	Major	Moderate	Minor	Negligible
Habitat degradation	NA	NA	<ul style="list-style-type: none"> Native-dominated secondary forest Abandoned-land forest Exotic-dominated secondary forest Unmanaged pond (D4) Urban vegetation Concrete drain / canal (D16) 	<ul style="list-style-type: none"> Scrubland / Grassland Forest or rural stream (D1) Naturalised stream (D7, D11, D12, D14, D15)
Introduction of exotic species	NA	NA	<ul style="list-style-type: none"> Native-dominated secondary forest Unmanaged pond (D4) Forest or rural stream (D1) 	<ul style="list-style-type: none"> Abandoned-land forest Exotic-dominated secondary forest Urban vegetation Scrubland / Grassland Concrete drain / canal (D16) Naturalised stream (D7, D11, D12, D14, D15)
Change in microclimatic conditions	NA	<ul style="list-style-type: none"> Native-dominated secondary forest Abandoned-land forest Exotic-dominated secondary forest Urban vegetation 	<ul style="list-style-type: none"> Scrubland / Grassland Forest or rural stream (D1) Naturalised stream (D7) 	

Impact Type	Impact Significance			
	Major	Moderate	Minor	Negligible
		<ul style="list-style-type: none"> • Unmanaged pond (D4) • Concrete drain / canal (D16) 		

7.11.2.2 Flora

There are no potential impacts to plants at the operational phase.

7.11.2.3 Fauna

A summary of the residual impacts to fauna receptors during the operational phase is given in Table 7-36 and detailed in Appendix N.

Table 7-36 Summary of operational phase residual impacts to fauna receptors

Impact type	No. of Species			
	Major	Moderate	Minor	Negligible
Accidental injury or mortality	-	-	81	-
Human disturbance	-	-	73	8
Human-wildlife conflict	-	-	17	64
Light disturbance	-	-	73	8
Loss of/reduction of ecological connectivity	-	1	67	13
Poaching	-	-	54	27

7.11.2.3.1 Accidental injury or mortality

Through the incorporation of bird-friendly building design, speed bumps near retained forest and connectivity infrastructures like the colugo poles and culverts, the likelihood of accidental injury or mortality to fauna can be reduced. Consequently, impact significance is reduced from **Moderate** to **Minor**.

7.11.2.3.2 Human disturbance

Creating sufficient buffer between residential area and retained forest would reduce human disturbance on fauna. In areas retained as parks, random patrols to remind park visitors not to stray off trail maintains the remaining part of the forest areas as an undisturbed area animal. Therefore, **Moderate** impacts area reduced to **Minor** with the implementation of these mitigation measures.

7.11.2.3.3 Human-wildlife conflict

Educational signboards in parks to remind users of the proper park etiquette and rules such as 'no feeding' signs and reminders to keep a distance with animals like the smooth otter (*Lutrogale perspicillata*) reduces the likelihood of conflict occurring. **Moderate** impacts are reduced to **Minor**.

7.11.2.3.4 Light disturbance

Lower building heights near retained forest reduces the amount of light spillage. Along with the restriction of park visiting hours and careful selection of lighting design, the type of light, light shielding and direction, light disturbance can be reduced to **Minor**.

7.11.2.3.5 Loss of or reduction of ecological connectivity

The connectivity recommendations in Section 7.10.1 both within the Study Area and outside of the Study Area can reduce the effects of connectivity loss due to habitat clearance by facilitating fauna movement. Installation of connectivity infrastructure such as colugo poles, culverts provide a safer way for fauna to move between forested patches. Planting flowering shrubs along streets and parks could also create a path in between forest patch for butterflies, wasps, and bees. Enhancing the retained urban vegetation in the north of the former golf course area is an important step as part of establishing the 100m ecological corridor that would connect two areas of high biodiversity concentration - Site A and Site C. Grade separated crossing is also important in ensuring ground connectivity between forest patches especially at the 100m peripheral buffer and in-between Site A and Site B. With the mitigation plan in place, the residual impact significance for most taxon can be reduced to from **Major** to

Minor. However, for aquatic species like the crescent betta (*Betta imbellis*), the loss of connectivity from the removal of freshwater habitat cannot be mitigated unless new interconnected freshwater habitat is introduced at suitable location. Therefore, the likelihood of this impact occurring remains as Possible and impact significance remains as **Moderate** for this species.

7.11.2.3.6 Poaching

Putting up 'no poaching' signage as a reminder for visitors, on top of conducting random patrols and planting out unauthorised entry points to ensure visitors stay on the designate trail would deter poaching activities. The impact significance of the 21 susceptible species are reduced from **Moderate** to **Minor**.

7.12 Recommendations for Further Studies

Given the challenges highlighted, the following further studies are suggested.

7.12.1 Connectivity

7.12.1.1 Rifle Range via culvert

The connectivity outside of the Study Area with Rifle Range Nature Park via a culvert along Jalan Kampong Chantek road elaborated in Section 7.10.1.1.2.1 currently faces the following challenges.

Challenge:

- Technical consideration for the modification of existing infrastructure (PIE flyover)
- A fence blocking fauna exit from the Study Area along Swiss View Road
- Limited options to allow for the safe crossing of fauna across Swiss View Road. A steep terrain between Swiss View road and Jalan Kampong Chantek road

Recommendation for further study:

- Conduct technical study to explore the feasibility implementing this measure

7.12.1.2 Central Catchment via Ecolink

Referring to the recommendation given in Section 7.10.1.1.2.2 some challenges and recommendations given below.

Challenge:

- Location selection for the bridge
- Construction engineering and design considerations
- Gaps in environmental baseline data on CCNR side

Recommendation for further study to determine a suitable location for the ecolink:

- Vegetation profile study on CCNR side
- Topography study on CCNR side
- Technical study of existing infrastructures such as underground water and gas pipe

7.12.1.3 Eng Neo Ave via culvert and Colugo poles

The installation of culverts and colugo poles along Eng Neo Avenue were recommended as a way to facilitate fauna movement in view of road expansion works in Section 7.10.1.2.3.2. Listed are the possible challenge and recommendations to overcome them.

Culvert

Challenges:

- Location and design for culvert (Figure 7-87, position 2) to avoid water ponding issue within the culvert

Recommendation for further study

- Technical study of existing infrastructure and site condition
- Further study into the design of the culverts e.g. size, planting, shape, angle

Colugo pole

Challenges:

- Usage of the poles by colugo

Recommendation for further study:

- Monitoring programmes to study the effectiveness of installed poles. Collected data would inform if more poles or further mitigation is required to further increase connectivity especially if there are significant observation of such incidents.

7.12.1.4 Ecological corridor at the former golf course

With reference to Section 7.12.1.4, the creation of a 100 m ecological corridor in the north of the former golf course will likely face the following challenge.

Challenges:

- Planted trees requires time to grow to a suitable size that can facilitate colugo movement between the retained forest between Site A and Site C.

Recommendation for further study:

- Location and number of colugo poles to be installed while the plant trees grow
- Monitoring programmes to study the effectiveness of installed poles. Data to inform if more poles are required to further increase connectivity

7.12.2 Creation and Enhancement of Freshwater habitats

For the creation and enhancement of freshwater habitat detailed in Section 7.10.1.3.1, listed are some possible challenges.

Challenges:

- Selection of a suitable location to create a new freshwater habitat
- Risk of exotic species being released by the public into created freshwater habitats and enhanced waterbodies where native species are being reintroduced

Recommendation for further study:

- For freshwater habitat creation, study the hydrology, drainage, and catchment size of the proposed location with consideration of incoming development in the area.
- Strategically reintroduce native species in aquatic habitats less accessible to the public, and design park trails with this in mind

7.13 Cumulative Impacts

During construction phase of this project, there would be concurrent development of the Cross Island Line Station at Site B and in the East of the Study Area opposite PIE.

Construction phase

Habitat loss and mortality for flora will not see any additional impacts as these have already been accounted for through the proposed preliminary land use plan. For fauna, there will be an increase in air and noise disturbances. However, this can potentially be mitigated through proper directional site clearance (towards retained forest) and phasing of construction works. Overall, the construction phase cumulative impacts will not result in significant increase or deviation from the assessed impacts in Section 7.9.1.

Operational phase

During operation phase, Cross Island Line construction would be complete and would act as a functioning MRT station. Traffic, light and noise are expected to increase in the Project Area. Hence, this could result in a slight increase in impacts to fauna within the Study Area.

7.14 Summary of Key Findings

The Study Area is largely non-vegetated and/or occupied by urban vegetation. These comprise more than 50% of the total area. One of the key findings from the present Study is the remarkably rich and diverse native-dominated secondary forest. The largest continuous patch was recorded in Site C, but scattered fragments of equally diverse native patches were also recorded in all other sites. Altogether, native forest makes up close to 10% of the total area. The other habitat types recorded in the Study Area are abandoned-land forest, exotic-dominated secondary forest, scrubland, and waterbodies.

Many plant species recorded in the native patches can also be found in the CCNR and are less commonly encountered in other disturbed secondary forests outside the nature reserves in Singapore. Some plant species associated with older forests and are rare even in the NSSF were recorded in the Study Area. This has contributed to the high overall native species richness, a feature characteristic of late-successional forests in Singapore. Nationally threatened species are widespread and occur in high numbers, and large parent trees also occur in the forested areas. While most plants of conservation significance were concentrated in the native fragments, several specimens were also recorded in the adjacent abandoned-land and exotic-dominated secondary forests, a positive indication that native propagules are dispersing into latter.

Field survey from 2019 to 2024 documented 407 fauna species, dominated by birds (111 species) and butterflies (101 species). Species of conservation significance are distributed across the Sites, including the globally threatened straw-headed bulbul (*Pycnonotus zeylanicus*) and Sunda pangolin (*Manis javanica*). In total 25 fauna species of conservation significance was recorded. Both species was found across the Study Area, and the Sunda Pangolin (*Manis javanica*) showed signs of breeding activity. A higher number of species of conservation significance were found in Site A likely due to its size and intact natural habitats. It is also noteworthy that Site A is a hotspot for the fiery coral-tail (*Cerigriion chaoi*), which were found in relatively high densities than commonly observed in other sites in Singapore. Site C recorded the highest number of Sunda colugo (*Galeopterus variegatus*) sighting (15 recorded), making it a colugo stronghold of the Former Turf Club area. Overall, the Study Area's proximity to the BTNR and CCNR, and the presence of good habitat, there is a high chance of expecting rare fauna species here.

The table below summaries the results of the biodiversity impact assessment.

Table 7-37 Summary of biodiversity impact assessment

Potential Source of Impact	Impact Significance with Minimum Control	Key Mitigation Measures	Residual Impact Significance with Mitigation Measures (if required)
Construction Phase			
Habitats	Negligible to Major	<ul style="list-style-type: none"> Avoid native-dominated secondary forest if possible. Maintain hoarding integrity to prevent vegetation clearance outside the agreed work space and restrict entry into retained forest. 	Negligible to Major
Flora	Minor to Major	<ul style="list-style-type: none"> Avoid plant removal, or transplant if unavoidable 	Negligible
Fauna	Negligible to Major	<ul style="list-style-type: none"> Create ecological connectivity within the project area and nearby green networks 	Negligible to Major

Potential Source of Impact	Impact Significance with Minimum Control	Key Mitigation Measures	Residual Impact Significance with Mitigation Measures (if required)
		<p>to allow dispersal of fauna affected by development</p> <ul style="list-style-type: none"> Avoid night works and incorporate lighting strategies to reduce light disturbance Construct connectivity structure Pre-felling inspection, wildlife response plan, biodiversity awareness training 	
Operational Phase			
Habitats	Negligible to Major	<ul style="list-style-type: none"> Put up signages to remind park visitors not to release exotic plants or stray off trails. 	Negligible to Moderate
Flora	N.A.	N.A.	N.A.
Fauna	Negligible to Major	<ul style="list-style-type: none"> Incorporate-bird friendly building designs Construct connectivity structures Road calming measures near retained forest Plant flowering shrubs along streets and parks Signages for park etiquette Restrict park opening hours Conduct random patrol to deter poaching activities Include macaque proofing into building designs, such as a 6m buffer between building façade and tree lines or other potential climbing structures. Macaque proof bins should also be used as part of the waste management plans. Otter-proof housing premises using adequate fencing, particularly in areas with fish ponds 	Negligible to Moderate