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Contract CR2005
Provision of Services to Conduct Environmental
Impact Study

Environmental Impact Study (Turf City and Holland Plain)
Study Stage: Final

Volume 2 of 5

Submitted by:
AECOM Singapore Pte Ltd

Submitted to:
Land Transport Authority

07 October 2022

7.   Biodiversity

7.1   Introduction

The Biodiversity Impact Assessment aims to establish baseline biodiversity information of the two Study Areas and evaluate the impacts of the proposed construction works on existing flora and fauna.

Baseline information was first gathered through reviews of past and present biodiversity records, published literature, and in consultation with taxonomic experts. Actual field surveys were then carried out to verify and supplement the data.

Through the desktop and field assessments, important habitats, species of flora and fauna of conservation significance were identified. The information was then used to evaluate the extent of the impacts of construction works. Mitigation measures were then recommended to reduce and/or minimise the impacts.

This section reports biodiversity field findings from surveys conducted from 14th September 2021 to 23rd May 2022 at Sites I to IV.

7.2   Methodology

7.2.1   Study Areas

The floristic and faunistic field assessments covered a total area of 30.0 ha (Table 7-1), comprising two worksites and adjacent areas of known or potential ecological sensitivity. Tree mapping surveys covered a total area of 13.0 ha (Table 7-1; Figure 7-1).

Table 7-1 Size of Floristic and Faunistic Study Areas and Tree Mapping Study Areas

Site	Worksite	Flora and Fauna (ha)	Tree Mapping (ha)
Sites I and II	CR14	16.9	4.0
Site III	CR14	2.9	2.9
Sites IV and V	CR15	10.2	6.1
Total area	**–**	**30.0**	**13.0**

HOLLAND PLAIN

Site IV

Site V

TURF CITY

Site III

Site II

Site I

0   100   200 m

Legend

▢ Study Area

▢ Tree Mapping Study Area

▢ Base Scenario Construction Worksite Footprint and Proposed CRL Alignment (Base)

▨ Road works

N

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	CONTRACT CR2005 ENVIRONMENTAL IMPACT STUDY (TURF CITY AND HOLLAND PLAIN)	**STUDY AREAS FOR BIODIVERSITY SURVEYS AND TREE MAPPING AT TURF CITY AND HOLLAND PLAIN**	
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Note: Source of basemap - Google Earth Map

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7.2.2 Nomenclature, Taxonomy and Definitions

7.2.2.1 Nomenclature and Taxonomy

The nomenclature and taxonomy for each taxonomic group follows these key references:

- Plants: Chong et al. (2009), World Checklist of Selected Plant Families and Plants of the World Online

- Aculeate hymenopterans: Soh and Ngiam (2013) and Ascher and Pickering (2018)

- Odonates: Soh et al. (2019)

- Butterflies: Khew (2015)

- Freshwater fish: Suzuki et al. (2015), Kottelat (2013) and Ho et al. (2016)

- Freshwater decapod crustaceans: Ng (1997) and Cai et al. (2007)

- Birds: Gill and Donsker (2020)

- Amphibians, reptiles, non-volant mammals and bats: Baker and Lim (2012)

7.2.2.2 Flora Classification System

Species of flora were first classified as native, exotic, or cryptogenic, i.e., they do not have a known origin. Native species are then further classified as nationally Extinct or Extant, i.e., still surviving. Extant native species are additionally classified as Common, Vulnerable, Endangered, or Critically Endangered. Exotic species are classified as Cultivated Only, Casual, or Naturalised (Table 7-2). The definitions were adapted from Chong et al. (2009).

Table 7-2 Classification System for Species of Flora

Origin	Status	Definition
Native	*Species that have originated in an area without human intervention or have arrived there without intentional or unintentional intervention of humans*	
	Extinct	Native species that have not been seen or collected locally from the wild in the last 30 years
	Extant	Native species that are common, i.e., have more than 1,000 mature individuals locally, vulnerable, endangered, or Critically Endangered
Exotic	*Species that are present in an area as a result of intentional or unintentional human involvement*	
	Cultivated Only	Exotic species that persist locally as a result of cultivation or other direct human care
	Casual	Exotic species that persist locally by repeated introductions or limited asexual reproduction and do not form self-replacing populations
	Naturalised	Exotic species that persist locally without direct human intervention and are self-replacing, usually through sexual reproduction
Cryptogenic	*Species with no historical or biogeographical evidence of being exotic, yet are restricted to only habitats modified or disturbed by humans*	

7.2.2.3 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 Chong et al. (2009) as nationally Vulnerable, Endangered, Critically Endangered, or Presumed Extinct (which indicates a rediscovery) (Table 7-3)—were 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 is 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. If the origin of a threatened species population is disputable or difficult to determine, we corroborated findings from field surveys of fauna and/or adopt the more conservative approach by considering them of conservation significance. In carrying out such assessments, we are able to prioritise conservation needs and focus resources in conserving them.

Faunal species of conservation significance include only threatened species. Threatened species of fauna are those listed as Vulnerable, Endangered, Critically Endangered, or Extinct under its global or national status. Both global and national conservation statuses were considered to provide a holistic view of the conservation value of the Study Areas. The national conservation statuses reference the Singapore Red Data Book (SRDB) (Davison et al., 2008) and other more updated local checklists, where available, such as Soh et al. (2019) for odonates, Jain et al. (2018) for butterflies and NParks (2021) for amphibians, reptiles, and mammals. The global conservation status reference the Red List of Threatened Species by the International Union for Conservation of Nature (IUCN, 2012).

Few resources with the national conservation status of species from the order Hymenoptera are available. Only a few bee species are listed in the SRDB (Davison et al., 2008). A paper on the updated conservation status of bees and wasps found in Singapore by Ascher et al. is in preparation. However, no comparable studies have been done for stinging wasps. For the purpose of this Study, the assessment was conducted based on personal records by Lee JXQ, together with specimen records in the Lee Kong Chian Natural History Museum (LCKNHM) and NUS' Insect Diversity Lab (IDL) collections. The assessment adopts the same conservation statuses used in Ascher et al. (in prep).

Notable records of non-threatened species include species that are deemed of conservation interest within the Study Areas. The Study Areas may provide important habitats for these species, including breeding sites. Species deemed sensitive to construction impacts may also be highlighted as a notable record and regarded as a species of conservation significance.

Table 7-3 Definition of Each Global and/or National Conservation Status Following the IUCN Red List (IUCN, 2012) and Singapore Red Data Book (Davison Et Al., 2008)

National conservation status	Definition
Vulnerable (VU)	Species facing a high risk of extinction in the wild/in Singapore
Endangered (EN)	Species facing a very high risk of extinction in the wild/in Singapore
Critically Endangered (CR)	Species facing an extremely high risk of extinction in the wild/in Singapore
Presumed Nationally Extinct (EX)	There is no reasonable doubt that the last reproductively capable individual within Singapore has died or disappeared in the last 50 years (fauna) or 30 years (vascular plants).

7.2.3   Desktop Assessment

Historical and present-day land use of the Study Areas were reviewed. Information on land use history was primarily gathered from old maps in the online collection of the National Archives of Singapore (NAS) as well as historical maps on the OneMap and the National University of Singapore (NUS) Libraries portals. A list of faunal species that are likely to occur at the site ("species of probably occurrence") was also generated using information on past faunal records and existing habitat types and past fauna records up to 2 km from the Study Areas.

Past and present floristic as well as faunistic species composition were examined using relevant key references that include books, scientific publications, unpublished literature, and online databases. Sources of databases include The Biodiversity of Singapore by Lee Kong Chian Natural History Museum (LCKNHM, 2020), Flora and Fauna Web by National Parks Board (NParks, 2020) and iNaturalist. Other key references include the Singapore Red Data Book (Davison et al., 2008), Singapore Biodiversity Records, encyclopedia on Singapore's biodiversity (Ng et al., 2011) and the database of flora and fauna records compiled by Camphora Pte. Ltd.

Local and regional references were examined for the various taxonomic groups:

- Plants (Boo, 1996; Keng, 2003; Chong et al., 2009);

- Aculeate hymenopterans (Soh & Ngiam, 2013; Ascher & Pickering, 2018; BOS);

- Odonates (Tang et al., 2010; Ngiam & Cheong, 2016; Soh et al., 2019);

- Butterflies (Khew, 2015; Jain et al., 2018; Theng et al., 2020);

- Freshwater fish (Ng & Lim, 1997; Giam et al., 2011; Ho et al., 2016; Tan et al., 2020);

- Freshwater decapod crustaceans (Ng, 1997; Cai et al., 2007; Wowor & Ng, 2010, Yeo, 2010; Ho et al., 2016);

- Birds (NSS, 2020; Singapore Birds; Singapore Bird Group; Singapore Birds Project);

- Herpetofauna, (Baker & Lim, 2012);

- Non-volant mammals and bats (Corlett, 1992; Teo & Rajathurai, 1997; Brook et al., 2003; Lane et al., 2006; Chua & Lim, 2011; Baker & Lim, 2012).

7.2.4   Floristic Field Assessment

The field assessment for flora consists of (1) vegetation mapping, (2) floristic surveys, and (3) tree mapping.

7.2.4.1   Vegetation Mapping

A preliminary vegetation map for the Study Areas was prepared based on visual interpretations of satellite images from Google Earth 7.1.2.2041 (Google Inc. 2013). Preliminary classification of the habitat types—for example, forest, grassland, or managed 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 the GPS receiver. Photographs were also taken. The boundaries of each habitat type were tracked on the GPS receiver and mapped out on Google Earth 7.1.2.2041. The classification of forest types referenced Yee et al. (2016) and NParks (2020).

7.2.4.2   Floristic Surveys

All plants observed in the Study Areas during floristic surveys were identified to species whenever possible. A checklist of plant species recorded from the present floristic surveys was compiled. 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 were 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.

7.2.4.3   Plant Species of Conservation Significance

Threatened species of flora—i.e., listed in Chong et al. (2009) as nationally Vulnerable, Endangered, Critically Endangered, or Presumed Extinct (which indicates a rediscovery)—were assessed to determine whether they are of conservation significance (Section 7.2.2.3). The geographic coordinates of plants of conservation significance were marked using a Global Positioning System (GPS) handheld 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 geographic coordinates of the approximated centre of the area are marked using the GPS receiver.

7.2.4.4   Large Plant Specimens

The GPS handheld receiver was used to record locations of all trees of $\geqslant$ 3.0 m girth, as well as bamboo clusters and strangling *Ficus* species of $\geqslant$ 3.0 m spread. We identified the individuals to species, whenever possible. Girth (for trees) and spread (for bamboo clusters and strangling *Ficus* species) were measured and estimated, respectively. The height of the specimens was also estimated and recorded.

7.2.4.5   Other Plant Specimens of Value

Locations of other specimens that do not meet the minimum size requirement detailed in Section 7.2.4.4 above but are of value, were also recorded using the GPS receiver. Examples of such specimens include bamboo clusters of

< 3 m spread but may be important refugia for rare bamboo bats, amongst others, as well as exotic trees with raptor nests (Table 7-2).
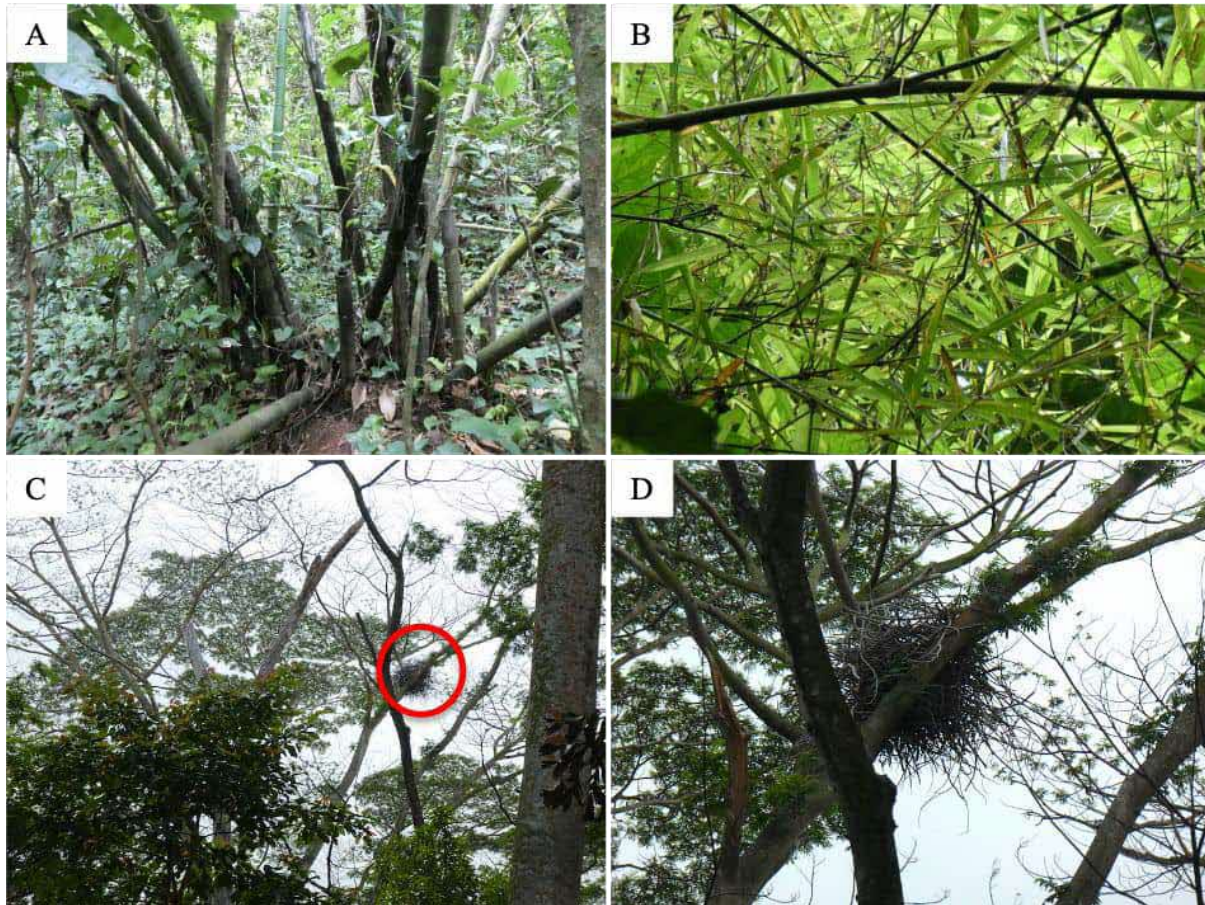

Figure 7-2 Other Plant Specimens of Value. (A) Bamboo Cluster of < 3 m Spread; (B) A Close-up of the Bamboo Leaves; (C) Raptor Nest on a Falcataria moluccana Tree; (D) A Close-up of the Raptor Nest.

7.2.4.6   Tree Mapping

All trees, single-stemmed palms, and strangling *Ficus* species of ≥ 1.0 m girth or spread, mangrove trees of ≥ 0.3 m girth, as well as species of conservation significance of ≥ 0.3 m girth or spread were mapped and tagged with a unique serial number. Single-stemmed palms are defined in this Study as having one obvious and erect stem (Table 7-3). The geographic locations, girth/spread and height were also recorded.

Figure 7-3Single-Stemmed Palms, Defined in this Study as Having One Obvious and Erect Stem. (A–B) Elaeis guineensis; (C) Caryota no.

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) was used to record the geographic locations of the specimens using the SVY21 plane coordinate system. Where there are clusters of specimens of the same species occurring within 1–2 m of each other, only one specimen was tagged, and its location marked using the DGPS.

Figure 7-4 (A) CHC® Navigation HCE320 GNSS Data Controller (Source: Geo-matching.com); (B) How It is Used in the Field

7.2.5   Faunistic Field Assessment

7.2.5.1   Targeted Field Surveys

Faunistic field surveys 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), and (7) freshwater aquatic fauna (fish, decapod crustaceans and molluscs). All observations of notable species from the aforementioned taxa were recorded if seen outside the stated survey times.

The routes, locations and number of sampling units were finalised upon completion of all site reconnaissance surveys (Figure 7-5; Figure 7-6). Table 7-4 summarises all the surveys that will be carried out for fauna. 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 were recorded using a handheld GPS (Garmin GPSMAP 64s). The number of individuals observed were also documented. Field surveys for fauna was carried out over four (4) months, from September–December 2021.

A summary of the survey methods for each faunal group is in Table 7-4 and described in the following section.

Table 7-4 Description of Sampling Locations at Each Study Area

Site	Description	Length/No. of Sampling Units)
Turf City		
B (Sites I and II)	Forested area adjacent to Fairway Quarters	1.93 km
D (Site III)	Forested Area within Racecourse Oval	0.72 km
D/S14 (waterbody in Site I)	Stream runs in the eastern part of the Study Area at Site I	0.45 km (2 aquatic sampling points)
D/S15 (stream in Site I)	Stream runs in the western part of Study Area at Site I	0.51 km (5 aquatic sampling points)
D/S8 (stream in Site III)	Stream runs through the length of the Study Area at Site III	0.62 km (5 aquatic sampling points)
No. terrestrial camera traps	Deployed on ground/base of tree	7
Holland Plain		
HW (Sites IV and V)	Forested areas adjacent to Rail Corridor and at Holland Plain	1.45 km
FW5 (waterbody in Site IV)	Waterbody north of Site IV	0.05 km (1 aquatic sampling point)
Freshwater marsh (waterbody in Site V)	Freshwater marsh area north of Site V	0.1 km (1 aquatic sampling point)
No. terrestrial camera traps	Deployed on ground/base of tree	3

HOLLAND PLAIN

Site IV

Site V

TURF CITY

Site III

D/S8

Site II

D/S16

D/S15

Site I

0   100   200 m

Legend

- 🟥 Study Area
- ⬜ Worksite and alignment
- ▨ Road works

Vegetation
- 🟩 Native-dominated secondary forest
- 🟩 Mixed forest
- 🟩 Abandoned-land forest
- 🟫 Waste woodland
- 🟩 Scrubland and herbaceous vegetation
- 🟫 Managed vegetation
- 🟦 Freshwater marsh

- 🟪 Others (infrastructure)
- 🟦 Waterbody
- ▬ Terrestrial Sampling Route 1 (Turf City only)
- ▬ Terrestrial Sampling Route 2
- 🔵 Aquatic sampling point

N

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(TURF CITY AND HOLLAND PLAIN)**

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Figure Title :

**TERRESTRIAL SAMPLING ROUTES
AND AQUATIC SAMPLING POINTS AT
TURF CITY AND HOLLAND PLAIN**

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HOLLAND PLAIN

TURF CITY

CT_20
Site IV
CT_21
Site V
CT_22

CT_23
CT_14
Site III
CT_12
Site II
CT_11
CT_19
Site I
CT_15
CT_13

0   100   200 m

N

Legend

- ☐ Study Area
- ☐ Worksite and alignment
- ☒ Road works

Vegetation
- ■ Native-dominated secondary forest
- ■ Mixed forest
- ■ Abandoned-land forest
- ■ Waste woodland
- ■ Scrubland and herbaceous vegetation
- ■ Managed vegetation
- ■ Freshwater marsh

- ■ Others (infrastructure)
- ■ Waterbody
- ▬ Terrestrial Sampling Route 1 (Turf City only)
- ▬ Terrestrial Sampling Route 2
- ● Camera trap

Note: Source of basemap - Google Earth Map

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Figure Title :

**LOCATIONS OF TERRESTRIAL
CAMERA TRAPS AT TURF CITY AND
HOLLAND PLAIN**

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HOLLAND PLAIN

Site IV
FT_10
FT_11
Site V

TURF CITY

Site III
FT_06
Site II
FT_07
FT_04
FT_03
Site I
FT_08
FT_05
FT_09

0   100   200 m

Legend

- Study Area
- Worksite and alignment
- Road works

Vegetation
- Native-dominated secondary forest
- Mixed forest
- Abandoned-land forest
- Waste woodland
- Scrubland and herbaceous vegetation
- Managed vegetation
- Freshwater marsh

- Others (infrastructure)
- Waterbody
- Terrestrial Sampling Route 1 (Turf City only)
- Terrestrial Sampling Route 2
- Fish trap

Note: Source of basemap - Google Earth Map

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Qualified Person Endorsement : NA

LTA Endorsement : NA

Consultant :

AECOM

Project Title :

CONTRACT CR2005 ENVIRONMENTAL IMPACT STUDY (TURF CITY AND HOLLAND PLAIN)

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LOCATIONS OF FISH TRAPS AT TURF CITY AND HOLLAND PLAIN

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Table 7-5 Summary of Survey Methods for Each Faunal Group

Survey Type	Taxon	Timing (h)	Duration	Sampling Unit	Technique
Diurnal transect surveys	Butterflies	0900–1500	20–30 minutes per transect	200-m continuous transects along a sampling route	Visual only; up to 25 m left, right, and front of surveyor
	Odonates (damselflies and dragonflies)	0900–1500	20–30 minutes per transect	200-m continuous transects along a sampling route	Visual only; up to 25 m left, right, and front of surveyor
	Hymenopterans (bees and wasps)	0900–1000; 1700–1900	20–30 minutes per transect	200-m continuous transects along a sampling route	Visual only; up to 25 m left, right, and front of surveyor
Nocturnal transect surveys	Mammals (bats)	2000–2300	20–30 minutes per transect	200-m continuous transects along a sampling route	Visual only; up to 25 m left, right, and front of surveyor
Diurnal and nocturnal transect surveys	Herpetofauna (amphibians and reptiles)	0700–1000; 2000–2300	20–30 minutes per transect	200-m continuous transects along a sampling route	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	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	Visual and auditory; up to 50 m left, right, and front of surveyor
Aquatic point counts*	Odonates (damselflies and dragonflies)	0900–1500	5 minutes per point	Sampling points at fresh-waterbodies (intervals vary with waterbodies)	Visual only; up to 25 m from sampling point or the extent of waterbodies, whichever is smaller
	Herpetofauna (amphibians and reptiles)	0900–1500; 2000–2300	5 minutes per point	Sampling points at fresh-waterbodies (intervals vary with waterbodies)	Visual only; up to 25 m from sampling point or the extent of waterbodies, whichever is smaller
Camera trapping	Mammals (non-volant)	24 hours a day	60 days	Traps spaced at least 200 m apart	Infrared motion sensing
Bioacoustics surveys	Mammals (bats)	2000–2300	20–30 minutes per transect	200-m continuous transects along a sampling route	Auditory only
Roost emergence surveys	Mammals (bamboo bats only)	1830–2100	-	Bamboo clusters (if any)	Visual and auditory

Survey Type	Taxon	Timing (h)	Duration	Sampling Unit	Technique
Push, scoop, and seine netting**	Freshwater aquatic fauna (fish)	Daytime	-	Sampling points inside waterbodies	-
Minnow trapping**	Freshwater aquatic fauna (fish and decapod crustaceans)	Overnight	One day one night	Traps (intervals vary with length of stream)	Baited

Notes:

* Aquatic point counts for odonates and herpetofauna were only carried out at identified natural streams, naturalised streams and waterbodies (see Figure 7-5)

** Surveys for aquatic fauna were only carried out if suitable waterbodies identified

7.2.5.1.1   *Butterflies*

Diurnal transect surveys were carried out for adult butterflies along 200-m continuous transects on a sampling route (Figure 7-5) between 0900h and 1500h. 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.

7.2.5.1.2   *Odonates (Dragonflies and Damselflies)*

Diurnal transect surveys were carried out for adult damselflies and dragonflies along 200-m continuous transects on a sampling route (Figure 7-5) between 0900h and 1500h. Owing to difficulties in sampling and identification, aquatic larvae and exuviae were surveyed. Adult odonates were identified visually (with binoculars where necessary), photographed or caught using insect nets, if required. Captured individuals were released immediately after identification.

7.2.5.1.3   *Aculeate Hymenopterans (Bees and Wasps)*

Diurnal surveys were carried out for aculeate hymenopterans along 200-m continuous transects on a sampling route (Figure 7-5) between 0900h and 1500h. Hymenopterans were identified visually, photographed or caught using insect nets, if required. Captured individuals were released immediately after identification.

7.2.5.1.4   *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 (Figure 7-5). As herpetofauna occupy a wide range of habitat types, both the diurnal and nocturnal surveys also involved active searches for individuals on the ground, below rocks, logs, leaf litter and debris, in the water, and/or on vegetation. Torches and/or headlamps were used to elicit eyeshine during nocturnal surveys. Vocalising fauna were 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.

7.2.5.1.5   *Birds*

Diurnal (0700h–1000h) and nocturnal (2000h–2300h) surveys were carried out for birds along 200-m continuous transects on a sampling route (Figure 7-5). 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.

7.2.5.1.6   *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 (Figure 7-5). Both the diurnal and nocturnal surveys also involved searches in burrows and tree holes. Tracks, scats and holts 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 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.

Ten terrestrial camera traps (one camera trap for every 4 ha of forest) were deployed – five at the (a) Forested area adjacent to Fairway Quarters (Sites I and II), two at the (b) Forested area within Racecourse Oval (Site III), and three at the (c) Forested area adjacent to Rail Corridor and next to Holland Plain (Sites IV and V) (Figure 7-6). Three camera traps were added to areas (a) and (b) of the Study Area as part of a concurrent ongoing contract. The additional sampling effort near areas (a) and (b) was necessary given that area (a) contains an intact forest and is close in proximity to CCNR. Area (a) and its adjacent area (b) are likely to host relatively more biodiversity and sensitive receptors. 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 habitat types.

Each camera trap was set up at approximately 20–30 cm above ground (Figure 7-8). They operated 24 hours a day and were programmed to record 10-second footage per motion trigger with a 10-second quiet period following each trigger. Each camera trap was deployed for 60 days. The two camera trap models that were used are (1) Browning Strike Force Explorer (BTC-EXP) and (2) Browning Dark Ops HD Pro (BTC-5HDP).

Figure 7-8 Example of a Camera Trap Setup.

7.2.5.1.7   *Mammals (Bats Only)*

Acoustics surveys were carried out for bats along 200-m continuous transects on a sampling route (Figure 7-5) between 2000h and 2300h. 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.

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

7.2.5.1.8   *Freshwater aquatic fauna (fish, decapod crustaceans and molluscs)*

Surveys involved diurnal (0900h–1500h) five-minute visual point counts at sampling points along aquatic sampling routes and minnow trapping (Figure 7-5; Figure 7-7). Visual surveys were conducted, in addition, minnow traps were baited with halal meat (e.g., sausage or liver) and systematically deployed at locations with deeper water (Figure 7-9B). Traps were left overnight, then checked and removed the following morning. Aquatic surveys (visual point counts and minnow trapping) were only carried out if suitable waterbodies were identified within the Study Area.

Figure 7-9 Minnow Trapping

7.2.6 Data Analyses

7.2.6.1.1 Camera Trapping

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

7.2.6.1.2 Acoustic Bat Recordings

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 kHz, duration of 2–500 millisecond (ms), maximum inter-syllable gap of 500 ms and a minimum of 2 pulses. These files were then visually processed to identify bat species based on call structures, peak frequency, minimum frequency and call duration Pottie et al. (2005). They were identified with reference to those in Pottie et al. (2005), which provides echolocation signatures for bats in Singapore, and other relevant references (Collen, 2012; Hughes et al., 2011).

7.2.6.1.3 Species of Conservation Significance Distribution Maps

The locations of fauna of conservation significance recorded during targeted surveys as well as incidental records outside the taxon-targeted surveys were presented as distribution maps to show areas where most fauna were seen. All maps were prepared and generated using the mapping software QGIS 3.40 (Quantum GIS Development Team, 2017).

7.2.6.1.4 Taxon Sampling Curves

Taxon sampling curves were plotted for the surveys conducted for seven taxa: aculeate hymneoptera, butterflies, odonates, amphibians, reptiles, birds, non-volant mammals, and molluscs.

The observed sample of incidence data was used to estimate sample coverage and species richness. 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.

Sample coverage refers to "the proportion of the total number of individuals in a community that belong to the species represented in the sample" [P-4]. The curve was extrapolated to provide an estimation of species richness and sample coverage if sample size was doubled. The associated standard error and 95% confidence interval were also computed. Standard error represents the range of uncertainty of the estimate, while 95% confidence interval is the interval in which there is a 0.95 probability of containing the estimated true species richness.

As some species will always remain undetected, total species richness had to be estimated via extrapolation. This was done using the Chao estimator. All statistical analyses were carried out in the statistical programming environment R version 3.4.3 [O-4] using the "iNEXT" package 2.0.20 [W-97].

7.3 Baseline Findings

7.3.1 Turf City: Sites I, II and III near Eng Neo Avenue Forest

The Study Area in Turf City comprises three zones, namely, the forested area adjacent to Fairway Quarters (Sites I and II) and the forested area within Racecourse Oval (Site III). As the zones are fragmented and do not form a continuous forested habitat, the description of the biodiversity baseline findings in Sites I and II, and Site III, are discussed separately.

As a result of a concurrent study [R-6], baseline findings for an extended contiguous area of Site III (additional 3 ha) were also included in this report (Figure 7-10); these findings are presented alongside those for Site III.

PIE

Eng Neo
Avenue Forest

Site III

Site II

Site I

0   100   200 m

N

Note: Source of basemap - Google Earth Map

Legend
- LTA EIS Study Area
- Study Area of concurrent study [R-6]
- Base Scenario Construction Worksite Footprint and Proposed CRL Alignment (Base)
- Road works

-	SEP 2022	JW	EIS (Turf City and Holland Plain)	JAG/NHT	JAG
Rev.	Date	By	Description	Chk'd	App'd

Qualified Person Endorsement :
NA

LTA Endorsement :
NA

Consultant :
AECOM

Project Title :
**CONTRACT CR2005
ENVIRONMENTAL IMPACT STUDY
(TURF CITY AND HOLLAND PLAIN)**

Land Transport Authority
We Keep Your World Moving

Figure Title :
**STUDY BOUNDARIES FOR
CONCURRENT PROJECTS AT
TURF CITY**

Designed	Checked	Approved	Figure No. :	Rev.	Sheet
JW	JAG/NHT	JAG	7-10	-	1 of 1
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JW		SEP 2022	CAD File Name : NA		A3

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7.3.1.1   Habitat Types

Sites I and II

The forested area adjacent to Fairway Quarters comprises two vegetated zones located east (Site I) and west (Site II) of an unnamed road, collectively comprising eight habitat types (Table 7-6; Figure 7-11). Mixed forest is the largest at 5 ha, which is approximately one-third of the Study Area. It occupies the southern half of Site II and majority of Site I, both of which are bordered by roads and other infrastructure. The native-dominated secondary forest, abandoned-land forest, as well as scrubland and herbaceous vegetation, are approximately 3 ha each. There are three patches of native forest, where the largest occupies the northern half of Site II. Abandoned-land forest is mostly in the southern half of Site I. Scrubland and herbaceous vegetation occur in several small patches throughout both sites, where they were found along forest edges and within the forest interior. Managed vegetation is the next largest habitat type, where two patches located in the northern half of Site approximately comprise 8% of the total area. The combined area of the remaining habitat types comprises 10% of both sites, namely, in descending order, infrastructure and two waterbodies. The two naturalised streams run along the edges of the Study Area, with a ponding area located north of the western stream.

Site III

The forested area within Racecourse Oval comprises six habitat types (Table 7-6; Figure 7-11). Waste woodland is the largest at 2.0 ha, followed by abandoned-land forest at 1.6 ha. This habitat type can be found throughout the site, of which, the largest patch is located at the centre. Native-dominated secondary forest and, scrubland and herbaceous vegetation occupy 0.6 ha and 1.1 ha, respectively. The former occupies only the northern portion, while the latter occurs in small fragments throughout the forest edges and within the forest interior. Infrastructure occupies 0.4 ha and is located northwest. Lastly, a 0.2 ha waterbody runs longitudinally along the centre and flows from the north to southwest.

Table 7-6 Absolute (ha) and Relative (%) Sizes of Each Vegetation Type in Sites I to III

	Sites I & II		Forested Area Within Racecourse Oval**	
	ha	%	ha	%
Native-dominated Secondary Forest	2.9	17.1	0.6	10.5
Abandoned-land Forest	3.0	18.0	1.6	27.0
Mixed Forest	5.1	30.4	–	–
Waste Woodland	–	–	2.0	33.7
Scrubland And Herbaceous Vegetation	2.7	16.2	1.1	19.1
Managed Vegetation	1.4	8.3	–	–
Others (Infrastructure)	1.3	7.5	0.4	6.8
Waterbody	0.4*	2.5	0.2	2.9
Total Area	**16.9***	**100.0**	**6.0****	**100.0**

Notes:

*The waterbodies in the Study Area partially overlap with the study boundary but were drawn as complete units beyond the arbitrary study boundary. Hence the total area reported here is slightly larger (by about 0.1 ha) than the original size of the Study Area.

**Includes Study Areas from the concurrent study [R-6].

PIE

Eng Neo
Avenue Forest

Site III

Site II

Site I

0   100   200 m

Legend

Study Area

Base Scenario Construction Worksite Footprint
and Proposed CRL Alignment (Base)

Road works

Others (infrastructure)

Vegetation

Native-dominated secondary forest

Mixed forest

Abandoned-land forest

Waste woodland

Scrubland and herbaceous vegetation

Managed vegetation

Waterbody

N

Qualified Person Endorsement :

NA

LTA Endorsement :

NA

Consultant :

AECOM

Land Transport Authority
We Keep Your World *Moving*

Project Title :

**CONTRACT CR2005
ENVIRONMENTAL IMPACT STUDY
(TURF CITY AND HOLLAND PLAIN)**

Figure Title :

**VEGETATION DISTRIBUTION
AT TURF CITY**

Designed	Checked	Approved	Figure No. :		Rev.	Sheet
JW	JAG/NHT	JAG	7-11		-	1 of 1
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-	SEP 2022	JW	EIS (Turf City and Holland Plain)	JAG/NHT	JAG
Rev.	Date	By	Description	Chk'd	App'd

7.3.1.1.1 *Native-dominated Secondary Forest*

Sites I and II

Native-dominated secondary forest is the third-largest habitat type in Sites I and II (Table 7-6). It is made up of three separate patches, which together add up to 2.9 ha. The features of the native patches here are similar to those in the Eng Neo Avenue Forest in that they are hotspots with a diverse pool of common and rare native species more typically found in old secondary forests.

Unique to the largest patch in Site II is the presence of fairly large trees of rare native species. For example, at least one *Ficus glandulifera* and two *Actinodaphne macrophylla* trees of at least 1 m girth were recorded during floristic surveys. The former is a nationally Critically Endangered species, and the tree was observed to be producing figs at the time of survey (Figure 7-26D), while the latter was thought to be nationally Extinct but has been rediscovered in recent years. These mature specimens play an important role in ensuring constant supplies of native propagules for the continued survival of the threatened species. Such forested patches may, as a result, serve as additional refuge for rare species such that they are also able to persist elsewhere in Singapore outside the Central Catchment Nature Reserve (CCNR).

Also present in this area of hotspot are common native species in the understory, such as *Gironniera nervosa*, *Xylopia malayana*, *Elaeocarpus ferrugineus*, and *Morella esculenta* (Figure 7-12A–D). Although listed as nationally Common, 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 still persist in the area; this tree species—as well as other species belonging to other genera— typically characterises forests in the post-Adinandra belukar successional stage (Gilliland, 1958; Yee et al., 2016).

The corroboration of the aforementioned observations suggest that this native patch could be the remnant of what was initially a continuous native-dominated secondary forest connected to the larger fragment of the CCNR and is in the later stages of forest succession. Another feature that distinguishes this patch from the other native patches in the Study Area is the fairly large population of the nationally Vulnerable *Alsophila latebrosa* at the wetter areas of the northern portion. This tree fern species has often been observed to grow near streams and in areas with wet/poor-draining soils. All in all, this patch of native forest in the western zone hosts a relatively rich and diverse group of native species, which was a surprising find considering the extent of disturbance and fragmentation it had undergone.

The second largest patch of native forest is within the circular horse track in the middle of Site I (Figure 7-11). This patch is mostly surrounded by mixed forest, where previously-planted exotic trees have grown to very large sizes and host a wide diversity of epiphytes and climbers (see Section 7.3.1.1.3 for the habitat description of the mixed forest). One of the epiphytic plants found to be widespread in the area is the nationally Endangered orchid species *Bulbophyllum vaginatum* (Figure 7-27B). The orchids were found to be widespread and abundant throughout the area; many were growing on the exotic trees alongside other epiphytes. Outside this central patch, the orchids were neither observed nor recorded in the Study Area. Also of particular interest in this native area is the presence of large nationally Critically Endangered *Ficus kerkhovenii* stranglers. One mature specimen spanned at least 14 m in width (Figure 7-30A–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. Nevertheless, even in its more commonly-associated coastal habitats, such large specimens are exceedingly rare in Singapore. As such, 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 exceedingly rare *Baccaurea pyriformis* (Figure 7-26C) and *Aporosa nigricans* (Figure 7-27A) (refer to Section 7.3.1.2.2 for the description of these species of conservation significance).

The third and smallest native patch is located north of Site I, surrounded by scrubland and herbaceous vegetation, managed vegetation, a road, and mixed forest. Although small fragmented and surrounded by areas with human disturbances, some species more commonly found in old growth secondary forests persist, such as *Gironniera nervosa* (Figure 7-12A). Large tembusu trees (*Cyrtophyllum fragrans*) were also recorded here, as well as throughout the Study Area. This slow-growing species, although planted in streetscapes, takes a long time to reach maturity. Hence, the maturity of these trees suggests that they germinated before commercial markets started to sell tembusu trees for streetscape planting. This implies that the specimens are most likely of native stock and belong to the native forest that was present prior to significant human disturbance.

The close proximity of the CCNR and Eng Neo Avenue Forest allow for constant and steady dispersal rates of propagules among the native patches. If left undisturbed, the entire area may eventually regenerate into a late-stage successional forest.

Figure 7-12 Nationally Common Native Plant Species in the Native-Dominated Secondary Forest in Sites I and II. (A) *Gironniera nervosa*; (B) *Xylopia malayana*; (C) *Elaeocarpus ferrugineus*; (D) *Morella esculenta*.

Site III

Native-dominated secondary forest occupies 0.6 ha and is located mainly at the northern portion of the forested area within Racecourse Oval. This habitat type mainly comprises native species, such as Malayan banyan (*Ficus microcarpa*), *Syzygium lineatum*, tembusu (*Crytophyllum fragrans)* and *Ixonanthes reticulata*, as well as native pioneer species, such as *Macaranga gigantea.* Similar to Sites I and II, some native species recorded here are uncommon in disturbed secondary forest. These include *Aporosa frutescens*, *Timonius wallichianus*, *Gironniera nervosa* and *Prunus polystachya* (Figure 7-13B–E). Other species of conservation significance also found within this habitat type include the nationally Vulnerable *Macaranga griffithiana* (Figure 7-13F)*, Oncosperma tigilarium,* and multiple clusters of the nationally Critically Endangered climber*, Piper pedicellosum,* in the forest understory (Section 7.3.1.2.2).

The area is currently used by mountain bikers and other recreational activities. Hence, this habitat type was observed to be more disturbed and sparsely vegetated compared to Sites I and II. Nevertheless, native species 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 basal 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.
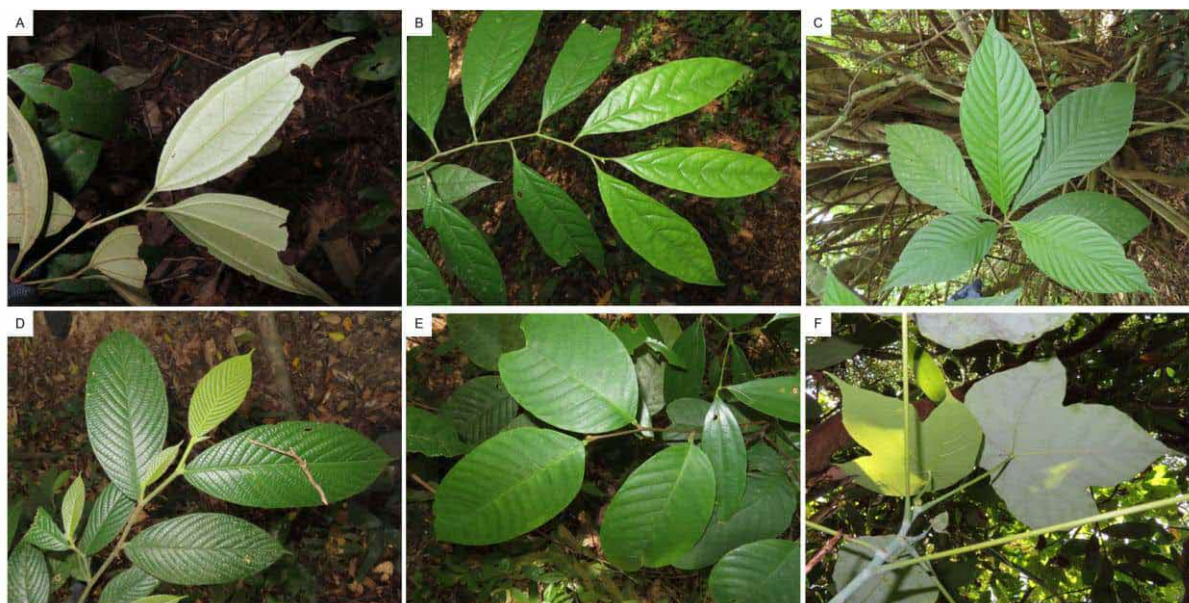
Figure 7-13 Native Species Found in the Native-dominated Secondary Forest in Site III. (A) *Rhodamnia cinerea*; (B) *Aporosa frutescens*; (C) *Timonius wallichianus*; (D) *Gironniera nervosa*; (E) *Prunus polystachya,* and; (F) Nationally Vulnerable *Macaranga griffithiana*

7.3.1.1.2 *Abandoned-land Forest*

Sites I and II

Abandoned-land forest (3.0 ha; 18.1%) is the second largest habitat type in the forested area adjacent to Fairway Quarters, located at the southern half of Site I and middle portion of Site II. For the former, old topographical maps dating between 1974 and 1983 (see Section 4.4.1) show that the area was "sundry tree cultivation", which is a term previously used to refer to abandoned-land forest (Yee et al., 2016). Remnant trees from past plantations occupy the canopy layer, mostly by the African tulip (*Spathodea campanulata*), mango (*Mangifera* sp.; Figure 7-14C), rambutan (*Nephelium lappaceum*; Figure 7-14A), and durian (*Durio zibethinus*; Figure 7-14B). The understorey is largely dominated by wild cinnamon (*Cinnamomum iners*), *Aphanamixis polystachya*, rambutan saplings, with African oil palms (*Elaeis guineensis*; Figure 7-14D) scattered across this habitat type. Findings of threatened native plant species, such as the nationally Vulnerable *Horsfieldia polyspherula* and *Litsea firma*, Endangered orchid *Bulbophyllum vaginatum*; Critically Endangered *Calophyllum inophyllum* and *Piper pedicellosum* were occasionally recorded in this habitat type as well.

In the middle section of both sites, majority of the canopy layer was dominated by the African tulip trees. The understorey is also made up of diverse plant species, such as the wild cinnamon, rambutan, *Claoxylon indicum*, and fishtail palm (*Caryota mitis*). Some specimens belonging to species of conservation significance, like the nationally Endangered *Calophyllum rubiginosum* and *Ficus globosa*, and nationally Vulnerable *Guioa pubescens* and *Planchonella obovata*, were also found here.
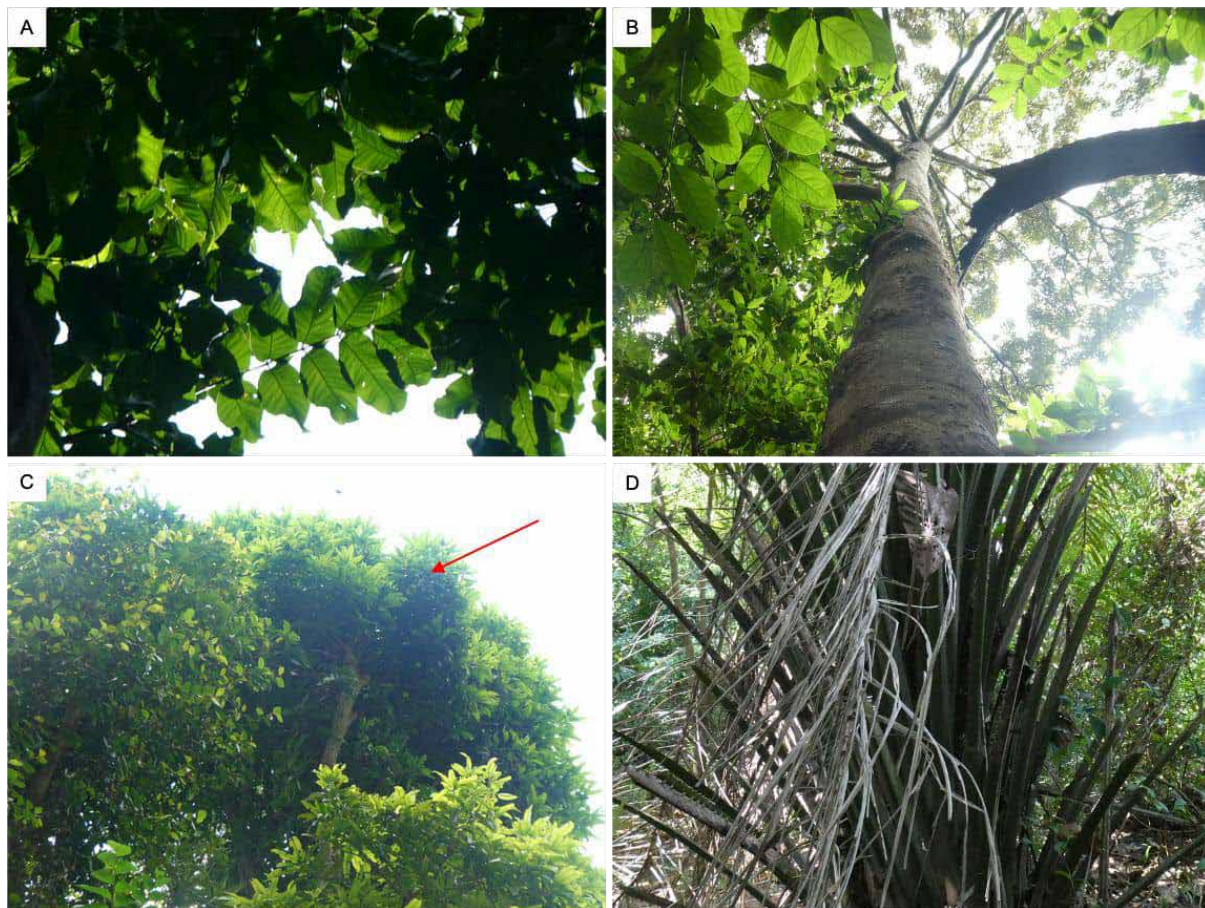
Figure 7-14 Common Crop Plant Species in the Abandoned-land Forest in Sites I and II. (A) Rambutan; (B) Durian; (C) Mango; (D) Oil Palm.

Site III

Within the forested area within 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 7-11). Majority of the canopy stratum is dominated by the exotic tree species, African tulip (*Spathodea campanulata*), interspersed with some fruit trees, such as Indonesian bayleaf (*Syzygium polyanthum*) and rambutan (*Nephelium lappaceum*). Within the understorey stratum, crop plants such as oil palm (*Elaies guineensis;* Figure 7-15A)*,* banana (*Musa* sp.), and giant taro *(Alocasia macrorrhiza;* Figure 7-15B) that has persisted from past cultivation were also observed alongside native saplings (e.g., *Cinnamomum iners* and *Leea indica*) and exotic (e.g., *Andira inermis*) tree species. Strips of vegetation within this habitat type were also cleared previously to create the existing cycling dirt track for the Centaurs Group's 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,* occupied the canopy stratum. The pillar trunks of these specimens were observed to be strangling remnants of a dilapidated wooded fence that was often seen along the old racecourse within the vicinity of Sites I to III (Figure 7-15D).

Figure 7-15 Abandoned-Land Forest in Site III. (A) Specimens of Oil Palm (*Elaeis guineensis*); (B) Giant Taro (*Alocasia macrorrhiza*); (C) Area Cleared for the Cycling Track; (D) *Ficus microcarpa* Growing Over the Dilapidated Wooded Fence.

7.3.1.1.3 *Mixed Forest*

Mixed forest can only be found in Sites I and II, and not Site III.

Mixed forest is the largest habitat type found in Sites I and II, taking up 5.1 ha (30.5%) (Table 7-6). This habitat type, as defined in this Study, is overgrown past streetscape and urban plantings with native recruits that are likely propagules from the nearby native patches. With the previous urban plantings abandoned and left to regenerate, this forest type is characterised by a mix of large exotic trees with native epiphytes growing on them, as well as young native saplings and treelets in the understory. Most of the exotic trees, which are relics from past urban plantings in the sites, are rain trees (*Samanea saman*) (Figure 7-16B; Table 7-13; Appendix E1). Not only do they typically host epiphytic plants, they also provide a diverse range of microhabitats for fauna and other organisms.

Besides having exotic street trees, the mixed forest is also interspersed by dense and overgrown *Baphia nitida*, a shrub species commonly planted as hedges in streetscapes (Figure 7-18D). Left unmanicured and unmaintained, the shrubs were observed to have grown vigorously and formed extensive patches of scrubland. These areas were mostly species-poor, perhaps owing to the strong species dominance that suppress the growth of other plants.

Based on the vegetation map by Gaw et al. (2009), the area here used to be "Vegetation with structure dominated by human management" with and without tree canopy. While an area as such is expected to be exotic-dominated and species-poor, it shows surprising signs of recruitment of native propagules, some of which are rare and nationally threatened. Several native species were recorded in the mixed forest habitat during floristic surveys. This includes the nationally Endangered epiphytic orchid species, *Bulbophyllum vaginatum*, which was found to be widespread and abundant in this habitat type. Other rare native species recorded here include the fern species, *Asplenium nitidum*, thought to be national Extinct but has been rediscovered in recent years, the nationally Endangered tree species *Calophyllum tetrapterum*, and nationally Vulnerable *Litsea firma*. Some native stranglers, such as *Ficus microcarpa,* were also seen growing over the abandoned infrastructure, such as concrete walls (Figure 7-16A).

A small fragment of what is categorised as mixed forest in this Study has been partially cleared and maintained by humans (Figure 7-16A–B). This is a thin stretch of vegetation along Turf Club Road, opposite the Bukit Timah

Junkyard and Turf Club Antique Shop. The area, although partially cleared and possibility maintained by humans, the tree canopy is still occupied by exotic tree species. The canopy layer is a mix of recently-planted trees and those from past cultivation. The understory, however, has mostly been cleared with little to no vegetation; man-made items such as swings, jugs, etc. are placed there, presumably from the nearby junkyards.

These forested areas surrounding the native patches are also important habitats with several specimens of conservation significance, albeit in lower concentrations. If left to regenerate, they may eventually succeed into a native-dominated forest as a result of natural ecological processes.

Figure 7-16 Mixed Forest in Sites I and II. (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 Disturbance and Usage Inside the Forest.

7.3.1.1.4   *Waste Woodland*

Waste woodland can only be found in Site III, and not Sites I and II.

This habitat type usually comprises exotic-dominated species that established themselves on areas that were recently cleared. This habitat type usually regenerates from scrublands dominated by sun-loving herbs and shrubs and in time. Within Site III, this habitat type occupies the largest area of approximately 2.0 ha. The northern patch is dominated by African tulip (*Spathodea campanulata*) *(*Figure 7-17A), interspersed with other exotic species, such as *Leucaena leucocephala* (Figure 7-17B)*.* Within the understorey*,* 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 albizia (*Falcataria moluccana*) (Figure 7-17C).

Albizia specimens were growing above the fruit trees, forming the forest emergent strata, as they are known to be fast-growing (Figure 7-17D). Although an exotic species, albizia trees provide important habitats for raptors and other bird species. Other exotic species that are typical of the waste woodland habitat, such as *Acacia auriculiformis,* were also observed to be scattered within this habitat type.

Some infrastructure were also observed within the waste woodland, such as an abandoned pump room (Figure 7-17E), and a swing structure as part of the obstacle courses for the jungle cross trail that is still being used today within Site III (Figure 7-17F).

Figure 7-17 Waste Woodland in Site III. (A) African Tulip (*Spathodea campanulata*); (B) *Leucaena leucocephala;* (C) Albizia (*Falcataria moluccana*). (D) Albizia Trees Towering Above Fruit Trees; (E) Abandoned Pump Room, and; (F) Swing.

7.3.1.1.5   *Scrubland and Herbaceous Vegetation*

Sites I and II

Scrubland and herbaceous vegetation occupy approximately 16% of the forested area adjacent to Fairway Quarters. Numerous random patches of scrubland are scattered across the forested area, and various different sub-types of this vegetation were observed. Among the sub-types, one is existing scrublands that seem to have remained as semi-open canopy patches within the forested area for a long period of time (Figure 7-18A). 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. These scrublands are dominated by the broad sword fern (*Nephrolepis biserrata*) and *Ottochloa nodosa*, which thrive best in environments with open canopy and high incidence of sunlight.

The other sub-type is mostly located at the northern half of Site II, within the native dominated forest. These patches of scrubland are dominated by the resam fern (*Dicranopteris linearis*; Figure 7-18B), mostly in open canopy areas. As a sun-loving species, the ferns most likely established themselves when the areas are fairly open and receive high light levels; they, however, would most likely be shaded out by the canopy as the surrounding trees grow, such as those of the pioneer species nearer towards the forest edge. Scrublands can also form when there are tree falls which create gaps in the canopy. Following tree fall events, sun-loving ferns and herbaceous vegetation tend to occupy the spaces and collectively form patches of scrubland in the open-canopy areas (Figure 7-18C).

Also, scrubland covered with a dense layer of camwood (*Baphia nitida*) shrub (Figure 7-18D) were also found. This sub-type was recorded in the southern side of Site I, in proximity to the Eng Neo Avenue. *B. nitida* is a shrub species commonly planted as hedges along the streetscapes, including the nearby Eng Neo Avenue. If not maintained and pruned regularly, as in the case in the sites, this species is able to overgrow and encroach into adjacent forested areas. This would result in extensive patches of scrubland dominated by the single species, which was recorded in the present Study.

Figure 7-18 Scrubland and Herbaceous Vegetation in Sites I and II. (A) Scrubland Within a Forested Patch; (B) Dominant Species in this Scrubland, *Dicranopteris linearis*, Getting Shaded Out by Larger Trees; (C) Open Canopy Formed by Tree Falls; (D) Dense *Baphia nitida* Shrubs.

Site III

Scrubland and herbaceous vegetation occupy approximately 20% of the forested area within Racecourse Oval. Similar to Sites I and II, 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 7-19A). Some patches of this habitat type were also observed to occur along steep terrains (Figure 7-19B).

Another habitat sub-type was also observed at the southern portion, along the waterbody. Within this area, the scrubland is mostly dominated by elephant grass (*Pennisetum purpureum*) (Figure 7-19C) and crepe ginger (*Cheilocostus ebracteatus*). As majority of these scrubland patches are adjacent to abandoned-land forest, crop plants such as banana (*Musa* sp.) (Figure 7-19D) and giant taro (*Aloccasia macrorrhizos*) (Figure 7-19E) were interspersed within this habitat type. Along the forest edge, treelets of *Leucaena leucocephala* were also observed in the open canopy environment (Figure 7-19F).

Figure 7-19 Scrubland Herbaceous Vegetation in Site III. (A) Within the Forest Interior; (B) Steep Terrain; (C) A Scrubland Dominated by Elephant Grass (*Pennisetum purpureum*); Crop Plants Interspersed within the Habitat Type: (D) Banana (*Musa* sp.); (E) Giant Taro (*Alocasia macrorrhizo*); (F) Treelets of *Leucaena Leucocephala* Forming Along the Forest Fringe.

7.3.1.1.6   *Managed Vegetation*

Managed vegetation can only be found in Sites I and II, and not Site III.

There are two main patches of managed vegetation in Sites I and II. The larger patch is located at the northern half of Site I. It consists of managed turf and scattered trees, bordering the premises north of the Bukit Timah Saddle Club where equestrian training is often being held (Figure 7-20A). Some of the common trees recorded here are the angsana (*Pterocarpus indicus;* Figure 7-20B)*,* rain trees (*Samanea saman*)*,* and tembusu (*Crytophyllum 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* is also planted in these areas as hedges which are regularly maintained as well (Figure 7-20B).

The second patch of managed 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 (*Adenanthera pavonina*) and African tulip (*Spathodea campanulata*) were planted on turf (Figure 7-20C). A Malayan colugo (*Galeopterus variegatus;* Figure 7-20D) was also opportunistically sighted on one of the *Syzygium grande* trees during floristic surveys.
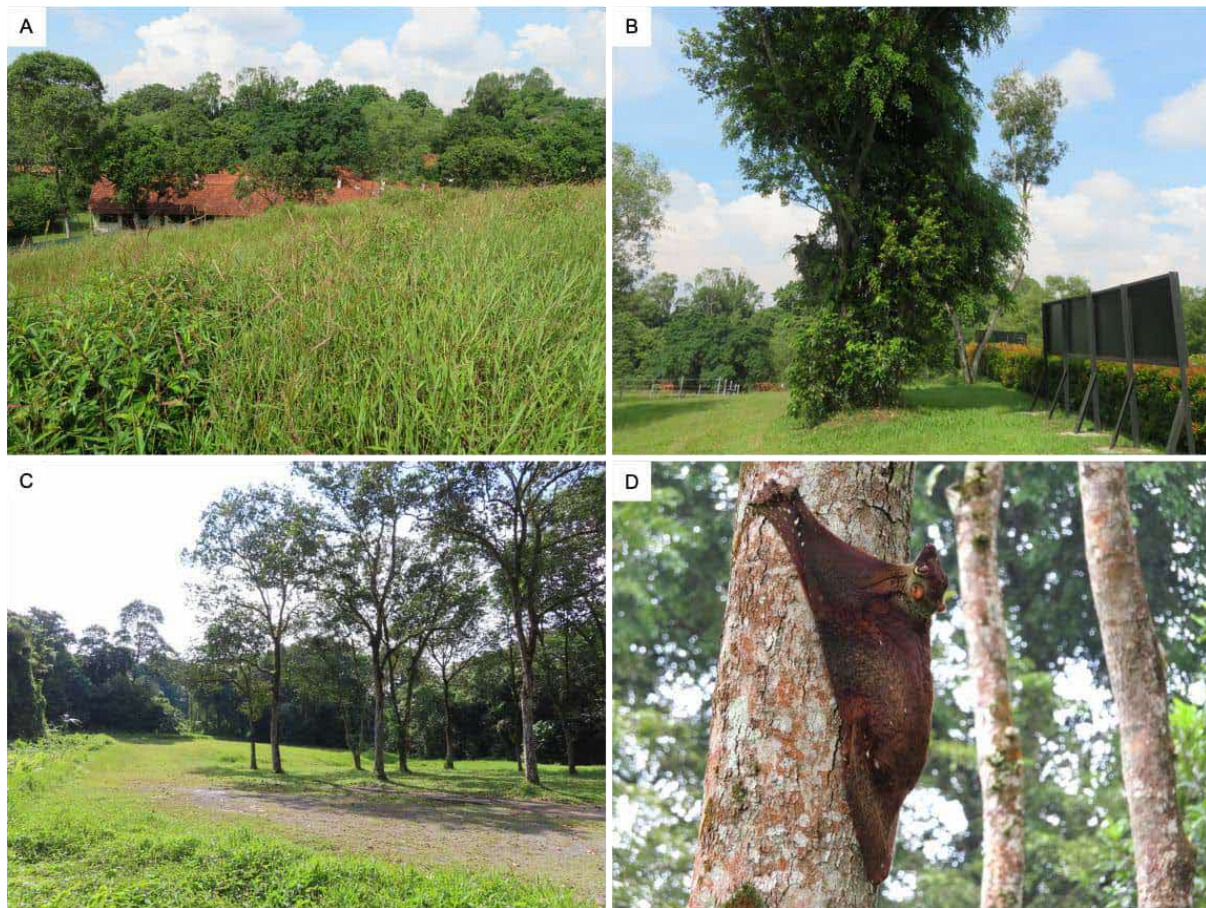
Figure 7-20 Managed Vegetation in Sites I and II. (A–B) Near the Bukit Timah Saddle Club; (C–D) South of the Bukit Timah Saddle Club, where a Malayan Colugo was Sighted.

7.3.1.1.7   *Others (Infrastructure)*

Sites I and II

Infrastructure within Sites I and II includes concrete roads and sand pathways that are now used by horses (Figure 7-21A-B). There are also abandoned buildings as well as water pump rooms (Figure 7-21C). These buildings are located within the forested areas, some of which were enclosed within dilapidated green chain-linked fences (Figure 7-21D). Multiple concrete culverts and drains were also present in the sites (Figure 7-21E).

Figure 7-21 Infrastructure in Sites I and II. (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 III

Infrastructure in the forested area within Racecourse Oval include areas that have been previously cleared to make way for the amenities for various sports activities (Figure 7-22A) and soccer fields (Figure 7-22B) that are located beside the forest fringe. There was also temporary container storage and sheds adjacent to forest fringe that is used as a form of storage facility for logistics (Figure 7-22D). Slopes that were created using compacted soil and sand were also observed to create ramps for the mountain biking activity within the site (Figure 7-22C). Within the forest interior, different obstacles courses for the jungle cross trail, such as monkey bars (Figure 7-22E) and other climbing structures (Figure 7-22F) were placed across the existing waterbodies and within the open areas.

Figure 7-22 Infrastructure in and surrounding Site III. Areas That Were Previously Cleared to Make Way For (A) Sports Amenities; and (B) Soccer Field; (C) Ramps Created by 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 and; (F) Other Climbing Structures.

7.3.1.1.8   *Waterbodies*

Sites I and II

Within Sites I and II, naturalised and concretised ponds and streams are present (Figure 7-23). The locations and alignment of the waterbodies is shown in (Figure 7-5).

There is a single stream system, D/S16, that runs from north to south on the western edge of Site I (Figure 7-23A–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 were overland.

In addition, parts of the old concrete drain system within the forested area remain inundated and formed shallow streams within the eastern part of Site I (Figure 7-23E-F). This is located within a horse track oval found in the middle of Site I within the forest habitat.

Figure 7-23 Waterbodies in Sites I and II. (A–D) Waterbody D/S16 with Different Microhabitats from Upstream (A) to Downstream (D); (E–F) Waterbody D/S15 Located Within the Horsetrack Oval Found in the Middle of Site II.

Site III

In contrast to Sites I and II, a wider stream, D/S8, with a much deeper flow was present in Site III 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 7-24). Since the stream was located within a Racecourse Oval that in recent years has been used as part of Centaurs Group's 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 7-24 Waterbody D/S8 in Site III. (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.

7.3.1.2   Floristic Field Findings

7.3.1.2.1   *Overall*

Sites I and II

A total of 270 plant species and species groups (i.e., plants that could not be identified with certainty), belonging to 89 families were recorded from Sites I and II (Table 7-7; Appendix C1). There are 13 species groups, namely (1) *Aglaonema* cultivar, (2) *Araucaria* cf. *columnaris*, (3) *Dillenia* sp., (4) *Heliconia* cultivar, (5) *Musa* cultivar, (6) cf. *Asplenium nitidum*, (7) cf. *Dibridsonia conferta*, (8) cf. *Psydrax* sp. 10, (9) *Dacryodes* cf. *rostrata*, (10) *Endospermum* sp., (11) *Nephrolepis* cf. *acutifolia*, (12) *Syzygium* cf. *fastigiatum*, and (13) *Syzygium* cf. *pustulatum*. The first five species groups are exotic planted species, some of which have several cultivars which are difficult to identify to species or the specific variety. The other nine species are native.

Of the 270 species and species groups recorded, almost half are native (139; 51.5%), 109 (40.4%) are exotic, and the remaining 21 (7.8%) are cryptogenic (i.e., of unknown or uncertain origin despite being a known species). One species has not been assessed (Table 7-7).

Native threatened species comprise species that have been accorded the following statuses: Vulnerable, Endangered, Critically Endangered, Presumed Extinct, and those that were recently rediscovered or not yet assessed. 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. This is discussed in greater detail in Sections 7.2.2.3 and 7.3.1.2.2 Species of Conservation Significance.

Table 7-7 Number and Percentage of Species Belonging to Each Status Category in Sites I and II

Origin	Status	Number Of Species	Percentage
Native		**139**	**51.5**
	Common	75	27.8
	Vulnerable	27	10.0
	Endangered	13	4.8
	Critically Endangered	16	5.9
	Presumed Extinct	6	2.2
	Not assessed	1	0.4
	Unidentified species	1	0.4
Exotic		**109**	**40.4**
	Cultivated Only	36	13.3
	Casual	25	9.3
	Naturalised	40	14.8
	Not assessed	7	2.6
	Unidentified species	1	0.4
Cryptogenic		**21**	**7.8**
Not assessed		**1**	**0.4**
Total		**270**	**100.0**

Site III

A total of 128 plant species and species groups (i.e., plants that could not be identified with certainty), belonging to 60 families were recorded from Site III (Table 7-7; Appendix C1). There are 2 species groups, namely (1) *Dillenia*

sp., and (2) *Endospermum* sp. Of the 128 species and species groups recorded, more than half are native (77; 60.2%), 38 (29.7%) are exotic, and the remaining 12 (9.4%) are cryptogenic (i.e., of unknown or uncertain origin despite being a known species). As with Sites I and II, a distinction was not made between native threatened species and those of which are of conservation significance (Sections 7.2.2.3 and 7.3.1.2.2 Species of Conservation Significance).

Table 7-8 Number and Percentage of Species Belonging to Each Status Category in Site III

Origin	Status	Number Of Species	Percentage
Native		**77**	**60.2**
	Common	51	39.8
	Vulnerable	15	11.7
	Endangered	4	3.1
	Critically Endangered	5	3.9
	Presumed Extinct	2	1.6
Exotic		**38**	**29.7**
	Cultivated Only	7	5.5
	Casual	4	3.1
	Naturalised	25	19.5
	Not assessed	2	1.6
Cryptogenic		**12**	**9.4**
Unidentified species		**1**	**0.8**
Total		**128**	**100.0**

7.3.1.2.2   *Plant Species of Conservation Significance*

Sites I and II

A total of 54 plant species are considered of conservation significance in Sites I and II. 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 of whether a threatened plant species is of conservation significance was carried out based on the criteria detailed in Section 7.2.2.3.

Altogether, 288 specimens and/or clusters of specimens belonging to these species of conservation significance were recorded in Sites I and II. Majority of the specimens are concentrated within the native-dominated secondary forest, followed by the mixed forest (Table 7-10). The distribution of plant specimens of conservation significance is in Figure 7-25. The findings suggest that while the mixed forest and abandoned-land forest are pre-dominantly occupied by exotic tree species, they too are recruiting natives.

Table 7-9 Number of Threatened Plant Species in Sites I and II

	VU	EN	CR	EX	UN
Non-Cultivated Threatened Species, i.e., CS Species	24	12	13	4	1
Cultivated Threatened Species	3	1	3	2	0
Total Number of Threatened Species	**27**	**13**	**16**	**6**	**1**

Note: VU – Vulnerable; EN – Endangered; CR– Critically Endangered; EX – Presumed Extinct; UN – Not assessed

Table 7-10 Number of Plant Specimens and Species of Conservation Significance in Each Habitat Type in Sites I and II

	Number of Individuals and Clusters						Number of Species					
	VU	EN	CR	EX	UN	Total	VU	EN	CR	EX	UN	Total
Native-Dominated Secondary Forest	101	9	39	4	0	**153**	19	5	7	2	0	**33**
Abandoned-Land Forest	23	4	9	0	1	**37**	8	4	4	0	1	**17**
Mixed Forest	39	7	16	1	0	**63**	14	3	7	1	0	**25**
Scrubland And Herbaceous Vegetation	10	1	2	0	0	**13**	5	1	1	0	0	**7**

	Number of Individuals and Clusters					**Number of Species**					
Managed Vegetation	0	0	0	0	0	**0**	0	0	0	0	0	**0**

Site III

A total of 17 plant species are considered of conservation significance in Site III. Up to 69 specimens and/or clusters of specimens belonging to these species of conservation significance were recorded in Site III. The majority of the specimens are concentrated within the native-dominated secondary forest (Table 7-10; Figure 7-25).

Table 7-11 Number of Threatened Plant Species in Site III

	VU	EN	CR	EX
Non-Cultivated Threatened Species, i.e., CS Species	12	2	2	1
Cultivated Threatened Species	3	2	3	1
Total Number of Threatened Species	**15**	**4**	**5**	**2**

Note: VU – Vulnerable; EN – Endangered; CR– Critically Endangered; EX – Presumed Extinct

Table 7-12 Number of Plant Specimens and Species of Conservation Significance in Each Habitat Type in Site III

	Number of Individuals and Clusters					**Number of Species**				
	VU	EN	CR	EX	Total	VU	EN	CR	EX	Total
Native-dominated Secondary Forest	18	1	6	1	**26**	8	1	1	1	**11**
Abandoned-land Forest	15	4	0	0	**19**	6	1	0	0	**7**
Waste Woodland	11	4	1	0	**16**	6	1	1	0	**8**
Scrubland and Herbaceous Vegetation	4	0	0	0	**4**	3	0	0	0	**3**
Cleared Area	0	0	0	0	**0**	0	0	0	0	**0**

Note: Total species richness of the Study Area is not the sum of species richness per habitat type as some species occur in more than one habitat type. VU – Vulnerable; EN – Endangered; CR – Critically Endangered; EX – Presumed Extinct.

Legend

- ⬛ (red outline) Study Area
- ⬜ Base Scenario Construction Worksite Footprint and Proposed CRL Alignment (Base)
- ▨ Road works

Vegetation
- 🟩 Native-dominated secondary forest
- 🟫 Mixed forest
- 🟩 Abandoned-land forest
- 🟧 Waste woodland
- 🟩 Scrubland and herbaceous vegetation
- 🟩 Managed vegetation
- 🟦 Waterbody

- 🟪 Others (infrastructure)

Plant specimens of conservation significance
- 🔴 Recently Rediscovered
- 🔴 Critically Endangered
- 🟠 Endangered
- 🟡 Vulnerable
- 🟣 Others (not assessed, unidentified)

N

Qualified Person Endorsement : NA	Consultant : **AECOM**			Land Transport Authority We Keep Your World *Moving*		
	Project Title : **CONTRACT CR2005 ENVIRONMENTAL IMPACT STUDY (TURF CITY AND HOLLAND PLAIN)**			Figure Title : **DISTRIBUTION OF PLANT SPECIMENS OF CONSERVATION SIGNIFICANCE AT TURF CITY**		
LTA Endorsement : NA						
	Designed JW	Checked JAG/NHT	Approved JAG	Figure No. : **7-25**	Rev. -	Sheet 1 of 1
	Drawn JW	Date SEP 2022		CAD File Name : NA		A3

-	SEP 2022	JW	EIS (Turf City and Holland Plain)	JAG/NHT	JAG
Rev.	Date	By	Description	Chk'd	App'd

Note: Source of basemap - Google Earth Map

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Sites I and II

Several nationally threatened species were found in Sites I and II. A key species of interest is the fern ally *Phlegmariurus carinatus* (Figure 7-26A). Two small clusters of this fern ally 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.). This species is classified as Extinct in the Singapore Red Data Book (Davison et al., 2008) and by Chong et al. (2009). The most recent specimen catalogued in the SING was collected from the Petaling stream at MacRitchie in 2010. Besides this, there are only two other specimens from mainland Singapore vouchered in the 18th and 19th century, respectively. The recent collection at MacRitchie as well as this finding from the present Study could indicate a rediscovery of this rare species. Although the specimens are not located within the boundaries of the Study Area (Appendix D1), there is a possibility that more of them occur in the forested areas nearby but were undetected during floristic surveys. Therefore, a more conservative approach was adopted by including the species as part of the findings from the present Study.

Another noteworthy species is the fern, *Asplenium nitidum* (Figure 7-26B). One specimen was encountered on 11 Nov 2021. It was growing on a rain tree, near Fairways Drive (Appendix D1). 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). No spores were observed during surveys. This species is listed as nationally Extinct in Davison et al. (2008), Chong et al. (2009), and Ho et al. (2019). 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 (Camphora, unpublished data) is evidence that the population may still be persisting on mainland Singapore. More studies on this species are needed to assess and determine its national conservation status as well as to put in place measures to conserve it as part of our natural heritage.

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) and Chong et al. (2009). 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 very 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 (Lam W.N., pers. comms.). Apart from these, there is very little information to-date on the distribution and habitats of *B*. *pyriformis* in Singapore.

Calophyllum inophyllum, listed as Critically Endangered in Chong et al. (2009), is a native coastal species. Currently, the only known area in Singapore where mature individuals of this species persist; the natural coastal forest southwest of St. John's Island, where a population was found to be widespread (Hung et al., 2017). 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 (Table 7-13; Appendix E1). 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 remanent of the original native population there before human disturbance and could still be persisting in spite of 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 *Ficus glandulifera* was at least 1.1 m girth (Appendix D1). It was also producing figs at the time of observation (Figure 7-26D). Two *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 Presumed Extinct, Critically Endangered, and/or recently rediscovered species recorded in the Study Area include *Psychotria sarmentosa*, *Aporosa lucida* var. *lucida*, *Gymnacranthera farquhariana* var. *farquhariana*, and *Strophanthus caudatus* (Appendix D1). 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.
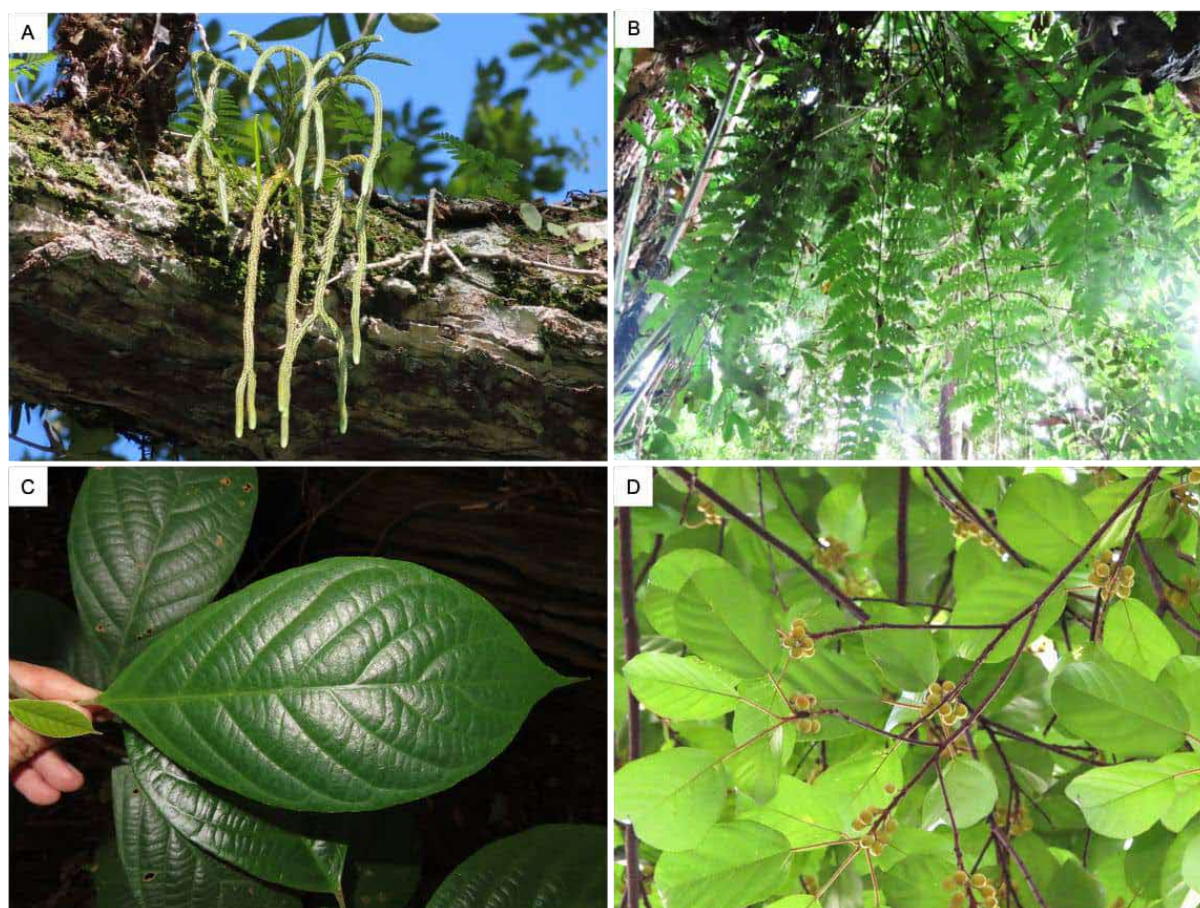
Figure 7-26 (A) Nationally Presumed Extinct *Phlegmariurus carinatus*, (B) cf. *Asplenium nitidum*; and (C) *Baccaurea pyriformis* and Nationally Critically Endangered (D) *Ficus glandulifera*.

Other findings of non-widespread species of conservation significance include a single sapling of nationally Endangered *Aporosa nigricans* that was encountered beside a drain outlet, within the native-dominated forest surrounded by the circular horse track in Site I. This species is characterised by the prominent glands at the base of the leaves, with whitish twig colour and leaf tends to dry with a distinct blackish colour. This species was a surprising find at the Study Area 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) and the NSSF (Lam et al., 2022). 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 (Lam et al., 2022). 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 Endangered orchid. According to Yam and Thame (2005), 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 both mixed forest and abandoned-land forest. Although there was no obvious pattern of distribution, this species appears to be well established within the forested areas of the Sites I and II.

Other nationally threatened species recorded in this Study had only a few specimens, such as the Endangered *Calophyllum rubignosum* with only one specimen (Figure 7-27D) and the Vulnerable *Symplocos fasciculata* with two specimens in the Study Area (Figure 7-28C). Others had slightly different distribution pattern; for example, the Vulnerable *Agelaea borneensis* (Figure 7-28A) and *Aporosa benthamiana* (Figure 7-28B) were found in small clusters within the same area, whereas specimens of *Amphineuron opulentum* (Figure 7-27C) and *Guioa pleuropteris* (Figure 7-28D) were recorded in small numbers and scattered across the sites.

Figure 7-27 Nationally Endangered (A) *Aporosa nigricans***; (B)** *Bulbophyllum vaginatum***; (C)** *Amphineuron opulentum***; (D)** *Calophyllum rubiginosum* **(Leaf Underside).**
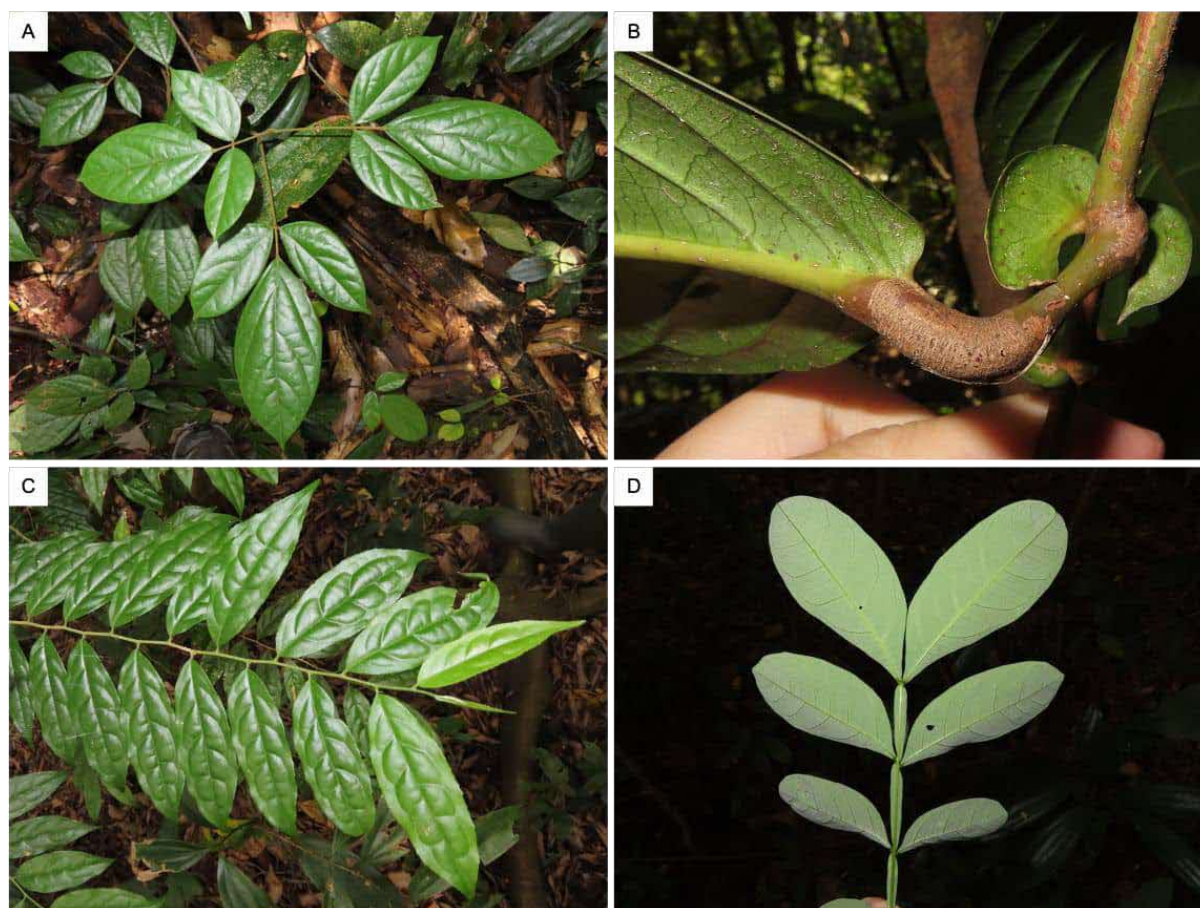
Figure 7-28 Nationally Vulnerable (A) *Agelaea borneensis*; (B) *Aporosa benthamiana* (Large Stipules); (C) *Symplocos fasciculata*; (D) *Guioa pleuropteris* (Stem Underside).

Site III

Majority of the species of conservation significance that were recorded in Site III were also found within Site I and II (Appendix D1). Among these, some rarer and important species and their conservation statuses are follows:

1. *Asplenium nitidum* (Presumed Extinct);

2. *Piper pedicellosum* (Critically Endangered);

3. *Calophyllum tetrapterum* (Vulnerable);

4. *Aporosa bethamiana* (Vulnerable); and

5. *Guioa pleuropteris* (Vulnerable).

A smaller specimen of nationally Extinct fern, *Asplenium nitidum,* was growing at the base of an oil palm, located near to the waterbody (Figure 7-29A). Given that both specimens from Sites II and Site III were found in different habitat types, it suggests that the species can persist in a range of habitats. It is likely that more individuals could be discovered as more environmental studies are conducted in the near future.

The nationally Critically Endangered climber, *Piper pedicellosum,* was recorded in clusters (Figure 7-29B). This climber can often be mistaken as another *Piper* species, *P. ribesioides,* that is listed as locally extirpated in Chong et al. (2009). *Piper ribesioides* is differentiated from *P. pedicellosum* by a longer leaf petiole (i.e., 2 to 5cm), and larger leaves that varies in shape (Figure 7-29) *Piper pedicellosum* is distinguishable by its short leaf petiole and its glabrous leaf that carries distinctive two to three pinnipalmate venations that branches out from its cordate leaf base (Figure 7-29C). At the time of encounter, no inflorescence was recorded but fertile specimens would be useful to quickly verify this species. Not much information is available regarding this species. The only specimen from Singapore was deposited to the Herbarium of Royal Botanic Gardens at Kew Gardens, United Kingdom in 1822, and has since then been used to compare other specimens of *P. pedicellosum* from other countries, such as Thailand [W-96].

Other than the two *Calophyllum* species that were highlighted in Site I and II, another species of *Calophyllum* was recorded in Site III. A single specimen of Vulnerable *Calophyllum tetrapterum* was recorded within the native-dominated secondary forest. This species has smaller and more elliptic leaves than *C. inophyllum* and *C. rubiginosum.* A common characteristic in most *Calophyllum* species, this species also exhibits dense secondary venation that is prominent on both leaf surfaces [P-117] (Figure 7-29D).

Two other nationally Vulnerable species of conservation significance was also recorded. A single specimen of *Aporosa bethamiana* was recorded in the middle of the native-dominated secondary forest (Figure 7-29E), and three specimens of *Guioa plueropteris* were scattered across the forested patch (Figure 7-29F). These saplings have dispersed from nearby larger patches of native-dominated secondary forest.

Figure 7-29 Species of Conservation Significance in Site III. (A) *Asplenium nitidum*; **(B)** *Piper pedicellosum,* **and; (C) Underside of** *P. pedicellosum* **Leaf; (D) Underside of** *Calophyllum tetrapterum*; **Specimen of (E)** *Aporosa bethaniana* **and; (F)** *Guioa plueropteris*

7.3.1.2.3   *Large Plant Specimens*

Sites I and II

A total of 128 large plant specimens were recorded during floristic surveys in Sites I and II, of which 58 specimens (45.3%) are exotic, 55 (43.0%) are native and the remaining 15 (11.7%) cryptogenic (i.e., of unknown origin) (Appendix E1). The distribution of all large plant specimens is shown in Figure 7-32.

Of 128 large plant specimens, 78 are trees belonging to 16 species. Majority of them (24 specimens) are rain trees (*Samanea saman*) (Table 7-13). Forty-four large specimens are stranglers comprising four *Ficus* species. The Malayan banyan (*F. microcarpa*) is the most abundant, with 26 specimens. The remaining six specimens are shrubs comprising two bamboo species, of which four specimens belong to the species *Thyrsostachys siamensis*.

The largest specimen recorded in Sites I and II was a nationally Critically Endangered strangler, *Ficus kerkhovenii,* with a spread of up to 14 m (Figure 7-30A). At the point of encounter, this specimen was also producing figs (Figure 7-30B). The largest tree specimen recorded was a rain tree (*S. saman*) with a girth of 7.8 m, while the largest bamboo specimen, *Bambusa vulgaris*, had a spread of 4 m (Figure 7-30D).

Table 7-13 Number of Large Plant Specimens in Sites I and II

Habit	Species	No. of Specimens
Tree	*Acacia auriculiformis*	1
	Calophyllum inophyllum	1
	Cinnamomum iners	1
	Cocos nucifera	1
	Cyrtophyllum fragrans	18
	Elaeis guineensis	1
	Elaeocarpus angustifolius	1
	Erythrophleum suaveolens	8

Habit	Species	No. of Specimens
	Ficus barteri	1
	Ficus variegata	1
	Nephelium lappaceum	1
	Peltophorum pterocarpum	2
	Pterocarpus indicus	6
	Samanea saman	24
	Spathodea campanulata	8
	Syzygium grande	3
Strangler	*Ficus benjamina*	15
	Ficus kerkhovenii	2
	Ficus microcarpa	26
	Ficus religiosa	1
Shrub (Bamboo)	*Bambusa vulgaris*	2
	Thyrsostachys siamensis	4
Total		**128**

Figure 7-30 Large Specimens in Sites I and II. (A–B) *Ficus kerkhovenii* of 14 m Spread; (C) *Samanea saman* of 7 m Girth; (D) *Bambusa vulgaris* of 4 m Spread.

Site III

A total of 54 large plant specimens from nine species were recorded during floristic surveys in Site III, of which 34 specimens (63.0%) are exotic, 10 (18.5%) are native and the remaining 10 (18.5%) cryptogenic (i.e., of unknown origin) (Appendix E1). The distribution of all large plant specimens is shown in Figure 7-32.

Of 54 large plant specimens, 21 specimens are albizia (*Falcataria moluccana*) (Table 7-13). Twelve large specimens are stranglers comprising two *Ficus* species. Of the two *Ficus* species, *Ficus microcarpa* is more abundant, with 10 specimens. Additionally, six large specimens of the Critically Endangered *Peltophorum pterocarpum* were also recorded.

The largest specimen recorded here was a *Ficus microcarpa* with a spread of up to 15 m (Figure 7-30A). The largest tree specimens recorded were a specimen of albizia (*Falcataria moluccana*) and a specimen of *Ficus benjamina* both with girths of 6 m (Figure 7-30D).

Table 7-14 Number of Large Plant Specimens in Site III

Habit	Species	No. of Specimens
Tree	*Cinnamomum iners*	1
	Elaeis guineensis	5
	Falcataria moluccana	21
	Leucaena leucocephala	1
	Peltophorum pterocarpum	6
	Spathodea campanulata	7
Strangler	*Ficus benjamina*	10
	Ficus microcarpa	2
Shrub (Palm)	*Oncosperma tigilarium*	1
Total		**54**

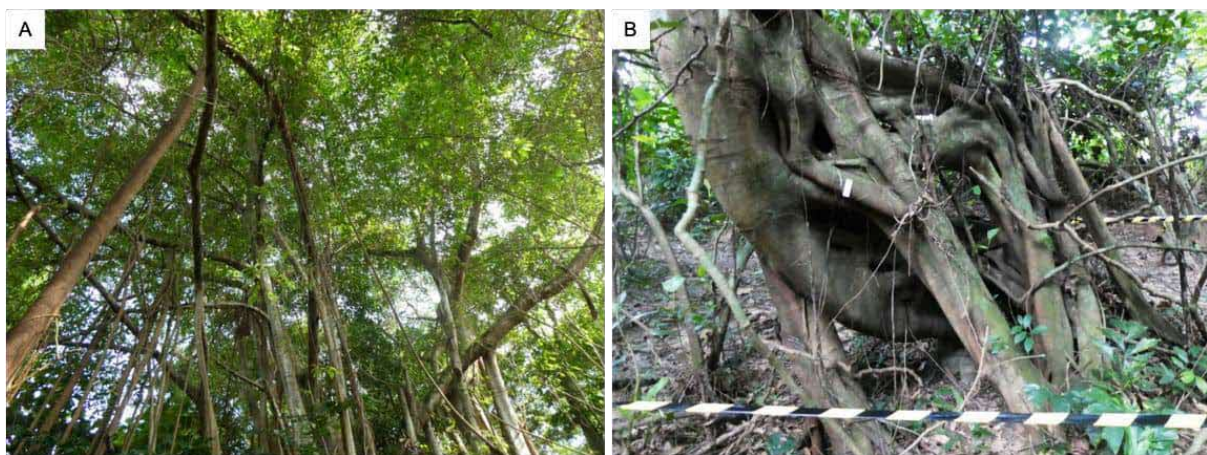**Figure 7-31 Large Specimens in Site III. (A) *Ficus microcarpa* of 15 m spread; (B) *Ficus benjamina* of 4 m spread.**

Legend

- Study Area
- Base Scenario Construction Worksite Footprint and Proposed CRL Alignment (Base)
- Road works

Vegetation
- Native-dominated secondary forest
- Mixed forest
- Abandoned-land forest
- Waste woodland
- Scrubland and herbaceous vegetation
- Managed vegetation
- Waterbody

- Others (infrastructure)

Large plant specimens
- Tree
- Strangler
- Bamboo

Note: Source of basemap - Google Earth Map

-	SEP 2022	JW	EIS (Turf City and Holland Plain)	JAG/NHT	JAG
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Qualified Person Endorsement : NA

Consultant : **AECOM**

Project Title : **CONTRACT CR2005 ENVIRONMENTAL IMPACT STUDY (TURF CITY AND HOLLAND PLAIN)**

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Figure Title : **DISTRIBUTION OF LARGE PLANT SPECIMENS AT TURF CITY**

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7.3.1.2.4   *Other Plant Specimens of Value*

Sites I and II

Four other plant specimens of value were recorded within Sites I and II (Appendix F1; Figure 7-34). They are two trees, one strangler, and one bamboo cluster. The tree specimens, namely Indonesian bayleaf (*Syzygium polyanthum*) and an unidentified tree species, each with a bird nest. The strangler specimen, *Ficus kerkhovenii*, has two active wasp nests. The bamboo specimen, *Bambusa vulgaris*, was small with only a 0.5-m spread (Figure 7-33 A-B). 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 (refer to Section 7.3.2.3.12).
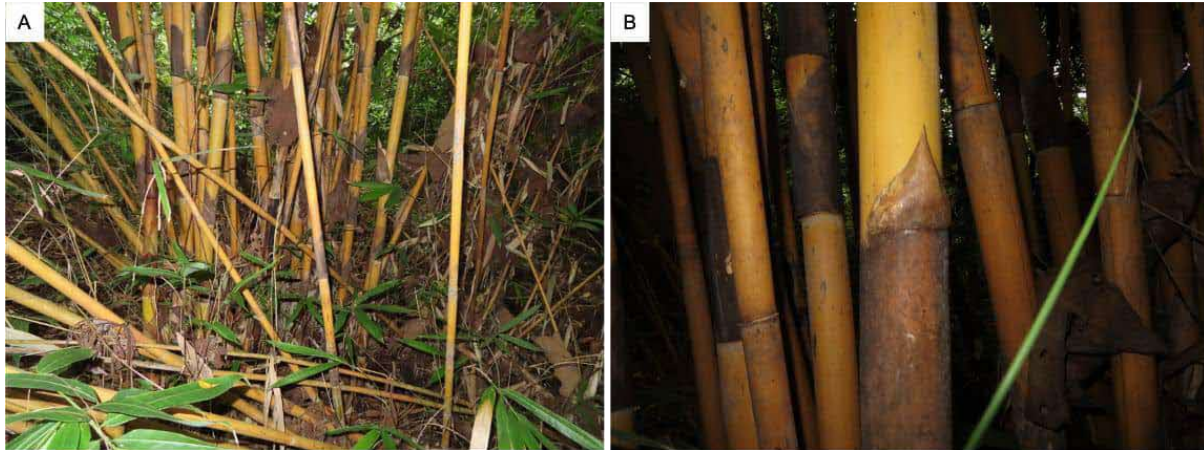

Figure 7-33 Other Specimens of Value in Sites I and II. (A–B) *Bambusa vulgaris* **of 0.5 m Spread.**

Site III

Only one other plant specimen of value was recorded in Site III – an albizia (*Falcataria moluccana*). The tree is also large specimen of 3 m girth and 30 m height. Tanimbar corellas (*Cacatua goffiniana*) were observed perching in the tree.

Legend

- Study Area
- Base Scenario Construction Worksite Footprint and Proposed CRL Alignment (Base)
- Planned road works

Vegetation
- Native-dominated secondary forest
- Mixed forest
- Abandoned-land forest
- Waste woodland
- Scrubland and herbaceous vegetation
- Managed vegetation
- Waterbody

- Others (infrastructure)

Other plant specimens of value
- Bamboo
- Bird nest
- Wasp nest

Note: Source of basemap - Google Earth Map

Site III
Site II
Site I
Eng Neo Avenue Forest
PIE

0   100   200 m

N

Qualified Person Endorsement : NA	Consultant : AECOM		Land Transport Authority We Keep Your World Moving
	Project Title : CONTRACT CR2005 ENVIRONMENTAL IMPACT STUDY (TURF CITY AND HOLLAND PLAIN)		Figure Title : DISTRIBUTION OF OTHER PLANT SPECIMENS OF VALUE AT TURF CITY
LTA Endorsement : NA			

-	SEP 2022	JW	EIS (Turf City and Holland Plain)	JAG/NHT	JAG			
Rev.	Date	By	Description	Chk'd	App'd			

Designed	Checked	Approved	Figure No. : 7-34	Rev. -	Sheet 1 of 1
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Drawn JW		Date SEP 2022	CAD File Name : NA		A3

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7.3.1.2.5   *Tree Mapping Findings*

Sites I and II

A total of 687 trees were tagged and assessed in Sites I and II during the tree mapping surveys, of which, half (345 trees; 50.2%) are native, 311 (45.3%) exotic, 29 (4.2%) cryptogenic and two species that could not be identified (Appendix G1).

The tree species with highest count is *Spathodea campanulata* (103 specimens) followed by *Cinnamomum iners* (58 specimens), *Samanea saman* (39 specimens), *Crytophyllum fragrans* (also 39 specimens) and *Ficus microcarpa* (34 specimens). Altogether, 271 specimens from these five species makes up 40% of the total number of trees. Most notably, three specimens are rare and of uncommonly large size. The first is the Critically Endangered *Ficus kerkhovenii* (Johor Fig) strangler. This specimen was straggling two large rain trees at the point of survey. The second is a very large *Calophyllum inophyllum* (3.3 m girth) and as mentioned, it's slow growth and large size here suggest that it's a native remnant that had somehow escaped removal through the years. The last is a *Macaranga hullettii* tree. While of a moderate 1.3m girth, is the largest of its kind we have encountered in a forest.

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 (Section 7.2.4.6).

Site III

A total of 344 trees were tagged in Site III, of which 25.9% (89 trees) are native, 70.6% (243 trees) are exotic and 3.5% (12 trees) are cryptogenic. The tree species with highest counts are mainly exotics. *Spathodea campanulata* accounted for 96 specimens, followed by *Falcataria moluccana* (46 specimens), *Leucaena leucocephala* (43 specimens) and *Acacia auriculiformis* (17 specimens). Altogether these 4 species accounted for more than half (58.7%) of the total number of trees mapped at this site. The site also had 15 large *Ficus microcarpa* and *Ficus benjamina* trees, some of which had very interesting pillar root architecture (Figure 7-35). *Peltophorum pterocarpum* trees tagged on site (16 trees) were also observed to be large with many exceeding 2 m in girth. These *Peltophorum pterocarpum* trees were likely planted and considered persistent through cultivation.

Figure 7-35 The Pillar Root Architecture of *Ficus benjamina* and *Ficus microcarpa*. (D) A Specimen with an Almost Spider-like Appearance, which is Notable as This Suggests a Negative Geotactic Growth of the Roots at Some Point.

Legend

- 🔲 Study Area
- ⬜ Base Scenario Construction Worksite Footprint and Proposed CRL Alignment (Base)
- ▨ Road works

Vegetation
- 🟩 Native-dominated secondary forest
- 🟫 Mixed forest
- 🟩 Abandoned-land forest
- 🟧 Waste woodland
- 🟩 Scrubland and herbaceous vegetation
- 🟩 Managed vegetation
- 🟦 Waterbody

- 🟪 Others (infrastructure)
- ◆ Mapped tree

Note: Source of basemap - Google Earth Map

Site III

Site II

Site I

Eng Neo
Avenue Forest

PIE

0   100   200 m

N

-	SEP 2022	JW	EIS (Turf City and Holland Plain)	JAG/NHT	JAG
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Qualified Person Endorsement :
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LTA Endorsement :
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Consultant :

AECOM

Project Title :

**CONTRACT CR2005
ENVIRONMENTAL IMPACT STUDY
(TURF CITY AND HOLLAND PLAIN)**

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Figure Title :

**DISTRIBUTION OF MAPPED TREES
AT TURF CITY**

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7-36

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-

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1 of 1

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7.3.1.3   Faunistic Field Findings

7.3.1.3.1   *Overall*

The desktop assessment identified 589 species of probable occurrence at Sites I to III. The field assessment documented 197 species, dominated by birds (71 species) and butterflies (38 species). From these, 16 species of conservation significance were also recorded. Two of the recorded species (one bird and one bat) were not listed as probable species. The list of probable and recorded species is available in Appendix H1 and summarised in Table 7-15. The list of faunal species of conservation significance and their conservation statuses is available in Table 7-16. The faunal survey and camera trap data are provided in Appendix I1 and Appendix J1 respectively.

Table 7-15 Summary of Probable and Recorded Faunal Species at Sites I to III

Faunal Group	No. of Probable Species		No. of Recorded Species		No. of Recorded Species Not on Probable List (CS Species)
	All Species	CS Species	All Species	CS Species	
Aculeate hymenopterans	92	0	19	0	0
Bees	45	0	10	0	0
Stinging wasps	47	0	9	0	0
Odonates	67	12	23	0	0
Dragonflies	45	3	17	0	0
Damselflies	22	9	6	0	0
Butterflies	171	14	38	3	0
Freshwater decapod crustaceans	2	0	0	0	0
Freshwater fish	13	0	7	0	0
Herpetofauna	51	2	20	0	0
Amphibians	16	0	9	0	0
Reptiles	35	2	11	0	0
Birds	166	24	71	9	1 (0)
Mammals	27	5	19	3	1 (0)
Non-volant mammals	17	2	10	2	0
Bats	10	3	9	1	1 (0)
Total	**589**	**57**	**197**	**15**	**2 (0)**

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

Table 7-16 List of Faunal Species of Conservation Significance Recorded in Sites I to III

Taxon	Species	Common Name	Local Status	Global Status	Locations of Records
Butterfly	*Borbo cinnara*	Formosan swift	Endangered	Not Assessed	Sites I and II
Butterfly	*Arhopala amphimuta*	NA	Nationally Extinct (Rediscovered)	Not Assessed	Site I and II
Butterfly	*Troides helena cerberus*	Common birdwing	Vulnerable	Not Assessed; CITES protected (Appendix II)	Sites I and II; Site III
Bird	*Accipiter trivirgatus*	Crested goshawk	Critically Endangered	Least Concern; CITES protected (Appendix II)	Sites I and II
Bird	*Anthracoceros albirostris*	Oriental pied hornbill	Critically Endangered	Least Concern; CITES protected (Appendix II)	Site III

Taxon	Species	Common Name	Local Status	Global Status	Locations of Records
Bird	*Copsychus saularis*	Oriental magpie-robin	Endangered	Least Concern	Site III
Bird	*Gallus*	Red junglefowl	Endangered	Least Concern	Sites I and II; Site III
Bird	*Loriculus galgulus*	Blue-crowned hanging-parrot	Endangered	Least Concern; CITES protected (Appendix II)	Sites I and II; Site III
Bird	*Psittacula longicauda*	Long-tailed parakeet	Not Assessed	Vulnerable; CITES protected (Appendix II)	Sites I and II
Bird	*Pycnonotus zeylanicus*	Straw-headed bulbul	Endangered	Critically Endangered; CITES protected (Appendix II)	Sites I and II; Site III
Bird	*Rallina fasciata*	Red-legged crake	Vulnerable	Least Concern	Sites I and II
Bird	*Strix seloputo*	Spotted wood owl	Critically Endangered	Least Concern; CITES protected (Appendix II)	Sites I and II
Mammal	*Macaca fascicularis*	Long-tailed macaque	Least Concern	Vulnerable; CITES protected (Appendix II)	Sites I and II; Site III
Mammal	*Manis javanica*	Sunda pangolin	Critically Endangered	Critically Endangered; CITES protected (Appendix I)	Sites I and II
Bat	*Tylonycteris* sp.	Bamboo bat	Vulnerable	Least Concern	Sites I and II

Given the site's proximity to CCNR and Eng Neo Avenue Forest, there remains a chance of expecting rare species here. While species of conservation significance appeared to be distributed across the Study Area, including the globally threatened straw-headed bulbul (Pycnonotus zeylanicus) and red junglefowl (Gallus gallus), more species of conservation significance were found in Sites I and II than in Site III (Figure 7-37). Species of conservation significance that were found only in Sites I and II but not in Site III include the Sunda pangolin (Manis javanica), the red-legged crake (Rallina fasciata) and the Formosan swift (Borbo cinnara). In particular, the pangolin was detected utilising the entire area of Sites I and II. Forest dependent species like the Sunda colugo (Galeopterus variegatus) were also found in Sites I and II. One of the exclusive findings at Site III was the oriental pied hornbill (Anthracoceros albirostris), on top of high butterfly species richness, including an abundant common birdwing (Troides helena cerberus) population.

Along the waterbodies, only the waterbody in Site I, D/S16, recorded a fish species of interest, the common walking catfish (*Clarias cf. batrachus*). The waterbody at Site III recorded mainly non-native fish, alongside common amphibians and odonates.

Legend

- Study Area
- Base Scenario Construction Worksite Footprint and Proposed CRL Alignment (Base)
- Road works

Vegetation
- Native-dominated secondary forest
- Mixed forest
- Abandoned-land forest
- Waste woodland
- Scrubland and herbaceous vegetation
- Managed vegetation
- Waterbody
- Others (infrastructure)
- Terrestrial sampling route 1
- Terrestrial sampling route 2

Faunal species of conservation significance
- Non-volant mammal and bat
- Bird
- Butterfly

- Critically Endangered
- Endangered
- Vulnerable

Note: Source of basemap - Google Earth Map

Qualified Person Endorsement :	Consultant :		
NA	**AECOM**	**Land Transport Authority** We Keep Your World *Moving*	
	Project Title :	Figure Title :	
	CONTRACT CR2005 ENVIRONMENTAL IMPACT STUDY (TURF CITY AND HOLLAND PLAIN)	**LOCATIONS OF FAUNAL SPECIES OF CONSERVATION SIGNIFICANCE FROM SURVEYS AND CAMERA TRAPPING CONDUCTED AT TURF CITY**	
LTA Endorsement : NA			

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			CAD File Name : NA		A3

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Rev.	Date	By	Description	Chk'd	App'd

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7.3.1.3.2   *Sampling Coverage*

Along the terrestrial sampling routes and at aquatic sampling points, the sample coverage for each taxon were all relatively high and above 70% (Figure 7-38; Table 7-17). When sampling effort is doubled, a marginal increase in richness is expected for most groups, but more than 10 species may be detected for butterflies and birds (Table 7-17). Given Turf City's proximity with the adjacent Eng Neo Avenue Forest and CCNR, the estimated richness with increased effort is well likely. Camera trapping obtained a high coverage of 99.1% (Figure 7-39; Table 7-17).

Table 7-17 Result Summary of Taxon Sampling Analysis for Sites I to III

Faunal Group	Sample Coverage (%)	Observed Richness	Estimated Richness (± Standard Error)	95% Confidence Interval For Estimated Richness	Estimated Coverage With Doubled Effort (%)	Estimated Richness (And Additional Species) With Doubled Effort
Terrestrial Sampling Routes						
Aculeate Hymenopteran	74.8	19	32 ± 11.5	22.4–76.2	91.0	27 (+8)
Odonate	76.0	20	38 ± 16.2	24.3–101.2	86.5	28 (+8)
Butterfly	72.9	36	62 ± 16.4	44.7–116.7	87.0	49 (+13)
Amphibian	100.0	9	9 ± 0.5	9.0–10.3	100.0	9 (+0)
Reptile	81.5	9	14 ± 6.9	9.9–45.7	95.0	13 (+4)
Bird	92.1	63	91 ± 16.4	72.7–144.4	96.3	77 (+14)
Non-Volant Mammal	100.0	3	3 ± 0.5	3.0–4.3	100.0	3 (+0)
Bat	96.1	8	9 ± 3.5	8.2–28.7	98.6	9 (+1)
Aquatic Sampling Points						
Odonate	70.9	7	14 ± 10.5	7.9–65.6	86.3	10 (+3)
Freshwater Fish	98.1	7	7 ± 0.7	7.0–11.4	100.0	7 (+0)
Amphibian	95.8	4	4 ± 1.2	4.0–11.8	99.6	4 (+0)
Reptile	N.A.	0	N.A.	N.A.	N.A.	N.A.
Camera Trapping						
Non-Volant Mammal	99.1	9	9 ± 1.9	9.1–20.0	100.0%	9 (+0)
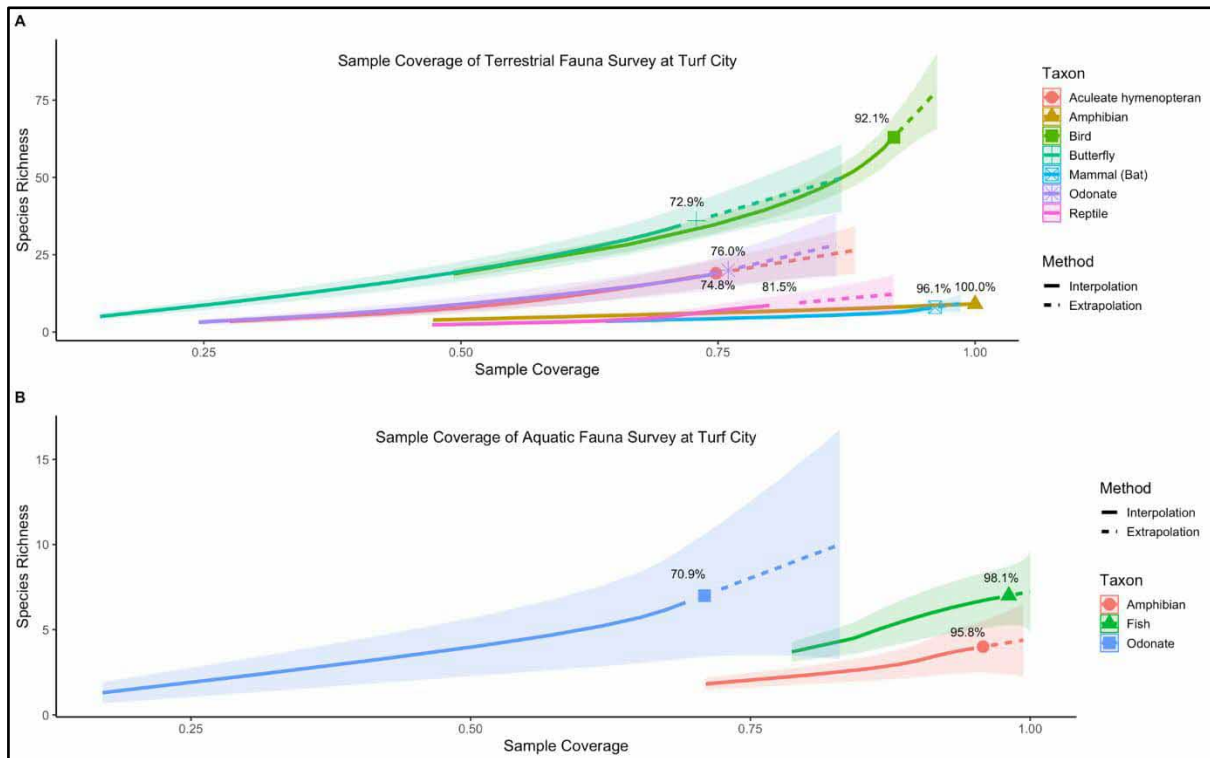
Figure 7-38 Taxon Sampling Curves for Respective Faunal Groups (A) Terrestrial Sampling Routes and (B) at Aquatic Sampling Points in Sites I to III
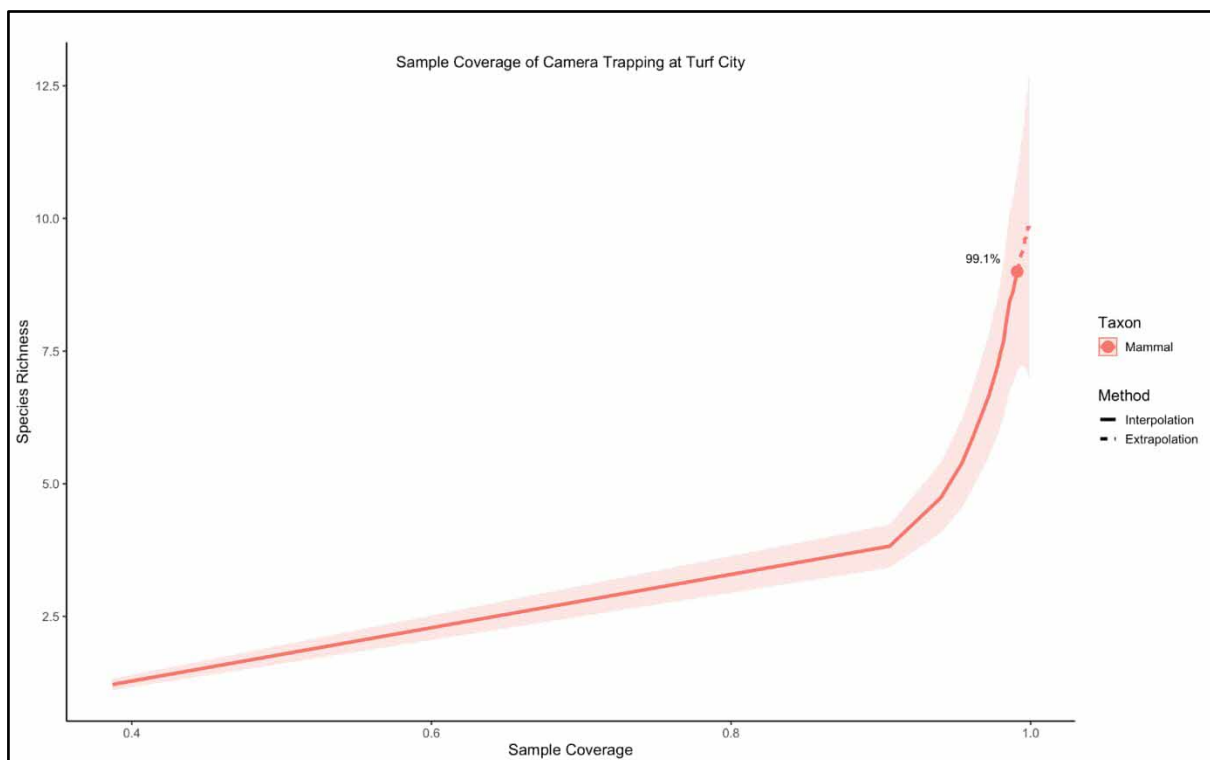
Figure 7-39 Taxon Sampling Curve for Camera Trapping in Sites I to III

7.3.1.3.3   *Aculeate Hymenopterans*

Aculeate Hymenoptera is a taxonomic group containing bees, stinging wasps and ants. They are defined mainly by their stingers – modified ovipositors, in females for self-defence, and for wasps, in subduing and paralysing prey (Tan et al., 2015). In this Study, only bees and wasps were assessed.

Bees and wasps play vital ecological roles, notably as pollinators and in some cases, as predators of other insects to naturally control populations. As pollinators, these flower-visiting insects help to sustain plant populations, which is particularly important in Singapore as most native flowering plant species are currently threatened (Soh & Ngiam, 2013; Chong et al., 2009). Stable plant populations, in turn, provide food for and support other animals such as birds and bats in the area (Black et al., 2009), as well as humans. A good diversity of aculeate hymenopterans is hence essential for and indicative of a healthy ecosystem.

While 92 species of aculeate hymenopterans were expected, a total of 19 species were recorded, from five families – Apidae (six species), Crabronidae (one species), Halictidae (four species), Sphecidae (one species) and Vespidae (seven species) (Table 7-15; Appendix H1). None of the species recorded were of conservation significance.

Two wasp species, *Sphex subtruncatus*, *Liostenogaster varipicta* and *Polistes stigma*, that were found across all three sites, can be classified as Near Threatened following the criteria in Ascher et al. (2022). These are forest-inclined species (not strictly forest-dependent) usually found in natural habitats. The most abundantly recorded species was the Eastern honeybee (*Apis cerana*) with 17 records. This is followed by *Ropalidia sumatrae* (Vespidae) with 14 records. Several species were recorded feeding on plant species within the site, suggesting that the site provides foraging opportunities for the species. For example, the Eastern honeybee (*Apis cerana*) was observed feeding on *Asystasia gangetica* ssp. *Micrantha* while the wasp species *Sphex subtruncatus* was observed feeding on *Lira indica*. Nests were observed for five species, namely *Parischnogaster* mellyi, *Tetragonula valdezi*, *Ropalidia sumatrae*, and *Ropalidia jacobsoni*, confirming the use of the site by these species. Of the nests found, the *Ropalidia sumatrae* nest located in Site II was noteworthy for its size (Figure 7-40A). All Aculeata species recorded onsite were native species.

Records of aculeate hymenopterans were significantly lower across Site III compared to Sites I and II despite the presence of native forest and scrubland which provides bees and wasps with food sources. Only one nesting record by *Parischnogaster mellyi* was noted in Site III (Figure 7-40B), proving that the wasps are utilising the site. This could be attributed to the fact that the Study Area is highly disturbed by regular maintenance and human activity due to the presence of a biking trail.

Figure 7-40 Records of wasp nests in Sites I to III. (A) *Ropalidia sumatrae* nest located at Site II; (B) *Parischnogaster mellyi* nest located at Site III

7.3.1.3.4   *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 freshwater breeding sites, of which can be many habitats, ranging from suburban drains to streams.

A total of 67 species of odonates were determined of probable occurrence in Sites I to III, including 12 of conservation significance. 23 species of odonates were recorded during the site assessment. No species of conservation significance were recorded (Table 7-15; Appendix H1). All species were considered widespread, but

some uncommon species were observed – such as the sultan (*Camacinia gigantea*), and dingy duskhawker (*Gynacantha subinterrupta*).

The diversity of waterbodies present (puddles, drains, streams and naturalised canals) within the Study Area, especially at Sites I and II, may have contributed to the assemblage of odonate sightings. Shallow puddles of water within the open country habitats along the old road within Site II provide habitats for common species such as the yellow-barred flutterer (*Rhyothemis phyllis*). Both the sultan (*Camacinia gigantea*) and dingy duskhawker (*Gynacantha subinterrupta*), which are considered widespread but uncommon, were also sighted in Site II along a forested section of the old road that was lined by shallow drains. While not ideal habitats for this species, it is likely able to make use of such habitats.

In addition, the presence of streams and naturalised canals within Sites I and II (D/S15, D/S16 and D/S8) also provides habitat for forest stream-associated species such as the yellow featherlegs (*Copera marginipes*). Along the streams, records of odonates were generally poor, especially for Site III (D/S8) which only recorded four sightings of two common odonate species – the variable wisp (*Agriocnemis femina)* and the blue sprite (*Pseudagrion microcephalum*) – during aquatic point count surveys.

Within Site III, odonate observations were concentrated North of the Study Area away from the biking trail, where the stream is adjacent to scrubland as well as the section of native-dominated secondary forest. Other parts of the stream in this Study Area have been degraded due to high levels of erosion and run off as it is adjacent to the biking trail, highlighting that the absence of odonates could be due to human disturbance within parts of the Study Area.

Figure 7-41 Odonates observed on site (A) Slender blue skimmer (*Orthetrum luzonicum*), (B) Crescent threadtail (*Prodasineura notostigma*), (C) Indigo dropwing (*Tritemis festiva*) and (D) Crimson dropwing (*Tritemis aurora*)

7.3.1.3.5   *Butterflies*

Like aculeate hymenopterans and odonates, 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 (Koh & Sodhi, 2004). In highly urbanised Singapore, it was estimated that almost half of the butterfly species (236 species) found locally have been lost over the last 160 years to habitat destruction (Theng et al., 2020). The careful conservation of remaining key habitats and butterflies is hence increasingly critical today.

A total of 171 butterfly species were deemed of probable occurrence within Sites I to III and 14 are of conservation significance (Table 7-15; Appendix H1). The field assessment recorded 38 species of butterflies, of which three were of conservation significance: the nationally Extinct (Rediscovered) *Arhopala amphimuta*, the nationally endangered Formosan swift (*Borbo cinnara*) and the nationally Vulnerable common birdwing (*Troides helena cerberus*). The open country and forest edge habitats within Sites I to III sites 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 allow for easier detection of species as well. Due to the presence of abundant scrubland and herbaceous vegetation present, grassland-associated species such as the bush browns (*Mycalesis* sp.) and grass yellows (*Eurema* sp.) were frequently recorded.

At Sites I and II, 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, all three species of conservation significance were found (Figure 7-42). These species, however, are now considered moderately common. In particular, the Formosan swift shares extensive morphological similarities with other species in the Hesperiidae family and is thus viewed as a cryptic species. Multiple species of grasses in the Poaceae family serve as host plants for this species. Considering the difficulty in identifying this species in the field and the variety of host plants it can utilise, the Formosan swift could be encountered more often than recorded in literature, making it a moderately common

species in Singapore. It is worth noting that amongst the known host plants of the species, the critically endangered *Centotheca lappacea* was found in this site during the floristic assessment. Some species were also observed foraging on flowering plants. For example, Chocolate pansy (*Junonia hedonia ida*), Common five-ring (*Y. baldus newboldi*) and Common bluebottle (*Graphium Sarpedon luctatius*) were seen feeding on plant species such as *Leea indica*.

At Site III, while diversity of butterflies found here was lower with 21 species recorded, 23 other species were also recorded in a recent study conducted by NSS (2021). In this Study, the only species of conservation significance encountered was the common birdwing. 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. The Dutchman's pipe is a climber, and if growing in a forest, only grows leaves at the canopy level when mature (NSS, 2021). This finding suggests that more caterpillars could be potentially observed, and that the forest is likely a stronghold for this nationally Vulnerable common birdwing. Moreover, the common birdwing shares its host plant with the nationally Vulnerable common rose (*Pachliopta aristolochiae asteris*) which is an expected species found in the Study Area although it was not encountered. In addition, the rare Malayan dartlet (*Oriens paragola*) (Figure 7-42) 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 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 III remains particularly important for the conservation of butterflies in Singapore. As butterflies are host specific, the retention of host plants here are also critical to maintaining the butterfly populations.
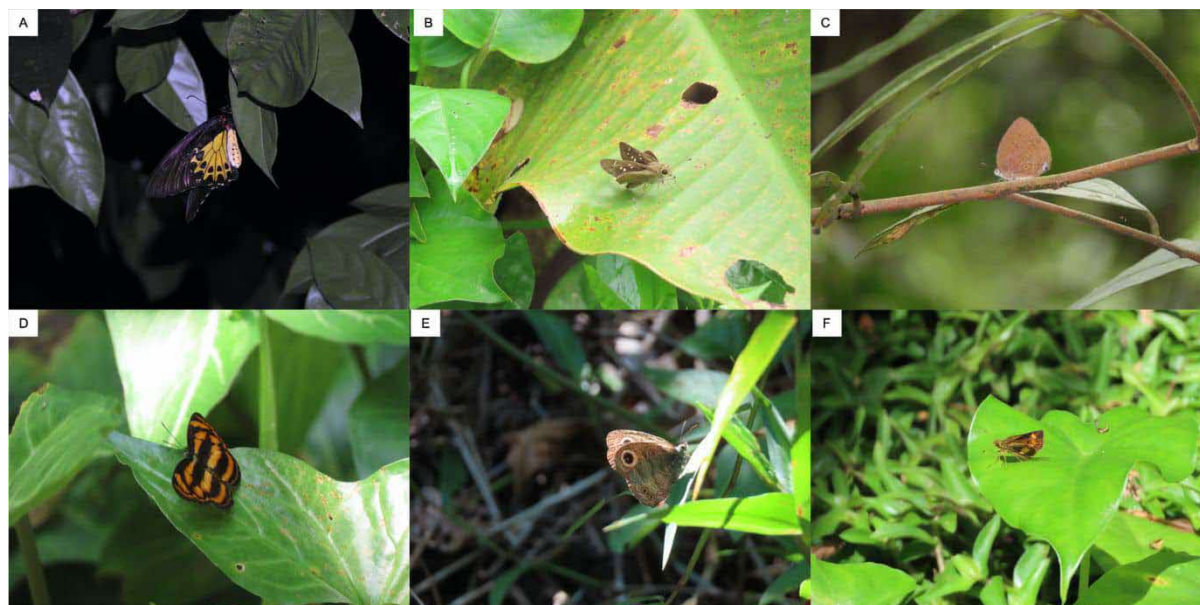

Figure 7-42 Butterfly species of conservation significance observed on site at Sites I and II (A) Common birdwing (*Troides helena cerberus*), (B) Formosan swift (*Borbo cinnara cinnara*), (C) *Arhopala amphimuta*; and Butterfly Species observed at Site III (D) Malayan lascar (*Lasippa tiga siaka*), (E) Malayan five ring (*Ypthima horsfieldii humei*), and (F) Malayan dartlet (*Oriens paragola*)

Legend

- ☐ Study Area
- ☐ Base Scenario Construction Worksite Footprint and Proposed CRL Alignment (Base)
- ▨ Road works

Vegetation
- Native-dominated secondary forest
- Mixed forest
- Abandoned-land forest
- Waste woodland
- Scrubland and herbaceous vegetation
- Managed vegetation
- Waterbody

- Others (infrastructure)
- Terrestrial sampling route 1
- Terrestrial sampling route 2

Butterfly species of conservation significance
- B. cinnara
- T. h. cerberus
- A. a. amphimuta

Site III
Site II
Site I
Eng Neo Avenue Forest
PIE

0   100   200 m

N

Note: Source of basemap - Google Earth Map

Qualified Person Endorsement : NA	Consultant : AECOM		Land Transport Authority We Keep Your World *Moving*		
	Project Title : CONTRACT CR2005 ENVIRONMENTAL IMPACT STUDY (TURF CITY AND HOLLAND PLAIN)		Figure Title : LOCATIONS OF BUTTERFLY SPECIES OF CONSERVATION SIGNIFICANCE AT TURF CITY		
LTA Endorsement : NA					

-	SEP 2022	JW	EIS (Turf City and Holland Plain)	JAG/NHT	JAG		
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	Drawn JW	Date SEP 2022	CAD File Name : NA		A3

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7.3.1.3.6   *Freshwater Decapod Crustaceans*

Only two species, the native maculate freshwater crab (*Parathelphusa maculata*) and the non-native ghost shrimp (*Macrobrachium lanchesteri*), were considered of probable occurrence (Table 7-15; Appendix H1). Both species were not recorded.

7.3.1.3.7   *Freshwater Fish*

The desktop assessment identified 13 species of probable occurrence at the Study Area, with seven species being recorded (Table 7-15; Appendix H1). Two of these were native species while four were non-native. The two recorded native species are the common snakehead (*Channa striata*) and the common walking catfish (*Clarias cf. batrachus*). The waterbodies across all three sites were dominated by three non-native species including the guppy (*Poecilia reticulata*), Indochinese spotted barb (*Barbodes rhombeus*) and pearl danio (*Brachydanio albolineata).*

At Sites I and II, six species of fish were found along D/S16 and none in D/S15, likely as the former stream is more naturalised with riparian vegetation than the latter. The common walking catfish was observed twice in mid-channel, which is rather noteworthy albeit not listed to be threatened nationally or globally. The common walking catfish was a previously widespread species in the non-forested waterways of Singapore but 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*), which was unfortunately also found in the same stream. With adequate species management, the existing stream habitat thus has value in supporting the populations of the species in Singapore.

At Site III, six species of fish were also found along D/S8, with five of them being non-native. The only native species found here was the common snakehead (*C. striata*). The poor 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.
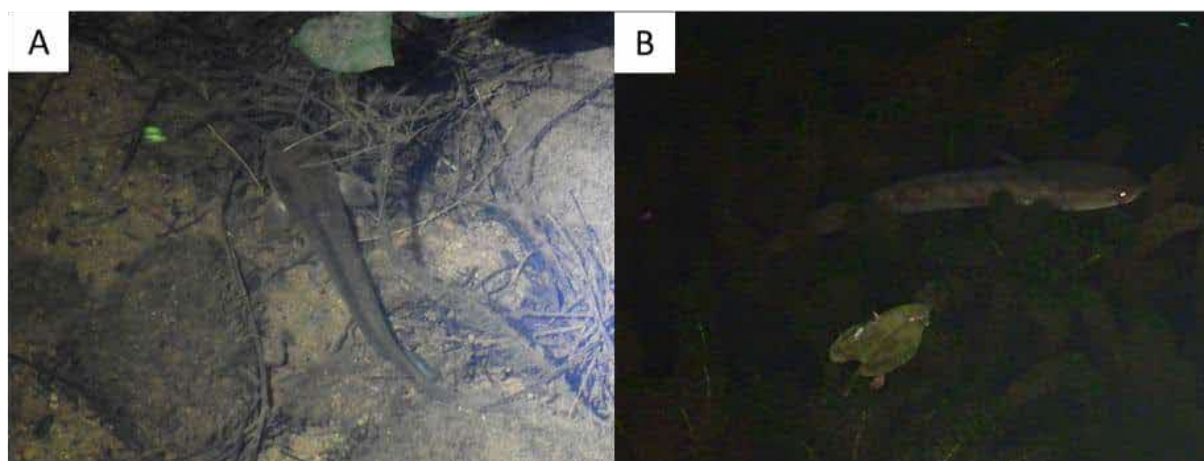
Figure 7-44 Freshwater fish species found along natural-naturalised streams in Sites I to III: (A) common walking catfish (*Clarias cf. batrachus* and (B) common snakehead (*Channa striata*)

7.3.1.3.8   *Amphibians*

A total of 16 amphibians, none of conservation significance, were deemed of probable occurrence (Table 7-15; Appendix H1). The field assessment recorded nine amphibian species (Table 7-15; Appendix H1). No species of conservation significance was recorded. Three non-native frogs, the greenhouse frog (*Eleutherodactylus planirostris*), banded bull frog (*Kaloula pulchra*) and East Asian ornate chorus frog (*Microhyla mukhlesuri*) were also recorded.

Sites I and II recorded nine amphibian species and was dominated by the greenhouse frog (*Eleutherodactylus planirostris*) with a total of 112 records. Site III recorded eight species and was dominated by the Asian toad (*Duttaphrynus melanostictus*). Both of these dominant species are highly tolerant of disturbance and are often found near or in human habitation (Baker & Lim, 2008). The next most abundant species, the Malayan giant frog (*Limnonectes blythii*), was also recorded for all three sites. The Malayan giant frog is a species with a globally Near Threatened status but locally of Least Concern. In general, all species recorded are considered widespread and common, except for the restricted and rare East Asian ornate chorus frog (*Microhyla mukhlesuri*) which is non-native.

Figure 7-45 Amphibians recorded within Sites I to III. (A) Banded bullfrog (*Kaloula pulchra);* (B) Malayan giant frog (*Limnonectes blythii)*; (C) Four-lined tree frog (*Polypedates leucomystax*)

7.3.1.3.9   *Reptiles*

The probable species list amounted to 35 reptiles comprising three terrapins, 12 lizards and 20 snakes (Table 7-15; Appendix H1). Of this, two species (one snake and one terrapin) were of conservation significance. The field assessment recorded 11 reptiles, which were mostly widespread and common (Table 7-15; Appendix H1). No reptiles of conservation status were recorded from these sites.

Of the 11 species, four were snakes and the rest were lizards. Many reptilian species found within the Sites I to III Study Areas are able to tolerate relatively degraded habitats and can be found in urban areas, such as the reticulated python (*Malayopython reticulatus*), changeable lizard (*Calotes versicolor*), and the spiny-tailed house gecko (*Hemidactylus frenatus*).

Sites I and II seems to be a favourable habitat for the painted bronzebacks (*Dendrelaphis pictus*) where 17 individuals were recorded over two-night surveys as opposed Site III, where only four individuals were recorded in one night throughout the sampling period. Other snake species such as the oriental whip snake (*Ahaetulla prasina*), reticulated python (*M. reticulatus*) and equatorial spitting cobra (*Naja sumatrana*) were only sighted once throughout the survey period. Although not captured in this study, the Wagler's pit viper (*Tropidolaemus wagleri*) was also recorded in Site III by NSS (2021). This finding is noteworthy as the Wagler's pit viper generally inhabits mature forests and was previously thought to be restricted to the CCNR (Baker & Lim, 2012).

While not of conservation status, it is also noteworthy that more individuals of the native green crested lizard (*Bronchocela cristatella*) were sighted than the changeable lizard (*C. versicolor*), a non-native species that has been displacing the green crested lizard.

Figure 7-46 Reptiles sighted in Sites I to III. (A) Painted bronzeback (*Dendrelaphis pictus*); (B) Reticulated python (*Malayopython reticulatus*); (C) Many-lined sun skink (*Eutropis multifasciata*)

7.3.1.3.10 *Birds*

A total of 166 species of birds were deemed of probable occurrence, of which 107 are resident (11 introduced), one is an introduced non-resident and 58 are migrant/visitor species (Table 7-15; Appendix H1).

The field assessment recorded 71 species which comprised 57 resident (47 native and 10 introduced) and 11 migrant/visitor species (Table 7-15; Appendix H1). Two other species were introduced species, including an unexpected species, the red lory (*Eos bornea*), which was probably an escapee. The remaining one species were recorded only to genus or family level, hence not classified by their native status. Two bird species were only recorded from camera traps.

Seven species of conservation significance were found in Sites I and II: the nationally Vulnerable red-legged crake (*Rallina fasciata*) (Figure 7-47), Endangered red junglefowl (*Gallus gallus*) and blue-crowned hanging parrot (*Loriculus galgulus*) that were recorded during targeted surveys, as well as the nationally Critically Endangered spotted wood owl (*Strix seloputo*) and crested goshawk (*Accipiter trivirgatus*) that were incidental observations. The remaining two species, the long-tailed parakeet (*Psittacula longicauda*) and straw-headed bulbul (*Pycnonotus zeylanicus*) are globally Vulnerable and Critically Endangered respectively, with the straw-headed bulbul being Endangered locally.

Five species of conservation significance were found in Site III, including the nationally Endangered red junglefowl (*Gallus gallus*), blue-crowned hanging parrot (*Loriculus galgulus*), oriental-pied hornbill (*Anthracoceros albirostris*) and oriental magpie robin (*Copsychus saularis*). The hornbills were frequently observed on the tall albizia trees (*Falcataria moluccana*), which are also likely nesting habitats for the non-native Tanimbar corella (*Cacatua goffiniana*). The globally Critically Endangered and nationally Endangered straw-headed bulbul (*Pycnonotus zeylanicus*) was also found in Site III.

Most of the species of conservation significance were previously regarded as rare but have since slowly increased in range and numbers such as the red junglefowl (*G. gallus*), blue-crowned hanging-parrot (*L. galgulus*), red-legged crake (*R. fasciata*) and oriental pied hornbill (*A. albirostris*) (Lim and Yong, 2011). The nationally Vulnerable red-legged crake (*R. fasciata*) can be found in many forested areas around Singapore, although the loss of habitat has contributed to its decline over the years. The long-tailed parakeet (*P. longicauda*) remains globally vulnerable and its population is threatened mainly by pet bird trade (Birdlife International, 2022). 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 (Collar et al., 2020). 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 (Lim and Yong, 2011). Singapore is now a global stronghold for this species. All habitats in Singapore that support the species play a critical role in its global conservation.

Uncommon migratory species encountered in Sites I and II include the forest wagtail (*Dendronanthus indicus*), yellow-rumped flycatcher (*Ficedula zanthopygia*) and Eastern crowned warbler (*Phylloscopus coronatus*), while the Hodgson's hawk cuckoo (*Hierococcyx nisicolor*) was encountered in Site III (Figure 7-47). While none are of conservation significance, these records show the value of the sites in providing habitats for some uncommon migratory species.
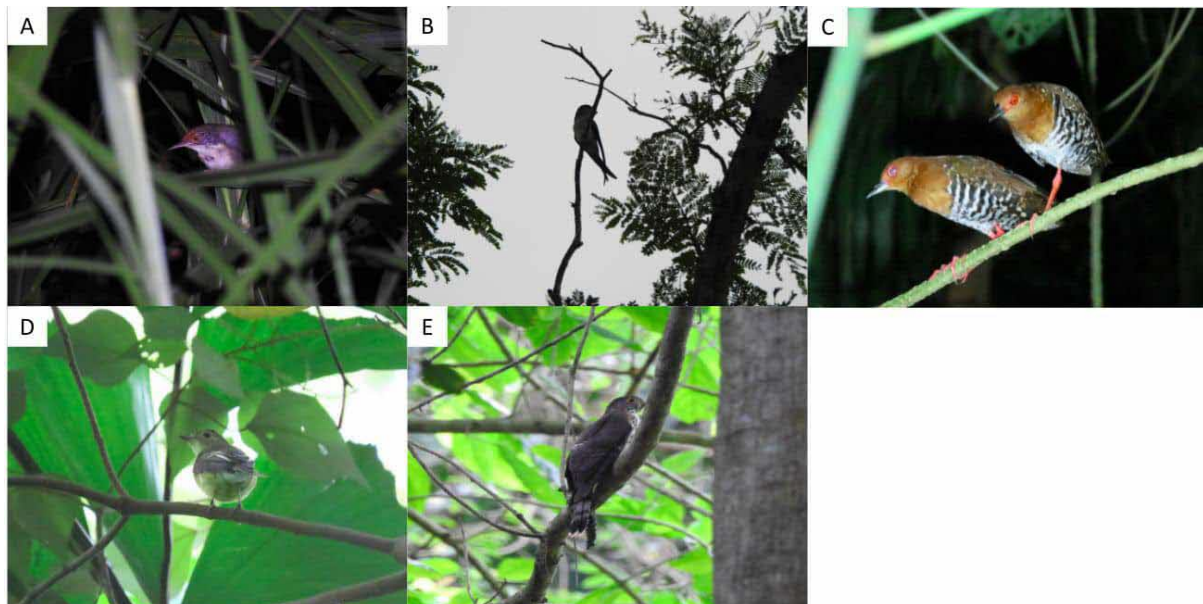
**Figure 7-47 Bird Species Encountered in Sites I and II (A) Common tailorbird (*Orthotomus sutorius)*; (B) Grey-rumped tree swift (*Hemiprocne longipennis)*; (C) Red-legged crake (*Rallina fasciata)*; (D) Yellow-rumped flycatcher (*Ficedula zanthopygia)*; and in Site III (E) Hodgson's Hawk-Cuckoo (*Hierococcyx nisicolor)*

Bird species of conservation significance
- ▲ Accipiter trivirgatus
- ▲ Anthracoceros albirostris
- ▲ Copsychus saularis
- ▲ Gallus gallus
- ▲ Loriculus galgulus
- ▲ Psittacula longicauda
- ▲ Pycnonotus zeylanicus
- ▲ Rallina fasciata
- ▲ Strix seloputo

Site I
Site II
Site III
Eng Neo Avenue Forest
PIE

0   100   200 m

Legend

- ▢ Study Area
- ▢ Base Scenario Construction Worksite Footprint and Proposed CRL Alignment (Base)
- ▨ Road works

Vegetation
- Native-dominated secondary forest
- Mixed forest
- Abandoned-land forest
- Waste woodland
- Scrubland and herbaceous vegetation
- Managed vegetation
- Waterbody

- Others (infrastructure)
- Terrestrial sampling route 1
- Terrestrial sampling route 2

N

Note: Source of basemap - Google Earth Map

Qualified Person Endorsement : NA	Consultant : AECOM			Land Transport Authority We Keep Your World Moving
	Project Title : CONTRACT CR2005 ENVIRONMENTAL IMPACT STUDY (TURF CITY AND HOLLAND PLAIN)			Figure Title : LOCATIONS OF BIRD SPECIES OF CONSERVATION SIGNIFICANCE AT TURF CITY
LTA Endorsement : NA				

							Designed JW	Checked JAG/NHT	Approved JAG	Figure No. : 7-48	Rev. -	Sheet 1 of 1
-	SEP 2022	JW	EIS (Turf City and Holland Plain)	JAG/NHT	JAG			Drawn JW	Date SEP 2022	CAD File Name : NA		A3
Rev.	Date	By	Description	Chk'd	App'd							

7.3.1.3.11 *Non-volant Mammals*

A total of 17 species of non-volant mammals were deemed of probable occurrence and two of which are of conservation significance: the nationally Critically Endangered Sunda pangolin (*Manis javanica*) and the globally Vulnerable long-tailed macaque (*Macaca fascicularis*) (Table 7-15; Appendix H1). Faunistic findings via field assessments revealed a total of nine recorded species, including both species of conservation significance. While not of conservation significance, the recorded Near Threatened Sunda colugo (*Galeopterus variegatus*) is also a species of interest, that may require additional protection measures during any future development.

The Sunda pangolin (*M. javanica*) was detected on camera traps across Sites I and II, with six independent detections which comes noteworthy given the relatively small size of the Sites. A sighting of a mother and its baby clinging on its tail at CT23 denotes signs of breeding activity (Figure 7-49). The vegetation-type where pangolins were detected comprises of a mixture of native-dominated forest and mixed-forest. While pangolins are known to reside mainly in both CCNR and Bukit Batok, fragmented patches of forest such as those within Sites I to III 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 was recently up-listed as a globally Vulnerable species as a result of human persecution across the rest of Southeast Asia (Eudey et al., 2020). This species was detected at all three sites (Figure 7-49).

During an incidental observation, the forest-dependent Sunda colugo was observed to have glided from the forest edge to an open area within Site I (Figure 7-49). The colugo is largely restricted to the CCNR and its surrounding forests, although it has been sighted in discrete forest patches (Bromley et al., 2019). In Singapore, colugos have been observed to glide across Pan Island Expressway (PIE), despite the heavy traffic and streetlamps, using mature trees as far as 63.5m apart (Lim., 2007). Therefore, it is probable that the observed individual is a result of dispersal from the main source population at CCNR; or part of a small population already residing within Sites I and II; or a stray individual.

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 (NParks, 2018). While the plaintain 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 (Baker and Lim 2012). The wild pig (*Sus scrofa*) was detected once by CT_11 (Table 7-18). This species is widespread across Singapore and able to persist in large patches of mixed secondary forest-abandoned plantation (Yong et al., 2010).

Figure 7-49 Mammalian species sighted in Sites I to III: (A) long-tailed macaque (*Macaca fascicularis*); (B) Sunda colugo (*Galeopterus variegatus*); (C) Sunda pangolin (*Manis javanica*) mother and young captured on camera trap.

Legend

- ☐ Study Area
- ☐ Base Scenario Construction Worksite Footprint and Proposed CRL Alignment (Base)
- ▨ Road works

Vegetation
- Native-dominated secondary forest
- Mixed forest
- Abandoned-land forest
- Waste woodland
- Scrubland and herbaceous vegetation
- Managed vegetation
- Waterbody

- Others (infrastructure)
- Terrestrial sampling route 1
- Terrestrial sampling route 2

Mammalian species of conservation significance or interest
- ■ M. javanica
- ■ M. fascicularis
- ■ G. variegatus

Note: Source of basemap - Google Earth Map

Qualified Person Endorsement :	NA	Consultant :	AECOM			Land Transport Authority — We Keep Your World *Moving*
		Project Title : CONTRACT CR2005 ENVIRONMENTAL IMPACT STUDY (TURF CITY AND HOLLAND PLAIN)			Figure Title : LOCATIONS OF MAMMALIAN SPECIES OF CONSERVATION SIGNIFICANCE AT TURF CITY	
LTA Endorsement :	NA					

						Designed	Checked	Approved	Figure No. :	Rev.	Sheet
						JW	JAG/NHT	JAG	7-50	-	1 of 1
-	SEP 2022	JW	EIS (Turf City and Holland Plain)	JAG/NHT	JAG						
							Drawn	Date			
Rev.	Date	By	Description	Chk'd	App'd		JW	SEP 2022	CAD File Name : NA		A3

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The 7 camera traps yielded 318 independent detections and nine species of mammals over 429 trap-nights (Table 7-18; Table 7-19). The list of camera trap data is available in Appendix J1. The most commonly recorded was the common treeshrew (*Tupaia glis*) with 143 independent detections. Notably, the Critically Endangered Sunda pangolin (*M. javanica*) was recorded over six occasions at four locations (CT11–CT13, CT23) across Sites I and II. The highest mammal richness (7 species) was recorded at CT11 in the eastern part of Site I. However, the highest mammal detection rate was recorded at CT25 (1.3 independent detections per trap-night).

Table 7-18 Locations and Number of Independent Detections of Mammalian Species at Sites I to III

Species	Common Name	CT Location	No. Of Independent Detections
Callosciurus notatus	Plantain squirrel	CT12 - CT15, CT23	116
Canis lupus familaris	Feral dog	CT14	2
Macaca fascicularis	Long-tailed macaque	CT11, CT12, CT14, CT23	16
Manis javanica	Sunda pangolin	CT11 - 13, CT23	6
Paradoxurus musangus	Common palm civet	CT11, CT14	3
Rattus sp.	Rat	CT11 - CT15	30
Sundasciurus tenuis	Slender squirrel	CT11	1
Sus scrofa	Wild pig	CT11	1
Tupaia glis	Common treeshrew	CT11 – CT 15, CT23	143
Total			**318**

Table 7-19 Number of Species and Detection Rate of Mammals Recorded at Each Camera Trap within Sites I to III

Station	No. Of Trap Nights	No. Of Mammalian Species Recorded	Detection Rate Of Mammals
CT_11	63	7	0.5
CT_12	60	5	1.1
CT_13	60	4	1.1
CT_14	63	6	0.7
CT_15	60	3	0.5
CT_19	60	0	0.0
CT_23	63	4	1.3

7.3.1.3.12 *Bats*

During field assessment, nine species of bats were detected. The frugivorous lesser short-nosed fruit bat (*Cynopterus brachyotis*) was detected visually. The remaining bats were insectivorous bats and were detected acoustically (Table 7-15). They are the Asian whiskered myotis (*Myotis muricola*), black-bearded tomb bat (*Taphozous melanopogon*), glossy horseshoe bat (*Rhinolophus refulgens*), Horsfield's myotis (*Myotis horsfieldii*), Javan pipistrells (*Pipistrellus javanicus*), lesser Asian house bat (*Scotophilus kuhlii*), pouched tomb bat (*Saccolaimus saccolaimus*), and an unidentified bamboo bat species (*Tylonycteris* sp.). Horsfield's myotis was an unexpected species given that they are nearly always found close to open waterbodies. Nonetheless, this species can also occur in town gardens and forests like that in the Study Area. The bamboo bat was the only species of conservation significance detected during the field assessment. 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 from Sites I and II only. Six bamboo clusters were identified within Sites I and II, and they were examined for its use by bamboo bats, as the species roosts in bamboo internodes. Bamboo bat activity was detected acoustically around two of the bamboo clusters during roost emergence survey, indicating that these clusters are likely a roosting site for the species (Figure 7-52).

Areas adjacent to the sites 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. Highly adapted to hunting in cluttered environments, the glossy horseshoe bat has been recorded 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. Given that the species is volant and was

recorded throughout the site, the glossy horseshoe bats detected during field assessment is most likely part of the larger population with CCNR, rather than an isolated population, and the species utilises the landscape as a contiguous habitat for its survival.
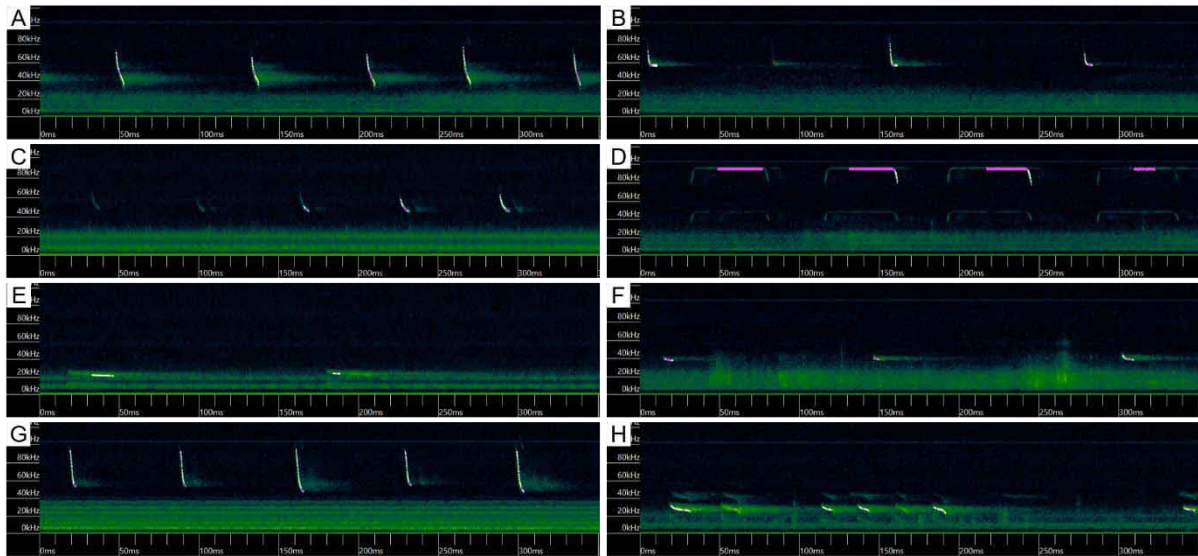

Figure 7-51 Spectograms of Bat Echolocation Calls. (A) Horsfield's Myotis (*Myotis horsfieldii*); (B) Whiskered Myotis (*Myotis muricola*); (C) Javan Pipistrelle (*Pipistrellus javanicus*); (D) Glossy Horseshoe Bat (*Rhinolophus refulgens*); (E) Pouch Bearing Bat (*Saccolaimus saccolaimus*); (F) Lesser Asian house bat (*Scotophilus kuhlii*); (G) Bamboo Bat (*Tylonycteris sp.*); (H) Black-bearded Tomb Bat (*Taphozous melanopogon*)

LOCATIONS OF BAT SPECIES OF CONSERVATION SIGNIFICANCE AT TURF CITY

7.3.2   Holland Plain: Sites IV and V near Clementi Forest

7.3.2.1   Habitat Types

There is a total of seven habitat types present in Sites IV and V (Table 7-20). Scrubland and herbaceous vegetation (5.0 ha; 48.5%) is the largest habitat type, which can be found throughout the site and occupies about half of the total Study Area. This is followed by waste woodland (2.1 ha; 20.6%), located only at the southern portion along the green corridor road. Likewise, for abandoned-land forest (1.2 ha; 11.5%), can only be found at the northern portion of the Study Area. There are two patches of native-dominated secondary forest (0.6 ha; 5.5 %) found in the Study Area, with freshwater marsh (0.3 ha; 3.3%) recorded beside one of the native patches near to Old Holland Road. The remaining habitat is covered by, in descending order, infrastructure (0.7 ha; 6.5%), managed vegetation (0.4 ha; 3.5%), and waterbody (0.1 ha; 0.7%).

Table 7-20 Absolute (ha) and Relative (%) Sizes of Each Habitat Type in Sites IV and V

	ha	%
Native-dominated Secondary Forest	0.6	5.5
Abandoned-land Forest	1.2	11.5
Waste Woodland	2.1	20.6
Scrubland and Herbaceous Vegetation	5.0	48.5
Managed Vegetation	0.4	3.5
Freshwater Marsh	0.3	3.3
Waterbody	0.1	0.7
Others (Infrastructure)	0.7	6.5
Total Area	**10.2**	**100.0**

Legend

- ☐ Study Area
- ☐ Base Scenario Construction Worksite Footprint and Proposed CRL Alignment (Base)
- ▨ Road works
- ☐ Others (infrastructure)

Vegetation

- Native-dominated secondary forest
- Abandoned-land forest
- Waste woodland
- Scrubland and herbaceous vegetation
- Managed vegetation
- Freshwater marsh
- Waterbody

Site IV

Site V

Clementi Forest

N

0   100   200 m

Note: Source of basemap - Google Earth Map

Consultant :

AECOM

Project Title :

CONTRACT CR2005 ENVIRONMENTAL IMPACT STUDY (TURF CITY AND HOLLAND PLAINS)

Qualified Person Endorsement :
NA

LTA Endorsement :
NA

Land Transport Authority
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Figure Title :

VEGETATION DISTRIBUTION OF HOLLAND PLAIN

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JW	SEP 2022	

Figure No. :	Rev.	Sheet
7-53	-	1 of 1

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-	SEP 2022	JW	EIS (Turf City and Holland Plain)	JAG/NHT	JAG
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7.3.2.1.1 *Native-dominated Secondary Forest*

Native-dominated secondary forest only takes up 5.5% of the overall Study Area. Based on historical maps, this forest seems to have regenerated from grassland that were likely cleared between 1945–1950s (Yee at al., 2019; Section 4.4.2). There are two forested patches identified within Sites IV and V, each of these patches were classified based on their stage of succession (i.e., early- or late-successional forest) and floristic composition.

The smaller native patch is located within the interior vegetated area at the northern portion of the site, surrounded by both scrubland and herbaceous vegetation, and abandoned-land forest. Closer to the scrubland and herbaceous vegetation at eastern side, this native patch has a steep slope and has a more open canopy (Figure 7-54A). This contrasts with the western side, facing the abandoned-land forest, where the topology is flatter and is more shaded. With extra sunlight exposure from the east, it encourages the growth of pioneer species that are fast-growing and light-demanding. Hence, the floristic composition within this patch comprises of native species that favours in this environment, such as *Sterculia cordata* (Figure 7-54D), slender pitcher plant (*Nepenthes gracilis*) (Figure 7-54E), terentang (*Camnosperma auriculatum*) (Figure 7-54F). A nationally Vulnerable tree *Litsea firma* with a girth size of 1.1 m was also found at the highest point in this Study Area (Figure 7-54B-C). This is note-worthy as it is uncommon to find *L. firma* trees of such sizes outside of the nature reserves in Singapore. Other rare native plant species that thrive well under full sun was also observed at this patch. They include the climber *Uncaria longiflora* var. *pteropoda* and *Uncaria cordata*, as well as previously presumed nationally Extinct *Gynochthodes rigida*, which is discussed in detail in Section 7.3.2.2.2.

The second larger patch is found in a forested area beside Old Holland Road. The perimeter of this patch is surrounded by a thin strip of scrubland and herbaceous vegetation. This native patch is mainly dominated by the slow-growing species, tembusu (*Cyrtophyllum fragrans*) in the core area and pioneer species, such as *Macranga hulletii*, along the edge. Several common native species also occupied the understorey layer. Many seedlings from the genus *Syzygium* were seen widespread across the area together with scattered individuals of *Timonius wallichinus*, *Gynochthodes sublanceolata* and *Morella esculenta*. This native patch plays a particularly important role in affecting and maintaining the unique microclimate of the adjacent freshwater marsh by providing some shade, which is essential for the rich fauna diversity observed (see Section 7.3.2.1.6).

Majority of the tembusu trees measured had a girth size range of 1–2 m and would suggest that these trees may be more than 50 years old (2 m girth tembusu trees are estimated to be more than 100 years old) given the slow-growing nature of this species. As such, it is unlikely that the trees were dispersed from those planted along Blackmore Road. It is more likely that they regenerated naturally within the site and were not removed through the years. However, because of its proximity to the road and pathway, it is almost certain that there has been consistent repetitive disturbance in the area, which plausibly led to changes in species composition. This would account for the scattered exotic *Acacia auriculiformis* trees observed within the canopy layer. In contrast, more native plants of conservation significance, such as *Macaranga hulletii*, *Endospermum* sp., and *Ficus aurata* var. *aurata* were found mainly in the western side of the patch, away from the road.
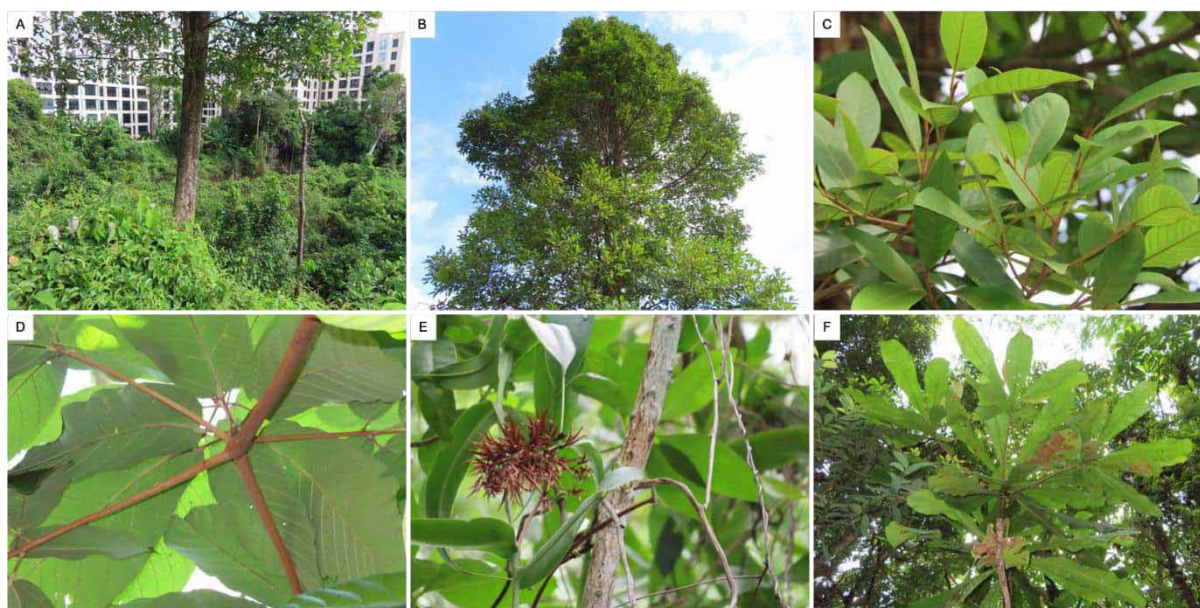
Figure 7-54 Native Features in Sites IV and V. (A) When Viewed from the Vantage Point with (B–C) A *Litsea firma* Tree in the Foreground; (D) *Sterculia cordata*; (E) *Nepenthes gracilis* Flowers; (F) *Campnosperma auriculatum*.

Figure 7-55 Nationally Common Native Plant Species in the Native Dominated Secondary Forest in Sites IV and V. (A) *Timonius wallichinus*; (B) *Gynochthodes sublanceolata*; (C) *Morinda esculenta*.

7.3.2.1.2   *Abandoned-land Forest*

Abandoned-land forest (1.2 ha; 11.5%) is the third largest habitat type in the Study Area, located in the northern section and covering almost half of the forested area at the Study Area. This habitat type can be separated into three different segments in the Study Area according to the dominant canopy species. The first segment is found in the lower south, dominated by oil palms (*Elaeis guineensis*) (Figure 7-56A), scattered rambutan (*Nephelium lappaceum*) and durian (*Durio zibethinus*) trees. The understorey here is dominated by saplings of these fruit trees alongside wild cinnamon (*Cinnamomum iners*) and *Claoxylon indicum*. Several clusters of nationally Vulnerable *Ficus aurata* var. *aurata* were also recorded within this segment and suggests that they were dispersed from the nearby native-dominated forest area.

In the second segment located at the middle portion, majority of the canopy is dominated by sea almond (*Terminalia catappa*). Trees of African tulip (*Spathodea campanulata*) and *Ficus variegata* also observed to be interspersed throughout the segment. The understorey of this segment was covered by various climbers, such as *Epipremnum aureum*, *Erycibe tomentosa*, *Smilax setosa* and *Syngonium podophyllum*. Few saplings of fishtail palm (*Caryota mitis*) and *Sterculia cordata* was scattered across the undergrowth as well.

Lastly, the third segment is located up in the north, beside a waterlogged area. This area of abandoned-land forest has a higher elevation and denser undergrowth compared to the previous two segments. Fruit trees including rambutan, mango (*Mangifera indica*) (Figure 7-56B) and *Musa* cultivar dominates this section. The understorey comprises a mixture of species, such as fishtail palm, wild cinnamon, African tulip and *Syzygium grande*. A small area of abandoned land was also found below Mayfair Garden Modern Showflat, like the last segment, it has a similar floristic composition consisting mainly of young fruit trees.

Figure 7-56 Fruit Crops Typically Found in the Abandoned-land Forest in Site IV. (A) Oil Palm (*Elaeis guineensis*); (B) Mango (*Mangifera indica*).

7.3.2.1.3   *Waste Woodland*

Waste woodland occupies the second largest area (2.1 ha; 20.6%). This habitat type occurs in fragmented patches throughout the southern portion of Sites IV and V. The dominant species across all the waste woodland patches are oil palm (*Elaeis guineensis*) and large albizia (*Falcataria moluccana*; Figure 7-57A) trees that formed a close canopy layer (Figure 7-57B). Only few numbers of *Acacia auriculiformis* trees was recorded within the top southern part. The understorey stratum was dominated by a single species, giant taro (*Alocasia macrorrhizos*). There are only two findings of nationally Vulnerable *Bridelia stipularis* recorded within this habitat type.

Figure 7-57 Waste Woodland in Sites IV and V. (A) Albizia Trees (*Falcataria moluccana*) Along the Green Corridor; and (B) Forming a Closed Forest Canopy.

7.3.2.1.4   *Scrubland and Herbaceous Vegetation*

Scrubland and herbaceous vegetation form the largest habitat type in Sites IV and V (Table 7-20). The two main patches are in the eastern half of the Study Area (Figure 7-53). The northern patch is flanked abandoned-land forest on the western side and developed areas on the eastern side, which were excluded in the biodiversity study. Similarly, the southern patch is also flanked by waste woodland and managed vegetation on the eastern and western sides, respectively. This habitat type is characterised by a single vegetated stratum, dominated by shrub and herbaceous plant species. Without forest cover often provided by trees in the canopy in forested areas, scrublands receive high light incidence and most species that form this habitat type are sun-loving and can also tolerate high temperatures.

While the open-canopy scrubland areas form a continuous habitat in Sites IV and V, a few distinct communities were present. Firstly, some areas were dominated mainly by *Dillenia suffruticosa*, a woody shrub species that can form dense and extensive patches (Figure 7-58C). Plants in the understory below these patches are often shaded out and sprout opportunistically when there are gaps. In spite of the mono-specific dominance of such areas, climbing plants and creepers could also establish themselves on and among the woody shrubs. Here in Sites IV and V, the nationally threatened climber *Uncaria species* was found growing alongside other shrub species (Section 7.3.2.2.2.). Large populations of this species were especially found in the northern patch of scrubland.

The second scrubland sub-type in Sites IV and V is commonly found across Singapore, i.e., the grassland habitat (Figure 7-58B). Here, grass species are the dominant plants that form the single vegetated layer. Periodic mowing often favours the persistence of grasses which propagate underground via rhizomes. Exotic and fast-growing tree species may occasionally be found growing in this habitat, where they are able to exploit similar resources with high light and temperature levels. A mix of grass- and fern-dominated scrubland was found mostly in the southern patch, which is the last scrubland community found in Sites IV and V.

The third and most valuable scrubland community found in Sites IV and V is fern-dominated, particularly, by the resam (*Dicranopteris linearis*) (Figure 7-58A). This habitat sub-type was found mostly on a steep slope adjacent to the sheltered walkway along Blackmore Drive, and partially in the southern patch where a mix of scrubland habitat sub-types were found. Although the ferns suppress the regeneration of forests by preventing seed recruitment and therefore, tree establishment (Corlett, 1991; Chua et al., 2013), some native species associated with adinandra belukar habitat are often found occurring within such habitats. The resam vegetation is also one of the most important habitats for *Nepenthes* species in Singapore (Lam & Tan, 2020), carnivorous pitcher plants that attract and capture animal prey (Figure 7-54E). Large populations of up to four native *Nepenthes* species occur in this parcel, of which two are nationally threatened and one is a rare native hybrid (Section 7.3.2.2.2) (Lam & Tan, 2020).

In addition, the pitcher plants are also associated with important and rare fauna. For example, specialist crab spiders inhabit pitcher plants and have been noted to be seldom present in such high density as in Sites IV and V (Lam W.N., pers. comms.). The resident butterfly species, the pitcher blue (*Virachola kessuma deliochus*) whose host plants are the nationally Common *N. gracilis* and Vulnerable *N. rafflesiana*, has also been recorded in this area. This butterfly species is regarded as rare, and its distribution restricted to the host plant distribution (Lam & Tan, 2020). The area in Sites IV and V is one of the last remaining refugia for the carnivorous plants (and the associated fauna) outside the nature reserves in Singapore. Therefore, such resam patches play an important role in preserving and contributing to local biodiversity and are of very high conservation value. Section 7.3.2.2.2 discusses the importance and rarity of the individual *Nepenthes* species found in Sites IV and V.

Figure 7-58 Scrubland and Herbaceous Vegetation in Sites IV and V. (A) A Patch Dominated by the Resam Fern (*Dicranopteris linearis*); (B) Overgrown Grasses (Foreground) with Some Spontaneous Trees and Shrubs (Background); (C) *Dillenia suffruticosa* Shrubs.

7.3.2.1.5   *Managed Vegetation*

Managed vegetation in Sites IV and V consist of regularly mowed turf in two places. One is adjacent to the Mayfair Garden Modern showflat, with planted *Planchonella obovate* trees. Undergrowth species consist of *Paspalum conjugatum*, *Paspalum scrobiculatum*, *Ischaemum ciliare*, *Asystasia gangetica* subsp. *Micrantha,* shrubs that spread from nearby scrubland. Another managed turf is located along the perimeter of freshwater marsh and waste woodland at the southern portion (Figure 7-59), where it is connected to a more extensive patch of turf beyond the study boundary. The growth cover here includes some species such as touch-me-not (*Mimosa pudica*), *Ischaemum muticum* and *Fimbristylis littoralis*.

Figure 7-59 Managed Vegetation in Sites IV and V. (A) Turf Next to the Forest and (B) Scrubland.

7.3.2.1.6   *Freshwater Marsh*

The freshwater marsh occupies approximately 3% of Sites IV and V, surrounded by waste woodland, scrubland, and native forest (Table 7-20; Figure 7-53). This habitat type is defined in NParks (2020) as "wetland which is covered by water and typically dominated by grasses, sedges and other herbaceous plants or hydrophytes that are able to tolerate flooding." At almost 0.3 ha, the freshwater marsh in Site V is an extensive and valuable patch of wetland.

Floristically, the area is dominated by the water chestnut (*Eleocharis dulcis*), a native Common sedge species known to be able to tolerate flooding (Figure 7-60B). In swampy areas, this species is able to grow in dense populations, even if nutrient levels are low. Despite this, *Spathologttis plicata* was also recorded in the freshwater marsh (Figure 7-60C). This is a native Common ground orchid species often associated with open-canopy wet areas. While the area may be relatively less diverse floristically, the community of plant species is unique and distinct from that of most other terrestrial habitats.

The aquatic plants that currently inhabit the marshland and the mature trees that surround the area play an important role in contributing to the uniqueness of the habitat (Figure 7-60). In particular, the area is an especially good site for marsh-specific odonate species not easily found elsewhere in Singapore. For example, among the 21 odonate species observed, the nationally Vulnerable dragonfly species, the restless demon (*Indothemis limbata*) was opportunistically sighted here in this Study. Other rare odonates, such as the nationally Critically Endangered damselfly species, the hooked midget (*Mortonagrion falcatum*), may also be attracted to this habitat (Tang, pers. comms, 2022). If rehabilitated into a prime wetland area, coupled with proper management, the marshland could plausibly attract even more aquatic and semi-aquatic fauna, such as odonates and amphibians. Eventually, this area could develop into a biodiversity hotspot in Singapore outside the nature reserves, a valuable asset in the highly urbanised landscape.

The freshwater marsh is a rather unique habitat, characterised by its clayey substrate, organic matter, shallow water depth, open and shaded edges, uneven edges, established mature tree line and emergent and submergent plants. These characteristics set it apart from existing larger-scale wetlands like Kranji Marshes and Jurong Lake Gardens. Elsewhere in Singapore, similar habitats used to also be present at Tuas, Punggol Barat, and Marina East (Ngiam, pers. comms., 2022). These, unfortunately, have since given way to developments, thus making such natural (or naturalised) wetland habitats increasingly rare in land-scarce Singapore. Compared to the surrounding habitats, the wetland sits on a relatively higher ground and has likely allowed storm runoff rather than groundwater to accumulate over time. Satellite imagery on Google Earth shows that a waterbody was present here as early as the 1980s following the exhumation of a graveyard, but it did not appear vegetated until early 2000s. By around 2010, the wet area appears to be almost fully covered with vegetation and this seems to be so even until the late 2010s when some development works directly south of this patch occurred. Although the site origin may not be natural due to anthropogennic land use change, the formation and maturation of the freshwater marsh is entirely natural over the course of 40 years or longer. The natural processes include rain inundation, self-sowing sedges and self-colonising odonates and amphibians.

Considering the amount of time taken for the freshwater marsh to form naturally and the rarity of such wetland habitats in Singapore, the marsh remains immensely valuable.

Figure 7-60 Freshwater Marsh in Sites IV and V. (A) Lined with Tall Mature Trees from the Adjacent Native-Dominated Secondary Forest Patch; (B) Waterlogged and Dominated by Water Chestnut (*Eleocharis dulcis*) and Other Herbaceous Plants; (C) *Spathoglottis plicata*, one of the Species that can Tolerate Flooding and was Recorded Here.

7.3.2.1.7   *Waterbody*

Within the Sites IV and V, several waterlogged areas are present, most notably in Site V, where the waterlogging has created a swampy marshland habitat that has been discussed in a previous section (7.3.2.1.6). The locations and alignment of the waterbodies is shown in (Figure 7-5).

In Site IV, two small waterbodies formed from waterlogging can be found, namely a smaller and a larger pond, both of which are overgrown with riparian vegetation and dense shrubs (Figure 7-61). Low canopy cover and leaf litter was found at these waterbodies. The isolated waterbodies could have been formed from groundwater and surface runoff, given that they are not connected to the surrounding man-made drainage system.

Figure 7-61 Waterbodies in Sites IV and V. (A) Small Pond about 5 by 5 m; (B) Large Pond about 20 by 20 m in the Northern Tip of the Study Area and (C) Covered in Dense Shrubs; (D) Ephemeral Waterlogged Areas (Not Included in the Vegetation Map).

7.3.2.1.8   *Others (infrastructure)*

Infrastructure takes up a small area in Sites IV and V. It includes a building and two pathways along Blackmore Drive. The building is a temporary showflat, the Mayfair Garden Modern Showflat (Figure 7-62A) with a sheltered

walkway (Figure 7-62B) connecting to King's Albert Park MRT. The other pathway is a green corridor covered with gravel (Figure 7-62C) branching off between Blackmore Drive and Old Holland Road.

Figure 7-62 Infrastructure in Sites IV and V. (A) Condominium Showroom Separated from the Forest by a Thin Strip of Managed Vegetation; (B) Sheltered Walkway Along Blackmore Drive; (C) The Green Corridor Covered with Gravel.

7.3.2.2   Floristic Field Findings

7.3.2.2.1   *Overall*

A total of 229 plant species and species groups (i.e., plants that could not be identified with certainty), belonging to 77 families were recorded from Sites IV and V (Table 7-7; Appendix C2). There are three species groups, namely (1) *Endospermum* sp., (2) *Passiflora* sp., and (3) *Zoysia* sp.

Of the 229 species and species groups recorded, 103 (45.0%) are native, while 96 (41.9%) are exotic, and 28 (12.2%) are cryptogenic (i.e., of unknown or uncertain origin despite being a known species). Two species could not be identified and thus do not have a conservation status (Table 7-7).

Native threatened species comprise species that have been accorded the following statuses: Vulnerable, Endangered, Critically Endangered, Presumed Extinct, and those that were recently rediscovered and not yet assessed. For overall findings, 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. This is discussed in greater detail in Sections 7.2.2.3 and 7.3.2.2.2 Species of Conservation Significance.

Table 7-21 Number and Percentage of Species Belonging to Each Status Category in Sites IV and V

Origin	Status	Number Of Species	Percentage
Native		**103**	**45.0**
	Common	74	32.3
	Vulnerable	14	6.1
	Endangered	5	2.2
	Critically Endangered	7	3.1
	Presumed Extinct	2	0.9
	Not assessed	1	0.4
Exotic		**96**	**41.9**
	Cultivated Only	14	6.1
	Casual	18	7.9
	Naturalised	56	24.0
	Not assessed	9	3.9
Cryptogenic		**28**	**12.2**
Unidentified species		**2**	**0.9**
Total		**229**	**100.0**

7.3.2.2.2   *Plant Species of Conservation Significance*

A total of 17 plant species are considered of conservation significance in Sites IV and V. 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 of whether a threatened plant species is of conservation significance was carried out based on the criteria detailed in Section 7.2.2.3.

Altogether, 66 specimens and/or clusters of specimens belonging to these species of conservation significance were recorded in Sites IV and V. The majority of the specimens are concentrated within the native-dominated secondary forest (Table 7-10). Some of these specimens are also found in the patches of abandoned-land forest. The distribution of plant specimens of conservation significance is in Figure 7-63. Again, the findings suggest that while the abandoned-land forest is pre-dominantly occupied by exotic tree species, it too is recruiting and supporting native populations of threatened species.

Table 7-22 Number of Threatened Plant Species in Sites IV and V

	VU	EN	CR	EX	UN
Non-Cultivated Threatened Species	9	3	3	1	1
Cultivated Threatened Species	5	2	4	1	0
Total Number of Threatened Species	**14**	**5**	**7**	**2**	**1**

Note: VU – Vulnerable; EN – Endangered; CR– Critically Endangered; EX – Presumed Extinct; UN – Not assessed

Table 7-23 Number of Plant Specimens and Species of Conservation Significance in Each Vegetation Type in Sites IV and V

	Number of Individuals and Clusters					Number of Species				
	VU	EN	CR	UN	Total	VU	EN	CR	UN	Total
Native-dominated Secondary Forest	18	2	11	1	**32**	7	2	3	1	**13**
Abandoned-land Forest	5	0	2	0	**7**	2	0	1	0	**3**
Waste Woodland	0	0	0	0	**0**	0	0	0	0	**0**
Scrubland and Herbaceous Vegetation	7	0	3	0	**10**	3	0	3	0	**6**
Managed Vegetation	1	1	0	0	**2**	1	1	0	0	**2**

Note: Total species richness of the Study Area is not the sum of species richness per habitat type as some species occur in more than one habitat type. VU – Vulnerable; EN – Endangered; CR – Critically Endangered; UN – Not assessed.

Site IV

Site V

Clementi
Forest

0   100   200 m

Legend

Study Area

Base Scenario Construction Worksite Footprint and Proposed CRL Alignment (Base)

Road works

Others (infrastructure)

Plant specimens of conservation significance

Recently Rediscovered

Critically Endangered

Endangered

Vulnerable

Vegetation

Native-dominated secondary forest

Abandoned-land forest

Waste woodland

Scrubland and herbaceous vegetation

Managed vegetation

Freshwater marsh

Waterbody

N

Qualified Person Endorsement :	Consultant :			
NA	**AECOM**		**Land Transport Authority** We Keep Your World *Moving*	
	Project Title :		Figure Title :	
	CONTRACT CR2005 ENVIRONMENTAL IMPACT STUDY (TURF CITY AND HOLLAND PLAINS)		**DISTRIBUTION OF PLANT SPECIMENS OF CONSERVATION SIGNIFICANCE AT HOLLAND PLAIN**	
LTA Endorsement :				
NA				
	Designed	Checked	Approved	Figure No. :	Rev.	Sheet
	JW	JAG/NHT	JAG	7-63	-	1 of 1

-	SEP 2022	JW	EIS (Turf City and Holland Plain)	JAG/NHT	JAG
Rev.	Date	By	Description	Chk'd	App'd

				Drawn	Date		
				JW	SEP 2022	CAD File Name : NA	A3

Note: Source of basemap - Google Earth Map

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Majority of the nationally threatened species were recorded within the northern portion of the Study Area. The only recorded species that is nationally Presumed Extinct is climber *Gynochthodes rigida* (Figure 7-64C). Other rarer nationally Critically Endangered species are *Macaranga hullettii*, *Sterculia parviflora*, *Strophanthus caudatus* (Figure 7-64F) and *Uncaria longiflora* var. *pteropoda* (Figure 7-64A).

The specimen of *G. rigida* was discovered within the native-dominated secondary forest of Sites IV and V, near Blackmore Drive. Compared to other *Gynochthodes* species, this climber can be identified through its leathery leaf texture, which is covered with hairs on the abaxial side of the leaves. Most recent voucher specimens catalogued in the SING, in 2011 and 2012, were collected from different locations. Namely Admiralty Park Forest, Pulau Pawai and Upper Seletar Forest. This species was also recorded in BTNR (Ho et al., 2019) and was recently rediscovered in the NSSF (Chong et al., 2018). Evidence from these recent records has shown that low population of *G. rigida* still persist in mainland Singapore, despite previously thought to be nationally extinct. However, there is no other information relating to its distribution and habitats it prefers in Singapore. For better conservation of this species, more studies will be needed to assess and determine its national conservation status.

Sterculia parviflora is known to be commonly cultivated along Singapore's streetscapes. However, there was no planted specimens seen within the vicinity of the Study Area. It is likely that these specimens recorded are remnants of the native population. Hence, a more conservative approach was chosen, and this species was considered of conservation significance in Sites IV and V.

Numerous clusters of two nationally vulnerable pitcher plants species, *Nepenthes ampullaria* (Figure 7-65A) and *Nepenthes rafflesiana* (Figure 7-65C) were also recorded. Majority of these pitcher plants are limited to the scrubland and herbaceous vegetation in the southern portion of the Study Area, inhabiting within and among the dense resam fern (*Dicranopteris linearis)* together with the native common *Nepenthes gracilis*. Some noteworthy observations were made of the pitcher plants on site. The first was that only the lower pitchers (has a globose shape with a large exposed opening and a small pitcher lid) of *N. ampullaria* were seen, the upper pitchers were largely absent. In contrast, only the upper pitcher of *N. rafflesiana* was seen on site. The upper pitchers of *N. rafflesiana* are larger in size and shape than its ground pitchers and carried a vibrant red colouration around the pitcher mouth and lid. The male plant of *N. rafflesiana* was also observed to be flowering (Figure 7-65D). According to Lam and Tan (2020), both species are limited to CCNR, Kent Ridge Park, Western Catchment and resam-dominated scrubland. However, it was noted by a taxonomic expert (Lam W.N., pers. comms.) that among the three native *Nepenthes* species in Singapore, it is very rare to encounter *N. rafflesiana* even within nature reserves. This makes the presence of this species here a notable find.

Notably, *Nepenthes × trichocarpa* (Figure 7-65B) was recorded together with other pitcher plants in the Study Area. This species is a hybrid between *N. ampullaria* and *N. gracilis*, where it thrives in open resam-dominated scrubland. It can only hybridise naturally when both parent species thrive well in the environment, suggesting that the population of this hybrid species has a restricted distribution. Our sightings of all the above-mentioned pitcher plants found within a scrubland near Clementi Forest support the findings of Lam and Tan (2020). There are three important habitats in Singapore for the pitcher plant's establishment: resam-dominated vegetation, native-dominated secondary forest and reservoir or quarry edges (Lam and Tan, 2020). With the limited habitat preference of these species, especially for the resam-dominated scrubland in this Study, it is important to conserve such areas so that these pitcher plants can continue to flourish in Singapore.

Other findings of rare plants in the Study Area were recorded in low numbers, such as *S. caudatus*, *U. longiflora* var. *pteropoda* and the Endangered *Uncaria cordata* with two or less specimens. Several small clusters of Vulnerable plant species like *Ficus aurata* var. *aurata* (Figure 7-64B), *Endospermum* sp. (Figure 7-64E) and Critically Endangered *M. hullettii* were also recorded in the Study Area.
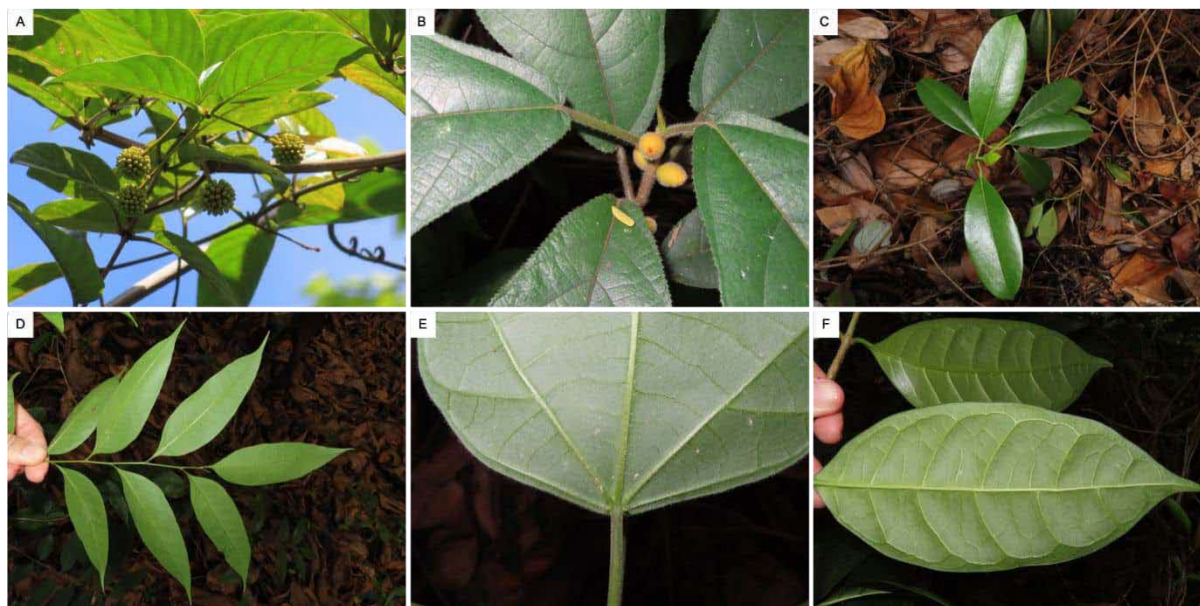
Figure 7-64 Species of Conservation Significance in Sites IV and V. (A) *Uncaria longiflora* var. *pteropoda*; (B) *Ficus aurata* var. *aurata*; (C) *Gynochthodes rigida*; (D) *Guioa pubescens*; I *Endospermum* sp. (F) *Strophanthus caudatus.*
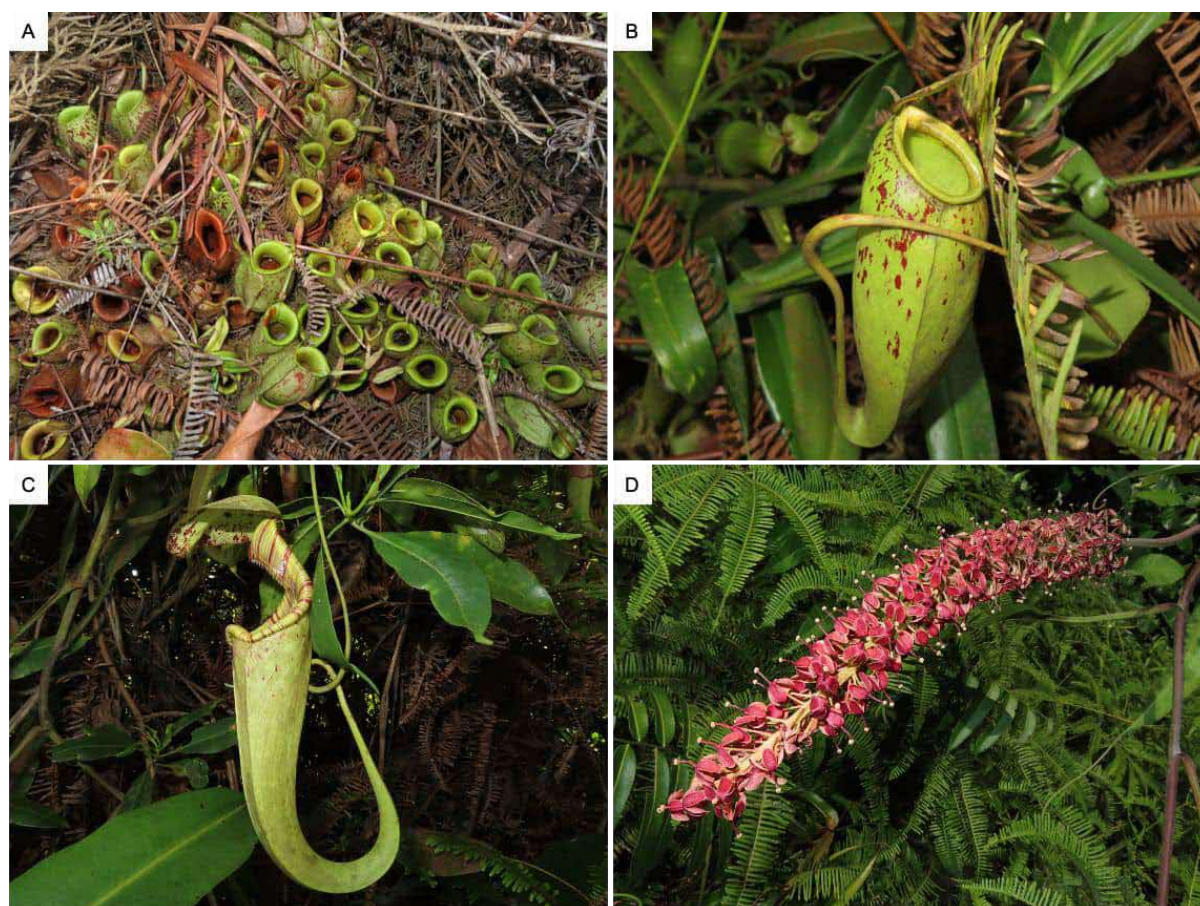

Figure 7-65 Pitcher plants in Sites IV and V. (A) *Nepenthes ampullaria*; (B) *Nepenthes × trichocarpa*; (C) *Nepenthes rafflesiana*; (D) Flower of *Nepenthes rafflesiana.*

7.3.2.2.3 *Large* Plant *Specimens*

A total of 17 large plant specimens from five species were recorded during floristic surveys in Sites IV and V, of which 14 specimens (82.4%) are exotic and two (11.8%) are native (Appendix E2). The distribution of all large plant specimens is shown in Figure 7-67. Of 17 large plant specimens, albizia trees (*Falcataria moluccana*) and oil palms (*Elaeis guineensis*) formed the majority of specimens with seven specimens recorded for each species (Table

7-13). The largest specimen recorded in Sites IV and V was an albizia (*Falcataria moluccana*) with a girth of 4.2 m (Figure 7-30A).

Table 7-24 Number of Large Plant Specimens in Sites IV and V

Habit	Species	No. of Specimens
Tree	*Elaeis guineensis*	7
	Falcataria moluccana	7
	Mangifera foetida	1
	Terminalia catappa	1
Shrub (Bamboo)	*Bambusa vulgaris*	1
Total		**17**

Figure 7-66 Large Specimens in Sites IV and V. (A) *Bambusa vulgaris* **of 3 m Spread; (B) Albizia Tree (***Falcataria moluccana***) of 3.5 m Girth; (C)** *Terminalia catappa* **With Large Buttresses of 3.4 m Girth; (D) Several Large Oil Palms (***Elaeis guineensis***) of at Least 3 m Girth.**

Legend

- ☐ (red outline) Study Area
- ☐ (white outline) Base Scenario Construction Worksite Footprint and Proposed CRL Alignment (Base)
- ▨ Road works

Vegetation
- Native-dominated secondary forest
- Abandoned-land forest
- Waste woodland
- Scrubland and herbaceous vegetation
- Managed vegetation
- Freshwater marsh
- Waterbody

- ☐ Others (infrastructure)

Large plant specimens
- ◆ Tree
- ◇ Strangler
- ◆ Bamboo

Note: Source of basemap - Google Earth Map

Clementi Forest

Site IV

Site V

0   100   200 m

N

	SEP 2022	JW	EIS (Turf City and Holland Plain)	JAG/NHT	JAG
Rev.	Date	By	Description	Chk'd	App'd

Qualified Person Endorsement :
NA

LTA Endorsement :
NA

Consultant :
AECOM

Project Title :
CONTRACT CR2005 ENVIRONMENTAL IMPACT STUDY (TURF CITY AND HOLLAND PLAINS)

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Drawn	Date	
JW	SEP 2022	

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Figure Title :
DISTRIBUTION OF LARGE PLANT SPECIMENS AT HOLLAND PLAIN

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7.3.2.2.4   *Other Plant Specimens of Value*

Twelve other plant specimens of value were recorded within Sites IV and V (Appendix F2) comprising eight trees with bird nests and four bamboo clusters. The tree specimens with bird nests are mostly exotic species including two *Acacia auriculiformis*, two Albizia (*Falcataria moluccana*) and one *Spathodea campanulata*. Two tree specimens with bird nests are native species: a Tembusu (*Cyrtophyllum fragrans*) and a sea almond (*Terminalia catappa*). One of the tree specimens with a bird nest is a dead tree. Raptor nests were found on each of the specimens of albizia while weaver bird nests were found on the two *Acacia auriculiformis*.

The four bamboo clusters included two clusters of *Bambusa heterostachya* and three clusters of *Bambusa vulgaris* although none of these bamboos were found to be the roost sites of bamboo bats (*Tylonycteris* sp.) during roost emergence surveys (Section 7.3.2.3.12).

Figure 7-68 Others of Specimens of Value in Sites IV and V. (A–B) Albizia Tree (*Falcataria moluccana*) with Raptor Nest; (C–D) *Bambusa vulgaris* of 1 m Spread; (E–F) *Acacia auriculiformis* Tree with Weaver Bird Nest.

Site IV

Clementi
Forest

Site V

0   100   200 m

Legend

☐ Study Area
☐ Base Scenario Construction Worksite Footprint and Proposed CRL Alignment (Base)
▨ Road works

Vegetation
■ Native-dominated secondary forest
■ Abandoned-land forest
■ Waste woodland
■ Scrubland and herbaceous vegetation
■ Managed vegetation
■ Freshwater marsh
■ Waterbody

■ Others (infrastructure)

Other specimens of value
▶ Bamboo
■ Bird nest
■ Raptor nest

N

Note: Source of basemap - Google Earth Map

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LTA Endorsement : NA						
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-	SEP 2022	JW	EIS (Turf City and Holland Plain)	JAG/NHT	JAG	Drawn JW	Date SEP 2022	CAD File Name : NA		A3
Rev.	Date	By	Description	Chk'd	App'd					

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7.3.2.2.5   *Tree Mapping Findings*

A total of 319 trees were tagged and assessed during the tree mapping surveys, of which, 83 trees (26%) are native and the remaining 236 trees (74%) are exotic (Appendix G2).

The tree species with highest count is *Falcataria moluccana* (155 specimens) which made up of nearly 50% of the trees found on that site. This is followed by *Elaeis guineensis* (35 specimens), *Crytophyllum fragrans* (29 specimens) and *Acacia auriculiformis* (21 specimens). Altogether, 240 specimens from these four species makes up 75% of the total number of trees. Of special mention here are three specimens that are rare and of uncommonly large size.

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 (Section 7.2.4.6).

Site IV

Clementi
Forest

Site V

0   100   200 m

N

Legend

- ☐ Study Area
- ☐ Base Scenario Construction Worksite Footprint and Proposed CRL Alignment (Base)
- ▨ Road works

Vegetation
- ■ Native-dominated secondary forest
- ■ Abandoned-land forest
- ■ Waste woodland
- ■ Scrubland and herbaceous vegetation
- ■ Managed vegetation
- ■ Freshwater marsh
- ■ Waterbody

- ☐ Others (infrastructure)
- ◆ Mapped tree

Qualified Person Endorsement :

NA

LTA Endorsement :

NA

Consultant :

AECOM

Project Title :

**CONTRACT CR2005
ENVIRONMENTAL IMPACT STUDY
(TURF CITY AND HOLLAND PLAINS)**

Land Transport Authority
We Keep Your World Moving

Figure Title :

**DISTRIBUTION OF MAPPED
TREES AT HOLLAND PLAIN**

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Drawn		Date
JW		SEP 2022

Figure No. :	Rev.	Sheet
7-70	-	1 of 1
CAD File Name : NA		A3

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Rev.	Date	By	Description	Chk'd	App'd

7.3.2.3   Faunistic Field Findings

7.3.2.3.1   *Overall*

The desktop assessment identified 558 species of probable occurrence at Sites IV and V, including 49 species of conservation significance (Table 7-25; Appendix H2).

The field assessment documented 160 species, dominated by birds (71 species) and odonates (29 species). From these, 11 species of conservation significance were recorded, all of which were listed as probable. The list of probable and recorded species is available in Appendix H2 and summarised in Table 7-25. The list of faunal species of conservation significance and their conservation status is available in Table 7-26. The faunal survey and camera trap data are provided in Appendix I2 and Appendix J2 respectively.

Table 7-25 Summary of Probable and Recorded Faunal Species at Sites IV and V

Faunal Group	No. Of Probable Species		No. Of Recorded Species		No. Of Recorded Species Not On Probable List (CS Species)
	All Species	CS Species	All Species	CS Species	
Aculeate hymenopterans	82	0	11	0	0
Bees	42	0	6	0	0
Stinging wasps	40	0	5	0	0
Odonates	54	4	29	1	0
Dragonflies	43	3	25	1	0
Damselflies	11	1	4	0	0
Butterflies	175	16	20	1	0
Freshwater decapod crustaceans	2	0	0	0	0
Freshwater fish	6	0	1	0	0
Herpetofauna	48	2	16	0	0
Amphibians	16	0	11	0	0
Reptiles	32	2	5	0	0
Birds	164	21	71	8	0
Mammals	27	6	12	1	0
Non-volant mammals	16	3	5	1	0
Bats	11	3	7	0	0
Total	**558**	**49**	**160**	**11**	**0**

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

Table 7-26 List of Faunal Species of Conservation Significance Recorded in Sites IV and V

Taxon	Species	Common Name	Local Status	Global Status	Location Of Records
Butterfly	*Troides helena cerberus*	Common birdwing	Vulnerable	Not Assessed; CITES protected (Appendix II)	Site V
Odonate	*Indothemis limbata*	Restless demon	Endangered	Least Concern	Site V
Bird	*Nisaetus cirrhatus*	Changeable hawk-eagle	Endangered	Least Concern; CITES protected (Appendix II)	Site V
Bird	*Vanellus indicus*	Red-wattled lapwing	Endangered	Least Concern	Site V
Bird	*Gallus*	Red junglefowl	Endangered	Least Concern	Sites IV and V
Bird	*Halcyon coromanda*	Ruddy kingfisher	Critically Endangered	Least Concern	Site IV
Bird	*Loriculus galgulus*	Blue-crowned hanging-parrot	Endangered	Least Concern; CITES protected (Appendix II)	Sites IV and V

Taxon	Species	Common Name	Local Status	Global Status	Location Of Records
Bird	*Psittacula longicauda*	Long-tailed parakeet	Not Assessed	Vulnerable; CITES protected (Appendix II)	Sites IV and V
Bird	*Pycnonotus zeylanicus*	Straw-headed bulbul	Endangered	Critically Endangered; CITES protected (Appendix II)	Site V
Bird	*Rallina fasciata*	Red-legged crake	Vulnerable	Least Concern	Sites IV and V
Mammal	*Manis javanica*	Sunda pangolin	Critically Endangered	Critically Endangered	Site V

Due to the connectivity of Sites IV and V to CCNR and proximity to the adjacent Clementi Forest, it might serve as an additional refugia for rare or forest-dependent species. The Study Area provides habitats for several species of conservation significance, including the globally Critically Endangered straw-headed bulbul (*Pycnonotus zeylanicus*), nationally Critically Endangered ruddy kingfisher (*Halcyon coromanda*), and nationally Endangered red-wattled lapwing (*Vanellus indicus*). Other noteworthy findings include the Sunda pangolin (*Manis javanica*), which was caught on camera trap within the scrubland and herbaceous vegetation at Site V. Pangolins were also sighted previously by Ho et al. (2019) in Clementi Forest, which could indicate that the pangolin population is utilising the entire forested area, making Sites IV and V another important patch for this globally and nationally Critically Endangered species.

In addition, the freshwater marshland in Site V also serves as an important habitat for odonates, amphibians and foraging grounds for migratory bee-eaters and kingfishers. The mere 0.3 ha marsh currently supports a diverse community of odonates (21 species), including certain marsh-specific species which thrives in such habitats like the crenulated spreadwing (*Lestes praemorsus*) and the nationally Endangered restless demon (*Indothemis limbata*). On the other hand, the waterbody in Site IV does not support as many species like the freshwater marsh, albeit it remains a hotspot for some odonates like the uncommon sultan (*Camacinia gigantea*).

Site IV

Site V

Clementi
Forest

● Critically Endangered   ● Endangered   ● Vulnerable

0   100   200 m

Legend

☐ Study Area
☐ Base Scenario Construction Worksite Footprint and Proposed CRL Alignment (Base)
▨ Road works

Vegetation
- Native-dominated secondary forest
- Abandoned-land forest
- Waste woodland
- Scrubland and herbaceous vegetation
- Managed vegetation
- Freshwater marsh
- Waterbody

- Others (infrastructure)
- Terrestrial sampling route

Faunal species of conservation significance
- ■ Non-volant mammal and bat
- ▲ Bird
- ⌒ Butterfly
- ▶ Odonate

N

Note: Source of basemap - Google Earth Map

Qualified Person Endorsement :	Consultant :	
NA	**AECOM**	**Land Transport Authority** We Keep Your World Moving
	Project Title :	Figure Title :
	CONTRACT CR2005 ENVIRONMENTAL IMPACT STUDY (TURF CITY AND HOLLAND PLAINS)	**LOCATION RECORDS OF CONSERVATION SIGNIFICANT FAUNAL SPECIES AT HOLLAND PLAIN**
LTA Endorsement : NA		

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7.3.2.3.2   *Sampling Coverage*

Along the terrestrial sampling routes and at aquatic sampling points, the sample coverage for each taxon were all near and above 70%, with the exception of aculeate hymenopterans (61.1%) and butterflies (41.6%) (Figure 7-72; Table 7-27). With doubled sampling effort, additional species may be detected. It is generally low across all taxa, although a higher number is expected for butterflies (21 species) and birds (14 species) (Table 7-27). The estimated richness for these groups with increased effort is well likely, given that similar numbers of species were previously recorded in the adjacent Clementi Forest. Sample coverage was not calculated for faunal groups with less than two species recorded. Taxon sampling curve for aquatic fauna survey was also not produced due to insufficient sample size required for a robust analysis. Camera trapping obtained a high coverage of 100.0% (Figure 7-73; Table 7-27).

Table 7-27 Result Summary of Taxon Sampling Analysis for Sites IV and V

Faunal Group	Sample Coverage (%)	Observed Richness	Estimated Richness (± Standard Error)	95% Confidence Interval for Estimated Richness	Estimated Coverage with Doubled Effort (%)	Estimated Richness (And Additional Species) With Doubled Effort
Terrestrial Sampling Routes						
Aculeate Hymenopteran	61.1	10	30 ± 26.0	13.0–149.78	77.7	18 (+8)
Odonate	72.7	19	29 ± 8.4	21.6–60.8	92.3	26 (+7)
Butterfly	41.6	18	111 ± 106.0	33.8–572.9	55.1	39 (+21)
Amphibian	90.2	11	18 ± 10.2	11.9–68.0	94.3	13 (+2)
Reptile	100.0	3	3 ± 0.4	3.0–4.3	100.0	3 (+0)
Bird	88.4	63	88 ± 14.6	72.1–135.6	95.0	77 (+14)
Non-Volant Mammal	100.0	2	2 ± 0.4	2.0–3.6	100.0	2 (+0)
Bat	100.0	5	5 ± 0.5	5.0–6.6	100.0	5 (+0)
Aquatic Sampling Points						
Odonate	69.1	14	20 ± 5.6	15.4–42.3	90.5	18 (+4)
Freshwater Fish	N.A.	1	N.A.	N.A.	N.A.	N.A.
Amphibian	92.6	7	7 ± 1.0	7.1–13.1	99.4	7 (+0)
Reptile	N.A.	1	N.A.	N.A.	N.A.	N.A.
Camera Trapping						
Non-Volant Mammal	100.0	5	5 ± 0.5	5–6.4	100.0	5 (+0)

Note: Est: estimated; s.e.: standard error, CI: confidence interval
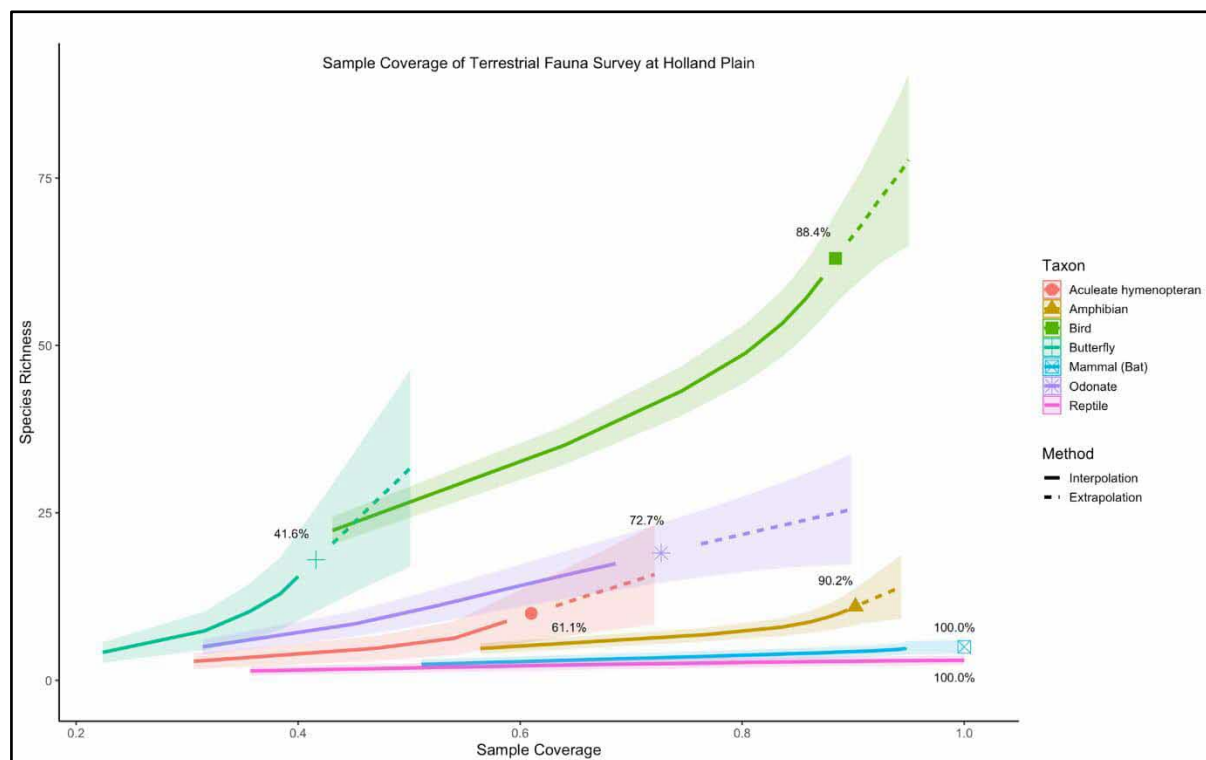
Figure 7-72 Taxon Sampling Curves for Respective Faunal Groups (A) along Terrestrial Sampling Routes in Sites IV and V
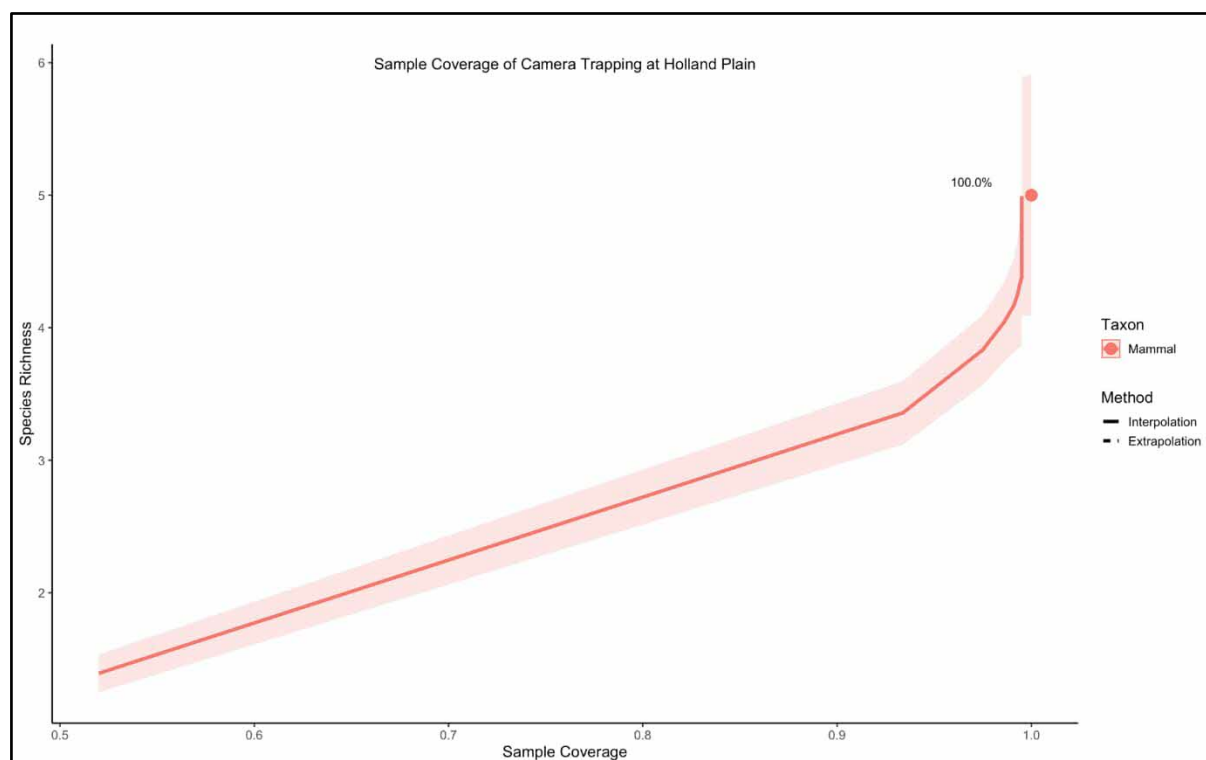
Figure 7-73 Taxon Sampling Curve for Terrestrial Camera Traps in Sites IV and V

7.3.2.3.3   *Aculeate Hymenopterans*

Aculeate Hymenoptera is a taxonomic group containing bees, stinging wasps and ants. They are defined mainly by their stingers – modified ovipositors, in females for self-defence, and for wasps, in subduing and paralysing prey (Tan et al., 2015). In this Study, only bees and wasps were assessed.

Bees and wasps play vital ecological roles, notably as pollinators and in some cases, as predators of other insects to naturally control populations. As pollinators, these flower-visiting insects help to sustain plant populations, which is particularly important in Singapore as most native flowering plant species are currently threatened (Soh & Ngiam, 2013; Chong et al., 2009). Stable plant populations, in turn, provide food for and support other animals such as birds and bats in the area (Black et al., 2009), as well as humans. A good diversity of aculeate hymenopterans is hence essential for and indicative of a healthy ecosystem.

A total of 11 species of aculeate hymenopterans were recorded, two five families – Apidae (six species) and Vespidae (five species) (Appendix H2).

Out of the 11 species of aculeate hymenopterans encountered, the species most commonly encountered is the eastern honeybee (*Apis cerana*), with highest richness of this species recorded in the scrubland with herbaceous vegetation South of the Study Area in Site V. The eastern honeybee is a generalist pollinator that obtains nectar from a wide range of flowers, favouring flowers with open access like those found in scrublands. An individual of the non-native species, red dwarf honeybee (*A. florea*), was also recorded in the same section of scrubland as the eastern honeybee. The expanse of the identified scrubland allows the honeybees to obtain food easily, and is thus crucial in supporting the honeybee populations in the Study Area. In return, the bees fulfil their role as pollinators to ensure stable plant populations within the scrubland habitat.

The section of scrubland adjacent to native-dominated secondary forest and waterbody identified North of the Study Area in Site IV had more records of larger bee species. Both carpenter bee species *Xylocopa flavonigrescens* and *Xyocapa latipes* were recorded almost exclusively in that section of the Study Area. This could be owing to the fact that Carpenter bees' nest in trees by driving a hole through wood of dead tree trunks. Larger specimens of trees were observed in the native-dominated secondary forest, allowing for more nesting opportunities compared to the waste woodland that is dominated by albizia trees (*Falcataria moluccana*).

The only forest-inclined species observed both North and South of the Study Area was the nationally Near Threatened wasp *Liostenogaster varipicta*. The wasp was recorded in both the native-dominated secondary forest as well as the waste woodland.

7.3.2.3.4   *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 freshwater breeding sites, of which can be many habitats, ranging from suburban drains to streams.

A total of 54 species of odonates were determined of probable occurrence in Sites IV and V, including four of conservation significance (Table 7-25; Appendix H2). A total of 29 species of odonates have been observed within the Study Area, one of which was of conservation significance: restless demon (*Indothemis limbata*) (Table 7-25; Appendix H2). It is noteworth that 21 out of 29 species of odonates were found at the freshwater marsh.

Amongst the odonate species encountered onsite, five species, namely the crenulated spreadwing (*Lestes praemorsus*), Sultan (*Camacinia gigantea*), black-tipped percher (*Diplacodes nebulosa*), sapphire flutterer (*Rhyothemis triangularis*) and striped grenadier (*Nesoxenia* lineata) are considered uncommon (Appendix H2). With reference to the floristic assessment of the Study Area, these uncommon species were observed perching and hovering at a waterbody adjacent to scrubland and native-dominated secondary forest. According to the floristic assessment, the waterbody has characteristics of a freshwater marsh (7.3.2.1.6). The presence of such a habitat within the Study Area has allowed for the establishment of marsh specific species in particular such as the striped grenadier and crenulated spreadwing. These species are more commonly encountered in the Central Catchment Nature Reserve, with the striped grenadier favouring swamps or freshwater swamp forests. Given the rapid loss of such habitat types within Singapore, the freshwater marsh present in the middle of the Study Area at Site V is of notable ecological value for its role in preserving these uncommon odonate species.

Figure 7-74 (A) Freshwater marsh like habitat at Northern tip of Site V; (B) Crenulated spreadwing (*Lestes praemorsus*); (C) Sultan (*Camacinia gigantea*) identified at waterbody

7.3.2.3.5   *Butterflies*

A total of 175 butterfly species were deemed of probable occurrence at Sites IV and V and 16 are of conservation significance (Table 7-25; Appendix H2). The field assessment recorded 20 species of butterflies, including one species of conservation significance. (Table 7-25; Appendix H2).

Greater richness of butterflies was encountered amongst the scrubland and herbaceous vegetation adjacent to the Rail Corridor, where behaviours such as mating and foraging amongst the herbaceous vegetation were observed.

Within the Hesperiidae family, the moderately rare full stop swift (*Caltoris* cormasa) was encountered. Only one of its host plants *Ottochola nodosa* was identified during the floristic assessment. Since butterflies are host specific, this suggests that the population of full stop swift in the Study Area is maintained by a single host plant. The sole record of the CITES protected and nationally Vulnerable common birdwing (*Troides Helena cerberus*) could be from adjacent Clementi Forest as the host plant Dutch's pipe (*Aristolochia acuminata*) was not recorded during the floristic assessment or supported by host plants frequently planted in the urban landscape. All other species encountered were common to moderately common and can be found in parks and gardens.
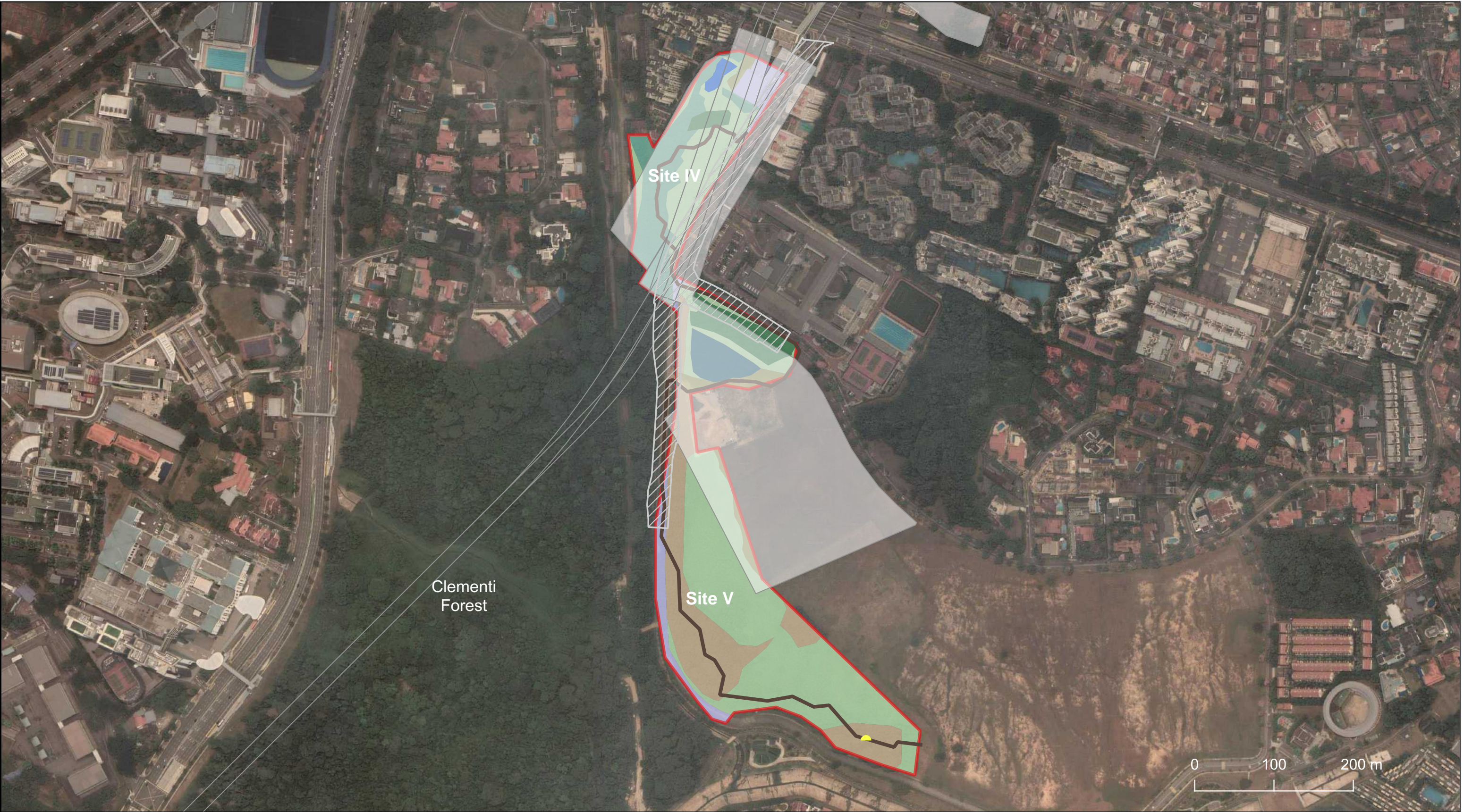
Site IV

Site V

Clementi
Forest

Legend

Study Area

Base Scenario Construction Worksite Footprint and Proposed CRL Alignment (Base)

Road works

Vegetation

Native-dominated secondary forest

Abandoned-land forest

Waste woodland

Scrubland and herbaceous vegetation

Managed vegetation

Freshwater marsh

Waterbody

Others (infrastructure)

Terrestrial sampling route

Butterfly species of conservation significance

T. h. cerberus

0   100   200 m

Qualified Person Endorsement :	Consultant :			
NA	**AECOM**			
	Project Title :		Figure Title :	
	CONTRACT CR2005 ENVIRONMENTAL IMPACT STUDY (TURF CITY AND HOLLAND PLAINS)		**LOCATIONS OF BUTTERFLY SPECIES OF CONSERVATION SIGNIFICANCE AT HOLLAND PLAIN**	
LTA Endorsement :				
NA				

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-	SEP 2022	JW	EIS (Turf City and Holland Plain)	JAG/NHT	JAG	JW	SEP 2022
Rev.	Date	By	Description	Chk'd	App'd		

N

Note: Source of basemap - Google Earth Map

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7.3.2.3.6 *Freshwater Decapod Crustaceans*

Only two species, the native maculate freshwater crab (*Parathelphusa maculata*) and the non-native ghost shrimp (*Macrobrachium lanchesteri*), were considered of probable occurrence (Table 7-25; Appendix H2). Both species were not recorded, suggesting poor habitat suitability for these species.

7.3.2.3.7 *Freshwater Fish*

The desktop assessment identified 6 species of probable occurrence at the Study Area, with only one non-native species recorded (Table 7-25; Appendix H2).

Only one non-native fish species, the guppy (*Poecilia reticulata*) was observed. This species is highly adaptable and can reside in a wide range of environments. (Ng et al., 2018). This suggests that the waterbodies present within the Study Area are of poor quality and not suitable for supporting fish populations.

7.3.2.3.8 *Amphibians*

A total of 16 amphibians, none of conservation significance, were deemed of probable occurrence (Table 7-25; Appendix H2). The field assessment recorded 11 amphibian species, none of which were of conservation significance (Table 7-25; Appendix H2). Three non-native frogs, the greenhouse frog (*Eleutherodactylus planirostris*), banded bull frog (*Kaloula pulchra*) and East Asian ornate chorus frog (*Microhyla mukhlesuri*) were also recorded.

Records of chorus frogs dominated the site at Sites IV and V, with 257 recorded individuals of painted chorus frog (*Microhyla butleri*), 188 dark sided chorus frog (*Microhyla heymonsi*) and 176 unidentified chorus frogs (*Microhyla sp.*). Apart from these dominant species, the presence of the restricted and rare East Asian ornate chorus frog (*Microhyla mukhlesuri*), which is non-native, was also recorded. Chorus frogs are commonly found in rural areas, parks and gardens (Lim & Lim, 1992).

Both the copper-cheeked frog (*Chalcorana labialis*) and Malayan giant frog (*Limnonectes blythii*) were recorded onsite and are species known to prefer forest streams with flowing water (Baker & Lim, 2012). 16 individuals of the Malayan giant frog (*Limnonectes blythii*), a species with a globally 'near threatened' status but locally of Least Concern was recorded from this site. A copper-cheeked frog (*Chalcorana labialis*) was also seen onsite and while this species is not of conservation significance, it is a forest-associated species that is largely restricted to Central Nature Reserves and Western Catchment Area (Baker & Lim, 2012). Its presence suggests the value of the Study Area in providing habitats for forest-associated species.

7.3.2.3.9 *Reptiles*

The probable species list amounted to 32 reptiles comprising three terrapins, 12 lizards and 17 snakes (Table 7-25; Appendix H2). Of this, two species were of conservation significance. The field assessment recorded five reptile species (four lizards and one snake), none of which are of conservation significance (Table 7-25; Appendix H2).

This included three commonly occurring lizards including the many-lined sun skink (*Eutropis multifasciata*), changeable lizard (*Calotes versicolor*) and clouded monitor (*Varanus nebulosus*), and a painted bronzeback snake (*Dendrelaphis pictus*). Apart from the many-lined sun skink which inhabits primary and secondary forests and the clouded monitor which has restricted distribution, the other two species have adapted to a wide range of habitats. One reptile species, the water monitor lizard (*Varanus salvator*) was also recorded on camera trap. No notable reptiles were recorded from this site.

7.3.2.3.10 *Birds*

A total of 164 species of birds were deemed of probable occurrence, of which 105 are resident (11 introduced), two are introduced non-resident and 55 are migrant/visitor species (Table 7-25; Appendix H2). One species was recorded only to genus level and hence not classified by their native status. There was presence of nests, including a raptor nest, scattered across the Study Area.

The field assessment recorded 71 species which comprised 54 residents (45 native and 9 introduced) and 16 migrant/visitor species (Table 7-25; Appendix H2). The remaining one species was recorded only to genus or family level, hence not classified by their native status.

Eight species of conservation significance were found onsite: the nationally Vulnerable red-legged crake (*Rallina fasciata*); the Endangered changeable hawk-eagle (*Nisaetus cirrhatus*), red junglefowl (*Gallus gallus*), red-wattled lapwing (*Vanellus indicus*), blue-crowned hanging parrot (*Loriculus galgulus*); the locally Critically Endangered ruddy kingfisher (*Halcyon coromanda*); the globally Vulnerable long-tailed parakeet (*Psittacula longicauda*), and

the globally Critically Endangered and locally Endangered straw-headed bulbul (*Pycnonotus zeylanicus*) (Figure 7-64).

Most of these species were previously regarded as rare but have since increased in range and numbers, namely the changeable hawk-eagle (*Nisaetus cirrhatus*), red junglefowl (*Gallus gallus*), blue-crowned hanging parrot (*Loriculus galgulus*), long-tailed parakeet (*Psittacula longicauda*), and red-legged crake (*Rallina fasciata*).

Of note is the red-wattled lapwing, which has become more widespread in recent years (Yong et al. 2016). However, its population may be threatened by the rapid loss of habitat as a result of the ongoing and upcoming developments in the western part of Singapore, which is known to be a stronghold of the species (Yong et al., 2016).

An uncommon migrant, the ruddy kingfisher (*Halcyon coromanda*), a species listed as Critically Endangered locally was also incidentally sighted on the northern forest patch during a flora survey. Other migratory species recorded comprised of common species, such as the crested honey buzzard as well as uncommon visitors like the yellow-rumped flycatcher (*Ficedula zanthopygia*) and tiger shrike (*Lanius tigrinus*) (Figure 7-76).

The blue-winged pitta (*Pitta moluccensis*) is listed as an uncommon migrant breeder. It is listed as "Not Assessed" in the SRDB and "Least Concern" on IUCN Red List. It was captured on camera trap within the Study Area. Currently, the only confirmed local breeding record of this species is from Pulau Ubin (Low et al., 2016). This makes it a notable species record for the Study Area.

Given the relatively even spread of birds of species of conservation significance across the Study Area, several species of conservation significance were located in the proposed worksite, such as the nationally Endangered red junglefowl (*Gallus gallus*) and the globally Vulnerable long-tailed parakeet (*Psittacula longicauda*).

Figure 7-76 Bird species observed at Sites IV and V. (A) Tiger shrike (*Lanius tigrinus*); (B) Amur paradise flycatcher (*Terpsiphone incei*); (C) Crested Honey Buzzard (*Pernis ptilorhynchus*); (D) Blue-throated bee-eater (*Merops viridis*).

Bird species of conservation significance

- ▲ Gallus gallus
- ▲ Halcyon coromanda
- ▲ Loriculus galgulus
- ▲ Nisaetus cirrhatus
- ▲ Psittacula longicauda
- ▲ Pycnonotus zeylanicus
- △ Rallina fasciata
- ▲ Vanellus indicus

Site IV

Site V

Clementi Forest

0   100   200 m

Legend

- ☐ Study Area
- ☐ Base Scenario Construction Worksite Footprint and Proposed CRL Alignment (Base)
- ▨ Road works
- ☐ Others (infrastructure)
- ▬ Terrestrial sampling route

Vegetation
- Native-dominated secondary forest
- Abandoned-land forest
- Waste woodland
- Scrubland and herbaceous vegetation
- Managed vegetation
- Freshwater marsh
- Waterbody

N

Note: Source of basemap - Google Earth Map

Qualified Person Endorsement : NA	Consultant : AECOM	Land Transport Authority We Keep Your World Moving
	Project Title : CONTRACT CR2005 ENVIRONMENTAL IMPACT STUDY (TURF CITY AND HOLLAND PLAINS)	Figure Title : LOCATIONS OF BIRD SPECIES OF CONSERVATION SIGNIFICANCE AT HOLLAND PLAIN
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						Designed JW	Checked JAG/NHT	Approved JAG	Figure No. : 7-77	Rev. -	Sheet 1 of 1
-	SEP 2022	JW	EIS (Turf City and Holland Plain)	JAG/NHT	JAG		Drawn JW	Date SEP 2022			
Rev.	Date	By	Description	Chk'd	App'd	CAD File Name : NA					A3

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7.3.2.3.11 *Non-volant mammals*

A total of 16 species of non-volant mammals were deemed of probable occurrence, including three of conservation significance (Table 7-25; Appendix H2). Visual surveys and camera trapping documented six species of non-volant mammals (Table 7-25; Appendix H2). Of this, one species is of conservation significance.

Species recorded here include the nationally Critically Endangered Sunda pangolin (*Manis javanica*), which was detected once on camera trap in Sites IV and V at CT_21 (Table 7-28). The habitat type where the pangolin was detected comprises of scrubland and herbaceous vegetation. While it is known to reside mainly in both CCNR and Bukit Batok, fragmented patches of forest such as the one at Sites IV and V can serve as a habitat for dispersing animals to reside or travel, contributing to the overall genetic health of the pangolin population. This understanding can be supported by the observation of pangolins at the adjacent Clementi Forest by Ho et al. in 2019.

Other mammal species that were detected consisted of common species such as the slender squirrel (*Sundasciurus tenuis*) and common palm civet (*Paradoxus musangus*), which were recorded both visually and captured via camera traps.

The three terrestrial camera traps accumulated 246 trap-nights and yielded 325 independent detections respectively, and recorded a total of seven species (Table 7-29). The list of camera trap data is available in Appendix J2.

The most commonly recorded species on the terrestrial camera traps is the common treeshrew (*Tupaia glis*) with 171 detections. The highest mammal richness (seven species) was recorded at CT_21(Table 7-28). However, the highest mammal detection rate (2.1 independent detections per trap-night) was recorded in the northern part of the Study Area at CT_20.

Table 7-28 Locations and Number of Independent Detections of Mammalian Species at Sites IV and V

Species	Common name	Locations	No of independent detections
Callosciurus notatus	Plantain squirrel	CT20 – CT22	87
Manis javanica	Sunda pangolin	CT21	1
Paradoxurus musangus	Common palm civet	CT20 – CT22	14
Rattus **sp.**	Rat	CT20 – CT22	49
Tupaia glis	Common treeshrew	CT20 – CT22	171
N.A	Bat	CT20 – CT21	2

Table 7-29 Number of Species and Detection Rate of Mammals Recorded at Each Camera Trap in Sites IV and V

Station	No. Of Trap Nights	No. Of Mammalian Species Recorded	No. Of Detections Of Mammals	Detection Rate Of Mammals
CT_20	82	4	172	2.1
CT_21	82	7	42	0.5
CT_22	82	4	111	1.4

Figure 7-78 Sunda Pangolin (*Manis javanica*) Recorded on Terrestrial Camera Trap

Site IV

Clementi
Forest

Site V

Legend

- Study Area
- Base Scenario Construction Worksite Footprint and Proposed CRL Alignment (Base)
- Road works

Vegetation
- Native-dominated secondary forest
- Abandoned-land forest
- Waste woodland
- Scrubland and herbaceous vegetation
- Managed vegetation
- Freshwater marsh
- Waterbody

- Others (infrastructure)
- Terrestrial sampling route

Mammalian species of conservation significance
- M. javanica

N

Qualified Person Endorsement :	Consultant :		
NA	**AECOM**		Land Transport Authority — We Keep Your World *Moving*
	Project Title :		Figure Title :
	CONTRACT CR2005 ENVIRONMENTAL IMPACT STUDY (TURF CITY AND HOLLAND PLAINS)		**LOCATIONS OF MAMMALIAN SPECIES OF CONSERVATION SIGNIFICANCE AT HOLLAND PLAIN**
LTA Endorsement :			
NA			

							Designed	Checked	Approved	Figure No. :		Rev.	Sheet
							JW	JAG/NHT	JAG	7-79		-	1 of 1
							Drawn		Date	CAD File Name : NA			A3
-	SEP 2022	JW	EIS (Turf City and Holland Plain)	JAG/NHT	JAG		JW		SEP 2022				
Rev.	Date	By	Description	Chk'd	App'd								

0   100   200 m

7.3.2.3.12 *Bats*

During field assessment, seven species of bats were detected. They are the Asian whiskered myotis (*Myotis muricola*), black-bearded tomb bat (*Taphozous melanopogon*), glossy horseshoe bat (*Rhinolophus refulgens*), Horsfield's myotis (*Myotis horsfieldii*), lesser Asian house bat (*Scotophilus kuhlii*), lesser short-nosed fruit bat (*Cynopterus brachyotis*), and pouched tomb bat (*Saccolaimus saccolaimus*). No species of conservation significance was detected during the field assessment. The lesser short-nosed fruit bat was the only frugivorous bat recorded, and was detected visually; the remaining bats were insectivorous bats, and were detected acoustically (Table 7-25; Appendix H2)

Together with Clementi Forest and the Rail Corridor, the Study Area sits on the eastern border of a larger forested matrix within the landscape. Being on the edge results in habitat complexity within the Study Area, hence attracting species with different habitat niches. Forest specialists such as the glossy horseshoe bat were documented alongside hawking species who prefer open habitats, such as the black-bearded tomb bat. Waterbodies within the Study Area also supports Horsfield's myotis, a species with a strong preference for aquatic habitats. The lesser Asian house bat, lesser short-nosed fruit bat, and whiskered myotis were detected throughout the Study Area. These species are highly adaptable and are likely utilising the urban habitats adjacent to the Study Area as well. While the pouched tomb bat was only detected from the waste woodland habitat, the species is also highly adaptable, and capable of utilising urban habitats. Although three bamboo clusters were documented within the Study Area, targeted acoustic and visual surveys did not detect the presence of bamboo bats (*Tylonycteris* sp.).

7.4   Assessment of Ecological Value

Habitats and species within the Study Areas were assessed for their ecological value based on the criteria described in Table 7-32 (habitat), Table 7-31 (plant species), and Table 7-32 (faunal species) (EPD, 2011). 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 Areas. The assessment was carried out using biodiversity baseline findings for each Study Area.

Each key biodiversity receptor was sub-categorised into their respective Priority Sensitivity Levels: Priority 1, Priority 2 and Priority 3 (from the most sensitive to the least) as shown in Table 6-1. The habitats/species with high ecological value are categorised as Priority 1 and habitats/species with low ecological value are categorised as Priority 3, while habitats/species with moderate ecological value are categorised as Priority 2.

Table 7-30 Criteria for Assessing the Ecological Value of Habitats

Criterion	Description
Naturalness	Degree to which the habitat is modified or disturbed owing to human activities, i.e., man-made, naturalised and natural.
	• This is indicated by species composition in terrestrial habitats. A man-made habitat is created; a naturalised habitat is dominated by exotic plant species; a natural habitat is dominated by native plant species.
	• In an aquatic habitat, it is indicated by the extent of human modification or disturbances. A man-made habitat is created; a naturalised habitat is modified by human actions; a natural habitat is largely pristine and not affected by human actions.
Size	Amount of physical space occupied by the habitat. Larger habitats usually have a greater carrying capacity and thus a higher ecological value.
Rarity	Extent to which the habitat occurs locally. The less common the habitat, the higher its rarity. Rare habitats are usually more difficult to create due to the need for specific conditions and thus making them less commonly occurring.
Ecological Linkage	Proximity of the habitat to other habitats. The value of a habitat increases if it lies in close proximity and/or links functionally to a high valued habitat type.
Large and Other Plant Specimens of Value	Number of large and other plant specimens of value found within the habitat. Habitat with higher number of these specimens have higher ecological value.
Species Of Conservation Significance	Number of species of conservation significance or other faunal species of value, and number of individuals of these species in a habitat. A habitat with higher number of these species and/or more individuals of these species have higher ecological value.

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: Species of conservation significance

- Medium ecological value: All other native species

- Low ecological value: Exotic and cryptogenic species

Species that were tentatively assigned medium (all other native species) or low (exotic and cryptogenic species) ecological value were then evaluated individually based on the criteria listed in Table 7-31. The evaluation of individual species served to either maintain or raise the pre-assigned ecological value. The following paragraphs detail how each criterion was considered in the evaluation.

Association with important fauna (native, exotic, and cryptogenic species): 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 plant species origin, cultivation intensity and effects, as well as national distribution. 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.

Cultivation intensity and effects (native species only): The ecological value of all native species previously or presently cultivated and/or with populations of relics or escapees, respectively, present in the secondary forests of Singapore were maintained at the medium level. Otherwise, those that are associated with important fauna were raised to high ecological value.

National distribution (non-cultivated native species only): The ecological value of non-cultivated native plant species with restricted national distribution—i.e., largely found in certain forest patches in Singapore or offshore islands, such as the primary and old growth secondary forests of the CCNR—were raised from the original medium level to high. On the other hand, that of non-cultivated plant species that are nationally widespread—i.e., occur at several secondary forest patches throughout Singapore—were maintained at the medium level.

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, (2) keystone fig species (*Ficus* sp.) as they fruit all year round and provide a steady source of food for frugivores (Lok et al., 2013), and (3) species planted for reforestation and/or previously thought to be extinct and are planted for species reintroduction. 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 7-31 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
Cultivation Intensity and Effects	Cultivated previously or presently—for various purposes such as reforestation, landscaping, species reintroduction, commercial sale, etc—and populations of relics and/or escapees are present/absent in forests
National Distribution	Extent of spread and/or occurrence at one or multiple forest patches in Singapore
Association With Important Fauna	Directly associated with the survival of important fauna at one or various life cycle stages

Table 7-32 Criteria for Assessing the Ecological Value of Faunal Species

Criterion	Definition
Conservation Significance	Listed as globally and/or nationally threatened and/or rare
Distribution	Global and/or national extent of spread of the species population. Species with restricted extent of spread are more susceptible to impacts, thus have higher ecological value
Rarity	Frequency at which the species occurs globally or locally. Rarer species have higher conservation significance, thus ecological value.

7.4.1   Turf City: Sites I, II and III near Eng Neo Avenue Forest

The ecological value of six terrestrial habitats, three waterbody habitats, 292 plant species and 197 faunal species present within Sites I to III were assessed.

7.4.1.1   Habitats

The ecological value of six terrestrial habitats and three waterbody habitats within Turf City were assessed. Of the nine habitats, two terrestrial habitats (native-dominated secondary forest and mixed forest) were assessed to be of high ecological value. Three of the terrestrial habitats (abandoned-land forest, waste woodland and scrubland and herbaceous vegetation) as well as the three waterbody habitats (D/S8, D/S15 and D/S16) were assessed to be of moderate ecological value. The remaining terrestrial habitat (managed vegetation) was assessed to be of low ecological value. The assessments of ecological value of each habitat, based on the scoring of each criterion outlined in Table 7-30, are summarised in Table 7-33.

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

The native-dominated secondary forest occupies 3.52 ha (15.4%) within Sites I to III. While the native-dominated secondary forest in Site III is currently being used for some recreational activities, the human disturbance to the habitat type overall is considered to be minimal and is therefore assessed to have high level of naturalness. Such native-dominated secondary forests are also increasingly rare in Singapore, and the complexities of such forests makes them challenging to reconstruct through human intervention. This habitat type is adjacent to mixed forest habitat in Sites I and II, which is also a habitat of high ecological value (see sub-section ii. Mixed Forest), and hence provides high value in ecological linkage.

Despite being one of the smaller terrestrial habitats, high conservation significant floral species richness was observed within this habitat type; 35 of the 57 flora species of conservation significance recorded in Turf City were be found within this habitat type, including three individuals of the Recently Rediscovered *Baccaurea pyriformis* found within this habitat type. This habitat type also recorded high conservation significant faunal species richness, such as the locally Endangered straw-headed bulbul (*Pycnonotus zeylanicus*). A moderate number of large plant specimens were also found in the area, for example, the cluster of *Ficus benjamina* located in the northern part of Site III.

With four criteria assessed to be high and two assessed to be medium, the overall ecological value of the native-dominated secondary forest is high.

ii.   Mixed Forest (High Ecological Value; Priority 1)

The mixed forest occupies 5.13 ha (22.5%), making it the most expansive habitat type within Sites I to III. This mixed forest used to comprise streetscape and urban plantings, but was later allowed to regenerate, with signs of recruitment of native propagules. Additionally, a small fragment of the mixed forest has been partially cleared and is being maintained by humans, thus, a moderate level of naturalness is conferred to this habitat type. This habitat is not commonly found in Singapore, and given its composition, hard to recreate. The mixed forest exists in large patches distributed across Site I and II and is contiguous with other habitat types including the high value native-dominated secondary forest patches. Thus, it provides high value in ecological linkage, allowing key floral and faunal species to disperse.

This habitat showed signs of recruitment of native propagules, some of which are rare and nationally threatened, resulting in the mixed forest harbouring high conservation significant floral species richness. Some of these species include the nationally Endangered epiphytic orchid species, *Bulbophyllum vaginatum*, which was found to be widespread and abundant in this habitat type. Other rare native species recorded here include the fern species, *Asplenium nitidum*, thought to be nationally Extinct but has been rediscovered in recent years, the nationally Endangered tree species *Calophyllum tetrapterum*. Likewise, a high conservation significant faunal species

richness was observed, and the only sighting of the forest-dependent Sunda colugo (*Galeopterus variegatus*) was in the mixed forest. Camera traps in this habitat type also recorded the nationally Critically Endangered Sunda pangolin (*Manis javanica*). A moderate number of large and other plant specimens of value was also recorded in this habitat type. Of which, bamboo clusters *Bambusa vulgaris* were found to be the roost site of nationally Vulnerable bamboo bats (*Tylonycteris sp.*) during roost emergence surveys.

With three criteria assessed to be high and three assessed to be medium, the overall ecological value of the mixed forest is high.

iii.   Abandoned-land Forest (Moderate Ecological Value; Priority 2)

The abandoned-land forest occupies 4.65 ha (20.4%), making it the second largest habitat type after mixed forest. This habitat has a moderate level of naturalness due to past land use. Moreover, some strips of the abandoned-land forest at Site III have been previously removed to create tracks for cyclists. This naturalised habitat is moderately difficult to recreate. The abandoned-land forest exists in large patches distributed across Site I and III and is contiguous with other habitat types, including the high valued mixed forest, and hence has high value in ecological linkage.

This habitat displayed a moderate conservation significant floral and faunal species richness, such as the locally Vunerable common birdwing (*Troides helena cerberus*). A moderate number of large trees or plant specimens of value was also recorded within the abandoned-land forest, including several large *Ficus microcarpa* with a spread of 10m.

With one criterion assessed to be high and five assessed to be medium, the overall ecological value of the abandoned-land forest is moderate.

iv.   Waste Woodland (Moderate Ecological Value; Priority 2)

Waste woodland occupies 2.01 ha (8.8%), making it the second smallest terrestrial habitat type in Sites I to III. This is a commonly encountered habitat in Singapore – where areas were cleared or highly disturbed in the past. Usually, this habitat type is considered easily created and commonly encountered. While only being found in Site III, the waste woodland habitat is connected to several other habitat types of high and moderate ecological value, rendering it a high value in providing ecological linkage.

A moderate conservation significant floral and faunal species richness was observed, floral examples include the nationally Endangered *Amphineuron opulentum* and nationally Vulnerable *Bridelia stipularis*. Likewise, a relatively moderate number of large trees or plant specimens of value was found in this habitat, mostly accounted for by large exotic trees such as oil plams (*Elaeis guineensis*) and albizia (*Falcataria moluccana*).

With one criterion assessed to be high, three assessed to be medium and two assessed to be low, the overall ecological value of waste woodland is moderate.

v.   Scrubland and Herbaceous Vegetation (Moderate Ecological Value; Priority 2)

The scrubland and herbaceous vegetation occupy 3.87 ha (16.9%), making it the third largest habitat type. Scrubland and herbaceous vegetation is a disturbed, naturalised habitat that is typically easy to recreate in Singapore. This is a common habitat as it mostly occupies the scattered patches within the forest where temperature and light levels are higher; and because of that, it is contiguous with other habitat types including the high valued native-dominated secondary forest, and hence has high value in providing ecological linkage for species.

This habitat type recorded intermediate conservation significant floral and faunal species richness and a relatively low number of large trees as compared to the other habitat types.

With one criterion assessed to be high, three assessed to be medium and two assessed to be low, the overall ecological value of scrubland and herbaceous vegetation is moderate.

vi.   Managed Vegetation (Low Ecological Value; Priority 3)

The managed vegetation occupies 1.41 ha (6.2%), making it the smallest terrestrial habitat type within Sites I to III. As the trees in this habitat are regularly pruned and maintained, it is considered highly disturbed and of low ecological value based on naturalness. This is a very common habitat in Singapore, represented by managed lawns, as well as small community gardens — a make-up typical of urban parks in Singapore, and can be easily

recreated. Being adjacent to other habitat types, including those of high value, and hence provides high value in ecological linkage.

A relatively low conservation significant floral and faunal species richness was observed; only one faunal species of conservation significance was observed. This habitat recorded the lowest number of large trees or plants specimens of value across all habitat types.

With one criterion assessed to be high and the other five to be low, the overall ecological value of managed vegetation is low.

vii.   Waterbody (D/S8; Moderate Ecological Value; Priority 2)

A ravine system (0.74 km) located at Site III runs north to south through the centre of the forested area. The stream is mostly naturalised, with obvious signs of human disturbance; concrete structures were found within various parts of the stream, hence concluding low level of naturalness. The stream appears to be connected to other nearby waterbodies, thus, ecological linkage for aquatic species is considered to be present.

The stream is characterised with low numbers of flora and faunal species of conservation significance; the faunistic field assessment mainly recorded non-native fish and common amphibian species.

With two criteria assessed to be high, one to be medium and two to be low, the overall ecological value of D/S8 is moderate.

viii.   Waterbody (D/S15; Moderate Ecological Value; Priority 2)

A partially concretised stream system (0.46 km) runs along the eastern edge of Site I. Such naturalised stream habitats are increasingly uncommon in Singapore. The waterbody has a moderate ecological linkage for aquatic species as it does not appear to be directly connecting to any other nearby waterbody.

Despite running along the edge of the mixed forest and some parts of native-dominated secondary forests, both of which have high species richness of conservation significant flora, the stream recorded low richness of conservation significant flora and fauna.

With four criteria assessed to be medium and one to be low, the overall ecological value of D/S15 is moderate.

ix.   Waterbody (D/S16; Moderate Ecological Value; Priority 2)

A stream system (0.36 km) runs from north to south on the western edge of Site I. Some parts of the waterway have been naturalised with soil and leaf debris filling up the old concrete drain, while other sections of the stream remained concrete-bottomed, hence concluding a moderate level of naturalness. Such naturalised stream habitats are increasingly uncommon in Singapore. The stream appears to be connected to other nearby waterbodies, hence providing ecological linkage for aquatic species.

The stream harbours low numbers of flora and faunal species of conservation significance. However, it is notable that records of the common walking catfish (*Clarias cf. batrachus*) within the study area were made only at this stream, implying its importance as a habitat for the species due to its local population decline in recent years.

With one criterion assessed to be high, three to be medium and one to be low, the overall ecological value of D/S16 is moderate.

Table 7-33 Habitat Ecological Assessment Table for Sites I to III

Criterion	Native-dominated Secondary Forest	Mixed Forest	Abandoned-land Forest	Waste Woodland	Scrubland and Herbaceous Vegetation	Managed Vegetation	Waterbody D/S8	Waterbody D/S15	Waterbody D/S16
Ecological value	**High**	**High**	**Moderate**	**Moderate**	**Moderate**	**Low**	**Moderate**	**Moderate**	**Moderate**
Naturalness	High	Medium	Medium	Medium	Medium	Low	Low	Medium	Medium
Size in hectares (% of Study Area)	3.5 (15.4%) Medium	5.1 (22.5%) Medium	4.7 (20.4%) Medium	2.0 (8.8%) Low	3.9 (16.9%) Medium	1.4 (6.2%) Low	0.7 km High	0.5 km Medium	0.4 km Medium
Rarity	High	High	Medium	Low	Low	Low	Medium	Medium	Medium
Ecological linkage	High	High	High	High	High	High	High	Medium	High
Conservation significance species richness	Flora: High Fauna: High	Flora: High Fauna: High	Flora: Medium Fauna: Medium	Flora: Medium Fauna: Medium	Flora: Medium Fauna: Medium	Flora: Low Fauna: Low	Flora: Low Fauna: Low	Flora: Low Fauna: Low	Flora: Low Fauna: Low
Large and other plant specimens of value species richness	Medium	Medium	Medium	Medium	Low	Low	N.A.	N.A.	N.A.

7.4.1.2   Plant Species

A total of 292 plant species were assessed for their ecological value at the Sites I to III. Among these species, 72 are of high value, 87 of medium value, and 133 of low value. Five species had their ecological value raised after assessment. Three species were raised from low to high ecological value, while the other two species from medium to high value.

All the three plants species that were raised from low to high ecological value are exotic species. Two of these are bamboo species, namely, *Bambusa vulgaris* and *Thyrsostachys siamensis*. Nationally threatened bamboo bats (*Tylonyecteris* sp.) are known to reside within bamboo internodes and roost for long hours. As such, bamboo clusters could be potential roost sites for the threatened fauna. In this Study, bamboo bats were recorded during bat roost emergence surveys at Site II (see Section 7.2.5.1.7), thus keeping bamboo clusters is important in ensuring the survival of the bats. Additionally, it is essential to conserve bamboo clusters in the Study Area to safeguard the local bamboo bat populations at large that are continually facing threats of habitat loss. Therefore, while non-native in origin, the association bamboo clusters have with bamboo bats make species of the former of high ecological value.

The remaining species that had its ecological value raised from low to high is *Aristolochia acuminata*. This climber is the host plant for the nationally threatened common birdwing (*Troides helena cerberus*), which was recorded in the Study Area too (see Section 7.3.1.3.5). As the caterpillar host plant for the threatened butterfly species, specimens of the former play an important role in allowing the butterflies to complete their life cycle stages and hence ensuring the continued persistence of the population. Therefore, the climber species has been accorded high ecological value even though it is non-native in origin.

The two species that had their ecological values raised from medium to high are native, namely, *Ardisia sanguinolenta* and *Campnosperma auriculatum*. Although these two species are listed as nationally Common, they are not known to be cultivated in local streetscapes and have restricted distributions locally, where they occur more commonly in old-growth secondary forests and/or forest reserves in the CCNR, BTNR and NSSF. Therefore, these species found in the forest fragments in Sites I to III have been accorded high ecological value given that they do not occur in most other forest fragments in Singapore.

7.4.1.3   Faunal Species

Of the 197 faunal species evaluated for their ecological value, 15 were of high value as they were considered of conservation significance at Sites I to III. This includes three butterflies, nine birds, two non-volant mammals and one bat species. Some noteworthy examples are the globally Critically Endangered Sunda pangolin (*Manis javanica*), straw-headed bulbul (*Pycnonotus zeylanicus*) and bamboo bat (*Tylonycteris sp.)*. The criteria for determining species of conservation significance are described in Section 7.2.2.3. The list of species is available in Appendix R1.

7.4.2   Holland Plain: Sites IV and V near Clementi Forest

The ecological value of five terrestrial habitats, two waterbody habitats, 229 plant species and 160 faunal species present within Sites IV and V were assessed.

7.4.2.1   Habitats

The ecological value of five terrestrial habitats and two waterbody habitats within Sites IV and V were assessed. Two terrestrial habitats (native-dominated secondary forest and scrubland and herbaceous vegetation) as well as one waterbody habitat (freshwater marsh) were assessed to have high ecological value. Two of the terrestrial habitats (abandoned-land forest and waste woodland) as well as the remaining waterbody habitat (pond) were assessed to have moderate ecological value. The remaining terrestrial habitat (managed vegetation) was assessed to be of low ecological value. The assessments of ecological value of each habitat are summarised in Table 7-34.

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

The native-dominated secondary forest occupies 0.56 ha (5.5%), making it the second smallest terrestrial habitat type within Sites IV and V. It has minimal human disturbance and thus considered to have high level of naturalness. Such forests are also increasingly uncommon locally, and difficult to manually recreate due the complexities of such forests. The native-dominated secondary forest comprises two patches, both surrounded by other habitat types such as the high valued freshwater marsh, thereby conferring it a high value in providing ecological linkage.

This habitat type recorded the highest conservation significant floral species richness, with 13 of the 17 flora species of conservation significance across Holland Plain found during the floristic field assessment. Species found in the habitat type include the nationally Critically Endangered *Macaranga hulletii*, locally Vulnerable *Litsea firma* as well as the nationally Presumed Extinct climber *Gynochthodes rigida*. It is also notable that the native-dominated secondary forest patch beside Old Holland Road is dominated by tembusu (*Cyrtophyllum fragrans*), which were likely regenerated naturally more than 50 years ago. One tembusu is also considered a plant specimen of value due to the presence of a bird nest on the tree. Additionally, this habitat type harbours fauna species of conservation significance as well, such as the only sighting of the locally Endangered changeable hawk-eagle (*Nisaetus cirrhatus*) during the field assessment.

With four criteria assessed to be high and two assessed to be low, the overall ecological value of the native-dominated secondary forest is high.

ii.   Abandoned-land Forest (Moderate Ecological Value; Priority 2)

The abandoned-land forest occupies 1.18 ha (11.5%) within Sites IV and V. This habitat type is a naturalised habitat that is mainly dominated by exotic fruit trees and crop plants cultivated in the past. It is becoming increasingly uncommon in Singapore as many forests have been largely disturbed and/or cleared to give way for development and is moderately difficult to recreate. The abandoned-land forest is contiguous with other habitat types and especially the high valued native-dominated secondary forest, rendering it a high value in providing ecological linkages for species utilising within the site.

The forest harbours high numbers of conservation significant floral and faunal species. It also recorded high numbers of large plants and other specimens of value, namely oil palm (*Elaeis guineensis*) and albizia (*Falcataria moluccana*).

With three criteria assessed to be high and three assessed to be medium, the overall ecological value of the abandoned-land forest is moderate, relative to the other habitats at Sites IV and V.

iii.   Waste woodland (Moderate Ecological Value; Priority 2)

The waste woodland occupies 2.11 ha (20.6%) within Sites IV and V, making it the second largest habitat type. This is a commonly encountered habitat in Singapore – where areas were cleared or highly disturbed in the past, thereby having a moderate level of naturalness. As the plant species in this habitat are known to be fast-growing exotic species that regenerate in cleared spaces, it is easy to recreate this habitat with minimal human intervention. Waste woodland habitat comprises several patches in the southern part of the study area, which are connected to other habitat types, mainly the scrubland and herbaceous vegetation which is of a higher ecological value. Thus, waste woodland is assessed to be of high value in terms of ecological linkage, allowing floral and faunal species to disperse or move across the Study Area.

Although only one floral species of conservation significance was recorded in waste woodlands, this habitat has one of the highest conservation significant faunal species richness across the habitats, recording 6 faunal species of conservation significance, such as the locally Vulnerable common birdwing (*Troides helena cerberus*) and nationally Endangered long-tailed parakeet (*Psittacula longicauda*). A moderate number of large and other plant specimens of value were recorded in this habitat type.

With two criteria assessed to be high, three assessed to be medium and the remaining as low, the overall ecological value of the waste woodland is moderate.

iv.   Scrubland and Herbaceous Vegetation (High Ecological Value; Priority 1)

Scrubland and herbaceous vegetation occupies 4.96 ha (48.5%), making it the largest habitat type in Holland Plain. This is a moderately natural and common habitat as it mostly occupies the scattered patches within the forest where temperature and light levels are higher. As such, it is contiguous with other habitat types including those of high value, making it also high value in providing ecological linkage for species utilising the site.

Compared to the other habitat types in Holland Plain, the scrubland and herbaceous vegetation displayed a relatively high richness of conservation significant plant species. This habitat also displayed the highest conservation significant faunal species richness, housing 7 of the 11 recorded fauna species, including the Sunda pangolin (*Manis javanica*). A moderate number of large trees or plant specimens of other value was also found in this habitat. Notably, many clusters pitcher plants were recorded in the area, including a hybrid species *Nepenthes × trichocarpa* and two nationally vulnerable species: *Nepenthes ampullaria* and *Nepenthes rafflesiana*. These

pitcher plants were generally limited to and thrive alongside resam ferns in such a habitat type. The limited habitat preference of these species thus makes this scrubland and herbaceous vegetation an important habitat for the conservation and propagation of these pitcher plants.

With three criteria assessed to be high, two assessed to be medium and the remaining as low, the overall ecological value of the scrubland and herbaceous vegetation is high.

v. Managed Vegetation (Low Ecological Value; Priority 3)

The managed vegetation occupies 0.36 ha (3.5%), making it the smallest terrestrial habitat within Sites IV and V. This habitat is considered to be highly disturbed, concluding a low level of naturalness. This habitat is also common and relatively easy to recreate. Given its proximity to other high value habitats, such as scrubland and herbaceous vegetation and the freshwater marsh, it is conferred a high ecological linkage.

Moderate conservation significant floral and faunal species richness was observed for this habitat type, as well as one *Bambusa vulgaris* specimen, although it was not found to be a roosting site of bamboo bats (*Tylonycteris sp.)* through a roost emergence survey.

With one criterion assessed to be high, one assessed to be medium and the remaining four as low, the overall ecological value of the managed vegetation is low.

vi. Freshwater Marsh (High Ecological Value; Priority 1)

A freshwater marsh occupies 0.34 ha in Site V, partly surrounded by the native-dominated secondary forest. The freshwater marsh was likely formed more than 40 years ago following the exhumation of a graveyard, followed by natural inundation, self-sowing sedges and self-colonising odonates and amphibians. Although the foundations of the marsh were a result of anthropogenic land use change, the formation and maturation of the marsh is entirely natural, which gave it a high level of naturalness. The freshwater marsh is a rather unique habitat, characterised by its impermeable clayey substrate, organic matter, shallow water depth, open and shaded edges, uneven edges, established mature tree line and emergent and submergent plants. Such freshwater marsh habitats are becoming increasingly rare as similar habitats in Singapore have been cleared to give way for developments. Considering the amount of time taken for the freshwater marsh to form naturally and the rarity of such wetland habitats in Singapore, it would be challenging to re-create a similar habitat artificially.

As this habitat is not connected to other waterbodies, it has low value in providing ecological linkages for strictly aquatic species. Nonetheless, this habitat houses a rich diversity of faunal species, especially odonates with up to 21 species recorded. Two fauna species of conservation significance was observed utilising the marsh: nationally Endangered red-wattled lapwing (*Vanellus indicus*) and restless demon (*Indothemis limbata*), which are only some of the several marsh-specific species found in this habitat. While not of conservation significance, this habitat type also presents several floral species that are unique to the habitat, such as the common ground orchid *Spathologttis plicata*.

If allowed to rehabilitate and managed properly, this habitat could plausibly attract even more aquatic and semi-aquatic fauna, and eventually develop into a biodiversity hotspot outside of nature reserves. Given the rapid loss of such habitat types within Singapore, this freshwater marsh plays an important role in preserving these uncommon faunal species.

With three criteria assessed to be high, one assessed to be medium and the remaining as low, the overall ecological value of the freshwater marsh is high.

vii. Waterbody (Pond; Moderate Ecological Value; Priority 2)

A 0.07 ha pond is located at the northern part of Site IV. The pond is surrounded with dense shrubs and likely formed from groundwater and surface runoff. The pond was conferred a moderate level of naturalness and in recreatability. The pond is not connected to the surrounding man-made drainage system and hence provides low value in providing ecological linkage for aquatic species. A low richness of species of conservation significant floral and faunal was found within the site.

With three criteria assessed to be medium and two assessed to be low, the overall ecological value of the pond is moderate.

Table 7-34 Habitat Ecological Assessment Table for Sites IV and V

Criterion	Native-dominated Secondary Forest	Abandoned-land Forest	Waste Woodland	Scrubland and Herbaceous Vegetation	Managed Vegetation	Freshwater Marsh	Waterbody (Pond)
Ecological value	**High**	**Moderate**	**Moderate**	**High**	**Low**	**High**	**Moderate**
Naturalness	High	Medium	Medium	Medium	Low	High	Medium
Size (% of Study Area)	0.6 ha (5.5%) Low	1.2 ha (11.5%) Medium	2.1 ha (20.6 %) Medium	5.0 ha (48.5%) High	0.4 ha (3.5%) Low	0.3 ha High	0.07 ha Medium
Rarity	High	Medium	Low	Low	Low	High	Medium
Ecological linkage	High	High	High	High	High	Low	Low
Conservation significance species richness	Flora: High Fauna: Medium	Flora: Medium Fauna: High	Flora: Low Fauna: High	Flora: Medium Fauna: High	Flora: Medium Fauna: Medium	Flora: Low Fauna: Medium	Flora: Low Fauna: Low
Large and other plant specimens of value species richness	Low	High	Medium	Medium	Low	N.A.	N.A.

7.4.2.2   Plant Species

In Sites IV and V, 229 species were assessed for their ecological value in total; 25 are of high ecological value, 81 medium and 123 low. Four species had their ecological value raised after assessment; one was raised from low to high ecological value, while three were raised from medium to high.

Only one exotic bamboo species, *Bambusa vulgaris*, was recorded from the Study Area. Originally of low ecological value owing to its exotic origin, the species has been accorded high ecological value following species evaluation. Bamboo bats (*Tylonyecteris* sp.) were not detected during roost emergence surveys at these clusters (see Section 7.3.2.3.12). Nonetheless, they could still be potential bamboo bat roost sites and are considered of high ecological value. This is discussed in detail in Section 7.4.1.2.

Three native species had their ecological value raised from the initial medium level to high value. Although listed as nationally Common, the two non-cultivated species, *Campnosperma auriculatum* and *Gynochthodes sublanceolata* have local distributions mainly restricted to old secondary forests and/or the forest reserves in CCNR, BTNR and NSSF. Hence, they have been accorded high ecological value given that they do not occur in most other forest fragments in Singapore.

The remaining native *Nepenthes gracilis* is known to host specialist crab spiders (Family: Thomisidae) by providing nesting spaces and ambush spots for food (Lam and Tan, 2020). They are also host plants of the rare pitcher blue butterfly (*Virachola kessuma deliochus*). The plants allow for the ensured continuity of the associated fauna, hence contributing to local biodiversity. Considering the important associations this plant species has with rare fauna, its ecological value was thus raised from medium to high even though it is listed as nationally Common.

7.4.2.3   Faunal Species

Of the 160 faunal species evaluated for their ecological value, 11 were of high value as they were considered of conservation significance. This includes one odonate, one butterfly, eight birds and one non-volant mammal species. Some noteworthy examples are the globally Critically Endangered Sunda pangolin (*Manis javanica*), nationally Endangered red-wattled lapwing (*Vanellus indicus*) and restless demon (*Indothemis limbata*). The criteria for determining species of conservation significance are described in Section 7.2.2.3. The list of species is available in Appendix R2.

7.5   Areas of High Conservation Value

The assessment of habitat and species ecological value was used to identify areas of high conservation value. Areas of high conservation value within the Study Areas are of highest priority and should be kept untouched as much as possible. Any development within these areas is likely to result in major to moderate impacts. A 30-m buffer was placed around some of these features to further safeguard these features from habitat degradation and reduce the impacts of edge effects. It is important to note that other areas of medium or low conservation value also contribute towards the ecological integrity of the Study Area, particularly in terms of maintaining ecological linkage, and should hence be preserved as well.

7.5.1   Turf City: Sites I, II and III near Eng Neo Avenue Forest

Areas of high conservation value at Sites I to III are (Figure 7-80):

i)   Waterbodies (D/S15 and D/S16): Waterbodies have an inherent importance in sustaining the basis of life for a range of other common/rare faunal species residing within the Study Area. Furthermore, waterbodies are uncommon habitats in Singapore. Stream associated floral and faunal species such as the common walking catfish (*Clarias* cf. *batrachus*) were observed along and around the stream. The stream D/S8 was not included in the areas of high conservation value as it has low level of naturalness and relatively higher richness of non-native fauna species, likely a result of the anthropogenic activities in Site III.

ii)   All contiguous vegetated areas of Sites I and II, consisting of native-dominated secondary forest, mixed forest, abandoned-land forest and scrubland and herbaceous vegetation. The native-dominated secondary forest and mixed forest patches contain most clusters of threatened plant species. The medium ecological value habitats in between are key in maintaining the ecological linkage within the sites and connectivity beyond the sites. Such ecological linkage is especially crucial as the Sunda pangolin (*Manis javanica*) was detected utilising the entire area of Sites I and II, and the forest dependent Sunda colugo (*Galeopterus variegatus*) was also detected in the mixed forest in Site I. Both these species have also

been detected in the adjacent Eng Neo Avenue Forest, which suggests the importance of intact Sites I and II as an additional refugia and stepping stone for the movement of the species.

iii) Native-dominated secondary forest patch with buffer at Site III as it contains high densities of plant specimens of conservation significance. Among the highly urbanised landscape, the patch might also serve as a key stepping stone corridor between the forested areas north of it (near Swiss Club) and Sites I and II as well as Eng Neo Avenue Forest.
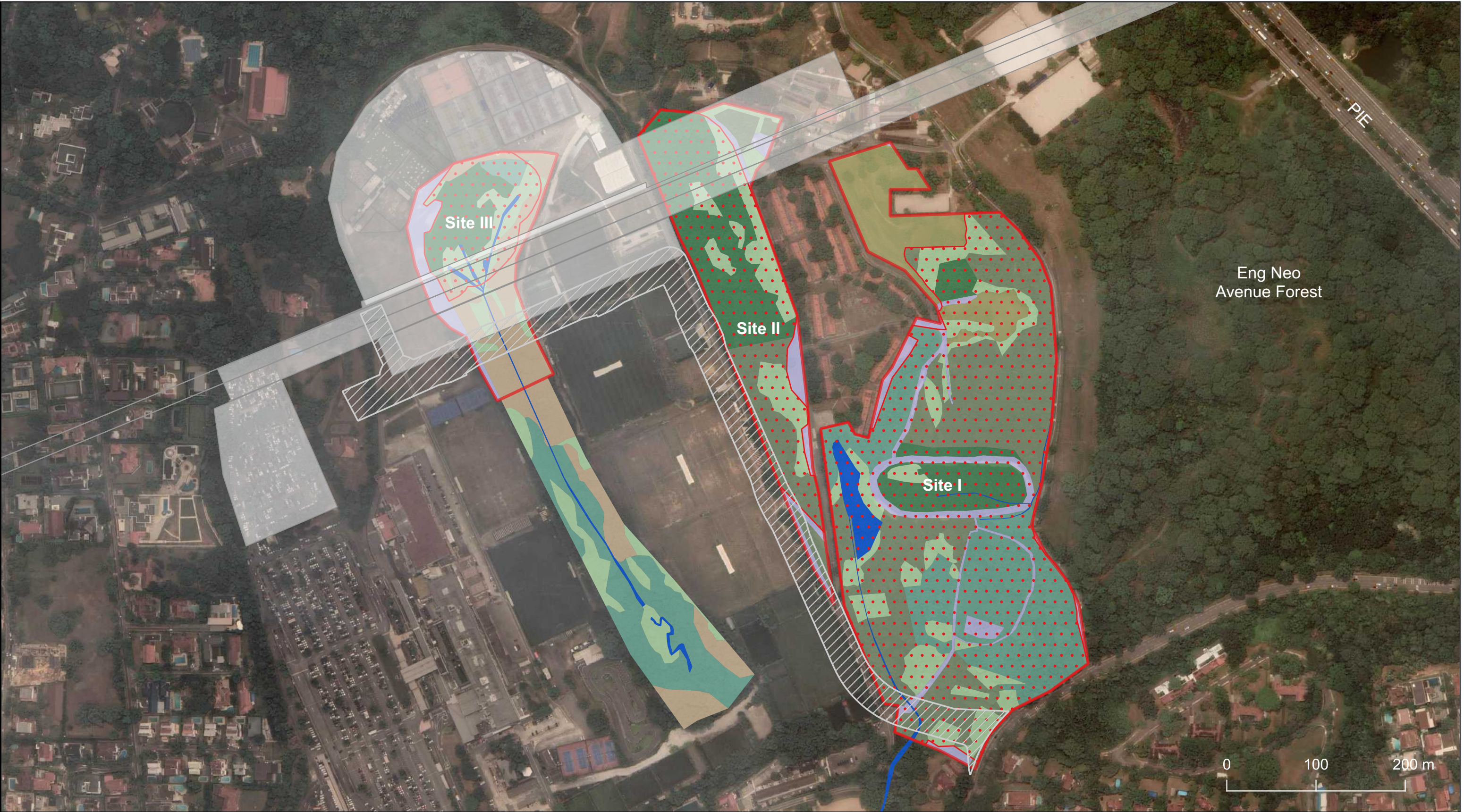
Legend

- Study Area
- Base Scenario Construction Worksite Footprint and Proposed CRL Alignment (Base)
- Road works
- Others (infrastructure)
- Areas of high conservation value

Vegetation

- Native-dominated secondary forest
- Mixed forest
- Abandoned-land forest
- Waste woodland
- Scrubland and herbaceous vegetation
- Managed vegetation
- Waterbody

Site I
Site II
Site III

Eng Neo Avenue Forest

PIE

Note: Source of basemap - Google Earth Map

N

0   100   200 m

								Qualified Person Endorsement :	Consultant :			
								NA	AECOM	Land Transport Authority		
										We Keep Your World Moving		
									Project Title :	Figure Title :		
									CONTRACT CR2005 ENVIRONMENTAL IMPACT STUDY (TURF CITY AND HOLLAND PLAIN)	AREAS OF HIGH CONSERVATION VALUE AT TURF CITY		
								LTA Endorsement :				
								NA				
									Designed	Checked	Approved	Figure No. :	Rev.	Sheet
									JW	JAG/NHT	JAG	7-80	-	1 of 1
-	SEP 2022	JW	EIS (Turf City and Holland Plain)	JAG/NHT	JAG				Drawn	Date				
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7.5.2   Holland Plain: Sites IV and V near Clementi Forest

Areas of high conservation value at Sites IV and V are (Figure 7-81):

i)   Native-dominated secondary forest patches with buffer at Sites IV and V as they contain higher densities of plant specimens of conservation significance. In particular, the native strip adjacent to the freshwater marsh is made up of mature tembusu trees (*Cyrtophyllum fragrans*), which are slow-growing and hence not easy to recreate. Moreover, the strip also plays an important role in affecting and maintaining the unique microclimate of the adjacent freshwater marsh by providing some shade, which is essential for the rich fauna diversity observed.

ii)   Freshwater marsh with buffer at Site V: the unique habitat is increasingly rare in Singapore today and has formed and matured entirely by natural processes over a course of 40 years or longer. Having accumulated a lot of organic matter, the marsh serves as an important carbon sink. It also supports a high diversity of fauna, particularly uncommon marsh-specific odonates which thrive in such habitats.

iii)   Scrubland and herbaceous vegetation in the south of Site V is naturally home to all three pitcher plant species found in Singapore, which can be considered rare in Singapore. Two out of the three pitcher plant species (*Nepenthes ampullaria* and *Nepenthes rafflesiana*) are threatened. A pitcher plant hybrid was also found here.

Legend

- Study Area
- Base Scenario Construction Worksite Footprint and Proposed CRL Alignment (Base)
- Road works

Vegetation
- Native-dominated secondary forest
- Abandoned-land forest
- Waste woodland
- Scrubland and herbaceous vegetation
- Managed vegetation
- Freshwater marsh
- Waterbody

- Others (infrastructure)
- Areas of high conservation value

Site IV

Site V

Clementi Forest

0   100   200 m

N

Note: Source of basemap - Google Earth Map

Qualified Person Endorsement : NA	Consultant : AECOM				Land Transport Authority We Keep Your World Moving		
	Project Title : CONTRACT CR2005 ENVIRONMENTAL IMPACT STUDY (TURF CITY AND HOLLAND PLAINS)			Figure Title : AREAS OF HIGH CONSERVATION VALUE AT HOLLAND PLAIN			
LTA Endorsement : NA							
	Designed JW	Checked JAG/NHT	Approved JAG	Figure No. : 7-81		Rev. -	Sheet 1 of 1
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7.6   Identification of Biodiversity Sensitive Receptors

Potential impacts to biodiversity arising from construction (Section 3.2) and operational (Section 3.3) activities are assessed in this section. The ecological impacts were identified and described in Section 7.8. The latest proposed development plans used for this assessment were provided by the LTA on 17th September 2020.

The two main categories of impacts are (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 plant receptors are defined as areas within 150 m from worksites of the proposed development. This is to primarily account for edge effects in forests adjacent to worksites, based on studies that found edge effects affecting vegetation up to 150 m from forest boundaries (Paton, 1994; Murcia, 1995; Didham, 1997; Laurance and Bierregaard, 1997). The impact zone for faunal receptors is the entire forest as most fauna are mobile throughout the Study Area.

Table 7-35 List of Ecological Impacts

Receptor	Impact type	Description	Impact category
Construction Phase			
Habitats	Loss of vegetation	Direct removal of vegetation (with extensive underground root systems that protect against soil erosion) to create space for construction activities	Direct
	Habitat degradation	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	Indirect
	Change in species composition	Formation of forest edge habitats that favour the growth of certain exotic plants and fauna, and accidental introduction of exotic species from construction materials (such as soil with seeds or bio-degradable erosion blankets with insect eggs)	Indirect
Plant Species	Mortality	Direct removal of vegetation to create space for construction activities	Direct
	Impediment to seedling recruitment	Pollution of habitats from improper disposal of construction waste and accidental release of hazardous materials (such as construction slurry, paint, and/or solvents)	Indirect
	Competition from exotic plant species	Formation of forest edge habitats that favour the growth of certain exotic plants and accidental introduction of exotic species from construction materials (such as soil with seeds)	Indirect
	Decline in plant health and survival	Changes in microclimatic conditions (i.e., dust, noise, and light, temperature, and humidity) and hydrology	Indirect
Faunal Species	Loss of/reduction in habitats and food sources	Direct removal of vegetation to create space for construction activities	Direct
	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	Direct
	Loss of ecological connectivity for faunal movement	Habitat fragmentation from the removal of vegetation	Indirect
Operational Phase			
Habitat	Change in plant species composition	Long-term changes in light, temperature, and humidity in habitats surrounding facility structures	Indirect
	Habitat degradation	Trampling on vegetation and pollution from increased human traffic	Indirect
Plant Species	Mortality	Stealing/poaching of plants by humans	Direct
	Competition from exotic plant species	Accidental and/or intentional release of exotic plants by humans	Indirect
Faunal Species	Collisions with buildings (birds only)	Distorted perceptions of reflective surfaces on buildings as flyways, greenery, and/or water	Direct

Receptor	Impact type	Description	Impact category
	Loss of ecological connectivity for faunal movement	Habitat fragmentation from the removal of vegetation	Indirect
	Injury or mortality	Navigation failures into the wrong areas and entrapment in facility structures	Indirect

7.6.1 Construction Phase

7.6.1.1 Turf City: Sites I, II and III near Eng Neo Avenue Forest

The CR14 worksite which spans a total of 15.8 ha across Sites II and III will involve ground improvement works, shaft construction, tunnelling or TBM launch/retrieval works, concrete batching works (if any), as well as the construction of superstructures such as MRT stations and facility buildings. Road works for the construction of a future road under study along the existing Turf Club Road will also be involved.

Six terrestrial habitat types, one waterbody and 94 plant species are likely to be impacted, while all faunal species recorded are expected to be indirectly impacted as well, as most fauna are mobile throughout the Study Area.

A summary of the key biodiversity receptors impacted during construction phase within Sites I to III is shown in Table 7-36.

Table 7-36 Key Biodiversity Habitat Receptors Likely to Experience Direct and Indirect Impacts in Sites I to III during Construction Phase

Category	Key Biodiversity Receptor	Priority Level and Other Relevant Status	Direct Impact (% of total habitat type within Study Area)	Indirect Impact (% of total habitat type within Study Area)
Habitat	Native-dominated Secondary Forest	Priority 1 Area of High Conservation Value	37.5% (1.3 ha)	32.7% (1.2 ha)
	Mixed Forest	Priority 1 Area of High Conservation Value	11.3% (0.6 ha)	3.7% (0.2 ha)
	Abandoned-land Forest	Priority 2 Area of High Conservation Value	2.2% (0.1 ha)	1.7% (0.1 ha)
	Waste Woodland	Priority 2 Area of High Conservation Value	40.3% (0.8 ha)	28.9% (0.6 ha)
	Scrubland and Herbaceous Vegetation	Priority 2 Area of High Conservation Value	26.4% (1.0 ha)	15.5% (0.6 ha)
	Managed Vegetation	Priority 3 Area of High Conservation Value	N.A.	70.9% (1.0 ha)
	D/S8 Waterbody	Priority 2	0.34 km	0.13 km

Legend

- ⬜ (red outline) Study Area
- ⬜ Base Scenario Construction Worksite Footprint and Proposed CRL Alignment (Base)
- ▨ Road works
- 🟦 Others (infrastructure)
- 🟨 150 m impact zone

Vegetation

- 🟩 Native-dominated secondary forest
- 🟩 Mixed forest
- 🟩 Abandoned-land forest
- 🟫 Waste woodland
- 🟩 Scrubland and herbaceous vegetation
- 🟩 Managed vegetation
- 🟦 Waterbody

Site I

Site II

Site III

Eng Neo Avenue Forest

PIE

0   100   200 m

N

Note: Source of basemap - Google Earth Map

-	SEP 2022	JW	EIS (Turf City and Holland Plain)	JAG/NHT	JAG
Rev.	Date	By	Description	Chk'd	App'd

Qualified Person Endorsement :
NA

LTA Endorsement :
NA

Consultant :
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Figure Title :
THE IMPACT ZONE 150 M FROM THE WORKSITE AT TURF CITY

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Figure No. :	Rev.	Sheet
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7.6.1.2   Holland Plain: Sites IV and V near Clementi Forest

The CR15 worksite which spans a total of 10.6 ha across Sites IV and V will involve ground improvement works, shaft construction, tunnelling or TBM launch/retrieval works, concrete batching works (if any), as well as the construction of superstructures such as MRT stations and facility buildings. Road works for the construction of a permanent road along the existing Blackmore Drive and Old Holland Road will also be involved.

Five terrestrial habitat types, two waterbodies and 48 plant species are likely to be impacted, while all faunal species recorded are expected to be indirectly impacted as well, as most fauna are mobile throughout the Study Area.

A summary of the key biodiversity receptors impacted during construction phase in Sites IV and V is shown in Table 7-37.

Table 7-37 Key Biodiversity Habitat Receptors Likely to Experience Direct and Indirect Impacts in Sites IV and V during Construction Phase

Category	Key Biodiversity Receptor	Priority Level and Other Relevant Status	Direct Impact (% of total habitat type within Study Area)	Indirect Impact (% of total habitat type within Study Area)
Habitat	Native-dominated Secondary Forest	Priority 1 Area of High Conservation Value	94.6% (0.5 ha)	5.4% (0.03 ha)
	Abandoned-land Forest	Priority 2 Area of High Conservation Value	91.5% (1.1 ha)	7.6% (0.1 ha)
	Waste Woodland	Priority 2	17.1% (0.4 ha)	64.9% (1.4 ha)
	Scrubland and Herbaceous Vegetation	Priority 1 Area of High Conservation Value	35.7% (1.8 ha)	50.0% (2.5 ha)
	Managed Vegetation	Priority 3 Area of High Conservation Value	100% (0.4 ha)	N.A.
	Freshwater Marsh	Priority 1 Area of High Conservation Value	100% (0.3 ha)	N.A.
	Waterbody (Pond)	Priority 2 Area of High Conservation Value	100% (0.1 ha)	N.A.

Site IV

Site V

Clementi
Forest

0   100   200 m

Legend

Study Area
Base Scenario Construction Worksite Footprint
and Proposed CRL Alignment (Base)
Road works

Others (infrastructure)

150 m impact zone

Vegetation
Native-dominated secondary forest
Abandoned-land forest
Waste woodland
Scrubland and herbaceous vegetation
Managed vegetation
Freshwater marsh
Waterbody

N

Note: Source of basemap - Google Earth Map

Qualified Person Endorsement : NA	Consultant :	**AECOM**		Land Transport Authority We Keep Your World Moving
	Project Title :	**CONTRACT CR2005 ENVIRONMENTAL IMPACT STUDY (TURF CITY AND HOLLAND PLAINS)**	Figure Title :	**THE IMPACT ZONE 150 M FROM THE WORKSITE AT HOLLAND PLAIN**
LTA Endorsement : NA				

						Designed JW	Checked JAG/NHT	Approved JAG	Figure No. : 7-83	Rev. -	Sheet 1 of 1
-	SEP 2022	JW	EIS (Turf City and Holland Plain)	JAG/NHT	JAG	Drawn JW		Date SEP 2022	CAD File Name : NA		A3
Rev.	Date	By	Description	Chk'd	App'd						

7.6.2   Operational Phase

7.6.2.1   Turf City: Sites I, II and III near Eng Neo Avenue Forest

During operational phase, the worksite will be converted into the CR14 station with above-ground structure such as station entrances and exits.

Six terrestrial habitat types, one waterbody and 94 plant species are likely to be impacted, while all faunal species recorded are expected to be indirectly impacted as well, as most fauna are mobile throughout the Study Area.

A summary of the key biodiversity receptors impacted during operational phase within Sites I to III is shown in Table 7-38.

Table 7-38 Key Biodiversity Habitat Receptors Likely to Experience Indirect Impacts in Sites I to III during Operational Phase

Category	Key Biodiversity Receptor	Priority Level and Other Relevant Status	Indirect Impact (% of total habitat type within Study Area)
Habitat	Native-dominated Secondary Forest	Priority 1 Area of High Conservation Value	32.7% (1.2 ha)
	Mixed Forest	Priority 1 Area of High Conservation Value	3.7% (0.2 ha)
	Abandoned-land Forest	Priority 2 Area of High Conservation Value	1.7% (0.1 ha)
	Waste Woodland	Priority 2 Area of High Conservation Value	28.9% (0.6 ha)
	Scrubland and Herbaceous Vegetation	Priority 2 Area of High Conservation Value	15.5% (0.6 ha)
	Managed Vegetation	Priority 3 Area of High Conservation Value	70.9% (1.0 ha)
	D/S8 Waterbody	Priority 2	0.13 km

7.6.2.2   Holland Plain: Sites IV and V near Clementi Forest

During operational phase, the worksite will be converted into the CR15 station with above-ground structure such as station entrances and exits.

Four terrestrial habitat types and 48 plant species are likely to be impacted, while all faunal species recorded are expected to be indirectly impacted as well, as most fauna are mobile throughout the Study Area.

A summary of the key biodiversity receptors impacted during operational phase within Sites IV and V is shown in Table 7-39.

Table 7-39 Key Biodiversity Habitat Receptors Likely to Experience Indirect Impacts in Sites IV and V during Operational Phase

Category	Key Biodiversity Receptor	Priority Level and Other Relevant Status	Indirect Impact (% of total habitat type within Study Area)
Habitat	Native-dominated Secondary Forest	Priority 1 Area of High Conservation Value	5.4% (0.03 ha)
	Abandoned-land Forest	Priority 2 Area of High Conservation Value	7.6% (0.1 ha)
	Waste Woodland	Priority 2	64.9% (1.4 ha)
	Scrubland and Herbaceous Vegetation	Priority 1 Area of High Conservation Value	50.0% (2.5 ha)

7.7   Minimum Control Measures

This section lists biodiversity-specific minimum controls commonly implemented in Singapore for similar construction activities. These are assumed to be implemented for the purpose of the impact assessment. Minimum controls for each potential impact occurring from the construction and operational phases are listed in Table 7-40. Since work activities/methods are largely similar across the Study Areas, all minimum control measures proposed are applicable to all worksites and utilities diversion works. Therefore, it will be examined across all Study Areas by development phases (i.e., construction and operational phase). These measures should be proposed in tandem with that proposed for other environmental receptors (i.e., hydrology, noise, etc).

7.7.1   Construction Phase

Main construction activities that would likely occur at all worksites include vegetation clearance for worksite and excavation for levelling ground, followed by above and below ground construction. Piling and TBM tunnelling will likely occur as well. With these work activities anticipated, the related minimum control measures are listed down in Table 7-40.

Table 7-40 Minimum Control Measures for the Construction Phase

Work activities	Minimum controls	Worksite
Vegetation Clearance	• Trees that are to be retained within worksite would require an arborist to clearly mark out Tree Protection Zones where no works are allowed. The Tree Protection Zones should be set up in accordance with NParks guidelines. • Before vegetation removal, pre-felling fauna inspection should be conducted by an Ecologist to identify wildlife or nesting structures that are being actively used such as bird nests, tree hollows, burrows and bamboos clusters. • Soil erosion control measures are to be executed once vegetation has been removed and soil is exposed as described in Section 7 under Hydrology and Surface Water Quality and Section 9 under Soil and Groundwater.	All
Excavation	• Implement soil erosion control measures as described in Section 7 under Hydrology and Surface Water Quality. • Implement dust control measures as described in Section 10 under Air Quality.	All
Above And Below Ground Construction	• Proper storage of materials that are likely to leech harmful chemicals and fuel-powered equipment away from waterbodies or sensitive habitats as described in Section 9 under Soil and Groundwater (and Waste).	All
Pilling and TBM Tunnelling Along Alignment	• Ensure noise levels are within approved limits as described in Section 11 under Airborne Noise. • Ensure vibration levels are within approved limits as described in Section 12 under Ground-borne Vibration.	All

7.7.2   Operational Phase

Regular and/or adhoc maintenance works are the main operational activities that would likely occur at all Study Areas. Operational activities are not expected to result in significant impacts. However, facility buildings will present as new sources of disturbance to the surrounding forest. At the operational stage, not much can be controlled, apart from daily operational works and regular maintenance works.

7.8   Assessment of Ecological Impacts

7.8.1   Construction Phase

In this section, key biodiversity receptors identified are evaluated against potential sources of impacts based on the impact intensity of work activity (refer to Table 6-6) and likelihood of impact occurring (refer to Table 6-7).

The two assumptions made in defining the levels of impact intensity (Table 7-41) and likelihood (Table 7-42) for habitat receptors during the construction phase are:

1. 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 7.6 for the definition of the impact zone).

2. 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; refer to Table 7-35] is presumed to be Less Likely for all habitat receptors, based on the assumption that all minimum controls (Section 7.7) are adequately and properly implemented.

Table 7-41 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 vegetation	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
Habitat degradation **Change in species composition**	The habitat does overlap with areas 30 m from the worksites	⩽ 10% of the habitat overlaps with areas 30 m from the worksites	10–40% of the habitat overlaps with areas 30 m from the worksites	>40% of the habitat overlaps with areas 30 m from the worksites

Table 7-42 Definitions of each level of likelihood for all three impact types during construction for habitat receptors

	Loss of Vegetation	Habitat Degradation	Change in Species Composition
Unlikely/Remote	The habitat does not overlap with the worksites	N.A.	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.	N.A. (see assumption above)	Formation of scrubland edges in scrubland areas only
Possible/ Occasional	N.A.	N.A.	Formation of some forest and scrubland edges in a mix of managed vegetation, scrubland and forested areas
Likely/ Regular	N.A.	N.A.	Formation of new forest edges (i.e., complete clearance within forested areas)
Certain/ Continuous	The habitat overlaps with the worksites	N.A.	N.A.

Following the assessment of ecological value for all plant species (Section 7.4), some were selected for the assessment of ecological impacts. The selection was based on the following: (1) species with specimens of conservation significance, large specimens, and/or other specimens of value found inside and within 30 m from the proposed worksite area, (2) keystone species, which are only the *Ficus* species in this Study, (3) species associated with important fauna, and (4) species that make up ≤ 1% of the total number of specimens of conservation significance. The selected species receptors were then evaluated based on impact intensity and likelihood, which eventually gives impact significance.

The various levels of impact intensity and likelihood for each impact type during the construction phase were specifically defined for plant species receptors. The definitions for impact intensity and likelihood for plant species at construction phase are presented in Table 7-43 and Table 7-44, respectively.

A few assumptions were made in defining the levels of impact intensity for plant species receptors:

1. 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. 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.
2. For tree/strangler species that are not bamboos or of conservation significance (i.e., native common or exotic species), and hence do not have count data, total specimen count was taken from arboricultural survey data. Note that the area for arboricultural surveys is a subset of the entire Study Area. For species

with zero counts (i.e., were not recorded during arboricultural surveys), it is 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.

3. For native common or exotic climbing fig species/species associated with important fauna that do not have count data from both floristic and arboricultural surveys, it is assumed that the intensity of impacts of work activities on them is negligible since most of these species are expected to be widespread. The impacts, however, will still be considered specifically for each species during evaluation (e.g., *Ficus heteropleura* and *Ficus punctata*).

Table 7-43 Definitions of Each Level of Impact Intensity for All Four Impact Types during the Construction Phase for Plant Species Receptors

	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
Impediment To Seedling Recruitment **Competition From Exotic Species** **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 7-44 Definitions of Each Level of Likelihood for All Four Impact Types during the Construction Phase for Plant Species Receptors

	Mortality	Impediment To Seedling Recruitment	Competition From Exotic Species	Decline In Plant Health and Survival
Unlikely/Remote	No plant specimens of this species are within the worksites	Plants are epiphytes and/or do not grow on soil	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.	N.A.	Formation of very little forest edges in managed vegetation only	
Possible/ Occasional	No count data/locations of specimens of this species are available, but specimens could possibly be within the worksites	Plants that grow on soil and whose dispersals are not restricted, i.e., they disperse via wind, water, and/or terrestrial fauna	Formation of little forest edges in scrubland areas only	
Likely/ Regular	N.A.	N.A.	Formation of some forest edges in a mix of managed vegetation, scrubland and forested areas	
Certain/ Continuous	Plant specimens of this species are within the worksite	Plants that grow on soil whose dispersals are restricted owing to environmental factors and/or growth strategies (e.g, bamboos that propagate via underground rhizomes and ground orchids)	Formation of new forest edges (i.e., complete clearance within forested areas)	

The definitions for impact intensity and likelihood for faunal species at construction phase are presented in Table 7-45 and Table 7-46, respectively.

Table 7-45 Definitions of level of impact intensity for all three 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	– Loss of <10% of original habitat;	– Loss of 10–40% of original habitat;	– Loss of >40% of original habitat;
Injury or mortality	Negligible susceptibility to roadkills	Species with low susceptibility to injury/mortality from construction activities (large vehicles, excavation, piling, etc): – Volant species (e.g., odonates, butterflies, highly volant birds, raptors and bats) – Pelagic species (marine context), ability to swim/crawl away quickly from danger (most fishes, crabs, shrimp) Low susceptibility to roadkills	Species that are mobile but possibly susceptible to injury/mortality from construction activities (large vehicles, excavation, piling, etc): – Amphibious aquatic species – All amphibians – Mammals: squirrels, shrews – Species (marine context) with ability to swim/crawl away but not very quickly (slow moving marine creatures, worms) Possibly susceptible to roadkills	Species with high susceptibility to injury/mortality from construction activities (large vehicles, excavation, piling, etc): – Less volant birds – Reptiles (snakes) – Mammals: Pangolin, long-tailed macaque, otter – Sessile species (marine context) cannot swim away (coral, anemone), move extremely slowly (echinoderms, molluscs, seahorses) – Birds, specifically migratory species
Loss/reduction of ecological connectivity for faunal movement	– Not dependent on connected and forested habitats for dispersal and able to traverse urban infrastructures;	– Slightly dependent on connected and forested habitats for dispersal and adaptable to traverse urban infrastructures if needed;	– Dependent on connected and forested habitats for dispersal;	– Highly dependent on connected and forested habitats for dispersal;

Table 7-46 Definitions of each level of likelihood for all three impact types during construction for faunal species receptors

Impact Type	Unlikely/Remote	Less likely/Rare	Possible/ occasional	Likely/Regular	Almost certain/ Continuous
Loss of/ reduction in habitats and food sources	Impact is not expected to happen during the construction phase of the project	Impact is not likely to happen during the construction phase of the project	Impact could possibly happen or known to occur during the construction phase of the project	Impact is a common occurrence during the construction phase of the project	Impact is a continual or repeated process during the construction phase of the project
Injury or mortality					
Loss/reduction of ecological connectivity for					

Impact Type	Unlikely/Remote	Less likely/Rare	Possible/ occasional	Likely/Regular	Almost certain/ Continuous
faunal movement					

7.8.1.1   Turf City: Sites I, II and III near Eng Neo Avenue Forest

7.8.1.1.1   *Habitats*

The most substantive impact to the habitats from construction phase at Sites I to III is of Major significance.

Construction phase site clearance will result in removal of 3.83 ha of forest and 46% of a waterbody within the Study Area. The Study Area consists of seven habitat types, two of high ecological value, four of moderate ecological value and one of low ecological value. Loss of vegetation due to site clearance will result in Major impact on native-dominated secondary forest, mixed forest, waste woodland, and D/S8 waterbody. This is due to the certainty of removal of more than 10% but less than 40% of the current habitats on site. While loss of vegetation results in Moderate impact on the scrubland and herbaceous vegetation due to this habitat being a priority 2 habitat. There is a Minor impact on abandoned land forest due to it being a priority 2 habitat and the certainty of removal of less than 10% of the current habitats on site. Since the managed vegetation is a priority 3 habitat and there is no predictable percentage of clearance of this habitat, estimated impact is negligible.

The impact of habitat degradation is assumed to be Negligible to Minor for all habitats affected due to the low likelihood of habitat degradation happening as a result of assumptions.

Changes in species composition due to creation of new forest edge is also expected to occur with the removal of forest. The impact significance for this particular impact is deemed to be Negligible to Minor for all habitats except the native-dominated secondary forest. This is because of the possible likelihood of the formation of some forest and scrubland edges in a mix of managed vegetation, scrubland and forested areas.

Summary of impact evaluation for all the habitats at Sites I to III can be found in Appendix R1.

7.8.1.1.2   *Plant Species*

A total of 94 plant species recorded from Sites I to III were selected for the assessment of ecological impacts. In the assessment of the four types of impact for individual species during the construction phase—(1) mortality, (2) impediment to seedling recruitment, (3) competition from exotic species, and (4) decline in plant health and survival—the impact significance was Negligible, Minor, Moderate, or Major. Here, we present the most severe impact for each species from the assessment of all four impact types. Forty species are likely to experience Major to Moderate impacts.

Major impacts due to mortality

Seventeen species are expected to experience Major impacts owing to mortality (Appendix R1). Of these, 13 have high ecological value while four have medium ecological value. These species are likely to experience major impacts because of two main reasons: (1) it is of high or medium sensitivity and (2) 50% or more of all the specimens recorded from the Study Area are located within the proposed worksite and will be directly affected by the proposed development.

1) Eight species listed as nationally Vulnerable (High sensitivity) are expected to experience Major impacts from mortality. These are *Angiopteris evecta*, *Dacryodes* cf. *rostrata, Ficus aurata* var. *aurata, Guioa pleuropteris, Macaranga griffithiana, Palaquium obovatum, Pternandra caerulescens* and *Xanthophyllum eurhynchum.* Less than 10 specimens per species were recorded in the Study Area. Only one specimen of *Dacryodes cf. rostrata* and *Palaquium obovatum* were recorded, both of which are within the proposed worksite and will be directly affected by the proposed works (High impact intensity). For the remaining species, more than 50% of all recorded specimens occur within the worksite (Medium impact sensitivity).

2) Two nationally Endangered species, one Critically Endangered species, and two Presumed Extinct species (High sensitivity) are represented singularly on site. All five specimens were found within the proposed work site (High impact intensity) and their removal is deemed to be certain (Almost certain likelihood).

Moderate impacts due to mortality

Twenty-three species are expected to experience Moderate impacts due to mortality. Of these, 19 have high ecological value, two have medium ecological value, while and the remaining two have low ecological value (Appendix R1).

1) The impacts due to mortality on 18 species with high ecological value (High sensitivity) were assessed to be Moderate as less than 50% of all specimens of this species recorded within the proposed worksite (**Low** impact intensity). While the impact intensity is low, it is almost certain (Almost certain likelihood) that these specimens would be affected by construction activities. Hence, the impact significance is **Moderate**.

2) Likewise, for the two species with medium ecological value (Medium sensitivity), less than 50% of all specimens of this species recorded within the proposed worksite (**Low** impact intensity) but the likelihood is Almost certain. Therefore, it results in an impact significance of Moderate.

3) For the remaining two species with low ecological value (Low sensitivity) (*Delonix regia* and *Gliricidia sepium*), only one specimen per species was recorded in this Study, and both of which are within the proposed worksite (High impact intensity). With Almost certain likelihood of mortality from vegetation clearance for the proposed worksite, the impact significance is therefore Moderate.

Moderate impacts due to impediment to seedling recruitment, competition from exotic species and decline in plant health

Only one climber species is expected to experience Moderate impacts owing to impediment to seedling recruitment. The impacts on *Uncaria longiflora* var. *pteropoda* was assessed to be moderate as all specimens of this Critically Endangered species (High sensitivity) were recorded within 30 m from the proposed worksite, giving a **High** impact intensity. As a flowering seed plant that grows on soil and whose dispersal modes are not restricted, there is a possibility that seedling recruitment within 30 m from the proposed worksite may still be somewhat impeded as a result of construction activities (**Possible** likelihood), such as site clearance that may reduce the available soil area for the establishment of seeds. This results in an impact significance of Moderate.

Five species are expected to experience Moderate impacts owing to competition from exotics species and decline in plant health once site clearance from construction starts. All five have high ecological value (High sensitivity) (*Alsophila latebrosa, Litsea firma*, *Macaranga hullettii, Piper pedicellosum*, and *Planchonella obovata*). As less than 20% of these specimens were found within 30 m from the proposed construction site, impact intensity is Low. However, as these species of medium to high ecological value are mostly not fast growing by nature, they will most likely be outcompeted by more rapid growing pioneer exotics like *Falcataria moluccana* and *Acacia auriculiformis* (**Likely** likelihood). Therefore, the impact significance is Moderate.

The remaining 54 species likely to experience Minor impacts have low to high ecological value. Most do not have any or have < 50% of all specimens located inside or within 30 m from the proposed worksites, giving an impact intensity of Negligible or Low, respectively.

7.8.1.1.3   *Faunal Species*

Species that are most impacted by the proposed worksites are the bamboo bats and the birds. The project involves the clearance of bamboo clusters which serve as an essential roosting site for bamboo bats, as well as impacts on stream and riparian vegetation which may impact species such as the red-legged crake (*Rallina fasciata*).

i)   Butterflies

The loss of habitats and subsequent loss of host plants causes a Moderate to Major impact for the butterflies found in this area. The Formosan Swift butterfly (*Borbo cinnara*) lays its eggs on shrubland plants and since the impact of habitat clearance on shrublands is medium, this butterfly species may suffer a decline in numbers. The common birdwing (*Troides helena Cerberus*) feeds on the Dutchman's Pipe plant, and it is in severe threat due to the high impact on site III which know to contain its host plant.

ii)   Birds

The impact on birds on site are mostly Moderate due to habitat loss. For example, the globally Critically Endangered straw-headed bulbul (*Pycnonotus zeylanicus*) will experience Moderate impacts from the loss of habitat connectivity from the removal of vegetation because this species is highly dependent on connected and forested habitats for dispersal. However, there is expected to be a Major impact on the red-legged crake (*Rallina fasciata*) because of the high impact on stream and riparian vegetation where it forages.

iii)   Non-volant mammals

While not of conservation significance, the Sunda colugo (*Galeopterus variegatus*) is a species of interest which would require additional mitigation measures and was observed within worksite. Sunda colugos are able to glide between tall trees, and suitable gliding spots are important for this species. Sunda colugos are known to show fidelity to the trees that it uses, thus are susceptible to construction impacts. The worksite represents a loss of habitat and connectivity, as well as potential of injury/mortality for this species. Hence, impact intensity is expected to be high and the overall impact significance is Moderate. Furthermore, impacts of disturbances to this species is unknown. It is a nocturnal species and will be subjected to disturbances from noise and light during the construction phase.

The Sunda pangolin (*Manis javanica*) has been recorded from the nature reserves and degraded forest fragments in Singapore. Notably, Singapore is a global stronghold for the species and is crucial in contributing to the conservation of pangolin populations globally. Yet, habitat loss, degradation and fragmentation, and road kills threaten the viability of the national population. The worksite results in a medium loss of habitat. Based on distribution records, it seems to be using the entire Study Area. Loss of connectivity between the south and north portions of the Study Area might result in detrimental impacts to the pangolins using this area. Subsequently, the increased presence of vehicles may contribute to the increased incidence of roadkill due to the lack of safe wildlife crossings. Due to its conservation status nationally and globally, the loss of any individual would constitute a major impact intensity. As habitat loss and mortality of fauna are permanent and irreversible and likelihood is possible, the overall impact significance is Moderate.

iv)   Bats

Since the road works will involve the clearance of bamboo clusters which are important for the breeding and roosting of bamboo bats (*Tylonycteris sp.*), which are also dependent on connected and forested areas for dispersal, it will have a Major impact on this particular species.

7.8.1.2   Holland Plain: Sites IV and V near Clementi Forest

7.8.1.2.1   *Habitats*

The most substantive impact to the habitats from construction phase at Sites IV and V is of Major significance.

Construction phase site clearance will result in removal of 4.51 ha of forest and waterbodies within the Study Area. The Study Area consists of seven habitat types, three of high ecological value, two of moderate ecological value and one of low ecological value. Loss of vegetation due to site clearance will result in Major impact on native-dominated secondary forest, abandoned land forest, scrubland and herbaceous vegetation, freshwater marsh, and the waterbody (pond). This is because loss of vegetation either results in a large loss of the above-mentioned habitats (more than 90%), or the habitats affected are of priority 1. Loss of vegetation results in Moderate impact on waste woodland and managed vegetation. The reason why the impact on managed vegetation, which is a priority 3 habitat, is Moderate is because 100% of it will be cleared by construction works.

The impact of habitat degradation is assumed to be Negligible to Minor for all habitats affected due to the low likelihood of habitat degradation happening as a result of assumptions.

Changes in species composition due to creation of new forest edge is also expected to occur with the removal of forest. The impact intensity of this impact is deemed to be Negligible to Minor for all habitats except in native-dominated secondary forest, waste woodland and scrubland and herbaceous vegetation, because the above-mentioned habitats will be affected by the formation of new forest or scrubland edges because of the construction.

Summary of impact evaluation for the habitat at Sites IV and V can be found in Appendix R2.

7.8.1.2.2   *Plant Species*

A total of 48 plant species recorded from Sites IV and V were selected for the assessment of ecological impacts. In the assessment of the four types of impact for individual species during the construction phase (1) mortality, (2) impediment to seedling recruitment, (3) competition from exotic species, and (4) decline in plant health and survival—the impact significance was negligible, low, moderate, or major. Here, we present the most severe impact for each species from the assessment of all four impact types. Forty-one species are likely to experience major to moderate impacts (Appendix R1).

Major impacts due to mortality

Thirty species are expected to experience Major impact from mortality. These species are likely to experience major impacts because of two main reasons: (1) it is high or medium ecological value (**High** or **Medium** sensitivity) and (2) more than 50% of the specimens are location within the proposed worksite and will be directly affected by the proposed development.

1) Sixteen species of high ecological value (High sensitivity) are expected to experience Major impacts from mortality and less than 11 specimens each were recorded. All or > 50% the specimens were found within the worksite and will be directly affected by the proposed works (High or Medium impact intensity, respectively). With Almost certain likelihood owing to vegetation clearance for the proposed works, the impact significance is therefore Major.

Moderate impacts due to mortality

Nine species are expected to experience Moderate impacts due to mortality. Eight of them have low ecological value (Low sensitivity) and all the specimens were recorded within the proposed worksite (**High** impact intensity). On the other hand, *Nepenthes gracilis* is of high ecological value (High sensitivity). An estimated 14% of all recorded specimens will be directly affected by the proposed development (Low impact intensity). As the likelihood of mortality of the aforementioned species is Almost certain, it results in an impact significance Moderate.

Moderate impacts due to impediment to seedling recruitment

Only two nationally Vulnerable species (High sensitivity) are expected to experience Moderate impacts from impediment to seedling recruitment.

1) The impacts on *Mangifera foetida* was assessed to be moderate as all specimens of this species were recorded within 30 m from the proposed worksite, giving a **High** impact intensity. As a flowering seed plant that grows on soil and whose dispersal modes are not restricted, there is a possibility that seedling recruitment found within 30 m from the proposed worksite may still be somewhat impeded as a result of construction activities (**Possible** likelihood), such as site clearance that may reduce the available soil area for establishment of seeds. Hence, the impact of impediment to seedling recruitment is Moderate.

2) *Nepenthes ampularia* is likely to experience Moderate impacts owing to seed dispersal as the species is considered to have a high ecological value (High sensitivity) and more than 50% of the recorded specimens are within 30 m of the proposed work site (Medium impact intensity).

7.8.1.2.3   *Faunal Species*

Species that are most impacted by the proposed worksites are those which are heavily dependent on the freshwater marsh. This is because the freshwater marsh and the pond in the study area will be removed completely by construction. The marsh is home to a considerable number of species such as the restless demon dragonfly (*Indothemis limbata*) and the red-wattled lapwing (*Vanellus indicus*).

i)   Odonates

The nationally Vulnerable restless demon dragonfly (*Indothemis limbata*) is primarily aquatic and heavily relies on the freshwater marsh to reproduce and to forage. Since the project will cause a continual and repeated impact on the freshwater marsh, the impact on this particular species is deemed to be Major.

ii)   Butterflies

The common birdwing (*Troides helena Cerberus*) is likely to be negatively affected by construction works due to the likelihood of its host plants being cleared. The impact on this particular species is Moderate.

iii)   Birds

The Red-wattled lapwing (*Vanellus indicus*) is a nationally Endangered species which is dependent on marshland and grassland environments. Since these habitats are likely to be impacted consistently and extensively by construction works, we predict the impact on this species to be Major.

The impact of habitat loss on other bird species are deemed to be Moderate because of the extensive scale of habitat clearance due to a high overlap of worksite with the sites.

Since most bird species are volant and can easily escape harm and injury, we classify these impacts as Minor.

iv)   Non-volant mammals

The Sunda pangolin (*Manis javanica*) species has been recorded from the nature reserves and degraded forest fragments in Singapore. Notably, Singapore is a global stronghold for the species and is crucial in contributing to the conservation of pangolin populations globally. Yet, habitat loss, degradation and fragmentation, and road kills threaten the viability of the national population. The presence of infants also suggests a breeding population in the Study Area. The worksite results in the loss of a considerable area of habitats, albeit the pangolin can also utilise other parts of the Study Area. The ground-dwelling mammal is also highly susceptible to injury or mortality from construction activities. As both habitat loss and injury or mortality of pangolins are possible events, the overall impact significance is Moderate.

7.8.2   Operational Phase

The tables below state the definitions of impact intensity (Table 7-47) and likelihood (Table 7-48) of the respective impact types on the habitat and species receptors, respectively.

Table 7-47 Definitions of each level of impact intensity for two impact types during operational phase for habitat receptors

Impact type	Negligible	Low	Medium	High
Habitat degradation	Developed area is not accessible to public.	Developed area is not designed with the intention for the public to use or visit, but may increase human accessibility to the surrounding natural habitats.	Developed area is designed for members of the public to visit (e.g., parks with boardwalks)	Developed area is designed for large groups of people to live in in the long-run (e.g., residential estates)
Change in species composition	Development footprint is temporary and/or operational activities are fully underground (e.g., train alignment)	Development footprint is permanent and small relative to the size of the surrounding habitats (i.e., ⩽ 10%)	Development footprint is permanent and medium-sized relative to the size of the surrounding habitats (i.e., 10-40%)	Development footprint is permanent and large-sized relative to the size of the surrounding habitats (i.e., ≥40%)

Table 7-48 Definitions of each level of likelihood for two impact types during operational for habitat receptors

	Habitat Degradation	Change in Species Composition
Unlikely/Remote	Development is largely green (e.g., Thomson Nature Park)	Surrounding natural habitats are not accessible to public
Less likely/Rare	Development involves the building of urban infrastructures but will be heavily landscaped (e.g, Gardens by the Bay)	Surrounding natural habitats are less accessible and public use is restricted/controlled
Possible/Occasional	Development involves the building of infrastructure that are designed to release heat (e.g., ventilation shafts)	Surrounding natural habitats are accessible and have some infrastructure for the public to use, such as boardwalks (but people can still stray off track)
Likely/Regular	Development involves the building of extensive pavements, structures, and other infrastructures with surfaces that absorb and retain heat (e.g., residential estate)	Surrounding natural habitats are easily accessible and do not have infrastructure for the public to use, such as boardwalks (but people can still stray off track)
Certain/ Continuous	N.A.	N.A.

The various levels of impact intensity and likelihood for each impact type during the operational phase were specifically defined for plant species receptors.

Table 7-49 Definitions of Each Level of Impact Intensity for Both Impact Types during the Operational Phase for Plant Species Receptors

	Negligible	Low	Medium	High
Mortality	No plant specimens of this species could get stolen	Less than 50% of plant specimens of this species could get stolen (i.e., most plant species)	More than or exactly 50% of all plant specimens of this species could get stolen (i.e., orchids)	All plant specimens of this species could get stolen (i.e., pitcher plants)
Competition From Exotic Species	Only native species are planted (assume so for all projects by the NParks)	Exotic species listed as 'Cultivated Only' are planted	Exotic species listed as 'Casual' are planted (assume so for projects by the LTA, HDB, and/or other agencies)	Exotic species listed as 'Naturalised' are planted

Table 7-50 Definitions of Each Level of Likelihood for Both Impact Types during the Operational Phase for Plant Species Receptors

	Mortality	Competition From Exotic Species
Unlikely/Remote	Species not known to have been stolen before	Original vegetation mostly retained with no new landscaping
Less Likely/ Rare	N.A.	Some original vegetation retained with some new landscaping using only native species

OR

Original vegetation mostly cleared with new large-scale landscaping using only native species |
Possible/ Occasional	Flowering species known to have been stolen before	Some original vegetation retained with some new landscaping using exotic species
Likely/ Regular	N.A.	Original vegetation mostly cleared with new large-scale landscaping
Certain/ Continuous	"Charismatic species" known to be stolen most of the time (i.e., pitcher plants and orchids)	N.A.

The definitions for impact intensity and likelihood for faunal species at operational phase are presented in Table 7-51 and Table 7-52, respectively.

Table 7-51 Definitions of each level of impact intensity for two impact types during operational phase for faunal species receptors

Impact Type	Negligible	Low	Medium	High
Injury or Mortality	Operation activities cause no injuries/deaths to the species.	Extent of injuries/ mortality arising from operation activities is low
OR
Species is able to move away from danger in operation activities relatively easily:
– Volant species (e.g., odonates, butterflies, non-ground-dwelling birds, raptors and bats) | Extent of injuries/ mortality arising from operation activities is medium
OR
Species is not able to move away from danger in operation activities very easily:
– Amphibious aquatic species
– All amphibians (frogs, lizards) | Extent of injuries/mortality arising from operation activities is high
– Has small population size
– Birds, specifically migratory species

OR

Species is unable to move away from danger in operation activities easily:
– Ground-dwelling birds
– Reptiles (snakes) |

Impact Type	Negligible	Low	Medium	High
		– Pelagic species (marine context), ability to swim/crawl away quickly from danger (most fishes, crabs, shrimp) Low susceptibility to roadkills, poaching and/or collision with buildings	– Mammals: squirrels, shrews – Species (marine context) with ability to swim/crawl away but not very quickly (slow moving marine creatures, slow swimming fishes, worms, snails) Possibly susceptible to roadkills, poaching and/or collision with buildings	– Mammals: Pangolin, long-tailed macaque, otter – Sessile species (marine context) cannot swim away (coral, anemone), move extremely slowly (echinoderms, molluscs, seahorses) High susceptibility to roadkills, poaching and/or collision with buildings
Loss of Ecological Connectivity for Faunal Movement	– Not dependent on connected and forested habitats for dispersal and able to traverse urban infrastructures;	– Slightly dependent on connected and forested habitats for dispersal and adaptable to traverse urban infrastructures if needed;	– Dependent on connected and forested habitats for dispersal;	– Highly dependent on connected and forested habitats for dispersal;

Table 7-52 Definitions of each level of likelihood for two impact types during operational for faunal species receptors

Impact Type	Injury or Mortality	Loss of Ecological Connectivity for Faunal Movement
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	

7.8.2.1   Turf City: Sites I, II and III near Eng Neo Avenue Forest

7.8.2.1.1   *Habitats*

In terms of negative impacts on habitats during operational phase, all habitats were estimated to experience negligible to minor impact in terms of habitat degradation (trampling or pollution) because the developed area is intended for people to visit but not to live in. The development also involves relatively small building infrastructure compared to surrounding areas.

Change in species composition is also negligible to minor because the development footprint is permanent and small relative to the size of the surrounding habitats. Furthermore, the surrounding natural habitats are less accessible and public use is restricted or controlled.

Summary of impact evaluation for all the habitats at Sites I to III can be found in Appendix R1.

7.8.2.1.2   *Plant Species*

A total of 94 plant species were selected for the assessment of ecological impacts. In the assessment of the two types of impact for individual species during the operational phase— (1) mortality and (2) competition from exotic species—the impact significance was minor, moderate, or major. Here, the most severe impact for each species from the assessment of both impact types is presented. Seventy-seven species are likely to experience Moderate impacts, and 17 are likely to experience Minor impacts.

The one species likely to experience Moderate impacts is the Endangered epiphyte *Bulbophyllym vaginatum* due to mortality. It is a native species of high ecological value (High sensitivity). Works occurring at the operational phase are likely to result in Medium impact intensity for this plant species as more than 50% of the orchid specimens could be poached. The likelihood is Likely as orchids are charismatic species and are known to get poached by members of the public, but the area in general will not be very accessible to public. This gives a resulting impact significance of Moderate for mortality. This species is also likely to experience Moderate impacts as a result of competition from exotic species (explained below).

All 77 species are likely to experience Moderate impacts as a result of competition from exotic species. Most of these plant species (63) are of high ecological value (High sensitivity), while the rest (14) are of medium ecological value (Medium sensitivity). As most of these plant species are native, with three of these species (*Aristolochia acuminata, Ficus barteri* and *Ficus lyrata*) are listed as "Cultivated Only", they are expected to experience Medium impact intensity due to competition from exotic species. Such competition is Possible (likelihood) as some original vegetation are expected to be retained, with some others cleared and replaced with landscaping. Therefore, the impact significance of competition from exotic species is Moderate.

The 17 species likely to experience Minor impacts is owing to competition with exotic species. Most are exotic plants with 9 of them having low ecological value (Low sensitivity). They will mostly experience either Low or Medium impact intensity if the species is listed as "Casual" or "Cultivated Only", respectively. Given that the original vegetation will mostly be cleared with new large-scale landscaping using exotic species, it is Possible (likelihood) that these species will be impacted. This results in an impact significance of Minor for competition from exotic species.

7.8.2.1.3   *Faunal Species*

Species that are most impacted by the proposed worksites are the birds and the bats. Certain birds are very dependent on the forest connectivity for dispersal, and some bats are reliant on the bamboo plant clusters for roosting and shelter.

i)   Butterflies

Since the *Arhopala amphimuta amphimuta* is highly dependent on connected and forested habitats for dispersal, and these habitats could be impacted during the operational phase of development, this species is estimated to experience moderate impact significance. Other butterfly species are estimated to experience Negligible impact during operational phase because they are not dependent on connected and forested habitats for dispersal and able to traverse urban infrastructures and are at no risk of injury or mortality due to them being volant.

ii)   Birds

The oriental magpie-robin (*Copsychus saularis*) and the straw-headed bulbul (*Pycnonotus zeylanicus*) are particularly susceptible to collision with infrastructure, which makes the impact significance during operational phase Moderate.

iii)   Non-volant mammals

The Sunda pangolin (*Manis javanica*) and the Sunda colugo (*Galeopterus variegatus*) are highly dependent on connected and forested habitats for dispersal. Since the habitats will be impacted frequently during the operational phase of the project, we estimate the impact significance to be Moderate for these two species of animals.

iv)   Bats

The bamboo bat (*Tylonycteris sp.*) relies heavily on bamboo clusters interspersed within neighbouring forest patches for dispersal, breeding, and roosting. The impact of operational activities on these bamboo clusters is predicted to be consistent and frequent, resulting in a Major impact on this species of bat.

7.8.2.2   Holland Plain: Sites IV and V near Clementi Forest

7.8.2.2.1   *Habitat*

During the operational phase, habitat degradation is deemed to be Negligible to Minor for all affected habitats. This is because the developed area is intended for members of the public to visit but not live in, and that the development involves relatively small building infrastructure compared to surrounding areas.

Change in species composition in habitats also have Negligible to Minor impacts because development footprint is permanent and small relative to the size of the surrounding habitats, and surrounding natural habitats are accessible and have some infrastructure for the public to use.

Summary of impact evaluation for the habitat at Sites IV and V can be found in Appendix R2.

7.8.2.2.2   *Plant Species*

A total of 48 plant species at Sites IV and V were selected for the assessment of ecological impacts. In the assessment of the two types of impact for individual species during the operational phase— (1) mortality and (2) competition from exotic species—the impact significance was negligible, low, moderate, or major. Here, the most severe impact for each species from the assessment of both impact types is presented. Two species are likely to experience Major impacts, 32 species are likely to experience Moderate impacts, and 14 species are likely to experience Minor impacts.

The two species likely to experience Major impacts are native plant species (*Nepenthes gracilis* and *Nepenthes ampullaria*) of high ecological value (High sensitivity). As both plant species are pitcher plants, all plant specimens of these species could get stolen and are known to have been stolen most of the time, thus giving an impact intensity of High with an Almost Certain likelihood of this taking place. Hence, the impact significance of mortality is Major.

Thirty-two species are likely to experience Moderate impacts as a result of competition from exotic species. The 32 plant species are of high or medium ecological value (High or Medium sensitivity). As all 32 plant species are listed as "Native", impact intensity due to competition from exotic species is expected to be High. This is a Possible (likelihood) event as some original vegetation are expected to be retained, with some others cleared and replaced with landscaping. Hence, the impact significance of competition from exotic species is Moderate.

Fourteen species are likely to experience Minor impacts due to mortality. They are likely to experience Low impact intensity as it is expected that less than 50% of plant specimens could be poached due to operational works. Given that these are flowering species known to have been stolen before, it is Possible (likelihood) that these species will be impacted. This results in an impact significance of Minor.

7.8.2.2.3   *Faunal Species*

   i)   Odonates

Since the restless demon dragonfly (*Indothemis limbata*) is volant, it can easily avoid collisions and injury during the operational phase. Loss of ecological connectivity is not expected to occur during operational phase, hence the impact intensity on odonates is considered Minor.

   ii)   Butterflies

The common birdwing (*Troides helena cerberus*) has host plants that can be found extensively elsewhere. As they are volant and likely able to find alternative habitats within or adjacent to the Study Area, only Negligible or Minor impacts are expected.

   iii) Birds

Collisions with buildings might occur for the Ruddy kingfisher (*Halcyon coromanda*), a migratory species, and the Straw-headed bulbul (*Pycnonotus zeylanicus*), hence the impact on these two species is Moderate. This is because both species are susceptible to collisions with buildings.

   iv)   Non-volant mammals

The Sunda pangolin (*Manis javanica*) species has been recorded from the nature reserves and degraded forest fragments in Singapore. Notably, Singapore is a global stronghold for the species and is crucial in contributing to the conservation of pangolin populations globally. The pangolin may be subject to injury or mortality during the operational phase of the project because it is non-volant and cannot get away from danger in operation activities relatively easily, resulting in a Moderate impact significance.

7.9   Recommended Mitigation Measures

In this section, mitigation measures for the Project are discussed. Mitigation measures are implemented in the following order: (1) avoidance (elimination), (2) minimisation (substitution, engineering controls and administrative controls), and (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, habitat connectivity and potential fauna mortality.

7.9.1   Mitigation at Design Phase

Although impacts only occur downstream (i.e., construction phase onwards), the design stage is of paramount importance. The design can significantly influence the extent of impacts, as the structural design will dictate the location of structures, construction methods and the amount of impact caused during the construction and operational phases.

7.9.1.1   Turf Club: Sites I, II and III near Eng Neo Avenue Forest

7.9.1.1.1   *Elimination/ Avoidance*

- The worksite and roadwork are currently situated on areas of high conservation value (Figure 7-80). It is recommended to shift the worksite away from the native-dominated secondary forest patches at Sites II and III, which have the highest ecological value. Furthermore, the shift is recommended to avoid further fragmenting Sites I, II and III from the forest patch in the north, which might have resulted in significant impacts to loss of connectivity for both floral and faunal species.

- To mitigate biodiversity impacts on ecological valuable habitats, LTA has agreed to shift construction works, avoiding areas of high conservation value as much as possible. The mitigated worksite will avoid the native-dominated secondary forest patches and utilise existing cleared and urban spaces (Figure 7-84).
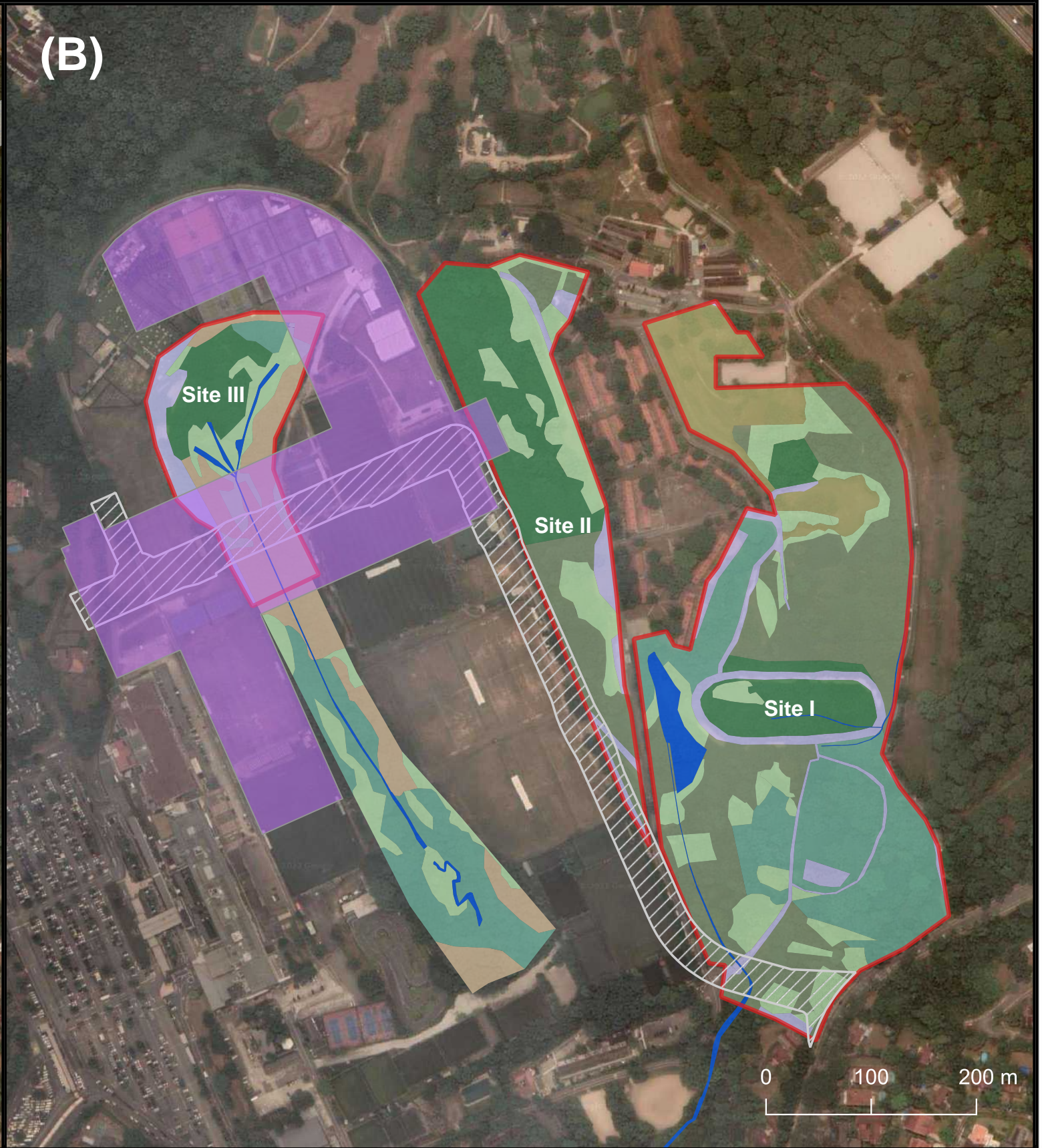
(A) CURRENT AND (B) RECOMMENDED DESIGN SHIFT IN CR14 WORKSITE AT TURF CITY

Legend

Study Area

Vegetation
- Native-dominated secondary forest
- Mixed forest
- Abandoned-land forest
- Waste woodland
- Scrubland and herbaceous vegetation
- Managed vegetation
- Others (infrastructure)
- Waterbody

- Base Scenario Construction Worksite Footprint
- Proposed CRL Alignment (Base)
- Mitigated Scenario Construction Worksite Footprint
- Road works

Note: Source of basemap - Google Earth Map

Qualified Person Endorsement : NA	Consultant : AECOM		Land Transport Authority We Keep Your World Moving
	Project Title : CONTRACT CR2005 ENVIRONMENTAL IMPACT STUDY (TURF CITY AND HOLLAND PLAIN)		Figure Title : (A) CURRENT AND (B) RECOMMENDED DESIGN SHIFT IN CR14 WORKSITE AT TURF CITY
LTA Endorsement : NA			

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7.9.1.1.2 *Minimisation (Substitution)*

- Bird collisions can be reduced by substituting certain aspects of the building design with bird-friendly building design:

  o Bird-friendly building design can significantly reduce the incidences of bird collisions, especially for higher storeys that are above tree canopy height. Although the proposed station building does not appear to be higher than two storeys, because of the proximity of these buildings to forested areas, bird collisions are still possible. Some recommendations are stated here (Sheppard & Phillips, 2015):

  o 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.

  o 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.

  o 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 (Green Development Standard, 2007). For example, for WindowAlert decals, it is recommended for decals to be 5cm apart horizontally and 10-cm apart vertically (FLAP, n.d.).

  o Avoid interior vegetation near windows as birds may confuse this with exterior vegetation and fly towards them.

  o Avoid planting vegetation close to glass so that reflection of vegetation does not confuse birds, which 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.

  o Buildings should not have courtyards or corridors that are enclosed by glass as these may confuse birds to fly through.

- Animals perceive light differently from humans. 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 (Voight et al., 2018; P-123). 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 (Blackwell et al., 2015; P-118). For example, ALAN may repel light-adverse bats from lit areas and restrict their use of commuting or feeding space. If night-time works are essential, it is recommended to adopt the following framework:

  o Prevent areas from being artificially lit, where lighting should only be installed when necessary.

  o Limit the duration of lighting, where peak nocturnal fauna activity is avoided.

  o 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 7-85; 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 (ILP, 2018).

  o 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 Kelvin.

o   Setting dark buffers, illuminance limits and zonation.

o   Species-specific strategies.

Figure 7-85 Low Level Bollards Directed Downwards and Shielded to Limit Lighting to Only the Area Intended
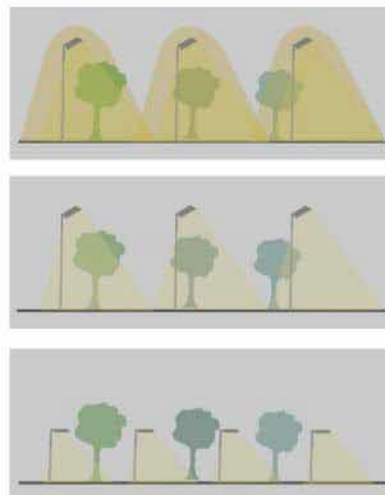
Figure 7-86 Combined Effect of Shielded Luminaires and Short Poles on Reducing Light Trespass. First Picture—Unshielded Luminaires, Second—Luminaires with Shield, Third—Shielded Luminaires on Short Poles which Cut-Off Light Trespass and Keep Adjacent Areas Dark.

7.9.1.1.3   *Minimisation (Engineering Controls) / Enhancement*

- Building should have no opening where fauna can be trapped. If there is any need for openings, meshing can be considered to be incorporated into the building's façade.

- Given that the development will still be near existing forest patches, it is important that the development is as green as possible. Besides making it aesthetically more pleasing, doing so might facilitate the

movement of fauna between green patches and might enhance biodiversity if implemented properly. This can be done via landscaping and planting on the reinstated areas.

- On the ground, considerations for increasing connectivity include:

  o Plant keystone flora such as fig trees. These trees have uncoordinated fruiting periods but fruit abundantly when in season. Fig trees are important food source for avian fauna and small mammals. In addition, planting of flowering plants will attract the pollinators such as butterflies, bees, wasps and improve ecological processes.

  o Increase vertical vegetation structures (i.e., ground cover, shrub, understorey and canopy layers) and forms (e.g., epiphytes, shrubs, ferns, trees).

  o Native plant species are highly recommended because they are genetically representative of the region's biodiversity and higher conservation value. Native plant specimens can be obtained from areas that will be cleared, planted back after works are completed. The transplantation should be carried out in consultation with NParks.

  o Select a diversity of flowering and fruiting plant species to include butterfly and bird attracting plant species. The planting palette should be planned for continuous flowering and fruiting throughout the year in order to provide food and improve ecological processes. However, planting location of bird attracting species should take into consideration bird collisions recommendations.

  o Prioritise greening along streets or in areas with low disturbances (e.g., low traffic volumes and speeds, low human activities).

7.9.1.1.4 *Remedy/ Repair/ Restore*

- A small section of the mitigated worksite is situated at the native-dominated secondary forest patch at Site II, which will shrink the width of the vegetated strip by one-third and introduce more edge effects. To minimise risk of habitat degradation, habitat fragmentation and maintain ecological connectivity, it is recommended to enhance the existing shrubland patches within the strip by planting trees and shrubs prior to the construction phase. The planting scheme should be as similar to forest composition to adjacent forest, if not as native as possible.

7.9.1.2 Holland Plain: Sites IV and V near Clementi Forest

7.9.1.2.1 *Elimination/ Avoidance*

- The worksite and road works are currently situated on areas of high conservation value (Figure 7-81). While it is recommended to shift the worksite away from high ecological value habitats: native-dominated secondary forest, scrubland and herbaceous vegetation and freshwater marsh, it remains difficult to avoid these areas due to the constraints of space and land use plan. Nonetheless, LTA has agreed to adjust the construction worksite to avoid impacting part of the native-dominated secondary forest which sits adjacent to Old Holland Road (Figure 7-87).

(A) CURRENT AND (B) RECOMMENDED DESIGN SHIFT IN CR15 WORKSITE AT HOLLAND PLAIN

Legend

Study Area

Vegetation
- Native-dominated secondary forest
- Abandoned-land forest
- Waste woodland
- Scrubland and herbaceous vegetation
- Managed vegetation
- Freshwater marsh
- Waterbody
- Others (infrastructure)

- Base Scenario Construction Worksite Footprint
- Proposed CRL Alignment (Base)
- Mitigated Scenario Construction Worksite Footprint
- Road works

N

Note: Source of basemap - Google Earth Map

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Qualified Person Endorsement : NA

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Consultant : **AECOM**

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Project Title :
CONTRACT CR2005 ENVIRONMENTAL IMPACT STUDY (TURF CITY AND HOLLAND PLAIN)

Figure Title :
(A) CURRENT AND (B) RECOMMENDED DESIGN SHIFT IN CR15 WORKSITE AT HOLLAND PLAIN

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7.9.1.2.2 *Minimisation (Substitution)*

- Similar to Sites I to III, strategies mentioned are also applicable at Sites IV and V (Section 7.9.1.1.2).

7.9.1.2.3 *Minimisation (Engineering Controls) / Enhancement*

- Similar to Sites I to III, strategies mentioned are also applicable at Sites IV and V (Section 7.9.2.1.1).

7.9.1.2.4 *Compensation / Offset*

- Given that the freshwater marsh will be almost completely lost with the mitigated station entrance footprint, it is recommended to compensate this impact with marsh creation in the vicinity of the existing marsh, which LTA has agreed to undertake. The created marsh should aim to provide ecosystem services equal to or succeed that performed by the existing marsh. The marsh creation plan should include both environmental (e.g., basin morphometry, suitable soil, hydrology) and biological (e.g., flora and fauna species) restoration, coupled with active monitoring and adaptive management. Some key considerations for the plan include:

    o In terms of timeline, the marsh creation programme must be done sufficiently before the clearance of the existing marsh to allow volant animals such as odonates to migrate over to the created marsh. This plan will also help minimise mortality of these animals, including those of conservation significance. As such, it is recommended that the marsh is constructed about two years prior to the construction of the entrance (which will directly affect the existing marsh). This duration includes a critical monitoring period, which should run monthly for at least one year, along with any necessary maintenance. Thereafter, clearance of the existing marsh can occur, and monitoring of the created marsh should continue monthly for at least five years (from the start of CR15 construction) or till the end of construction of the entrance.

    o In terms of personnel, adequate supervision by qualified experts: ecologists, landscape architects and hydrologists, during the critical phases of construction, monitoring and maintenance is necessary.

    o The created marsh should exhibit similar habitat and microclimate characteristics as the existing marsh, such as: size (0.34 ha), established tree line as hinterland and refugia for fauna, narrow upland buffer, shallow water, clay loam substrate, shady and open edges, uneven edges, submerged and emergent plants (e.g., *Eleocharis dulcis*, *Spathoglottis plicata*, *Ceratopteris thalictroides*) and snags for perching.

    o When constructing the marsh, the following items are some things to note:

        ▪ After excavation, depending on the topography and water table of the selected site, a pond lining may be required to retain appropriate water level conditions.

        ▪ Some degree of substrate stabilisation is necessary along the edges to prevent erosion, by using erosion control blankets (ECBs).

        ▪ To jumpstart the soil and flora establishment at the created marsh, some soil containing intact seedbank of the plant species, mature plants and organic matter from the existing marsh can be transferred to the restoration site. This translocation effort can also help to prevent significant loss of carbon into the atmosphere, that would have been expected during the clearance of the existing marsh. However, the sourcing should be done minimally and sensitively to avoid significant alteration of the existing marsh. Any gaps can be supplemented with nursery stocks. Planting should occur over the wet season to reduce in-situ desiccation.

        ▪ To mimic the characteristics of the existing marsh, a 5 m buffer of trees and shrubland should also be planted around the created marsh, where applicable.

    o During monitoring, fauna species richness (taxa should include minimally bees, odonates, birds, herpetofauna), plant and habitat establishment and water quality should be looked into at the created marsh. Comparisons with the EIS findings at the existing marsh should be made to determine fauna establishment, draw correlations with water quality parameters if any, make recommendations and perform maintenance works where necessary, in consultation with NParks. Should assisted reintroduction of fauna be necessary, a proper assessment of its feasibility should be done.

o   During the duration of CR15 construction, the created marsh should remain hoarded up to minimise impacts from adjacent construction on the marsh.

7.9.2   Mitigation in Construction Phase

Mitigation measures stated here should be relevant for all the Study Areas and enforced if applicable. Most of the mitigation measures stated have overlapping and cascading effects on other impacts. For example, by reviewing the construction footprint primarily reduces working space and the need for vegetation removal. Subsequently, this would also reduce other potential impacts such as habitat degradation, fauna and flora mortality, and the decline in species fitness and survival etc. Therefore, the relevant mitigation measures proposed should be implemented as good practice even if the impacts were evaluated as insignificant (i.e. Negligible or Minor).

7.9.2.1   Flora

7.9.2.1.1   *Elimination/ Avoidance*

- Ensure there are no works and disturbances to areas outside of worksite, especially into areas of high conservation value as shown in Section 7.5 (Sites I to III – Figure 7-80; Sites IV and V – Figure 7-81).

- Ensure any associated slope stabilisation and grading works will not impact topography of areas outside worksite and, water quality and hydrology of the waterbodies within the Study Area. The areas of high conservation value should be observed at all times

- Consider engaging arborists, flora and fauna specialists to clearly mark out areas and plants with conservation value before the start of works. This would minimise the working space, reduce the disturbance to adjacent forested areas and eliminate the need of removing specimens of value and plants of conservation significance as much as possible. It is important to conserve large trees and fruit trees as they serve important ecological processes and, provide habitat and food for faunal species. This includes trees with active bird's nest.

- To eliminate the need of removing bamboo clusters found within worksites as they are found to be potential roosting sites for the Critically Endangered bamboo bats (*Tylonycteris spp.*). Proper Tree Protection Zones (TPZs) should be established to ensure proper conservation of these bamboo clusters. This would apply specifically to the bamboo clusters recorded within Sites I (Section 7.3.1.3.12).

7.9.2.1.2   *Minimisation (Substitution, Engineering and Administrative Controls)*

- Transplant or harvest plant specimens of conservation significance (usually in the form of saplings) instead if they have to be cleared, e.g., the Recently Rediscovered fern ally, *Phlegmariurus carinatus*, near Sites I and II, and the Vulnerable pitcher plants, *Nepenthes rafflesiana* and *Nepenthes ampullaria*, and the uncommon hybrid *Nepenthes × trichocarpa* at the scrubland in Site V. The plants could be transplanted to other parts of the scrubland in Site V unaffected by current and future developments, but this is subjected to each specific site-suitability. Other suitable sites could also be identified and determined after discussions with NParks.

- Erect Tree Protections Zones to prevent encroachment of construction activities and excessive vegetation clearance around retained trees or areas (if any). For tembusu (*Cyrtophyllum fragrans*) in particular, TPZs must be at least 5 m in radius to avoid damaging any root structures.

- Conduct regular inspections to ensure the Contractor's compliance and identify any impacts to the adjacent forest areas.

7.9.2.2   Fauna

7.9.2.2.1   *Elimination/ Avoidance*

- It is recommended to avoid felling trees and clearing vegetation during the peak bird breeding season (March to July) as much as possible.

7.9.2.2.2   *Minimisation (Substitution, Engineering and Administrative Controls)*

- A small section of the mitigated worksite is situated at the native-dominated secondary forest patch at Site II which sits on a slope. As such, soil grading works there will likely result in more area impacted. Soil grading and its impacts on the surrounding patch can be limited with the use of earth retaining and stabilising structures (ERSS).

- Wildlife shepherding via directional clearing should be adopted over the usual site clearance (Table 7-53; Figure 7-124). This entails clearing the site from built up areas towards forested refuge areas to avoid trapping ground-dwelling mammals within the site. Additionally, it is crucial to ensure that hoarding be set up along worksite boundary adjacent to the road (if any) to prevent fauna from being displaced onto the road during the wildlife shepherding. This should be planned and overseen by an Ecologist.

- Pre-felling fauna inspection should be conducted before felling any trees or removing any vegetation. This should be planned and overseen by an Ecologist.

- Noisy work activities should only be allowed from 0900–1700-h.

- Above-ground works not critical for safety reasons should be avoided to prevent disturbance to nocturnal fauna; recommended to restrict working hours to 0700–1900-h. If night works are necessary, lighting strategies as mentioned in Section 7.9.1.1.2 should be adopted.

- Subsequently, if night-time works are essential, noise impacts from night work would need to be kept to the minimal as well. Measures should be adopted as specified in Section 11.8.

- At planned road works and other roads in the vicinity, it is also recommended to adopt road calming measures such as speed bumps, coupled with other mitigation measures such as restriction on speed of vehicles and working time (Figure 7-89). This can include sequencing of trucks leaving the worksite to reduce the number of trucks on the road at one time and the possible use of tri-axle trucks with larger capacity to reduce number of trips.

- 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 wildlife friendly (e.g. loose weave, non-welded mesh, rectangle (elongated) mesh) erosion control blankets (ECB) to avoid trapping fossorial fauna such as snakes.

- Train site personnel on biodiversity awareness and actions to take when encountering wildlife.

- Ensure good housekeeping controls such as provision of wildlife proof bins and eating areas.

- Execute fauna response—as specified in Appendix K—and rescue protocol when fauna is found on-site.

- Monitor the water quality and aquatic faunal community in retained streams and streams adjacent to the construction areas.

- Ensure silt fences or other silt control measures along the site hoarding are installed and maintained properly.

- 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 waterbodies.

- Engage a Qualified Erosion Control Professional (QECP) to formulate and implement ECM plan in accordance with PUB requirements.

- Implement dust control measures such as dust screens and water suppression systems as specified in Section 10.8.

- Implement acoustic barriers to reduce noise pollution outside worksites as specific in Section 11.8.

- Conduct regular site inspections to ensure the Contractor's compliance and to identify potential fauna entrapments.

Roadside wildlife crossing signages   Speedbumps

Figure 7-88 Examples of Road Calming Measures that Can be Implemented at Sites I to IV

Table 7-53 Direction of Clearing to be Adopted at Each Study Area

Worksite	Directional Of Clearing
CR14 (Sites I to III)	The development clearance of vegetation should be done in the direction towards the remaining forest patch south of the worksite. Information from previous environmental impact study conducted at Eng Neo Avenue Forest recorded several roadkill victims. Although these accidents occurred along Fairways Drive, this not only suggest that faunal species do frequent the edges of the forested areas, the similarity of Eng Neo Avenue Forest to Sites I to III also indicates the potential for such roadkill incidents to occur here. Therefore, hoarding should be set up around the worksite before commencing directional clearing to minimise the chances of roadkill accidents and prevent re-entry of faunal species.
CR15 (Sites IV and V)	The development clearance of vegetation should be done in the direction towards south of worksite, where the remaining forest patch is. Results from baseline studies and information from previous environmental impact study conducted in the vicinity indicates that the Study Area and forest in the vicinity is used by the Critically Endangered pangolin. Therefore, hoarding should be set up along the boundary of the worksite before commencing directional clearing to minimise the chances of roadkill accidents and prevent re-entry of faunal species.

HOLLAND PLAIN

Site IV

Site V

TURF CITY

Site III

Site II

Site I

0   100   200 m

Legend

- Study Area
- Worksite
- Road works
- → Direction of site clearance

Others (infrastructure)
Waterbody

Vegetation

- Native-dominated secondary forest
- Mixed forest
- Abandoned-land forest
- Waste woodland
- Scrubland and herbaceous vegetation
- Managed vegetation
- Freshwater marsh

N

Note: Source of basemap - Google Earth Map

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NA	**AECOM**		**Land Transport Authority** We Keep Your World Moving
	Project Title :	Figure Title :	
LTA Endorsement :	**CONTRACT CR2005 ENVIRONMENTAL IMPACT STUDY (TURF CITY AND HOLLAND PLAIN)**	**SHOWING DIRECTION OF CLEARING AT (A) TURF CITY AND (B) HOLLAND PLAIN**	
NA			

-	SEP 2022	JW	EIS (Turf City and Holland Plain)	JAG/NHT	JAG	Designed	Checked	Approved	Figure No. :	Rev.	Sheet
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Rev.	Date	By	Description	Chk'd	App'd	Drawn		Date	CAD File Name : NA		A3
						JW		SEP 2022			

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7.9.3   Mitigation in Operational Phase

Mitigation measures stated here should be relevant for all the Study Areas and enforced if applicable. However, most of the strategies for avoidance (elimination) and enhancement should have been considered during the design phase. Minimisation (substitution, engineering controls and administrative controls) would be the most applicable at the operational phase.

7.9.3.1   Flora

*   Areas not used should be returned to earth ground and replanted if possible. Planting scheme should be as similar to forest composition to adjacent forest, if not as native as possible. Other than minimising edge effects, it can serve as a natural barrier to light, noise, and dust to reduce disturbance. As a general guide, 400 trees should be replanted for every hectare to be reinstated.

*   Conduct regular site inspections at least during the first six (6) months of the commissioning phase to ensure that proposed planting/mitigating measures are effective and to identify any impacts to the adjacent forest areas.

7.9.3.2   Fauna

*   Conduct regular site inspections at least during the first six (6) months of the commissioning phase to ensure that proposed mitigating measures are effective and to identify any impacts to the adjacent forest areas. Key species such as the straw-headed bulbul (*Pycnonotus zeylanicus*), Sunda pangolin (*Manis javanica*) and the Sunda colugo (*Galeopterus variegatus*) should be monitored. This will contribute to evaluating the actual impact of the developments.

*   If any artificial lights are required at night (e.g., for pedestrian safety), wildlife friendly night lighting as mentioned in Section 7.9.1.1.2 should be adopted.

7.9.4   Mitigation Measures for Specific Fauna

Several threatened faunal species have been recorded at multiple Study Areas. These include the straw-headed bulbul (*Pycnonotus zeylanicus*), Sunda pangolin (*Manis javanica*) and Sunda colugo (*Galeopterus variegatus*). Broadly, mitigation measures to protect threatened faunal species include retaining habitats and food sources, maintenance/enhancement of ecological connectivity and promotion of wildlife-friendly building design. The mitigation measures for specific faunal species are listed below and should be applied at areas where they are recorded, on top of general mitigation measure that have been mentioned in the section above.

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 spp.* (LCKNHM, 2020b).
*   Include fruit and fig trees (known food sources) as part of the native planting palette when replanting the area in the operational phase.

Sunda pangolin

*   Retain large trees (3 0.5cm DBH) and fallen logs which are known to be used by the pangolin for their natal dens (Lim & Ng, 2007).

*   Pangolins are ground-dwelling animals and are hence highly susceptible to becoming roadkill. Given that pangolins have been recorded across Sites I and II, and are probable in Site III, all roads with planned road works should be lined to minimise the risk of roadkill during construction. The roads can be lined with hoarding, noise barriers, water barriers or road barriers, whichever applicable. Where the road barriers are used, they should be at least 0.5 m to 1 m in height, with overhang and be made with a smooth material to prevent pangolin from scaling it (Figure 7-90). The barriers will also be useful in minimising roadkill of snakes. In tandem with mitigation measures for the adjacent A1-W2 worksite [R-2; R-3] the strategic construction of culverts and barriers can help reduce injury or mortality for the pangolins, while still ensuring connectivity with surrounding viable forested areas.

> **Fencing design options.** (*Left*) On US Highway 441, Florida, a concrete barrier wall with lip limits access to roadways. (*Right*) Metal flashing is designed to funnel animals, especially reptiles and amphibians, to a highway crossing grate (photos by Marcel Huijser).

Figure 7-90 Recommended Temporary Road Barrier Design Along Planned Road Works (Source: Green Infrastructure Design for Transport Projects, Asian Development Bank, 2019)

Sunda colugo

- Include climbing pole structures and nets in large ECM tanks (Figure 7-91) to ensure colugos can avoid drowning and safely climb out if they fall in. In the event colugos are found in the ECM tanks, the Fauna Response and Rescue Plan will be activated immediately. This measure is applicable for Sites I, II and III, where colugos have been recorded within Site I and the surrounding forest patches.
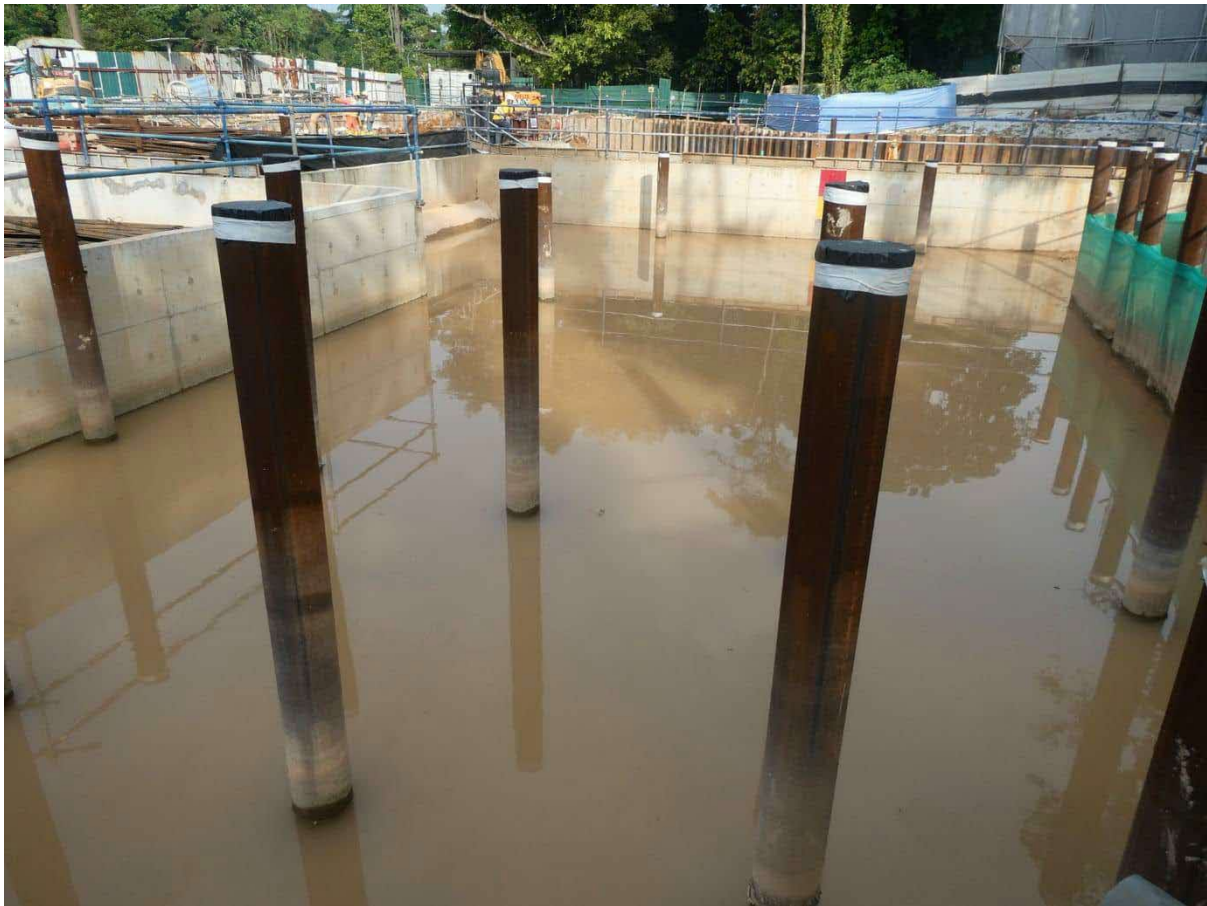
Figure 7-91 Example of pole structures and nets in an ECM tank as a mitigation measure for colugos

Bamboo bat

Translocation of specific species may be considered as a last measure if the original habitats cannot be retained (Figure 7-92). However, these measures are not considered to lower the impact significance of the works as the success rate of the translocation exercise cannot be secured as many environmental factors have to be considered and cannot be pre-determined. For example, the sex and number of individuals captured for the translocation exercise, finding similar habitat conditions which provide food and refuge for the species translocated and existing populations in the receptor sites, the stress that translocated individuals face and whether the individuals translocated return to the original habitats which are meant to be cleared.

Figure 7-92 Photos Showing the Prototype of An Example Bat Internode Roost that Bamboo Bats Will be Translocated to

7.10 Residual Impacts

Impacts evaluated to have major and moderate significance in Section 7.8 were addressed with appropriate mitigation measures to help reduce the impact as much as possible. However, the significance of certain impacts such as site clearance (resulting in vegetation and habitat loss) remains as major because it is a permanent and irreversible impact that cannot be mitigated. Hence, the greatest impact significance of proposed developments at some of the Study Areas are still expected to be major/moderate.

7.10.1 Construction Phase

7.10.1.1 Turf City: Sites I, II and III near Eng Neo Avenue Forest

7.10.1.1.1 *Habitats*

The most substantive Base Scenario impact significance of the proposed development during the construction phase is expected to be Major (refer to Section 7.8.1.1.1). After mitigation measures are applied, the overall impact significance from habitat loss during the construction phase will be reduced to mainly **Moderate**. Though majority impact significance levels are already reduced, it is still recommended to adopt the mitigation measures where applicable. Refer to Table 7-54 for residual impact significance after application of mitigation measures during the construction phase.

Table 7-54 Residual Impact Significance after the Implementation of Proposed Mitigation Measures at Sites I to III during the Construction Phase

Impact Type	Receptor	Base Scenario Impact Significance	Mitigation Measures	Mitigated Scenario Impact Significance
Loss Of Vegetation	Native-dominated Secondary Forest (Priority 1)	**Major**	• By adopting the optimisation of worksite (Section 7.9.1.2.1), there would be more than half reduction in habitat clearance (due to a shift in worksite), resulting in reduced impact significance for most habitats under Mitigated Scenario.	**Moderate**
	Mixed Forest (Priority 1)	**Major**		**Moderate**
	Abandoned-land Forest (Priority 2)	Minor		Negligible
	Waste Woodland (Priority 2)	**Major**		**Major**
	Scrubland and Herbaceous	**Moderate**		Minor

Impact Type	Receptor	Base Scenario Impact Significance	Mitigation Measures	Mitigated Scenario Impact Significance
	Vegetation (Priority 2)			
	Managed Vegetation (Priority 3)	Negligible		Negligible
	Waterbody D/S8 (Priority 2)	**Major**		**Moderate**
Habitat Degradation	Native-dominated Secondary Forest (Priority 1)	Minor	• Monitor the water quality and aquatic faunal community in retained streams and streams adjacent to the construction areas.	Minor
	Mixed Forest (Priority 1)	Minor		Minor
	Abandoned-land Forest (Priority 2)	Negligible	• Retain ground cover for as long as possible. When ground cover is removed, erosion control measures are to be in place.	Minor[1]
	Waste Woodland (Priority 2)	Minor	• 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 waterbodies.	Minor
	Scrubland and Herbaceous Vegetation (Priority 2)	Minor		Minor
	Managed Vegetation (Priority 3)	Negligible	• Engage a qualified erosion control professional to formulate and implement ECM plan in accordance with pub requirements.	Negligible
	Waterbody D/S8 (Priority 2)	Minor	• Conduct regular inspections to ensure the Contractor's compliance and identify any impacts/unnecessary clearance in adjacent forest areas. • Conduct regular biodiversity surveys to monitor the flora and faunal community in retained and forest adjacent to the construction areas. Applying the above mitigation strategies together with design recommendations, impact significance can be maintained at negligible/minor for Mitigated Scenario.	Minor
Change In Species Composition	Native-dominated Secondary Forest (Priority 1)	**Moderate**	• Conduct regular inspections to ensure the Contractor's compliance and identify any impacts/unnecessary clearance in adjacent forest areas. • Conduct regular biodiversity surveys to monitor the flora and faunal community in retained and forest adjacent to the construction areas. Applying the above mitigation strategies together with design recommendations, impact significance can be reduced from	Minor
	Mixed Forest (Priority 1)	Negligible		Negligible
	Abandoned-land Forest (Priority 2)	Negligible		Negligible
	Waste Woodland (Priority 2)	Minor		Minor
	Scrubland and Herbaceous Vegetation (Priority 2)	Minor		Minor

Impact Type	Receptor	Base Scenario Impact Significance	Mitigation Measures	Mitigated Scenario Impact Significance
	Managed Vegetation (Priority 3)	Negligible	moderate to minor for Mitigated Scenario.	Negligible
	Waterbody D/S8 (Priority 2)	Minor		Minor

[1]**Compared to the base scenario construction worksite** which subsumed all abandoned-land forest, **the mitigated scenario will** exclude majority of the abandoned-land forest, which is hence susceptible to indirect impacts like **habitat degradation.**

7.10.1.1.2 *Plant Species*

For the 94 plant species recorded from Sites I to III and selected for the assessment of ecological impacts, the most substantive impacts during the construction phase before mitigation measures were theoretically implemented are Major for 17 species, Moderate for 23 species and Minor for the remaining 54 species. Following the implementation of mitigation measures, the most severe impacts were reduced to **Major** for five species, **Moderate** for 30 species, **Minor** for 52 species and **Negligible** for seven species.

Five species are likely to experience **Major** impact significance after mitigation, due to mortality. These five species are all of high sensitivity, of which three are of conservation significance and one a bamboo species (*Thyrsostachys siamensis*) having association with important fauna (bamboo bats). The impact intensity of mortality for five species including *Actinodaphne macrophylla, Ficus glandulifera, Ficus religiosa, Sterculia macrophylla* and *Thyrsostachys siamensis* was medium or high as at least 50% of their specimens are present in the mitigated construction worksite. This gives an impact significance of Major for mortality.

Thirty species are likely to experience **Moderate** impact significance after mitigation, mainly owing to mortality, competition from exotic species and decline in plant health and survival. Twenty-eight species are of conservation significance and hence high sensitivity, while two species *Commersonia bartramia* and *Gliricidia sepium* are of medium and low sensitivity, respectively. These two species had an overall moderate impact due to competition from exotic species and decline in plant health and survival as the only specimen recorded falls within 30 m from the proposed mitigated construction worksite, thus giving an impact intensity of high.

Majority (52 out of 94) of the plant species are likely to experience **Minor** impact significance after mitigation as a result of impediment to seedling recruitment, competition from exotic species and decline in plant health and survival. Most do not have any or have less than 50% of specimens located inside or within 30 m from the mitigated worksite.

The seven species likely to experience **Negligible** impact significance from all four impact types are *Arthrophyllum diversifolium, Delonix regia, Dillenia* sp*., Litsea elliptica, Ixonanthes reticulata, Rhodamnia cinerea* and *Vitex pinnata*. As the mitigated worksite is expected to affect fewer or no specimens from these species listed above (except for *Dillenia* sp.), the impact of mortality is negligible.

In general, the severity of impacts has reduced as the proposed mitigated worksites have reduced in size, thus affecting a smaller portion of the Study Area and resulting in fewer species likely to experience Major or Moderate impact significance.

7.10.1.1.3 *Faunal Species*

The most substantive Base Scenario impact significance from Eng Neo Avenue Forest during the construction phase is **Major**. After mitigation measures, in particular the shift and reduction of worksite size, impacts have largely been reduced to **Moderate** during construction phase but remains **Major** for the bamboo bats (*Tylonycteris sp.*) as road works will still impact the bamboo clusters. The mitigated worksite would also act as a barrier and further fragment the forested areas in the north of Site III with Sites I and II, thereby possibly resulting in some loss of connectivity for the forest-dependent animals during construction phase.

7.10.1.2 **Holland Plain: Sites IV and V near Clementi Forest**

7.10.1.2.1 *Habitats*

The most substantive Base Scenario impact significance of the proposed development during the construction phase is expected to be **Major** (refer to Section 7.8.1.2.1). After mitigation measures are applied, the overall impact

significance of habitat loss during the construction phase is still **Major** due to the small difference between the base and mitigated worksite footprint – a result of limited land constraints and land use plan. Nonetheless, mitigation measures will be in place to help compensate for the loss of some habitats like the freshwater marsh. Refer to Table 7-55 for residual impact significance after application of mitigation measures during the construction phase.

Table 7-55 Residual Impact Significance after the Implementation of Proposed Mitigation Measures at Sites IV and V during the Construction Phase

Impact Type	Receptor	Base Scenario Impact Significance	Mitigation Measures	Mitigated Scenario Impact Significance
Loss Of Vegetation	Native-dominated Secondary Forest (Priority 1)	**Major**	• By adopting the optimisation of worksite (Section 7.9.1.2.1), habitat clearance is still significant, resulting in similar impact significance for Mitigated Scenario.	**Major**
	Abandoned-land Forest (Priority 2)	**Major**		**Major**
	Waste Woodland (Priority 2)	**Moderate**		**Moderate**
	Scrubland and Herbaceous Vegetation (Priority 1)	**Major**		**Major**
	Managed Vegetation (Priority 3)	**Moderate**		**Moderate**
	Freshwater Marsh (Priority 1)	**Major**		**Major**
	Waterbody Pond (Priority 2)	**Major**		**Major**
Habitat Degradation	Native-dominated Secondary Forest (Priority 1)	Minor	• Monitor the water quality and aquatic faunal community in retained streams and streams adjacent to the construction areas. • Retain ground cover for as long as possible. When ground cover is removed, erosion control measures are to be in place. • 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 waterbodies. • Engage a qualified erosion control professional to formulate and implement ECM plan in accordance with PUB requirements. • Conduct regular inspections to ensure the Contractor's compliance and identify any impacts/unnecessary clearance in adjacent forest areas. • Conduct regular biodiversity surveys to Monitor the flora and faunal community in retained and forest adjacent to the construction areas.	Minor
	Abandoned-land Forest (Priority 2)	Negligible		Minor[1]
	Waste Woodland (Priority 2)	Minor		Minor
	Scrubland and Herbaceous Vegetation (Priority 1)	Minor		Minor
	Managed Vegetation (Priority 3)	N.A.		Negligible[2]
	Freshwater Marsh (Priority 1)	N.A.		N.A.

Impact Type	Receptor	Base Scenario Impact Significance	Mitigation Measures	Mitigated Scenario Impact Significance
	Waterbody Pond (Priority 2)	N.A.	Applying the above mitigation strategies together with design recommendations, impact significance can be reduced from moderate to minor for Mitigated Scenario.	N.A.
Change In Species Composition	Native-dominated Secondary Forest (Priority 1)	**Moderate**	• Adopting a smaller worksite, would also result in a smaller area of adjacent forest edge being affected by edge effects. • Conduct regular inspections to ensure the Contractor's compliance and identify any impacts/unnecessary clearance in adjacent forest areas. • Conduct regular biodiversity surveys to monitor the flora and faunal community in retained and forest adjacent to the construction areas. Applying the above mitigation strategies together with design recommendations, impact significance can be reduced from moderate to minor for Mitigated Scenario.	Minor
	Abandoned-land Forest (Priority 2)	Minor		Minor
	Waste Woodland (Priority 2)	**Moderate**		Minor
	Scrubland and Herbaceous Vegetation (Priority 1)	**Moderate**		Minor
	Managed Vegetation (Priority 3)	N.A.		Negligible[2]
	Freshwater Marsh (Priority 1)	N.A.		N.A.
	Waterbody Pond (Priority 2)	N.A.		N.A.

[1] **As compared to the base scenario construction footprint, the mitigated scenario will result in more** areas of **the abandoned-land forest patch** susceptible to habitat degradation.

[2] **As compared to the base scenario construction footprint which subsumed all managed vegetation, the mitigated scenario ll exclude a small portion of the managed vegetation habitat, which is hence susceptible to indirect impacts like** habitat **degradation and change inn species composition.**

7.10.1.2.2 *Plant Species*

For the 48 plant species recorded from Site IV and V and selected for the assessment of ecological impacts, the most severe impacts during the construction phase before mitigation measures were theoretically implemented are Major for 28 species, Moderate for 13 species, and Minor for seven species. Following the implementation of the proposed mitigation measures, the most severe impacts are **Major** for 17 species, **Moderate** for 21 species and **Minor** for 10 species.

Seventeen species are likely to experience **Major** impacts due to mortality even after mitigation. Out of these 17 species, 14 species are likely to experience high impact intensity from mortality as all (100%) of the specimens of those species are within the mitigated worksite area. This includes *Bambusa vulgaris*, a species of bamboo accorded with high sensitivity as the bamboo clusters are potential roost sites for the nationally threatened bamboo bats (*Tylonycteris* sp.).

Eleven species had their residual impact significance as a result of mortality reduced from Major to **Moderate** as the modified worksite impacted fewer specimens or did not directly impact specimens.

The three species that had the impact significance reduced to **Minor** are *Cyrtophyllum fragrans, Nepenthes gracilis* and *Syzygium grande.* For *Syzygium grande,* its residual impact reduced from Major to **Minor** as the specimens are outside the mitigated worksite (and within 30 m from the proposed mitigated worksite instead). For *Cyrtophyllum fragrans* and *Nepenthes gracilis,* residual impact significance dropped from Moderate to **Minor**. After mitigation, *Cyrtophyllum fragrans* has 30% of its specimen within the mitigated worksite as compared to 97% of its specimens

within the base worksite, thus reducing impact intensity of mortality from medium to low. *Nepenthes gracilis* is of high sensitivity. With the mitigated worksite, the percentage of specimens within the worksite decreased from 14% to 0%, hence the impact intensity of mortality is reduced from low to negligible.

7.10.1.2.3 *Faunal Species*

As the mitigated worksite footprint does not significantly avoid the habitats, the impact significance of habitat loss remains **Moderate** to **Major**. Nonetheless, with mitigation measures in place, accidental injury or mortality during construction phase for the red junglefowl (Gallus gallus), red-legged crake (*Rallina fasciata*) and Sunda pangolin (*Manis javanica*) is reduced from Moderate to Minor.

7.10.2 Operational Phase

7.10.2.1 Turf City: Sites I, II and III near Eng Neo Avenue Forest

7.10.2.1.1 *Habitats*

The most substantive Base Scenario impact significance of the proposed development during the operational phase is expected to be Minor. After mitigation measures are applied, the significance of the residual impacts has remained generally at **Minor**. Refer to table below for residual impact significance after application of mitigation measures during the operational phase.

Table 7-56 Residual Impact Significance after the Implementation of Proposed Mitigation Measures at Sites I to III during the Operational Phase

Impact Type	Receptor	Base Scenario Impact Significance	Mitigation Measures	Mitigated Scenario Impact Significance
Habitat Degradation	Native-dominated Secondary Forest (Priority 1)	Minor	At the operational stage, not much habitat degradation impacts will be experienced by the habitats present. Impacts will mainly come from the regular and ad-hoc maintained works. As long as minimum controls and mitigation measures mentioned in Section 7.9.3 are applied, impact significance would remain at minor.	Minor
	Mixed Forest (Priority 1)	Minor		Minor
	Abandoned-land Forest (Priority 2)	Minor		Minor
	Waste Woodland (Priority 2)	Minor		Minor
	Scrubland and Herbaceous Vegetation (Priority 2)	Minor		Minor
	Managed Vegetation (Priority 3)	Negligible		Negligible
	Waterbody D/S8 (Priority 2)	Minor		Minor
Change In Species Composition	Native-dominated Secondary Forest (Priority 1)	Minor	At the commissioning phase, the following should be adopted: • Conduct regular inspections (at least 6 months) to identify any impacts/unnecessary clearance in adjacent forest areas. • Conduct regular biodiversity surveys (at least 6 months) to monitor the flora and faunal community in retained and forest adjacent to the construction areas. Applying the above mitigation strategies together with design recommendations, impact significance can be maintained at Negligible to Minor for Mitigated Scenario.	Minor
	Mixed Forest (Priority 1)	Minor		Minor
	Abandoned-land Forest (Priority 2)	Negligible		Negligible
	Waste Woodland (Priority 2)	Negligible		Negligible
	Scrubland and Herbaceous Vegetation (Priority 2)	Negligible		Negligible
	Managed Vegetation (Priority 3)	Negligible		Negligible

Impact Type	Receptor	Base Scenario Impact Significance	Mitigation Measures	Mitigated Scenario Impact Significance
	Waterbody D/S8 (Priority 2)	Negligible		Negligible

7.10.2.1.2 *Plant Species*

For the 94 plant species recorded from Sites I to III and selected for the assessment of ecological impacts, the most severe impacts during the operational phase before mitigation measures were theoretically implemented are Moderate for 77 species and Minor for the remaining 17 species. The species are likely to experience moderate impacts due to competition from exotic plant species. Following the implementation of mitigation measures, the impacts on plant species will theoretically reduce to **Moderate** for 1 species and **Minor** for the remaining 93 species.

The species with **Moderate** residual impact due to mortality is *Bulbophyllum vaginatum,* a nationally Endangered epiphytic orchid. It is a native species of high ecological value (High sensitivity). Works occurring at the operational phase are likely to result in medium impact intensity for this plant species as more than 50% of the orchid specimens could be poached. The likelihood is Likely (reduced from Almost certain) as orchids are charismatic species and are known to get poached by members of the public, but the area in general will not be very accessible to the public. This gives a resulting **Moderate** residual impact significance for mortality.

The residual impact significance of 93 species is **Minor** as a result of competition from exotic species. After implementation of mitigation measures, the theoretical likelihood of competition from exotic species is less likely as using a native planting palette for landscaping is one of the recommended mitigation measures during the operational phase. If this mitigation measure is implemented appropriately, the resulting impact significance would be **Minor** for majority of the species.

7.10.2.1.3 *Faunal Species*

Due to the mitigation measures put in place such as replanting, we expect the impact significance for the loss of connectivity on the straw-headed bulbul (*Pycnonotus zeylanicus*) and the bamboo bat (*Tylonycteris sp.*) during the operational phase to be reduced from Major to **Negligible**. Overall, the impact significance of all faunal species during operational phase was reduced to **Minor** or **Negligible**.

7.10.2.2   Holland Plain: Sites IV and V near Clementi Forest

7.10.2.2.1   *Habitats*

The most substantive Base Scenario impact significance of the proposed development during the operational phase is expected to be Minor. After mitigation measures are applied, the significance of the residual impacts has generally remained at **Minor**. Refer to Table 7-57 for residual impact significance after application of mitigation measures during the operational phase.

Table 7-57 Residual Impact Significance after the Implementation of Proposed Mitigation Measures at Sites IV to V during the Operational Phase

Impact Type	Receptor	Base Scenario Impact Significance	Mitigation Measures	Mitigated Scenario Impact Significance
Habitat Degradation	Native-dominated Secondary Forest (Priority 1)	Minor	At the operational stage, not much habitat degradation impacts will be experienced by the habitats present. Impacts will mainly come from the regular and ad-hoc maintained works. As long as minimum controls and mitigation measures mentioned in Section 7.9.3 are applied, impact significance would remain at minor.	Minor
	Abandoned-land Forest (Priority 2)	Minor		Minor
	Waste Woodland (Priority 2)	Minor		Minor
	Scrubland and Herbaceous Vegetation	Minor		Minor

Impact Type	Receptor	Base Scenario Impact Significance	Mitigation Measures	Mitigated Scenario Impact Significance
	(Priority 1)			
	Managed Vegetation (Priority 3)	N.A.		Negligible[1]
	Freshwater Marsh (Priority 1)	N.A.		N.A.
	Waterbody Pond (Priority 2)	N.A.		N.A.
Change In Species Composition	Native-dominated Secondary Forest (Priority 1)	Minor	At the commissioning phase, the following should be adopted: • Conduct regular inspections (at least 6 months) to identify any impacts/unnecessary clearance in adjacent forest areas. • Conduct regular biodiversity surveys (at least 6 months) to monitor the flora and faunal community in retained and forest adjacent to the construction areas. Applying the above mitigation strategies together with design recommendations, impact significance can be maintained at Negligible to Minor for Mitigated Scenario.	Minor
	Abandoned-land Forest (Priority 2)	Minor		Minor
	Waste Woodland (Priority 2)	Minor		Minor
	Scrubland and Herbaceous Vegetation (Priority 1)	Minor		Minor
	Managed Vegetation (Priority 3)	N.A.		Negligible[1]
	Freshwater Marsh (Priority 1)	N.A.		N.A.
	Waterbody Pond (Priority 2)	N.A.		N.A.

[1]**As compared to the base scenario footprint which subsumed all managed vegetation, the mitigated scenario will exclude a small portion of the managed vegetation habitat, which is hence susceptible to indirect impacts like habitat degradation and change in species composition.**

7.10.2.2.2 *Plant Species*

For the 48 plant species recorded from Site IV and V and selected for the assessment of ecological impacts, the most severe impacts during the construction phase before mitigation measures were theoretically implemented are Major for two species, Moderate for 32 species, and Minor for 14 species. Following the implementation of mitigation measures, the impacts on plant species will theoretically reduce to **Major** for 2 species and **Minor** for the remaining 46 species.

The two species likely to experience **Major** residual impact for mortality are *Nepenthes gracilis* and *Nepenthes ampullaria*, which are the same two species likely to experience Major impact before mitigation. As both species of pitcher plants are known to be stolen most of the time and all plant specimens of these two species could be stolen, the impact intensity for mortality is high with an almost certain likelihood of this taking place, resulting in **Major** residual impact.

Majority (46 out of 48) of the species are likely to experience **Minor** impacts as a result of competition from exotic plant species. As these species are native, the impact intensity due to competition from exotic species remains high, but the impact likelihood was reduced to Less likely because of expected landscaping and retention of only some original vegetation. Using a native planting palette for landscaping is one of the recommended mitigation measures during the operational phase. If this mitigation measure is implemented appropriately, the resulting impact significance would be **Minor** to **Negligible** for majority of the species. Of these, the same 14 species identified in pre-mitigation impact assessment are likely to experience **Minor** impacts due to mortality. It is expected that less than 50% of these plant specimens could be poached by members of the public, hence giving an impact

intensity of low. Given that these species are flowering species known to be stolen, the impact likelihood is Possible, resulting in an impact significance of **Minor**.

7.10.2.2.3 *Faunal Species*

The most substantive Base Scenario impact significance of the proposed development during the operational phase is expected to be Moderate due to collisions with buildings and injury/mortality. After mitigation measures are applied, the impact significance for the affected species during the operational phase is expected to reduce to **Minor**.

7.11   Cumulative Impacts from Other Major Concurrent Development

- This section assessed the cumulative impacts from major concurrent developments in the vicinity of the Study Areas. Cumulative impacts will be discussed qualitatively and given four general levels of assessment:

-
1. **No/negligible impacts** – No significant impacts from concurrent developments

2. **Minor impacts** – Minor impacts incurred from concurrent developments that may result in short duration and small-scale localised spatial changes that could cause minimal changes to species population

3. **Moderate impacts** – Moderate impacts incurred from concurrent developments that may result in moderate duration and medium-scale localised spatial changes that could cause moderate reduction in size of species population but would not threaten species long-term viability

4. **Major impacts** – Major impacts incurred from concurrent developments that may result in extended duration and large-scale localised spatial changes that could cause substantial reduction in size of species population but threaten species long-term viability

- Subsequently, it is important to note that cumulative impacts are considered after mitigations measures applied. The list and description of concurrent developments can be found in Section 3.4.1.

7.11.1   Construction Phase

7.11.1.1   Turf City: Sites I, II and III near Eng Neo Avenue Forest

A1-W2 construction works at Site I will commence in the first quarter of 2023 up till third quarter of 2028, which will overlap with timeline for the construction of CR14. A temporary access road will also be constructed on the existing road separating Sites I and II to aid A1-W2 construction works. Note, that an EIA for A1-W2 has been conducted separately

Impacts to habitats and flora: A1-W2 construction works should have **negligible/minor cumulative impacts** as it occurs on the eastern edge of Site I, particularly on managed vegetation.

Impacts to fauna: Similarly, there should **negligible/minor cumulative impacts** incurred by A1-W2 as it occurs on the managed vegetation of Site I, and mitigation measures including culverts and barriers along the temporary access road will be in place. The culverts and barriers are aimed at preventing roadkill of ground-dwelling animals like the pangolins at Sites I and II.

7.11.1.2   Holland Plain: Sites IV and V near Clementi Forest

The only ongoing works at Sites IV and V will be the construction of the road network to serve the future Holland Plain development. The works will include road widening of existing roads and pavement, including Old Holland Road and Blackmore Drive, which overlaps with the road works for the construction of CR15. Other ongoing works in the vicinity include the construction of CR16, but it is more than 200 m away from the sites and separated by Clementi Forest.

Impacts to habitats and flora: road network construction works should have **negligible/minor cumulative impacts** as it occurs on the edge of the sites, and impacts on sensitive receptors have already been assessed for CR15.

Impacts to fauna: Similarly, there should **negligible/minor cumulative impacts** incurred by the road network construction as it occurs on the edge of the sites, and impacts on sensitive receptors have already been assessed for CR15.

7.11.2   Operational Phase

7.11.2.1   Turf City: Sites I, II and III near Eng Neo Avenue Forest

No concurrent major development in the vicinity.

Agencies are currently studying plans for future development within the area and a separate environmental study is being conducted for these.

7.11.2.2   Holland Plain: Sites IV and V near Clementi Forest

No concurrent major development in the vicinity.

7.12   Summary of Key Findings

7.12.1   Turf City: Sites I, II and III near Eng Neo Avenue Forest

Sites I, II and III near Eng Neo Avenue Forest collectively comprise seven habitat types, namely (1) native-dominated secondary forest, (2) abandoned-land forest, (3) mixed forest, (4) waste woodland, (5) scrubland and herbaceous vegetation, (6) managed vegetation, and (7) waterbody. The remaining areas are occupied by infrastructure. A total of 270 and 128 plant species were recorded in Sites I and II, as well as Site III, respectively. Of these, 54 and 17 species are of conservation significance. The floristic assemblage is largely native. Many species found in the native-dominated secondary forest can also be found in the CCNR and are less commonly encountered in other secondary forests in Singapore. Some species associated with older forests that are even rare in the Nee Soon Swamp Forest (NSSF) were also recorded in the Study Area. This has contributed to the high overall native species richness at the site, a feature characteristic of late-successional forests in Singapore. Nationally threatened specimens are widespread and occur in high numbers, and large parent trees also occur in the Study Area.

The field assessment documented 197 species, dominated by birds (71 species) and butterflies (38 species). A total of 16 species of conservation significance were recorded, scattering across the Study Area. These species, such as the globally threatened straw-headed bulbul (*Pycnonotus zeylanicus*) and red junglefowl (*Gallus gallus*), were generally distributed throughout the Study Area, with more recorded in Sites I and II than in Site III. Notably, species such as the Sunda pangolin (*Manis javanica*) was recorded throughout Sites I and II. The forest-dependent Sunda colugo (*Galeopterus variegatus*) was also found in Site I. Along the waterbodies, only the waterbody in Site I, D/S16, recorded a fish species of interest, the common walking catfish (*Clarias cf. batrachus*). The waterbody at Site III recorded mainly non-native fish, alongside common amphibians and odonates.

Given the site's proximity to the Central Catchment Nature Reserve and Eng Neo Avenue Forest, the entire Study Area provides important forest connectivity between the larger forest patches to the north and to the east (Eng Neo Avenue Forest), which allows for the dispersal of flora and fauna. The native-dominated secondary forest and mixed forest in particular, were found to be rich in plant species of conservation significance, while the Sunda pangolin (*Manis javanica*) was found to be utilising the entire Study Area. Hence, the majority of the Study Area, i.e., all contiguous vegetated areas of Sites I and II, consisting of native-dominated secondary forest, mixed forest, abandoned-land forest and scrubland and herbaceous vegetation, as well as the native-dominated secondary forest in Site III are regarded as of high ecological value. The waterbodies (D/S15 and D/S16) are also included as part of the areas of high conservation value.

7.12.2   Holland Plain: Sites IV and V near Clementi Forest

Sites IV and V near Clementi Forest collectively comprise seven habitat types, namely (1) native-dominated secondary forest, (2) abandoned-land forest, (3) waste woodland, (4) scrubland and herbaceous vegetation, (5) managed vegetation, (6) freshwater marsh, and (7) waterbody. The remaining areas are occupied by infrastructure. A total of 229 plant species were recorded, of which 17 are of conservation significance. One of the key habitat findings is the freshwater marsh, an extensive and value patch of wetland which occupies approximately 3% of Sites IV and V. The aquatic plants that inhabit the marshland and the mature trees that surround the area contribute to the uniqueness of the habitat, which is also is an especially good site for odonate species not easily found elsewhere in Singapore. The odonate assemblage is made up of up to 21 species, including marsh-specialists like the crenulated spreadwing (*Lestes praemorsus*) and the nationally Endangered restless demon (*Indothemis limbata*).

Additionally, the extensive patch of scrubland in Site V is one of the last remaining refugia for the native pitcher plants (and the associated fauna) outside the nature reserves in Singapore. Dominated by the resam fern (*Dicranopteris linearis*), the vegetation is one of the most important habitats for *Nepenthes* species in Singapore, which are carnivorous pitcher plants that attract and capture animal prey. Large populations of up to four native *Nepenthes* species occur here, of which two are nationally threatened and one is a rare native hybrid.

The carnivorous plants are also associated with important and rare fauna, such as specialist crab spiders that inhabit pitcher plants, and a resident butterfly species, the pitcher blue (*Virachola kessuma deliochus*). The butterfly caterpillar host plants are the nationally Common *N. gracilis* and Vulnerable *N. rafflesiana*, both of which have been recorded in this area. This butterfly species is rare and its distribution restricted to the host plant distribution.

A total of 160 species were recorded during surveys of fauna, of which most were dominated by birds (71 species) and odonates (29 species). Of these, 11 species are of conservation significance. These include the globally

Critically Endangered straw-headed bulbul (*Pycnonotus zeylanicus*), nationally Critically Endangered ruddy kingfisher (*Halcyon coromanda*), and nationally Endangered red-wattled lapwing (*Vanellus indicus*). Other noteworthy findings include the Sunda pangolin (*Manis javanica*) recorded at Site V.

The close proximity of Sites IV and V to the CCNR and the adjacent Clementi Forest, allows the former to serve as additional refugia for rare or forest-dependent species. Records of important terrestrial fauna such as the globally and nationally Critically Endangered Sunda Pangolin (*Manis javanica*) and rare pitcher plant hybrids suggest the importance of these sites as habitats for flora and fauna. The native-dominated secondary forest patches, the freshwater marsh, and the scrubland and herbaceous vegetation where the pitcher plants were found are all regarded as areas of high ecological value and recommended for conservation.

Table 7-58 Summary of Biodiversity Impact Assessment

Potential Source of Impact	Impact Significance with Minimum Controls	Residual Impact Significance with Mitigation Measures (if required)
Construction Phase		
Sites I, II and III	Habitats: Native-dominated secondary forest: Major Mixed forest: Major Abandoned-land forest: Minor Waste woodland: Major Scrubland and herbaceous vegetation: Moderate Managed vegetation: Minor Waterbody (D/S8): Major Flora (94 species): Major: 17 Moderate: 23 Minor: 54 Negligible: 0 Fauna (16 species): Major: 4 Moderate: 12 Minor: 0 Negligible: 0	Habitats: Native-dominated secondary forest: **Moderate** Mixed forest: **Moderate** Abandoned-land forest: Minor Waste woodland: **Major** Scrubland and herbaceous vegetation: Minor Managed vegetation: Negligible Waterbody (D/S8): **Moderate** Flora (94 species): **Major**: 5 **Moderate**: 30 Minor: 52 Negligible: 7 Fauna (16 species): **Major**: 1 **Moderate**: 5 Minor: 10 Negligible: 0
Site IV and V	Habitats: Native-dominated secondary forest: Major Abandoned-land forest: Major Waste woodland: Moderate Scrubland and herbaceous vegetation: Major Freshwater marsh: Major Managed vegetation: Moderate Waterbody (pond): Major Flora (48 species): Major: 28 Moderate: 13 Minor: 7 Fauna (11 species): **Major**: 2 **Moderate**: 9	Habitats: Native-dominated secondary forest: **Major** Abandoned-land forest: **Major** Waste woodland: **Moderate** Scrubland and herbaceous vegetation: **Major** Freshwater marsh: **Major** Managed vegetation: **Moderate** Waterbody (pond): **Major** Flora (48 species): **Major**: 17 **Moderate**: 21 Minor: 10 Fauna (11 species): **Major**: 2 **Moderate**: 9
Operational Phase		

Potential Source of Impact	Impact Significance with Minimum Controls	Residual Impact Significance with Mitigation Measures (if required)
Sites I, II and III	Habitats: Native-dominated secondary forest: Minor Mixed forest: Minor Abandoned-land forest: Minor Waste woodland: Minor Scrubland and herbaceous vegetation: Minor Managed vegetation: Negligible Waterbody (D/S8): Minor Flora (94 species): Moderate: 77 Minor: 17 Fauna (16 species): Major: 2 Moderate: 7 Minor: 5 Negligible: 2	Habitats: Native-dominated secondary forest: **Minor** Mixed forest **Minor** Abandoned-land forest: **Minor** Waste woodland: **Minor** Scrubland and herbaceous vegetation: **Minor** Managed vegetation: **Negligible** Waterbody (D/S8): **Minor** Flora (94 species): **Moderate**: 1 Minor: 93 Fauna (16 species): Major: 0 Moderate: 0 Minor: 14 Negligible: 2
Sites IV and V	Habitats: Native-dominated secondary forest: Minor Abandoned-land forest: Minor Waste woodland: Minor Scrubland and herbaceous vegetation: Minor Freshwater marsh: N.A. Managed vegetation: N.A. Waterbody (pond): N.A. Flora (48 species): Major: 2 Moderate: 32 Minor: 14 Fauna (11 species): Major: 0 Moderate: 4 Minor: 6 Negligible: 1	Habitats: Native-dominated secondary forest: Minor Abandoned-land forest: Minor Waste woodland: Minor Scrubland and herbaceous vegetation: Minor Freshwater marsh: N.A. Managed vegetation: Negligible Waterbody (pond): N.A. Flora (48 species): **Major**: 2 **Moderate**: 0 Minor: 46 Fauna (11 species): Major: 0 Moderate: 0 Minor: 10 Negligible: 1