

Holland Plain Environmental Impact Assessment (EIA)

Final Report

Urban Redevelopment Authority (URA)

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Appendix A. List of Probable and Recorded Faunal Species

Appendix B. Biodiversity Impact Assesment

Appendix C. Wildlife Incident Form

Appendix D. Air Quality Sensitive Receptor List

Appendix E. Airborne Noise Sensitive Receptor List (Ecology)

Appendix F. Airborne Noise Sensitive Receptor List (Human)

Appendix G. Construction Equipment Inventory

Appendix H. Construction Noise Impact Assesment (Human)

List of Acronyms

Acronym	Definition
ACMV	Air conditioning and mechanical ventilation
AECOM	AECOM Singapore Pte. Ltd.
AHCV	Area of High Conservation Value
ALARP	As Low As Reasonably Practicable
APCP	Air Pollution Control Plan
ASEAN	Association of Southeast Asian Nations
ASR	Air sensitive receptors
BAT	Best Available Technology
BEP	Best Environmental Practice
BIA	Biodiversity Impact Assessment
BOD_5	Biological Oxygen Demand
CEMMP	Contract-specific EMMP
CO	Carbon Monoxide
COD	Chemical Oxygen Demand
CRL2	Cross Island Line Phase 2
CS	Conservation significant
CVES	Commercial Vehicle Emissions Scheme
DGPS	Differential Global Positioning System
DO	Dissolved Oxygen
EBS	Environmental Baseline Study
ECM	Earth Control Measures
EIA	Environmental Impact Assessment
EIS	Environmental Impact Study
EMMP	Environmental Management and Monitoring Plan
EU	European Union
HASP	Health and Safety Plan
HDV	Heavy duty vehicles
IAQM	Institute of Air Quality Management
LCVs	Light commercial vehicles
LTA	Land Transport Authority
NAS	National Archives of Singapore
NEA	National Environment Agency, Singapore
NO_2	Nitrogen Dioxide
Nox	Nitrogen oxides
NParks	National Parks Board, Singapore
NSRs	Noise sensitive receptors
NUS	National University of Singapore
PM	Particulate Matter
PM_{10}	Particulate Matter with a diameter of 10 micrometres or less
$PM_{2.5}$	Particulate Matter with a diameter of 2.5 micrometres or less
PRO	Public Relations Officer
PUB	Public Utilities Board, Singapore
QECP	Qualified Erosion Control Professional

Acronym	Definition
RAC	Recommended Areas of Conservation
SAAQT	Singapore Ambient Air Quality Long Term Targets
SO_2	Sulfer Dioxide
TDS	Total Dissolved Solids
TN	Total Nitrogen
TP	Total Phosphorus
TSS	Total Suspended Solids
UK	United Kingdom
UK IAQM	UK Institute of Air Quality Management
URA	Urban Redevelopment Authority, Singapore
US	United States of America
USEPA	United States Environmental Protection Agency
VES	Vehicular Emissions Scheme
WHO	World Health Organisation

1 Executive Summary

AECOM Singapore Pte. Ltd. was appointed by the Urban Redevelopment Authority (URA) to provide Environmental Impact Assessment for development planned in Holland Plain (hereinafter referred as the "the Project"). This environmental consultation services require preparation of an Environmental Impact Assessment (EIA) including a preliminary Environmental Monitoring and Management Plan (EMMP) for the construction and operational stages (hereinafter referred as 'the Study') for the development of the Project.

The Project encompasses development of 14.5 ha Study Area located in central Singapore, covering southwest of Holland Plain and a part of Clementi Forest and Rail Corridor in close vicinity to existing residential area and a school. Currently, the southwest region of Holland Plain is covered with exotic-dominated forest, scrubland and herbaceous vegetation. Moreover, it sits in between Clementi Forest / Rail Corridor and Greenleaf vegetated area, acting as an additional refuge for forest-dependent species. As it is slated to be developed into residential and park land, there is a need to study the impacts that would arise from the Project.

This Report includes a review of the environmental baseline of the Study Area (biodiversity, hydrology and water quality, air quality and airborne noise), which are retrieved from Holland Plain section of the EIS for Turf City and Holland Plain (2022) [P-1], and the Clementi Forest section of the EIS for Clementi Forest and Maju Forest (2022) [P-2], both by Land Transport Authority (LTA). Thereafter, the impacts on biodiversity, hydrology, water quality, air quality, and airborne noise arising from the Project were assessed after consideration of the minimum controls, and mitigations measures were proposed for moderate or major impacts following the mitigation hierarchy including the incorporation of a green finger into the future park. A preliminary EMMP was developed. Relevant local and international laws and regulations such as the NParks biodiversity impact assessment guidelines were used to guide the assessment.

Review of Environmental Baseline

Biodiversity – A total of 131 fauna species and six (6) conservation significant flora species were found in this area in total from the sources reviewed. The previous reports recommended an area for conservation which occupies a large part of the current Project's study area. After the publication of LTA's CRL2 reports, an additional locally critically endangered straggly rush orchid (*Dendrobium lobbii*) was also found within the study area.

Hydrology and Water Quality – Two (2) natural streams (D/S1 and D/S2) from Clementi Forest, two (2) roadside drains (D/S3 and D/S4) west of Holland Plain within the Study Area and a freshwater marsh north of the Study Area is included in this study. The natural streams and Freshwater Marsh support local habitats and are deemed ecologically significant. Furthermore, the streams and drains flow into Pandan Reservoir that supplies drinking water.

In Clementi Forest, DO levels were below the criteria for aquatic life (4.0 mg/L) stream D/S2 and midstream of stream D/S1 during dry and/or wet weather, due to their stagnant conditions. However, previous study also showed that at DO below 4 mg/L in Singapore natural streams, freshwater aquatic life may have adapted and therefore are found to thrive in these conditions in Singapore. Elevated TSS levels found at D/S2 indicates high levels of sediment in stagnant water conditions. Relatively high phosphorus concentrations (i.e. TP and PO_4-P) were detected from water samples of both streams. This suggests that existing watercourses have high eutrophication potential, which is consistent with the site observation of greenish watercourses with algae. The overall baseline water quality of the perennial watercourses was deemed likely to be suitable for aquatic life. This supports the biodiversity findings, especially the natural stream D/S1 to be of high ecological value.

Ephemeral roadside drain (D/S3) was found to have relatively low pH, which was attributed to the flushing of humic acid from its earth banks. The other ephemeral drain (D/S4) was found to have relatively good water quality.

The Freshwater Marsh which is located outside of the Study Area scored relatively poorly against the aquatic life criteria during dry weather. However, the marsh was found to support an ecosystem of conservation significant biodiversity, which include marsh-specific odonates and birds.

Air Quality – Baseline air quality data for particulates (PM_{10} and $PM_{2.5}$) was collected at two (2) representative monitoring locations (Methodist Girls' School and near the rail corridor and Clementi Forest) between 25 February – 3 March 2020 and 6 – 13 July 2022 (during COVID pandemic) in the reference reports in Holland Plain. Both pollutant concentrations were found to be within the Singapore Ambient Air Quality Long Term Targets.

Airborne Noise – Baseline airborne noise monitoring was conducted at three (3) representative locations. Noise levels captured by the noise monitoring locations at Methodist Girls' School and adjacent to Rail Corridor within the

EIA Study Area remained within the permissible limits specified by the Environmental Protection and Management (Control of Noise at Construction Sites) Regulations, 2008 [R-31]. Noise levels at these two locations were monitored between 24 February 2020 to 31 September 2021. The lower noise levels recorded at these locations may have been influenced by COVID-19 restrictions. However, noise levels reported at the location which was situated at the north-western of the EIA study area exceeded the permissible noise levels specified by Environmental Protection and Management (Control of Noise at Construction Sites) Regulations, 2008 [R-31]. It can be noted that noise monitoring at this location was conducted during between 23 June and 30 June 2022 when most of the restrictions due to COVID were lifted.

Environmental Impact assessment

The impacts from the development on sensitive receptors are summarised in Table 1.1 and Table 1.2 for construction and operational phases, respectively, below. Key mitigation measures are summarised in Table 1.3.

Table 1.1 Summary of potential impact significance during construction phase

Environmental Parameter	Impact Significance with Minimum Controls	Residual Impact Significance with Mitigation Measures
Biodiversity	Habitat: Negligible to Major Flora: Negligible to Major Fauna: Negligible to Major	Habitat: Negligible to Major Flora: Negligible to Major Fauna: Negligible to Moderate
Hydrology and Surface Water Quality	Ecology: Negligible to Minor Human: Negligible to Moderate	Ecology: Negligible to Minor Human: Negligible to Minor
Air Quality	Ecology: Moderate to Major Human: Moderate to Major	Ecology: Minor Human: Minor
Airborne Noise	Ecology: Negligible to Major Human: Negligible to Major	Ecology: Negligible to Major Human: Negligible to Moderate

Table 1.2 Summary of potential impact significance during operational phase

Environmental Parameter	Impact Significance with Minimum Controls	Residual Impact Significance with Mitigation Measures
Biodiversity	Habitat: Negligible to Minor Flora: Negligible Fauna: Negligible to Moderate	Habitat: Negligible to Minor Flora: Negligible to Moderate* Fauna: Negligible to Moderate
Hydrology and Surface Water Quality	Ecology: Negligible to Minor Human: Negligible to Minor	Ecology: Negligible to Minor Human: Negligible to Minor
Air Quality	Ecology: Minor Human: Minor	Ecology: Minor Human: Minor
Airborne Noise	Ecology: Negligible to Moderate Human: Negligible to Minor	Ecology: Negligible Human: Negligible

**The impact to flora receptors increased from "negligible" to "negligible to moderate" after the implementation of mitigation measures as the retention of conservation significant species in the green finger exposes them to other impacts such as poaching.*

Table 1.3 Summary of key mitigation measures

Environmental Parameter	Key Mitigation Measures During Construction Phase	Key Mitigation Measures During Operational Phase
Biodiversity	• Mark out RAC and flora species of conservation value to prevent unnecessary clearance. • Ensure no works are conducted in areas outside the development footprint. • Conduct regular inspections to ensure contractor compliance with the Environmental Management and	• Regular monitoring of 12 months post-construction is recommended to ensure the effectiveness of mitigation measures. • Place signboards within residential and public park areas to provide advisories on wildlife encounters, proper food waste disposal, and emergency hotlines.

Environmental Parameter	Key Mitigation Measures During Construction Phase	Key Mitigation Measures During Operational Phase
	Monitoring Plan (EMMP), in consultation with NParks. • Ensure proper installation and maintenance of silt fences and other control measures along the worksite hoarding. • Engage a Qualified Erosion Control Professional (QECP) to implement an Earth Control Measures (ECM) plan per PUB requirements. • Implement dust control measures such as dust screens and water suppression systems to protect sensitive habitats from anthropogenic impacts.	• Use bins that prevent wildlife from accessing rubbish to minimise human-wildlife conflicts. • Avoid planting non-native flora in public parks to maintain ecological balance. • Implement measures to reduce roadkill accidents and protect wildlife. • Educate residents about living near nature and the likelihood of wildlife encounters. • Incorporate design features to increase glass visibility and prevent bird collisions, avoiding vegetation near glass to reduce confusion. • Carefully manage lighting duration to avoid disturbing nocturnal fauna, setting dark buffers and illuminance limits to minimise light pollution. • Implement measures to maintain local microclimate and hydrology of RAC (e.g.water retention measures in future park)
Hydrology and Water Quality	• Increase capacity of ECM tanks/ponds by 25% to contain stormwater runoff from Project Site and possible runoff from other concurrent projects. • Use of standby tarp to cover bare soil when not in use or during rain events	Not required.
Air Quality	• Implement dust control measures e.g., dust screens, etc. • Install hard surfaced haul routes. • Only use cutting, grinding and sawing equipment with dust suppression water spray mechanisms. • Erect hoarding around dusty activities and site boundary. • Impose and signpost maximum speed-limit of 25 km/hr on paved roads and 15 km/hr on unpaved roads and work areas. • No burning of waste allowed on site. • Revegetate earthworks and exposed areas/ soil stockpiles. • Implement a wheel washing system.	Not required.
Airborne Noise	• Staggered building heights should be considered to reduce duration of noisy activities near receptors. • Access routes should avoid facing receptors. • Use equipment with lower noise levels. • Noise barriers should be installed along boundary of worksites facing noise sensitive receptors as detailed in the section.	• Utilise noise attenuators and other Best Available Technology (BAT) and Best Environmental Practice (BEP) to mitigate potential noise from air conditioning and mechanical ventilation (ACMV) systems. • Utilise low speed postings, speed humps, speed limit signages at drop-off points and parking areas to mitigate noise from increased road traffic. • Consider alternative siting of roads away from areas with noise sensitive receptors. • Application of low-noise pavement mix can be considered for the road sections facing NSRs.

Recommendations and Conclusion

A set of EMMP has also been developed for each environmental parameter, which will be updated and implemented during construction and operational phases, to ensure the effectiveness of the proposed mitigation measures. The EMMP is described in Section 15 of the EIA report. Table 1.4 summarises of the key monitoring parameters, its locations and triggers for investigative and corrective actions.

Table 1.4 Summary of key EMMP

Environmental Parameter	Key EMMP During Construction Phase	Key EMMP Plan During Operational Phase
Biodiversity	• Monitoring habitat quality. • Determine if there are any unauthorised removal of flora within areas of conservation (if any) or beyond the demarcated development boundary. • Implementation of directional clearing. • Implementation of pre-site clearance fauna inspection. • Recording of number of number of occurrences of human-wildlife conflict. • Check for presence of trapped/injured/dead fauna, potential fauna entrapments and gaps in site hoarding. • Conduct toolbox briefings on biodiversity awareness.	• Assessment of habitat quality (e.g., water quality, excessive vegetation removal). • Inspection for presence of trapped/injured/dead fauna, potential fauna entrapments and gaps in site hoarding. • Recording of number of number of occurrences of human-wildlife conflict. • Conduct biodiversity survey to monitor construction impacts on fauna activity and presence.
Hydrology and Water Quality	• Monitor water quality parameters in Table 15.10.1 at construction site discharge outlet and at D/S1. • Monitor for flooding issues.	• Monitor water quality parameters in Table 15.10.2 at construction site discharge outlet and at D/S1. • Monitor for flooding issues.
Air Quality	• Monitor PM_{10}, $PM_{2.5}$, dust at Rail Corridor and 44 Holland Green. • Investigation and corrective actions required when monitored parameters exceed Singapore long term air quality targets.	• Not required.
Airborne Noise	• Monitor $L_{Aeq(12\ hours)}$, $L_{Aeq(1hour)}$ and $L_{Aeq(5\ mins)}$ at forested area in northwest and southwest of Project Site, and 20 Holland Green. • Investigation and corrective actions required when monitored parameters exceed applicable values of EPM regulations.	• Not required.

The unmitigated Project impacts on biodiversity, hydrology and water quality, air quality, and airborne noise with consideration of the minimum controls range from Negligible to Major. With the recommended mitigation measures, majority of the impacts can be lowered. However, noise impacts remain as high as Major. This is due to the proximity of the Rail Corridor and Clementi Forest. Similarly, although the overall development footprint has been amended with the conservation of the green finger, the large loss of the scrubland habitat remains as a Major impact for biodiversity.

2 Introduction

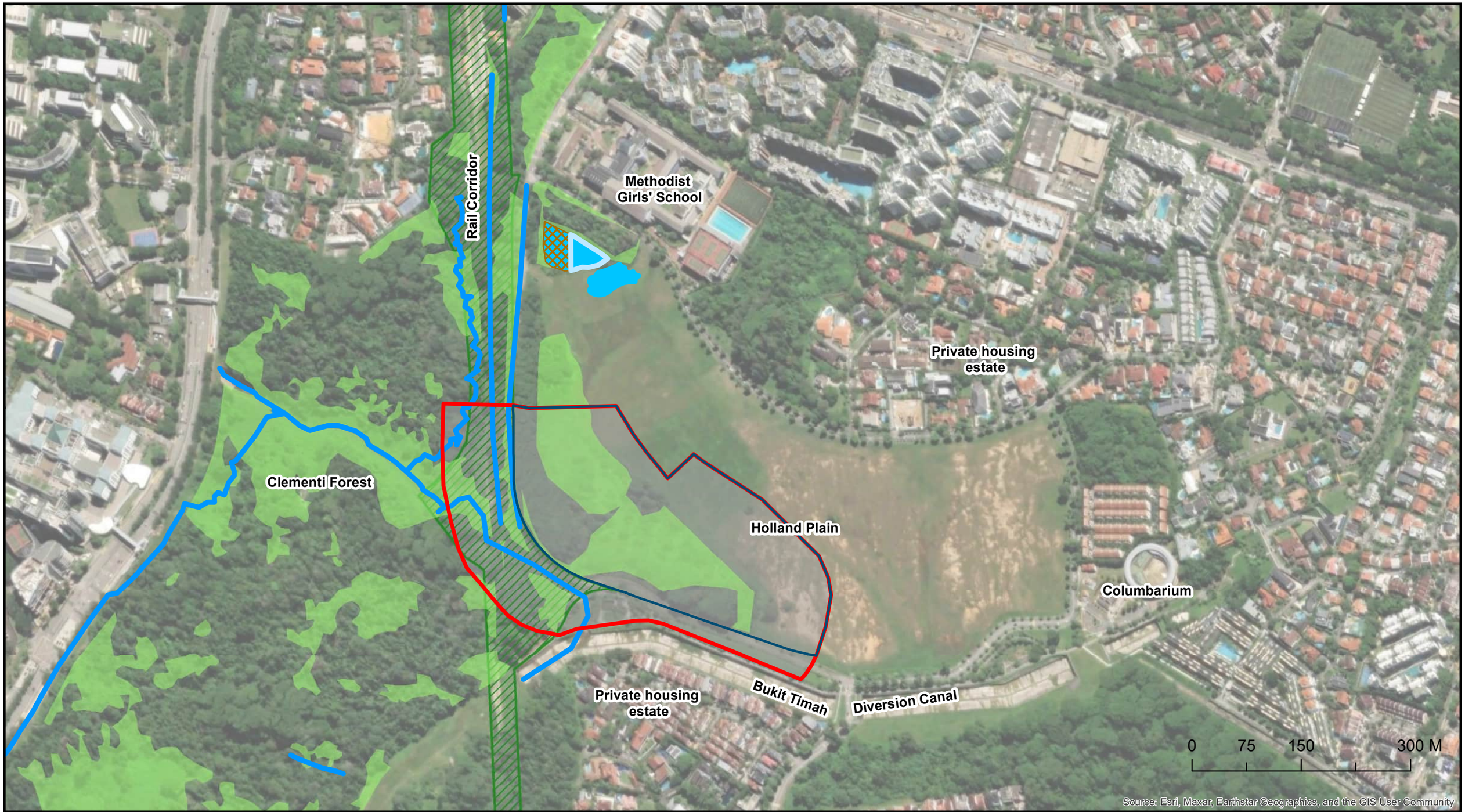
2.1 Overview

AECOM Singapore Pte Ltd was appointed by Urban Redevelopment Authority (URA), through the Letter of Acceptance dated 11 December 2024, to carry out Holland Plain Environmental Impact Assessment, intended for future residential and park development (hereinafter the EIA shall be referred to as 'the Study' and the future developments as 'the Project').

URA intends to develop Holland Plain in various phases into residential area and a park. The southwest of Holland Plain which is the focus of this Study. The Study Area provided for study for this EIA is approximately 14.5 ha, covering part of the vegetated areas of Holland Plain and Clementi Forest, while the Project Site slated for development lies within the Study Area (see Figure 2.1.1). Currently, it comprises a mix of vegetation including an ecologically significant scrubland. A unique freshwater marsh is located in the vicinity of the Study Area. The development abuts an existing low rise residential area and Methodist Girls' School as well. This implies both ecological and human sensitive receptors are present surrounding the Project Study Area.

The Client acknowledges that Land Transport Authority (LTA)'s has conducted recent environmental studies for their intended development in the vicinity of this area namely, the Environmental Impact Assessment (EIA), Environmental Impact Study (EIS) for Cross Island Phase 2 (CR2005) and Contract CR2005 –Environmental Monitoring and Management Plan (EMMP) for Construction of Marsh, which have study areas overlapping with this Study and that AECOM can use of the information gathered from these studies [P-1, P-2, P-3, P-4] especially for the baseline environmental data, to assist this EIA. Hence, this Study did not carry out any primary baseline data collection (other than additional information provided by other technical agencies during the course of engagement) and focuses on environmental impact assessment only. Figure 2.1.2 shows the areas covered in the aforementioned studies.

This Report provides the project understanding, the methodology used for the biodiversity, hydrology, surface water quality, air quality and airborne noise impact assessment, the environmental baseline summary of the Study Area, the impact assessment and Environmental Management and Monitoring Plan (EMMP). Additionally, other developments such as the King Albert Park station construction will run concurrent to the Project. Hence, this Study will assess the cumulative impacts.



Legend

- Project Site
- Study
- Rail Corridor
- Scrubland
- Other types of vegetated areas
- Freshwater Marsh (Natural) - Filled
- Freshwater Marsh (Natural) - Retained
- New Marsh (U/C)
- Watercourses

N

Rev.	Date	By	Description	Chk'd	App'd
-	MAR 2025	HBS	Holland Plain EIA	LAL	JAG

Qualified Person Endorsement : NA

URA Endorsement : NA

Consultant : AECOM

Client: Urban Redevelopment Authority

Project Title :

CONTRACT URA/T/23/048
HOLLAND PLAIN
ENVIRONMENTAL IMPACT ASSESSMENT

Figure Title :

Study location

Designed	Checked	Approved	Figure No. :	Rev.	Sheet
HBS	LAL	JAG	2.1.1	-	1 of 1
	Drawn HBS	Date MAR 2025	CAD File Name : NA		A3

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

Legend

- Study Area (in this Study)
- Flow direction
- Identified watercourses
- Previous studies' focus area for air quality
- Previous studies' focus for airborne noise
- Freshwater Marsh
- Previous studies' focus for biodiversity
- Gap in biodiversity baseline data

N

Rev.	Date	By	Description	Chk'd	App'd
-	MAR 2025	HBS	Holland Plain EIA	LAL	JAG

Qualified Person Endorsement : NA

URA Endorsement : NA

Consultant : AECOM

Client: URBAN REDEVELOPMENT AUTHORITY

Project Title :

CONTRACT URA/T/23/048
HOLLAND PLAIN
ENVIRONMENTAL IMPACT ASSESSMENT

Figure Title :

Extent of previous studies

Designed	Checked	Approved	Figure No. :	Rev.	Sheet
HBS	LAL	JAG	2.1.2	-	1 of 1
	Drawn HBS	Date MAR 2025	CAD File Name : NA		A3

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2.2 Scope of Work

The key objectives of this Study are as follows:

- To understand the Project and its related activities (e.g. grading and infrastructural works, road and main drainage works, building works, road construction and widening, etc.) during construction and operational phases.
- To carry out a desktop study to review the findings of all relevant literatures and related previous studies and collate available information regarding the baseline environmental status of the Project Site.
- To review and list the regulatory framework that governs the activities of the Project in relation to environment.
- To identify the biodiversity connectivity between the Project Site and surrounding green spaces within Singapore.
- To identify and describe the elements of biodiversity, water resources (i.e. hydrology and surface water quality) and airborne noise that are likely to be affected by the Project and/ or related proposed activities within the Study Area.
- To identify, predict and assess potential impacts and cumulative impacts to determine the significance of impact(s) on identified sensitive receptors and potential affected uses, using qualitative methods.
- To propose mitigation measures to minimise significant adverse impacts (e.g. pollution, environmental disturbance, nuisance) during construction and operational phases of the Project.
- To identify, predict and evaluate the residual environmental impact (i.e. after implementation of mitigation measures) expected to arise during construction and operational phases of the Project, in relation to sensitive receptors.
- To propose a Preliminary EMMP to guide the Project development, including to identify, assess and specify the methods, measures and standards, to be included during the construction and operational phases of the Project, which are necessary to mitigate the residual environmental impacts and cumulative effects, and reduce them to minimal levels.
- It should be noted that stakeholder engagement has been carried out as required by the Client and the Authorities. Feedback, queries and responses from Nature Groups were collected and included in relevant sections of the report.

2.3 Report Structure

To outline the details of the Project, EIA methodology, environmental baseline and impact findings, and proposed EMMP, this Report has been structured as follows:

Section 1– **Executive Summary** of the Project provides an overview of the planned developments, summarised baseline findings as well as EIA findings;

Section 2 – **Introduction** of the Project provides detailed scope, report structure, study limitations, assumptions and constraints;

Section 3 – **Project Overview** provides a general description of the Project components, construction activities, operational activities, and schedule of the Project;

Section 4 – **Environment Legislation, Policies, Plans, Standards and Criteria** provides the legislative requirements relevant to the Study;

Section 5 – EIA Approach and Methodology provides the overview of the methodology used for the assessment;

Section 6 – **Description of the Environment** provides a general description of the site setting, land use, historical features, geology, water catchment and climate of the Project;

Section 7 – Environmental Baseline Conditions reviews the baseline environment for biodiversity, hydrology and water quality, air quality and airborne noise within the Study Area;

Section 8 – Identification of Sensitive Receptors presents the sensitive receptors for biodiversity, hydrology and water quality, air quality and airborne noise that are likely to be impacted by the Project;

Section 9 – Potential Sources of Impact lists the works of the Project that may potentially impact the sensitive receptors;

Section 10 – Minimum Control Measures lists the legislations and typical industrial practices that are mandatory be implemented during the course of the Project;

Section 11 – Prediction of Impacts provides the assessment of potential impacts on the identified sensitive receptors while considering the minimum controls;

Section 12 – Recommended Mitigation Measures provide recommendations to reduce the impacts that are Moderate or Major;

Section 13 – Residual Impacts assess the impacts after implementation of the proposed mitigation measures;

Section 14 – Cumulative Impacts from Major Concurrent Projects analyses the overall impact on sensitive receptors from this Project and nearby concurrent projects;

Section 15 – Environmental Monitoring and Management Plan details the organisational framework, stakeholder roles and responsibilities, monitoring program requirements and detailed EMMP; and

Section 16 – Conclusion provides a conclusive summary of the EIA's outcomes.

2.4 Study Limitations, Assumptions and Constraints

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Due to the above, the statements, conclusions and opinions contained in this report are approximations of the existing environmental conditions within the Project Site, based on available literature, expert observations and

opinion at the time of reporting. Reliance on the report after the date of issuance as an accurate representation of current site conditions shall be at the user's sole risk.

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It should be noted that the EIA for the development of CRL2 has been completed by LTA [P-1, P-2, P-2], and hence will not be included in this report. However, as the CRL2 development will occur concurrent to Holland Plain development, this Study will include cumulative impact assessment.

3 Project Overview

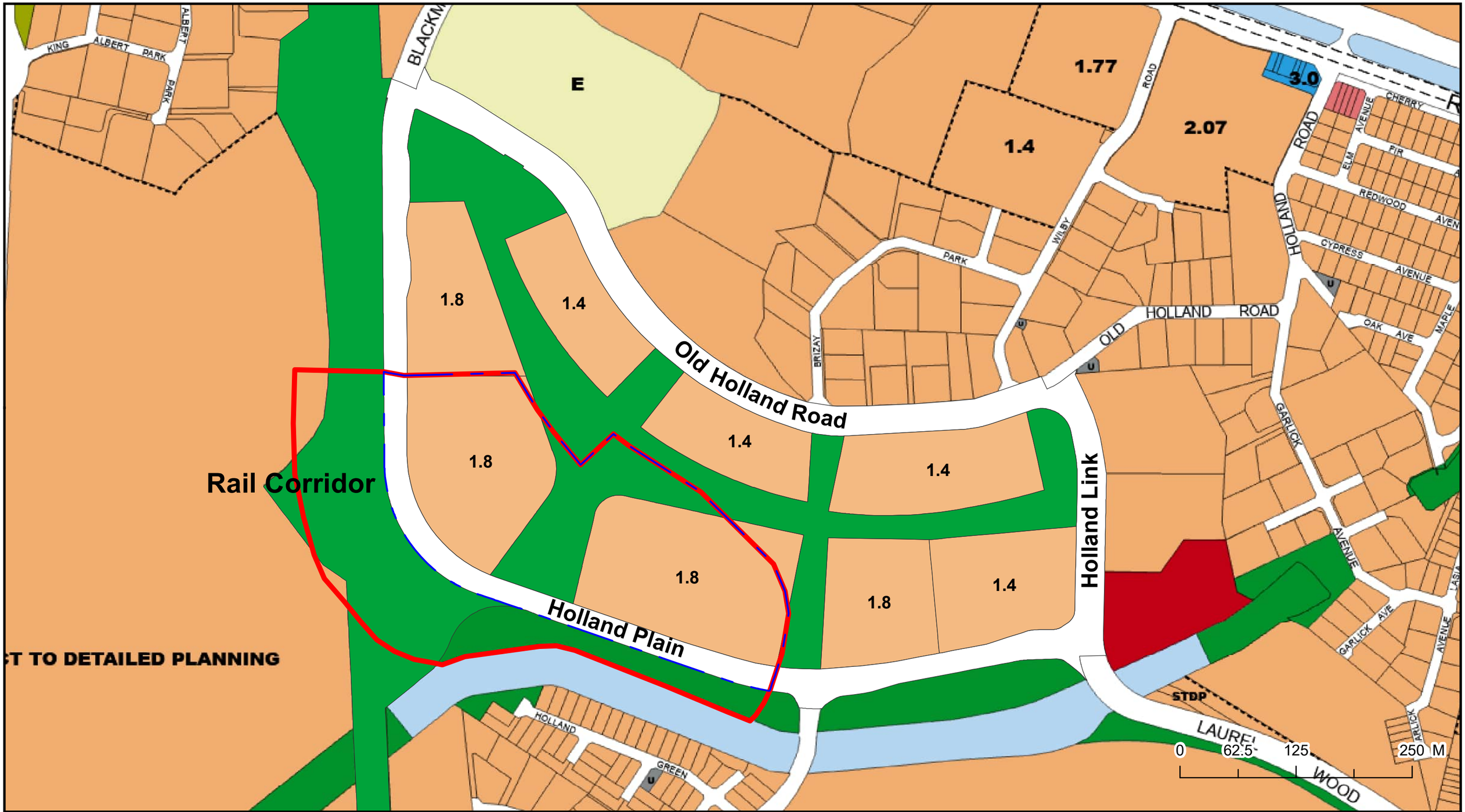
This section includes description of the location of the Project in both local and regional context, prospective development plans as well as description of activities anticipated to be conducted during the construction and operational phases of the Project.

3.1 Existing Project Location

The Project Site is situated in the southwestern part of Holland Plain. To the south of the Project Site lies the Bukit Timah First Diversion Canal, beyond which are residential establishments. To the north lies Methodist Girls' School and residential developments. The Fong Yun Thai Association is located east of the Study Area, with private housing estates situated further to the east. An ecologically significant freshwater marsh sits north of the Project Site, below Methodist Girls' School. It is currently undergoing shifting and re-creation works as part of LTA's CR2005 project. Clementi Forest lies to the west, with the Rail Corridor running through it as shown in Figure 2.1.1. The Project Site is located within the Study Area.

3.2 Proposed Project

Based on URA Master Plan 2019, the Project Site is proposed to be developed as two residential plots with a connective park in between. The construction road currently on site will be upgraded into a new road, Holland Plain, to serve the area. The road will separate the residential and community plain from the Rail Corridor and Clementi Forest on the west (see Figure 3.2.1), which has no development plans known for the course of this Study. URA has stated that the staging of sites for residential developments is currently under review. The southern portion of the Study Area (between Holland Plain Road and the canal) will be developed into a wetland park.



Legend

Study Area | Project Site

Land Use

- Park
- Residential
- Road
- Waterbody
- Civic & Community Institution
- Commercial & Residential
- Educational Institution
- Residential w Commercial at 1st storey

N

Rev.	Date	By	Description	Chk'd	App'd
-	MAR 2025	HBS	Holland Plain EIA	LAL	JAG

Qualified Person Endorsement : NA

URA Endorsement : NA

Consultant : AECOM

Client: Urban Redevelopment Authority

Project Title :

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HOLLAND PLAIN
ENVIRONMENTAL IMPACT ASSESSMENT

Figure Title :

Proposed land use of the Project Site and its surroundings

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	Drawn: HBS	Date: MAR 2025

Figure No. : 3.2.1 | Rev. : - | Sheet : 1 of 1

CAD File Name : NA | A3

Note: Source of basemap - URA Masterplan

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3.3 Project Activities

At this stage of Report writing, limited information is available regarding the activities planned during the development and operation of the proposed Project. Hence, this section only provides description of general activities expected.

3.3.1 Proposed Construction Activities

The activities expected to occur during the construction phase can be categorised into pre-construction and main construction activities and will entail, but not limited, to the following:

Pre-construction activities, with the main objective of preparing the site so that the main construction activities can be carried out. These activities include site investigation works (e.g. soil investigation, etc.), site clearance (i.e. removal of existing trees and vegetation etc), earthworks (i.e. excavation and filling to achieve desirable platform levels required for the development of Project Site), construction of access roads and other infrastructure of construction work machinery, establishment of temporary structures and infrastructure and utilities diversion.

Main construction activities, such as foundation works, superstructure works, utilities/services laying, landscaping works and habitat creation. In addition, activities such as earth works, site surveying, trial trenching and other site investigation work etc. will also be carried out during the construction phase. Before the development becomes operational, it is assumed that the temporary structures and facilities will be removed.

It should be noted that pre-construction and construction activities may take place concurrently. The identified pre-construction and construction activities, typical construction machinery as well as equipment to be utilised for each of the activities are summarised in Table 3.3.1. More details regarding each of the assumed activities during the construction phase can be found in the subsequent sub-sections.

These above-mentioned activities may potentially impact the biodiversity and associated habitat, freshwater quality, and cause potential air and noise disturbances. Furthermore, dust may be emitted into the air during activities such as earthworks, increasing the amount of particulate matter in the air. Consequently, this may have an adverse impact to flora, fauna as well as humans.

Table 3.3.1 Typical construction phase activities and construction machinery and equipment for each of the activities

Main Activities	Related Activities	Typical Construction Machinery and Equipment Used for the Activity
Pre-Construction Activities		
Site Clearance	• Tree felling and removal of other vegetation (e.g. bushes, turf, etc.) not planned to be conserved	• Excavators • Bulldozers • Lorries
Earthworks	• Soil Investigation • Site levelling to obtain planned platform levels • Soil excavation for foundations (i.e., excavation of soil to depth at which the foundations of the future structures will be placed)	• Temporary water pumps • Excavators • Bulldozers • Graders • Rollers • Lorries • Generators
Basic Infrastructure	• Construction of access roads and other infrastructure required for construction activities • Construction of temporary structures (e.g. site office) required for the construction phase of the Project	• Temporary water pumps • Excavators • Graders • Rollers • Lorries • Concrete trucks • Concrete vibrators • Generators
Main Construction Activities		

Main Activities	Related Activities	Typical Construction Machinery and Equipment Used for the Activity
Foundation Works	• Delivery and installation of construction machinery (i.e., crane for lifting operations and boring rig for soil drilling) • Soil dewatering • Installation of bore casings • Soil boring work • Installation of rebar cage • Concreting works – construction of piles and pile caps • Pile head hacking/ removal • Delivery of steel sections • Hot works – welding of steel beams, brackets, etc. • Stage excavation • Hoisting of walers and struts • Stage excavation with walers and struts • Spoil and slurry removal	• Temporary water pumps • Mobile cranes • Cranes • Bore pilling machines • Ready-mix concrete trucks • Breakers • Welding equipment • Trailers • Excavators (with and without lifting appliance) • Mini Excavators • Dump trucks • Generators
Superstructure Works	• Establishment of power supply (e.g. for lighting, pumps,) • Excavation below ground surface (e.g. for working platform, for preparing of lean concrete) • Spoil removal • Formwork construction and cleaning before casting • Rebar handling and positioning • Hoisting of falsework • Casting of concrete • Scaffolding • Finishing works (e.g. plastering, waterproofing, tiling, etc.)	• Excavators • Mini excavators • Cranes • Mobile cranes • Air compressor • Dump trucks • Ready-mix concrete trucks • Concrete pumps • Generators
General Landscaping Works and Park Construction	• General landscaping activities such as planting works • Construction of landscape / park amenities/ constructions (e.g. benches, pathways and park connectors)	• Generators • Excavators mounted sheet pile vibrator • Mobile cranes • Welding and cutting equipment
Removal of Temporary Structures and Reinstatement	• Removal of Earth Retaining and Stabilising Structures (ERSS) • Reinstatement of the area to original (or required) condition	• Generators • Excavators mounted sheet pile vibrator • Mobile cranes • Welding and cutting equipment • Trucks

3.3.1.1 Pre-Construction

Prior to the main construction, the pre-construction activities will prepare the land to be ready for development and building construction. During the site clearance, vegetation within the Study Area will be cleared. Following this, earthworks including soil excavation, utility diversion and ground levelling will be carried out.

3.3.1.1.1 Site Clearance

Site clearance is the first activity to be carried out as a part of site preparation for construction works. It involves the removal of vegetation and topsoil and is carried out by excavators. The works generally generate substantial amount of horticultural waste, besides dust and noise in their activities. Potential environmental impacts arising from site clearance have been assessed in the relevant sections of this Report.

3.3.1.1.2 Earthworks

Following site clearance, earthworks are usually carried out. This will include activities during which the soil will be excavated, transported, placed at the new location, and compacted. The excess soil which is not used for filling will be permanently removed from the site.

3.3.1.1.2.1 Site Levelling

Currently, the Project Site is gently sloping with generally decreasing elevation towards the south. The proposed final platform levels follow the same terrain but differs from the current topographic levels. Hence, some terrain will be levelled for construction activities to start. This may involve cutting the areas of Project Site where proposed platform levels are lower than existing terrain levels and filling areas which are currently lower than the proposed future platform levels. This may or may not require geotechnical engineers will develop Earth Retaining Stabilisation Structures (ERSS) schemes to stabilise the exposed slopes in their engineering design. During this event, exposed soil is expected, and Environmental Control Officer (ECO) considers measures to prevent erosion of soil into any watercourses. This may accompany ground improvement works depending on the nature of the soil in the area. One example of site levelling in a construction site is shown in Figure 3.3.1. Site levelling would involve large machineries such as excavator, lorry, concrete vibrator, grader, roller, etc.

3.3.1.1.2.2 Basic Infrastructure

Infrastructure earthworks will be carried out prior to or concurrently with main construction works and include utilities diversion or construction as well as construction of accompanying infrastructure (e.g. temporary and permanent roads, sewerage, drainage etc.).Temporary access will be constructed to provide controlled and safe access for vehicles carrying materials and equipment as well as for other machinery. Temporary roads are generally constructed from aggregate/soil which is placed on the required location and compacted.

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



Figure 3.3.1 An example of site levelling at construction worksite in Singapore (AECOM©)

3.3.1.2 Main Construction

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

3.3.1.2.1 Foundation Works

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

To seal the pile foundation, a pile cap is necessary. For this, steel waler and struts are required to hold the temporary formworks to proceed with pile cap concreting. The steel is delivered with a 40-feet trailer where hot works (e.g. welding of steel beams, brackets, etc.) may be required with the usage of welding equipment. Hoisting of waler and struts is carried out using an excavator with lifting appliance.

3.3.1.2.2 Superstructure Works

Following the completion of foundation works, superstructures will be constructed for this Project. Firstly, generators provide the power supply on site for lighting and pumps. Before the installation of superstructures, temporary water pumps are positioned to pump the water from ground or collected rain in order to prevent it from affecting the quality of concrete. To form the working platform, excavation below surface is conducted using an excavator, followed by the formation of lean concrete as the first ground layer for waterproofing purposes. Cranes are used for the spoil removal as well. To construct building until the designated height, up to 10 storeys in this Project, temporary formwork is necessary at each level before casting, where air compressor will be used for cleaning. During this process, mobile crane is used to transport rebar and for the hoisting of falsework, formwork, scaffolding and the construction of temporary working platforms. A concrete truck is used to transport ready mix concrete to the site and concrete pump is used for the superstructure's concreting works. No concrete batching plant is expected to be on-site.

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

3.3.1.2.3 General Landscaping and Park Construction Works

A community park connecting between the residential plots with a running bioswale from north to south are proposed within the Project Site. Hence, landscaping and park construction works will be conducted. Generators provide the power supply for lightning and running of machineries during landscaping works. If needed, excavator and mobile crane will be used to remove patches of soil and relocate them or transport from the site. Welding and cutting equipment are commonly used to form landscape structures and common park amenities such as benches. The potential environmental impacts associated with the general landscaping works will be assessed and incorporated as a whole in the relevant sections of the Report.

3.3.1.2.4 Removal of Temporary Structures and Reinstatement

As the final step towards completion of construction activities, the developer and/or contractor shall remove all the temporary structures for the reinstatement of working area to its original condition and/or required conditions. A well-reinstated and stabilised land will also enhance the landscape and visual amenity values to create a better living environment for the public and residents of this Project development.

3.3.2 Proposed Operational Activities

People will occupy the residential plots and utilise the park once the Project moves into operational phase. Hence, there will be an increase in general human activity in the area such as traffic, including vehicular traffic, lighting and noise. The vehicular traffic volume within the site and its vicinity is predicted to increase when the proposed residential housing and its main road access (Holland Plain) start operating.

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

3.4 Project Schedule

The residential plots of the Project are set to be staged in the near-term and will be developed over the course of 4 to 5 years after its staging. There is no definitive schedule for the park development at the time of writing this Report, but its development will occur in the near- to medium-term

3.5 Major Concurrent Developments

Concurrent to the development of the Project Site will be the development of residential areas at the northeastern half of Holland Plain, as well as King Albert Park Station as part of the CRL2 construction to the north of the Study Area. Residential parcels east to the Study Area as well as roads Old Holland Road, Holland Link, Holland Plain, Laurel Woods Avenue and Sixth Avenue will also be enhanced concurrent to the early stages of the Project. For the purpose of this Study, there are no planned works that will affect Rail Corridor and Clementi Forest.

4 Relevant Regulatory Framework, International Standards and Guidelines

An indicative list of relevant legislative requirements applicable to the Study is provided in Table 3.5.1.

Table 3.5.1 Relevant regulatory framework, international standards and guidelines

Environmental Parameter	Applicable Legislation	Key Points
General	Biodiversity Impact Assessment (BIA) Guidelines, 2020 [R-9]	This document is published by National Parks Board (NParks) to provide a framework guiding biodiversity baseline study in Singapore. It recommends methods for conducting baseline survey. Section 2 of this BIA Guidelines detailed the baseline study methods recommended for vegetation mapping, habitat mapping, hydrology (including waterbody mapping, water conditions, water quantity and water quality)
	Environmental Protection and Management Act, 2020 [R-11]	An Act to consolidate the laws relating to environmental pollution control, to provide for the protection and management of the environment and resource conservation, and for purposes connected therewith. For surface water, it regulates the discharge of trade effluent, oil chemical, sewage or other pollution onto land and drains. For air quality, it provides standards and regulations on air impurities.
Biodiversity	National Biodiversity Strategy and Action Plan (NBSAP), 2019 [R-1]	This document provides a framework to guide biodiversity conservation efforts in Singapore. It intends to establish both policy frameworks and specific measures to ensure better planning and co-ordination in the sustainable use, management and conservation of biodiversity. A holistic approach has been adopted where the input of various public sector agencies and nature groups have been taken into consideration in the preparation of the document.
	Wildlife Act, 1965 [R-2]	Any person who kills, takes or keeps any wild animal or bird, other than those specified in the Act, without a licence shall be guilty of an offence and shall be liable on conviction to a fine not exceeding $50,000 or to imprisonment for a term not exceeding 2 years or to both and to the forfeiture of the wild animal or bird.
	Parks and Trees Act, 2006 [R-3]	An Act to provide for the planting, maintenance and conservation of trees and plants within national parks, nature reserves, tree conservation areas, heritage road green buffers and other specified areas, and for matters connected therewith. No tree with a girth exceeding one meter (when measured 1-m from the ground) located within tree conservation areas and vacant lands should be cut or

Environmental Parameter	Applicable Legislation	Key Points
		damaged without the prior approval of the relevant authorities; and No tree or plant will be cut or damaged if located within the heritage road green buffer.
	Parks and Trees Act (Parks and Trees Regulations), 2006 [R-4]	Prohibitions and regulations on trees and animals within national park, nature reserve or public park.
	Parks and Trees (Heritage Road Green Buffers) Order, 2006 [R-5]	Lists the areas designated as heritage road green buffers.
	Parks and Trees (Preservation of Trees) Order, 1998 [R-6]	Lists the designated tree conservation areas No cutting or damaging of tree having girth of more than one metre.
	3rd Edition Singapore Red Data Book (SRDB3) [P-12]	Lists the endangered plants and animals in Singapore Published by NParks Provides the scientific name, common name, status, description, habitat, distribution, threats, scientific interest and potential value, as well as conservation measures for each plant and animal listed.
	The International Union for Conservation of Nature and Natural Resources (IUCN) Red List of Threated Species [R-7]	Provides taxonomic, conservation status and distribution information on plants, fungi and animals that have been globally evaluated.
	The Hong Kong Environmental Impact Assessment Ordinance - Technical Memorandum (HK EIAO TM)[1] [R-8]	Sets out the principles, procedures, guidelines, requirements and criteria for deciding whether the Project is environmentally acceptable.
Hydrology and Water Quality	Sewerage and Drainage Act, 2001 [R-14]	An Act to provide for and regulate the construction, maintenance, improvement, operation and use of sewerage and land drainage systems, and to regulate the discharge of sewage and trade effluent. Regulates the protection, maintenance and provision of stormwater drainage system.
	Sewerage and Drainage (Surface Water Drainage) Regulations, 2007 [R-17]	Regulates measures to be implemented to protect the stormwater drainage system.
	Sewerage and Drainage (Trade Effluent) Regulations, 2007 [R-15]	Regulates trade effluent discharge into public sewerage system.
	Environmental Protection and Management (Trade Effluent) Regulations, 2008 [R-12]	Regulates the discharge of trade effluent to public watercourse. Any discharge into a watercourse has to comply with the regulatory standards established in these regulations.

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

Environmental Parameter	Applicable Legislation	Key Points
	PUB Code of Practice on Surface Water Drainage, 2013 [R-18]	Provides guidelines for measures to be implemented to protect the stormwater drainage system and manage surface water drainage (e.g. development and implementation of an Earth Control Measures (ECM) plan).
	SS 593: 2013 – Code of Practice for Pollution Control (COPPC) [R-13]	Provides guidelines for the appropriate discharge of any effluent into public sewer or watercourse. Provides guidelines for the appropriate storage and accidental release of oils & chemicals.
	Allowable Limits for Trade Effluent Discharge to Watercourse or Controlled Watercourse (NEA) [R-27]	Provides allowable limits for trade effluent discharge to watercourse or controlled watercourse in Singapore.
	PUB Circular on Preventing Muddy Water from the Construction Site, October 2015 [R-19]	All new construction sites with site area of 0.2ha and above, sites with problematic ECM, and sites within sensitive areas are required to implement CCTV including a Silty Imagery Detection System (SIDS) at the public drain to monitor the surface run-off discharges from the sites.
	Standard Statistical Classification of Surface Freshwater Quality for the Maintenance of Aquatic Life, New York and Geneva UNECE (1994) [R-20]	Provides standards for water quality assessment relating to aquatic life for surface waterbodies.
	Australian & New Zealand Guidelines for Freshwater and Marine Water Quality (2000) [R-23]	Provides standards for water quality assessment relating to aquatic life for surface waterbodies.
	Canadian Water Quality Guidelines for the Protection of Aquatic Life (2007) [R-24]	Provides standards for water quality assessment relating to aquatic life for surface waterbodies.
	Water Quality Standards Handbook USEPA (2017) [R-22]	Provides standards for water quality assessment relating to aquatic life for surface waterbodies.
	Mitigating Impact from Aquaculture in the Philippines (PHILMINAQ) [R-25]	Provides standards for water quality assessment relating to aquatic life for surface waterbodies.
	National Water Quality Standards for Malaysia (DOE) [R-26]	Provides standards for water quality assessment relating to aquatic life for surface waterbodies.
	Water Quality Requirements World Health Organisation (WHO) (n.d.) [R-21]	Provides standards for water quality assessment relating to aquatic life for surface waterbodies.
Air Quality	Singapore Ambient Air Quality Targets (Long Term Targets) [W-17]	Stipulates the recommended limit values for ambient concentrations of NO_2, SO_2, PM_{10}, $PM_{2.5}$, CO and O_3 to be applied from the year 2020. Target values are based on WHO Limit Values (mixture of Interim and Final values).

Environmental Parameter	Applicable Legislation	Key Points
	Environmental Protection and Management Act, 2020 [R-11]	Provides standards and regulations on air impurities.
	Environmental Protection and Management (Air Impurities) Regulations 2015 [R-35]	Regulates air emissions and impurities in Singapore.
	Environmental Protection and Management (Off-Road Diesel Engine Emissions) Regulations 2012 [R-36]	Stipulates that all off-road diesel engines (including construction equipment with diesel engines) imported for use in Singapore from July 2012 must comply with the EU Stage II, US Tier II or Japan Tier I off-road diesel engine emission standards.
	UK Institute of Air Quality Management (IAQM) Guidance on the Assessment of Dust from Demolition and Construction 2024 [R-33]	The document provides guidance for developers, their consultants and environmental health practitioners on how to undertake a construction impact assessment (including demolition and earthworks).
	Environmental Protection and Management (Vehicular Emissions) Regulations 2008 [R-34]	The document provides guidance for enforcement against smoky vehicles and idling engines while the vehicle is stationary.
Airborne Noise	Singapore Environmental Protection and Management (Control of Noise at Construction Sites) Regulations, 2008 [R-31]	Stipulates a set of maximum allowable noise limits for construction sites for different time periods of the day and for different types of premises affected by construction noise. Stipulates the correction factor that needs to be applied to the applicable noise criteria based on background noise levels.
	Singapore SS 593: Code of Practice for Pollution Control (COPPC), 2013 [R-13]	Specifies recommended pollution control requirements and good practices for prevention of impacts with respect to noise.
	Singapore SS602:2014 Code of Practice for Noise Control on Construction and Demolition Sites [R-30]	Specifies recommendations and good practices for prevention of noise impacts from construction and demolition activities.
	Singapore Technical Guideline for Land Traffic Noise Impact Assessment from National Environment Agency (NEA) [R-37]	Airborne noise limit of LAeq(1hour) of 67 dB at the façade of existing residential buildings/ noise sensitive premises are set by the National Environment Agency (NEA) for operational phase impacts.
	Singapore Technical Guideline on Boundary Noise Limit for Air Conditioning and Mechanical Ventilation Systems in Non-Industrial Buildings by National Environmental Agency (NEA); Code of Practice on Pollution Control by National Environment Agency [R-38]	Legislative requirements for boundary noise due to noise emissions from mechanical ventilation systems for non-industrial buildings during operational phase.

5 EIA Approach and Methodology

5.1 Approach

The overall EIA workflow is shown in Figure 5.1.1. A Scoping study of the EIA was developed based on the Project understanding (Section 3) and was reported in the Inception Report of this Study. The general approach to the EIA is listed as follows:

- Scoping of the Study;
- Baseline data study and analysis;
- Impact Assessment and evaluation, propose mitigation measures and residual impact evaluation;
- Proposed preliminary EMMP; and
- Report writing (this report).

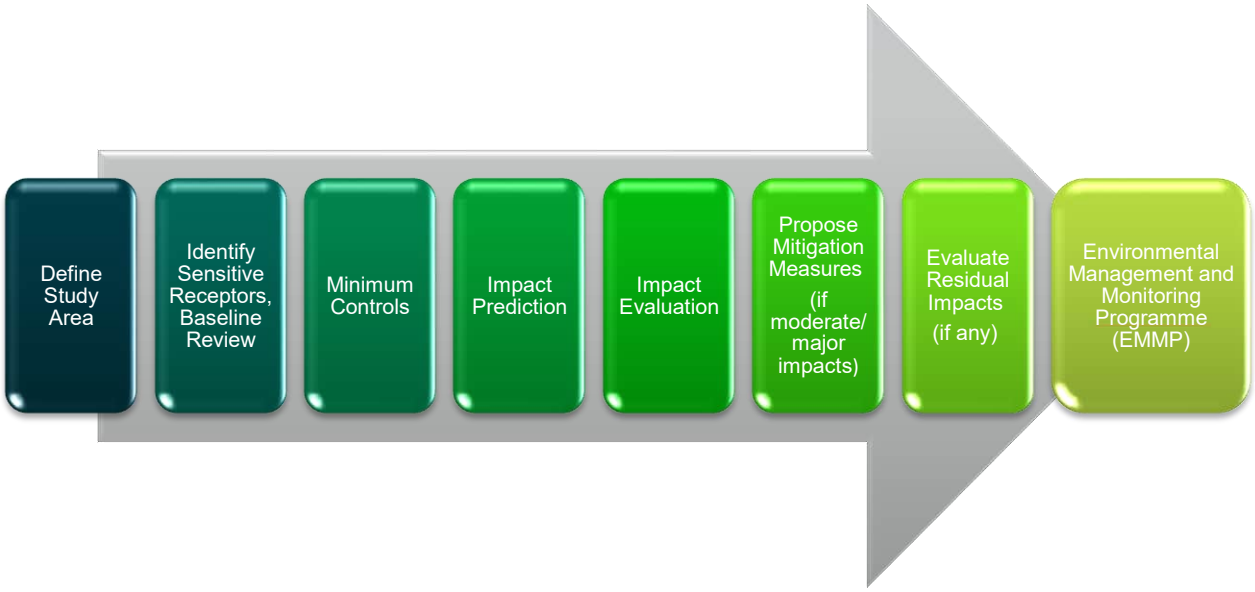


Figure 5.1.1 Overall EIA workflow

5.2 Scoping of Study

5.2.1 Assessment Extent and Study Parameters

The environmental parameters that are covered as part of the EIA and the extent of their coverage are detailed in Table 5.2.1.

Table 5.2.1 Environmental parameters assessed in this EIA

Environmental Disciplines	Assessment Extent
Biodiversity	The assessment extent for biodiversity impacts is defined as the habitats, flora and fauna within the Study Area
Hydrology, Surface Water Quality	Watercourses with direct impact from the proposed developments
Air Quality	Construction Phase 50 m (ecological receptors) and 250 m (human receptors) from planned Project Site Operational Phase 250 m from operational footprint
Airborne Noise	Construction Phase 150 m around the Project Site Operational Phase Immediate boundary of the operational footprint and 70 m from roads (if available)

5.2.2 Identification and Categorisation of Sensitive Receptors

Sensitive receptors are those receptors within or in the vicinity of the Study Area which may potentially be impacted by the Project's construction and operational activities. Environmentally sensitive receptors are categorised into three categories: Priority 1, Priority 2 and Priority 3 (from the most sensitive to the least) as shown in Table **5.2.2**. The identification of sensitive receptors for each environmental parameter was developed based on the findings of the environmental reconnaissance surveys, secondary baseline data from LTA's Environmental Impact Assessment (EIA), Environmental Impact Study (EIS) for Cross Island Phase 2 (CR2005) and Contract CR2005 –Environmental Monitoring and Management Plan (EMMP) for Construction of Marsh, which have study areas overlapping with this Study [P-1, P-2, P-3, P-4], and review of the proposed Study Area.

Table 5.2.2 Receptor sensitivity classification

Environmental Parameter	Receptor Sensitivity		
	Priority 1	**Priority 2**	**Priority 3**
Biodiversity	Flora, fauna species and habitats of high ecological value (i.e., presence of conservation significant flora and fauna species; identified keystone species; flora species that is essential for the survival of threatened fauna species).	Flora, fauna species and habitats of moderate ecological value (i.e., mainly native species of flora, fauna and habitats).	Flora, fauna species and habitats of low ecological value (i.e., mainly exotic or cryptogenic flora, fauna and habitats; managed vegetation which can provide habitat for significant species).
Hydrology	**Ecological Receptors**		
	• Aquatic habitats and/ or biocenosis of high ecological value that are highly dependent on freshwater water flow conditions and/ or quantities. Examples of fauna include fish, amphibians, odonates in aquatic or semi-aquatic habitats. • Aquatic habitats and/ or biocenosis of high ecological value which would be permanently impacted by changes in freshwater flow conditions.	• Aquatic habitats and/ or biocenosis of high ecological value that are resilient of changes in water quantities and water flow conditions. • Terrestrial habitats of high ecological value that obtain water from multiple sources.	• Habitats and/ or biocenosis that are not of high ecological value. • Habitats and/ or biocenosis that will not be disturbed due to changes in existing hydrology.
	Human Receptors		
	• Humans within and in the vicinity of the Study Area whose activities would be permanently altered or prevented by changes in hydrology. • Humans within and in the vicinity of the Project Site whose safety would be largely compromised.	• Humans within and in the vicinity of the Project Site whose activities would be temporarily altered or prevented. • Humans within and in the vicinity of the Project Site whose safety would be moderately compromised.	• Humans within and in the vicinity of the Project Site whose activities would not be altered or prevented. • Humans within and in the vicinity of the Project Site whose safety would not be compromised.
Water Quality	**Ecological Receptors**		

Environmental Parameter	Receptor Sensitivity Priority 1	Priority 2	Priority 3
	Freshwater waterbodies supporting ecosystems of biodiversity conservation significance in consultation with Biodiversity specialist.	Freshwater waterbodies which do not support ecosystems of biodiversity conservation significance in consultation with Biodiversity specialist.	Freshwater waterbodies not used for any purposes and not protected.
	Human Receptors		
	• Protected waterbodies or waterbodies used for drinking water supply or aquaculture farms	• Waterbodies used for recreational purposes • Waterbodies used for industrial and/ or agricultural water supply	• Waterbodies not used for beneficial purposes
Air Quality[2]	**Ecological Receptors**		
	Flora Species or Plant Communities, and Habitats of High Ecological Value within 20 m of construction worksite area.	Flora Species or Plant Communities, and Habitats of High Ecological Value within 20 m to 50 m of construction worksite area. Ecological sites [3] having known sensitive communities within 20 m of construction worksite area.	Ecological sites having known sensitive communities within 20 m to 50 m of construction worksite area. Any other ecological sites within the Study Area of 50 m.
	Human Receptors		
	• Sensitive receptors [4] (more than 100 receptors) within 50 m of the construction area. • Sensitive receptors (1-100 receptors) within 20 m of the construction area.	• Sensitive receptors (more than 100 receptors) between 50 m to 100 m of the construction area. • Sensitive receptors (1-100 receptor) between 20 m to 50 m of the construction area. • Office, industrial facilities, or shops (more than 10 receptors) within 20 m of the construction area.	• Public footpath, playing fields and parks within 20 m from the construction area. • All other buildings within the 250 m study boundary.
Airborne Noise[5]	**Ecological Receptors**		

[2] As per UK IAQM [R-33], ecological receptor refers to any sensitive habitat affected by dust deposition. This includes direct impacts on vegetation or aquatic ecosystems of dust deposition, and the indirect impacts on fauna (e.g., on foraging habitats) if any. In terms of air quality impact assessment of this Project, only the direct impacts on flora of conservation significance or sensitive plant communities of large specimens which are the key species affected by dust deposition will be emphasised.
[3] As per UK IAQM [R-33], ecological site refers to a site with international statutory designation, which are areas of value to the natural heritage (i.e., Special Conservation Areas (SACs), Special Protection Areas (SPAs) designated internationally under the Habitats Directive (92/43/EEC)) and RAMSAR sites (wetland site designated to be of international importance under the Ramsar Convention). Non-statutory sites (i.e., site of nature conservation interest) can be considered if appropriate.
[4] Sensitive receptors for air impact assessment include residential blocks, hospitals, medical centre, schools and education and residential care home. This is according to classification made in the IAQM's guidance. Hawker centres shall also be checked.
[5] The fact is that different species are likely to react differently to disturbance and that will be influenced by various other factors such as how percussive the noise is (e.g. from blasting and piling), how far away the receptor is generally, behaviour of the fauna, and other factors such as whether the species is feeding or breeding/nesting and in particular from the complication of visual disturbance (particularly humans on foot nearby).

Environmental Parameter	Receptor Sensitivity		
	Priority 1	**Priority 2**	**Priority 3**
	Areas inhabited by fauna Conservation Significance (CS)/ non-CS species that use sound for communication, foraging and breeding, and are known to have their behaviours disrupted by increase in baseline noise (e.g., due to immobility from impacted area such as raptor nests).	Areas inhabited by species of Conservation Significance (CS) that are less affected by airborne noise; or CS species which have the ability to move away temporarily to neighbouring areas which are not impacted by the construction noise.	Area inhabited by species that are less affected by airborne noise and are not of Conservation Significance.
	Human Receptors		
	Schools and Education Buildings, Hospitals, Religious Buildings and Medical Centres, Nursing Homes	Residential Buildings	Other Buildings (Industrial, Commercial, Infrastructure, Sport & Recreation Areas, etc.).

The scope of this EIA was documented in an Inception Report and approved on 5 March 2025.

5.3 Environmental Baseline Study and Analyses

Environmental baseline data was collected from secondary sources, namely LTA's CRL2 EIS for Turf City and Holland Plain (2022) [P-1], and the EIS for Clementi Forest and Maju Forest (2022) [P-2], and other publicly available sources such as websites.

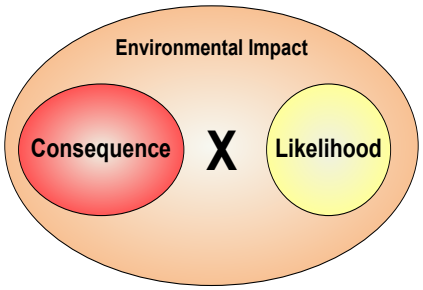
A walkover validation survey was performed to verify the locations of the flora species of conservation significance i.e., pitcher plants and orchid species. No primary data was collected through surveys, monitoring or sampling in this Study.

5.4 Impact Assessment Methodology

5.4.1 Evaluation of Impacts

Key potential environmental impacts arising from the proposed Project and significance of impacts will be assessed using the methodology described in the following sections.

In evaluating the Significance of impacts, the following factors will be taken into consideration:



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

5.4.1.1 Impact Consequence

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

- **Receptor Sensitivity**: categorises receptors according to their susceptibility to adverse impacts from the Project's construction and operational phases (refer to Table 5.2.2).

- **Impact Intensity**: defines the magnitude of the impact and the status of the impact in relation to regulations (e.g. discharge limits), standards (e.g. environmental quality criteria) and guidelines. The criteria presented in Table 5.4.1 will be used to categorise the impact intensity.

Table 5.4.1 Evaluation of impact intensity for construction and operational phases

Environmental Parameters	Impact Intensity			
	Negligible	Low	Medium	High
Biodiversity-Habitats	Potential impacts with no detectable changes to viability/function of habitats	Potential impacts with small temporal and spatial (localised) scale changes that could affect part of the habitat but does not cause the loss of viability/function of the habitat	Potential impacts with moderate duration and/or over a considerable spatial scale changes that could affect part of the habitat but does not threaten the long-term viability/function of the habitat	Potential impacts with extensive duration and large spatial scale that affects the entire habitat, or a significant proportion of it, and could affect the long-term viability/function of the habitat
Biodiversity – Flora and Fauna	No expected changes to the ecologically sensitive receptors and/or individuals	Short duration and small-scale localised spatial changes that could cause minimal changes to the ecologically sensitive receptors and/or individuals	Moderate duration and medium-scale spatial changes that could cause moderate effects on the ecologically sensitive receptors but would not threaten long-term viability	Extended duration and large-scale spatial changes that could cause substantial effects on the ecologically sensitive receptors and threaten long-term viability
Hydrology	Very minor change to existing hydrology and flow	Small scale localised changes to existing hydrology or flow	Medium scale changes to existing hydrology or flow	Major changes to existing hydrology or flow
Water Quality	No contamination; or Likely to be well within regulatory limits	Small scale localised contamination within regulatory limits	Medium scale contamination to just exceeding regulatory limits	Large scale contamination exceeding regulatory limits

Environmental Parameters	Impact Intensity			
	Negligible	Low	Medium	High
Air Quality (Construction Phase) [1]	-	For Earthworks: • Total site area <18,000 m^2 • Soil type with large grain size (e.g., sand) • <5 heavy earth moving vehicles active at any one time • Formation of bunds <3 m in height	For Earthworks: • Total site area 18,000 m^2 – 110,000 m^2 • Moderately dusty soil type (e.g., silt) • 5-10 heavy earth moving vehicles active at any one time • Formation of bunds 3 m - 6 m in height	For Earthworks: • Total site area >110,000 m^2 • Potentially dusty soil type (e.g., clay, which will be prone to suspension when dry due to small particle size) • >10 heavy earth moving vehicles active at any one time • Formation of bunds >6 m in height
	-	For Construction: • Total building volume <12,000 m^3 • Construction material with low potential for dust release (e.g., metal cladding or timber)	For Construction: • Total building volume 12,000-75,000 m^3 • Potentially dusty construction material (e.g., concrete) • On-site concrete batching	For Construction: • Total building volume >75, 000 m^3 • On-site concrete batching • Sandblasting
	-	For Trackout: • <20 HDV[2] (>3.5t) outward movements in any one day • Surface material with low potential for dust release • Unpaved road length <50 m	For Trackout: • 20-50 HDV[2] (>3.5t) outward movements in any one day • Moderately dusty surface material (e.g. high clay content) • Unpaved road length 50-100 m	For Trackout: • >50 HDV[2] (>3.5t) outward movements in any one day • Potentially dusty surface material (e.g. high clay content) • Unpaved road length >100 m
	-	For Demolition: • Total building volume <12,000 m^3 • Construction material with low potential for dust release (e.g. metal cladding or timber) • Demolition activities <6 m above ground • Demolition during wetter months	For Demolition: • Total building 12,000 – 75,000 m^3 • Potentially dusty construction material • Demolition activities 6-12 m above ground level	For Demolition: • Total building >75,000 m^3 • Potentially dusty construction material (e.g. concrete) • On-site crushing and screening • Demolition activities >12 m above ground level

Environmental Parameters	Impact Intensity			
	Negligible	**Low**	**Medium**	**High**
Air Quality (Operational Phase)	No increase in air quality levels in the vicinity of Project Site due to Project operation	Small scale increase in air quality levels in the vicinity of Project Site due to Project operation	Medium scale increase in air quality levels in the vicinity of Project Site due to Project operation	Large scale increase in air quality levels in the vicinity of Project Site due to Project operation
Airborne Noise (Construction and Operational Phase)	Ecological Receptors: No detectable change to fauna	Ecological Receptors: Potential impacts last a short duration, are reversible and/or of a small magnitude for species with low auditory sensitivity level	Ecological Receptors: Potential impacts last for a moderate duration, are reversible with significant input and compensatory measures, and/or of a moderate magnitude for species with medium auditory sensitivity level	Ecological Receptors: Potential impacts last for a long time, are non-reversible, and/or of a significant magnitude for species with high auditory sensitivity level
	Human Receptors: Just noticeable, non-intrusive, increase in noise levels: Noise can be heard but does not result in any change in behaviour or attitude. Can slightly affect the character of the area but not such that there is a perceived change in quality of life.	Human Receptors: Noticeable, mildly intrusive, increase in noise levels: Noise can be heard and may cause small changes in behaviour and/ or attitude. Potential for non-awakening sleep disturbance. Can slightly affect the character of the area but not such that there is a perceived change in quality of life.	Human Receptors: Noticeable, disruptive, increase in noise levels: Causes an important change in behaviour and/ or attitude during periods of intrusion. Potential for sleep disturbance resulting in difficulty in getting to sleep, premature awakening, and difficulty in getting back to sleep. Quality of life diminished due to change in character of area.	Human Receptors: Noticeable, very intrusive, increase in noise levels: Significant changes in behaviour and/ or an inability to mitigate effect of noise leading to psychological stress or psychological effects.

Notes:

1. This impact intensity criterion is equivalent to the Emission Magnitude as defined in IAQM's Guidance [R-33].
2. Heavy duty vehicles (HDV) defined as vehicles with a gross weight greater than 3.5 tonnes.
3. The Flora & Fauna Specialist will be consulted to identify the species sensitivity to the potential change to their habitat, conservation status and foraging regime.

An impact consequence category is then derived based on receptor sensitivity and impact intensity, as shown in Table 5.4.2, which is generally applicable for the individual impact assessments except for air quality. It should be

noted that air quality impact assessment has its own specific matrices defined based on applicable international guideline as detailed below.

Table 5.4.2 Impact consequence matrix

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

The dust impact assessment that falls under air quality evaluates the overall consequence prior to the implementation of mitigation. The worksite will be assessed by considering both the impact intensity and the Receptor Sensitivity to obtain an overall consequence rating. Since the definition of impact intensity is different for each activity, the overall consequence for each activity are explained in matrices shown in Table 5.4.3 to Table 5.4.5. Each activity for the worksite has been rated as being High, Medium, Low, or Imperceptible in terms of overall consequence based upon pre-mitigation measures but with incorporation of minimum controls.

Table 5.4.3 Impact consequence matrix for air impact analysis (Earthworks)

Receptor Sensitivity / Impact Intensity	Priority 3	Priority 2	Priority 1
Negligible	-	-	-
Low	Imperceptible	Low	Low
Medium	Low	Medium	Medium
High	Low	Medium	High

Table 5.4.4 Impact consequence matrix for air impact analysis (Construction)

Receptor Sensitivity / Impact Intensity	Priority 3	Priority 2	Priority 1
Negligible	-	-	-
Low	Imperceptible	Low	Low
Medium	Low	Medium	Medium
High	Low	Medium	High

Table 5.4.5 Impact consequence matrix for air impact analysis (Trackout)

Receptor Sensitivity / Impact Intensity	Priority 3	Priority 2	Priority 1
Negligible	-	-	-
Low	Imperceptible	Low	Low
Medium	Low	Medium	Medium
High	Low	Medium	High

5.4.1.2 Likelihood

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

Table 5.4.6 Likelihood criteria

Likelihood Criteria	Definition for All Environmental Parameters	Definition for Airborne Noise (Construction)
Unlikely/ Remote	Would be unlikely or not expected to occur during construction and operational activities	Frequency of exposure of less than 5% to active duration of equipment over daily working period
Less Likely/ Rare	Would less likely/ rarely occur during construction and operational activities	Frequency of exposure of 5% and up to 15% to active duration of equipment over daily working period
Possible/ Occasional	Would possibly/ occasionally occur during construction and operational activities	Frequency of exposure of 15% and up to 25% to active duration of equipment over daily working period
Likely/ Regular	Would likely to occur or would occur on a regular basis during construction and operational activities	Frequency of exposure of 25% and up to 50% to active duration of equipment over daily working period
Certain/ Continuous	Would be certain to occur or would occur continuously during construction and operational activities	Frequency of exposure of more than 50% to active duration of equipment over daily working period

References:

Ecological Impact Assessment (EcIA). EIANZ Guidelines for use in New Zealand: terrestrial and freshwater ecosystems. 2nd Edition. May 2018. [R-40]

CIEEM (2018). Guidelines for ecological impact assessment in the UK and Ireland: Terrestrial, Freshwater and Coastal. September 2018. [R-41]

5.4.1.3 Impact Significance

The significance of each impact will be determined by assessing the impact consequence against the likelihood of the impact occurring using the Impact Significance Assessment Matrix. A simple risk-based matrix will be used for summation of consequence and likelihood, a sample of which is shown below in Table 5.4.7.

Table 5.4.7 Impact significance matrix

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

Positive impacts are classified under a single category. Impacts assessed as Negligible or Minor will require no additional management or mitigation measures (on the basis that the magnitude of the impact is sufficiently small, or that the receptor was of low sensitivity and/or that adequate controls were already included in the Project design). Negligible and Minor impacts are therefore deemed to be "Insignificant". Impacts evaluated as Moderate or Major require the adoption of management or mitigation measures. Major impacts are therefore deemed to be "Significant" and Moderate impact as "Relatively Significant". Major impacts require further management or mitigation measures to minimise the impact as far as possible. An "acceptable level" is the reduction of a major impact to a moderate one after mitigation. In seeking to mitigate Moderate impacts, the emphasis is on demonstrating that the impact has been reduced to a level that is as low as reasonably practicable. It will not always practical to reduce Moderate impacts to Minor ones in consideration of the cost-ineffectiveness of such an approach (due to the diminishing return of a reduction of impact versus cost). Residual impact assessment shall be conducted for those parameters where impact from the activity is identified to be significant and additional mitigation measures are recommended. Positive impacts were not assessed for significance. Assessment of residual impact shall follow similar risk approach as outlined above.

Detailed prediction and evaluation of impacts specific to each environmental parameter are provided in the following sections.

5.4.2 Biodiversity

The biodiversity impact assessment methodology is described below.

Table 5.4.8 Biodiversity impact assessment methodology

Biodiversity	Methodology	Justification
Assessment Criteria	Applicable legislation detailed in Table 3.5.1.	Assessment will be in accordance with the NParks' BIA guidelines [R-9].
Predictive Methods	Qualitative assessment to evaluate the ecological value of the habitats, floral and faunal species recorded within the Study Area. Sensitive receptors within the Study Area and within the immediate surrounding area (if any) which may be impacted by the Project's construction and operational activities were identified. Sensitive receptors were sub-categorised into three priority levels (Table 5.2.2) depending on their ecological value. Thereafter, a qualitative impact assessment evaluated the potential impacts from the Project's construction and operational activities on the identified sensitive receptors, taking into consideration the likelihood (Table 5.4.6) of impact occurrence; where the likelihood depends on factors such as	

Biodiversity	Methodology	Justification
	duration of impact. Suitable mitigation measures will then be recommended based on the assessed potential impacts.	

5.4.3 Hydrology and Water Quality

The hydrology and water quality impact assessment methodology are described below.

Table 5.4.9 Hydrology and water quality impact assessment methodology

	Methodology	Justification
Impact Prediction (Construction and Operational Phases)		
Assessment Criteria	Singapore Environmental Protection and Management (Trade Effluent) regulations [R-15;R-16] Singapore PUB Code of Practice on Surface Water Drainage, 2018 [R-18] Water Quality Criteria for Aquatic Life from other countries including ASEAN Strategic Plan of Action on Water Resources Management 2005 [R-28] United Nations Economic Commission for Europe [R-20] World Health Organization (WHO) [R-21] United States Environmental Protection Agency [R-22] Mitigating Impact from Aquaculture in the Philippines [R-25] Canadian Water Quality Guidelines for the Protection of Aquatic Life [R-24] and Australian & New Zealand Guidelines for Freshwater and Marine Water Quality [R-23]	-
Predictive Methods	Qualitative and analytical methods were applied to assess surface water quality impacts of the proposed development's construction and operational phases; and Qualitative water quality impact assessment were carried out with the assumption that the related standard minimum controls have been implemented; and Hydrological analysis and catchment delineation of the site were carried out to supplement surface water quality impact assessment.	Qualitative and analytical methods were applied to assess the hydrology and surface water quality impacts of the proposed development's construction and operational phases; Qualitative water quality impact assessment was carried out with the assumption that the related standard minimum controls have been implemented; and Hydrological analysis of the site was carried out to supplement surface water quality impact assessment. Impacts related to the stream alignment and potential runoff were identified.

5.4.4 Air Quality

The air quality impact assessment methodology is described below.

Table 5.4.10 Air quality impact assessment methodology

Air Quality	Methodology	Justification
Impact Prediction (Construction)		
Assessment Criteria	Assessment broadly followed "Guidance on the Assessment of Dust from Demolition and Construction" which was published by the UK Institute of Air Quality Management (IAQM) in 2024 [R-33].	The assessment will determine the likely magnitude (high, medium, low) of impact to ambient air quality from the Project. The assessment will recommend mandatory, and good practices/mitigation measures to be adopted based on the scale of construction activities on site in order to pose a low risk to the air sensitive receptors in the vicinity.
Predictive Methods	**Qualitative Assessment** following dust risk assessment methodology focusing on fugitive particulate emissions (dust) from the construction site.	Dust Risk Assessment was conducted for earthworks, construction, trackout and demolition (if any) activities during the construction. Study was conducted using parameters like volume of spoil, volume of concrete used, area of construction site, number of vehicles and access routes for construction, and soil type of the construction worksite area.
Impact Prediction (Operation)		
Assessment Criteria	Compare the change in predicted increase in traffic volume and access routes due to operation of the Project.	-
Predictive Methods	Qualitative assessment was conducted to assess air quality impacts of the development operational phases due to increased traffic in the vicinity.	Air quality impact assessment will help to understand the impact of operational activities, such as the increase in traffic volume in the vicinity of the Project.

5.4.5 Airborne Noise

The airborne noise impact assessment methodology is described below.

Table 5.4.11 Airborne noise impact assessment methodology

Air Quality	Methodology	Justification
Impact Prediction (Construction)		
Assessment Criteria	Assessed all noise sensitive receptors when compared to Environmental Protection and Management (Control of Noise at Construction Sites) Regulations, 2008 [R-31].	Legislative requirement for the noise emissions due to the construction activities.
	Biodiversity 2020 (UK) "Theme 3: reduce environmental pressures - integrate consideration of biodiversity within the sectors which have the greatest potential for direct	Local and international policies to address airborne noise's impact on human health but inferring effects on biodiversity from human impacts is unreliable due to differing auditory sensitivities. Human noise criteria are based on a 20Hz to 20 kHz frequency range, while species-specific hearing capabilities vary.

Air Quality	Methodology	Justification
	influence and reduce direct pressures." [R-32]	Baseline noise for weekdays were used as the criteria to be maintained preferably for the fauna in the intact non disturbed areas of the development. A no worse-off criteria step change of 3 dB similar to humans was used to devise the criteria for low, medium, and high impacts for impact intensity.
Predictive Methods	Qualitative assessment of Cumulative noise in Decibels (dB) generated from construction activities within the Project Site and the Baseline at sensitive receptors based on the Singapore SS 593: Code of Practice for Pollution Control (COPPC), 2013 [R-13], Singapore standard. SS602:2014 "Code of Practice (CP49) for Noise Control on the Construction and Demolition Sites; [R-30] and British Standard BS5228-1:2009 [R-39]. Qualitative assessment of the cumulative impacts from nearby activities surrounding the proposed Project.	Noise impact assessment will help to understand the impact of Project's construction activities.
Impact Prediction (Operation)		
Assessment Criteria	Biodiversity 2020 (UK) "Theme 3: reduce environmental pressures -integrate consideration of biodiversity within the sectors which have the greatest potential for direct influence and reduce direct pressures." [R-32]	Local and international policies to address airborne noise's impact on human health, but inferring effects on biodiversity from human impacts is unreliable due to differing auditory sensitivities. Human noise criteria are based on a 20 Hz to 20 kHz frequency range, while species-specific hearing capabilities vary.
	Assessed all noise sensitive receptors when compared to Guideline on Boundary Noise Limit for Air Conditioning and Mechanical Ventilation (ACMV) Systems in Non-Industrial Buildings by National Environmental Agency (NEA) [R-38] from air conditioning and mechanical ventilation (ACMV) noise, if applicable.	Legislative requirements for boundary noise due to noise emissions from mechanical ventilation systems for non-industrial buildings.
	Assessed all noise sensitive receptors when compared to existing ambient noise levels experienced by ecological receptors in proximity to areas proposed for erection of Non-Industrial Buildings with Air Conditioning and Mechanical Ventilation Systems.	No existing legislative requirements for boundary noise emissions from Non-Industrial Buildings with Air Conditioning and Mechanical Ventilation Systems applicable to ecological receptors. Ambient noise levels captured near existing/ new proposed infrastructures was adopted representative of assessment criteria.
	Traffic noise with the NEA Technical Guideline for Land Traffic Noise Impact	Legislative requirements for Land Traffic Noise Impact Assessment for the proposed

Air Quality	Methodology	Justification
	Assessment, 2023 [R-37] for noise sensitive receptors.	developments for the noise sensitive receptors for the project.
	Assessed all noise sensitive receptors when compared to existing ambient noise levels experienced by ecological receptors in proximity to land traffic/ roads.	No existing legislative requirements for boundary noise emissions from land traffic/ roads applicable to ecological receptors. Ambient noise levels captured near existing/ new proposed traffic networks was adopted representative of assessment criteria.
Predictive Methods	Qualitative assessment was conducted to assess operational airborne noise impacts due to increased traffic and potential operational noise emissions in the vicinity of the Project.	Noise impact assessment will help to understand the impact of Project's operational activities.

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

Where implemented minimum controls are insufficient in alleviating significant environmental construction and operational impacts (i.e. 'significant impacts' are defined as 'Moderate' or 'Major' impacts), Project-specific mitigation measures will be proposed in consultation with URA. Where applicable and practical, engineering control measures will be accompanied by specifications (product brochures), estimated cost and source of supply. In addition, mitigation measures at receptors' end will also be recommended on a case-by-case basis. For example, if the unmitigated construction noise levels are found to exceed the relevant criteria, practical direct mitigation measures such as the use of noise barriers, enclosures, quieter powered mechanical equipment (PME) and construction methods, etc, will be recommended. Effective dust control measures will be recommended to minimise dust emission from the site, where necessary. Mitigation measures will be proposed in accordance with the following hierarchy in line with Biodiversity Impact Assessment (BIA) Guidelines published by NParks in 2020 [R-9]:

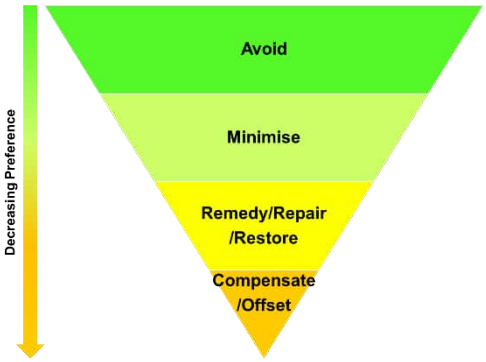


Figure 5.5.1 Mitigation hierarchy

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

Minimise – Where changes to the Project design and construction/ operation methodology cannot affect impact elimination or avoidance, use of alternative construction methodology or any enhancement measures can be adopted to minimise for identified impacts. For example, a directional clearance plan and wildlife corridor will be proposed to ensure that animals trapped within the site can escape into the surrounding vegetation.

Remedy/ Repair/ Restore – Where changes to the Project design and construction/ operation is unable to result in impact avoidance and impact minimisation, restoration methodology can be applied after construction is completed to remedy/ repair/ restore the ecological habitat as much as possible. For example, after construction, appropriate trees and shrubs can be replanted in appropriate locations within the impacted site to restore part of the habitat.

Compensation/ Offset – Where measures taken to compensate or offset the residual impacts after implementing the first three steps of the mitigation hierarchy, wherever technically and financially feasible. An example would be the transplanting of rare shrubs or trees to other suitable sites in consultation with government authorities, etc.

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

5.6 Evaluation of Cumulative Impacts

As described in Section 3.5, there are other concurrent construction activities planned in the vicinity of the Project. The cumulative impacts of these concurrent developments will be assessed qualitatively in each individual section of different environmental disciplines.

5.7 Stakeholder and Public Engagements

It is known that effective communication and cooperation between various expert groups, the Client and other stakeholders can minimise risks throughout the project delivery process.

A Nature Group (NG) engagement was held on 21 July 2025 to share findings from the study, the proposed plans for the area, the associated environmental impact assessment, proposed environmental monitoring and management plan (EMMP) and also to better understand the concerns regarding the Project.

Key concerns that were raised during the NG engagement and subsequently adding into this report include:

1. Impacts on invertebrates from fumigation (Section 11.1.2.3)
2. Creating a narrative of the site's natural heritage (Section 6.2)

6 Description of the Environment

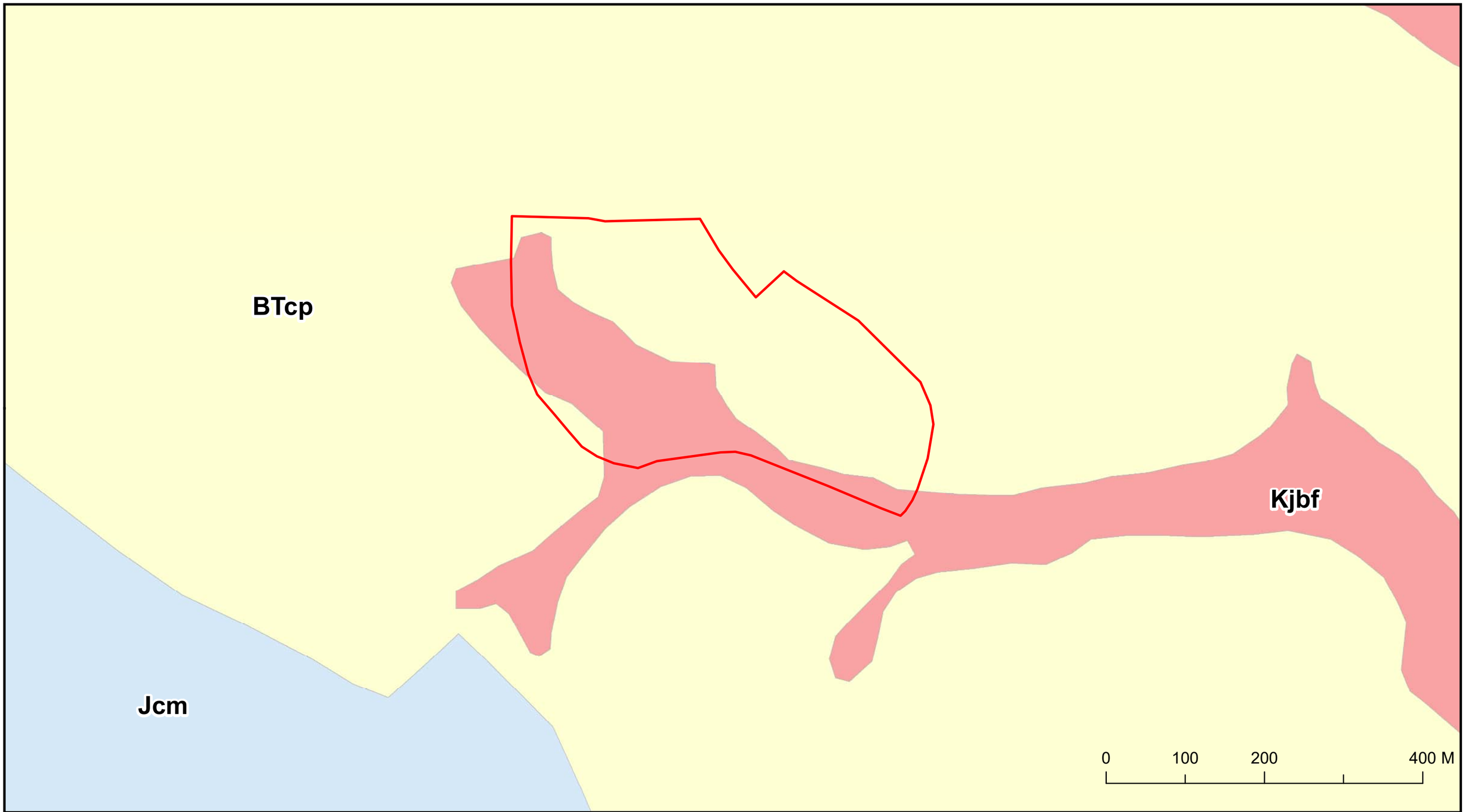
6.1 Physical Environment

6.1.1 Geology

Based on the Geological Map of Singapore (see Figure 6.1.1), the Study Area is mostly underlain by Choa Chu Kang Granodiorite-tonalite Pluton (CCK GtP) and Jalan Besar (Kjbf) formation.

The granite-rock accouts for more than 50 percent of CCK GtP while mixed and or mingled mafic- felsic- rocks are found around 15 to 20 per cent, forming an area with extremely high rock strength. It has notably lower porosity possibly due to recrystallisation associated with tectonic deformation.

The Jalan Besar formation comprises silt to coarse sand with occasional traces of organic matter and pebbles. It ranges in colour from brown and red to light-grey. Usually found at depths of 40m, it occurs nearer the surface towards the centre of the island. It is highly permeable and this limits their usefulness as aquifers. Peat and soft clay, also found in the formation are highly compressible deposits will provide very poor foundation conditions. Its sand rich nature also means that immediate support is needed for excavations in the area.



Legend

- Study Area
- CCK GtP (BTcp)
- Clementi Formation (Jcm)
- Jalan Besar Formation (Kjbf)

N

Rev.	Date	By	Description	Chk'd	App'd
-	MAR 2025	LHN	Holland Plain EIA	LAL	JAG

Qualified Person Endorsement : NA

URA Endorsement : NA

Consultant : AECOM

Client: Urban Redevelopment Authority

Project Title :

CONTRACT URA/T/23/048
HOLLAND PLAIN
ENVIRONMENTAL IMPACT ASSESSMENT

Figure Title :

Geological map of the Study Area and its surrounding

Designed	Checked	Approved
LHN	LAL	JAG
	Drawn: LHN	Date: MAR 2025

Figure No. : 6.1.1 | Rev. : - | Sheet : 1 of 1

CAD File Name : NA | A3

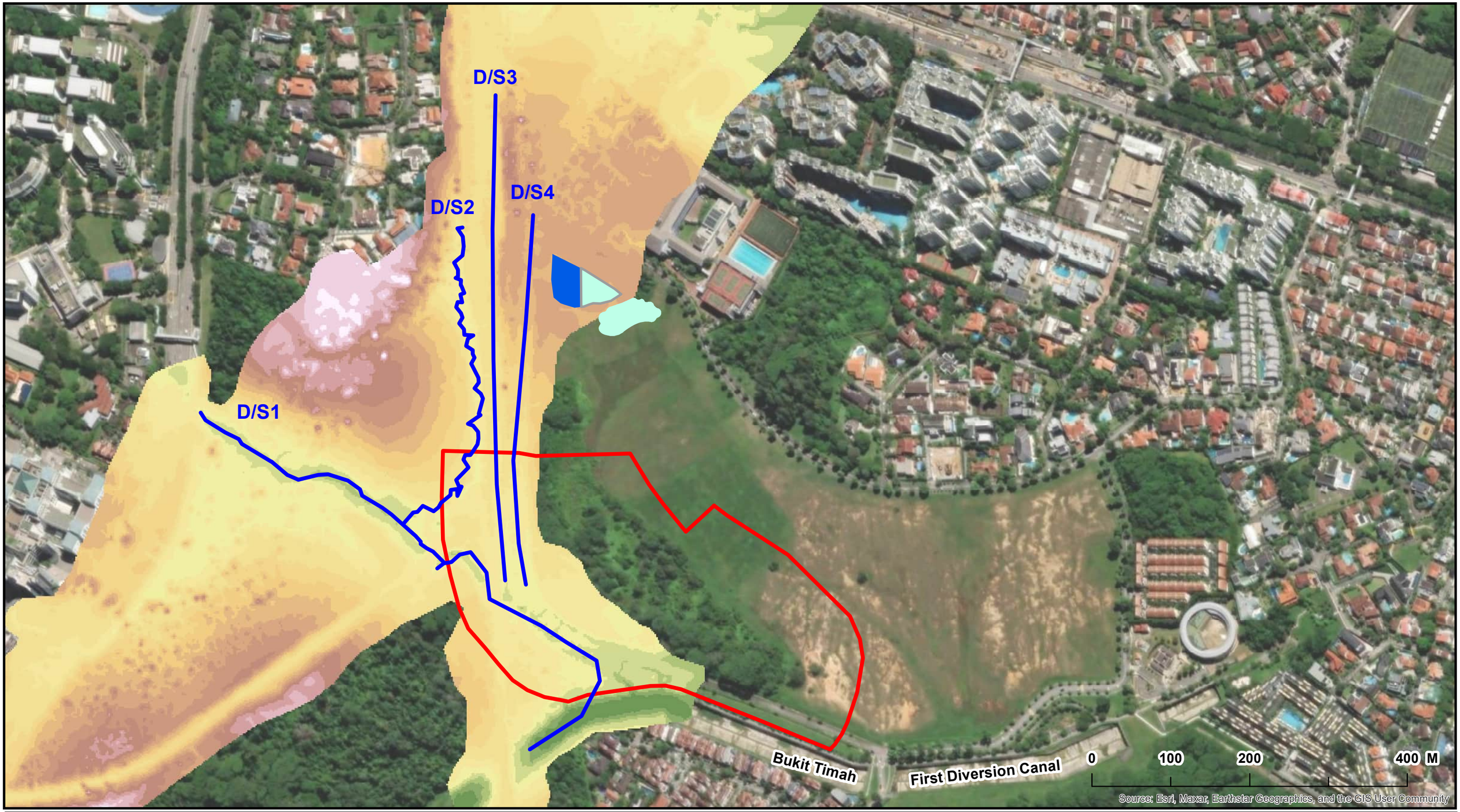
Note: Source of basemap - Google Earth Map

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6.1.2 Topography

The topography data used in this Study is from the Holland Plain section of the EIS for Turf City and Holland Plain (2022) [P-1], and the Clementi Forest section of the EIS for Clementi Forest and Maju Forest (2022) [P-2]. The data is incomplete over the Study Area but provides a general overview of the elevation over the Study Area, and is depicted in Figure 6.1.2. A levels map provided by the Client supplemented the existing topographic data for further analysis done in the Study.

Based on the review of the known topography data, it was noted that the topography of the Study Area generally slopes downwards from north to south with elevations ranging from 3 to 20 mSHD. The Freshwater Marsh that was studied as part of LTA's EIA lays on higher elevation compared to its surrounding at 26 mSHD.



Legend

- Waterbodies
- Study Area

Status

- Retained Freshwater Marsh
- New Freshwater Marsh
- Freshwater Marsh (Natural)

Elevation

- <6
- 6 - 8
- 8 - 10
- 10 - 12
- 12 - 14
- 14 - 16
- 16 - 18
- 18 - 20
- 20 - 22
- 22 - 24
- 24 - 26
- 26 - 28
- 28 - 30
- 30 - 32
- 32 - 34
- 34 - 36
- >36

N

Rev.	Date	By	Description	Chk'd	App'd
1	AUG 2025	LHN	Holland Plain EIA	LAL	ADP
-	MAC 2025	LHN	Holland Plain EIA	LAL	JAG

Qualified Person Endorsement : NA

URA Endorsement : NA

Consultant : AECOM

Client: Urban Redevelopment Authority

Project Title :

CONTRACT URA/T/23/048
HOLLAND PLAIN
ENVIRONMENTAL IMPACT ASSESSMENT

Figure Title :

Elevation Map with freshwater bodies within Study Area

Designed	Checked	Approved
LHN	LAL	JAG
	Drawn: LHN	Date: MAC 2025

Figure No. : 6.1.2 | Rev. : - | Sheet : 1 of 1

CAD File Name : NA | A3

Note: Source of basemap - Esri, Maxar, Earthstar Geographics, and the GIS User Community

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6.1.3 Catchment Area

As Singapore does not have extensive natural aquifers or lakes and has limited land to store collected stormwater, it aims to maximise stormwater harvesting. Stormwater is collected through a network of rivers, canals and drains and channelled to seventeen (17) reservoirs, after which it is treated, filtered and disinfected at the water treatment plans. Stormwater is one of Singapore's main sources of drinking and industrial water. As shown Figure 6.1.3, the Study Area falls within the catchment for Pandan Reservoir that is used for drinking water. All drains and streams within the Study Area eventually drains into the reservoir. The detailed hydrology baseline information will be further discussed in Section 7.2.1.

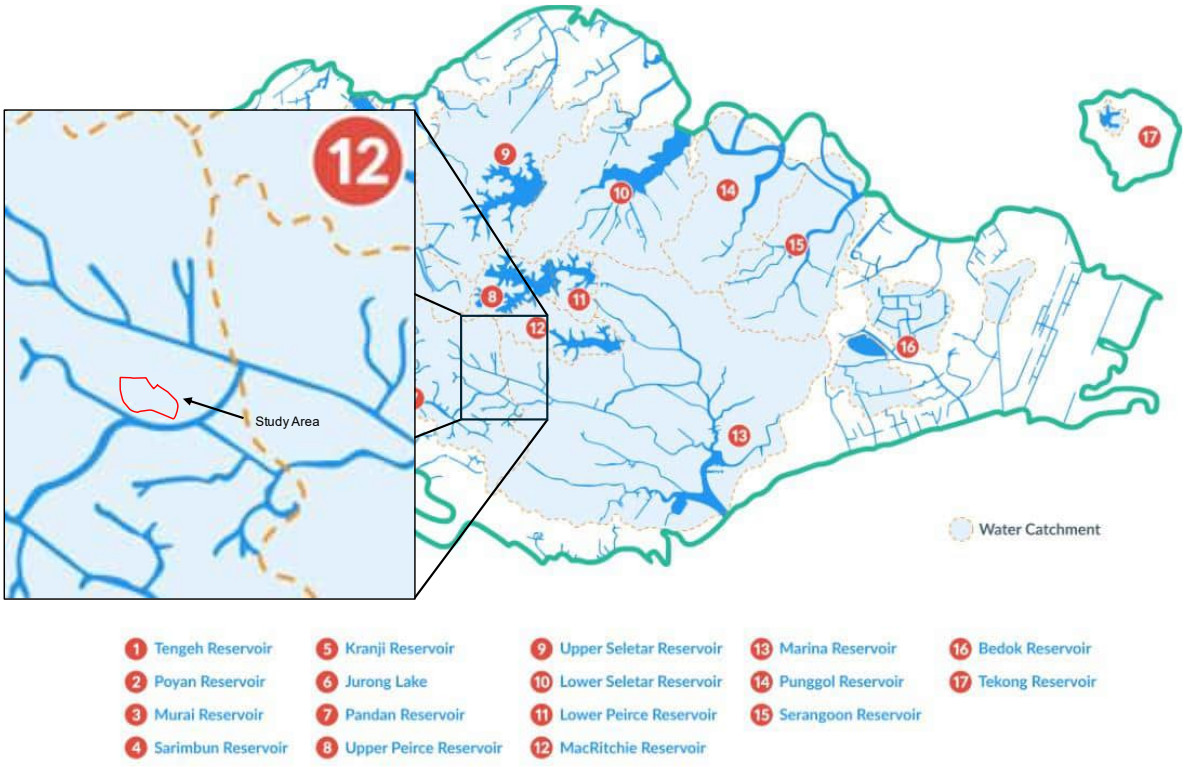


Figure 6.1.3 Figure of catchment areas in Singapore

6.1.4 Climate

6.1.4.1 Rainfall

Singapore is situated near the equator and has typically tropical climate. Singapore's year-to-year rainfall is highly variable. The long-term mean annual rainfall total is 2534.3 millimetres (mm) when averaged across island-wide stations with long-term records [W-27]. Based on the findings from MSS, the annual rainfall total has increased at an average rate of 77.3 mm per decade, and hourly rainfall increased at the rate of 0.5 days per decade for heavy rain (>40 mm) and reduced by 0.1 days per decade for very heavy rain (>70 mm) from Year 1980 to 2023 (refer to Figure 6.1.4).

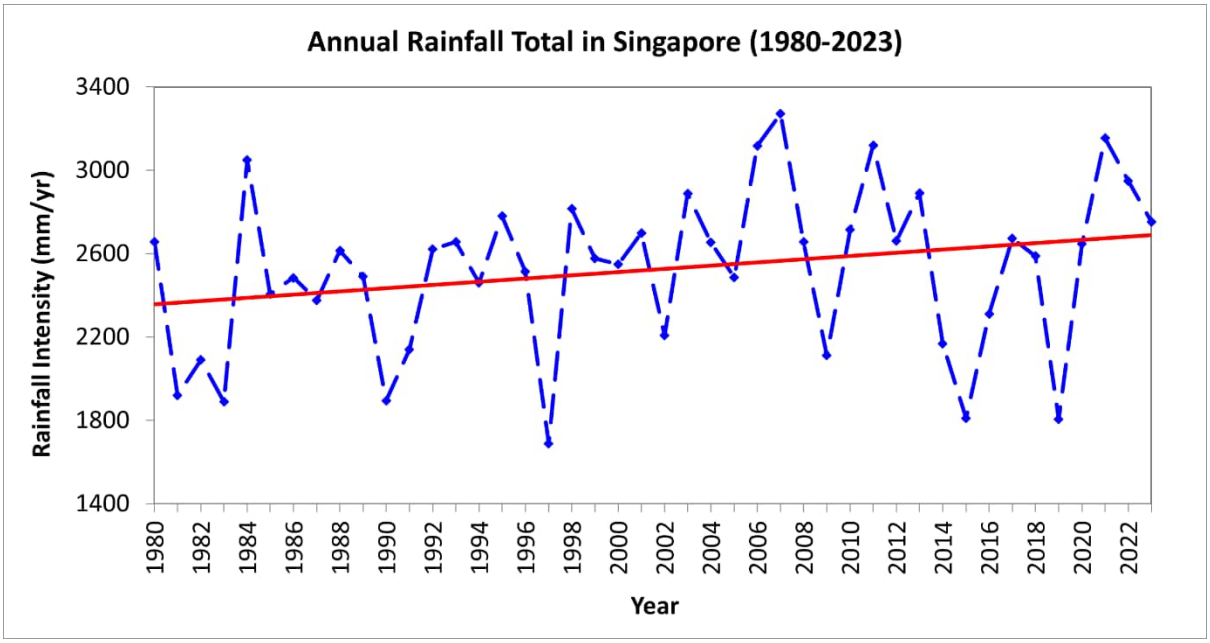


Figure 6.1.4 Annual rainfall total in Singapore from 1980 to 2023 (Source: Meteorological Service Singapore [MSS] [W-30]).

In terms of spatial distribution, rainfall is higher over the northern and western parts of Singapore and decreases towards the eastern part of the island (Figure 6.1.5) [W-29]. The figure also shows that the Central Catchment possibly receives the maximum rainfall in Singapore.



Figure 6.1.5 Annual average rainfall spatial distribution (1991-2020) (Source: MSS).

The annual average rainfall in the Project Site is anticipated to be approximately 2,200 mm to 2,400 mm. The recent findings from MSS had shown an overall upward trend in total annual rainfall at increased average rates ranging from 0.7 mm/ year to 12.3 mm/year, during the period from 1980 to 2023 (refer to Figure 6.1.6) if compared to the 30-years long-term basis, except for the areas near Queenstown climate station at the south of Singapore and Tai Seng climate station at the central of Singapore [W-29].

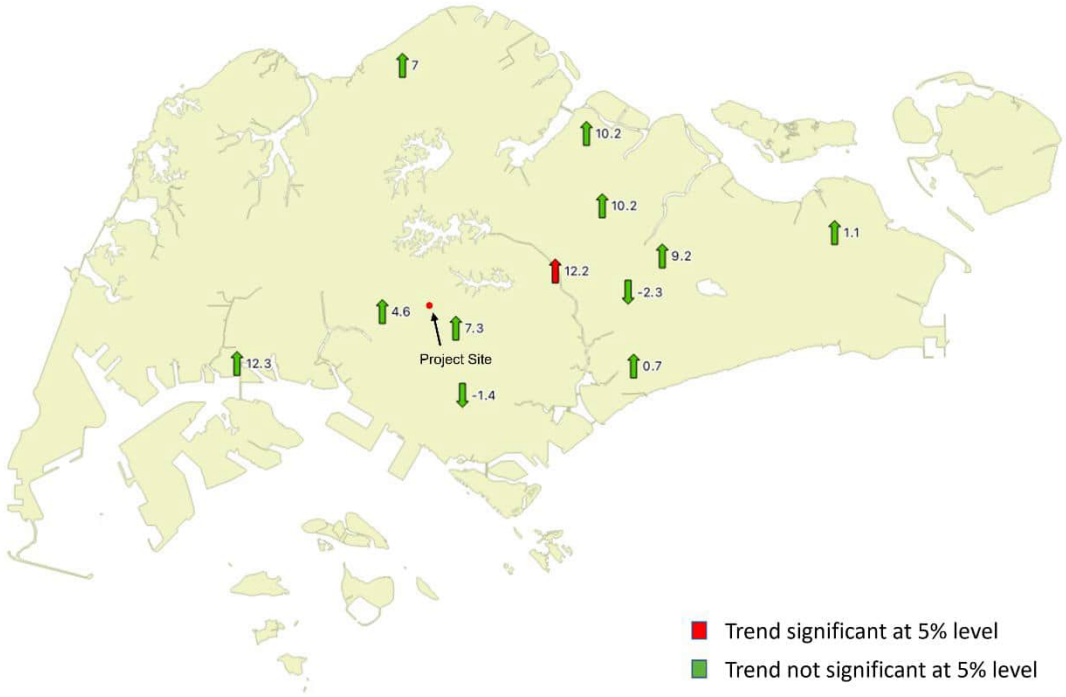


Figure 6.1.6 Past trends of annual rainfall total at indicative stations (1980-2023) [W-30]

6.1.4.2 Temperature

Singapore's continuous temperature records since 1948 show that the island has warmed by an average of 0.25°C per decade, with a visible and sudden rapid increase after the mid-1970s (see Figure 6.1.7). This may have been due to the rapid economic development and urbanisation that took place after Singapore's political reformation, as well as due to the influence of anthropogenic global warming effects. Eight (8) out of the ten (10) warmest years recorded in Singapore have occurred in the 21st century and all ten (10) occurred after 1997. This increasing trend has led to an increase in warm days and warm nights, and a decrease in cool days and cool nights.

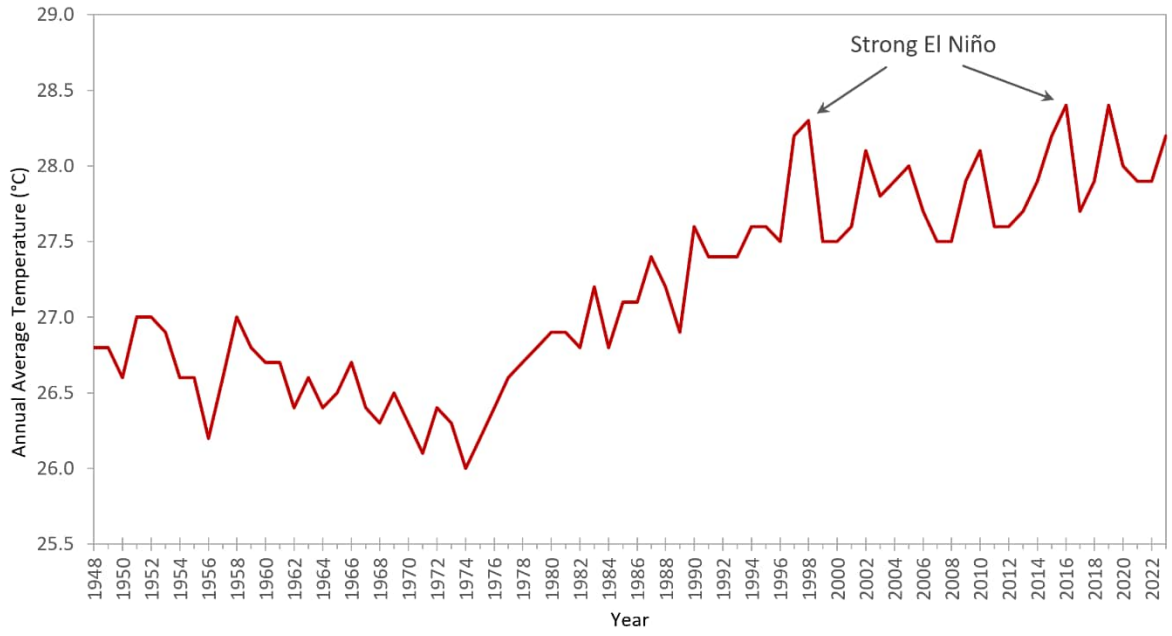


Figure 6.1.7 Annual mean temperature in Singapore from 1948 to 2023 (Source: MSS [W-30]).

Generally, the temperature variation throughout the year is relatively small as compared to the mid-latitude regions [W-27**]**. The mean temperature from 2015 to 2024 was 28.11°C, which is 0.05°C higher than the previous record of 28.06°C for the decade from 2014 to 2023. In Year 2024, the annual mean temperature was 28.4°C, with April 2024 being the warmest month at 29.4°C and December 2024 being the coolest month at 26.8°C. Overall, the annual mean temperature of Year 2024 is 0.5°C above the long-term average of 27.8°C. July 2024 has exceeded the long-term monthly temperature records [W-27] as shown in Figure 6.1.8.

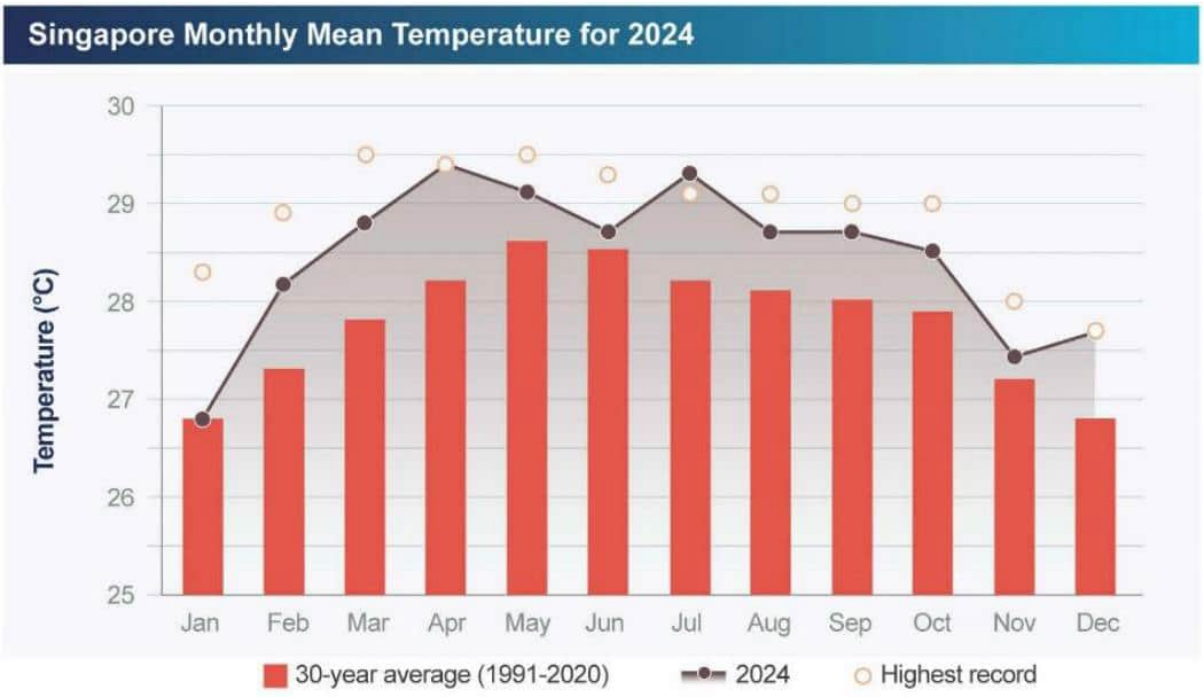


Figure 6.1.8 Singapore monthly mean temperature for 30-years average from Changi Climate Station with comparison to Year 2023 monthly mean temperature [W-27].

Although there is no distinct borderline between “urban” and “rural” areas in Singapore, maximum temperature difference of 4.01°C was observed between well-planted area, such as the LCK area, and the Central Business District (CBD) area [P-56]. This shows the presence of an Urban Heat Island (UHI) effect in Singapore. Green areas in cities have been considered as potential measure in mitigating the UHI effect. This finding is also supported by a study conducted by Jusuf et al (2007), which shows different daytime temperature at different type of land use areas in Singapore. As observed in Figure 6.1.9, the daytime temperature in park areas is considerably lower compared to other type of land use areas [P-57].

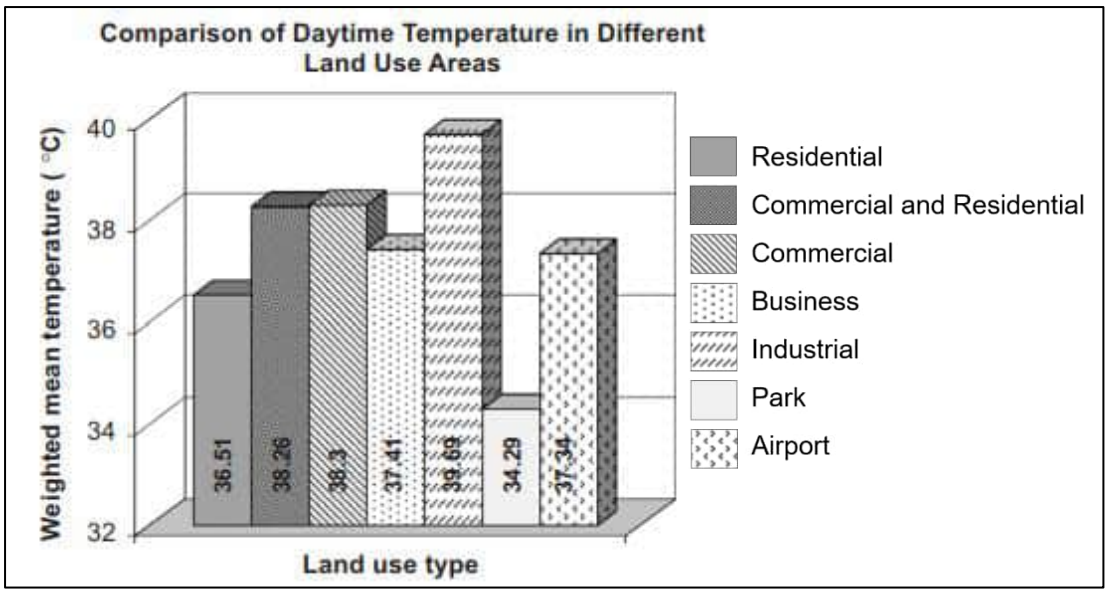


Figure 6.1.9 Comparison of daytime and night time temperature in different land use areas [P-57].

6.1.4.3 Relative Humidity

Relative humidity shows a fairly uniform pattern throughout the year and does not vary much from month to month (refer to Figure 6.1.10). Its daily variation is more marked, varying from more than 90% before sunrise to around 60% in the afternoon on days when there is no rain. While the mean annual relative humidity is 82%, the relative humidity frequency reaches 100% during prolongated periods of rain.

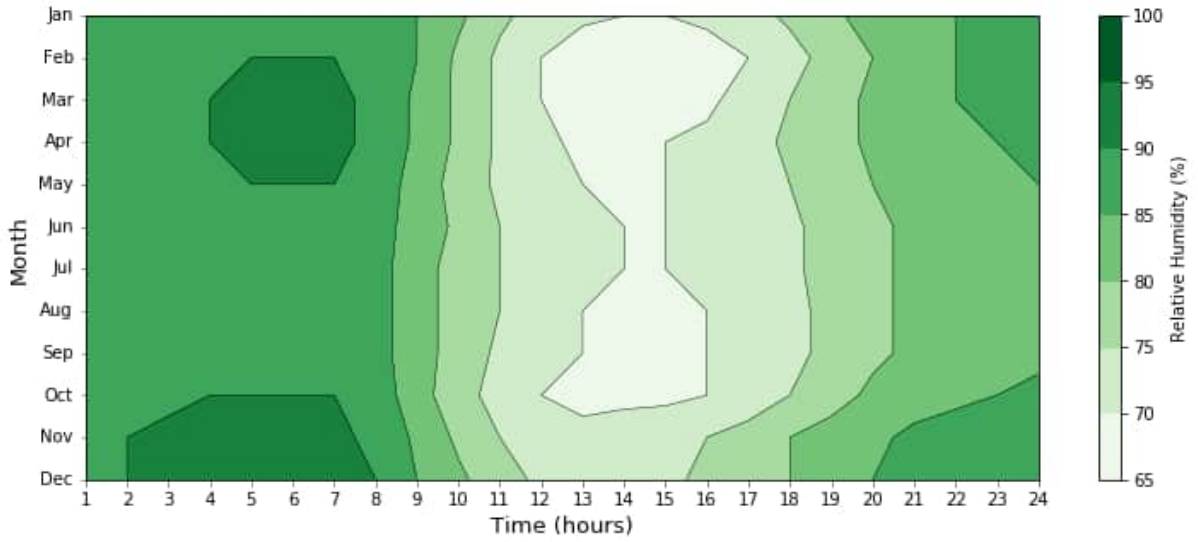


Figure 6.1.10 Hourly variation of relative humidity for each month from 1981 to 2020 (Source: MSS [W-29])

6.1.4.4 Surface Wind

Winds in Singapore are generally light, with the mean surface wind speed of 2.32 m/s. An exception to this is during the presence of a Northeast Monsoon surge, where mean speeds of 10 m/s or more have been observed. Strong winds also occur during thunderstorms. Surface wind gusts are produced from thunderstorm downdrafts and from the passage of Sumatra Squall Lines. As shown in Figure 6.1.11, the most prominent winds in Singapore are from northeast, south, and southwest, occuring during the Northeast and Southwest Monsoon, respectively. The mean monthly wind speeds ranges from 1.5 m/s to 9 m/s [W-29].

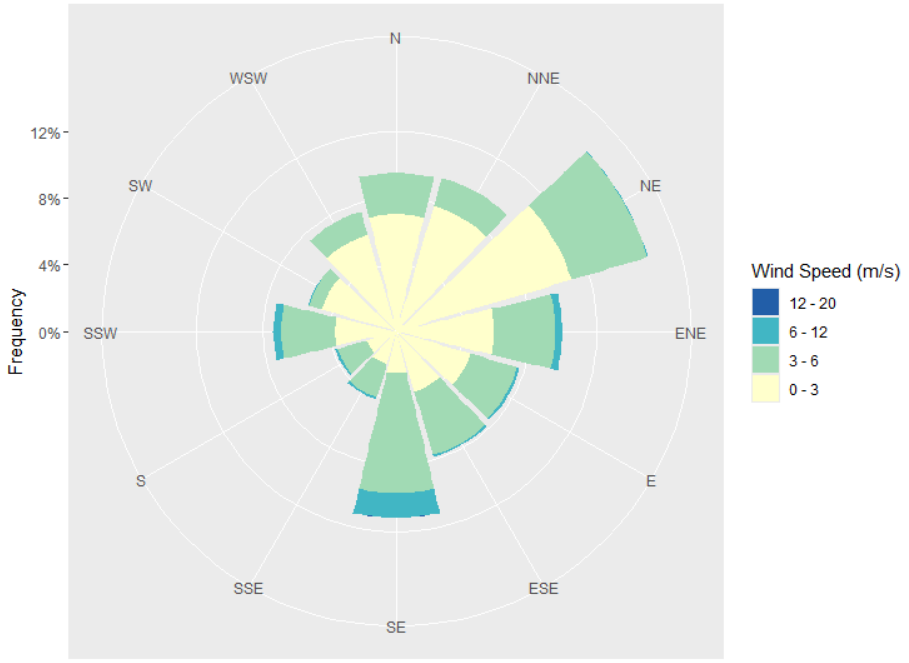


Figure 6.1.11 Annual wind rose of Singapore of 2023 (Source: NEA [W-32])

6.2 Historical Land Use

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

A chronological account of the changes in land use of the Project Site is provided below, with inferences drawn from historical resources (maps and aerial photographs) contained within the National University of Singapore Libraries Historical Maps of Singapore [M-2], unless otherwise stated.

Holland Plain in Singapore has undergone significant transformations over the years. In 1914, it was a forested area that may have included a freshwater swamp. By 1945, much of the area had been cleared, with the turf club developed to the northeast and a train track constructed through the Clementi Forest. Holland Plain itself was turned into a Hakka Chinese cemetery. By 1975, the cemetery was still in use. However, by 1998, the cemetery was exhumed, and the remains were relocated to the Fong Yun Thai Association Columbarium, marking a shift in the area's land use and development.

Small forest patches in Singapore, such as Clementi Forest, provide stepping stones for forest-dependent wildlife to move across the fragmented landscape. Landscape-level habitat connectivity is crucial in maintaining the long-term viability of populations and important ecological processes (Nor et al., 2017 [**P-23**]). The Project Site is located close to key biodiversity hotspots like Bukit Timah Nature Reserve and Central Catchment Nature Reserve and provides important habitats for wildlife across the landscape. The Project Site is hence potentially ecologically sensitive in its own right, and important in a regional context. Providing context of the heritage and ecological significance around the site to developers and residents can promote a greater sense of ownership and sensitivity to the site context. For instance, developers could adopt design measures that facilitate a better appreciation of the local flora (e.g. storyboards on natural heritage, choice of planting palette).

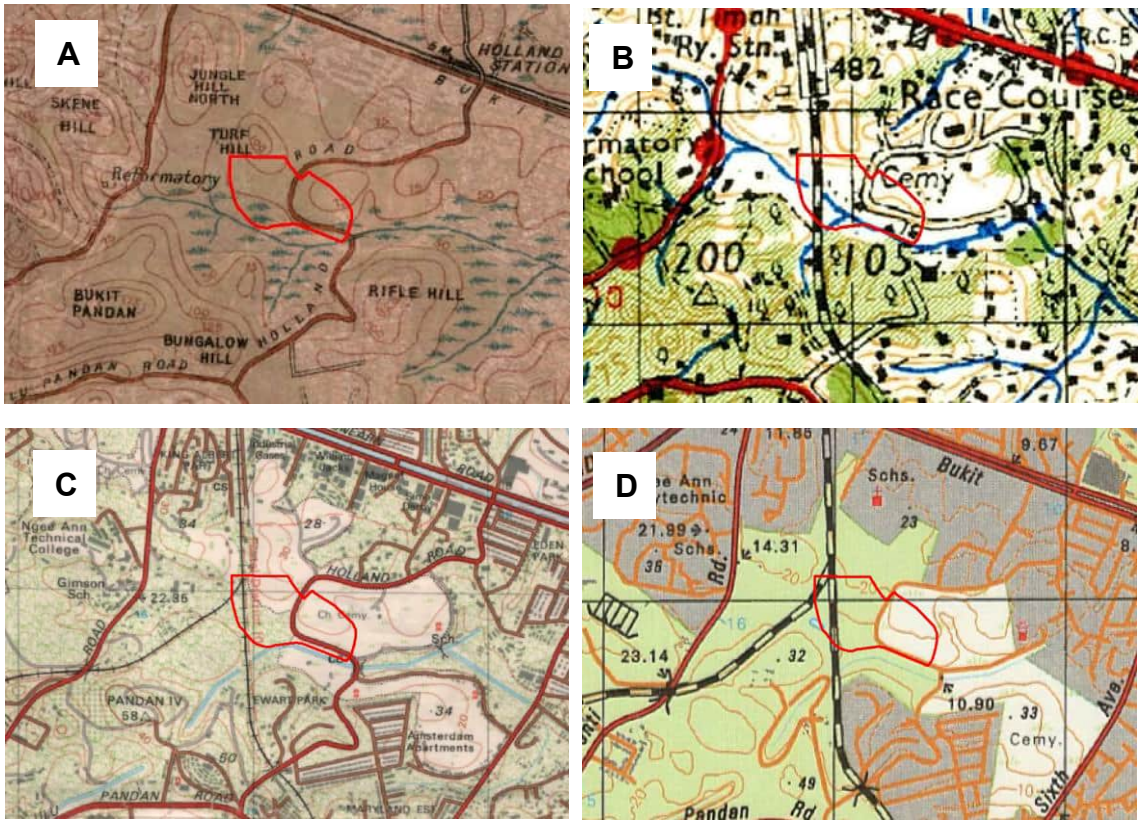


Figure 6.2.1 Maps showing chronological land use of the Study Area (bounded in red line) in (A) 1914; (B) 1945; (C) 1975; (D) 1998. Source: National University of Singapore Libraries (2021) [M-2]

6.3 Current Land Use

The Study Area encompasses three distinct zones: Holland Plain, the Rail Corridor (part of Clementi Forest), and the Holland Green Linear Park. The portion of the Study Area overlapping with Holland Plain is undeveloped, consisting of an open field with patches of scrubland and exotic-dominated forests, which is frequently used for activities such as flying model aeroplanes, drones and kites. There is an existing temporary road for maintenance and construction between Blackmore Drive and Holland Plain. The Rail Corridor, a continuous green passage (as well as a small area of the Clementi Forest), is another part of the Study Area. It serves as a vital ecological corridor and is popular for recreational activities. The section of the Rail Corridor within the Study Area is next to Clementi Forest and the region beyond it remains largely undeveloped. Lastly, the Holland Green Linear Park is part of a network of trails further connecting the Rail Corridor to other nature parks, along the Bukit Timah First Diversion Canal. Other existing land use types within and around the Study Area can be seen in Figure 3.2.1.

7 Environmental Baseline Conditions

As mentioned in the previous sections, baseline data from LTA's EIA and EIS studies [P-1, P-2, P-3, P-4] and from CR2016 EMMP were used for this Study with approval from LTA. Baseline data for biodiversity, hydrology, water quality, air quality and airborne noise in overlapping sections of Holland Plain and Clementi Forest with the Study Area are summarised in the sections below.

7.1 Biodiversity Baseline Findings

The biodiversity results for the eastern and western sections of the Study Area have been drawn from the Holland Plain section of the EIS for Turf City and Holland Plain (2022) [P-1], and the Clementi Forest section of the EIS for Clementi Forest and Maju Forest (2022) [P-2], respectively. A total of 229 plant species were observed across the total extent of Holland Plain, while 303 flora species recorded in Clementi Forest. Of these species, most of the species of conservation significance occur in the large patch of scrubland in the Study Area. Known to be a stronghold for *Nepenthes* species, this scrubland patch was part of the CRL2 study's Area of High Conservation Value (AHCV) [P-1].



Figure 7.1.1 Pitcher plants found within the Study Area in the EIS for Turf City and Holland Plain (2022) [P-1]. (A) *Nepenthes ampullaria*; (B) *Nepenthes x trichocarpa;* (C) *Nepenthes rafflesiana*; (D) Flower of *Nepenthes rafflesiana* [P-1].

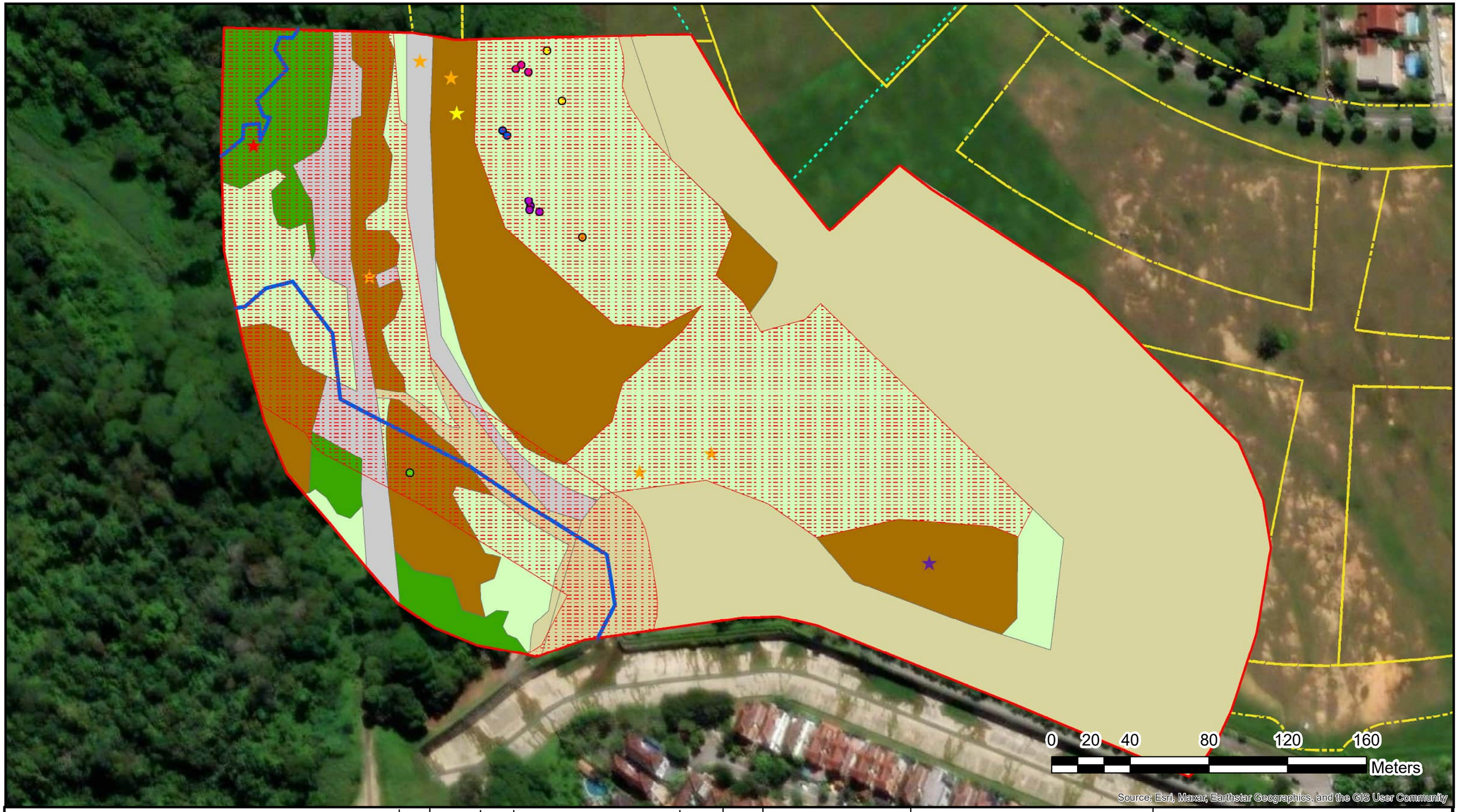
A native hybrid species of pitcher plant (*Nepenthes* × *trichocarpa*) and two locally vulnerable pitcher plant species – the narrow-lid pitcher plant (*Nepenthes ampullaria*) and Raffles' pitcher plant (*Nepenthes rafflesiana*) – were found in the Study Area. Although it is worth noting that the Raffles' pitcher plant (*Nepenthes rafflesiana*) could not be found during visits by NParks and AECOM in 2025. The locally critically endangered *Sterculia parviflora* was also found, although this individual had likely dispersed from streetscape trees and is of cultivated stock. After the publication of the EIS for Turf City and Holland Plain (2022) [P-1], a locally critically endangered species of orchid, the straggly rush orchid (*Dendrobium lobbii*), was also found in the current Study Area [P-37]. Within the flora findings for EIS for Clementi Forest and Maju Forest (2022) [P-2], only the locally vulnerable climber nanas batu (*Phytocrene bracteata*) was found.

The Study Area consists of exotic-dominated forests, scrubland and herbaceous vegetation, managed vegetation and urban infrastructure. Within the Study Area, a total of 115 fauna species were recorded in previous EIA and EIS studies, of which four are of conservation significance. These species include the Malayan softshell turtle (*Dogania subplana*), straw-headed bulbul (*Pynonotus zeylanicus*), Swinhoe's white-eye (*Zosterops simplex*) and common birdwing (*Troides helena cerberus*). Besides the fauna species found within the Study Area, a total of 16 additional conservation significant species were identified as species of probable occurrence as they have been recorded in the vicinity of the study area. These include the locally critically endangered Sunda pangolin (*Manis javanica*), and endangered smooth-coated otter (*Lutrogale perspicillata*).

Although not recorded during the previous EIA studies, the locally endangered pitcher blue (*Virachola kessuma deliochus*) butterfly has also been added to the list of probable occurrences due to its reliance on host plants, the slender pitcher plant (*Nepenthes gracilis*) and Raffles' pitcher plant (*Nepenthes rafflesiana*). A full list of fauna found within the Study Area and species of probable occurrence can be found in Appendix A.



Figure 7.1.2 Fauna species of conservation significance recorded in the EIS for Clementi Forest and Maju Forest (2022) [P-2]. (A) Straw-headed bulbul (*Pynonotus zeylanicus*); (B) Sunda pangolin (*Manis javanica*).



Legend

Conservation Significant Flora

- Dendrobium lobbii [CR]
- Nepenthes ampullaria [VU]
- Nepenthes rafflesiana [VU]*
- Nepenthes x trichocarpa [Native Hybrid]
- Phytocrene bracteata [VU]
- Sterculia parviflora [CR]

Conservation Significant Fauna

- Dogania subplana [CR]
- Pycnonotus zeylanicus [EN]
- Troides helena cerberus [VU]
- Zosterops simplex [VU]

*No longer on site

Habitat Types

- Abandoned-land forest
- Managed vegetation
- Others (infrastructure)
- Scrubland and herbaceous vegetation
- Exotic-dominated secondary forest
- EIA Study Area
- CR15 Worksite Boundary
- Masterplan Development Footprint
- Area of High Conservation Value
- Waterbodies

Rev.	Date	By	Description	Chk'd	App'd
-	FEB 2025	MSL	Holland Plain EIA	KAM	JAG

Qualified Person Endorsement : NA

URA Endorsement : NA

Consultant : AECOM

Client: URA Urban Redevelopment Authority

Project Title :

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Figure Title :

Vegetation Maps with Locations of Conservation Significant Flora and Fauna

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BTO	KAM	JAG	7.1.3	-	1 of 1
	Drawn MSL	Date FEB 2025	CAD File Name : NA		A3

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7.1.1 Assessment of Ecological Values

Habitats and species within the Study Area were assessed for their ecological value. Habitats and species accorded with higher ecological value were regarded of greater importance for conservation relative to other habitats and species, respectively, within the Study Area. Those of high ecological value were assigned the Priority 1 sensitivity level, while those of moderate or low ecological value were assigned the Priority 2 or 3 sensitivity levels, respectively. The assessment was carried out using biodiversity baseline findings.

7.1.1.1 Habitats

The ecological value of four terrestrial habitats within the biodiversity Study Area were assessed.

The ecological value of each habitat type was determined utilising data from a national assessment of ecological value of each habitat type (Singapore Biodiversity Accounting Metric, W-31) (Table 7.1.1). Each individual criterion is scored out of three (3), and the total score being scored out of 12. Using the criteria assessment, the overall score for each habitat was assessed as follows to determine the priority score:

- < 6 – Low
- 6 to 7 – Moderate
- > 7 – High

Table 7.1.1 National assessment of habitat ecological value in the biodiversity Study Area

Criterion	Terrestrial habitat			
	Scrubland	Exotic-dominated Secondary Forest	Abandoned-land Forest	Managed Vegetation
Flora and fauna species richness	1	2	2	1
Irreplaceability	1	1	1	1
National rarity of habitat	2	2	2	1
Unique flora and fauna species	3	1	1	1
Total score	**7**	**6**	**6**	**4**
Ecological value	**High* (Priority 1)**	**Medium (Priority 2)**	**Medium (Priority 2)**	**Low (Priority 3)**

*While scrubland has a score of seven which gives it a Medium ecological value, the scrubland found on site is considered a stronghold for *Nepenthes* species and contains a critically endangered orchid. Therefore, it sees its value raised to High.

I. Scrubland (High Ecological Value; Priority 1)

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 heliophytes (prefer direct sunlight) and can also tolerate high temperatures. Most of the scrubland habitat in the study area are dominated by resam (*Dicranopteris linearis*) ferns, which form a thick mat suppressing the regeneration of forests by preventing seed recruitment and tree establishment (Corlett, 1991; Chua et al., 2013). Some native species associated with *Adinandra belukar* habitat are often found occurring within such habitats. Resam-dominated vegetation is also one of the most important habitats in Singapore for *Nepenthes* species (Lam & Tan, 2020), carnivorous pitcher plants that attract and capture animal prey.

Scrubland generally have low overall flora and fauna species richness (Score 1), is easy to regenerate with minimal human intervention (Score 1), and is increasingly uncommon in the face of urbanisation in Singapore (Score 2). However, the locally critically endangered straggly rush orchid (*Dendrobium lobbii*) can be found in this parcel, together with large populations four native *Nepenthes* species – of which two are nationally threatened and one is a rare native hybrid. The scrubland habitat in the Study Area scores highly for unique flora and fauna (Score 3),

and its ecological value has been determined to be increased to High. The high-priority scrubland patch containing these species was recognised by AECOM (2022) [P-1] as CRL2's AHCV.

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

The species that dominate the exotic-dominated secondary forest patches include oil palm (*Elaeis guineensis*) and mature stands of albizia (*Falcataria moluccana*) trees that form a closed canopy layer with the understorey stratum dominated by giant taro (*Alocasia macrorrhizos*). Exotic-dominated secondary forests have moderate species richness (Score 2) being comprised mostly by non-native species. There are few unique flora and fauna species (Score 1) and the habitat can be recreated and replaced by means of human intervention, thus scoring a low score in irreplaceability (Score 1). However, because of rapid land developments, exotic-dominated secondary forests are becoming uncommon in Singapore (Score 2). The total score for exotic-dominated secondary forest is six (6) after the assessment, having medium ecological value compared to other terrestrial habitats in Singapore.

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

Abandoned-land forests generally have moderate species richness (Score 2) with fewer unique flora and fauna species (Score 1). It is possible to recreate and replace this habitat by means of human intervention, natural or accelerated succession, it is therefore assessed to have a low score for irreplaceability (Score 1). However, because of rapid land developments, abandoned-land forests are uncommon in Singapore (Score 2). The total score for abandoned-land forest is six after assessment, having medium ecological value compared to other terrestrial habitats in Singapore.

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

The managed vegetation in the western and southern sections of the study area comprises of managed cow grass (*Axonopus compressus*) turf and park areas, respectively, with no plant species of conservation significance observed. Managed vegetation has low species richness (Score 1) but can surprisingly host a few unique flora and fauna species (Score 1).

This habitat type is common in Singapore (Score 1) and can be easily reconstructed via human intervention, which renders it a low score for irreplaceability (Score 1). With all four assessment criteria as Score 1, the overall score for urban vegetation is four. Therefore, urban vegetation is of low ecological value compared to other terrestrial habitats in Singapore.

7.1.1.2 Flora

Eight flora species were identified as sensitive receptors within the study area, from which, two species (*Falcataria moluccanas* and *Acacia auriculiformis*) were elevated from their original priority 3 status to priority 1 due to them being large specimens, and one species (*Bambusa heterostachya*) was elevated to priority 1 from priority 3 due to its importance as a potential bamboo bat roost.

7.1.1.3 Fauna

The ecological value of 115 faunal species in the Study Area was assessed. All four faunal species of conservation significance (recorded and probable) were accorded a Priority 1 sensitivity level and deemed to be of high ecological value

7.1.2 Ecological Connectivity

Due to Singapore's heavily fragmented landscape, green spaces such as the one found in the Study Area serve as stepping stones that help facilitate movement of fauna across the landscape. Habitat connectivity is therefore crucial to maintain healthy populations and important ecological processes **[P-60]**.

The Study Area is situated in proximity to multiple key habitats (Figure 7.1.4). To the west lies Clementi Forest, Maju Forest, Toh Tuck Forest, and the Old Jurong Line. Via the Rail Corridor which "constitutes the longest belt of existing greenery in Singapore that is relatively well-connected" **[P-61]** the Study Area is also connected to much larger vegetation patches such as the Central Catchment Nature Reserve (CCNR), Bukit Timah Nature Reserve (BTNR); and facilitates the movement of fauna through northern, central and southern Singapore. For volant species and other mobile wildlife, the Study Area is located in close vicinity to vegetated patches listed under Bird Life International's Important Biodiversity and Bird Areas (IBA). The Study Area therefore acts as an important stepping stone habitat for species navigating Singapore's increasingly fragmented landscape.



Legend

- Old Jurong Railway
- Important Bird Areas (IBA)
- Rail Corridor
- Maju and Clementi Forest
- EIA Study Area

Rev.	Date	By	Description	Chk'd	App'd
-	FEB 2025	MSL	Holland Plain EIA	JOA	CCB

Qualified Person Endorsement : NA

URA Endorsement : NA

Consultant : AECOM

Client: URBAN REDEVELOPMENT AUTHORITY

Project Title :

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Figure Title :

Ecological connectivity map

Designed	Checked	Approved
BTO	JOA	CCB
	Drawn: MSL	Date: JUN 2025

Figure No. : 7.1.4 | Rev. : - | Sheet : 1 of 1

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7.1.3 Area of High Conservation Value from Cross Island Line Phase 2 Study

AECOM (2022) [**P-1**] selected the large patch of scrubland and herbaceous vegetation as an AHCV as it is considered a stronghold of pitcher plants in Singapore. It is naturally home to all three pitcher plant species in Singapore – two of which, the narrow-lid pitcher plant (*Nepenthes ampullaria*) and Raffles' pitcher plant (*Nepenthes rafflesiana*) are locally vulnerable – and a native hybrid (*Nepenthes* × *trichocarpa*). It is worth noting that the Raffles' pitcher plant (*Nepenthes rafflesiana*) could not be detected during visits by NParks and AECOM in 2025. After the publication of the report (AECOM, 2022) [**P-1**], the locally critically endangered straggly rush orchid (*Dendrobium lobbii*) was also found within this AHCV which highlights the high ecological value of this scrubland patch.

On the western portion of the Study Area, another AHCV patch was defined as part of the EIS for Clementi Forest and Maju Forest (2022) [P-2]. Most of the AHCV comprises of the southeastern portion of an abandoned-land forest patch where a large cluster of threatened plant species including the locally critically endangered *Neoscortechinia* cf. *sumatrensis* was found. This AHCV also comprises waterbodies where uncommon stream-associated vegetation and faunal species can be found. This AHCV is vital to the continuation of habitat for locally critically endangered fauna such as the Sunda pangolin (*Manis javanica*) and Malayan forest softshell turtle (*Dogania subplana*). Consisting of naturalised grassland and scrubland habitat, the AHCV also acts as a stepping-stone habitat for birds moving across Singapore's fragmented landscape.

7.2 Hydrology and Water Quality Baseline Findings

Hydrological and water quality findings of natural streams D/S1 and D/S2, roadside drains D/S3 and D/S4 and the Freshwater Marsh from previous samplings done for LTA's EIA and EIS studies are presented in this section. Additionally, water quality findings are also included from the respective projects' EMMP [P-4] [P-59].



Legend

- Study Area
- Waterbodies included in current Study
- Waterbodies identified in previous studies
- New Freshwater Marsh
- Retained Freshwater Marsh
- Freshwater Marsh (Original)
- Bukit Timah First Diversion Canal
- Water quality sampling points
- Exceedances reported at sampling point

N

Rev.	Date	By	Description	Chk'd	App'd
-	AUG 2025	LHN	Holland Plain EIA	LAL	JAG

Qualified Person Endorsement : NA

URA Endorsement : NA

Consultant : AECOM

Client: URA Urban Redevelopment Authority

Project Title :

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Figure Title :

Waterbodies identified from previous studies included in current Study

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LHN	LAL	JAG	7.2.1	-	1 of 1
	Drawn LHN	Date AUG 2025	CAD File Name : NA		A3

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7.2.1 Hydrology

7.2.1.1 Clementi Forest (D/S1, D/S2)

As seen in Figure 7.2.1, three (3) natural streams, one (1) concrete drain, one (1) earth drain were identified in Clementi Forest. Only two of the three natural streams (D/S1 and D/S2) overlap with the Study Area and are included for further analysis. The key natural stream (D/S1) receives discharge mainly from an upstream canal running across Clementi Road and minor discharge from another forest stream (D/S2). The stream discharges into the Bukit Timah First Diversion Canal that eventually flows into Pandan Reservoir and to be treated for drinking supply. Both streams in Clementi Forest are located within the areas of high ecological values and support biodiversity life.

7.2.1.2 Holland Plain (D/S3, D/S4)

At Holland Plain, there are one (1) earth drain, two (2) concrete drains, a pond and a freshwater marsh. No natural streams have been identified on the site. The earth drain (D/S3) and a concrete drain (D/S4) overlap with the Study Area. Surface water from both drains eventually discharges into the Pandan Reservoir that is used for drinking water supply. The freshwater marsh is stagnant but supports a unique habitat. Thus, it is deemed valuable ecologically. As part of the mitigation measures of LTA's project, a new freshwater marsh has been designed and is in the process of being developed. The new outline and retained portion of the original Freshwater Marsh is seen in Figure 7.2.1.

D/S1
D/S2
D/S3
D/S4
Bukit Timah
First Diversion Canal
0 100 200 400 M
Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community

Legend

- Waterbodies
- Study Area

Status

- Retained Freshwater Marsh
- New Freshwater Marsh
- Freshwater Marsh (Natural)

Elevation

- <6
- 6 - 8
- 8 - 10
- 10 - 12
- 12 - 14
- 14 - 16
- 16 - 18
- 18 - 20
- 20 - 22
- 22 - 24
- 24 - 26
- 26 - 28
- 28 - 30
- 30 - 32
- 32 - 34
- 34 - 36
- >36

N

Rev.	Date	By	Description	Chk'd	App'd
1	AUG 2025	LHN	Holland Plain EIA	LAL	ADP
-	MAC 2025	LHN	Holland Plain EIA	LAL	JAG

Qualified Person Endorsement : NA

URA Endorsement : NA

Consultant : AECOM

Client: URBAN REDEVELOPMENT AUTHORITY

Project Title :

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Figure Title :

Elevation Map

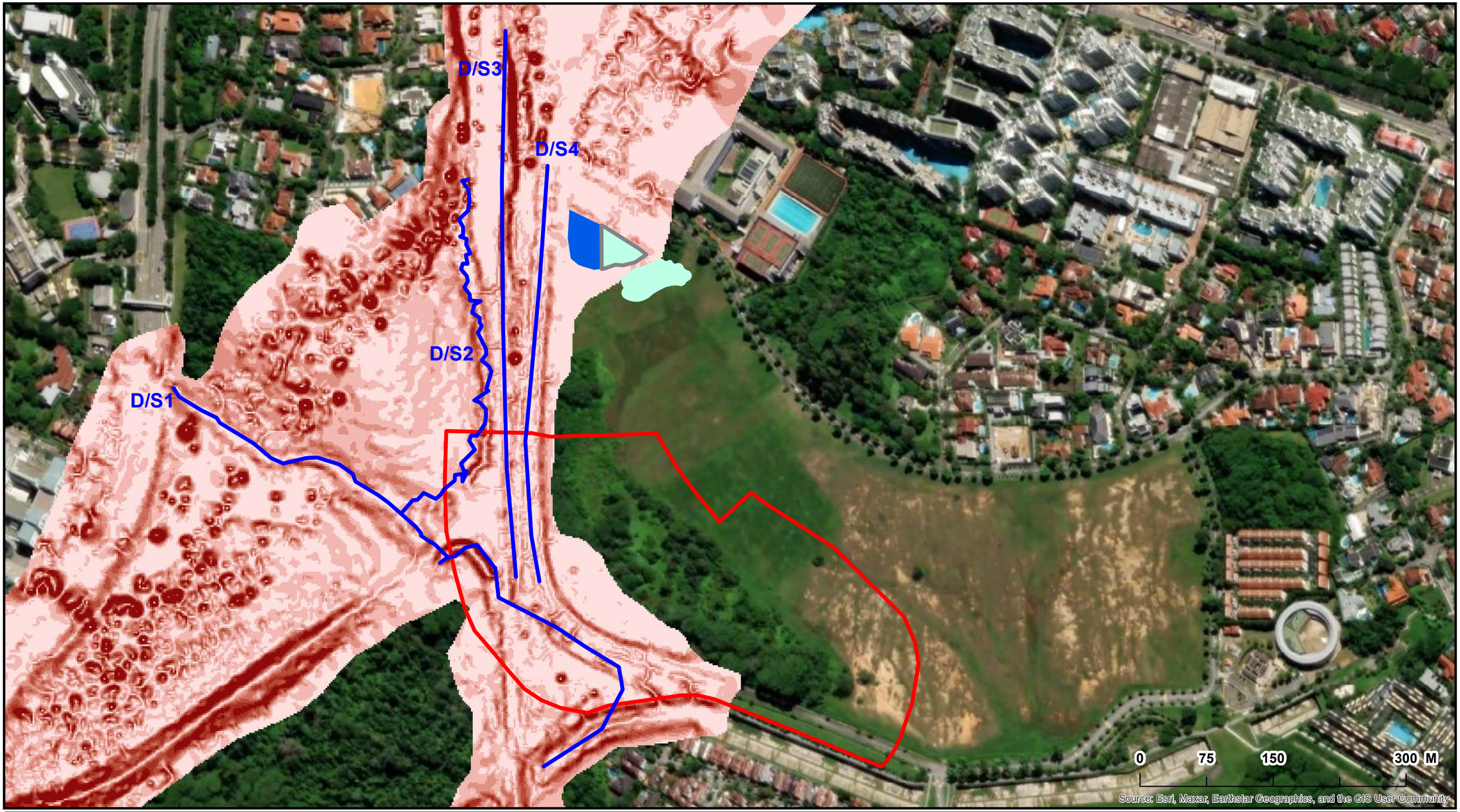
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	Drawn: LHN	Date: MAC 2025

Figure No. : 7.2.2 | Rev. : - | Sheet : 1 of 1

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Legend

- Study Area
- Waterbodies

Status

- Retained Freshwater Marsh
- New Freshwater Marsh
- Freshwater Marsh

Slope (%)

- <10
- 10 - 20
- 20 - 30
- 30 - 40
- 40 - 50
- 50 - 60
- >60

N

Rev.	Date	By	Description	Chk'd	App'd
-	MAC 2025	LHN	Holland Plain EIA	LAL	JAG

Qualified Person Endorsement : NA

URA Endorsement : NA

Consultant : AECOM

Client: Urban Redevelopment Authority

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Figure Title :

Slope Map

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LHN	LAL	JAG	7.2.3	-	1 of 1
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7.2.2 Water Quality

Both in-situ and ex-situ water quality analyses were conducted for all water quality stations. The water quality sampling dates for two (2) dry weather events and one (1) wet weather event for in the Study Area. The water quality results were assessed against guidelines listed in Table 7.2.1. The two earth drains in Holland Plain, D/S3 and D/S4 were only sampled during storm events, as they were mostly dry or had no flow during dry weather conditions. Hence, only wet weather samples were collected at these ephemeral drains. Dry weather conditions are defined as after a continuous 48-hour period of no-rain, while wet-weather conditions are defined as a rainfall event having more than 10 mm of rainfall, with samples to be collected within three (3) hours after the rain stops.

Table 7.2.1 Water quality guidelines and criteria

Parameter	NEA Trade Effluent Limits[a]	International Aquatic Life Criteria[b]
pH	6 - 9	6.5 - 9
Temperature (°C)	45	-
Conductivity (µS/cm)	-	-
Total Dissolved Solids, TDS (mg/L)	1,000	1,000
Dissolved Oxygen, DO (mg/L)	-	> 4.0
Turbidity (NTU)	-	50
Total Suspended Solids, TSS (mg/L)	30 SDA: 50[d]	50
Biological Oxygen Demand, BOD5 (mg/L)[c]	20	3
Chemical Oxygen Demand, COD (mg/L)	60	25
Total Phosphorous, TP (mg/L)	-	
Orthophosphate, PO_4-P (mg/L)	0.65 (equivalent to 2 as PO_4)	0.033 (equivalent to 0.1 as PO_4)
Total Nitrogen, TN (mg/L)	-	Eutrophic limit: 1.5 mg/L
Nitrate, NO_3-N (mg/L)	4.52 (equivalent to 20 as NO_3)	10 (equivalent to 44 as NO_3)

Note:

a. NEA Trade Effluent Limits for discharge into a controlled watercourse.
b. The sources of international water quality criteria for aquatic life include United Nations Economic Commission for Europe [R-20], World Health Organization [R-21], United States Environmental Protection Agency [R-22], Australian New Zealand [R-23], Canada [R-24], Philippines [R-25], and Malaysia [R-26]
c. BOD_5 is the amount of dissolved oxygen needed by aerobic biological organisms to break down organic material per litre of sample during 5 days of incubation at 20 °C.
d. The limit value is for TSS discharge into storm water drainage system (i.e. ECM discharge) which referred from Sewerage and Drainage (Surface Water Drainage) Regulations.

Table 7.2.2 Description of watercourses and its water quality sampling points

Watercourses	Bank Characteristics	Water Flow Conditions	Photos
D/S1	Upstream of stream D/S1 is a closed culvert followed by a concrete drain with artificial banks. The midstream of stream D/S1 is a natural stream with dense vegetation. The downstream and near the outlet (WQ20 and WQ1) of stream D/S1 is a wide concrete drain. Estimated stream length is 800 m.	• Originates from two natural streams in Clementi Forest and upstream urban area • Perennial flow **During dry weather condition:** Downstream (WQ20 and WQ1): slow water flow velocity (estimated at 0.26 m/s) • At WQ20, the water depth was approximately 2 - 3 cm with an approximate water width of 140 - 150 cm, at time of survey • At WQ1: slow water flow observed of approximately 0.25 m/s • Approximately 1 - 2 cm in water depth with water width of 300 cm, at time of survey • Water was clear and had no odour **During wet weather condition:** Downstream (WQ20, WQ1): fast water flow velocity (estimated 1.42 m/s at WQ20 and 1.23 m/s at WQ1) • At WQ20, the water depth was approximately 15 cm with an approximate water width of 200 - 400 cm, at time of survey • At WQ1, approximately 19 cm in water depth with water width of 160 cm, at time of survey • Water was clear and had no odour	**WQ20 (Downstream)** During Dry Weather  During Wet Weather  **WQ1 (Downstream)** During Dry Weather  During Dry Weather 

Watercourses	Bank Characteristics	Water Flow Conditions	Photos
D/S2	Natural stream covered by dense vegetation. Estimated stream length is 550 m.	• Originates from forested area in the north of Clementi Forest, located to the west of Old Bukit Timah Railway Station • Perennial flow **During dry weather condition:** • Stagnant flow was observed • Approximate water depth of 10 cm and an approximate water width of 100 - 150 cm, at time of survey • Water had low turbid but no odour **During wet weather condition** • Slow water flow velocity was observed (estimated 0.05 m/s) • Approximate water depth of 13 -14 cm and an approximate water width of 100 - 200 cm, at time of survey • Water was clear and had no odour	**WQ2** During Dry Weather  During Wet Weather 
D/S3	Earth banks covered by dense vegetation Estimated drain length is 610 m.	• Originates from stormwater runoff from forested areas north of Study Area • Ephemeral flow during wet weather condition only **During dry weather condition:** • Dry at both upstream and downstream of D/S3. • A puddle of water in the midstream was observed at time of survey **During wet weather condition** • Water puddle became a pond in middle section of D/S3 • Stagnant water observed	**WQ3** During Dry Weather  During Wet Weather 
D/S4	Concrete roadside drain with artificial banks	• Originates from the forested area of north of Study Area	**WQ4** During Dry Weather During Dry Weather

Watercourses	Bank Characteristics	Water Flow Conditions	Photos
	Estimated drain length is 470 m	• Ephemeral flow during wet weather condition only **During dry weather condition:** • Almost no flow **During wet weather condition** • Slow wet weather flow observed in 120 cm width drain (estimated 0.2 m/s) • Water had approximately 5 cm depth with width of 30 cm, at time of survey	 
Freshwater Marsh	Freshwater Marsh habitat with earth banks, covered by dense vegetation and surrounded by large trees	• Potentially mainly recharged by direct precipitation over the Marsh area • Perennial waterbody • Area of the Marsh is approximately 0.34 ha. **During both dry and wet weather condition:** • Stagnant • Water depth in the Marsh was approximately 1 - 1.5 m. • Water was clear and had no odour	**WQ36** During Dry Weather  During Wet Weather 

Table 7.2.3 Water quality results

		D/S1		D/S2	D/S3	D/S4	Freshwater Marsh	NEA Trade Effluent Discharge Limits	Criteria for Aquatic Life
Parameter		**WQ1**	**WQ20**	**WQ2**	**WQ3**	**WQ4**	**WQ36**		
Temperature (°C)	Wet	26.7	26.7	25.9	26.2	26.2	24.8		
	Dry Average	28.4	27.1	26.3	-	-	26.3	45	-
pH	Wet	7.1	7.3	6.8	6.0	7.1	6.6		
	Dry Average	7.6	7.1	6.7	-	-	6.2	6-9	6.5-9
DO (mg/L)	Wet	5.6	5.2	3.4	1.9	7.7	5.2		
	Dry Average	9.4	4.2	1.1	-	-	0.5	-	>4.0
Conductivity (µS/cm)	Wet	71	70	214	533	335	48		
	Dry Average	246	233	288	-	-	67	-	-
Total Dissolved Solids, TDS (mg/L)	Wet	44	44	137	338	213	31		
	Dry Average	151	145	183	-	-	43	1000	1000
Biological Oxygen Demand, BOD (mg/L)	Wet	<1	<1	2.4	4.8	2.1	<1		
	Dry Average	1.7	1.7	2.8	-	-	<1	20	3
Total Suspended Solids (mg/L)	Wet	3.40	3.60	20.00	16.00	5.20	5.60		
	Dry Average	3.67	8.34	36.75	-	-	49.65	30	50
Turbidity (NTU)	Wet	7.0	6.6	24.0	17.0	10.0	12.0		
	Dry Average	5.2	5.7	45.0	-	-	16.0	-	50
COD (mg/L)	Wet	7.00	13.00	19.00	14.00	22.00	41.00		
	Dry Average	7.00	7.00	15.50	-	-	29.00	60	25
Total Nitrogen (mg/L)	Wet	0.54	0.55	1.37	2.36	1.19	0.54		
	Dry Average	0.57	0.65	1	-	-	0.56	-	Eutrophic Limit: 1.5mg/L
Nitrate (NO_3-N) (mg/L)	Wet	0.36	0.38	0.79	1.54	0.51	0.12		10 (Equivalent to 44 as NO3)

Parameter		D/S1		D/S2	D/S3	D/S4	Freshwater Marsh	NEA Trade Effluent Discharge Limits	Criteria for Aquatic Life
		WQ1	WQ20	WQ2	WQ3	WQ4	WQ36		
	Dry Average	0.11	0.07	<0.005	-	-	<0.005	4.52 (Equivalent to 20 as NO3)	
Total Phosphorous (mg/L)	Wet	0.024	0.031	0.051	0.052	0.130	0.027	-	Eutrophic Limit: 0.075mg/L
	Dry Average	0.084	0.105	0.115	-	-	0.025		
Orthophosphate (PO_4-P) (mg/L)	Wet	0.012	0.012	0.032	0.034	0.051	0.017	0.65 (Equivalent to 2 as PO4)	0.033 (Equivalent to < 0.1 as PO4)
	Dry Average	0.065	0.067	0.065	-	-	0.017		

Note:
a. NEA Trade Effluent Discharge Limits are for controlled watercourses.
b. The sources of water quality criteria for aquatic life include United Nations Economic Commission for Europe [R-20], United States Environmental Protection Agency [R-22], Australian & New Zealand [R-23], Canada [R-24], Philippines [R-25], and Malaysia [R-26].
c. Red values mean data exceeding the NEA limits; Blue values mean data exceeding the aquatic life criteria; Purple values mean data exceeding both NEA limits and aquatic life criteria.
d. "-" indicates samples were only collected for wet weather conditions, thus dry weather data were not available.
e. <1 means lower than 1 mg/L of level of detection limit, etc.

7.2.2.1 Clementi Forest (D/S1, D/S2)

Two (2) water sampling points (WQ20 and WQ1) from the key natural steam (i.e. D/S1) and one (1) sampling point (WQ2) from the tributary of key natural stream (i.e. D/S2) are located in the vicinity of the Study Area and are included in this baseline review.

All three sampling points generally met the NEA guideline and aquatic life criteria with the exception of DO, TSS, TP and orthophosphate for the tributary (D/S2) and TP and orthophosphate for the main natural stream (D/S1). The tributary did not meet the aquatic life criteria for DO level due to its stagnant conditions. However, previous study also showed that at DO below 4 mg/L in Singapore natural streams, freshwater aquatic life may have adapted and therefore found to thrive in these conditions in Singapore. Elevated TSS found at the minor natural stream indicated high sediments existing in the stagnant water. Compared with water quality criteria for aquatic life, during dry weather, (TP) concentration at the stations within perennial stream of D/S1 and tributary D/S2 exceeded the eutrophication limit (i.e. 0.075 mg/L), while the orthophosphate (PO4-P) concentration at all the perennial watercourses had exceeded the aquatic life criteria limit (i.e. 0.033 mg/L). Stream D/S1 have high phosphorus from its upstream with increasing concentration till its downstream. This has indicated the source of phosphorus might come from both upstream residential area (e.g. fertiliser from tree plantation, food wastes, etc.) as well as organic decomposition from dead plants within the Study Area. The overall baseline water quality of the perennial watercourses was likely to be suitable for aquatic life.

Results from water sampling done at the upstream of D/S1 during the EMMP stage of CR2016 indicated that TP and orthophosphate levels remained high throughout the year, ranging from 0.040 mg/L to 0.108 mg/L and from 0.018 mg/L to 0.086 mg/L respectively. Other notable trends observed include an increase of pH values (raging 6.81 to 10.14) due to alkaline pollutants from the CR2016 worksite entering the stream and elevated TN levels (0.859 mg/L to 3.213 mg/L) from pollutants possibly from the worksite. It is to note the sampling point was located upstream of D/S1 which may not accurately reflect the state of the midstream and downstream conditions of the stream that was discussed in the previous paragraph.

7.2.2.2 Holland Plain (D/S3, D/S4, Freshwater Marsh)

Three (3) sampling points in total are included in this baseline review, WQ3 from D/S3, WQ4 from D/S4 and WQ36 from the freshwater marsh.

The stormwater runoff during wet weather in ephemeral earth drain (D/S3) was found to have a low pH value which exceeds the NEA guidelines. All other water quality parameters were well within the NEA guidelines. The ephemeral concrete drain (D/S4) was found to have relatively good water quality that are also well within the guidelines.

The freshwater marsh, which lies north of the Study Area, had a low pH (i.e. pH 6.21), extremely low DO (i.e. 0.52 mg/L) and elevated COD (i.e. 29 mg/L) which all exceeded the aquatic life criteria (i.e. pH 6.5 – pH 9; 4 mg/L; 25 mg/L) and had TSS levels (i.e. 49.65 mg/L) that exceeded the NEA guidelines during dry weather conditions. COD similarly exceeded the aquatic life criteria during wet weather conditions (i.e. 41 mg/L). Other parameters tested were within guidelines. While the water quality results indicate an unfavourable condition for aquatic life in the freshwater marsh, the marsh area was found to support an ecosystem of conservation significant biodiversity, which include marsh-specific odonates and birds.

Findings from the ongoing CR2005 Marsh EMMP further show similar results to those found in the baseline study. The Freshwater Marsh maintained low pH (6.25 – 7.14), extremely low DO at times (0.22 mg/L – 8.82 mg/L), elevated COD (10 mg/L – 44 mg/L) and TSS (8 mg/L – 135 mg/L).

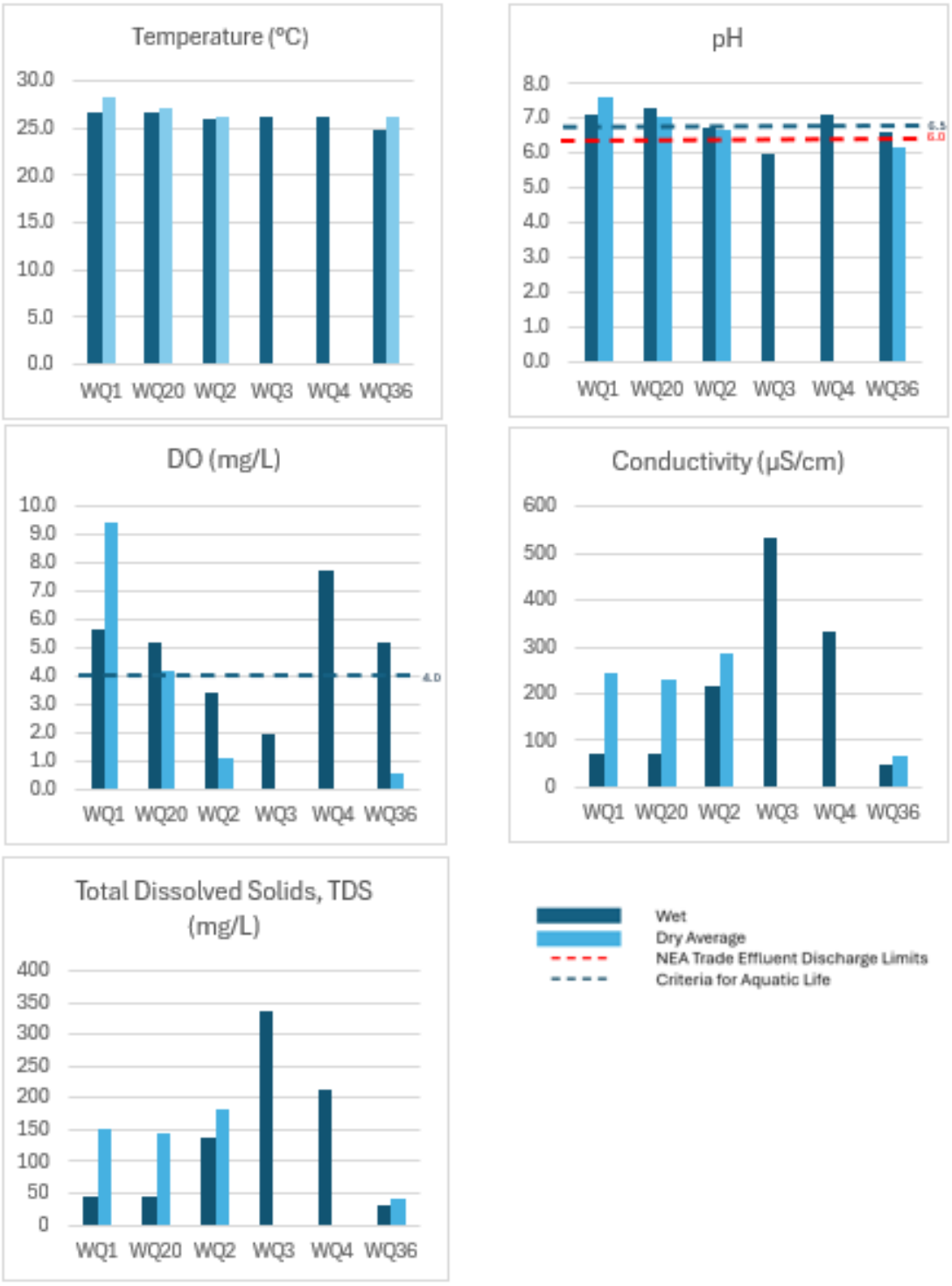


Figure 7.2.4 Average monitoring results of in-situ parameters for dry and wet weather conditions

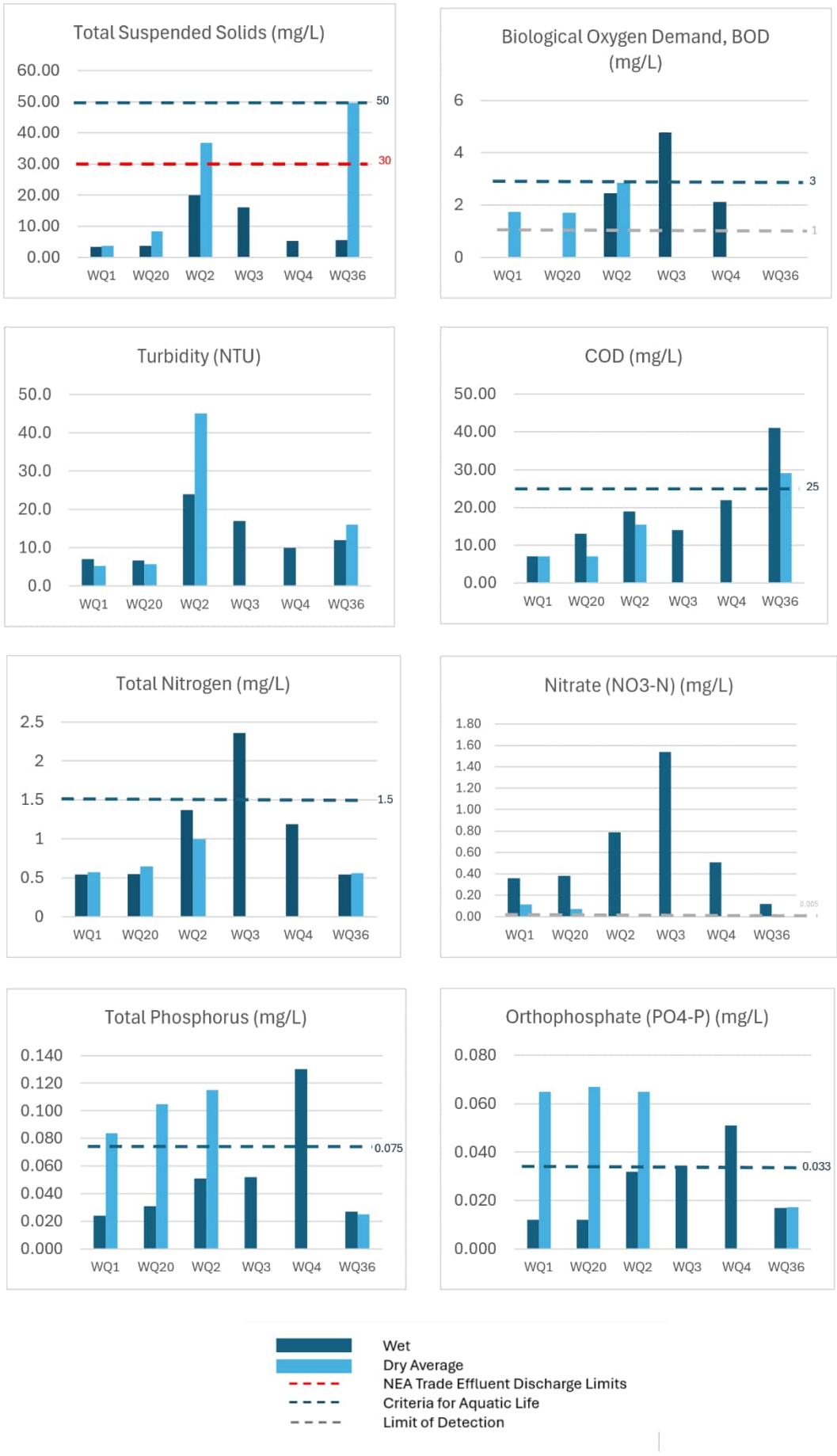


Figure 7.2.5 Average monitoring results of ex-situ parameters for dry and wet conditions

7.3 Air Quality

Baseline air quality data was collected at two (2) representative monitoring locations (A01 and A02) for seven (7) days continuously (as shown in Figure 7.3.1). The data was collected between 25 February – 3 March 2020 and 6 – 13 July 2022 (as shown in Table 7.3.1). The two monitoring locations included human receptors near Methodist Girls' School, and ecological receptors near the rail corridor and Clementi Forest. The monitoring results for each pollutant (PM_{10} and $PM_{2.5}$) at all monitoring locations are summarised in Table 7.3.1 below and compared with the Singapore Ambient Air Quality Long Term Targets (SAAQT). All pollutant concentrations were within the SAAQT at all monitoring locations. It should be noted that air quality monitoring was conducted during COVID-19 pandemic.

Table 7.3.1 Baseline Air Quality Monitoring Results [P-1]

Monitoring Locations	Monitoring Date	Daily PM_{10} Concentration ($\mu g/m^3$)			Daily $PM_{2.5}$ Concentration ($\mu g/m^3$)		
		Average	Max	Min	Average	Max	Min
A02: Methodist Girls' School	25 February – 3 March 2020	14.3	18.3	11.6	10.7	13.6	9.0
A06: Near the rail corridor and Clementi Forest	6 – 13 July 2022	26.8	36.0	20.6	14.1	21.7	10.2
A1: Clementi Forest (near Clementi Road)	1 – 7 April 2023	20.1	30.0	14.7	20.0	**29.9**	14.6
A3: Singapore University of Social Sciences (SUSS)	11 – 17 April 2023	26.8	44.1	15.9	**26.6**	**43.9**	15.8
Singapore Ambient Air Quality Long Term Targets		*50*			*25*		



Legend

- Baseline Air Monitoring Locations
- Study Boundary
- Air Quality Study Area (250m buffer)

N

Rev.	Date	By	Description	Chk'd	App'd
1	APR 2025	TTR	Holland Plain EIA	KAM	JAG
-	FEB 2025	TTR	Holland Plain EIA	KAM	JAG

Qualified Person Endorsement : NA

URA Endorsement : NA

Consultant : AECOM

Client: Urban Redevelopment Authority

Project Title :

CONTRACT URA/T/23/048
HOLLAND PLAIN
ENVIRONMENTAL IMPACT ASSESSMENT

Figure Title :

Baseline air monitoring locations

Designed	Checked	Approved
TTR	KAM	JAG
	Drawn	Date
	TTR	APR 2025

Figure No. : 7 - X | Rev. 1 | Sheet 1 of 1

CAD File Name : NA | A3

Note: Source of basemap - Onemap

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7.4 Airborne Noise

7.4.1 Construction Phase

Baseline airborne noise monitoring was conducted at three (3) representative locations (N05, N15 and N14) (refer to Figure 7.4.1). The $L_{Aeq(12hours)}$ levels varied between 52 and 74 dB(A) during the daytime (7:00 AM to 7:00 PM) and between 49 and 75 dB(A) during the nighttime (7:00 PM to 7:00 AM) (refer to Table 7.4.1). Meanwhile, the $L_{Aeq(5mins)}$ levels ranged from 50 to 73 dB(A) during the daytime (7:00 AM to 7:00 PM), 49 to 74 dB(A) during the evening (7:00 PM to 10:00 PM), and 43 to 74 dB(A) during the nighttime (10:00 PM to 7:00 AM). The highest noise level was observed at N15. Apart from N15, the highest noise levels were recorded during the daytime (7 AM–7 PM), followed by the evening (7 PM–10 PM) and nighttime (10 PM–7 AM). Noise levels at different monitoring locations remained within the permissible limits specified by the Environmental Protection and Management (Control of Noise at Construction Sites) Regulations, 2008 [R-31] except for N15. The elevated noise levels at N15 were attributed to variations in the baseline measurement period. Noise levels at N05 were monitored between 24 February 2020 and 02 March 2020, while measurements at N14 were conducted from 24 September to 31 September 2021. The lower noise levels recorded at these locations may have been influenced by COVID-19 restrictions. In contrast, the noise levels at N15 were recorded between 23 June and 30 June 2022 when most of the restrictions due to COVID were lifted. However, as mentioned in the LTA's EIS studies [P-1], the residual noise level resulted from the construction activities from the construction of station would result in 10 to 12 dB(A) increment in baseline noise level. This noise level would work as the modified baseline for this project since the construction of CRL2 rail station will commence before the commencement of the construction works of this project. This additional increment in noise level was considered during the noise impact assessment of this report.

Table 7.4.1 Summary of baseline noise monitoring results - Weekdays (For Construction Noise Impact)

Location	Date of Monitoring	$L_{Aeq(12\ hours)}$		$L_{Aeq(5\ mins)}$								
		7am – 7pm	7pm-7am^	7am – 7pm			7pm – 10pm^			10pm – 7am^		
		Average		Min	Max	Avg.	Min	Max	Avg.	Min	Max	Avg.
N05: Methodist Girls School	24 Feb – 02 Mar 2020	55	49	46	71	53	42	71	51	37	59	43
N14: Adjacent to Rail Corridor within the EIA Study Area	24 Sep – 30 Sep 2021	52	51	38	69	50	42	57	49	44	73	49
N15: North-western of the EIA study area	23 Jun – 30 Jun 2022	74	75	49	86	73	72	78	74	71	94	74

^ No night works beyond the 7am – 7pm construction schedule were proposed in this Project as per information provided by URA. Information of baseline noise levels measured at other timings are for purposes of reference. Night-works will only be allowed if permission from relevant local agencies is sought and approved.

Table 7.4.2 Summary of baseline noise monitoring results - Sunday/Public Holiday^ (For Construction Noise Impact)

Location	Date of Monitoring	$L_{Aeq(12\ hours)}$		$L_{Aeq(5\ mins)}$								
		7am – 7pm	7pm-7am^	7am – 7pm			7pm – 10pm^			10pm – 7am^		
		Average		Min	Max	Avg.	Min	Max	Avg.	Min	Max	Avg.
N05: Methodist Girls School	24 Feb – 02 Mar 2020	52	48	45	66	50	44	52	48	39	56	44
N14: Adjacent to Rail Corridor within the EIA Study Area	24 Sep – 30 Sep 2021	49	52	41	61	47	41	63	48	44	63	49
N15: North-western of the EIA study area	23 Jun – 30 Jun 2022	74	73	72	76	73	73	77	74	72	74	73

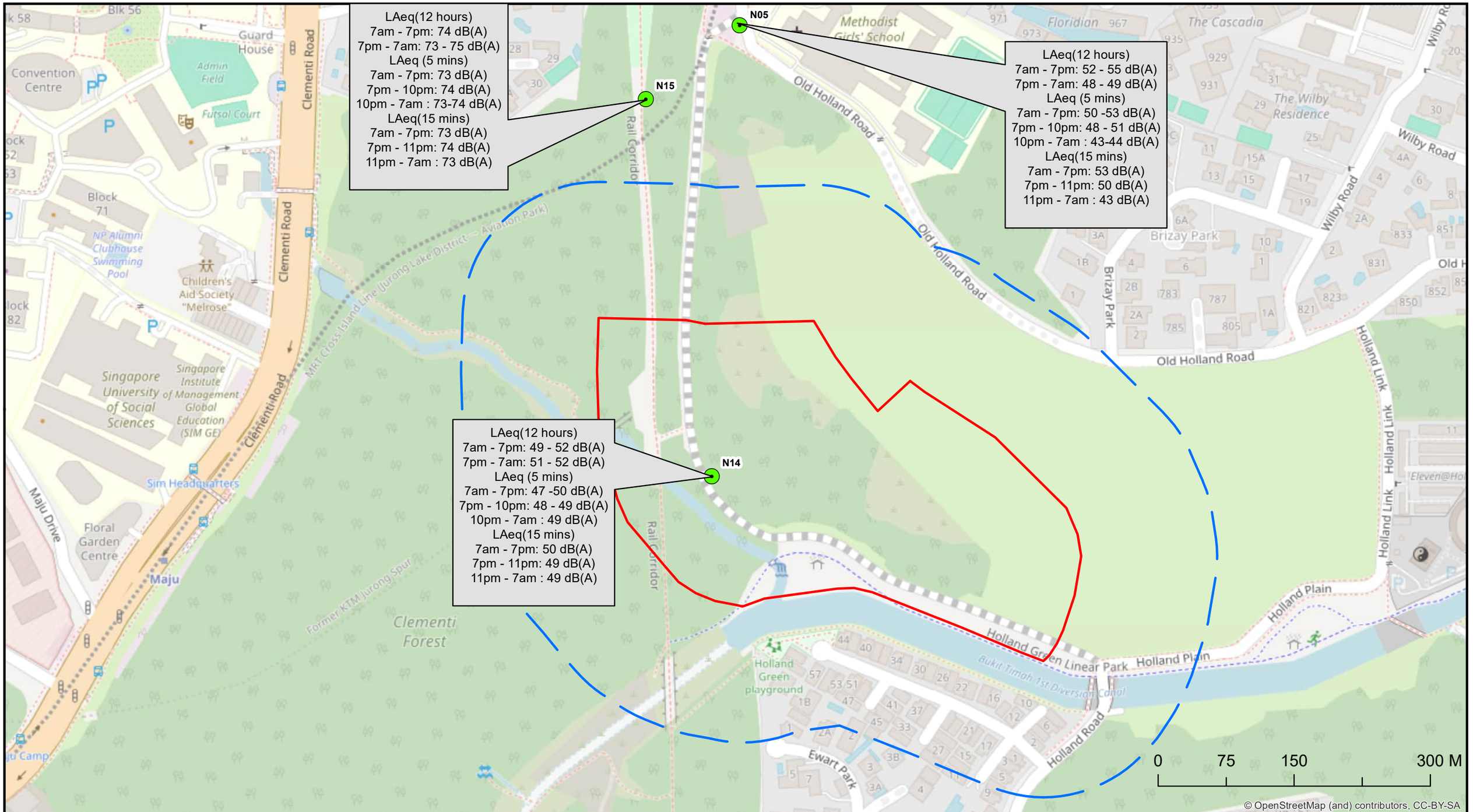
^ No night works beyond the 7am – 7pm construction schedule or work on Weekend/ Public Holidays were proposed in this Project as per information provided by URA. Information of baseline noise levels measured at other timings are for purposes of reference. Night-works or works on Weekend/ Public Holidays will only be allowed if permission from relevant local agencies is sought and approved.

7.4.2 Operational Phase

Similar to the noise level reported for $L_{Aeq(12\ hours)}$ and $L_{Aeq\ (5mins)}$, the highest noise levels for $L_{Aeq\ (15mins)}$ were reported for N15. $L_{Aeq((15mins)}$ levels ranged from 53 to 73 dB(A) during the daytime (7:00 am to 7:00 pm), 50 to 74 dB(A) during the evening (7:00 pm to 11:00 pm), and 43 to 73 dB(A) during the nighttime (11:00 pm to 7:00 am). Noise levels at different monitoring locations remained within the permissible limits specified *by NEA Technical Guideline on Boundary Noise Limits for Air Conditioning and Mechanical Ventilation Systems in Non-Industrial Buildings,2018* [R-38] except for N15.

Table 7.4.3 Summary of baseline noise monitoring results - Weekdays (For Operational Noise Impact)

Location	Date of Monitoring	$L_{Aeq(15\ mins)}$								
		7am – 7pm			7pm – 11pm			11pm – 7am		
		Min	Max	Avg.	Min	Max	Avg.	Min	Max	Avg.
N05: Methodist Girls School	24 Feb – 02 Mar 2020	47	67	53	44	66	50	38	58	43
N14: Adjacent to rail corridor within the	24 Sep – 30 Sep 2021	43	67	50	42	59	49	44	71	49
N15: North-western of the EIA study area	23 Jun – 30 Jun 2022	52	81	73	72	77	74	71	93	73



Legend

- Noise Assessment Extent (150 m-buffer)
- Study Area
- Noise Monitoring Location

N

Rev.	Date	By	Description	Chk'd	App'd
-	MAR 2025	SHA	Holland Plain EIA	LAL	JAG

Qualified Person Endorsement : NA

URA Endorsement : NA

Consultant : AECOM

Client: URBAN REDEVELOPMENT AUTHORITY

Project Title :

CONTRACT URA/T/23/048
HOLLAND PLAIN
ENVIRONMENTAL IMPACT ASSESSMENT

Figure Title :

Airborne noise monitoring locations

Designed	Checked	Approved
SHA	LAL	JAG
	Drawn: SHA	Date: MAR 2025

Figure No. : 7.4.1 | Rev. : - | Sheet : 1 of 1

CAD File Name : NA | A3

Note: Source of basemap - Google Earth Map

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Summary of Key Baseline Findings

Biodiversity

Biodiversity baseline data (flora, fauna and habitat distribution) has been retrieved from two previously conducted studies - the Holland Plain section of the EIS for Turf City and Holland Plain (2022) [P-1], and the Clementi Forest section of the EIS for Clementi Forest and Maju Forest (2022) [P-2]. The locations of all conservation significant flora within in the Study Area, along with fauna species of probable occurrence taken from LTA's CRL2 study area were compiled. After the publication of LTA's CRL2 reports, a locally critically endangered straggly rush orchid (*Dendrobium lobbii*) was also found within the study area. A total of 131 fauna species and six (6) conservation significant flora species were found.

Hydrology and Water Quality

Two (2) natural streams (D/S1 and D/S2) from Clementi Forest, two (2) roadside drains (D/S3 and D/S4) west of Holland Plain and a freshwater marsh is included in this study. The natural streams and Freshwater Marsh support local habitats and are deemed ecologically significant. Furthermore, the streams and drains flow into Pandan Reservoir that supplies drinking water.

In Clementi Forest, DO levels were below the criteria for aquatic life (4.0 mg/L) stream D/S2 and midstream of stream D/S1 during dry and/or wet weather, due to their stagnant conditions. However, previous study also showed that at DO below 4 mg/L in Singapore natural streams, freshwater aquatic life may have adapted and therefore are found to thrive in these conditions in Singapore. Elevated TSS levels found at D/S2 indicates high levels of sediment in stagnant water conditions. Relatively high phosphorus concentrations (i.e. TP and PO_4-P) were detected from water samples of both streams. This suggests that existing watercourses have high eutrophication potential, which is consistent with the site observation of greenish watercourses with algae. The overall baseline water quality of the perennial watercourses was deemed likely to be suitable for aquatic life. This supports the biodiversity findings, especially the natural stream D/S1 to be of high ecological value.

Ephemeral roadside drain (D/S3) was found to have relatively low pH, which was attributed to the flushing of humic acid from its earth banks. The other ephemeral drain (D/S4) was found to have relatively good water quality. The Freshwater Marsh scored relatively poorly against the aquatic life criteria during dry weather. However, the marsh was found to support an ecosystem of conservation significant biodiversity, which include marsh-specific odonates and birds.

Air Quality

Baseline air quality data was collected at two (2) representative monitoring locations between 25 February – 3 March 2020 and 6 – 13 July 2022. The two monitoring locations included human receptors near Methodist Girls' School, and ecological receptors near the rail corridor and Clementi Forest. All pollutant concentrations (PM_{10} and $PM_{2.5}$) were found to be within the Singapore Ambient Air Quality Long Term Targets. It should be noted that air quality monitoring was conducted during COVID-19 pandemic.

Airborne Noise

Baseline airborne noise monitoring was conducted at three (3) representative locations. Noise levels captured by the noise monitoring locations at Methodist Girls School and adjacent to rail corridor within the EIA Study Area remained within the permissible limits specified by the Environmental Protection and Management (Control of Noise at Construction Sites) Regulations, 2008 [R-31] when captured as baseline during COVID.

However, noise levels reported at the location which was situated at the north-western of the EIA study area exceeded the permissible noise levels specified by Environmental Protection and Management (Control of Noise at Construction Sites) Regulations, 2008 [R-31] when they were captured after the pandemic owing to the road traffic in the vicinity returning to normal.

8 Identification of Sensitive Receptors

8.1 Biodiversity Sensitive Receptors

8.1.1 Construction Phase

Following the assessment of ecological value in Section 7.1.1 for habitats, all habitats within the Project Site and within 30 m from the Project Site were identified to be at risk of impact.

Terrestrial habitats found within Project Site would be assessed for direct impacts, while those not found within, but are within 30 m from the Project Site would be assessed for indirect impacts such as habitat degradation.

8.1.2 Operational Phase

All habitats found within the Project Site would be completely cleared during the construction phase, hence only habitats found within 30 m of the Project Site would be assessed for indirect impacts.

8.1.3 Flora

Following the assessment of ecological value for all flora species, some were selected for the assessment of ecological impacts. The selection was based on the following: (1) species with specimens of conservation significance, (2) large specimens, or (3) other specimens of value, such as bamboo clusters which could serve as potential roosts for bamboo bats, and/or trees found inside and within 30 m from the Project Site. A total of eight sensitive receptors were identified, all of which fit at least one of the three criteria mentioned above.

8.1.4 Fauna

Since most terrestrial fauna are mobile throughout the Study Area, all terrestrial faunal species recorded are expected to be indirectly impacted during the construction and operational phase. Following the assessment of ecological value for faunal species, all species with a Priority 1 sensitivity level were identified as the sensitive receptors. These include 12 bird species, one reptile species and two butterfly species, three mammal species, one fish species and one odonate species. Table 8.1.1 below shows a detailed breakdown of the number of species of each taxa by priority level.

Table 8.1.1 Summary of fauna findings

Taxa	Number of recorded species					
	All species	Total CS* (SRDB3 and IUCN)	VU	EN	CR	NT, LC and NL
Aculeata	7	0	0	0	0	7
Amphibians	11	0	0	0	0	11
Birds	66	12	10	2	0	54
Butterflies	20	2	1	1	0	18
Mammals	7	3	1	1	1	4
Odonata	15	1	1	0	0	14
Reptiles	4	1	0	0	1	3
Fish	1	1	0	1	0	0
Total	131	20	13	5	2	111

*CS = conservation significant, VU = vulnerable, EN = endangered, CR = critically endangered, NT = near threatened, LC = least concern, NL = not listed

8.2 Hydrology and Water Quality Sensitive Receptors

8.2.1 Construction Phase

During construction phase, the human and ecological receptors are identified and classified based on sensitivity classification (Table 5.2.2) as shown in Table 8.2.1.

Table 8.2.1 Classification of sensitive receptors identified within the Study Area for construction phase

Sensitive Receptor	Environmental Parameter	Receptor Description	Receptor Classification
Ecological Receptors			
Waterbodies supporting Clementi Forest and the Rail Corridor	• Hydrology • Surface Water Quality	Natural streams found in Clementi Forest: • D/S1 is the main natural stream in Clementi Forrest that has presence of aquatic life. • The downstream of D/S1 runs through the Rail Corridor. It has presence of aquatic life • D/S2 is a natural stream that discharges into D/S1 that has presence of aquatic life.	Priority 1
Freshwater marsh	• Hydrology • Surface Water Quality	Freshwater marsh that supports unique marsh ecosystem. A new marsh next to the current marsh is under development as part of mitigation measures for LTA's CR2005 project.	Priority 1
Roadside Drains	n/a	D/S3 and D/S4 are ephemeral drains not found to support any habitats.	n/a
Human Receptors			
Future residents and visitors in the vicinity of the Study Area developments	• Hydrology	Regular activities of humans may be disrupted due to localised flooding within/nearby the Project Site	Priority 2
All local residents and visitors	• Surface Water Quality	Water will flow into reservoirs and eventually be used for drinking by local residents and visitors (humans)	Priority 1

8.2.2 Operational Phase

During operational phase, the human, ecology and water-dependent socio-economic receptors are identified and classified based on sensitivity classification (Table 5.2.2) as shown in Table 8.2.2.

Table 8.2.2 Classification of sensitive receptors identified within the Study Area for operational phase

Sensitive Receptor	Environmental Parameter	Receptor Description	Receptor Classification
Ecological Receptors			
Waterbodies supporting Clementi Forest and the Rail Corridor	• Hydrology • Surface Water Quality	Natural streams found in Clementi Forest: • D/S1 is the main natural stream in Clementi Forrest that has presence of aquatic life • The downstream of D/S1 runs through the Rail Corridor. It has presence of aquatic life • D/S2 is a natural stream that discharges into D/S1 that has presence of aquatic life	Priority 1
Freshwater marsh	• Hydrology • Surface Water Quality	Freshwater marsh that supports unique marsh ecosystem	Priority 1
Human Receptors			
Residents and visitors in the vicinity of the Project Site developments	• Hydrology	Regular activities of humans may be disrupted due to localised flooding within/ nearby the Project Site	Priority 2
All local residents and visitors	• Surface Water Quality	Water will flow into reservoirs and eventually be used for drinking by local residents and visitors (humans)	Priority 1

8.3 Air Quality Sensitive Receptor

8.3.1 Construction Phase

Ecological Receptors

The construction activities at the construction worksite pose a potential risk of dust emissions that may impact upon target habitat areas lying within the zone of influence of the construction site. Earthworks footprint, construction footprint and access roads are located within or in close proximity to ecologically sensitive receptors. In line with the IAQM Guidance, a Study Area of 50 m was considered for ecological impacts during construction phase.

As classified in Table 5.2.2, Priority 1 refers to the nearest ecologically sensitive receptors of high ecological value located <20 m from the construction worksites with potential air emission sources, while Priority 2 refers to the nearest ecologically sensitive receptors of high ecological value located within 20 m – 50 m from the construction worksites. For this Project, based on the distances of emission sources to the identified receptors presented in Figure 9.3.1 to Figure 9.3.3, the Sensitivity of the Area was determined to range from Priority 1 to Priority 2. There are no other internationally-recognised or locally-gazetted ecological sites within 50 m of the Study Area, hence no Priority 3 receptors are identified.

As discussed in Table 5.2.2, according to UK IAQM [R-33], ecological receptor refers to any sensitive habitat affected by dust soiling, hence the air quality impact assessment of this EIA will only focus on the flora of conservation significance or sensitive plant communities of large specimens which may receive the direct impacts species due to dust deposition from the construction worksites. The focal list with flora species of high ecological

value identified within the air quality Study Area are presented in Table 8.3.1. A more comprehensive list of flora and fauna species as well as the associated biodiversity baseline and impact assessment findings are provided in Section 7.1 and Section 11.1. Table 8.3.2 summarises the sensitivity of each construction phase for earthworks and construction, as well as trackout.

Table 8.3.1 Focal list of flora species of high ecological value identified within the air quality Study Area

Distance from Worksites	Identified Species	Status	Number of Individuals Found
Earthworks			
Species of Conservation Significance			
Within 20 m	*Centotheca lappacea*	Least Concern	1
Between 20 m to 50 m	*Goniophlebium percussum* *Phytocrene bracteata*	Vulnerable Vulnerable	1 1
Large Specimens			
Within 20 m	*Falcataria moluccana*	Naturalised	1
Between 20 m to 50 m	-	-	-
Other Specimens of Value			
Within 20 m	-	-	-
Between 20 m to 50 m	*Bambusa heterostachya* *Falcataria moluccana*	Casual Naturalised	1 2
Construction			
Species of Conservation Significance			
Within 20 m	*Centotheca lappacea*	Least Concern	1
Between 20 m to 50 m	*Goniophlebium percussum* *Phytocrene bracteata*	Vulnerable Vulnerable	1 1
Large Specimens			
Within 20 m	*Falcataria moluccana*	Naturalised	1
Between 20 m to 50 m	-	-	-
Other Specimens of Value			
Within 20 m	-	-	-
Between 20 m to 50 m	*Bambusa heterostachya* *Falcataria moluccana*	Casual Naturalised	1 2
Trackout			
Species of Conservation Significance			
Within 20 m	*Centotheca lappacea*	Least Concern	1
Between 20 m to 50 m	*Alsophila latebrosa* *Bridelia stipularis* *Goniophlebium percussum* *Nepenthes ampullaria* *Nepenthes x trichocarpa*	Least Concern Least Concern Vulnerable Vulnerable Native Hybrid	1 2 1 2 2
Large Specimens			
Within 20 m	*Elaeis guineensis* *Falcataria moluccana*	Cultivated Only Naturalised	1 1
Between 20 m to 50 m	*Bambusa vulgaris*	Casual	1
Other Specimens of Value			
Within 20 m	-	-	-

Distance from Worksites	Identified Species	Status	Number of Individuals Found
Between 20 m to 50 m	*Bambusa heterostachya* *Bambusa vulgaris*	Casual Casual	4 1

Table 8.3.2 Receptor sensitivity for air quality impact assessment – construction phase (ecological receptors)

Distance	Identified Receptors	Sensitivity of the Area
For Earthworks		
Within 20 m Between 20 m to 50 m	• Scrubland and exotic-dominated forests at Holland Plain • Rail Corridor (part of Clementi Forest)	Priority 1
For Construction		
Within 20 m Between 20 m to 50 m	• Scrubland and exotic-dominated forests at Holland Plain • Rail Corridor (part of Clementi Forest)	Priority 1
For Trackout		
Within 20 m Between 20 m to 50 m	• Scrubland and exotic-dominated forests at Holland Plain • Rail Corridor (part of Clementi Forest)	Priority 1

Human Receptors

Study Area of 250 m was considered for human health impacts during construction phase. Based on Table 5.2.2, in line with the IAQM Guidance, Priority 1 is defined as having sensitive receptors (i.e., residentials, hospitals, schools) within 20 m of construction worksite or > 100 sensitive receptors within 50 m of construction worksite. While Priority 2 is defined as having > 10 commercial receptors within 20 m of construction worksite, having 1–100 sensitive receptors between 20–50 m of construction worksite or having > 100 sensitive receptors between 50–100 m of construction worksite. All other buildings within the 250 m Study Area will be considered as Priority 3.

Therefore, based on the distances of emission sources to the identified receptors presented in Figure 9.3.1 to Figure 9.3.3, the Sensitivity of the Area for each construction worksite was determined to be ranging from Priority 1 to Priority 3 as summarized in Table 8.3.3 for earthworks, construction, and trackout. Due to the extensive list of the identified sensitive receptors for construction phase, this is elaborated and presented in Appendix D. It shall be noted that there is no sensitive receptor identified within the Study Area of trackout.

Table 8.3.3 Receptor sensitivity for air quality impact assessment – construction phase (human receptors)

Activities	Number of Receptors	Sensitivity of the Area
Earthworks		
Within 20m	-	Priority 2
Between 20m to 50m	Residential: 10 – 100	
Between 50m to 100m	Residential: 10 – 100	
Between 100m to 250m	Residential: 10 – 100 Educational: >100	
Construction		
Within 20m	-	Priority 3
Between 20m to 50m	-	
Between 50m to 100m	Residential: 10 – 100	
Between 100m to 250m	Residential: >100 Educational: >100	
Trackout		
Within 20m	-	-

Activities	Number of Receptors	Sensitivity of the Area
Between 20m to 50m	-	

8.3.2 Operational Phase

Potential air quality impact during operational phase of the Project would be vehicular emissions due to increased traffic to the proposed development (e.g., existing road of Old Holland Road, Blackmore Drive, Holland Link, Holland Road, Holland Plain and existing temporary road for maintenance and construction between Blackmore Drive and Holland Plain). Potential human and ecological sensitive receptors which might be impacted by the increased traffic within 250 m air quality Study Area (see Figure 9.3.4) are presented in Table 8.3.4 below. It should be noted that there is no detailed plan of project or operational footprint (e.g., rooftop stacks or pollutant-generating equipment on buildings) at this early stage, hence the air quality sensitive receptors were identified based on the existing land uses and the future proposed land use plan in Figure 3.2.1.

Table 8.3.4 Receptor sensitivity for air quality impact assessment – operational phase

No.	Receptor Name	Land Use	Receptor Type	Sensitivity Classification
Existing Receptors				
1	22, 24, 26, 28, 30, 32 Bukit Sedap Road	Residential	Human	Priority 1
2	969, 971, 973, 975, 987, 989, 991, 993, 995, 997, 1001, 1003, 1005 Bukit Timah Road	Residential	Human	Priority 1
3	870, 900 Dunearn Road	Residential	Human	Priority 1
4	1, 1A, 1B, 2, 2A, 3, 3A, 3B, 4, 5, 6, 7, 8, 8A, 9, 15, 16, 17, 17A, 18, 19, 19A, 19B, 21, 22, 23, 23A, 24, 25, 25A, 26, 26A, 27, 27A, 28 Ewart Park	Residential	Human	Priority 1
5	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 27, 29 Greenleaf Avenue	Residential	Human	Priority 1
6	1, 1B, 1C, 2, 3, 3A, 4, 5, 6, 8, 9, 10, 11, 12, 14, 15, 16, 17, 18, 20, 22, 23, 24, 25, 26, 27, 28, 30, 32, 34, 36, 38, 40, 42, 44, 46, 48, 50, 52, 54, 56, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73 Greenleaf Drive	Residential	Human	Priority 1
7	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 14, 15, 16, 17, 18, 19, 20, 21, 23 Greenleaf Grove	Residential	Human	Priority 1
8	1, 3, 5 Greenleaf Lane	Residential	Human	Priority 1
9	2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 35, 37, 39, 41, 43, 45, 47, 49, 51, 53 Greenleaf Place	Residential	Human	Priority 1
10	1, 3, 5, 7, 9, 11, 15, 17, 19, 21, 23, 25, 27, 29, 30, 31, 33, 35, 37, 39, 41, 43, 45, 47, 49 Greenleaf Rise	Residential	Human	Priority 1
11	39, 41, 43, 45, 51, 53, 53A, 53B, 53C, 55, 58, 60, 62, 64 Greenleaf Road	Residential	Human	Priority 1
12	1, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 66A, 66B, 66C, 67, 68, 69, 70, 72, 74, 76, 78, 80 Greenleaf View	Residential	Human	Priority 1
13	2 Greenleaf Walk	Residential	Human	Priority 1

No.	Receptor Name	Land Use	Receptor Type	Sensitivity Classification
14	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 47, 49, 51, 53, 55, 57, 59, 61 Holland Green	Residential	Human	Priority 1
15	11, 33 Holland Link	Residential	Human	Priority 1
16	57, 438, 440, 440, 442, 442A, 442B, 448, 450, 452, 456, 458, 460, 462, 464, 470, 472, 474, 474A, 476, 476A, 480, 482, 484, 486, 488, 490, 492, 559, 561, 563, 565, 567, 569, 571 Holland Road	Residential	Human	Priority 1
17	2A, 3A, 4, 5, 6, 7, 8, 20B, 21, 21C, 28, 29, 30, 30A King Albert Park	Residential	Human	Priority 1
18	33, 35, 37, 39, 41, 43, 45, 47 Maryland Drive	Residential	Human	Priority 1
19	1A, 787, 805, 807, 821, 823, 831, 850, 852, 854, 856, 858, 860 Old Holland Road	Residential	Human	Priority 1
20	2 Wilby Road	Residential	Human	Priority 1
21	Eleven @ Holland Unit 1 - 82	Residential	Human	Priority 1
22	100, 120, 134, 144, 166, 168, 186, 196, 234, 280, 390 Laurel Wood Avenue (The Teneriffe)	Residential	Human	Priority 1
23	6, 8, 10A, 12, 16, 17, 18, 20, 22, 24, 40, 42 Garlick Ave	Residential	Human	Priority 1
24	Fong Yun Thai Association	Place of Worship	Human	Priority 1
25	Methodist Girls' School	Educational Institution	Human	Priority 1
26	Link@896	Commercial	Human	Priority 1
27	870 Dunearn Rd	Commercial (Gas Station)	Human	Priority 1
28	King Albert Park (DT6)	MRT Station	Human	Priority 1
29	Rail Corridor	Natural Area	Ecological	Priority 1
30	Holland Green Linear Park	Park	Human	Priority 3
Future Receptors as per Proposed Land Use Plan (see Figure 3.2.1)				
31	Proposed Community Plain within Project Site	Park/ Natural Area	Ecological	Priority 1
32	Proposed Community Plain outside Project Site	Park/ Natural Area	Ecological	Priority 1
33	Proposed Residential Development within Project Site	Residential	Human	Priority 1
34	Proposed Residential Development outside Project Site	Residential	Human	Priority 1
35	Proposed Wetland Park outside Project Site	Park/ Natural Area	Ecological	Priority 1

8.4 Airborne Noise Sensitive Receptors

8.4.1 Construction Phase

Ecological Receptors

The prioritisation of the ecological receptors within and surrounding the Study Area follows the approach listed in the below factors:

- The actual presence or likely presence (from records) from faunistic field assessment conducted;

- The conservation significance or importance of the identified ecological receptors; and
- The ecological receptor's likelihood to be sensitive to airborne noise impacts.

Based on faunistic field assessment conducted within and surrounding the Study Area of the Project, mainly Priority 1 and Priority 2, are of particular concern due to their auditory sensitivities to airborne noise. Priority 3 fauna species of conservation significance, identified as not likely to be affected by noise were also identified. The priority levels for auditory sensitivity reflected in Table 8.4.1 were assigned based on the following general framework provided by the biodiversity specialists of this Project:

- Priority 1: Animals that vocalise during important life cycle stages such as courtship, territorial claims and/ or mating;
- Priority 2: Animals that have auditory sensory systems but do not necessarily need to vocalise during important life cycle stages; and
- Priority 3: Animals that are not likely to be affected by airborne noise.

Table 8.4.2 illustrates the list of Priority Level 1 receptors identified within the noise assessment area for this project.

Amphibians such as frogs are considered to have highly auditory sensitive as studies have demonstrated that anthropogenic noise is likely to substantially decrease the reproductive success in frogs [P-42]. Hence, amphibians are classified as Priority 1 ecological receptors.

Birds are considered to be highly auditory sensitive as most make use of sound for communication and breeding. Studies have also shown that birds are impacted negatively by anthropogenic noise [P-43]. Hence, birds are classified as Priority 1 ecological receptors.

Lepidoptera such as the butterflies are known to behaviourally respond to low-frequency vibrations and sounds to avoid insect predators and parasites [P-44]. Adult butterflies are known to make use of existing airborne noise in order to avoid predators [P-45]. Based on the above, lepidopterans are considered highly auditory. Hence, are classified as Priority 2 ecological receptors.

Non-volant mammals such as rodents are known to display stressed behaviour in response to sounds of heavy machinery which could be common occurrence from construction noise [P-48]. Hence, non-volant mammals are deemed to be highly auditory sensitive and classified as Priority 2 ecological receptors.

While for volant mammals such as bats, anthropogenic noise is known to impacts bats negatively by disrupting foraging patterns [P-51] and are hence classified as highly auditory sensitive. Hence, they are classified as Priority 1 ecological receptors.

It is documented that adult odonates appear to be able to hear however sound does not appear to cause significant behavioural change [P-47]. Odonates are consequently regarded as being less auditory sensitive. Hence, they are classified as Priority 3 ecological receptors, dependant on conservation significance.

Reptiles such as lizards are considered to be highly auditory sensitive due to studies showing these species exhibiting stress responses when exposed to anthropogenic noise [P-52. For snakes, though not equipped with outer-ears and tympanic middle ear, have vestiges for hearing inside their heads and can feel low-frequency airborne sounds [P-49]. Turtles on the other hand, follows the classification of aquatic species such as decapod crustaceans and fish due to their ability to traverse land and water [P-50]. As such, reptiles are classified as Priority 2 sensitive ecological receptors.

Studies have been conducted on the transmission of noise energy across the air to water boundary. Research shows that the transmission of airborne noise energy to the water medium is low due to the difference in acoustic characteristic impedance of air to water by a ratio of 1:3600 [P-46]. Hence, aquatic/ marine species such as arthropods, cephalopods, cnidarians, decapods, echinoderms, marine worms, molluscs, and fishes that primarily dwell within water bodies are considered to be Priority 3 sensitive ecological receptors [P-54].

Table 8.4.1 Ecological receptors and airborne noise auditory sensitivity classification

Receptor Number	Receptors	Auditory Sensitivity Classification
Terrestrial Fauna		

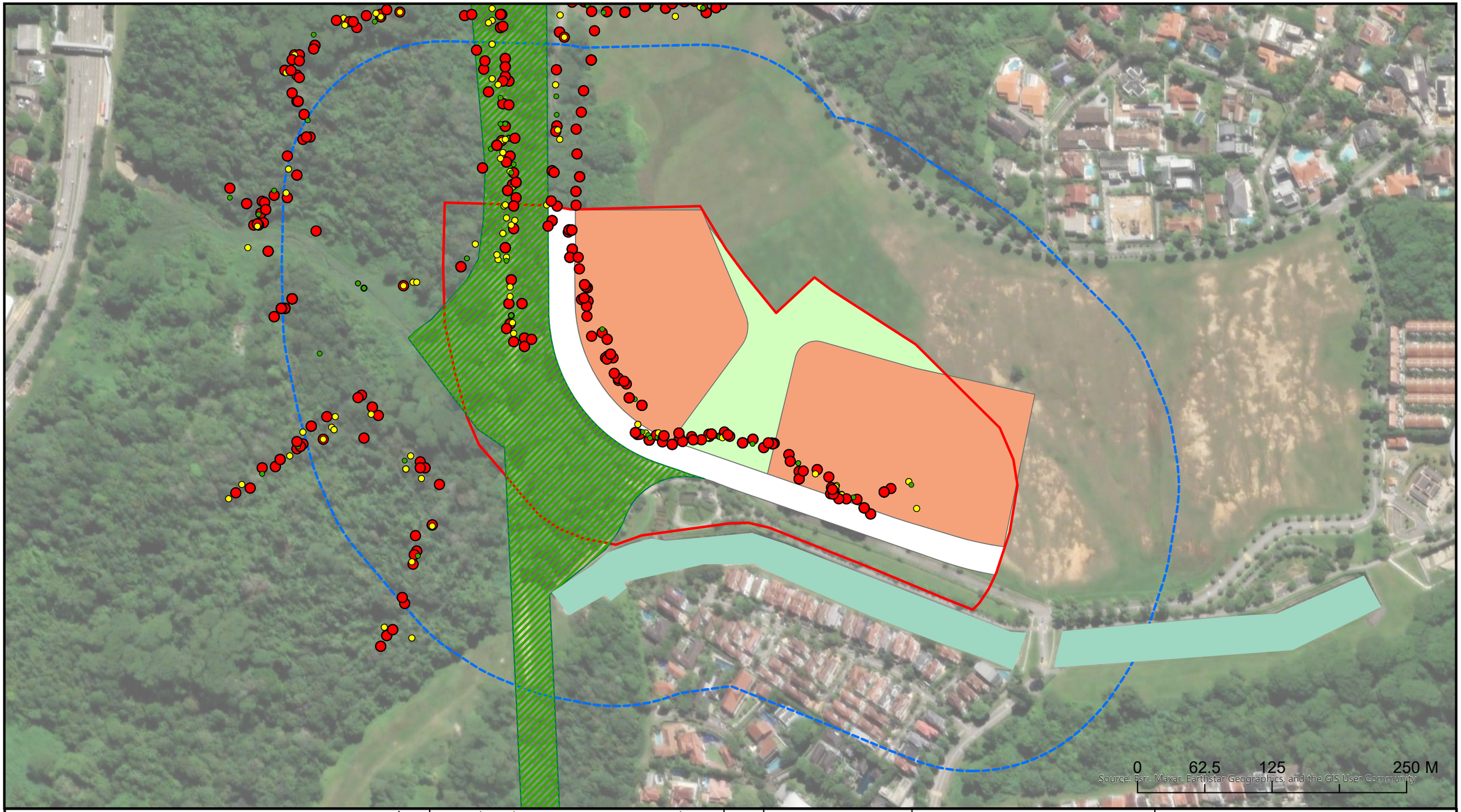
Receptor Number	Receptors	Auditory Sensitivity Classification
1	Amphibians • Frogs • Toads	Priority 1
2	Bird	Priority 1
3	Butterfly	Priority 2
4	Non-volant Mammals	Priority 2
5	Volant Mammals (Bats)	Priority 1
6	Odonates • Damselfly • Dragonfly	Priority 3
7	Reptiles • Snakes • Turtles • Lizards	Priority 2
Marine/Aquatic Fauna		
1	Fish	Priority 3

Table 8.4.2 List of ecological receptors with auditory priority level 1

S/N	Scientific Name	Taxa
1	*Chalcorana labialis*	Amphibian
2	*Duttaphrynus melanostictus*	Amphibian
3	*Eleutherodactylus planirostris*	Amphibian
4	*Fejervarya limnocharis*	Amphibian
5	*Hylarana erythraea*	Amphibian
6	*Kaloula pulchra*	Amphibian
7	*Limnonectes blythii*	Amphibian
8	*Limnonectes malesianus*	Amphibian
9	*Microhyla butleri*	Amphibian
10	*Microhyla heymonsi*	Amphibian
11	*Microhyla mukhlesuri*	Amphibian
12	*Polypedates leucomystax*	Amphibian
13	*Pulchrana laterimaculata*	Amphibian
14	*Acridotheres javanicus*	Bird
15	*Aegithina tiphia*	Bird
16	*Aerodramus sp.*	Bird
17	*Aethopyga siparaja*	Bird
18	*Amaurornis phoenicurus*	Bird
19	*Anthracoceros albirostris*	Bird
20	*Anthreptes malacensis*	Bird
21	*Aplonis panayensis*	Bird
22	*Ardeola sp.*	Bird
23	*Bubulcus coromandus*	Bird
24	*Cacatua goffiniana*	Bird
25	*Caprimulgus affinis*	Bird
26	*Caprimulgus macrurus*	Bird
27	*Cecropis daurica*	Bird
28	*Centropus sinensis*	Bird
29	*Chalcophaps indica*	Bird
30	*Chrysococcyx xanthorhynchus*	Bird
31	*Chrysophlegma miniaceum*	Bird
32	*Cinnyris jugularis*	Bird
33	*Corvus splendens*	Bird
34	*Dicaeum cruentatum*	Bird

S/N	Scientific Name	Taxa
35	*Dicrurus paradiseus*	Bird
36	*Dinopium javanense*	Bird
37	*Eudynamys scolopaceus*	Bird
38	*Eurystomus orientalis*	Bird
39	*Ficedula zanthopygia*	Bird
40	*Gallus gallus*	Bird
41	*Garrulax leucolophus*	Bird
42	*Geopelia striata*	Bird
43	*Gracula religiosa*	Bird
44	*Halcyon smyrnensis*	Bird
45	*Haliaeetus leucogaster*	Bird
46	*Haliastur indus*	Bird
47	*Hirundo rustica*	Bird
48	*Hirundo tahitica*	Bird
49	*Lalage nigra*	Bird
50	*Lanius cristatus*	Bird
51	*Larvivora cyane*	Bird
52	*Lewinia striata*	Bird
53	*Loriculus galgulus*	Bird
54	*Merops viridis*	Bird
55	*Micropternus brachyurus*	Bird
56	*Mixornis gularis*	Bird
57	*Muscicapa dauurica*	Bird
58	*Ninox scutulata*	Bird
59	*Nisaetus cirrhatus*	Bird
60	*Oriolus chinensis*	Bird
61	*Orthotomus atrogularis*	Bird
62	*Orthotomus ruficeps*	Bird
63	*Orthotomus sericeus*	Bird
64	*Orthotomus sutorius*	Bird
65	*Otus lempiji*	Bird
66	*Pericrocotus divaricatus*	Bird
67	*Pernis ptilorhynchus*	Bird
68	*Phylloscopus borealis*	Bird
69	*Picus vittatus*	Bird
70	*Psilopogon haemacephalus*	Bird
71	*Psilopogon lineatus*	Bird
72	*Psittacula alexandri*	Bird
73	*Psittacula krameri*	Bird
74	*Psittacula longicauda*	Bird
75	*Pycnonotus goiavier*	Bird
76	*Pycnonotus jocosus*	Bird
77	*Pycnonotus plumosus*	Bird
78	*Pycnonotus zeylanicus*	Bird
79	*Rallina fasciata*	Bird
80	*Rhipidura javanica*	Bird
81	*Spilopelia chinensis*	Bird
82	*Spilornis cheela*	Bird
83	*Terpsiphone affinis*	Bird
84	*Todiramphus chloris*	Bird
85	*Treron vernans*	Bird
86	*Trichoglossus haematodus*	Bird
87	*Vanellus indicus*	Bird
88	*Zapornia fusca*	Bird
89	*Zosterops simplex*	Bird
90	*Cynopterus brachyotis*	Mammal
91	*Myotis muricola*	Mammal
92	*Paradoxurus musangus*	Mammal

S/N	Scientific Name	Taxa
93	*Rhinolophus lepidus*	Mammal
94	*Saccolaimus saccolaimus*	Mammal
95	*Scotophilus kuhlii*	Mammal
96	*Tylonycteris spp.*	Mammal



Legend

- Study Boundary
- Indicative residential development
- Road
- Indicative Park
- Noise Study Area (150m-buffer)
- Rail Corridor
- Bukit Timah Diversion Canal

Priority

- Priority 1
- Priority 2
- Priority 3

N

Rev.	Date	By	Description	Chk'd	App'd
1	NOV 2025	SHA	Holland Plain EIA	LAL	ADP
-	JAN 2025	SHA	Holland Plain EIA	LAL	ADP

Qualified Person Endorsement : NA

URA Endorsement : NA

Consultant : AECOM

Client: URA Urban Redevelopment Authority

Project Title :

CONTRACT URA/T/23/048
HOLLAND PLAIN
ENVIRONMENTAL IMPACT ASSESSMENT

Figure Title :

Noise sensitive receptors (ecology)

Designed	Checked	Approved	Figure No. :	Rev.	Sheet
SHA	LAL	ADP	8.4.1	-	1 of 1
	Drawn SHA	Date NOV 2025	CAD File Name : NA		A3

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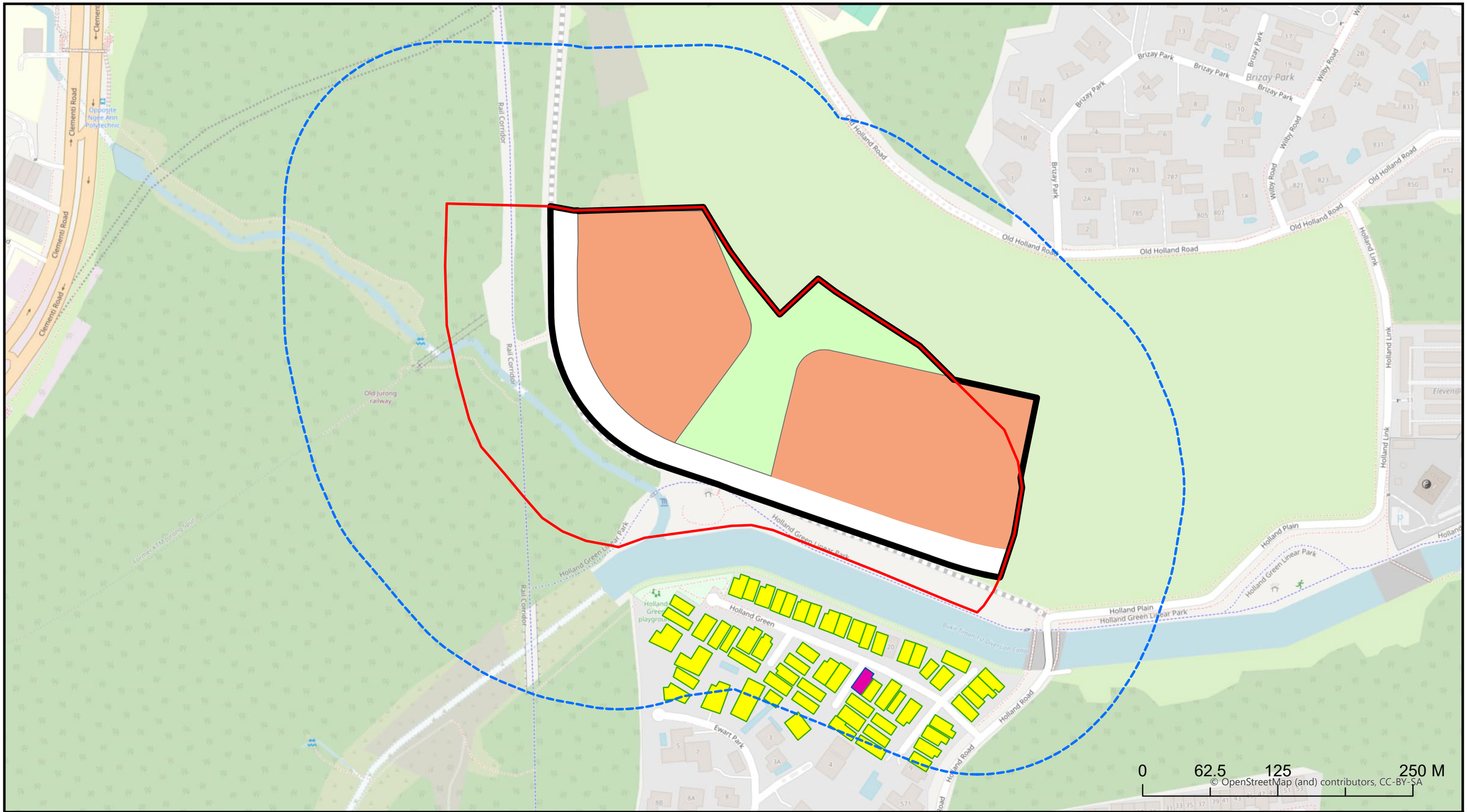
Human Receptors

According to the *Environmental Project and Management Regulation, 2008* [R-31], the sensitive human receptors for the construction phase are buildings within 150 m from the proposed construction worksites within the Study Area. As an initial step of noise impact assessment, the buildings within the Assessment Area that may be potentially sensitive to the construction noise from the Project were analysed. As a result, the human noise sensitive receptors (NSRs) for the construction phase were identified and reflected in Figure 8.4.2 and summarised in Table 8.4.3 where the respective sensitivity classifications are based on Table 5.2.2.

For the purposes of qualitative impact assessment, the baseline noise levels recorded at SLMs associated with the different human receptors listed in Appendix F shall serve as a gauge towards the determination of the perceivability and noticeability of additional noise impacts on these receptors arising from the construction phase.

Table 8.4.3 Summary of Human noise sensitive receptors (construction phase)

Receptor Sensitivity	Building Type	No. of Receptors	Height (m)	Distance from the Project Sites (m)
Priority 2	Residential	60	3.2-12.8	71-187
Priority 3	Service Facility	1	4.8	115



Legend

- Study Boundary
- Road
- Construction Worksite
- Noise Study Area (150m-buffer)
- Indicative residential development
- Indicative Park

Priority
- 2
- 3

Building Type
- Residential
- Service Facility

N

Rev.	Date	By	Description	Chk'd	App'd
1	NOV 2025	SHA	Holland Plain EIA	LAL	ADP
-	JAN 2025	SHA	Holland Plain EIA	LAL	ADP

Qualified Person Endorsement : NA

URA Endorsement : NA

Consultant : AECOM

Client: URBAN REDEVELOPMENT AUTHORITY

Project Title :

CONTRACT URA/T/23/048
HOLLAND PLAIN
ENVIRONMENTAL IMPACT ASSESSMENT

Figure Title :

Noise sensitive receptors (human)

Designed	Checked	Approved
SHA	LAL	ADP
	Drawn: SHA	Date: NOV 2025

Figure No. : 8.4.2 | Rev. : - | Sheet : 1 of 1

CAD File Name : NA | A3

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8.4.2 Operational Phase

Ecological Receptors

Ecological receptors considered for assessment of noise impacts arising from the operational phase shall consider similar ecological receptors identified for the construction phase as discussed in Section 8.4.1 above. With necessary and adequate mitigation measures implemented for the construction phase to reduce noise impacts on the ecological receptors, similar fauna species identified surrounding the proposed construction worksites and within/ surrounding the Project Study Area prior to construction works, should continue to inhabit the surrounding areas.

It is advised that faunistic survey and baseline noise monitoring be conducted upon completion of the construction phase and commencement of the operational phase to determine the new baseline conditions and fauna species that remain in the vicinity of the proposed construction worksites to determine actual operational noise impacts.

Human Receptors

Apart from the human receptors identified in the Section 8.4.1 human receptors within the Project Site need to be considered for the operational phase and assessed as part of operational noise impacts arising from noise associated with the air conditioning and mechanical ventilation (ACMV) systems of residential buildings, and as part of Traffic Noise Impact Assessment (TNIA). Both elements were considered to assess the operational noise impact within the Study Area.

9 Potential Sources of Impacts

9.1 Potential Sources of Biodiversity Impacts

This section discusses possible biodiversity impacts arising from the construction and operational phases of the Project, based on the proposed construction and operational activities.

Potential impacts to biodiversity arising from construction (Section 9.1.1) and operational (Section 9.1.2) activities are assessed in this section. It is assumed that all vegetation within the development site will be cleared to allow for development. Construction activities such as excavating and vegetation clearance will be conducted.

During the operational phase, the area within the development boundary would contain residential developments as well as public parks, leading to a likely increase in human traffic and/or disturbance to biodiversity in the form of noise, air, dust and light pollution.

The impacts were separately assessed for habitats, plant and faunal species (Table 9.1.1). There are two main categories in which the impacts fall into, namely, (1) direct, i.e., impacts to habitats and species within the development area and (2) indirect, i.e., impacts to habitats and species outside the development area but within the impact zone. Impact zones for habitat and species receptors are defined as areas within 30 m from the development boundary, even though there are some studies that found edge effects affecting vegetation up to 150 m from forest boundaries (Farmer, 1993 [R-49]; Guderian, 1986 [R-48]; Jusuf et al., 2007 [R-47]; Wong & Yu, 2005 [R-46]). The 30-m impact zone assumes that edge effects in the forests adjacent to the development boundary, are greatest (Chatterjea, 2014 [R-50]).

9.1.1 Construction Phase

Table 9.1.1 Summary of construction phase impacts, descriptions and impact categories on ecological receptors

Receptor	Impact Type	Description	Impact Category
Construction Phase			
Habitats	Habitat Loss	Direct removal of habitats (including vegetation with extensive 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
	Formation of Edge Effects	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
Flora	Mortality	Direct removal of vegetation to create space for construction activities	Direct
	Decline in plant health and survival	Changes in microclimatic conditions (i.e., dust, noise, and light, temperature, and humidity) and hydrology	Indirect

Receptor	Impact Type	Description	Impact Category
	Poaching	Stealing/poaching of plants due to ethnobotanical value (eg: ornamental, medicinal, food, craft etc.)	Direct
Fauna	Accidental injury or mortality	Collisions with machineries, entrapments in construction materials (such as non-biodegradable erosion control blankets) and structures (such as exposed pits or drains), and accidental kills by construction personnel	Direct
	Increased invertebrate mortality from fumigation	Increase in invertebrate mortality via exposure of harmful chemicals in fumigants	Direct
	Decline in invertebrate health from fumigant runoff and residue	Physiological stress or mortality of invertebrates from fumigant runoff into nearby waterbodies and/or residue on vegetation	Indirect
	Loss / reduction of ecological connectivity for faunal movement	Habitat fragmentation from the removal of vegetation	Indirect
	Light disturbance	Increase in light levels from construction activities	Indirect
	Human Disturbance	Increase in human traffic flow, such as workers and site personnel, which may result in human-wildlife conflicts	Indirect

9.1.2 Operational Phase

Table 9.1.2 Summary of operational phase impacts, descriptions and impact categories on ecological receptors

Receptor	Impact Type	Description	Impact Category
Operational Phase			
Habitat	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
Flora	Decline in plant health and survival	Changes in microclimatic conditions (i.e., dust, noise, and light, temperature, and humidity) and hydrology	Indirect
Fauna	Accidental injury or mortality	Collisions with machineries, entrapments in construction materials (such as non-biodegradable erosion control blankets) and structures (such as exposed pits or drains), and	Direct

Receptor	Impact Type	Description	Impact Category
		accidental kills by construction personnel	
	Fumigation impacts on invertebrate mortality	Increase in invertebrate mortality via exposure of harmful chemicals in fumigants	Direct
	Decline in invertebrate health from fumigant runoff and residue	Physiological stress or mortality of invertebrates from fumigant runoff into nearby waterbodies and/or vegetation	Indirect
	Loss / reduction of ecological connectivity for faunal movement	Habitat fragmentation from the removal of vegetation	Indirect
	Light disturbance	Increase in light levels from construction activities	Indirect
	Human Disturbance	Increase in human traffic flow, such as workers and site personnel, which may result in human-wildlife conflicts	Indirect

9.2 Potential Sources of Hydrology and Water Quality Impact

This section discusses the potential environmental impacts arising from the construction and operational phases of the Project.

9.2.1 Construction Phase

Nearby waterbodies can be potentially exposed to contamination due to the activities taking place during the project's construction phase. The sources that could potentially impact on the nearby freshwater quality and quantity include, but are not limited to, those listed in Table 9.2.1.

Table 9.2.1 Potential hydrology and water quality Impacts during the construction phase

Environmental Parameter	Potential Source of Impacts	Potential Associated Impacts
Hydrology	Temporary or permanent land use change during construction phase activities such as site clearance.	• Change in area of impervious surfaces due to land use change from land clearance which leads to the change in water seepage into the ground and change in stormwater runoff peak flow and quantities, which could cause alterations in current dry and wet weather flow conditions; • Change in water levels within watercourses and potential flooding of adjacent area; • Disturbances in aquatic habitats due to altered dry and wet weather conditions; • Localised flooding may have adverse impacts on surrounding terrestrial habitats; and • Addition of construction discharge inlets into watercourses.
	Temporary or permanent land use change due to earthworks, including site levelling and excavation works.	
	Temporary or permanent land use change due to construction of temporary and permanent structures and accompanying infrastructure.	
Water Quality	Discharge of potentially contaminated surface water runoff originating from exposed soil and construction	• Wastewater from construction activities can contain elevated levels of suspended solids

Environmental Parameter	Potential Source of Impacts	Potential Associated Impacts
	activities. The potential sources of such contaminants are: • Runoff from exposed soil surface, earth work areas, utilities diversion, soil stockpiles; • Stormwater/groundwater pumped out from excavated areas; • Release of grouting and cement materials; • Runoff from dust suppression sprays; • Elevated suspended solids (e.g. silt and sediment) in site runoff due to heavy rain; • Spoil generation, handling and transport; and • Heavy rain during construction.	which can lead to increased turbidity and sedimentation rates in the watercourses, etc; • Wastewater from construction activities can contain high levels of oil, grease, and other chemical substances (e.g. calcium hydroxide) therefore contaminating the watercourses; • Inappropriate storage and disposal of wastewater will generate contaminated runoff and pollute nearby watercourses (e.g. improper discharge of construction wastewater, and domestic sewage); • Solid waste generated can lead to elevated levels of suspended solids entering watercourses via runoff or improper handling/disposal. It can also block the temporary drains which can lead to localised flooding and mosquito breeding; • Improper storage, handling, disposal or leakage of toxic waste generated at temporary work areas can lead to water contamination; • Contaminated stormwater due to improper storage/disposal/transport of chemical materials handled and stored on site leading to an increase in the levels of oil, grease and other chemical substances (e.g. calcium hydroxide) in the nearby watercourses; and • Fuel and lubricants spillage from maintenance of construction vehicles and mechanical equipment can also lead to elevation in levels of oil and grease in the nearby watercourses.
	Storage and disposal of solid wastes leading to improper handling, transfer, storage, and disposal of spoil and solid waste (e.g. TBM spoil, excavated earth, construction debris).	
	Storage and disposal of liquid wastes leading to: • Improper management of sewage effluents from on-site; and • Inappropriate discharge of domestic sewage and poor maintenance of the portable chemical toilet, storage tanks and septic tanks (e.g. overflow or overload).	
	Use and storage of chemical substances, and refuelling activities leading to: • Improper handling, transfer and storage of chemical substances. • Accidental spill and leaks. • Fuel and lubricant spillage from the maintenance of construction vehicles and mechanical equipment.	

9.2.2 Operational Phase

Waterbodies can potentially be exposed to contamination due to the activities taking place during the project's operational phase. The sources that could potentially impact on nearby surface water quality and quantity include but are not limited to the ones listed in Table 9.2.2.

Table 9.2.2 Potential hydrology and water quality Impacts during the operational phase

Environmental Parameter	Potential Source of Impacts	Potential Associated Impacts
Hydrology	Permanent land use change with more impervious surfaces due to proposed developments.	• Increased stormwater peak flow contributions to the channel can lead to increased water level and subsequent flooding of surrounding areas adjacent to the stream/drain; • Alter dry weather flow in natural stream that can lead to impact on downstream aquatic habitats; and • Localised flooding which may obstruct regular activities of future residents and/or visitors.
Water Quality	Discharge of potentially contaminated surface water runoff, especially during storm events in the new development area.	• Elevated suspended solids (e.g. silt and sediment) and pollutants (e.g. heavy metals and nutrients from human activities) in site run-off; • Solid waste can block the watercourses and lead to contamination; and • Inappropriate discharge of liquid wastes to the watercourses may result in contamination.
	Improper management of liquid and solid wastes generated within the site.	

9.3 Potential Sources of Air Quality Impact

9.3.1 Construction Phase

For human receptors, dust emissions could potentially result in adverse impacts on air quality and public health causing respiratory problems on human during this phase. For ecological receptors, dust generated during construction works can have adverse effects upon vegetation in immediate vicinity restricting photosynthesis, respiration and transpiration. Furthermore, it can lead to phytotoxic gaseous pollutants penetrating the plants. The overall effect can be a decline in plant productivity, which may then have indirect effects on the quality of the affected habitats and associated fauna. Table 9.3.1 listed potential sources of air quality impact during construction phase of the project. The impacts of fumigation on the fauna have been considered in Section 9.1.1.

Table 9.3.1 Potential air quality impacts during the construction phase

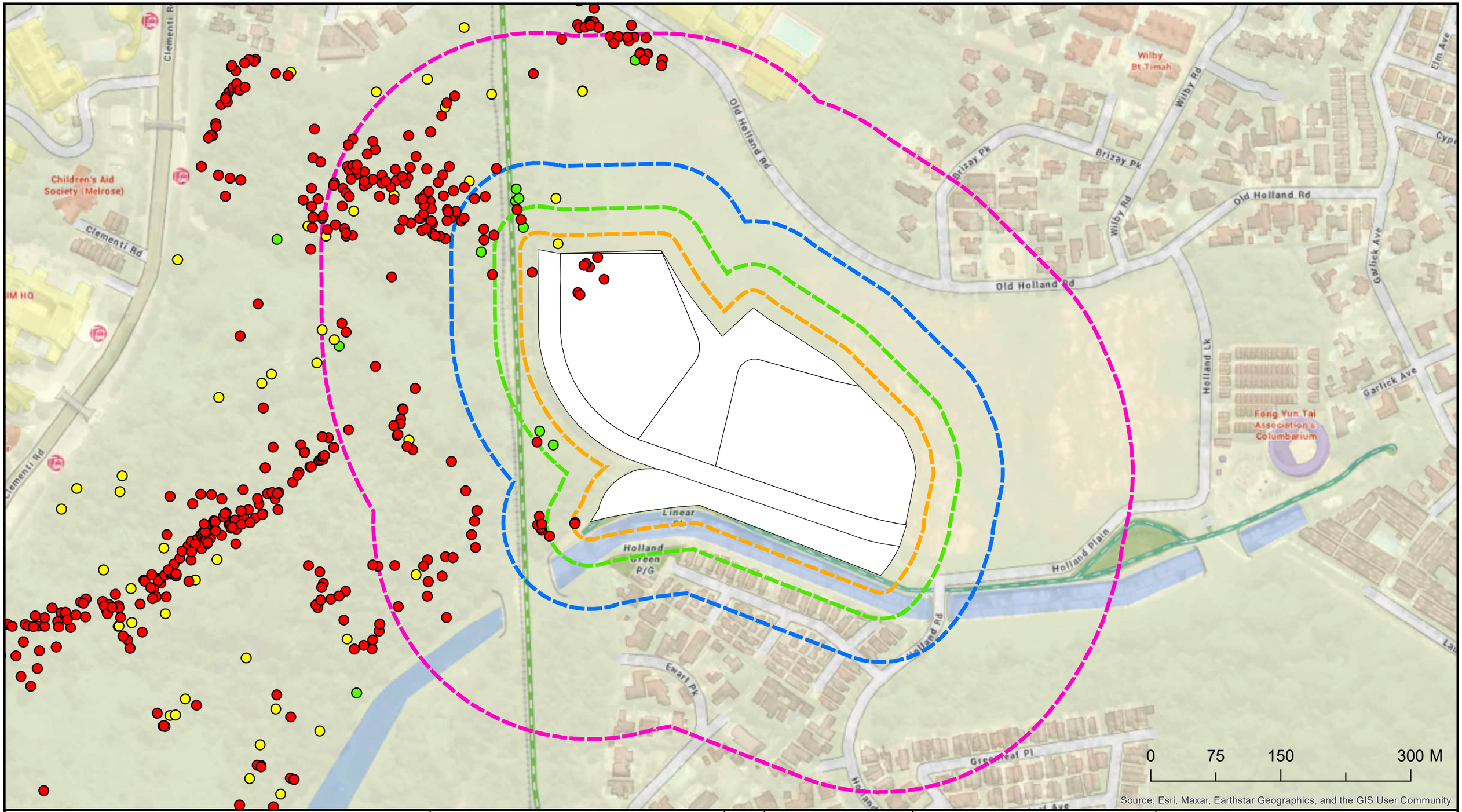
Potential Source of Impacts	Potential Associated Impacts
Dust emissions generated by earthworks processes, including land clearance (e.g., waste wood debris), soil-stripping, ground levelling, excavation, stockpiling of spoil and landscaping.	Dust emissions could potentially result in adverse impacts on air quality and public health and may also generate significant nuisance at receptors, including the biodiversity, located nearby heavy construction worksite areas.
Dust emissions generated by the construction of new structures, including holding areas, site offices and road works, if any.	Dust emissions could potentially result in adverse impacts on air quality and public health and may also generate significant nuisance at receptors, including the biodiversity, located nearby heavy construction worksite areas.
Dust emissions generated from potential demolition works, if any.	Dust emissions could potentially result in adverse impacts on air quality and public health and may also generate significant nuisance at receptors, including the biodiversity, located nearby heavy construction worksite areas.
Dust emissions from transport of dust and dirt by dumper trucks for transporting spoil within the site and from the site onto public road	Dust emissions could potentially result in adverse impacts on air quality and public health and may also generate significant nuisance at receptors nearby haulage routes.

Potential Source of Impacts	Potential Associated Impacts
network, where it may be deposited and resuspended by vehicles using the network.	
Gaseous emissions from vehicle exhaust due to movement of construction vehicles and equipment, including spoil disposal	Exhaust emissions (NO_2, SO_2, CO, PM_{10} and $PM_{2.5}$) could potentially impact the air quality in the vicinity of construction worksites.
Gaseous emissions from off-road diesel engines on-site such as generators, if any	Exhaust emissions (NO_2, SO_2, CO, PM_{10} and $PM_{2.5}$) could potentially impact the air quality in the vicinity of construction worksites.

In the general context of air quality impact assessment, earthworks include some extent of soil-cutting, excavation, piling and excavation works, while the construction activity includes the construction of the proposed buildings. According to the preliminary planning, the total site area of the Project is expected to be approximately 85,900 m^2. In view of the scale of this Project, more than 10 heavy vehicles / machineries per day are expected to be operating on site at any of the time throughout the construction phase. The Project Site will be cleared and the fauna within the development area will be directionally cleared out prior to earthworks, thus they were not considered as sensitive receptors.

The planned total building volume is estimated to be approximately 412,000 m^3. No concrete batching plant was planned to be located within the Project Site. Since this Project is situated on a piece of less-developed area with mainly scrubland and exotic-dominated forests, it is also assumed that no demolition of permanent structure/ building will be required. The final building layout is still undergoing discussion with URA and will be updated in the revised report once finalised.

The trucks carrying construction materials and/or spoil to and from the Project Site on access roads are also considered as a potential source of emission (referred to as trackout activity) as shown in Figure 9.3.3. The assessment covered up to 250 m of the access road from the site entrance, in line with the IAQM Guidance. The number of outward trucks movement is expected to be around > 50 HDVs per day. The HDVs are assumed to travel along the existing paved roads (i.e., Holland Road, Holland Plain, Old Holland Road and Blackmore Drive) for access to the Project Site. Thus, it is assumed that no unpaved roads are involved. Impact prediction and evaluation are detailed in Section 11.3.1.1. Note that the numbers presented in this section are based on estimation and are subject to further changes.



Legend

- Species of Conservation Significance
- Large Plant Specimen
- Other Specimens of Value
- 20m from Source
- 50m from Source
- 100m from Source
- 250m from Source
- Earthworks Footprint

Sensitive Receptors

- Commercial Building
- Place of Worship
- Educational Institution
- Park/ Natural Reserve/ Garden
- Unclassified Building (incl. Landed Properties and Condominiums)

IN

Rev.	Date	By	Description	Chk'd	App'd
01	MAY 2025	TTR	Holland Plain EIA	KAM	ADP
-	FEB 2025	TTR	Holland Plain EIA	KAM	ADP

Qualified Person Endorsement : NA

URA Endorsement : NA

Consultant : AECOM

Client: Urban Redevelopment Authority

Project Title :

CONTRACT URA/T/23/048
HOLLAND PLAIN
ENVIRONMENTAL IMPACT ASSESSMENT

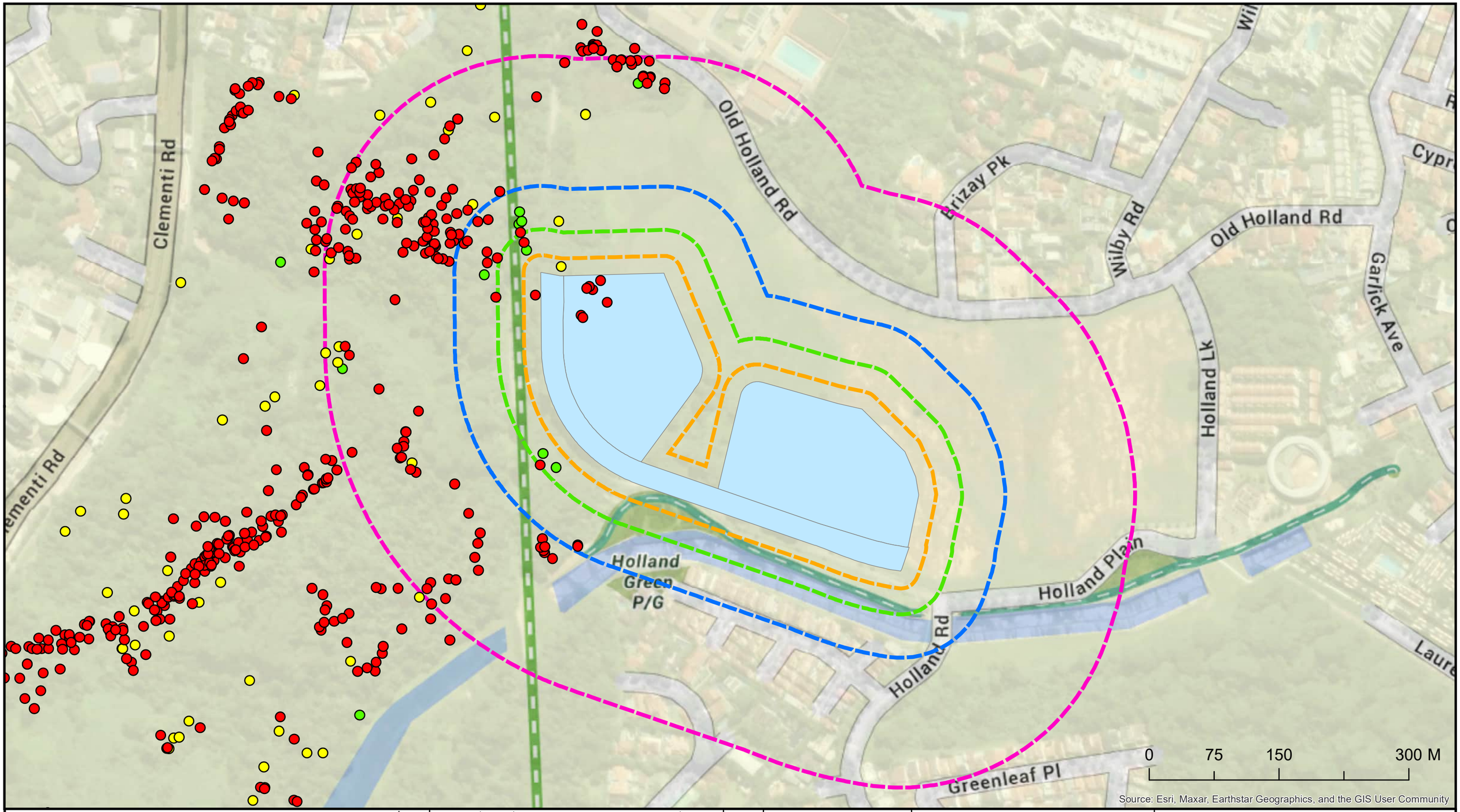
Figure Title :

Emission sources and sensitive receptors - earthworks

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TTR	KAM	ADP	9.3.1	01	1 of 1
	Drawn TTR	Date MAY 2025	CAD File Name : NA		A3

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Legend

- Species of Conservation Significance
- Large Plant Specimen
- Other Specimens of Value
- 20 m from Source
- 50 m from Source
- 100 m from Source
- 250 m from Source
- Construction Footprint

Sensitive Receptors

- Commercial Building
- Place of Worship
- Educational Institution
- Park/ Natural Reserve/ Garden
- Unclassified Building (incl. Landed Properties and Condominiums)

Note: The construction footprint is preliminary and is subject to further changes.

N

Rev.	Date	By	Description	Chk'd	App'd
02	OCT 2025	TTR	Holland Plain EIA	KAM	ADP
01	MAY 2025	TTR	Holland Plain EIA	KAM	ADP
-	FEB 2025	TTR	Holland Plain EIA	KAM	ADP

Qualified Person Endorsement : NA

URA Endorsement : NA

Consultant : AECOM

Client: URBAN REDEVELOPMENT AUTHORITY

Project Title :

CONTRACT URA/T/23/048
HOLLAND PLAIN
ENVIRONMENTAL IMPACT ASSESSMENT

Figure Title :

Emission sources and sensitive receptors - construction

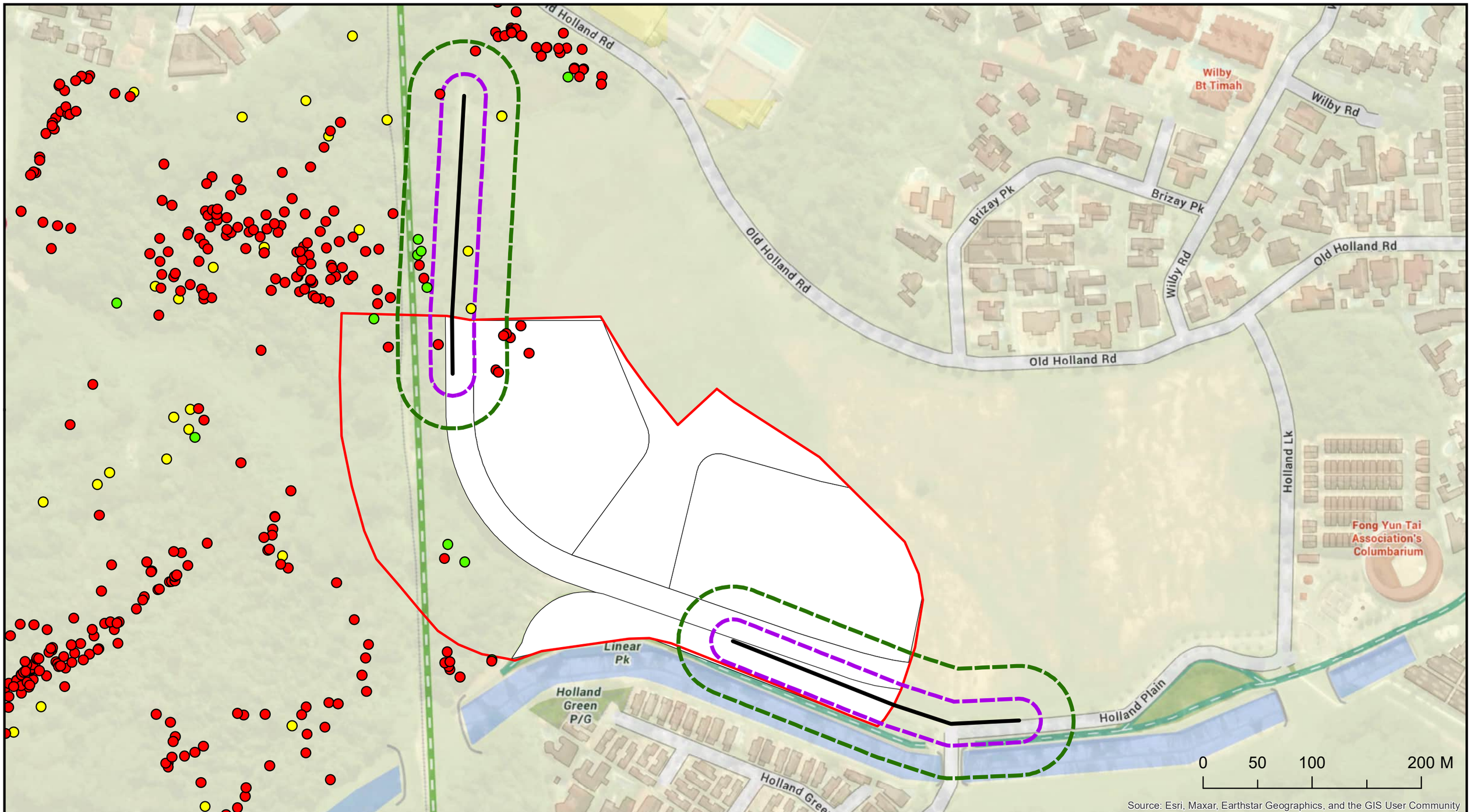
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Figure No. : 9.3.2 | Rev. 02 | Sheet 1 of 1

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Legend

- Species of Conservation Significance
- Large Plant Specimen
- Other Specimens of Value
- Access Road
- 20m from source
- 50m from Source
- Study Boundary
- Earthworks Footprint

Sensitive Receptors

- Commercial Building
- Place of Worship
- Educational Institution
- Park/ Natural Reserve/ Garden
- Unclassified Building (incl. Landed Properties and Condominiums)

N

Rev.	Date	By	Description	Chk'd	App'd
02	OCT 2025	TTR	Holland Plain EIA	KAM	ADP
01	MAY 2025	TTR	Holland Plain EIA	KAM	ADP
-	FEB 2025	TTR	Holland Plain EIA	KAM	ADP

Qualified Person Endorsement : NA

URA Endorsement : NA

Consultant : AECOM

Client: URBAN REDEVELOPMENT AUTHORITY

Project Title :

CONTRACT URA/T/23/048
HOLLAND PLAIN
ENVIRONMENTAL IMPACT ASSESSMENT

Figure Title :

Emission sources and sensitive receptors - trackout

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	Drawn: TTR	Date: OCT 2025

Figure No. : 9.3.3 | Rev. 02 | Sheet 1 of 1

CAD File Name : NA | A3

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9.3.2 Operational Phase

As presented in Table 9.3.2, potential air quality impact during operational phase of the Project would be vehicular emissions due to increased traffic in the vicinity of the Project, which in this context, the potential emission sources would be the stretch of existing road (e.g., existing road of Old Holland Road, Blackmore Drive, Holland Link, Holland Road, Holland Plain and existing temporary road for maintenance and construction between Blackmore Drive and Holland Plain) connected to the nearest junctions from the Project Site based on the review of the proposed land use plan in Figure 3.2.1. Moreover, the internal roads around the potential residential development within the Project Site would be potential emission sources as well. An overview of the potential emission sources and sensitive receptors within the 250 m air quality Study Area (as defined in Section 5.4.4) for operational phase is provided in Figure 9.3.4. The impacts of fumigation on the fauna have been considered in Section 9.1.2.

For human receptors, gaseous and particulate emissions from the increased traffic could potentially result in adverse impacts on air quality and public health causing respiratory problems on humans. For ecological receptors, the main air pollutants affecting vegetation and ecosystems are nitrogen oxides (NO_x), sulphur dioxide (SO_2) and ammonia (NH_3) [R-43]. In the context of this Project, the air pollutant of concern will be NO_x which are produced from road traffic emission. SO_2 is not relevant for this Project as low sulphur content fuel will be used by vehicles in Singapore. NH_3 is mainly produced from agricultural / decaying of waste and therefore, not relevant for the purpose of this Project. There is no published evidence for any direct toxic effect of NO_x on animals and therefore effects on animals are not included in ecological impact assessment [R-43].

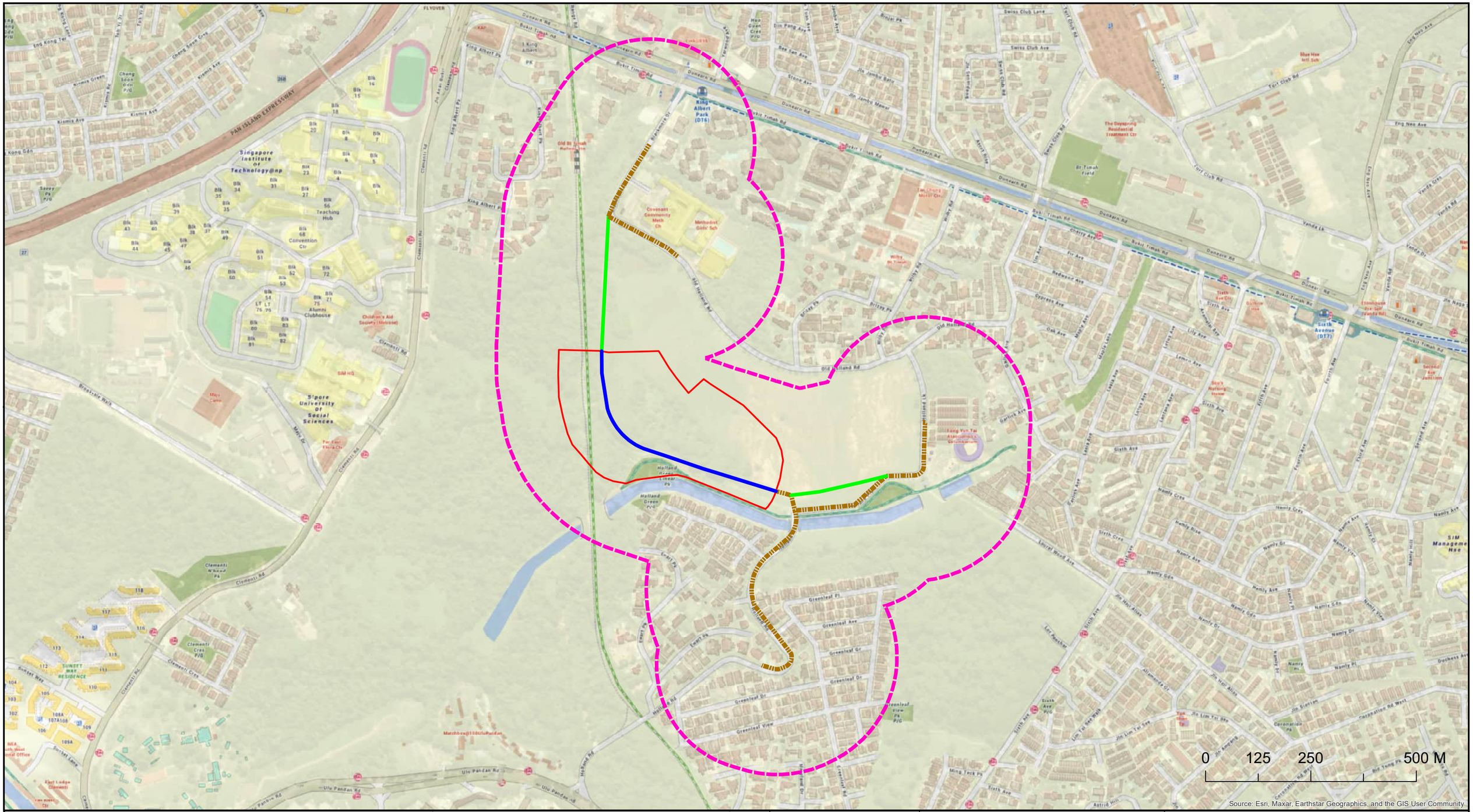
As per the NEA website, since 1 September 2017, all new petrol vehicles have had to meet the Euro 4 emission standard, and since 1 January 2018, all new diesel vehicles have had to meet the Euro 6 emission standard. The new standards will tighten fine particulate emissions from direct-injection petrol engines in addition to the other pollutants. Since 1 January 2018, the emission standard for all three-wheeled (Cat L5e) and large motorcycles with an engine capacity more than 200cc have been tightened to Euro 4 standard, while smaller motorcycles with an engine capacity of 200cc and below will see the Euro 4 emission standard implemented from 1 January 2020. Compared to the Euro 3 emission standard, the tighter Euro 4 emission standard will help reduce emissions of hydrocarbons and nitrogen oxides (NOx), which are precursors to ozone. The emission standards for various vehicle classes have been summarized in Table 9.3.3. Additionally, the Vehicular Emissions Scheme (VES), introduced in 2018 and updated in 2024, categorizes passenger cars and taxis based on pollutant emissions, providing incentives for cleaner vehicles while imposing surcharges on more pollutive ones. Similarly, the Commercial Vehicle Emissions Scheme (CVES) applies a tiered structure to light commercial vehicles, rewarding cleaner options. The CVES has been extended to 2027. Besides that, the cessation of new diesel car and taxi registrations from 2025 and the continued push towards electrification further will significantly minimise harmful emissions such as nitrogen oxides (NO_x) and particulate matter ($PM_{2.5}$).

Table 9.3.2 Potential air quality impacts during the operational phase

Potential Source of Impacts	Potential Associated Impacts
Gaseous and particulate emissions from vehicle exhaust due to the increased traffic in vicinity of the project due to project operation.	Exhaust emissions (NO_2, SO_2, CO, PM_{10} and $PM_{2.5}$) could potentially impact the air quality in the vicinity of the project.

Table 9.3.3 Emission standard of various vehicle classes

No.	Implementation Date	Vehicle Classes	Emission Standard
1	1 September 2017	New petrol vehicles	Euro 6
2	1 January 2018	New diesel vehicles	Euro 6
3	1 January 2018	Three-wheeled (Cat L5e) and large motorcycles with engine capacity more than 200cc	Euro 4
4	1 January 2020	Smaller motorcycles with engine capacity of 200cc and below	Euro 4



Legend

Potential Emission Sources

- Existing Road
- Additional Road (out of Project Boundary)
- Additional Road (within Project Boundary)
- 250 m from Source
- Study Boundary

Sensitive Receptors

- Commercial Building
- Place of Worship
- Educational Institution
- Park/ Natural Reserve/ Garden
- Unclassified Building (incl. Landed Properties and Condominiums)

N

Rev.	Date	By	Description	Chk'd	App'd
-	FEB 2025	TTR	Holland Plain EIA	KAM	ADP

Qualified Person Endorsement
NA

URA Endorsement : NA

Consultant : AECOM

Client: URBAN REDEVELOPMENT AUTHORITY

Project Title :

CONTRACT URA/T/23/048
HOLLAND PLAIN
ENVIRONMENTAL IMPACT ASSESSMENT

Figure Title :

Emission sources and sensitive receptors - operational footprint

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TTR	KAM	ADP	9.3.4	-	1 of 1
	Drawn TTR	Date FEB 2025	CAD File Name : NA		A3

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9.4 Potential Sources of Airborne Noise Impact

9.4.1 Construction Phase

Construction activities will inevitably result in some degree of noise disturbances at locations in close proximity to the proposed construction worksites of the Project. This is, however, a temporary source of noise, albeit lasting up to few years in this case. The noise levels generated by the construction activities have a potential to impact the noise sensitive receptors (NSRs). Noise levels at the receptors depends on several factors such as the number and type of Powered Mechanical Equipment (PMEs) used, the distance between the NSRs and the construction worksites, and the level of attenuation likely due to ground absorption, air absorption or barrier effects. Table 9.4.1 listed potential sources of airborne noise impact during construction phase of the project.

Table 9.4.1 Potential airborne noise impacts during the construction phase

Potential Source of Impacts	Potential Associated Impacts
Noise from trucks transporting spoil / equipment. Noise from traffic congestion caused due to inadequate lane compensation and traffic diversion during construction. Noise generated by the use of Powered Mechanical Equipment (PME), (such as excavators, generators, pumps, cranes, etc.,) for various construction activities within the site, including construction of holding areas, site offices and road widening works.	Potential for terrestrial transects to alter their natural behaviours or relocate to avoid unfamiliar noises caused by construction works in their habitats. Noise could potentially generate nuisance at the sensitive receptors in the vicinity of construction

At this point in the report-writing process, there is only limited information on the construction activities scheduled for the proposed project's development. The anticipated future activities during the project's construction phase are listed on Table 9.4.2.

The study on the construction noise impacts on the NSRs focused on worst-case noisiest activities for the construction during certain construction schedules provided by URA (refer to Appendix G). The intent of selecting the worst-case activity for assessment was such that if noise can be controlled in this activity by permanent features during the entire construction, the noise from other less noisy construction activities will also be mitigated. As per information communicated by URA, no night works will be involved in the construction phase and as legislated by NEA, no construction works should be conducted on the Weekends (Sunday/ Public Holidays) unless necessary and granted approval by relevant agencies. Hence, construction noise assessment was only conducted for the construction schedule of 8am -6pm and for Weekdays (i.e. Monday – Saturday).

At this point of the report writing process, the detailed equipment inventory for different construction activities were not available. A tentative list of equipment was provided by URA (refer to Appendix). The PMEs and their respective sound power levels (SPL) provided in this study by the Client are listed in the equipment inventory list in Appendix H. A summary of the six (6) construction activities and their overall effective sound power levels derived from the PMEs engaged in each of these activities are reflected in Table 9.4.2 below. The respective sound power levels of the selected construction activity provide an insight into the potential magnitude of noise perceived by the ecological and human receptors and how noticeable these noise emissions may be to the receptors on the receiving end for the purposes of conducting qualitative impact assessment.

The activities chosen for assessment were based on the worst-case activities with the highest overall sound power levels of the construction phase as reflected in Table 9.4.2 below in **bold** (i.e. Foundation Works).

Table 9.4.2 Effective sound power level (construction phase)

No.	Pre-construction and Construction Activities	Approximated Duration (months)	Effective Sound Power Level L_{wA}, dB(A) from equipment list	
			$L_{Aeq(12hours)}$	$L_{Aeq(5\ mins)}$
			7am – 7pm	7am – 7pm
1	Site Clearance Earthworks	30	117	126
2	**Foundation and Earthworks**	**30**	**125**	**126**
3	Superstructure Works (Prefab Installation)	36	117	**118**

No.	Pre-construction and Construction Activities	Approximated Duration (months)	Effective Sound Power Level L_{wA}, dB(A) from equipment list	
			$L_{Aeq(12hours)}$	$L_{Aeq(5\ mins)}$
			7am – 7pm	7am – 7pm
4	Landscape Works	24	119	120
5	Removal of Temporary Structures and Reinstatement	24	120	120
6	Road Construction	30	110	113

9.4.1.1 Determination of Assessment Scenarios

Considering the noise level generated during different construction activities as per Table 9.4.2, the **Foundation and Earthworks – Day Time (7 am -7 pm)** scenario was assessed as worst case. It should be noted that in accordance with information provided by URA on the construction work schedules, construction works are only proposed to occur within the time period of 7am – 7pm on Weekdays (i.e., no night-works, no works on Weekends).

9.4.1.2 Likelihood of occurrence of impacts

The Likelihood of Occurrence of construction noise impacts were determined based on the active duration of the proposed PMEs provided by URA over the daily working period (i.e., 7am – 7pm, 7pm – 7am, 7pm – 10pm, and 10pm – 7am) associated to the $L_{Aeq(12\ hours)}$, and $L_{Aeq(5\ mins)}$ dB descriptor in accordance with EPM, 2008 [R-31] for the three (3) respective assessment scenarios (refer to Section 9.4.1.1, detailed as frequency of exposure in Table 9.4.3.)

Table 9.4.3 Likelihood of evaluation for airborne noise impact assessment

Assessment Scenario	L_{Aeq}, dB(A)	Working Period Over Specified Time Period	Active Duration of Equipment	Frequency of Exposure	Likelihood of Occurrence
Scenario 01: Foundation and Earthworks – Day Time (7 am - 7 pm)	$L_{Aeq(12\ hours)}$	0.625	0.9	0.56	**Certain/ Continuous**
	$L_{Aeq(5\ mins)}$	0.625	1.0	0.625	**Certain/ Continuous**

9.4.2 Operational Phase

The typical potential noise sources during the operational phase of the Project includes the following:

- Air-conditioning and mechanical ventilation (ACMV) noise from services emitted from residential buildings; and
- Traffic noise due to increase in vehicular volume and new road networks due to the development of the Project and in the vicinity of the Study Area.

Operational noise arising from ACMV systems, if any, are expected to persist throughout the day, emitting from proposed residential buildings.

The potential impacts due to the increase in noise levels from the above-mentioned sources includes noise disturbance to humans and in addition, disturbance to ecological receptors (i.e. fauna species) found within the nearby forested areas as the potential impacts of affecting ecological foraging behaviour, and intra-species and inter-species communication. Table 9.4.4 listed potential sources of airborne noise impact during construction phase of the project.

Table 9.4.4 Potential airborne noise impacts during the operational phase

Potential Source of Impacts	Potential Associated Impacts
Traffic noise due to increase vehicular volume. Air-conditioning and mechanical ventilation noise from developments	Potential impacts due to the increase in noise level includes noise disturbance to fauna affecting ecological foraging behaviour, Intra-species and inter-species communication

10 Minimum Control Measures

This section lists the minimum controls, or standard practices, commonly implemented in Singapore for similar construction and operational activities, which have been assumed to be implemented for the purposes of impact assessment.

10.1 Minimum Control Measures for Biodiversity

10.1.1 Construction Phase

This section lists biodiversity-specific minimum controls commonly implemented in Singapore for similar construction activities. Minimum controls for each potential impact occurring from the construction phase are listed in Table 10.1.1. These measures should be proposed in tandem with other environmental receptors (e.g., air and noise).

Table 10.1.1 Description of minimum controls implemented at the construction phase

Work Activities/ Impacts	Impacted Parameter	Minimum Controls
Vegetation Clearance / Habitat Degradation	Habitat	• Set up protection zones with physical barriers around the perimeter of the RAC to prevent access and intrusion by vehicles or site personnel • Set up Tree Protection Zones (TPZ) around all trees earmarked to be retained within the site boundary where the root system may overlap underneath the soil into the site. The Tree Protection Zones will be set up in accordance with NParks guidelines. Soil erosion control measures will be executed once vegetation has been removed and soil is exposed. Ensure silt fences or other silt control measures along the site hoarding are installed and maintained properly. • Engage a Qualified Erosion Control Professional (QECP) to formulate and implement ECM plan in accordance with PUB requirements.
	Flora	• Regular inspections and monitoring will be conducted to ensure compliance with the tree protection measures, and any deviations or potential risks will be promptly addressed. • Before vegetation removal, pre-felling fauna inspections will 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. • Implement soil erosion control measures to prevent seedlings and seeds from being eroded or smothered. The measures should also be executed to avoid fast-growing exotics from proliferating.
Loss of ecological connectivity, habitats and food sources	Fauna	• Wildlife shepherding via directional clearing will be adopted. This will be planned and overseen by an ecologist. • Execute Wildlife Response Plan according to the Wildlife Act to minimise animal injury and mortality by responding appropriately whenever a trapped / injured / dead / dangerous animal is encountered around or within the worksite. • Train site personnel on biodiversity awareness and actions to take when encountering wildlife. • Conduct pre-felling fauna inspection prior to vegetation removal by an Ecologist to identify wildlife or nesting features that are actively used.

Work Activities/ Impacts	Impacted Parameter	Minimum Controls
		• Use only fully biodegradable erosion control blankets (ECBs) to avoid trapping fossorial fauna. • Trim overgrown vegetation near the worksite hoarding to prevent / reduce the potential of wildlife entering the site.
Increased invertebrate mortality from fumigation / Decline in invertebrate health from fumigant runoff and residue	Fauna	• Implement proper preventative source control practices for pest control such as application of anti-mosquito (AM) oil and proper disposal of food waste in appropriate bins to reduce sources of pests and thus the frequency of fumigation
General construction activities	Habitat / Flora / Fauna	• Implement soil erosion control measures such as erosion control blankets to reduce soil erosion and edge effects. • Implement dust control measures and noise barriers to reduce edge effects
General	Habitat / Flora / Fauna	• Installation of hoarding to delineate the worksite • Providing well-maintained pitched roof, clearing discarded items daily, storing materials appropriately, levelling up ground depression/uneven surfaces, ensure effective drainage flow. • Daily checks by the Environmental Control Officer on site to ensure contractor compliance and to identify potential fauna entrapments.

10.1.2 Operational Phase

This section lists biodiversity-specific minimum controls commonly implemented in Singapore for similar operational activities. Minimum controls for each potential impact occurring from the operational phase are listed in Table 10.1.2. These measures should be proposed in tandem with other environmental receptors (e.g., air and noise).

Table 10.1.2 Description of minimum controls implemented at the operational phase

Work activities/impacts	Impacted parameter	Minimum controls
Light disturbance	Fauna	• Artificial lighting should only be installed where required for human access and safety
Human-wildlife conflict	Fauna	• Place educational signboards around the residential development and public park to educate people on the proper ways to managing human-wildlife encounters
Mortality	Flora	• If the RAC is not conserved, transplantation of the conservation significant flora should be carried out
Increased invertebrate mortality from fumigation / Decline in invertebrate health from fumigant runoff	Fauna	• Implement proper preventative source control practices for pest control such as application of AM oil and proper disposal of food waste to reduce sources of pests and thus the frequency of fumigation

10.2 Minimum Control Measures for Hydrology and Water Quality

10.2.1 Construction Phase

Table 10.2.1 has a non-exhaustive list of minimum controls for each potential impact identified in Section 9.2 for construction phase.

Table 10.2.1 Minimum controls during the construction phase applicable to hydrology and water quality impact assessment

Potentially Affected Environmental Parameter	Potential Source(s) of Impact	Minimum Control Measures
Hydrology	Land clearing, earthworks and excavation activities leading to changes in existing hydrological and flow conditions. Temporary and/ or permanent land use change with mode impervious surfaces.	• The Contractor must not intefere with the existing drainage system or flow pattern without prior approval from PUB. • Design adequate drainage in accordance with PUB COP to effectively manage runoff from within, upstream of, and adjacent to the work site. The proposed system must not cause flooding nearby. • Conduct regular maintenance of stormwater and drainage systems to prevent channel blockages and consequent flooding. • Include geotechnical aspects of site slope stability, such as Earth Retaining Stabilising Structure (ERSS), in the detailed engineering design for the construction phase. • The design engineers must propose ERSS when the site is clear and excavated. Simultaneously, the Environmental Control Officer (ECO) must ensure successful implementation of these measures during construction. • Develop water recycling systems on-site to minimize discharge from the construction site into the surface water drainage system. • Formulate a detailed emergency evacuation plan for potential flash floods on-site, including the development of an early warning system where applicable. • Install pumping stations to remove excess water accumulated within the site after heavy rainfall events. • Implement a construction Environmental Management and Monitoring Plan (EMMP) and ensure complete preparation of associated plans and procedures.
Water Quality	Land clearing, earthworks and excavation activities leading to increased loads of sediments, suspended solids and contaminants. Building construction activities (inclusive of activities that might have indirect impact such as road widening, holding areas and site offices activities etc.)	• The planning, design, and submission of Earth Control Measures (ECM) plans to PUB will be handled by a Qualified Erosion Control Professional. This includes the installation, maintenance, monitoring, reporting, provision of erosion control blankets, CCTV at discharge points, Siltation and Erosion Control Measures (SIDS), sedimentation tanks, to comply with PUB's COP on Surface Water Drainage. • The Contractor must synchronize earthworks with ECM provision. Progress of earthworks will be carefully regulated to avoid exposing more areas than the proposed ECM can manage.

Potentially Affected Environmental Parameter	Potential Source(s) of Impact	Minimum Control Measures
		• Biodegradable erosion blankets must be promptly provided to areas with bare soil surfaces on the same day of soil exposure. • Demolition and earthworks scheduling will be organized to minimize the quantity of stockpiles stored on-site. • ECM tanks/ponds will be designed with sufficient capacity to contain turbid stormwaterbefore treatment at the ECM facility. • Contractors must ensure proper operation and maintenance of their CxV system at all times in line with PUB's circular on Preventing Muddy Waters from Construction Sites. This measure aims to prevent deliberate tampering with the CCTV system to disguise silty discharge. • Effective implementation of ECM and monitoring will adhere to the Code of Practice on Surface Water Drainage to ensure that discharge into the stormwater drainage system does not exceed prescribed limits for Total Suspended Solids (TSS) under the Sewerage and Drainage (Surface Water Drainage) Regulations. • A Sediment Control Plan will be formulated, including measures such as sealing site hoarding and installing berms along the site hoarding, to prevent silty water from leaking out and accumulating at the site entrance. • Topsoil removed will be stockpiled in a designated area and adequately covered to prevent soil loss from secondary erosion. Conserved soil can be used for backfilling, while excess soil material must be stored properly for potential reuse. • Approved materials of the same or superior quality as the surrounding area will be used for backfilling works. All backfilled material will be free of debris and of good soil quality. • Where feasible, clean water flow will be segregated from silty water flow to maximize sedimentation tank holding capacity. • Manholes will always be adequately covered and temporarily sealed. • Implementation of a construction Environmental Management and Monitoring Plan (EMMP) and thorough preparation of associated plans and procedures will be ensured.
	Discharge of liquid waste, including construction wastewater	• Finalise a complete inventory of all anticipated wastewater streams and volumes before the onset of construction phase works. • Maintain daily records of wastewater volume, as well as the volumes of sludge and other produced onsite. • Ensure containment ponds are made of impervious material and designed with sufficient capacity to hold the volumes of wastewater produced on site, accounting for stormwater runoff and firefighting needs as well. • Provide temporary storage volumes for overflow situations of untreated wastewater. This temporary storage should have sufficient capacity to capture any unexpected additional volumes, ensuring that untreated wastewater is not released to watercourses

Potentially Affected Environmental Parameter	Potential Source(s) of Impact	Minimum Control Measures
		unless it complies with NEA guidelines on trade effluent discharge concentrations. • Equip containment ponds, as well as wastewater generating areas on site with spill clean-up kits. • Design adequate drainage systems, including cut-off drains, sump pit, road kerb, piping and toe walls to channel construction process wastewater streams (e.g. wash water) and stormwater runoff separately through detailed design to capture and treatment in the containment pond(s)/ kerb(s). Where applicable, include oil-water separators. • Seek approval from relevant authorities (i.e. PUB and NEA) in accordance with PUB Sewerage and Drainage (Trade Effluent) Regulations, if the wastewater is planned to be disposed to public sewer, or NEA's Trade Effluent Discharge Limits to watercourse if disposal to surface watercourses is intended. If such discharges are not approved, the trade effluent will be stored, treated or recycled on site and finally disposed off-site. • Obtain comments and approval from relevant authorities (e.g., Singapore Civil Defence Force [SCDF] and NEA) for the use of treated wastewater for firefighting purposes. • Provide appropriate concrete washout areas, ensuring these are not located near watercourses. • All vehicles are to undergo a wheel washing process before leaving the site to prevent earth, mud, and debris from being disposed of on surrounding roads. The wastewater generated from this activity should be stored and removed for treatment and disposal offsite by an approved Waste Management Contractor. • Establish regular and dedicated procedures for the inspection and maintenance of wastewater collection, storage, and treatment infrastructure (e.g., pipes, oil-water separators). • Implement regular and dedicated procedures for the management of stormwater collection, settling, testing, and eventual discharge to watercourses. • Develop a training program for all onsite workers, including subcontractors, to educate them on their obligations regarding proper water quality management. • Prohibit the discharge of pumped groundwater from soil dewatering and other wastewaters into aquatic habitats. • Prohibit the unmanaged discharge of any wastewater stream. • No trade effluent other than the nature or type approved by the NEA Director-General will be discharged into any watercourse or soil. • Apply the principles of reduce, reuse, and recycle to wastewater management onsite. • Store hazardous wastewater, such as oil water, thinners, solvents, or paints, on a hard stand under shelter with a curb around the storage area. Ensure this wastewater is removed for treatment and disposed of offsite by an approved Waste

Potentially Affected Environmental Parameter	Potential Source(s) of Impact	Minimum Control Measures
		Management Contractor. Handle hazardous liquids as Hazardous Waste. • Implement a construction Environmental Management and Monitoring Plan (EMMP) and ensure full preparation of associated plans and procedures.
	Improper handling, transfer and storage of toxic chemical waste (liquid effluents / wastewater).	• Conduct leak detection tests periodically on toxic waste storage containers. • Store toxic waste and hazardous substances on a hard stand, under shelter with a kerb around the storage area. • Provide spill trays for all waste containers and regularly maintain them to prevent rain from washing out pollutive substances. • Ensure appropriate disposal of toxic waste in accordance with the Environmental Public Health (Toxic Industrial Waste) Regulations by a Licensed Waste Operator/Collector. • Establish a consignment notification/tracking system and a transport emergency response plan for the transportation of toxic waste. • Develop a Standard Operating Procedure (SOP) for the safe handling, transfer, and storage of toxic waste; conduct housekeeping checks at least once a day to ensure all toxic waste is cleared from the site. • Implement the construction Environmental Management and Monitoring Plan (EMMP) and ensure complete preparation of associated plans and procedures.
	Seepage and leakage of contaminants from solid waste generated, handled, and stored on site.	• Provide an adequate number of enclosed bins. • Ensure waste disposal facilities are cleared up as often as necessary to prevent buildup. Conduct housekeeping checks at least once a day to ensure all litter is cleared from the site. • Develop a Standard Operating Procedure (SOP) for the safe handling, transfer, storage, and disposal of solid waste. • Conduct appropriate tests to ascertain the presence or absence of contamination in excavated soil. • Ensure appropriate disposal of any waste listed in the Environmental Public Health (General Waste Collection) Regulations by a licensed waste operator. • Implement the construction Environmental Management and Monitoring Plan (EMMP) and ensure complete preparation of associated plans and procedures.
	Direct or indirect (e.g. via seepage into soil and groundwater) contamination of watercourses originating from chemicals used and/ or stored on site.	• Remove any hazardous substances or chemicals if safer alternatives are available. • Ensure chemical storage areas are adequate, located on paved ground, bunded, sheltered with adequate ventilation, and positioned away from waterways and drains. Safety Data Sheets (SDS) must be kept together with the stored chemicals. • The storage area must have a volume of 110% of the largest volume of chemical substances to be stored. • Utilize secondary containment with a capacity of more than 10% volume for single large containers and 25% of the total volume for multiple containers for all chemical stores and diesel generators to

Potentially Affected Environmental Parameter	Potential Source(s) of Impact	Minimum Control Measures
		minimize spillages and soil and surface water contamination as per requirements in COPPC/SS593. Take caution around watercourses to prevent leaks of toxic chemicals such as petrol, diesel, oil, paint, and thinner from equipment. • Include oil-water separators in the proposed infrastructure for separate channelling of construction wastewater streams and stormwater runoff to capture inadvertent spills or leaked oils or greases, particularly in the vicinity of liquid storage or refuelling areas. • Immediately maintain or remove off-site any construction equipment causing pollution to the water system due to oil or fuel leakage. • Conduct all activities involving repair, servicing, engine overhaul works, etc., in appropriately contained areas (e.g., concreted area with proper containment), and channel all wastes for proper treatment or disposal to meet regulations. • Prepare an emergency response plan, train the Emergency Response Team (ERT) to be competent in the response mechanism, and provide response kits for any spillages. • Implement good housekeeping practices to minimize careless spillage and maintain storage and workspace cleanliness. Assign a responsible person (e.g., ECO) to oversee the efficient operation of containment ponds/kerbs, adhering to good housekeeping practices. Regularly check containment ponds/kerbs at least daily to ensure proper functionality. Provide appropriate training, including safety codes and relevant manuals, to personnel handling chemicals on site. • Implement the construction Environmental Management and Monitoring Plan (EMMP) and ensure complete preparation of associated plans and procedures.
	Seepage of contaminants due to inappropriate discharge of domestic sewage and poor maintenance of portable chemical toilets, storage tanks, and septic tanks.	• Provide a sufficient number of proper sanitary facilities and ensure their maintenance. It is recommended to have one portable toilet per 10 individuals, serviced three times per week by NEA's Licensed Waste Collector (LWC) for regular sewage disposal. • Ensure toilet facilities are appropriately located away from any nearby watercourses. • If on-site dormitories are present, it is advised to install container toilets and obtain written approval from PUB to connect them to public sewers. • Establish a regular maintenance schedule to check and maintain the cleanliness and functionality of sanitary facilities on site, at least once a week, depending on the number of facilities. • Conduct inspections and audits to assess the hygienic conditions on site. • Implement the construction Environmental Management and Monitoring Plan (EMMP) and ensure complete preparation of associated plans and procedures.

10.2.2 Operational Phase

Table 10.2.2 has a non-exhaustive list of minimum controls for each potential impact identified in Section 9.1.2 for operational phase.

Table 10.2.2 Minimum controls during the operational phase applicable for hydrology and water quality impact assessment

Potentially Affected Environmental Parameter	Potential Source(s) of Impact	Minimum Control Measures
Hydrology	Permanent land use change with more impervious surfaces due to proposed developments.	• Ensure the future drainage system is designed in accordance with PUB COP to ensure appropriate water conveyance within the proposed future development and to prevent flooding of adjacent areas. • Geotechnical aspect of site's slope stability (such as Earth Retaining Stabilising Structure [ERSS]) will be included in detailed design engineering for the operational phase. • Providing more softscape area should be considered in the design of the development which will help to reduce the peak flow and reduce flood risk at downstream area. ABC Water design approach can be considered to reduce the peak flow. • Provide more pervious areas to increase the seepage of surface water into the soil. • Installation of recharge wells, if necessary.
Water Quality	• Heavy rain and stormwater wash-off pollutants built-up in the new development area and discharge to the streams. • Improper management of liquid and solid wastes.	• Adequate drainage, piping and/ or channelling of stormwater runoff to be assured through detailed design [e.g. ABC Water design approach] for capturing and treatment before discharge into receiving watercourses. • Regular and dedicated procedures for the inspection and maintenance of stormwater collection, storage, and treatment infrastructure, such as pipes, oil water separation and silt screens etc. • Regular and dedicated procedures for the management of stormwater collection, settling, testing and eventual discharge of 'clean' water to surface waters, including associated measures required to prevent high sediment concentration stormwater drainage to surface waters. • Prepare sufficient disposal bins surrounding the Project to avoid improper disposal of waste. • Conduct regular inspection on wastes' storage system of the Project. • Monitor the proposed watercourses and its surroundings with CCTV surveillance regularly to ensure no contamination occurred. • Develop an Emergency Response Plan and conduct adequate training to maintenance workers to cope the accidental contamination of water. • Raise awareness of various stakeholders with community/ stakeholder engagement (e.g. signage boards, warning signs, etc.). • No vehicles allowed within the future managed vegetation (i.e. proposed park) at development area.

10.3 Minimum Control Measures for Air Quality

10.3.1 Construction Phase

The following control measures should be observed during the construction phase:

- The construction footprint shall be hoarded on all sides;
- No demolition of permanent structure is expected as part of the project;
- No concrete batching plant to be located on-site;
- Vehicles entering and leaving sites to be fully covered; and
- Access road construction or expansion is recommended to be completed first and paved before the construction of other development commences.

10.3.2 Operational Phase

The following minimum control has been assumed for the purpose of air quality impact assessment during operational phase:

- All construction equipment fall under the definition of off-road diesel engine will comply to Singapore's Environmental Protection and Management (Off-Road Diesel Engine Emissions) Regulations 2012.

10.4 Minimum Control Measures for Airborne Noise

10.4.1 Construction Phase

- It is recommended to reduce noise impact to avifauna by various administrative controls at the Study Area. For example, avoid breeding seasons (March to July) for the activity, or to avoid early morning daytime noisy activities between 7 – 9 am as far as possible on site. This may reduce some impacts on this fauna on behavioural aspects and communication. Machines (such as trucks) that may be in intermittent use should be shut down between work periods or should be throttled down to a minimum;
- Only well-maintained construction plants should be utilised on-site, and construction plants should be serviced regularly during the entire construction period;
- The number of PMEs should be reduced as far as practicable when construction works are carried out at areas close to the noise sensitive receivers:
- Silencers or mufflers on construction equipment if incorporated in a machine should be properly maintained;
- Behavioural practices including no shouting, no loud stereos/ radios on site, no dropping of materials from height, no throwing of metal items should be ensured;
- Construction respite: Restrict high noise generating drilling activities only in continuous blocks, not exceeding 3 hours each, with a minimum respite period of one hour between each block, if possible;
- Periodic noise monitoring by an independent third party, to establish compliance with requirements and to advise on equipment causing concern, and additional potential mitigation measures;
- Night works, apart from advance works/ site clearance if approved by Agencies, will be prohibited after 6 pm to minimise noise disturbance to nocturnal animals;
- Plan the layout of the site by considering using materials and other large structural equipment as noise barriers;
- Construction plants known to emit noise strongly in one direction should, wherever possible, be orientated so that the noise is directed away from the nearby noise sensitive receptors;
- Material stockpiles and other structures will be effectively utilised, wherever practicable, in screening noise from on-site construction activities;
- All handheld percussive breakers and air compressors used on site will comply with local legislation and requirements;
- Activities may be scheduled to minimise noise generated at certain areas during periods which may be particularly sensitive to noise;
- Works using machines or vehicles that generate noise should be prohibited in the night and the dawn;

- Appropriate hearing protectors should be used by personnel operation the plant or equipment, the hearing protector must attenuate the exposure of the user to sound pressure levels below 85dB (A). Signage to remind personnel to put on hearing protection will be put up at work areas that emit excessive noise. Choice of hearing protector such as ear plugs (for < 100 dB (A)), earmuffs (for 100 dB (A) to 120 dB (A), ear plugs and earmuffs (for > 120dB (A)) in various noise exposure level;
- Noise awareness briefing should be conducted regularly and highlighted the noise mitigation measures such as position of machinery, making use of portable noise barriers and dos and don'ts for use of machinery at night; and
- If noise remains an issue even after implementation of recommended mitigation measures such as noise barriers, contractor should consider implementation of proprietary noise barriers of high noise reduction capabilities to further reduce noise to acceptable levels.

10.4.2 Operational Phase

Boundary noise levels are in compliance with the adjusted boundary noise limits to be derived by an appointed Noise Consultant as part of quantitative operational noise impact assessment at the detailed design stage as mandated by law. Some noise sources might be located close to the boundary and might require special attention for boundary noise limits compliance, and if necessary, be equipped with additional mitigation measures. These are to be provided upon assessment of noise arising from the operational phase.

Minimum control measures for noise emissions arising from the operational phase such as originating from air conditioning and mechanical ventilation (ACMV) and land traffic noise are listed below. This list is non-exhaustive and should be practised as minimum control to reduce noise levels during the operational phase of the Project:

- Use low noise ACMV system equipment, if applicable;
- Ensure that exhaust outlets or intakes from the mechanical ventilation system is designed to be adequately set back as far as possible from the boundary line of the development;
- Acoustic treatment if any to be designed and implemented;
- Acoustic enclosures should be provided for outdoor equipment, if applicable;
- Road design should be considered as part of land use planning to minimise potential impact of land traffic noise on existing residential buildings;
- Alternative siting/ alignment of roads should be considered during road design to propose road siting/ alignment away from existing noise sensitive development; and
- Screening should be done to identify noise tolerant buildings (e.g. multi-storey car park building) and placing noise tolerant buildings between road traffic and existing residential buildings during road design phase.

Screening by noise tolerant buildings where to assign road prior to construction such as choosing to construction road along noise tolerant buildings away from existing residential buildings, placing noise tolerant building in between road traffic and existing residential building e.g. use of multi-storey carpark building.

11 Prediction and Evaluation of Impacts

11.1 Biodiversity Impact

In this section, the identified biodiversity sensitive receptors were evaluated based on impact intensity and likelihood, in order to derive the impact significance. The various levels of impact intensity and likelihood for each impact type during the construction and operational phases were defined for the biodiversity sensitive receptors. Some assumptions were made in defining the levels of impact intensity and are detailed in the respective sections below.

For both construction and operational phases, the full list of the priority level, impact intensity, impact consequence, impact likelihood, as well as the resulting impact significance for all biodiversity sensitive receptors is provided in Section 9.1. **Appendix B** summarises the impact assessments for all impacts during the construction and operation phases.

11.1.1 Construction Phase

The definitions for impact intensity and likelihood of occurrence for habitat receptors are given in Table 11.1.1 and Table 11.1.2 respectively. An assumption made in defining the levels of impact intensity and the likelihood of direct and indirect impacts for habitat receptor was that habitats within 30 m from the worksites are assumed to experience the greatest extent of edge effects (refer to Section 9.1 for the definition of impact zone).

The definitions for impact intensity and likelihood for habitat receptors are presented in Table 11.1.1 and Table 11.1.2 respectively.

Table 11.1.1 Definitions of each level of impact intensity for habitat receptors during construction

Impact Type	Negligible	Low	Medium	High
Habitat loss	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	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
Formation of edge effects	The habitat does not overlap with the worksites	⩽ 10% increase in perimeter to area ratio of the habitat due to the worksites	10-40% increase in perimeter to area ratio of the habitat due to the worksites	>40% increase in perimeter to area ratio of the habitat due to the worksites

Table 11.1.2 Definitions of each level of likelihood for habitat receptors during construction

Likelihood	Loss of Vegetation	Habitat Degradation	Formation of edge effects
Unlikely/Remote	The habitat does not overlap with the worksites	This habitat is unlikely to be degraded.	The habitat does not overlap with the worksites
Less Likely/ Rare	N.A.	This habitat would rarely experience degradation	The worksites are small (e.g., trails, boardwalks) and / or are not expected to change the vegetation structure significantly to effect changes in microclimatic conditions

Likelihood	Loss of Vegetation	Habitat Degradation	Formation of edge effects
			(e.g., minimal tree or vegetation removal)
Possible/ Occasional	N.A.	This habitat occasionally experiences degradation	The worksites are of considerable size (e.g., single land roads) and/or are expected to change the vegetation structure significantly to effect changes in microclimatic conditions (e.g., some tree or vegetation removal)
Likely/ Regular	N.A.	This habitat regularly experiences degradation	N.A.
Certain/ Continuous	The habitat overlaps with the worksites	This habitat continuously experiences degradation	N.A.

The definitions for impact intensity and likelihood for flora species are presented in Table 11.1.3 and Table 11.1.4 respectively.

Table 11.1.3 Definitions of each level of impact intensity for flora receptors during construction

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

Table 11.1.4 Definitions of each level of likelihood for flora receptors during construction

Likelihood	Mortality	Decline In Plant Health and Survival	Poaching
Unlikely/Remote	No plant specimens of this species are within the worksites	No formation of forest edges (i.e., construction activities are fully underground and/or in existing built-up areas outside the forest)	Specimens of these species are commonly found and/or hold little to no ornamental value
Less Likely/ Rare	N.A.	Formation of scrubland edges in scrubland areas only	N.A.
Possible/ Occasional	N.A.	Formation of some forest and scrubland edges in a mix of urban vegetation, scrubland and forested areas	Specimens of these species hold moderate ornamental value and/or known to be collected
Likely/ Regular	N.A.	Formation of new forest edges (i.e., complete clearance within forested areas)	N.A.
Almost Certain/ Continuous	Plant specimens of this species are within the worksite	N.A.	Specimens of these species (“Charismatic species”) hold high ornamental value and/or known to be highly sought after

The definitions for impact intensity and likelihood for faunal species are presented in Table 11.1.5 and Table 11.1.6 respectively.

Table 11.1.5 Definitions of each level of impact intensity for faunal receptors during construction

Impact Type	Negligible	Low	Medium	High
Accidental injury or mortality	Species with negligible susceptibility to accidental injury/mortality from construction activities (large vehicles, excavation, piling, etc,) and roadkills	Species with low susceptibility to accidental injury/mortality from construction activities (large vehicles, excavation, piling, etc.) and roadkills: – Volant species (e.g., odonates, butterflies, highly volant birds, raptors and most bats) – Aquatic species (most fishes, crabs, shrimps)	Species that are mobile but possibly susceptible to accidental injury/mortality from construction activities (large vehicles, excavation, piling, etc.) and roadkills: – Less volant birds – All amphibians – Some mammals (e.g., squirrels, shrews)	Species with high susceptibility to accidental injury/mortality from construction activities (large vehicles, excavation, piling, etc.) and roadkills: – Reptiles – Some mammals (e.g., Sunda pangolin, long-tailed macaque, smooth otter) – Migratory birds – Nesting birds – Bamboo bats
Increased invertebrate mortality from fumigation	-	-	Species which are moderately susceptible to mortality from fumigants – Odonates – Butterflies	Species which are highly susceptible to mortality from fumigants – Aculeata
Decline in invertebrate health from fumigant runoff and residue	-	-	Species which have moderate susceptibility to physiological damage from fumigant runoff and residue – Aculeata	Species which have higher susceptibility to physiological damage from fumigant runoff and residue due to larvae foraging and exposure – Odonates – Butterflies
Human-wildlife conflict	Species that are not perceived as nuisances or threats by construction personnel – Odonates – Butterflies – Most birds – Aquatic species	Species that are possibly perceived as both nuisances and threats by construction personnel, less tolerant of human presence and urban environments: – Some reptiles – Most amphibians – Most bats	Species that are typically perceived as nuisances and possibly as threats by construction personnel, highly tolerant of human presence and urban environments, and frequently implicated in human-wildlife conflict: – Smooth otter	Species that are typically perceived as both nuisances and threats by construction personnel, highly tolerant of human presence and urban environments, and are frequently implicated in human-wildlife conflict: – Long-tailed macaque

Impact Type	Negligible	Low	Medium	High
			– Aculeate hymenopterans	– Some snakes
Loss of/reduction in of ecological connectivity for faunal movement	Not dependent on connected habitats for dispersal and able to traverse urban infrastructure	Slightly dependent on connected habitats for dispersal and adaptable to traverse urban infrastructures if needed	Dependent on connected habitats for dispersal	Highly dependent on connected habitats for dispersal
Light disturbance	Species that are not sensitive to changes in light levels: aculeate hymenopterans, most aquatic and marine species	Species that are slightly sensitive to changes in light levels: odonates, butterflies	Species that are sensitive to changes in light levels: diurnal birds, reptiles and mammals	Species that are extremely sensitive to changes in light levels: nocturnal, crepuscular fauna and nesting / hatching sea turtle species, migratory birds
Human disturbances	Species that are not sensitive to human presence	Species that are slightly sensitive to human presence	Species that are sensitive to human presence	Species that are extremely sensitive to human presence, and nesting birds

Table 11.1.6 Definitions of each level of likelihood for faunal receptors during construction

Likelihood	Likelihood definition for fauna impact types
Unlikely/ Remote	Impact is not expected to happen during the construction phase of the project
Less Likely/ Rare	Impact is not likely to happen during the construction phase of the project
Possible/ Occasional	Impact could possibly happen or known to occur during the construction phase of the project
Likely/ Regular	Impact is a common occurrence during the construction phase of the project
Almost Certain/ Continuous	Impact is a continual or repeated process during the construction phase of the project

11.1.1.1 Habitats

Three construction phase impacts were identified and assessed for the habitat receptors: (1) Habitat loss and (2) Habitat degradation and (3) Formation of edge effects. A summary of the key biodiversity habitat receptors impacted during construction phase is shown in Table 11.1.7.

The only **Major** impacts are from habitat loss of scrubland and exotic-dominated secondary forest while the remaining impacts ranged from **Minor** – **Negligible** on all habitat types.

Table 11.1.7 Summary of construction phase impacts to habitat receptors during construction phase

Habitat receptor	Priority level	Direct impact (% of total habitat type within Study Area)	Indirect impact (% of total habitat type within Study Area)	% Change in Perimeter-to-Area ratio post-development	Impact type and significance
Scrubland	Priority 1	3.05 ha (77.2%)	0.26 ha (6.6%)	**+235.7%**	**Habitat loss -** Major **Habitat degradation -** Minor **Formation of edge effects* -** Negligible
Abandoned land forest	Priority 2	NA	NA	**0%**	**Habitat loss -** Negligible **Habitat degradation -** Negligible **Formation of edge effects -** Negligible
Exotic-dominated secondary forest	Priority 2	1.56 ha (65.0%)	0.30 ha (12.5%)	**-50.0%**	**Habitat loss -** Major **Habitat degradation -** Moderate **Formation of edge effects –** Negligible
Managed vegetation	Priority 3	3.86 ha (73.4%)	1.12 ha (21.3%)	**-11.11%**	**Habitat loss -** Moderate **Habitat degradation -** Negligible **Formation of edge effects –** Negligible

*While there is a significant increase in Perimeter to Area (P:A) ratio for scrubland, it is unlikely that edge effects will have significant impacts on the habitat as most edge habitats are a form of scrubland

11.1.1.2 Flora

Three construction phase impacts were identified and assessed for flora receptors: (1) Mortality and (2) decline in plant health and survival and (3) poaching. A summary of the key biodiversity habitat receptors impacted during construction phase is shown in the table below (Table 11.1.8).

Table 11.1.8 Summary of construction phase impacts to flora receptors during construction phase

Impact Type	No. of Species			
	Major	Moderate	Minor	Negligible
Mortality	5	1	2	0
Decline in plant health and survival	0	0	4	4
Poaching	0	0	4	4

Mortality is the only impact which has **Major** impacts on any flora species, with species such as the straggly rush orchid (*Dendrobium lobbii*), narrow-lid pitcher plant (*Nepenthes ampullaria*), Raffles' pitcher plant (*Nepenthes rafflesiana*) and *Nepenthes x trichocarpa* having all specimens within the study area found within the development area.

11.1.1.3 Fauna

Four construction phase impacts were identified and assessed for faunal receptors: (1) accidental injury or mortality, (2) human-wildlife conflict, (3) loss of / reduction in ecological connectivity, (4) human disturbances and (5) light

disturbances. The more substantial impacts arising from each impact type are briefly summarised below. A summary of the impact on fauna receptors is given in Table 11.1.9.

Table 11.1.9 Summary of construction phase impacts to fauna receptors

Impact Type	No. of Species			
	Major	Moderate	Minor	Negligible
Accidental injury or mortality	3	3	32	94
Human-wildlife conflict	0	6	5	121
Loss/reduction of ecological connectivity for faunal movement	16	86	27	3
Human disturbances	12	56	63	1
Light disturbances	0	0	33	99
Increased invertebrate mortality from fumigation	0	10	62	0
Decline in invertebrate health from fumigant runoff and residue	0	55	11	6

Out of the seven impacts assessed, only three have any **Major** impacts on fauna species – accidental injury or mortality, loss/reduction of ecological connectivity for faunal movement and human disturbances.

The Sunda pangolin, *Manis javanica*, is likely to experience **Major** impacts from accidental injury or mortality as it is not extremely mobile and could potentially be injured during construction activities and roadkill. For loss/reduction of ecological connectivity for faunal movement, there are 16 species which would experience **Major** impacts such as common birdwing, *Troides helena cerberus*, and the Malayan softshell turtle, *Dogania subplana*, all of which are heavily reliant on well-connected habitats and would suffer greatly from habitat fragmentation. The remaining impact, human disturbance, has **Major** impacts for species such as the spotted wood owl, *Strix seloputo* and the changeable hawk-eagle, *Nisaetus cirrhatus* as they are species which could potentially exhibit altered foraging behavior or nest abandonment due to human disturbances [**W-35, P-62, P-63**].

Due to the proximity of the Project Site to the Holland Marsh, impacts to invertebrates due to fumigation have been specifically included in the assessment. With effective source-reduction measures to control mosquitoes and other pests, fumigation is expected to be infrequent; and as a result, no species are expected to experience **Major** direct or indirect impacts from fumigant exposure.

11.1.2 Operational Phase

The definitions for impact intensity and likelihood of occurrence for habitat receptors are given in Table 11.1.10 and Table 11.1.11.

Table 11.1.10 Definitions of each level of impact intensity for habitat receptors at the operational phase

Impact type	Negligible	Low	Medium	High
Habitat degradation	Developed area is not accessible to	Developed area is designed with the	Developed area is designed for	Developed area and surroundings

Impact type	Negligible	Low	Medium	High
	public and no long-term degradation is expected. E.g., core conservation areas with no public access, infrastructure works with no public access	intention for the public to use or visit and will increase human accessibility to the surrounding natural habitats. Limited or controlled degradation is expected near areas of higher human activity. E.g., nature parks	members of the public to visit. E.g., parks. Degradation is expected to occur within at least 50% of the habitat	are designed for large groups of people to live or work in the long run. Degradation is expected to occur throughout 100% of the habitat. E.g., residential estates

Table 11.1.11 Definitions of each level of likelihood for habitat receptors at the operational phase

Likelihood	Habitat Degradation
Unlikely/Remote	Surrounding natural habitats are not accessible to public
Less likely/Rare	Surrounding natural habitats are accessible but public use is restricted/controlled
Possible/Occasional	Surrounding natural habitats are accessible and have infrastructure for the public to use, such as boardwalks (but people can still stray off track)
Likely/Regular	Surrounding natural habitats are easily accessible and do not have infrastructure for the public to use, such as boardwalks (thus public are off track)
Certain/ Continuous	N.A.

The definitions for impact intensity and likelihood of occurrence for flora receptors are given in Table 11.1.12 and Table 11.1.13.

Table 11.1.12 Definitions of each level of impact intensity for flora receptors during operational phase

Impact Type	Negligible	Low	Medium	High
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
Poaching				

Table 11.1.13 Definitions of each level of likelihood for flora receptors during operational phase

Likelihood	Decline In Plant Health and Survival and Poaching
Unlikely/Remote	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	Formation of scrubland edges in scrubland areas only
Possible/ Occasional	Formation of some forest and scrubland edges in a mix of urban vegetation, scrubland and forested areas
Likely/ Regular	Formation of new forest edges (i.e., complete clearance within forested areas)
Almost Certain/ Continuous	N.A.

The definitions for impact intensity and likelihood of occurrence for faunal receptors are given in Table 11.1.14 and Table 11.1.15

Table 11.1.14 Definitions of each level of impact intensity for faunal receptors at the operational phase

Impact Type	Negligible	Low	Medium	High
Human-wildlife conflict	Species that are not perceived as nuisances or threats by members of the public – Odonates – Butterflies – Most birds – Aquatic species	Species that are possibly perceived as both nuisances and threats by members of the public, less tolerant of human presence and urban environments: – Some reptiles – Most amphibians – Most bats	Species that are typically perceived as nuisances and possibly as threats by members of the public, highly tolerant of human presence and urban environments, and frequently implicated in human-wildlife conflict: – Smooth otter – Red junglefowl – Aculeate hymenopterans	Species that are typically perceived as both nuisances and threats by members of the public, highly tolerant of human presence and urban environments, and are frequently implicated in human-wildlife conflict: – Long-tailed macaque – Some snakes
Human disturbances	Species that are not sensitive to human presence	Species that are slightly sensitive to human presence	Species that are possibly sensitive to human presence	Species that are sensitive to human presence
Accidental injury or mortality	Species with negligible susceptibility to accidental injury/mortality from operational activities (bird strikes and roadkills.)	Species with low susceptibility to accidental injury/mortality from operational activities (bird strikes and roadkills); – Volant species (e.g., odonates, butterflies, highly volant birds, raptors and most bats) – Aquatic species (most fishes, crabs, shrimps)	Species that are mobile but possibly susceptible to accidental injury/mortality from operational activities (bird strikes and roadkills.); – Less volant birds – All amphibians – Some mammals (e.g., squirrels, shrews)	Species with high susceptibility to accidental injury/mortality from operational activities (bird strikes and roadkills.) – Reptiles – Some mammals (e.g., Sunda pangolin, long-tailed macaque, smooth otter) – Migratory birds – Nesting birds – Bamboo bats
Increased invertebrate mortality from fumigation	-	-	Species which are moderately susceptible to mortality from fumigation – Odonates – Butterflies	Species which are highly susceptible to mortality from fumigants. – Aculeata
Decline in invertebrate health from fumigant runoff and residue	-	-	Species which have moderate susceptibility to physiological damage from	Species which have moderate susceptibility to physiological damage from

Impact Type	Negligible	Low	Medium	High
			fumigant runoff or residue – Aculeata	fumigant runoff or residue – Odonates – Butterflies
Loss of/reduction in of ecological connectivity for faunal movement	Not dependent on connected habitats for dispersal and able to traverse urban infrastructure	Slightly dependent on connected habitats for dispersal and adaptable to traverse urban infrastructures if needed	Dependent on connected habitats for dispersal	Highly dependent on connected habitats for dispersal
Light disturbance	Species that are not sensitive to changes in light levels: aculeate hymenopterans, most aquatic and marine species	Species that are slightly sensitive to changes in light levels: odonates, butterflies	Species that are sensitive to changes in light levels: diurnal birds, reptiles and mammals	Species that are extremely sensitive to changes in light levels: nocturnal, crepuscular fauna and nesting / hatching sea turtle species, migratory birds

Table 11.1.15 Definitions of each level of likelihood for faunal receptors at the operational phase

Likelihood	Likelihood definition for fauna impact types
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

11.1.2.1 Habitat

Table 11.1.16 Summary of operational phase impacts on habitat receptors

Habitat receptor	Priority level	Indirect impact (% of total habitat type within Study Area)	Habitat degradation significance
Scrubland	Priority 1	0.26 ha (6.6%)	Minor
Abandoned land forest	Priority 2	NA	Negligible
Exotic-dominated secondary forest	Priority 2	0.30 ha (12.5%)	Minor
Managed vegetation	Priority 3	1.12 ha (21.3%)	Negligible

None of the habitats would experience significant impacts from habitat degradation as during the operational phase, the residential areas are a distance from these natural habitats and the conditions for those areas will be similar to pre-existing conditions.

11.1.2.2 Flora

Table 11.1.17 Summary of operational phase impacts on flora receptors

Impact Type	No. of Species			
	Major	Moderate	Minor	Negligible
Decline in plant health and survival	0	0	4	4

Since most specimens are found within the development area, they are not assessed for decline in plant health and survival as they would be removed. The remaining species to be assessed such as *Acacia auriculiformis* and *Falcataria moluccana* can be found in degraded and/or exotic-dominated secondary forests, indicating that they are able to tolerate disturbed environments and grow there, leading to their **Minor** impact significance.

11.1.2.3 Fauna

Five operational phase impacts were identified and assessed for faunal receptors: (1) accidental injury or mortality, (2) human-wildlife conflict, (3) loss of / reduction in ecological connectivity, (4) human disturbances and (5) light disturbances. The more substantial impacts arising from each impact type are briefly summarised below. A summary of the impact on fauna receptors is given in Table 11.1.18

Table 11.1.18 Summary of operational phase impacts to faunal receptors

Impact Type	No. of Species			
	Major	Moderate	Minor	Negligible
Accidental injury or mortality	0	7	8	117
Human-wildlife conflict	0	6	5	121
Loss/reduction of ecological connectivity for faunal movement	0	86	43	3
Human disturbances	0	60	70	2
Light disturbances	0	20	13	99
Increased invertebrate mortality from fumigation	0	10	62	0
Decline in invertebrate health from fumigant runoff and residue	0	55	11	6

There are no major impacts on faunal receptors during the operational phase. However, many species of amphibians, odonates and reptiles which suffer from loss/reduction of ecological connectivity which includes the locally critically endangered Sunda pangolin (*Manis javanica*) and Malayan softshell turtle (*Dogania subplana*).This

can be addressed using an additional mitigation measure, conserving the recommended area of conservation (RAC) which will be delved upon in Section 12.1.

Similarly to the construction phase assessment of fumigation impacts to invertebrates, no **Major** impacts to any invertebrate species are expected with the application of source-reduction measures to tackle mosquitoes and other pests.

11.2 Hydrology and Water Quality Impact

The assessed hydrological and water quality impacts of the identified sensitive receptors (Table 8.2.1, Table 8.2.2) are described in the following section.

As seen in Figure 11.2.1 and Figure 11.2.2, the concrete drain D/S4 is located directly beside the Project Site, with another drain, D/S3, positioned next to D/S4. These two drains serve as a buffer between the Project Site and portion of the stream D/S1 and D/S2 which support the Clementi Forest. Given the presence of these drains and the distance between the Project Site and the streams, the Project Site is unlikely to affect the portion of waterbodies supporting Clementi Forest. Hence, the following sections will focus on the Rail Corridor rather than the Clementi Forest when assessing the impact on the ecological receptor. The ecological receptor will be referred to as 'waterbodies supporting the Rail Corridor' for brevity.

11.2.1 Construction Phase

11.2.1.1 Hydrology

11.2.1.1.1 Liquid effluents and stormwater run-off generation

Ecological receptors

As described in Section 9.2.1, generation of liquid effluent and stormwater runoff would be the main source of impact for hydrology. Land use modification due to land clearing or other similar construction activities may affect the existing hydrology of the Study Area. As vegetation gets removed and more earth is exposed, the volume of surface runoff is expected to increase. Furthermore, due to the reduced seepage of surface water into the soil, quantities of stormwater surface runoff may increase, with reduced runoff propagation over the land and increased peak flows. Water levels in streams or drain may increase and flooding would subsequently occur in areas adjacent to the watercourses.

Run-off from the Project Site is likely to flow towards the downstream portion of D/S1 which are widened concrete drains (Table 7.2.2). Hence, the impact intensity would be **Low**. As it is a Priority 1 receptor, the impact intensity would be **Low**. Implementation of minimum controls would mean it is **Unlikely** for liquid effluent or stormwater runoff generated by construction from entering the watercourse. Therefore, the impact significance is **Negligible**.

The Freshwater Marsh is also located at the upstream of the development boundary. Taking into consideration its higher elevation compared to the rest of Holland Plain and precipitation as its most likely source of recharge, the impact intensity would be **Negligible**. Given that Freshwater Marsh is a Priority 1 receptor, the impact consequence would be **Very Low**. With the minimum control measures in place, flooding in the area would be **Unlikely** and result in **Negligible** impact significance.

Human receptors

Land use modification due to land clearing followed may affect existing hydrological conditions of the Study Area. Proposed construction activities such as site clearance and excavations will reduce the vegetation on site, exposing bare soil. This could lead to rapid and significant increase of water levels and possible flooding in surrounding areas during heavy storm events. Two drains will be built near the Project Site before construction starts as seen in Figure 11.2.1. This will assist in directing surface run-off towards the Bukit Timah Diversion Canal and possibly prevent flooding. With minimum controls in place, the assessed impact intensity would be **Low** as most drainage systems in place should be able to drain the areas effectively. As human receptors are Priority 2 receptors, the impact consequence would be **Very Low**. Likelihood for this source of impact is determined as **Less Likely** as extreme heavy storms resulting in floods are rare and hence the impact significance would be **Negligible**.

11.2.1.2 Water Quality

As detailed in Section 9.2.1 of this Report, water quality of watercourses within and in the vicinity of the Study Area could be impacted due to various pollution sources and waste streams expected to be generated during the

construction phase of the developments. Consequently, such pollution could have adverse impacts on the surrounding flora, fauna, and associated habitats. Based on the proposed construction phase activities, the following key sources of impact were identified:

- Stormwater run-off generation
- Construction wastewater generation
- Accidental spills and leaks of pollutants due to improper management (storage, handling, disposal) of chemical substances and waste
- Solid and toxic waste generation

11.2.1.2.1 Stormwater run-off

Ecological receptors

The construction site has more exposed bare soil compared to the current vegetated conditions of the Study Area. Hence, rainfall over the construction site will generate runoff of a different quality than the baseline. The elevated suspended solids may lead to increased turbidity and water quality contamination.

During site clearance, there is a period when Erosion Control Measures (ECM) such as the ECM pond are not yet implemented which allows stormwater to directly discharge into nearby waterbodies. The impact intensity and consequence are both assessed as **Medium** for the waterbodies supporting the Rail Corridor. While Singapore often experiences wet weather, the using soil erosion blankets can reduce the likelihood of this occurring to **Rare/Less Likely**, resulting in an overall impact significance of **Minor**.

As the Freshwater Marsh is located some distance away from the developments and on a higher elevation as seen in Figure 7.2.2, the likelihood would be **Unlikely**. Hence, the impact significance would be **Negligible**.

However, when minimum controls which include ECM are implemented the suspended solids are reduced prior to discharge to comply with NEA Limits. Hence, a **Low** impact intensity to the watercourses is expected on both ecological receptors. Subsequently, the impact consequence for both priority 1 receptors would be **Low**. According to the development layout shown in Figure 11.2.1, the interim drains near the site could possibly divert run-off away from the Rail Corridor. Taking into account the elevation of the Study Area, it is unlikely stormwater would drain into the mid or upstream of D/S1 that is shown to be ecologically significant. Therefore, the likelihood is **Less Likely/ Rare**. Therefore, there would be **Minor** impact.

The likelihood and impact significance for the Freshwater Marsh would remain as **Unlikely** and **Negligible**.

Human receptors

With the minimum controls implemented to ensure that the suspended solids are reduced prior to discharge to comply with NEA Limits, a **Low** impact intensity to the watercourses is expected on all local residents and visitors. Consequently, the impact consequence is **Low** on local residents and visitors (Priority 1). Projections from Meteorological Service Singapore's recent climate change study show that extreme rainfall events in Singapore are likely to increase in frequency and rainy months in Singapore are also expected to become even wetter [W-36]. Hence, the likelihood was assessed to be **Likely**. Hence, the impact significance is assessed to be **Moderate** on the local residents and visitors.

11.2.1.2.2 Construction wastewater generation

Ecological receptors

The proposed construction activities are expected to general significant number of liquid effluents and construction wastewater. Such effluents commonly include sanitary discharges, and stormwater runoff from waste storage facilities etc. Besides the elevated silty content often found in the effluent, a variety of other pollutants ranging from human pathogens (e.g. from sanitary discharges) to heavy metals and other toxic substances (e.g. from waste storage areas). Hence, uncontrolled discharge of such effluents into watercourses could cause elevated levels of contaminants and affect the surrounding habitats.

Majority of the waterbodies supporting Rail Corridor are in undeveloped portions of the Study Area with only the downstream section of D/S1 within proximity of the developments. With proper minimum control measures such as implementing Erosion Control Measures and proper wastewater management, the runoff and liquid effluents are expected to have **Low** impact intensity on the waterbodies. Impact consequence on the priority 1 receptor would subsequently be **Low**. The likelihood was assessed to be **Less Likely**. Therefore, there would be **Minor** impact.

Construction wastewater would cause **Low** impact intensity on the Freshwater Marsh. It is a priority 1 receptor, so the impact consequence was assessed to be **Low**. The likelihood was assessed to be **Unlikely**. Hence, the impact significance would be **Negligible**.

Human receptors

With the minimum controls implemented to ensure that the suspended solids and other contaminants are reduced prior to discharge to comply with NEA Limits, a **Low** impact intensity to the watercourses is expected on all local residents and visitors. Consequently, the impact consequence is **Low** on local residents and visitors that are priority 1 receptors. As the likelihood of contaminated stormwater to affect humans is **Unlikely**, the impact significance is assessed to be **Negligible** on the local residents and visitors.

11.2.1.2.3 Accidental spills and leaks of pollutants

Ecological receptors

Mishandling of chemical substances on construction sites might lead to accidental spills and leaks of pollutants that might affect local ecology. During maintenance of construction vehicles or mechanical equipment, the chemical substances such as fuel and lubricants may accidentally spill and leak to the surrounding streams or drains. As the water quality criteria for aquatic life is lower than NEA trade effluent limits for most parameters, it is important to ensure that such incidences are prevented. With the minimum control measures in place, small amount of spillage of chemicals have potential to cause impacts with **Medium** intensity to the waterbodies supporting the Rail Corridor and the Freshwater Marsh. Both are priority 1 receptors and would have **Medium** impact consequence. As part of minimum control measures, chemicals used during the construction phase are to be stored and used in designated areas with a kerb or appropriately contained areas. In the event that spillage does occur, spill kits will be provided on-site to be operated by an emergency response team competent in their use. With this in mind, the quantities of such pollutants released into the environment are expected to be minimal and quickly removed. Hence, the likelihood was assessed as **Less Likely** for the waterbodies supporting Rail Corridor. The Freshwater Marsh has the added protection from its high elevation and distance from the developments, so the likelihood was assessed to be **Unlikely**. The impact significance would be **Minor** and **Negligible** respectively.

Human receptors

Given the relatively small quantities of such potential spills, the impact intensity would be **Medium**. As the local residents and visitors have been categorised as Priority 1 sensitive receptor, the impact consequence would be **Medium**. With the minimum controls, such as proper SOP and storage of chemicals in containers, spillage of chemical substances could happen throughout the construction period with an **Unlikely** likelihood, the impact significance is assessed to be **Negligible** on local residents and visitors.

11.2.1.2.4 Solid waste

Ecological receptors

Solids and toxic waste generated during construction works may enter the waterbodies and cause significant adverse effects on water quality of the identified streams and drains. However, quantity of the waste stored on the site (e.g. chemical waste, construction debris, wood waste etc.) is expected to be limited and it would be periodically removed by the licensed waste management contractors. With the implementation of minimum control measures such as proper SOP for the handling, transfer, storage and disposal of waste and enclosed bins for disposal, in addition to regular clearing from site, only small amounts of waste may be spilled. Hence, the impact intensity would be **Low** for both ecological receptors. As both receptors are of Priority 1, the impact consequence will be Low. As the aforementioned minimum control measures would be in place, the likelihood would be **Less Likely** for the waterbodies supporting Rail Corridor and **Unlikely** for the Freshwater Marsh. Therefore, leading to **Minor** and **Negligible** impact significance respectively.

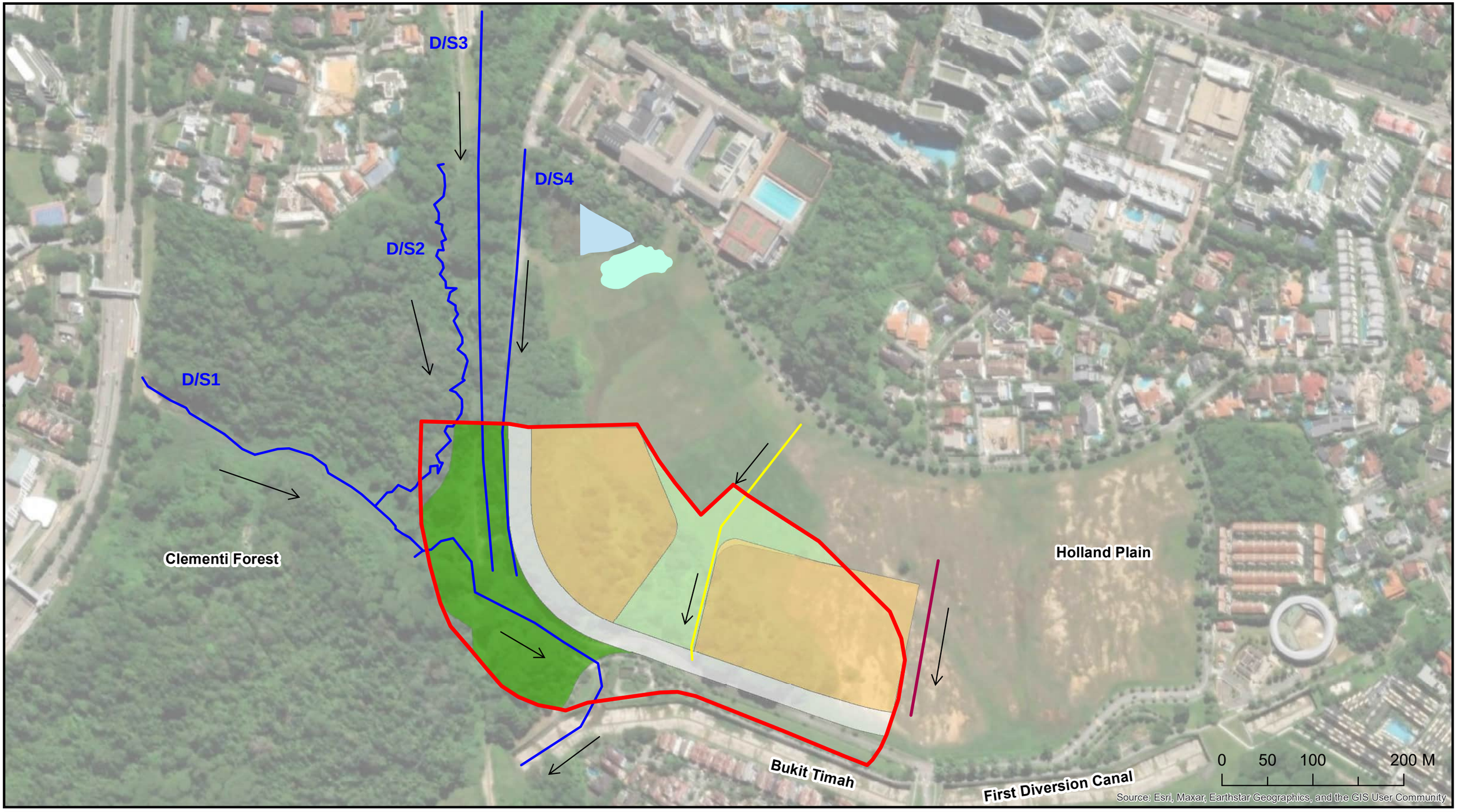
Human receptors

With minimum control measures in place, the impact intensity on local residents and visitors would be **Low**. Hence, impact consequence will be **Low** on all local residents and visitors (Priority 1). Given the minimum controls, the expected likelihood of such solid waste spillage is **Unlikely** to affect the humans, hence impact significance is assessed to be **Negligible** on local residents and visitors.

Table 11.2.1 Summary of impact evaluation during construction phase

Impact Source	Receptor	Receptor Sensitivity	Impact Intensity	Impact Consequence	Likelihood	Impact Significance
Hydrology						
Liquid effluents and stormwater run-off generation	Ecological Receptors					
	Waterbodies supporting Clementi Forrest and the Rail Corridor	Priority 1	Low	Low	Unlikely/ Remote	Negligible
	Freshwater marsh	Priority 1	Negligible	Very Low	Unlikely/ Remote	Negligible
	Human Receptors					
	Future residents and visitors in the vicinity of the Study Area developments	Priority 2	Low	Very Low	Less Likely/ Rare	Negligible
Water Quality						
Stormwater run-off generation	Ecological Receptors					
	Waterbodies supporting Clementi Forrest and the Rail Corridor (site clearance)	Priority 1	Medium	Medium	Less Likely/ Rare	Minor
	Waterbodies supporting Clementi Forrest and the Rail Corridor (rest of construction phase)	Priority 1	Low	Low	Likely/ Regular	Minor
	Freshwater marsh	Priority 1	Low	Low	Unlikely/ Remote	Negligible
	Human Receptors					
	All local residents and visitors	Priority 1	Low	Low	Unlikely/ Remote	Moderate
Construction wastewater generation	Ecological Receptors					
	Waterbodies supporting Clementi Forrest and	Priority 1	Low	Low	Less Likely/ Rare	Minor

Impact Source	Receptor	Receptor Sensitivity	Impact Intensity	Impact Consequence	Likelihood	Impact Significance
	the Rail Corridor					
	Freshwater marsh	Priority 1	Low	Low	Unlikely/ Remote	Negligible
	Human Receptors					
	All local residents and visitors	Priority 1	Low	Low	Unlikely/ Remote	Negligible
Accidental spills and leaks of pollutants	Ecological Receptors					
	Waterbodies supporting Clementi Forrest and the Rail Corridor	Priority 1	Medium	Medium	Less Likely/ Rare	Minor
	Freshwater marsh	Priority 1	Medium	Medium	Unlikely/ Remote	Negligible
	Human Receptors					
	All local residents and visitors	Priority 1	Medium	Medium	Unlikely/ Remote	Negligible
Solid waste generation	Ecological Receptors					
	Waterbodies supporting Clementi Forrest and the Rail Corridor	Priority 1	Low	Low	Less Likely/ Rare	Minor
	Freshwater marsh	Priority 1	Low	Low	Unlikely/ Remote	Negligible
	Human Receptors					
	All local residents and visitors	Priority 1	Low	Low	Unlikely/ Remote	Negligible



Legend

- Study Area
- Waterbodies
- Planned drain
- Planned interim drain
- Retained old marsh
- New Freshwater Marsh
- Residential development
- Road
- Residential Plain
- Rail Corridor

N

Rev.	Date	By	Description	Chk'd	App'd
-	MAC 2025	LHN	Holland Plain EIA	LAL	JAG

Qualified Person Endorsement : NA

URA Endorsement : NA

Consultant : AECOM

Client: URBAN REDEVELOPMENT AUTHORITY

Project Title :

CONTRACT URA/T/23/048
HOLLAND PLAIN
ENVIRONMENTAL IMPACT ASSESSMENT

Figure Title :

Indicative drainage and watercourses during construction phase

Designed	Checked	Approved
LHN	LAL	JAG
	Drawn: LHN	Date: MAC 2025

Figure No. : 11.2.1 | Rev. : - | Sheet : 1 of 1

CAD File Name : NA | A3

Note: Source of basemap - Esri, Maxar, Earthstar Geographics, and the GIS User Community

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11.2.2 Operational Phase

11.2.2.1 Hydrology

11.2.2.1.1 Permanent land use change

Ecological receptors

The key hydrological impact during the operational phase of the Project is expected to occur due to the permanent land use change. Higher percentage of urbanised areas could potentially have impact on surface water both in quantity and quality. Based on the future land use, the Rail Corridor and the majority of Clementi Forest remains untouched. Therefore, the waterbodies supporting the Rail Corridor would face **Low** impact intensity. While Holland Plain would largely be developed, the impact intensity of the Freshwater Marsh was assessed to be **Low** due it mainly being recharged by direct precipitation over the marsh area. Both receptors are classified as priority 1 receptors and the impact consequence would be **Low**. It is **Unlikely** that hydrological changes within the development area would further impact the receptors. Therefore, the impact significance was assessed to be **Negligible** for both receptors.

Human receptors

Although the distribution of water flow within the Study Area may change due to the increase of impervious surfaces, the impact intensity was assessed to be **Low**. It is to be noted the proposed drains and bioswale (as seen in Figure 11.2.2) should be designed complying with PUB COP and needs to assure the effective conveyance of the surface water runoff outside of the Study Area, not impacting the surrounding area. Since the human receptors have been categorised as Priority 2 sensitive receptors, the impact consequence would be **Very Low**. Since the detention system will be provided as required in PUB's COP on Surface Water Drainage (2023) to capture the stormwater during heavy storm events to reduce the peak runoff and to ensure zero increase in flood peak from the baseline condition, the likelihood of such floods is considered **Less Likely**, and the impact significance would be **Negligible**.

11.2.2.2 Water Quality

11.2.2.2.1 Stormwater Runoff Contamination

Ecological receptors

As the Clementi Forest and Rail Corridor will largely remain undeveloped and the higher elevation of the Freshwater Marsh, the estimated impact intensity of stormwater runoff contamination on the watercourses would be **Negligible**. Since both ecological receptors have been categorised as priority 1 sensitive receptors, the impact consequence would be **Very Low**. The likelihood of stormwater contamination affecting the local habitats is assessed to be **Unlikely**. Therefore, the impact significance for both receptors would be **Negligible**.

Human receptors

The land use of the Project Site will become more urbanised once in operational phase, causing a change in surface runoff water quality. However, the development of the bioswale might improve the quality of stormwater runoff. The estimated impact intensity of stormwater runoff contamination on the watercourses would then be **Negligible**. Since residents and visitors have been categorised as priority 1 sensitive receptors, the impact consequence would be **Very Low**. With the minimum controls such dedicated procedures for stormwater management, wastewater and solid waste management practice, the likelihood of stormwater contamination within NEA Limits affecting humans is **Unlikely**. Therefore, the impact significance on local residents and visitors will be **Negligible**.

11.2.2.2.2 Improper Management of Liquid and Solid Wastes

Ecological receptors

The Rail Corridor and the Freshwater Marsh are planned to be retained habitats with trails for public visit, with the former already functioning so. With minimum controls, there would likely be disposal bins prepared in areas that humans will enter, with adequate signages prohibiting littering. Routine checks on watercourses to ensure it is free of contamination is also expected. Also, these will be is retained forests with trails, the number of humans entering these spaces are considered to be low. With this, the impact intensity of improper management of wastes on these areas may be **Low**, and hence the impact consequence is **Low**. The likelihood of such contamination is **Possible**. Therefore, the impact significance is **Minor** for both receptors.

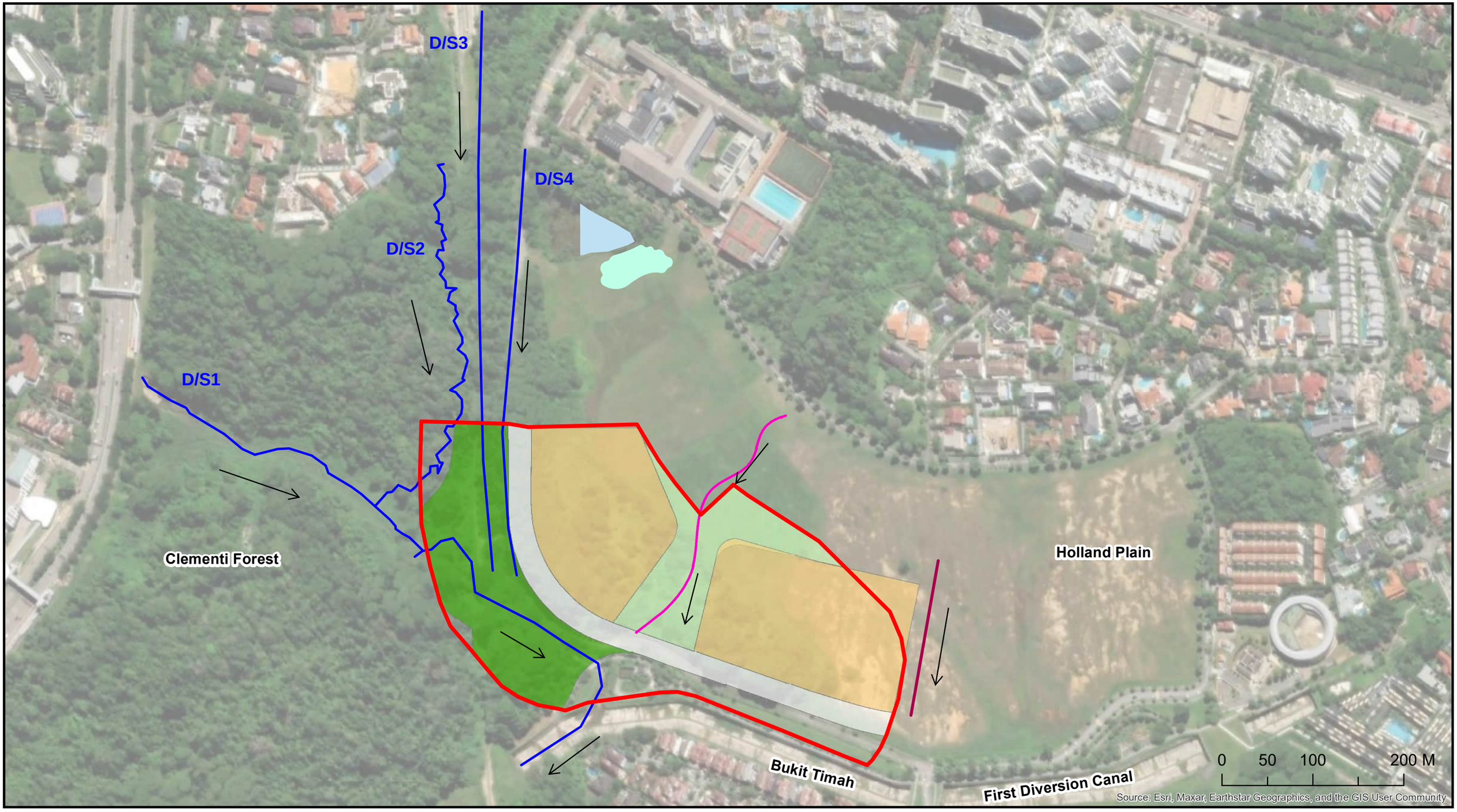
Human receptors

During operation phase, the surface water in the Project and surroundings watercourses might easily be contaminated due to inappropriate disposal and storage of liquid and solid wastes. The impact intensity of improper management of liquid and solid wastes on the local residents and visitors would be **Medium**. Since the humans (local residents and visitors) have been categorised as Priority 1 sensitive receptor, the impact consequence would be **Medium**. By providing inspection on wastes storage system and monitor the proposed watercourses of the operational footprint, **Less Likely** likelihood of the impact would be expected on the local residents and visitors, the impact significance is considered as **Minor**.

Table 11.2.2 Summary of impact evaluation during operational phase

Impact Source	Receptor	Receptor Sensitivity	Impact Intensity	Impact Consequence	Likelihood	Impact Significance
Hydrology						
Permanent land use change	Ecological Receptors					
	Waterbodies supporting Clementi Forrest and the Rail Corridor	Priority 1	Low	Low	Unlikely/ Remote	Negligible
	Freshwater marsh	Priority 1	Low	Low	Unlikely/ Remote	Negligible
	Human Receptors					
	Future residents and visitors in the vicinity of the Study Area developments	Priority 2	Low	Very Low	Less Likely	Negligible
Water Quality						
Stormwater Runoff Contamination	Ecological Receptors					
	Waterbodies supporting Clementi Forrest and the Rail Corridor	Priority 1	Negligible	Very Low	Unlikely/ Remote	Negligible
	Freshwater marsh	Priority 1	Negligible	Very Low	Unlikely/ Remote	Negligible
	Human Receptors					
	All local residents and visitors	Priority 1	Low	Low	Unlikely/ Remote	Negligible
Improper Management of Liquid and Solid Wastes	Ecological Receptors					
	Waterbodies supporting Clementi Forrest and the Rail Corridor	Priority 1	Low	Low	Possible	Minor

Impact Source	Receptor	Receptor Sensitivity	Impact Intensity	Impact Consequence	Likelihood	Impact Significance
	Freshwater marsh	Priority 1	Low	Low	Possible	Minor
	Human Receptors					
	All local residents and visitors	Priority 1	Medium	Medium	Unlikely/ Remote	Minor



Legend

- Study Area
- Waterbodies
- Planned drain
- Planned bioswale
- Retained old marsh
- New Freshwater Marsh
- Residential development
- Road
- Residential Plain
- Rail Corridor

N

Rev.	Date	By	Description	Chk'd	App'd
-	MAC 2025	LHN	Holland Plain EIA	LAL	JAG

Qualified Person Endorsement : NA

URA Endorsement : NA

Consultant : AECOM

Client: URBAN REDEVELOPMENT AUTHORITY

Project Title :

CONTRACT URA/T/23/048
HOLLAND PLAIN
ENVIRONMENTAL IMPACT ASSESSMENT

Figure Title :

Indicative drainage and watercourses during operational phase

Designed	Checked	Approved
LHN	LAL	JAG
	Drawn: LHN	Date: MAC 2025

Figure No. : 11.2.2 | Rev. : - | Sheet : 1 of 1

CAD File Name : NA | A3

Note: Source of basemap - Esri, Maxar, Earthstar Geographics, and the GIS User Community

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11.3 Air Quality Impact

11.3.1 Construction Phase

Throughout the study a conservative but credible approach was adopted to assess the air quality impacts of this Project where the potential sources are mainly dust emissions (PM_{10} and $PM_{2.5}$) from construction activities (e.g., earthworks, dust/ dirt from on-site transport), and other gaseous emissions (e.g., NO_2, SO_2, CO) from construction equipment (e.g., off-road diesel engines like generator) and site vehicle exhausts as discussed in Section 9.3.1. This may lead to an over-estimation of the levels of pollutants that will arise in practice, but this is considered to be appropriate for planning purposes at this stage of the project and is consistent with precautionary principles. It shall be noted that the impacts of fumigation on the fauna are discussed and assessed in Section 11.1.1.3.

11.3.1.1 Impact Assessment on Dust Emissions from Earthworks, Construction and Trackout

The assessment is conducted using the site area, hours of operation, timescale of construction, construction material, excavation quantities, surface material and number of vehicles on site based on the approach described in Section 5.4.4.

Ecological Receptors

Dust from construction worksites deposited on vegetation may create ecological stress within the local plant community. During dry periods dust can coat plant foliage adversely affecting photosynthesis and other biological functions. Rainfall removes the deposited dust from foliage and can rapidly leach chemicals into the soil. Large scale construction worksites may give rise to dust deposition over an extended period of time and adversely affect vascular plants. Deposition of concrete dust has the potential to increase the surface alkalinity, which in turn can hydrolyse lipid and wax components, penetrate the cuticle, and denature proteins, finally causing the leaf to wilt [P-39]. Dust may affect photosynthesis, respiration, transpiration and allow the penetration of phytotoxic gaseous pollutants [P-40].

In line with the IAQM Guidance, the Impact Intensity was determined by reviewing the scale of construction activities and classifying them as low, medium or high for each activity type (earthworks, construction, and trackout). The amount of dust deposited, and its effects are also dependent upon weather conditions. During wet weather, less dust will be generated and that which has been deposited upon foliage is more likely to be washed off. As discussed in Section 6.1.4.1, the Project is expected to receive relatively higher rainfall in the long term compared to the other parts of Singapore. Hence, this is expected to help to lessen the intensity of dust generated and deposited upon plant foliage. However, the IAQM methodology does not take into account the rainfall intensity in the Study Area. Therefore, the air quality assessment is expected to be conservative for the purpose of the Project.

The overall Consequence for each activity was classified by considering Impact Intensity with the Receptor Sensitivity. Without any mitigation measures in place, the Likelihood of occurrence of impacts from construction of the project was classified as **Regular** as the activity would occur on a regular basis during construction. The Impact Intensity, overall Consequence and Impact Significance are outlined in Table 11.3.1.

Based on the assessment, the Impact Significance was predicted to be **Major** for ecological impact. Hence, based on the assessment methodology, Impact Significance evaluated as Major and Moderate requires the adoption of management or mitigation measures.

Human Receptors

In line with the IAQM Guidance, the Impact Intensity was determined by reviewing the scale of construction activities and classifying them as low, medium or high for each activity type (earthworks, construction, and trackout). The project was expected to receive relatively higher rainfall in the long term compared to the other parts of Singapore. Hence, this was expected to help to lessen the intensity of dust generated and deposited. However, the IAQM methodology does not take into account the rainfall intensity in the Study Area. Therefore, the air quality assessment was expected to be conservative for the purpose of the project. Since there are no identified receptors within the Study Area of the trackout, the assessment for human receptors due to impacts from trackout has been excluded.

The overall Consequence for each activity was classified by considering Impact Intensity with the Receptor Sensitivity. Without any mitigation measures in place, the Likelihood of occurrence of impacts from construction of

the project was classified as **Regular** as the activity would occur on a regular basis during construction. The Impact Intensity, overall Consequence and Impact Significance are outlined in Table 11.3.1.

Based on the assessment, the Impact Significance was predicted to be **Moderate** to **Major** for human health impact. Hence, based on the assessment methodology, Impact Significance evaluated as Moderate or Major requires the adoption of management or mitigation measures.

Table 11.3.1 Impacts of dust risk assessment (before mitigation)

Key Parameter - Earthworks			Impact Assessment							
Total Site Area (m^2) [1]	No. of Vehicles Moving Within the Site	Earthworks Material	Impact Intensity	Sensitivity of the Area		Overall Consequence / Dust Risk		Likelihood	Impact Significance	
				Ecological Receptor	Human Receptor	Ecological Receptor	Human Receptor		Ecological Receptor	Human Receptor
18,000-110,000	>10	Moderately dusty	High	Priority 1	Priority 3	High	Low	Regular	**Major**	**Moderate**
Key Parameter - Construction			**Impact Assessment**							
Total Building Volume (m^3) [1]	Construction Material	No. of On-Site Concrete Batching Plant	Impact Intensity	Sensitivity of the Area		Overall Consequence / Dust Risk		Likelihood	Impact Significance	
				Ecological Receptor	Human Receptor	Ecological Receptor	Human Receptor		Ecological Receptor	Human Receptor
>75,000	Potentially dusty (e.g., concrete)	0	High	Priority 1	Priority 3	High	Low	Regular	**Major**	**Moderate**
Key Parameter - Trackout			**Impact Assessment**							
No. of Outward Trucks Movement Per Day [1]	Road surface material	Unpaved Road Length (m) [1]	Impact Intensity	Sensitivity of the Area		Overall Consequence / Dust Risk		Likelihood	Impact Significance	
				Ecological Receptor	Human Receptor	Ecological Receptor	Human Receptor		Ecological Receptor	Human Receptor
>50	Potentially dusty	<50	High	Priority 1	-	High	High	Regular	**Major**	-

Note:

1. **The numbers are based on estimation and are subject to further changes.**
2. The HDVs are expected to travel along the existing paved road along Holland Road, Holland Plain, Old Holland Road and Blackmore Drive for access to the Project Site, hence an unpaved road length of 0 m (<50 m) is considered in this air quality impact assessment.

11.3.1.2 Impact Assessment on Gaseous Emissions from Construction Equipment, Vehicle and Off-Road Diesel Exhaust

Exhaust emissions from construction equipment, machineries and vehicles have the potential to cause air quality impact. Petrol and diesel construction equipment utilised during the construction period will generate pollutants such as PM_{10}, $PM_{2.5}$, CO, SO_2, and NO_x. It shall be noted that all construction machines will not operate at the same time and at the same location. The emission will be spread out across the construction duration within the day and also across the Project Site, hence the human and ecological receptors in terms of equipment exhaust activities will be classified as **Priority 1** receptors. All construction equipment fall under the definition of off-road diesel engine will also comply to Singapore's Environmental Protection and Management (Off-Road Diesel Engine Emissions) Regulations 2012 (see Section 4). The impact is usually localised within the construction worksite and only short-term during the operation of the equipment/ vehicle only. Therefore, only small-scale increase in air quality levels is expected and the Impact Intensity is considered as **Low**, hence resulting in a **Low** Impact Consequence based on Table 5.4.2. With likelihood of **Regular**, the overall Impact Significance from equipment exhaust is expected to be **Moderate**, which requires the adoption of management or mitigation measures. The Impact Intensity, Impact Consequence and Impact Significance are outlined in Table 11.3.2.

Table 11.3.2 Impacts of gaseous emissions assessment (before mitigation)

Impact Intensity	Sensitivity of the Area		Impact Consequence		Likelihood	Impact Significance	
	Ecological Receptor	Human Receptor	Ecological Receptor	Human Receptor		Ecological Receptor	Human Receptor
Low	Priority 1	Priority 1	Low	Low	Regular	**Moderate**	**Moderate**

11.3.2 Operational Phase

As discussed in Section 9.3.2, emissions from vehicle exhaust due to increased traffic to the Project is expected. It is assumed that all new petrol and diesel vehicles will meet Euro 6 emission standard, while all motorcycles will meet Euro 4 standard going forward and slowly completely convert to these or better standards as they get phased out in 10 years from their onset. It can be observed from Table 11.3.3, NO_x reduction from the last three Euro emission standard tier is 55.6% and 25% for diesel and gasoline passenger cars respectively. Similarly, as observed in Table 11.3.4, NO_x reduction from the last three Euro emission standard tier is approximately 55% and 25% for diesel and gasoline commercial good vehicles respectively across all vehicle categories. It shall be noted that the impacts of fumigation on the fauna are discussed and assessed in Section 11.1.2.3.

Table 11.3.3 Euro emission standard for passenger cars [W-24]

Tier	Approval Date	Emission standard for passenger cars, g/km				
		CO	HC	NO_X	$HC+NO_X$	PM
Compression Ignition (Diesel)						
Euro 5a	September 2009	0.50	-	0.18	0.23	0.005
Euro 5b	September 2011	0.50	-	0.18	0.23	0.005
Euro 6	September 2014	0.50	-	0.08	0.17	0.005
Positive Ignition (Gasoline)						
Euro 4	January 2005	1.00	0.10	0.08	-	-
Euro 5	September 2009	1.00	0.10	0.06	-	0.005
Euro 6	September 2014	1.00	0.10	0.06	-	0.005

Table 11.3.4 Euro emission standard for commercial good vehicles [W-24]

Category	Tier	Approval Date	Emission standard for commercial good vehicles, g/km				
			CO	HC	NO_X	HC+NO_X	PM
Compression Ignition (Diesel)							
N1, Class I ≤ 1305 kg	Euro 5a	September 2009	0.50	-	0.18	0.23	0.005
	Euro 5b	September 2011	0.50	-	0.18	0.23	0.005
	Euro 6	September 2014	0.50	-	0.08	0.17	0.005
N1, Class II 1305 – 1760 kg	Euro 5a	September 2009	0.63	-	0.235	0.295	0.005
	Euro 5b	September 2011	0.63	-	0.235	0.295	0.005
	Euro 6	September 2014	0.63	-	0.105	0.195	0.005
N1, Class III 1760-3500 kg	Euro 5a	September 2009	0.74	-	0.28	0.35	0.005
	Euro 5b	September 2011	0.74	-	0.28	0.35	0.005
	Euro 6	September 2014	0.74	-	0.125	0.215	0.005
N2, 3500 – 12000 kg	Euro 5a	September 2009	0.74	-	0.28	0.35	0.005
	Euro 5b	September 2011	0.74	-	0.28	0.35	0.005
	Euro 6	September 2014	0.74	-	0.125	0.215	0.005
Positive Ignition (Gasoline)							
N1, Class I ≤ 1305 kg	Euro 4	January 2005	1.00	0.10	0.08	-	-
	Euro 5	September 2009	1.00	0.10	0.06	-	0.005
	Euro 6	September 2014	1.00	0.10	0.06	-	0.005
N1, Class II 1305 – 1760 kg	Euro 4	January 2005	1.81	0.13	0.10	-	-
	Euro 5	September 2009	1.81	0.13	0.075	-	0.005
	Euro 6	September 2014	1.81	0.13	0.075	-	0.005
N1, Class III 1760-3500 kg	Euro 4	January 2005	2.27	0.16	0.11	-	-
	Euro 5	September 2009	2.27	0.16	0.082	-	0.005
	Euro 6	September 2014	2.27	0.16	0.082	-	0.005
N2, 3500 – 12000 kg	Euro 5	September 2009	2.27	0.16	0.082	-	0.005
	Euro 6	September 2014	2.27	0.16	0.082	-	0.005

Additionally, the introduction of the Commercial Vehicle Emissions Scheme (CVES) in April 2021 to encourage the adoption of cleaner light commercial vehicles (LCVs) which have lower emissions, including Light Goods Vehicles, Goods-Cum-Passenger Vehicles, and small buses, with maximum laden weight not exceeding 3,500kg could also help to reduce the emission of CO_2, HC, CO, NO_x and PM. Similarly, the Enhanced Vehicular Emissions Scheme (VES) introduced in 2018 and extended to 2025 also encourages the adoption of cleaner passenger cars and taxis. The phase-out of diesel vehicles, with new diesel cars and taxis no longer permitted for registration started in 2025, and could also help to reduce the emission of NO_x and PM.

Within the 250 m Study Area, the existing residential properties are mostly located at the south and northeast of the Project Site, including the private residences (i.e., Holland Green and Brizay Park). There is also educational institute located at the north of the Project Site, (i.e., Methodist Girls' School). There is an existing temporary road for maintenance and construction between Blackmore Drive and Holland Plain. Directly connected to this road is a cycling path beside Bukit Timah Diversion Canal. Typically, the pollutants of concern in traffic-related pollution tend

to be CO, NO_x (NO/NO_2), PM_{10} and $PM_{2.5}$. As the vehicles use low sulphur fuel, SO_2 is less of concern these days from vehicular exhaust.

Ecological Receptors

The particulates, viz. PM_{10} and $PM_{2.5}$ (dust) can have direct and indirect impacts on ecological receptors. Dust emissions can have direct adverse effects upon vegetation restricting photosynthesis, respiration and transpiration. It can also lead to phytotoxic gaseous pollutants penetrating the plants. The overall effect can be a decline in plant productivity, which may then have indirect effects on the quality of the affected habitats and associated fauna.

NO_x can affect plants directly or indirectly. It may directly enter a plant via the stomata, where it has phytotoxic effects. Lower plants such as lichens and bryophytes (including mosses, landworts and hornwarts) are particularly vulnerable to direct exposure to the gases in this way [W-25]. Since the biodiversity survey was focused on only vascular plants, there is limited information on the locations of these non-vascular species. However, based on empirical observation, rain trees are known to harbour other biomes such as mosses. Numerous specimens of large trees were recorded within the Study Area (refer to Section 8.3.1).

Indirectly, NO_x can also deposit onto soil and, following transformation to nitrate, enrich the soil, leading to eutrophication. The effects of elevated NO_x concentrations on vegetation can be broadly categorised as [R-44]:

- growth effects: particularly increased biomass, changes in root to shoot ratio and growth of more competitive species, but also including growth suppression of some species;
- physiological effects: e.g., CO_2 assimilation and stomatal conductivity; and
- (bio)chemical effects: e.g., changes in enzyme activity and chlorophyll content (probably through the effects of increased nitrogen).

Indirectly in the long run, accumulation of nitrogen oxides (NO_x) via acidic rain causes soil and water to become more acidic and hence, reducing the nutritional value of food sources for fauna [P-41]. There is no published evidence for any direct toxic effect of NO_x on animals and therefore effects on animals are not included in ecological impact assessment [R-43].

Lichens/ mosses are indicators of good air quality and high level of SO_2 emission might impact these plants tremendously. Although this is not seemingly a potential concern in the operation of a residential area, other development within the residential estates, such as community centre, might employ generators which might emit high level of SO_2. In order to avoid this, low sulphur diesel fuel should be used as minimum control in line with NEA's latest regulations.

From CO however, there is no known specific impact on ecological receptors. It should also be noted that some of the ecological receptors within the Study Area are immediately adjacent to the Old Holland Road and Blackmore Drive with the existing disturbance from the vehicular road emissions.

Human Receptors

As for impacts of pollutants on human, NO_2 increases the risk of respiratory infection and impairs lung functions in asthmatics. CO deprives body tissues of oxygen and causes nausea and impairs vigilance. Particulate matters can affect the heart and lungs, especially in people who already have chronic heart or lung disease (e.g., asthma). $PM_{2.5}$ can cause decreased lung function, increased respiratory symptoms and heart attacks. PM_{10} can cause respiratory impairment and aggravate existing respiratory and cardiovascular disease. Short term exposure to particulate matters may also cause irritation of the eyes, nose and throat in healthy individuals [W-26].

In 2010, the Health Effects Institute published their authoritative report titled "Traffic-related air pollution: a critical review of the literature on emissions, exposure, and health effects". This report has been used as the basis of WHO Technical Report on Review of evidence on health aspects of air pollution 2013 [R-45]. In this WHO Technical Report, Roorda-Knape et al. (1998), Hitchins et al. (2000), Zhu et al. (2002), and Gilbert et al. (2003) reported a significant decrease of particulates and gases within 150-200 m of a road. However, on the downwind side of a highway, concentrations do not generally reach background levels until at least 300 m – 500 m, though Zhu et al. (2002) found a 60% to 80% decrease of CO from roadside concentrations within 100 m. In some studies, this was extended to up to 1500 m for NO_2 (Gilbert et al., 2003; Jerrett et al., 2007). At the moment, the vehicles are using low sulphur content fuel, hence the decrease of SO_2 with distance is not discussed.

The potential source of operational air quality impacts would be due to the vehicular emissions from the existing road of Old Holland Road, Blackmore Drive, Holland Link, Holland Road and Holland Plain. In addition, the existing temporary road for maintenance and construction between Blackmore Drive and Holland Plain, which is currently closed to public vehicles, will also be in use in the future. Hence, locally the traffic within and in the vicinity of the Project Site is likely to increase. The exact numbers in terms of increase /change in volume of traffic to and from the worksites were not available. Without any mitigation measures in place, the Likelihood of occurrence of impacts during the operational phase is classified as Regular.

With consideration of all the discussed factors, including the implementation of Euro emission standard on new vehicles, cleaner transportation solutions as promoted by Singapore's regulations and vehicle scheme, and the 60% to 80% decrease over distance (by Zhu et al. (2002)) from the existing road, insignificant increase in air quality pollutant levels for the existing human receptors is expected during the operational phase of the Project, therefore resulting in a **Negligible** Impact Intensity as per Table 5.4.7.

With the Priority 1 sensitive receptors identified for operational phase of this Project (see Section 8.3.2), according to the assessment matrix in Table 5.4.2, the Impact Consequence would be **Very Low** and **Imperceptible** respectively. Without any mitigation measures in place, the Likelihood of occurrence of impacts during the operational phase is classified as **Regular**. Based on the impact significance matrix in Table 5.4.7, the Impact Significance is predicted to be **Minor** (refer to Table 11.3.5). No mitigation measures are required during operational phase.

Table 11.3.5 Impacts of air quality from vehicular traffic – operational phase

Impact Intensity	Sensitivity of the Area	Overall Consequence	Likelihood	Impact Significance
Negligible	Priority 1	Very Low	Regular	**Minor**

11.4 Airborne Noise Impact

11.4.1 Assessment Criteria

As a part of the Project scope, qualitative noise impact assessment criteria adopted to assess airborne noise impacts on nearby noise sensitive receptors (NSRs) that may potentially arise from the construction phase and operational phase of the Project at the pre-design stage is outlined in this section. Baseline noise levels were used to develop the specific construction and operation noise criteria for this Project.

11.4.1.1 Construction Noise Criteria (Construction Phase)

11.4.1.1.1 Ecological Receptors

The ecological impacts from airborne noise are species dependent and hence the assessment would be based on species identified during site surveys within and surrounding the Study Area for airborne noise sensitive receptors. Species which are noise sensitive are those that use noise, for example for their communication or identification of their way, at certain times of the day. Construction and noisy activities during their active times can cause interference with their day-to-day activities. Therefore, at these times, construction noise criteria are made more stringent for ecological receptors than the human noise criteria.

At present, there are no established guidelines or standards for evaluating the noise generated by construction activities concerning ecological receptors. The existing criteria are designed solely for assessing noise impacts on humans and do not address the specific concerns related to ecological environments. Unlike human receptors, baseline monitoring results were chosen as a basis of comparison for ecological receptors because fauna species face a direct form of impact, given that the habitats where they reside in are directly impacted by the noises emitted from the introduction of construction activities in the vicinity. Therefore, it is not advisable to adopt similar assessment criteria to human receptors where they operate in different nature.

For the purpose of noise impact assessment on ecological receptors in this EIA, a criterion of no-worse-off than baseline shall be adopted in absence of adequate research data on criteria and applied to the ecological receptors identified within and surrounding the Study Area as a part of the qualitative noise impact assessment.

11.4.1.1.2 Human Receptors

Specific construction noise criteria for the construction phase of this Project were developed with the baseline noise levels detailed in Section 7.4.1, included in the calculation to derive a background noise correction factor to establish the maximum noise level permitted from the construction activities in accordance with the *Environmental Protection and Management (Control of Noise at Construction Sites) Regulations, 2008* [R-31].

The legislative requirements for environmental noise arising from construction activities in Singapore contains three parts which specifies the applicable noise criteria for construction sites over different periods of time. The corresponding permissible noise criteria are provided in Table 11.4.1 to Table 11.4.3 for different periods of duration.

They are reflected in the order as follows:

- $L_{Aeq(12\ hours)}$ refers to equivalent continuous noise level over a period of 12 hours;
- $L_{Aeq(1\ hour)}$ refers to equivalent continuous noise level over a period of 1 hour within a 24-hour period; and
- $L_{Aeq(5\ mins)}$ refers to equivalent continuous noise level over a period of 5 minutes within a 24-hour period.

Table 11.4.1 Maximum permissible noise levels for construction works over a period of 12 hours

Types of Affected Buildings	Days of the week	Maximum Permissible $L_{Aeq(12\ hours)}$, dB	
		7am – 7pm	7pm – 7am
(a) Hospitals, schools, institutions of higher learning, homes for the aged or sick etc.	All days	60	50
(b) Residential buildings located less than 150 m from the construction site where the noise is being emitted	All days	75	–
(c) Buildings (other than those in paragraphs (a) and (b))	All days	75	65

Table 11.4.2 Maximum permissible noise levels for construction works over a period of 1 hour

Types of affected buildings	Days of the week	Maximum Permissible $L_{Aeq\ (1\ hour)}$ (dB)		
		7am – 7pm	7pm – 10pm	10pm – 7am
(a) Hospitals, schools, institutions of higher learning, homes for the aged or sick etc.	Monday to Saturday	–	–	–
(b) Residential buildings located less than 150 m from the construction site where the noise is being emitted	Monday to Saturday	–	65	55
(c) Buildings (other than those in paragraphs (a) and (b))	Monday to Saturday	–	–	–

Table 11.4.3 Maximum permissible noise levels for construction works over a period of 5 minutes

Types of affected buildings	Days of the week	Maximum Permissible $L_{Aeq\ (5\ mins)}$ (dB)		
		7am – 7pm	7pm – 10pm	10pm – 7am
(a) Hospitals, schools, institutions of higher learning, homes for the aged or sick etc.	All days	75	55	55
(b) Residential buildings located less than 150 m from the construction site where the noise is being emitted	Monday to Saturday	90	70	55
	Sunday and PH	75	55	55
(c) Buildings (other than those in paragraphs (a) and (b))	All days	90	70	70

As per the legislation, if there exists other sources of noise affecting the measurement of noise emitted from the construction site, the maximum permissible noise levels from the construction sites will be subjected to adjustments by the addition of a correction factor to account for the existing background noise levels in the area. The correction factor corresponds to the difference between the relevant permissible levels, and the background noise levels as presented in Table 11.4.4. The difference in noise levels are then added to the higher of the two noise levels (background noise/ criteria as appropriate) to deduce the applicable noise criteria for the specified construction area.

Table 11.4.4 Construction noise correction factor

Difference between Permissible & Background Noise Levels, dB (A)	Correction Factor to be Added to the Higher of the Two Noise Levels, dB (A)
Below 2	3
2 to less than 4	2
4 to less than 10	1
10 and above	Nil.

The corrected construction noise criteria will be presented and further elaborated in Section 11.4.1.3.

11.4.1.2 Operational Noise Criteria (Operational Phase)

For airborne noise arising from the operational phase, there exists two (2) aspects of impact for consideration:

1. Boundary noise from the operation of air conditioning and mechanical ventilation (ACMV) systems for proposed development (non-industrial) within the Study Area; and
2. Vehicular noise from road traffic at the Study Area.

11.4.1.2.1 Ecological Receptors

The ecological impacts from airborne noise is species dependent, hence the assessment will be based on the species identified by the fauna specialists during site surveys within and surrounding the Study Area as stated in Section 8.4.1, in sync with the biodiversity section of this Report.

There are currently no guidelines or standards available to assess the noise from operational activities on the ecological receptors. The current guidelines and standards available are used to assess the respective noise impacts to humans only and do not account for the specific considerations associated with the ecological receptors.

In evaluating the noise impact on ecological receptors in this EIA, a criterion of no-worse-off than baseline shall be employed in absence of sufficient research data on criteria and implemented to the ecological receptors identified within and surrounding the Study Area as a part of the qualitative noise impact assessment.

11.4.1.2.2 Human Receptors

11.4.1.2.2.1 Air Conditioning and Mechanical Ventilation Systems

According to the *NEA Technical Guideline on Boundary Noise Limits for Air Conditioning and Mechanical Ventilation Systems in Non-Industrial Buildings, 2018* [R-38], non-industrial buildings refers to any permanent or temporary building or structure used for the purposes of trade, business or commerce and includes any shopping complex, financial institution, office tower, hotel, educational institution, hospital, transport infrastructures, community infrastructure, sport and recreational infrastructure but does not include any factory and residential premises.

Based on the proposed preliminary land use plan provided by URA, the Project Site has been proposed to be used for two residential plots with a connective park in between. A road (Holland Plain) will also be developed, separating the residential and urban park from the Rail Corridor and Clementi Forest on the west (see Figure 3.2.1). Since the proposed development doesn't include any non-industrial building ,the criteria set by the *NEA Technical Guideline on Boundary Noise Limits for Air Conditioning and Mechanical Ventilation Systems in Non-Industrial Buildings, 2018* [R-38] are not applicable,

11.4.1.2.2.2 Land Traffic Noise

The Technical Guideline for Land Traffic Noise Impact Assessment provides guidance to conduct for the following:

- Part 1 – Land traffic Noise Impact Assessment on new residential and noise sensitive developments located in close proximity to existing land traffic noise sources/hotspots (e.g. expressways/major arterial roads/MRT tracks); and
- Part 2 – Land traffic Noise Impact Assessment on existing residential and noise sensitive developments located in close proximity to new transport-related developments (e.g. expressway/major arterial roads/MRT track/bus interchanges/bus depots), inclusive of the expansion of existing transport-related infrastructures.

The noise emissions due to movement of traffic can be assessed against the *NEA Technical Guideline for Land Traffic Noise Impact Assessment, 2016* [R-37] for the proposed development for operation of transportation networks in the Study Area. The noise levels of the new residential and noise sensitive development shall comply with the following NEA's noise requirement.

NEA's noise requirements are as follows:

- The noise levels at 1 m from the façade of the new residential/noise sensitive building shall not exceed $L_{Aeq(1hr)}$ 67 dB; and
- The indoor noise level of the new residential/noise sensitive building under natural ventilation shall not exceed $L_{Aeq(1hr)}$ 57 dB.

11.4.1.3 Corrected Baseline Noise Criteria

Based on the baseline airborne noise monitoring results and correction noise factor introduced in accordance to the "adjusted maximum permissible noise level" explained in Section 11.4.1, the corrected noise criteria for airborne noise impact assessment on ecological and human receptors were deduced separately and reflected in this section for the construction phase.

11.4.1.3.1 Construction Phase

Construction noise criteria for $L_{Aeq\ (12\ hours)}$, $L_{Aeq(1\ hour)}$ and $L_{Aeq\ (5\ mins)}$ were deduced for the period of 7am – 7pm, 7pm – 7am, 7pm – 10pm and 10pm – 7am for Weekdays (Monday – Saturday) and Weekend/ Public Holidays according to regulations. However, it should be noted that the developer/developing agent will be required to seek approval from relevant local agencies if it wishes to conduct construction works beyond 7am – 7pm.

11.4.1.3.1.1 Ecological receptors

As mentioned in Section 11.4.1.1.1, there are currently no guidelines or standards available to assess construction noise impacts on the ecological receptors, thus the average baseline monitoring results in Table 7.4.1 and Table

7.4.2 was used to establish the assessment criteria for construction noise impact on ecological receptors as reflected in Table 11.4.5 below.

This approach was taken as part of a conservative means; that if no noise exceedances is predicted when compared to these stringent criteria, the airborne noise impact on fauna in the vicinity will also not experience noise levels exceeding the established criteria.

Table 11.4.5 Noise criterion established for ecological receptors (construction phase)

No	Location	Noise Criteria for $L_{Aeq(12\ hour)}$, dB		Noise Criteria for $L_{Aeq(5\ min)}$, dB		
		7am - 7pm	7pm -7am	7am - 7pm	7pm - 10pm	10pm - 7am
Weekdays (Monday-Saturday)						
N05	Methodist Girls School	55	49	53	51	43
N14	Adjacent to rail corridor within the EIA Study Area	52	51	50	49	49
N15	North-western of the EIA study area	74	75	73	74	74
Sunday/Public Holidays						
N05	Methodist Girls School	52	48	50	48	44
N14	Adjacent to rail corridor within the EIA Study Area	49	52	47	48	49
N15	North-western of the EIA study area	74	73	73	74	73

11.4.1.3.1.2 Human receptors

For human receptors, the corrected noise criteria was deduced from using the overall recorded baseline noise levels for $L_{Aeq\ (12\ hours)}$, $L_{Aeq(1\ hour)}$ and $L_{Aeq\ (5\ mins)}$ recorded at N05, N14 and N15 to calculate the "adjusted maximum permissible noise level" as per the *Environmental Protection and Management (Control of Noise at Construction Sites) Regulation, 2008* [R-31]. Table 11.4.6 and Table 11.4.7 below reflect the corrected noise criteria for Weekdays (Monday – Saturday) and Weekend/Public Holidays according to EPM (2008).

Table 11.4.6 Noise criterion established for human receptors for weekdays (construction phase)

No	Types of Affected Buildings	Noise Criteria for LAeq(12 hour), dB		Noise Criteria for LAeq(5 min), dB		
		7am - 7pm	7pm - 7am	7am - 7pm	7pm - 10pm	10pm - 7am
N05	(a) Hospitals, schools, institutions of higher learning, homes for the aged or sick etc.	61	53	75	56	55
	(b) Residential buildings located less than 150 m from the construction site where the noise is being emitted	75	-	90	70	55

No	Types of Affected Buildings	Noise Criteria for LAeq(12 hour), dB		Noise Criteria for LAeq(5 min), dB		
		7am - 7pm	7pm - 7am	7am - 7pm	7pm - 10pm	10pm - 7am
	(c) Buildings (other than those in paragraphs (a) and (b))	75	65	90	70	70
N14	(a) Hospitals, schools, institutions of higher learning, homes for the aged or sick etc.	62	53	75	59	57
	(b) Residential buildings located less than 150 m from the construction site where the noise is being emitted	75	NA	90	70	57
	(c) Buildings (other than those in paragraphs (a) and (b))	75	65	90	70	70
N15	(a) Hospitals, schools, institutions of higher learning, homes for the aged or sick etc.	74	75	77	74	74
	(b) Residential buildings located less than 150 m from the construction site where the noise is being emitted	78	-	90	75	74
	(c) Buildings (other than those in paragraphs (a) and (b))	78	75	90	75	75

Table 11.4.7 Noise criterion established for human receptors for weekends/public holidays (construction phase)

No	Types of Affected Buildings	Noise Criteria for LAeq(12 hour), dB		Noise Criteria for LAeq(5 min), dB		
		7am - 7pm	7pm - 7am	7am - 7pm	7pm - 10pm	10pm - 7am
N05	(a) Hospitals, schools, institutions of higher learning, homes for the aged or sick etc.	61	52	75	55	55
	(b) Residential buildings located less than 150 m from the construction site where the noise is being emitted	75	NA	75	55	55
	(c) Buildings (other than those in paragraphs (a) and (b))	75	65	90	70	70
N14	(a) Hospitals, schools, institutions of higher learning, homes for the aged or sick etc.	62	53	75	56	56
	(b) Residential buildings located less than 150 m from the construction site where the noise is being emitted	75	NA	75	56	56
	(c) Buildings (other than those in paragraphs (a) and (b))	75	65	90	70	70
N15	(a) Hospitals, schools, institutions of higher learning, homes for the aged or sick etc.	74	73	77	74	73
	(b) Residential buildings located less	78	-	77	74	73

No	Types of Affected Buildings	Noise Criteria for LAeq(12 hour), dB		Noise Criteria for LAeq(5 min), dB		
		7am - 7pm	7pm - 7am	7am - 7pm	7pm - 10pm	10pm - 7am
	than 150 m from the construction site where the noise is being emitted					
	(c) Buildings (other than those in paragraphs (a) and (b))	78	74	90	75	75

11.4.1.3.2 Operation Phase

At the current pre-design stage, detailed information such as footprint of different types of buildings and their locations, the position of façade, design of ACMV systems etc. are unavailable. Operational noise baseline has been deduced understanding the limitation above. However, proper baseline noise for operational impact assessment may need to be re-captured when more detail is available. Please note that the baseline noise levels reflected in Section 7.4.2 for $L_{Aeq(15\ mins)}$ shall only serve as indicative operational baseline noise levels for reference purposes of potential baseline conditions experienced by the noise sensitive receptors prior to any establishment of permanent facilities that may contribute to operational noise (i.e. new road network/ residential building ACMV systems).

As such, an appointed Noise Consultant(s) should be engaged by the developer/ developing agent to conduct baseline noise monitoring once new road networks are laid out and used for quantitative operational noise impact assessment as mandated by law at the detailed design stage.

11.4.2 Construction Phase

In this section, construction noise impacts arising from the worst-case scenario identified for assessment in Section 9.4.1.1, are presented for the noise sensitive receptors (i.e. ecological and human receptors).

11.4.2.1 Ecological Receptors

Visualised in Figure 8.4.1, ecological receptors assessed for construction noise impacts (i.e. within 150 m from proposed construction worksites) were primarily found in the Clementi forested area which is situated on the western side of the study area.

As shown in Figure 8.4.1, fauna species were also recorded within the Project Site, proposed for the siting of construction worksites. Hence, under the assumption that when construction work commences and land is cleared in preparation for construction activities, habitats frequented by the fauna species within the Project Site will be moved towards Clementi Forest to the west and no fauna species will remain within the proposed construction worksites.

The fauna species inhabiting the forested areas near the existing Project Site (within 150 m Assessment Area) are Clementi Forest dwellers. During the construction phase, due to the potential of noise impacts from high noise sources emitting from the worksites, terrestrial ecological receptors found at all elevations were predicted through qualitative means of assessment to face potential noise impact intensity that are **High** attributed to their proximity to the noise sources and direct exposure to noise via the air medium (refer to Table 11.4.8).

Fauna species at ground level are typically ground dwellers comprising of odonates and mammals reflected in Appendix E Noise impact on these species of fauna is not yet clearly known but it is possible that these fauna species will avoid the immediate vicinity of the proposed construction worksites, seeking refuge in nearby densely forested areas. Identified as species of probable occurrence, the locally critically endangered Sunda Pangolin (*Manis javanica*) is a key sensitive receptor of construction noise due to its conservation significance and auditory sensitivity.

Noise generated from human activities, especially from construction sites, significantly impacts the physiology and behavior of birds. This noise masks important acoustic signals used for communication, mating, and hunting. The added construction noise can lead to both short- and long-term behavioral and physiological changes in birds, such as altered foraging locations, interference with communication, inability to detect predators or prey, temporary or permanent hearing loss, and increased stress or hormonal imbalances [R-51,P-55].

Butterflies are perturbed by intermittent noise. Therefore, as a minimum control for the Project's proposed construction worksites, it is recommended that high intermittent noises be avoided as much as possible while not compromising human safety.

Reptiles such as snakes, and turtles were also observed in these areas. Snakes, though not equipped with outer-ears and the tympanic middle ear, have vestiges for hearing inside their heads and can feel low-frequency airborne sounds.

Aquatic fauna deduced by fauna specialists to not be sensitive to airborne noise (i.e. Priority 3, refer to Section 8.4.1) due to transmission loss of noise across the air to water boundary therefore the fauna in freshwater marsh may not be impacted.

It is notable that the PMEs associated with construction activities might contribute to significantly high noise levels due to the high effective sound power levels (refer to Section 9.4.1). Considering proximity of the forested area on the Western side to the proposed construction worksites with fauna also populating the areas in between, potential long-term, non-reversible impacts on noise sensitive ecological receptors with high auditory sensitivities are predicted with potential behavioural effects on species that may result in temporary / permanent abandonment of territory, population decline due loss of ability to reproduce with the onslaught of physiological changes due to stress responses, to hearing loss on species that rely on hearing for important environmental cues and signals.

As established in Table 11.4.5, noise criteria for ecological receptors are ranged from 52 to 74 dB(A) for day time (7 am to 7 pm) and 48 to 75 dB(A) for nighttime (7 pm -7am) for $L_{Aeq(12\ hours)}$. In case of $L_{Aeq(5\ mins)}$, noise criteria for ecological receptors are ranged from 50 to 73 dB(A) for Day Time (7 am to 7 pm) , 48 to 74 dB(A) for evening (7pm – 10 pm) and 44 – 74 dB(A) for nighttime (10 pm -7am). With the considerations of current pre-existing conditions, contribution from the concurrent projects and noise contributing factors from the worst-case scenario **(Scenario 01: Foundation and Earthworks – Day Time (7 am -7 pm)),** the impact intensity was qualitatively assessed as **Low** to **High** for ecological receptors (refer to Table 11.4.5,). This corresponds to overall Impact Consequences to be **Low** to **High** for Priority 1, **Very Low** to **Medium** for Priority 2, and **Very Low** to **Low** for Priority 3 (refer Table 5.4.2). When assessing the Impact Consequence in relation to the Likelihood of Occurrence being **Certain/Continuous**, it was deduced that the maximum overall Impact Significance stemming from the proposed construction activities associated with the assessment scenario would fall within **Moderate to Major** for Priority 1, **Minor to Major** for Priority 2 and **Minor to Moderate** for Priority 3 (refer to Table 5.4.7).

Summary of the unmitigated qualitative construction noise impacts on ecological receptors is illustrated in Table 11.4.8.

However, due to limited information available during this preliminary phase, accurately estimating the noise impact is not possible. AECOM recommends that quantitative noise impact assessment for ecological receptors through noise modelling by a 3D simulating software such as SoundPLAN and CadnaA conducted by Noise Consultant(s) appointed by Contractor (s) be it roadworks/ earthworks/ construction contractor prior to commencement of construction works.

Table 11.4.8 Summary of unmitigated construction noise impact on Ecological receptors

Assessment Scenario	L_{Aeq}, dB(A)	Receptor Priority	Impact Intensity	Impact Consequences	Likelihood of Occurrence	Impact Significance
Scenario 01: Foundation and Earthworks – Day Time (7 am -7 pm)	$L_{Aeq(12\ hours)}$	Priority 1	Low - High	Low - High	**Certain/ Continuous**	**Moderate - Major**
		Priority 2	Low - High	Very Low - Medium		**Minor - Major**
		Priority 3	Low - High	Very Low - Low		**Negligible Minor - Moderate**
	$L_{Aeq(5\ mins)}$	Priority 1	Low - High	Low - High	**Certain/ Continuous**	**Moderate - Major**
		Priority 2	Low - High	Very Low - Medium		**Minor - Major**
		Priority 3	Low - High	Very Low - Low		**Negligible Minor - Moderate**

11.4.2.2 Human Receptors

For human receptors, it is important that distinction be made to establish the current environmental conditions the receptors are subjected to, to allow for an understanding on the additional noise impacts arising from the proposed construction activities.

Noise levels recorded at monitoring locations representative of baseline conditions experienced by human receptors reflect relatively noise levels in comparison to maximum permissible noise levels for construction works in accordance with the noise legislation stated in *Environmental Protection and Management (Control of Noise at Construction Sites) Regulations, 2008* [R-31]. However, powered mechanical equipment (PMEs) associated with assessed scenario contribute to significantly high noise levels due to the high effective sound power level (SPL) as reflected in Appendix G. Considering the maximum permissible noise criteria for construction activities established for different human receptors based on their sensitivities to noise (refer to Section 11.4.1.3) and relevant distances between the receptors and project sites, qualitative assessment was conducted to derive impact significance for construction phase.

The noise criteria established for Priority 2 receptors (residential) for **Scenario 01: Foundation and Earthworks – Day Time (7 am -7 pm)** for $L_{Aeq(12\ hours)}$ was 75 dB (A) (refer to Table 11.4.9). Therefore, if the shortest distance between the Priority 2 receptors and overall construction site was approximately less than 80 m, the impact intensities were qualitatively deduced as **Medium to High.** This corresponds to overall Impact Consequences from **Low** to **Medium** (refer to Table 5.4.2). When assessing the Impact Consequence in relation to the Likelihood of Occurrence being **Certain/Continuous**, it was deduced that the maximum overall Impact Significance stemming from the proposed construction activities associated with the assessment scenario **(Scenario 01: Foundation and Earthworks – Day Time (7 am -7 pm))** for $L_{Aeq(12\ hours)}$ would fall within the range of **Moderate** to **Major** (refer to Table 5.4.7).

On the other hand, if the shortest distances between the Priority 2 receptors and the overall construction site were approximately greater than 80m, the impact intensities were qualitatively deduced as **Negligible to Low.** This corresponds to overall Impact Consequences from **Imperceptible** to **Very Low** (refer to Table 5.4.2). When assessing the Impact Consequence in relation to the Likelihood of Occurrence being **Certain/Continuous**, it was deduced that the maximum overall Impact Significance stemming from the proposed construction activities associated with the assessment scenario **(Scenario 01: Foundation and Earthworks – Day Time (7 am -7 pm)** for $L_{Aeq(12\ hours)}$ would fall within the range of **Negligible to Minor (**refer to Table 5.4.7).

The noise criteria established for Priority 3 receptor (service facility) for Scenario 01: Foundation works – Day Time (7 am -7 pm) for $L_{Aeq(12\ hours)}$ (Day Time: 7 am to 7 pm) was 75 dB (A) (refer to Table 11.4.9). Since the shortest distances between the Priority 3 receptor and the overall construction site were approximately greater than 60 m, the impact intensities were qualitatively deduced as **Negligible to Low.** This corresponds to overall Impact Consequences from **Imperceptible** to **Very Low** (refer to Table 5.4.2). When assessing the Impact Consequence in relation to the Likelihood of Occurrence being **Certain/Continuous**, it was deduced that the maximum overall Impact Significance stemming from the proposed construction activities associated with the assessment scenario **(Scenario 01: Foundation and Earthworks – Day Time (7 am -7 pm))** for $L_{Aeq(12\ hours)}$ would fall within the range of **Negligible to Minor (**refer to Table 5.4.7).

The noise criteria established for Priority 2 receptors (residentials) for **Scenario 01: Foundation and Earthworks – Day Time (7 am -7 pm)** for $L_{Aeq(5\ mins)}$ was 90 dB (A) (refer to Table 11.4.9). Since the shortest distances between the Priority 2 receptors and the overall construction site were approximately greater than 15 m, the impact intensities were qualitatively deduced as **Negligible to Low.** This corresponds to overall Impact Consequences from **Imperceptible** to **Very Low** (refer to Table 5.4.2). When assessing the Impact Consequence in relation to the Likelihood of Occurrence being **Certain/Continuous**, it was deduced that the maximum overall Impact Significance stemming from the proposed construction activities associated with the assessment scenario **(Scenario 01: Foundation and Earthworks – Day Time (7 am -7 pm**)) for $L_{Aeq(5\ mins)}$ would fall within the range of **Negligible to Minor** (refer to Table 5.4.7).

The noise criteria established for Priority 3 receptors (service facility) for **Scenario 01: Foundation and Earthworks – Day Time (7 am -7 pm)** for $L_{Aeq(5\ mins)}$ was 90 dB (A) (refer to Table 11.4.9). Since the shortest distances between the Priority 2 receptors and the overall construction site were approximately greater than 15 m, the impact intensities were qualitatively deduced as **Negligible to Low.** This corresponds to overall Impact Consequences from **Imperceptible** to **Very Low** (refer to Table 5.4.2). When assessing the Impact Consequence in relation to the Likelihood of Occurrence being **Certain/Continuous**, it was deduced that the maximum overall Impact Significance stemming from the proposed construction activities associated with the assessment scenario

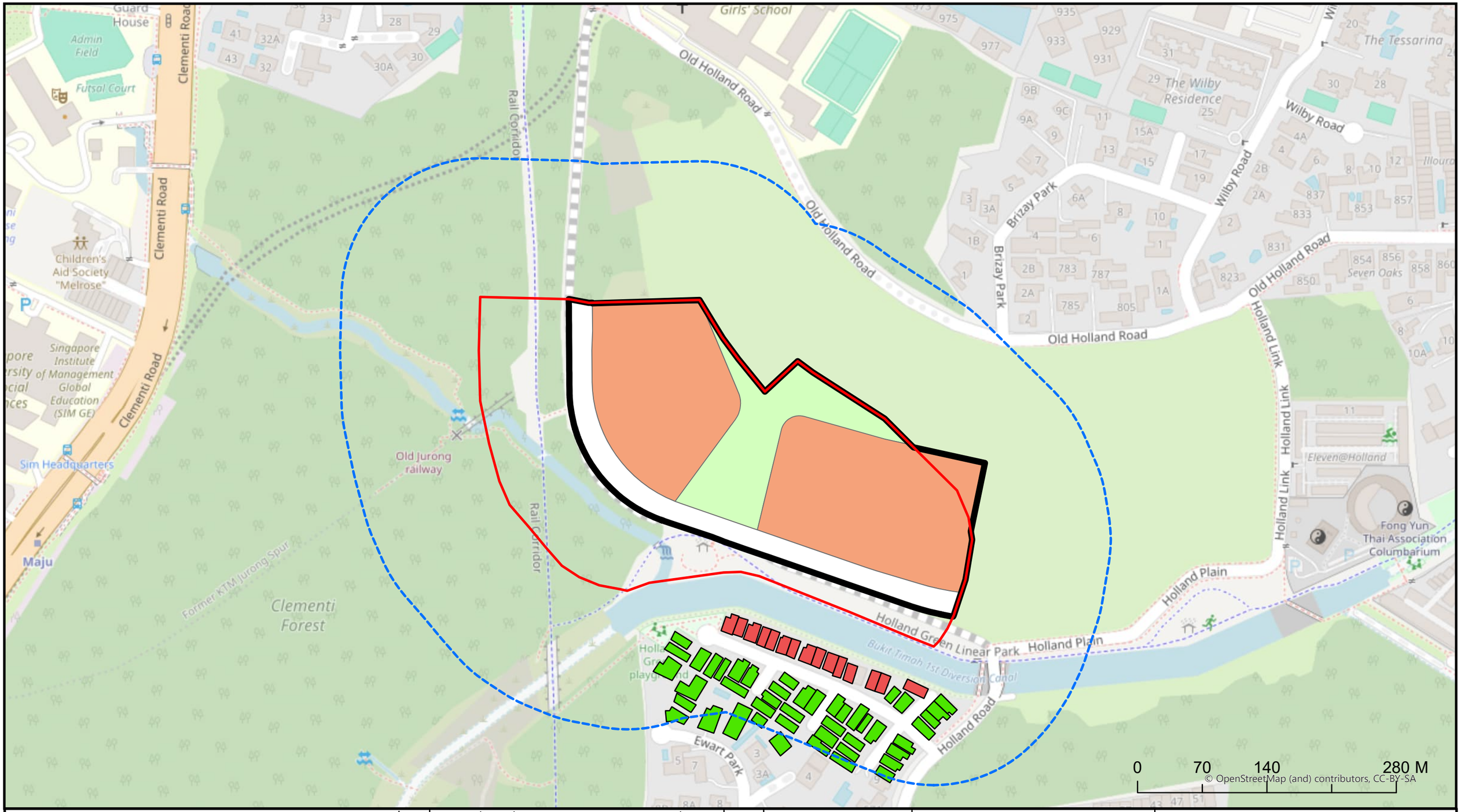
(Scenario 01: Foundation and Earthworks – Day Time (7 am -7 pm)) for $L_{Aeq(5\ mins)}$ would fall within the range of **Negligible to Minor** (refer to Table 5.4.7).

Summary of the unmitigated qualitative construction noise impacts on human receptors is illustrated in Table 11.4.9 and detailed unmitigated construction noise impacts on human receptors have been included in Appendix H.

However, due to limited information available during this preliminary phase, accurately estimating the noise impact is not possible. AECOM recommends that quantitative noise impact assessment through noise modelling by a 3D simulating software such as SoundPLAN and CadnaA conducted by Noise Consultant(s) appointed by Contractor (s) be it roadworks/ earthworks/ construction contractor prior to commencement of construction works as required by NEA regulations for human impacts.

Table 11.4.9 Summary of unmitigated noise impact assessment on Human receptors (construction phase)

Assessment Scenario	L_{Aeq}, dB(A)	Receptor Sensitivity	Criteria (dB(A))	Approximate Distance between Receptor and Project Site	Impact Intensity	Impact Consequence	Likelihood	Impact Significance
Scenario 01: Foundation and Earthworks – Day Time (7 am -7 pm)	$L_{Aeq(12\ hours)}$	Priority 2	75	≤ ~80 m	Medium - High	Low - Medium	Certain/Continuous	Moderate - Major
				> ~80 m	Negligible - Low	Imperceptible - Very Low		Negligible - Minor
		Priority 3		> ~60 m	Negligible - Low	Imperceptible - Very Low		Negligible - Minor
	$L_{Aeq(5\ mins)}$	Priority 2	90	> ~15 m	Negligible - Low	Imperceptible - Very Low		Negligible - Minor
		Priority 3		> ~15 m	Negligible - Low	Imperceptible - Very Low		Negligible - Minor



Legend

- Study Boundary
- Indicative residential development
- Road
- Indicative Park
- Noise Study Area (150m-buffer)
- Construction Worksite

Impact Significance

- Moderate - Major
- Negligible - Minor

N

Rev.	Date	By	Description	Chk'd	App'd
1	NOV 2025	SHA	Holland Plain EIA	LAL	ADP
-	JAN 2025	SHA	Holland Plain EIA	LAL	ADP

Qualified Person Endorsement : NA

URA Endorsement : NA

Consultant : AECOM

Client: URBAN REDEVELOPMENT AUTHORITY

Project Title :

CONTRACT URA/T/23/048
HOLLAND PLAIN
ENVIRONMENTAL IMPACT ASSESSMENT

Figure Title :

Unmitigated construction noise impacts on noise sensitive receptors (Human)
Scenario 1: Foundation and Earthworks
Day Time (7 am -7 pm)
LAeq(12 hours)

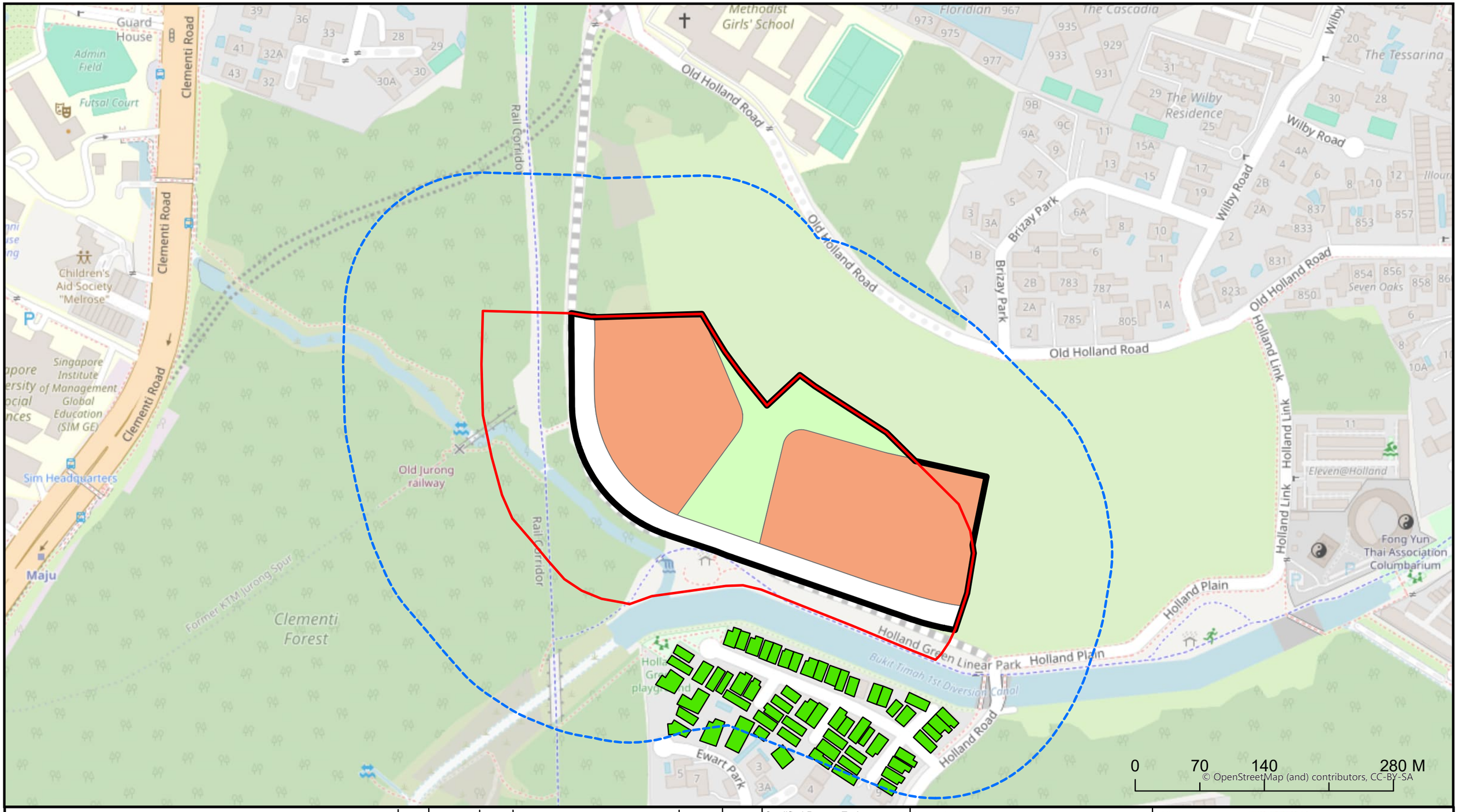
Designed	Checked	Approved
SHA	LAL	ADP
	Drawn: SHA	Date: NOV 2025

Figure No. : 11.4.1 | Rev. : - | Sheet : 1 of 1

CAD File Name : NA | A3

Note: Source of basemap - Google Earth Map

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Legend

- Study Boundary
- Indicative residential development
- Road
- Indicative Park
- Noise Study Area (150m-buffer)
- Construction Worksite

Impact Significance

- Negligible - Minor

N

Rev.	Date	By	Description	Chk'd	App'd
1	NOV 2025	SHA	Holland Plain EIA	LAL	ADP
-	JAN 2025	SHA	Holland Plain EIA	LAL	ADP

Qualified Person Endorsement : NA

URA Endorsement : NA

Consultant : AECOM

Client: URBAN REDEVELOPMENT AUTHORITY

Project Title :

CONTRACT URA/T/23/048
HOLLAND PLAIN
ENVIRONMENTAL IMPACT ASSESSMENT

Figure Title :

Unmitigated construction noise impacts on noise sensitive receptors (Human)
Scenario 1: Foundation and Earthworks
Day Time (7 am -7 pm)
LAeq(5 mins)

Designed	Checked	Approved
SHA	LAL	ADP
	Drawn: SHA	Date: NOV 2025

Figure No. : 11.4.2 | Rev. : - | Sheet : 1 of 1

CAD File Name : NA | A3

Note: Source of basemap - Google Earth Map

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11.4.3 Operational Phase

11.4.3.1 Ecological Receptors

Forested areas and water bodies surrounding the proposed construction worksites are home to several ecological receptors identified in Section 8.1. For this Study, operational noise impacts on ecological receptors were qualitatively assessed based on the auditory sensitivities of identified fauna species. Within the group of fauna species identified to reside within 150 m from the Study Area, Priority 1 (most sensitive) – Priority 3 fauna have been identified.

However, it should be noted that the larger impact on this area regardless of noise is due to urbanisation and removal of the habitats where these identified fauna species reside in which impacts them directly. Whether the fauna species will eventually move south-westwards and north-westwards to take shelter in less disturbed areas of Clementi Forest or develop new habitats elsewhere is uncertain at this stage making it difficult to analyse the impact of noise on these fauna species.

For fauna species found to reside further away from the boundary of the proposed construction worksites, as noise propagation reduces with distance, it is possible that with time in the operational phase, that the fauna species may adapt itself to a continuous noise level (i.e. new baseline). The developer/ developing agent should appoint a Noise Consultant(s) to assess the impacts arising from the operational phase to procure a more accurate understanding of noise impacts arising from operational conditions based on updated baseline conditions as required by NEA as part of the detailed design process. It is advised that faunistic survey and baseline noise monitoring be conducted upon completion of the construction phase and commencement of the operational phase to determine the new baseline conditions and fauna species that remain in the vicinity of the proposed construction worksites to determine actual operational noise impacts.

The average baseline noise levels for LAeq(15 mins) recorded at the monitoring locations (N05, N14 and N15) ranged from 53 – 73 dB(A) for 7am – 7pm, 50 – 74 dB(A) for 7pm-11pm and 43-73 dB(A) for 11pm – 7am (see Table 7.4.3). Comparing this to the *NEA Technical Guideline on Boundary Noise Limits for Air Conditioning and Mechanical Ventilation Systems in Non-Industrial Buildings, 2018* [R-38] for noise sensitive premises and *NEA Technical Guideline for Land Traffic Noise Impact Assessment, 2023* [R-37], current recorded baseline noise levels are relatively lower than the noise limits provided by NEA except at N15 (see Table 7.4.1). However, with reference to information on the proposed developments within the Project Site (see Figure 3.2.1), proposed development establishments will be residential building that may potentially emit noise from ACMV systems during periods of operation. Since the primary origin of ACMV in residential buildings is expected to be the condenser unit of each individual air conditioning system, it was qualitatively assessed that the operational noise from ACMV will be of small magnitude.

Assuming that contractors will comply with regulations regarding land traffic noise at the residential building façades, fauna species may still potentially face **Negligible to Moderate** impacts due to detectable disturbances from increased noise levels in the surrounding nature areas (see Table 5.4.1). The corresponding impact consequence may range from **Imperceptible to Medium** (see Table 5.4.2). The likelihood of noise levels exceeding the criteria would be **Possible/Occasional**, dependant on human activities. Hence, the overall impact significances can be qualitatively assessed to range from **Negligible to Moderate** (see Table 5.4.7) for ecological receptors found in forested areas and water bodies in vicinity of the proposed residential development site.

In accordance with the impact evaluation matrices in Section 5.40, the summary of operational noise impacts as assessed qualitatively are presented in Table 11.4.10 below.

Table 11.4.10 Summary of operational noise impacts on Ecological receptors

Auditory Sensitivity of Ecological Receptors	Impact Intensity	Impact Consequence	Likelihood	Impact Significance
Priority 1	Negligible to High	Very Low to Medium	Possible/Occasional	Minor to Moderate
Priority 2	Negligible to High	Imperceptible to Low	Possible/Occasional	Negligible to Minor
Priority 3	Negligible to High	Imperceptible to Very Low	Possible/Occasional	Negligible to Minor

11.4.3.2 Human Receptors

Referring to Section 11.4.1.2, it is mandatory for the proposed developments to comply with NEA's guidelines for Traffic Noise Impact Assessment (TNIA) for existing/ new road networks for the developments within the Project proposed construction worksites. Usually conducted by an appointed Noise Consultant during the detailed design stage, AECOM recommends the works for TNIA to be conducted in the later stages of the development in accordance with *NEA Technical Guideline for Land Traffic Noise Impact Assessment, 2016* [R-37].

With reference to the proposed developments within the Project Site (see Figure 3.2.1), the planned establishments will consist of residential buildings that may generate noise from ACMV systems during operation. As the primary source of ACMV noise in residential buildings is expected to be the condenser units of individual air conditioning systems, a qualitative assessment indicates that the operational noise from ACMV will be of low magnitude. For TNIA, developers of the residential developments should assess noise impacts from the proposed new road networks on the noise sensitive receptors as outlined by the guideline.

As part of qualitative impact assessment for operational noise impacts on human receptors, judging from the construction noise impacts which are considerably more significant compared to operational noise impacts in terms of magnitude of noise, size of/ area impacted by noise source, operational noise impacts should constitute lesser significance. Based on this, the impact intensity of operational noise on human receptors was qualitatively assessed as **Negligible to Low** (see Table 5.4.1), with the corresponding impact consequence deduced to range from **Imperceptible to Very Low** (see Table 5.4.2) depending on the sensitivity of the receptor (see Section 8.4). The likelihood of noise levels exceeding the criteria would be **Possible/Occasional** (see Table 5.4.6), dependant on human activities. Hence, the overall impact significance can be qualitatively assessed to range from **Negligible to Minor** (see Table 5.4.7) for operational noise impacts on human receptors.

It should be noted that as regulated by NEA, the developer/ developing agent should appoint Noise Consultant(s) to conduct quantitative operational noise impact assessment duly in the later stages of the Project development as part of the detailed design process.

Table 11.4.11 Summary of operational noise impacts on Human receptors

Receptor Sensitivity	Impact Intensity	Impact Consequence	Likelihood	Impact Significance
Priority 1	Negligible to Low	Very Low to Low	Possible/Occasional	Minor
Priority 2	Negligible to Low	Imperceptible to Very Low	Possible/Occasional	Negligible to Minor
Priority 3	Negligible to Low	Imperceptible to Very Low	Possible/Occasional	Negligible to Minor

12 Recommended Mitigation Measures

12.1 Biodiversity

In this section, mitigation measures for future developments are discussed. Mitigation measures are implemented in the following order: (1) avoidance, (2) minimisation, 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 should be adopted as a form of impact mitigation. Due to the nature of this project, mitigation measures may not be fully applicable during construction phase and habitat loss is unavoidable, but the creation of a high ecological value habitat from a low value habitat results in a net gain.

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 and human-wildlife interactions/conflict.

12.1.1 Design Phase

The design of the Project should first be considered in the mitigation as it has the most potential to influence the extent and types of impacts that affect the sensitive biological receptors.

12.1.1.1 Avoid

Avoid the Recommended Area of Conservation

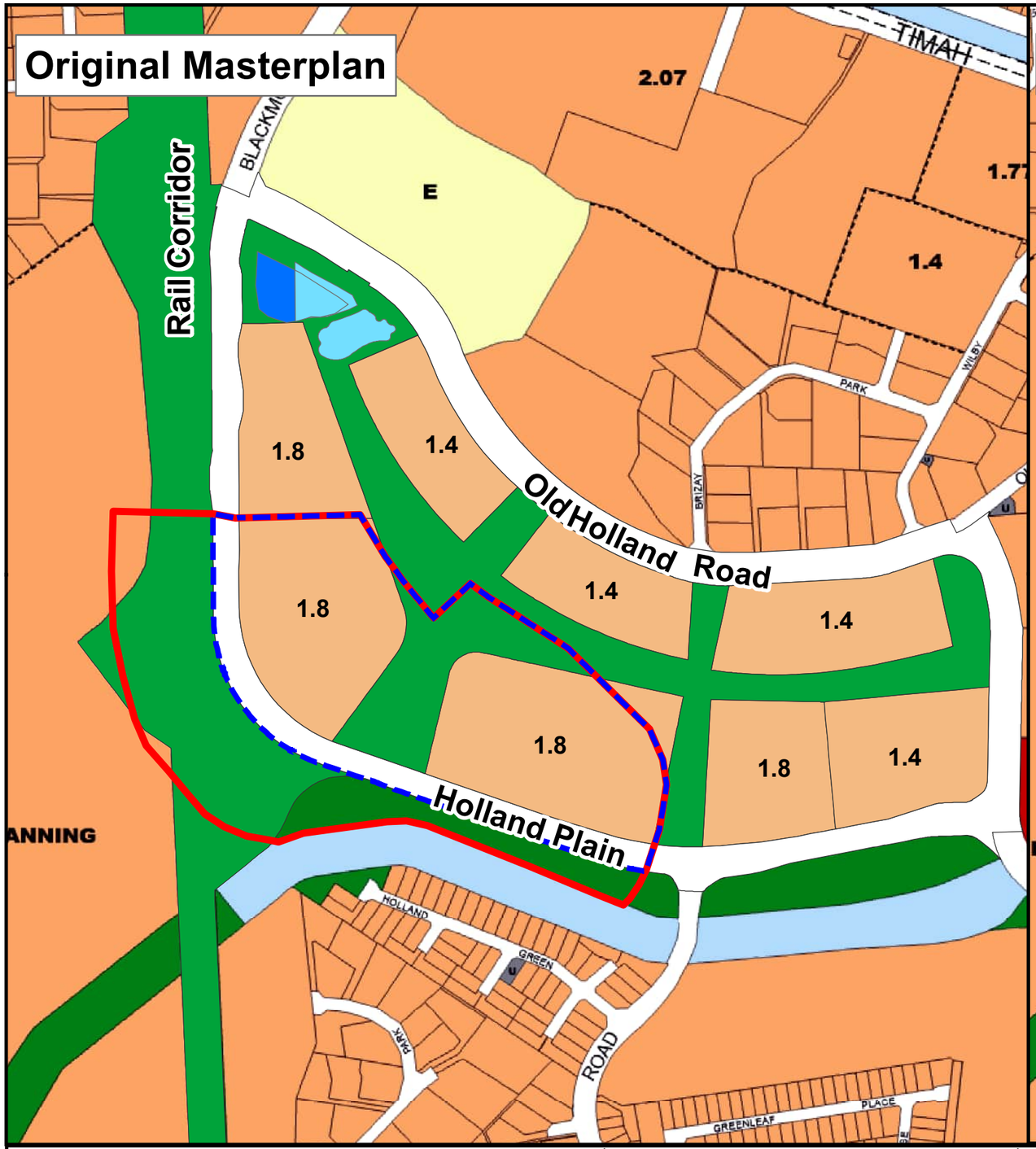
The CRL2's AHCV identified in the previous EIS on Turf City and Holland Plain [P-1], currently overlaps with the future development footprint. The ecological value of this AHCV is high – being considered a stronghold for pitcher plants in Singapore containing a native hybrid (*Nepenthes* × *trichocarpa*), and the locally vulnerable narrow-lid pitcher plant (*Nepenthes ampullaria*) and Raffles' pitcher plant (*Nepenthes rafflesiana*)*; and a locally critically endangered orchid straggly rush orchid (*Dendrobium lobbii*). The AHCV is one of two published localities where the straggly rush orchid (*Dendrobium lobbii*) can be found in Singapore after its discovery at MacRitchie Reservoir in 2007 [P-38].

URA will be amending the masterplan to retain a portion of the scrubland to be incorporated into the future park as a green finger (which is the Recommended Area of Conservation (RAC)), as shown in Figure 12.1.1.

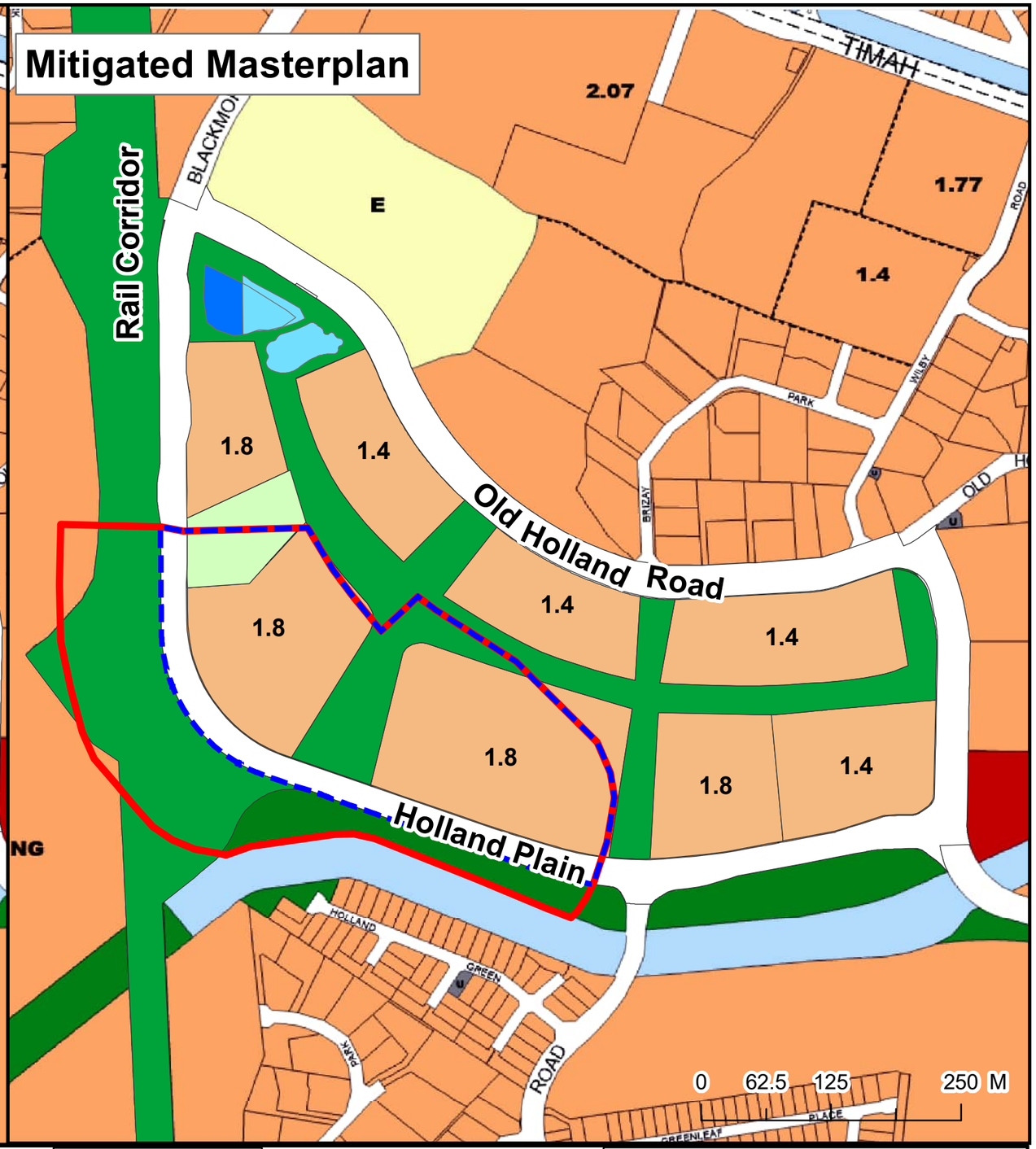
This RAC boundary has been determined by prioritising the retention of areas where unique flora species of conservation significance have been recorded on site, given the need to balance conservation efforts with developmental needs. It also includes adequate buffer from the flora to allow for in-situ conservation and ensure sufficient distance from future development, to increase the surviviability of the species of conservation significance and long-term ecosystem health.

*While earlier baseline surveys had found the Raffles' pitcher plant (Nepenthes rafflesiana), subsequent on-site surveys were unable to locate them.

Original Masterplan



Mitigated Masterplan



Legend

- Study Area
- Development boundary
- Future marsh outline
- Freshwater Marsh
- Recommended Area of Conservation

Land Use

- Park
- Residential
- Road
- Waterbody

N

Rev.	Date	By	Description	Chk'd	App'd
-	JUN 2025	LHN	Holland Plain EIA	LAL	JAG

Qualified Person Endorsement : NA

URA Endorsement : NA

Consultant : AECOM

Client: Urban Redevelopment Authority

Project Title :

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Figure Title :

Proposed mitigated land use of the Project Site and its surroundings

Designed	Checked	Approved	Figure No. :	Rev.	Sheet
LHN	LAL	JAG	12.1.1	-	1 of 1
	Drawn LHN	Date JUN 2025	CAD File Name : NA		A3

Note: Source of basemap - URA Masterplan

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12.1.2 Construction Phase

Impact mitigation should focus on reducing Moderate to Major impacts, such as human disturbances and wildlife-human conflict, on fauna receptors during the construction phase. Key measures to minimise these impacts are described below and should be implemented in the Environmental Monitoring and Management Plan (EMMP) during the construction phase.

12.1.2.1 Minimise

Transplantation for the conservation significant (CS) plant species within the development area must be done before construction activities commence to reduce mortality of these species. All individuals of CS flora species found within the development boundary should be identified. A suitable recipient site should be determined with the approval of relevant authorities (e.g., NParks), and depending on the size, the number of individuals for CS flora species that will be salvaged will be determined. The physical parameters of the recipient site that should be evaluated include, but are not limited to, humidity, existing vegetation, and soil type.

In addition to minimum controls in Section 10.1, table below provides a summary of the key recommended measures to minimise biodiversity impacts during the construction phase.

Table 12.1.1 Key recommended measures to minimise biodiversity impacts during the construction phase

Receptors	Impact Types	Mitigation Measures
Habitats	• Loss of vegetation • Habitat degradation • Formation of Edge Effects	• Set up protection zones with physical barriers around the perimeter of the RAC to prevent access and intrusion by vehicles or site personnel • Conduct regular inspections to ensure contractor compliance to the EMMP in consultation with NParks. • Ensure silt fences and other silt control measures along the worksite hoarding are installed and maintained properly. • Engage a Qualified Erosion Control Professional (QECP) to formulate and implement an Earth Control Measures (ECM) plan in accordance with PUB requirements. • Implement dust control measures such as dust screens and water suppression systems. • Manual backfilling is recommended over the use of machinery. • Care should be taken to ensure the silt fences form a closed environment during outgoing tide as much as possible. • The opening of the silt fence should be positioned to receive marine inflow.
Plant species	• Mortality	• Engage flora specialists to assess if native species in the direct development footprint such as straggly rush orchid (*Dendrobium lobbii*), pitcher plants (*Nepenthes* sp.) or tembusu (*Cyrtophyllum fragrans*) require to be transplanted prior to the start of works. • Engage flora specialists to clearly mark out areas and plants with conservation value before the start of works. This would avoid clearing unnecessary working space, eliminate the need of removing plants of conservation significance as much as possible. • Ensure there are no works and disturbances to areas outside of the development footprint. • Conduct regular inspections to ensure contractor compliance to the EMMP.
Faunal species	• Accidental injury or mortality • Human-wildlife conflict • Human disturbances • Increased invertebrate mortality from fumigation • Decline in invertebrate health from fumigant runoff and residue	• It is recommended to avoid tree felling and vegetation clearance during peak bird breeding season (March to July) • Pre-felling fauna inspection should be conducted before felling any trees or removing any vegetation. This should be planned and overseen by an Ecologist. • Any tree found during pre-felling inspection to be harbouring an active nest should be left undisturbed until when the nest is abandoned. • Bamboo clusters to be felled will be observed during dusk for bamboo bat activities, as well as during felling, so that roosting bats may be secured and released safely. • Quieter construction machinery/equipment should be used over loud and noisy machinery/equipment whenever possible.

Receptors	Impact Types	Mitigation Measures
		• Night-time works should be avoided to prevent disturbance to nocturnal fauna; recommended to restrict working hours to 0800–1800. • Establish a Wildlife Response Plan in consultation with NParks, to be executed during encounters with trapped, injured or dead wildlife, as well as incidents of human-wildlife conflict. • Conduct regular site inspections to ensure contractor compliance to EMMP and to identify potential fauna entrapments. • 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 to prevent macaques and wild boars from accessing anthropogenic food sources. • Reduce use of heavy machinery during backfilling. • Restrict entry of site personnel to areas outside the worksite. • Fumigation on-site should be avoided where possible. Pest-control measures should focus heavily on source-reduction.

12.1.3 Operational Phase

The most substantive impacts in the operational phase were **Moderate** impacts on fauna, incurred through human-wildlife conflict, human disturbances and loss of/reduction in ecological connectivity. **Negligible** to **Minor** impacts are only incurred to habitats and flora receptors at the operational phase. Key measures to minimise these impacts are described below and should be implemented as part of the post-construction monitoring during operational phase.

As mentioned, regular post-construction monitoring is recommended in the initial phase (12 months) is recommended to ensure that the proposed mitigating measures are effective.

Educational signboards can be placed within the residential development and the public park. The content of these signboards can include:

- General advisories on what to do when public encounter wildlife.
- Advising proper food waste disposal methods (specifically, advising against throwing of food or waste into the RAC or areas of high biodiversity value).
- Cautioning against feeding wildlife.
- Hotlines to call in the event of an emergency / injury because of human-wildlife interactions.

Mitigation measures related to the design and landscaping of the estate can also be implemented. These include:

- Using wildlife-proof bins prevent wildlife access to rubbish.
- Refrain from planting non-native flora species for landscaping in the public park.
- Implementing traffic calming measures to help minimise roadkill accidents.
- Educating future residents on living near nature and likelihood of encountering wildlife.
- Incorporating features that increase the visibility of glass.

Additionally, avoiding planting vegetation close to glass so that reflection of vegetation would not confuse birds that may fly into the building.

To mitigate the impact of artificial light during the operational phase, lighting duration should be carefully managed to avoid peak periods of nocturnal fauna activity (7PM – 7AM), minimising disturbances to sensitive species. Set dark buffers and illuminance limits of <100 lux to minimise effects on animal behaviour due to light pollution and zonation. Additionally, avoid excessive use of artificial lighting to reduce light spillage into the Rail Corridor.

12.1.4 Additional Mitigation Against the Poaching of Ornamental Flora

The RAC contains conservation significant specimens of high ornamental value such as the straggly rush orchid, *Dendrobium lobbii*, and other *Nepenthes* species which are known to be collected by hobbyists and enthusiasts. To ensure the proliferation of these charismatic species, access to the orchids and pitcher plants should be strictly restricted and controlled to prevent potential cases of poaching.

12.1.5 Additional Mitigation Against Impact on Exotic-Dominated Secondary Forest

To facilitate the movement of key species like the straw-headed bulbul (Pycnonotus zeylanicus) and other forest-dependent fauna between existing green spaces, agencies to study the possibility of planting appropriate canopy species within the future park.

12.1.6 Additional Mitigation Against Direct and Indirect Impacts of Fumigation on Invertebrates

Firstly, to reduce the impact of fumigation on invertebrates, the implementation of source reduction measures is recommended to reduce the frequency of fumigation. According to NEA, source reduction, which is the removal of mosquito breeding habitats through measures such as their recommended B-L-O-C-K steps, is the most effective way to control mosquito populations and reduce dengue cases. In cases where fumigation is unavoidable, it should not be conducted on days when rainfall is anticipated, to prevent fumigant runoff and the spread of residues to adjacent waterbodies and vegetation.

12.2 Hydrology and Water Quality

12.2.1 Construction Phase

Stormwater run-off during construction phase was evaluated to have Moderate impact significance on the water quality of the local residents and visitors.

The ECM holding tank/ponds on site should be designed to capture turbid stormwater with an additional 25% in volume to a 5-year return period, as specified in PUB's Code of Practice on Surface Water Drainage. Based on AECOM's past experience the increase of 25% would be sufficient to account for the additional runoff from concurrent sites during the aforementioned extreme weather events. Additionally, contractors should have a standby tarp on hand while working on site to immediately cover bare soil when the soil not in use, especially during rain events.

12.2.2 Operational Phase

No additional mitigation measures aside from the proposed minimum controls were proposed to further minimise the adverse impacts on the water resources as none of the impacts on the ecological and human sensitive receptors have been assessed Moderate to Major.

12.3 Air Quality

12.3.1 Construction Phase

Based on the assessment in Section 11.3.1, the Impact Significance was determined to be ranging from **Moderate** to **Major**. In line with the general mitigation measures, the areas to be excavated and the construction area have also been reduced. While for trackout, there is no change considering the same site entrance and surrounding public roads, as shown in Figure 12.3.3. Refer to Figure 12.3.1 and Figure 12.3.2 for earthworks and construction potential emission sources for the mitigated development plan.

Table 12.3.1 below summarises the sensitivity of the area for earthworks and construction comparing base and mitigated scenario. The worksite is located within or in close proximity to ecologically sensitive receptors. Based on the distances of emission sources to the identified receptors presented in Figure 12.3.1 and Figure 12.3.2, the Sensitivity of the Area was determined.

On top of the reduction of development, the range of dust mitigation measures to be implemented at the construction sites are outlined in Table 12.3.2. Upon the implementation of mitigation measures, the Impact Significance was determined to be **Minor**. This will be detailed in Section 13.3.1.

Table 12.3.1 Receptor sensitivity for air quality impact assessment – construction phase (base and mitigated scenarios)

Distance	Base Scenario		Mitigated Scenario	
		Sensitivity of the Area	Identified Receptors	Sensitivity of the Area
Within 20 m **Between 20 m to 50 m**	• Scrubland and exotic-dominated forests at Holland Plain • Rail Corridor (part of Clementi Forest)	Priority 1	• Scrubland and exotic-dominated forests at Holland Plain • Rail Corridor (part of Clementi Forest)	Priority 1
For Construction				
Within 20 m **Between 20 m to 50 m**	• Scrubland and exotic-dominated forests at Holland Plain • Rail Corridor (part of Clementi Forest)	Priority 1	• Scrubland and exotic-dominated forests at Holland Plain • Rail Corridor (part of Clementi Forest)	Priority 1

Base Scenario

Mitigated Scenario

Covenant Community Meth Ch
Methodist Girls' Sch
Wilby Bt Timah
Old Holland Rd
Brizay Pk
Wilby Rd
Linear Park
Holland Green P/G
Holland Plain
Holland Rd
Ewart Pk
Greenleaf Pl
Greenleaf Ave
Greenleaf Gr

0 75 150 300 M

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

12.3 Air Quality

12.3.1 Construction Phase

Based on the assessment in Section 11.3.1, the Impact Significance was determined to be ranging from **Moderate to Major.** In line with the general mitigation measures, the areas to be excavated and the construction area have also been reduced. While for trackout, there is no change considering the same site entrance and surrounding public roads, as shown in Figure 12.3.3. Refer to Figure 12.3.1 and Figure 12.3.2 for earthworks and construction potential emission sources for the mitigated development plan.

Table 12.3.1 below summarises the sensitivity of the area for earthworks and construction comparing base and mitigated scenario. The worksite is located within or in close proximity to ecologically sensitive receptors. Based on the distances of emission sources to the identified receptors presented in Figure 12.3.1 and Figure 12.3.2, the Sensitivity of the Area was determined.

Legend

- Species of Conservation Significance
- Large Plant Specimen
- Other Specimens of Value
- 20m from Source
- 50m from Source
- 100m from Source
- 250m from Source
- Earthworks Footprint

Sensitive Receptors

- Commercial Building
- Place of Worship
- Educational Institution
- Park/ Natural Reserve/ Garden
- Unclassified Building (incl. Landed Properties and Condominiums)

N

Rev.	Date	By	Description	Chk'd	App'd
01	JUN 2025	TTR	Holland Plain EIA	KAM	ADP
-	FEB 2025	TTR	Holland Plain EIA	KAM	ADP

Qualified Person Endorsement : NA

URA Endorsement : NA

Consultant : AECOM

Client: URBAN REDEVELOPMENT AUTHORITY

Project Title :

CONTRACT URA/T/23/048
HOLLAND PLAIN
ENVIRONMENTAL IMPACT ASSESSMENT

Figure Title :

Mitigated emission sources and sensitive receptors - earthworks

Designed	Checked	Approved	Figure No. :	Rev.	Sheet
TTR	KAM	ADP	12.3.1	01	1 of 1
	Drawn TTR	Date JUN 2025	CAD File Name : NA		A3

Note: Source of basemap - Onemap and Google Earth Map

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Base Scenario

Mitigated Scenario

Old Holland Rd
Brizay Pk
Wilby Rd
Holland Green P/G
Holland Plain
Holland Rd
Greenleaf Pl
Greenleaf Ave
Ewart Pk
0 75 150 300 M
Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community

Legend

- Species of Conservation Significance
- Large Plant Specimen
- Other Specimens of Value
- 20 m from Source
- 50 m from Source
- 100 m from Source
- 250 m from Source
- Construction Footprint

Sensitive Receptors

- Commercial Building
- Place of Worship
- Educational Institution
- Park/ Natural Reserve/ Garden
- Unclassified Building (incl. Landed Properties and Condominiums)

Note: The construction footprint is preliminary and is subject to further changes.

N

Rev.	Date	By	Description	Chk'd	App'd
02	OCT 2025	TTR	Holland Plain EIA	KAM	ADP
01	JUN 2025	TTR	Holland Plain EIA	KAM	ADP
-	FEB 2025	TTR	Holland Plain EIA	KAM	ADP

Qualified Person Endorsement : NA

URA Endorsement : NA

Consultant : AECOM

Client: Urban Redevelopment Authority

Project Title :

CONTRACT URA/T/23/048
HOLLAND PLAIN
ENVIRONMENTAL IMPACT ASSESSMENT

Figure Title :

Mitigated emission sources and sensitive receptors - construction

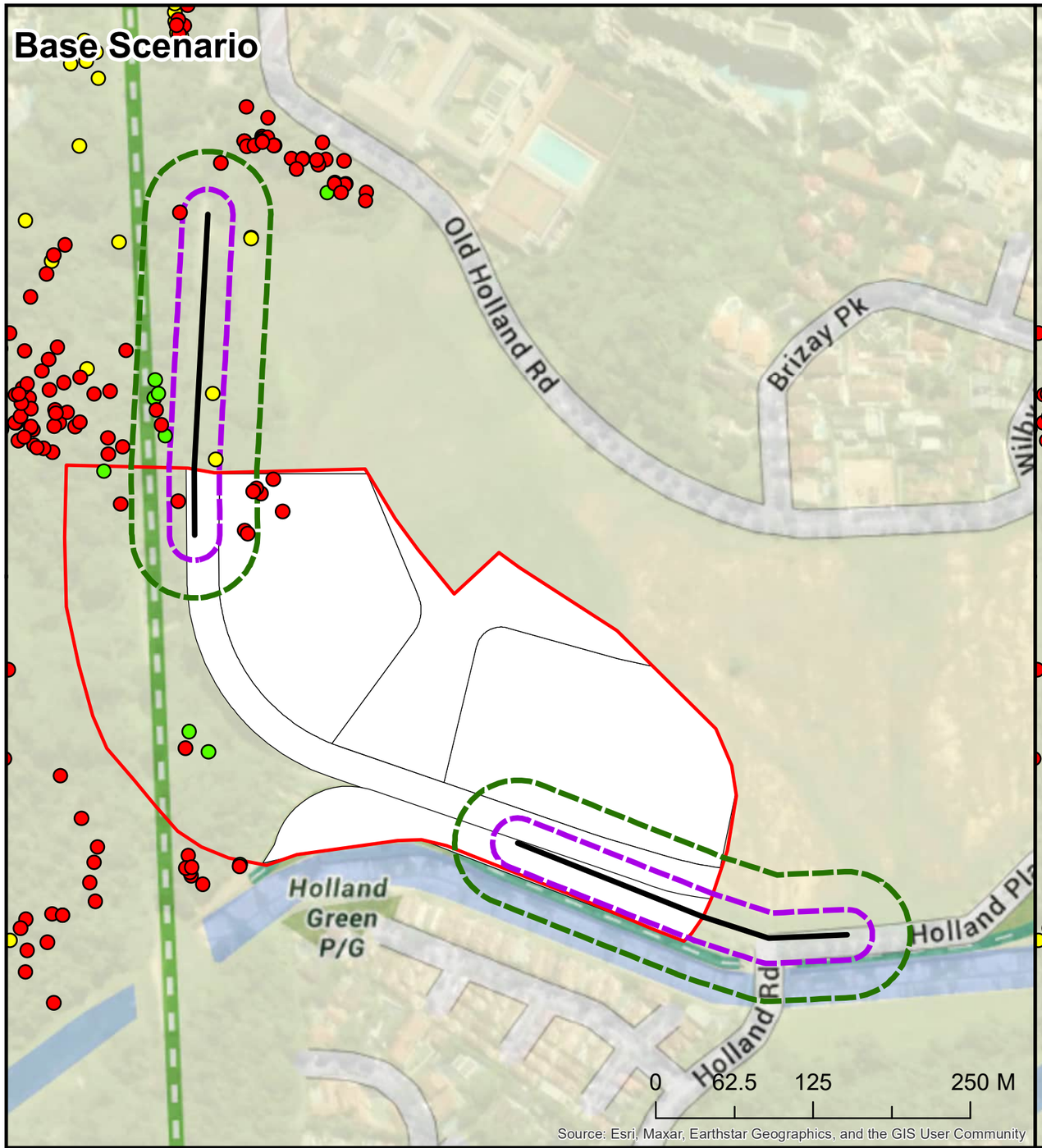
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TTR	KAM	ADP	12.3.2	02	1 of 1
	Drawn TTR	Date OCT 2025	CAD File Name : NA		A3

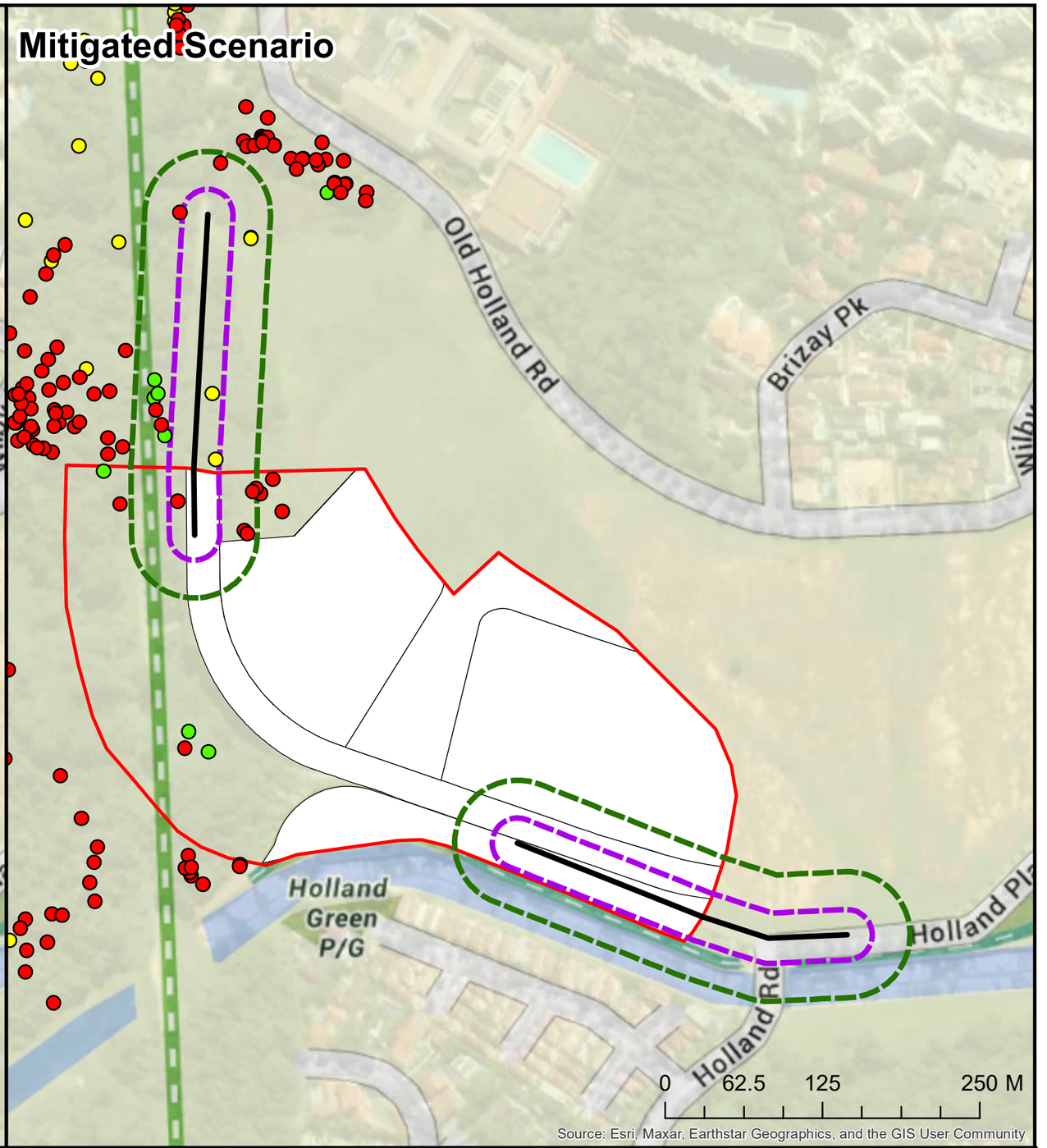
Note: Source of basemap - Onemap and Google Earth Map

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Base Scenario

Mitigated Scenario





Legend

- Species of Conservation Significance
- Large Plant Specimen
- Other Specimens of Value
- Access Road
- 20m from source
- 50m from Source
- Study Boundary
- Earthworks Footprint

Sensitive Receptors

- Commercial Building
- Place of Worship
- Educational Institution
- Park/ Natural Reserve/ Garden
- Unclassified Building (incl. Landed Properties and Condominiums)

N

Rev.	Date	By	Description	Chk'd	App'd
02	OCT 2025	TTR	Holland Plain EIA	KAM	ADP
01	MAY 2025	TTR	Holland Plain EIA	KAM	ADP
-	FEB 2025	TTR	Holland Plain EIA	KAM	ADP

Qualified Person Endorsement : NA

URA Endorsement : NA

Consultant : AECOM

Client: Urban Redevelopment Authority

Project Title :

CONTRACT URA/T/23/048
HOLLAND PLAIN
ENVIRONMENTAL IMPACT ASSESSMENT

Figure Title :

Mitigated emission sources and sensitive receptors - trackout

Designed	Checked	Approved	Figure No. :	Rev.	Sheet
TTR	KAM	ADP	12.3.3	02	1 of 1
	Drawn TTR	Date OCT 2025	CAD File Name : NA		A3

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Based on the assessment in Section 11.3.1, the Impact Significance was determined to be ranging from **Moderate** to **Major**. The range of dust mitigation measures that should be implemented at the construction sites are outlined in Table 12.3.2. Upon the implementation of mitigation measures, the residual Impact Significance was determined to be **Minor**. This will be detailed in Section 13.3.1.

Table 12.3.2 Air quality mitigation measures – construction phase

Mitigation Measures
GENERAL MITIGATION MEASURES TO BE IMPLEMENTED THROUGHOUT CONSTRUCTION PERIOD
Communications
Develop and implement a stakeholder communications plan that includes community engagement before work commences on site.
Display the name and contact details of person(s) accountable for air quality and dust issues on the site boundary. This may be the environment manager/engineer or the site manager.
Develop and implement an Air Pollution Control Plan (APCP) (see paragraph below for APCP details).
Site Management
Record all dust and air quality complaints, identify cause(s), take appropriate measures to reduce emissions in a timely manner, and record the measures taken.
Make the complaints log available to the local authority when asked.
Record any exceptional incidents that cause dust and/or air emissions, either on-site or off- site, and the action taken to resolve the situation in the logbook.
Hold liaison meetings with other high-risk construction sites within 250 m of the site boundary, if any, to ensure plans are co-ordinated and dust and particulate matter emissions are minimised.
Monitoring
Undertake regular (daily frequency recommended) on-site and off-site inspections and record results. The log should be made available to the NEA or other Government Agencies if required. Inspections should include regular dust soiling checks of surfaces such as street furniture, cars, and windowsills within 100 m of site boundary. Cleaning should be provided if necessary.
Carry out regular site inspections to monitor and record compliance with the APCP.
Increase the frequency of site inspections during prolonged dry or windy conditions.
Conduct monitoring for PM_{10}, $PM_{2.5}$ and dust at suitable locations (refer to Section 15.11.1).
Preparing and maintaining the site
Plan site layout so that machinery and dust causing activities are located away from receptors, as far as is possible.
Erect hoarding around dusty activities and at the site boundary wherever possible. Boundary screens / hoarding should be at least as high as any stockpiles or dust emission sources on site.
Fully enclose site or specific operations where there is a high potential for dust production and the site is actives for an extensive period.
Keep site fencing, barriers, and scaffolding clean by cleaning regularly using wet methods (dry methods may give rise to fugitive dust).
Remove materials that have the potential to produce dust from site as soon as possible, unless being re-used on site. If they are being re-used on-site, stockpiled material should be covered, seeded, fenced or enclosed to prevent fugitive dust formation.
After excavation, put metal sheets / canvas sheet / turfing to cover the exposed area.
Operating vehicle/machinery and sustainable travel
Ensure all vehicles and engine powered equipment comply with the legislative requirements of Singapore.

Mitigation Measures
Ensure all vehicles and equipment switch off their engines when stationary – i.e., no idling vehicles or engines. Clear signs should be erected at site entrance to inform all visitors.
Where practicable, avoid the use of diesel- or petrol-powered generators and use mains electricity or battery powered equipment.
Impose and signpost a maximum-speed-limit of 25 km/hr on paved or surfaced haul roads and 15 km/hr on unpaved haul roads and work areas.
Produce a Construction Logistics Plan to manage the sustainable delivery of goods and materials.
Construction Operations
Only use cutting, grinding or sawing equipment fitted with, or in conjunction with, suitable dust suppression techniques such as water sprays or local extraction e.g., local exhaust ventilation system.
Ensure an adequate water supply on the site for effective dust/ particulate matter suppression/ mitigation, using non-potable water where possible and appropriate.
Use enclosed chutes and conveyors and covered skips wherever possible.
Minimise drop heights from conveyors, loading shovels, hoppers, and other loading or handling equipment and use fine water sprays on such equipment wherever appropriate.
A stringent “Clean as you go” Policy should be implemented on site to ensure no loose dry material is left exposed when not in use. Equipment should be readily available on site to clean any dry spillages, and cleaning should be conducted as soon as reasonably practicable after the event using wet cleaning methods.
Waste Management
Avoid burning of waste or other materials.
Where possible, horticultural waste should be upcycled as wood material for products. As much as possible, horticultural waste should be transported offsite by licensed waste management contractors to horticultural waste recycling facilities where the wood waste can be grinded into wood chips for horticultural reuse (i.e. compost or mulch).
MITIGATION MEASURES FOR EARTHWORKS
Closed turfing to the exposed areas where possible and maintain proper storage of soil stockpiles to stabilise surfaces as soon as practicable. When a particular work is finished in an area, the soil will need to be reinstated upon completion, before moving on to different areas.
Use Hessian, mulches or soil tackifiers where it is not possible to re-vegetate or cover with topsoil, as soon as practicable. Soil erosion blankets may also be used as an alternative.
Only remove the cover in intended working areas and not all at once.
MITIGATION MEASURES FOR CONSTRUCTION
Avoid scabbling (roughening of concrete surfaces) if possible.
Ensure sand and other aggregates are stored in bunded areas and are not allowed to dry out, unless this is required for a particular process, in which case ensure that appropriate additional control measures are in place.
Ensure bulk cement and other fine powder materials are delivered in enclosed tankers and stored in silos with suitable emission control systems to prevent escape of material and overfilling during delivery.
For smaller supplies of fine power materials ensure bags are sealed after use and stored appropriately to prevent dust.
MITIGATION MEASURES FOR TRACKOUT
Use water-assisted dust sweeper(s) on the access and affected local roads, to remove, as necessary, any material tracked out of the site. This may require the sweeper being continuously in use.
Avoid dry sweeping of large areas.

Mitigation Measures
Inspect on-site haul routes for integrity and instigate necessary repairs to the surface as soon as reasonably practicable.
Record all inspections of haul routes and any subsequent action in a site logbook.
Install hard surfaced haul routes, which are regularly damped down with fixed or mobile sprinkler systems, or mobile water bowsers and regularly cleaned.
Implement a wheel washing system (with rumble grids to dislodge accumulated dust and mud prior to leaving the site where reasonably practicable).
Ensure there is an adequate area of hard surfaced road between the wheel wash facility and the site exit, wherever site size and layout permit.
Site access gates to be located at least 10 m from receptors where possible.

The APCP should include the following information as a minimum:

- Summary of all work to be carried out including breakdown of phases and individual activities that may give rise to fugitive dust formation;
- Project title, project location and area, description of the site layout and locations of areas where dust is most likely to be generated such as haulage routes, excavation areas, etc. This description should also include the location of the water supply or chemical suppressants for applying to the dust generating areas on site;
- List of each dust generating activity, the likely schedule for each activity and the dust control measures to be implemented and frequency for their implementation. The level of detail will depend on the overall Consequence classification identified in this report and should include as a minimum the mitigation measures listed as mandatory in this document;
- Summary of the air monitoring to be undertaken including monitoring location and schedule. The air monitoring results should be recorded, and trends observed to determine the efficacy of dust control measures over the different construction stages;
- Details and procedures on using the site logbook which is used to record information on incidents such as dust episodes, the sources identified, and the action taken and its efficacy. Any complaints should also be recorded within the logbook along with the subsequent mitigation implemented and time to close out the complaint. The logbook should also be used to keep track of the daily dust control measures implemented such as wheel washing, site watering, site inspections etc.;
- Details of the Superintending Officer (SO) should be included in this plan for managing dust management at the site; and
- The air pollution control plan should be reviewed at regular intervals during the construction phase to ensure the effectiveness of the procedures in place and to maintain the goal of minimisation of dust and emissions through the use of best practice and procedures.

12.3.2 Operational Phase

As discussed in Section 11.3.2, the potential impact significance due to increased traffic is considered to be **Minor**. No mitigation measures are required during operational phase.

12.4 Airborne Noise

12.4.1 Construction Phase

Due to the proximity of the noise sensitive receptors (NSRs) to the Project proposed construction worksites boundary, mitigation measures for the control of noise at source were recommended as per the mitigation principles outlined in Section 5.5.

12.4.1.1 Avoid

12.4.1.1.1 High Noise Powered Mechanical Equipment

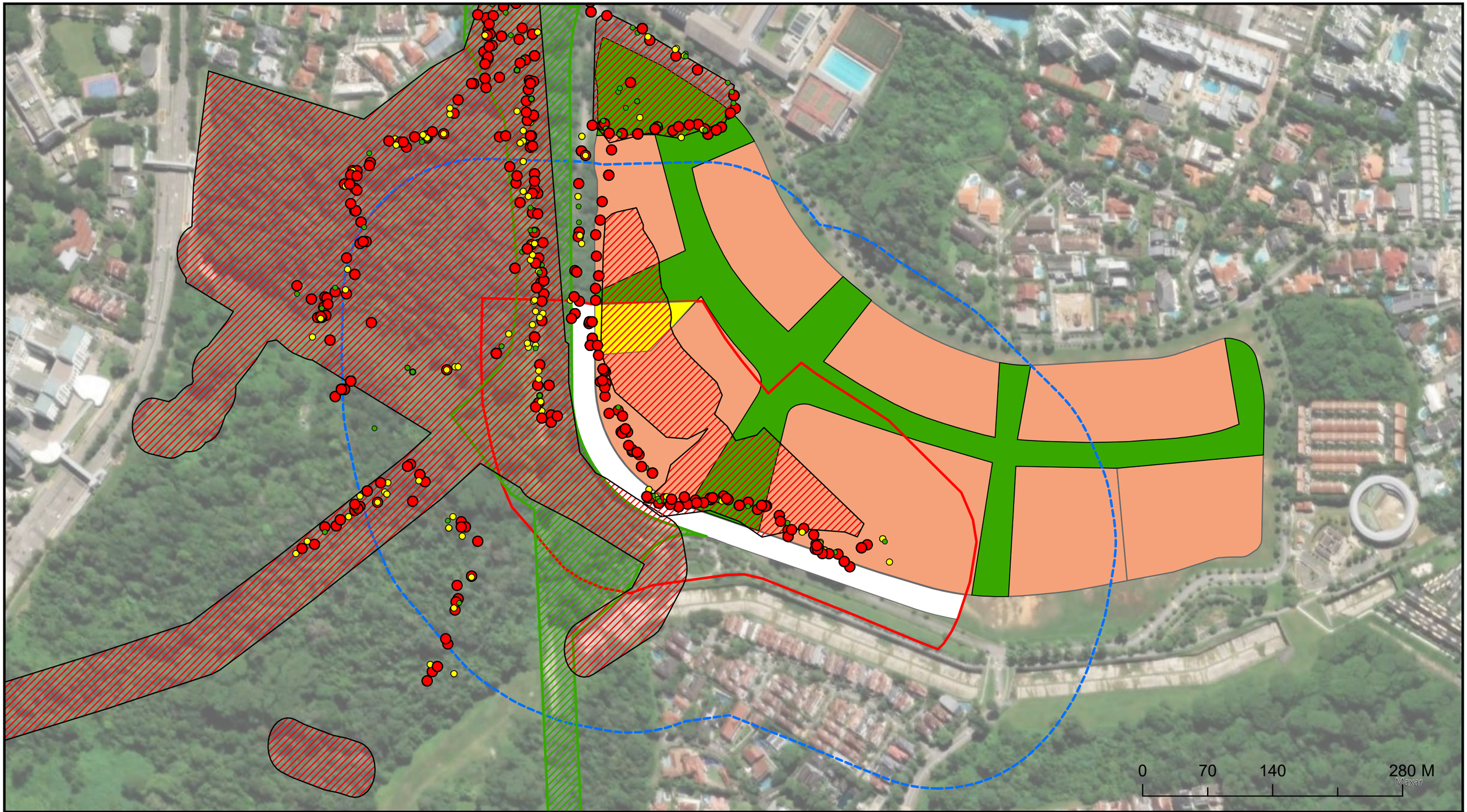
The equipment inventory list shall be analysed to check the equipment (PME) causing high noise levels (higher quantity and/or longer working periods of PME can cause higher noise levels). The use of equipment with lower noise level shall be prioritised, as this is the most effective way to mitigate the noise level at the source.

12.4.1.1.2 Access Routes facing Noise Sensitive Receptors

Access routes to the worksites should avoid facing receptors in vicinity of the proposed construction worksites to reduce noise impacts arising from increased traffic noise from heavy duty vehicles (HDV), as well as to prevent noise escaping from noise barriers implemented to reduce noise impacts along the boundaries of proposed construction worksites facing the noise sensitive receptors.

12.4.1.1.3 CRL2's Area of High Conservation Value

The AHCV was identified in the previous EIS on Turf City and Holland Plain [P-1] (refer to Figure 12.4.1). Noise sensitive receptors were sighted in CRL2's AHCV to great extent (refer to Figure 12.4.1). As much as possible temporary worksites such as equipment laydown areas, should not be constructed abutting the AHCV and RAC area, as it can cause major impacts to the sensitive receptors. Nevertheless, minimising the construction activities close to AHCV and RAC will reduce the noise impact on the ecological sensitive receptors.



Legend

- Study Boundary
- Indicative residential development
- Noise Study Area (150m-buffer)

Priority

- Priority 1
- Priority 2
- Priority 3

- Area of High Conservation Value
- Rail Corridor
- Road
- Indicative Residential Development
- Indicative Park
- Revised RAC

N

Rev.	Date	By	Description	Chk'd	App'd
1	JUN 2025	SHA	Holland Plain EIA	LAL	ADP
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URA Endorsement : NA

Consultant : AECOM

Client: URBAN REDEVELOPMENT AUTHORITY

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CONTRACT URA/T/23/048
HOLLAND PLAIN
ENVIRONMENTAL IMPACT ASSESSMENT

Figure Title :

Noise sensitive receptors (ecology) and Recommended Area of Conservation (RAC)

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SHA	LAL	ADP	12.4.1	1	1 of 1
	Drawn SHA	Date JUN 2025	CAD File Name : NA		A3

Note: Source of basemap - Google Earth Map

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12.4.1.2 Minimise

12.4.1.2.1 Install Noise Barriers

When substitution of noisy equipment is not applicable or feasible, installation of noise barriers should be considered. The barrier height and placement position of a noise barrier are the prime factors in determining its efficiency and are as follows:

- Noise barriers should be placed as close as possible to either the source, or the receiver position for maximum effectiveness; and
- Noise sensitive receptors within 150 m from construction worksites not predicted to experience exceedance may not require noise barriers.

The height of the barrier should be determined based on the heights of the receptors in the vicinity and the viability of implementation with consideration on space required to stabilise and install the barriers. According to the latest circular on noise barrier mandate issued by NEA in 2024 [R-52], **noise barrier with minimum height of 6 m needs to be installed along the perimeter of the whole construction worksite, even adjoining or surrounding the RAC**. To deduce optimised barrier heights required at each site, AECOM recommends that quantitative noise impact assessment with noise modelling by a 3D simulating software such as SoundPLAN and CadnaA be conducted by Noise Consultant(s) appointed by the Contractor (s) be it for roadworks/ earthworks/ construction contractor prior to commencement of construction works as required by NEA regulations for human impacts for residents, or ecological receptors and embed that part in the Contract specific EMMP for this site to be submitted to NParks before commencement of construction works. Contractors should note that the installation of noise barriers must not result in additional clearance of vegetation beyond the bounds of the proposed construction worksites area.

12.4.1.2.2 Source Noise Control

As a last resort for engineering control, when noise barriers are also not so effective in mitigating noise, or in order to manage complaints if there are intermittent noisy works, Table 12.4.1 below provides information on methods of quietening PME to be adopted for further mitigation on construction noise impact.

The maximum reduction in sound power level in Table 12.4.1 is achievable when all source control measures stated in this table are adopted. Noise enclosures should be used at the locations of the noise generating equipment at the construction site. Acoustic sheds should be provided at the locations of the noise generating activity such as operation of hand-held breaker. Sound pressure levels reduction ranging from 0 – 3 dB can be achieved by using all or combination of the following measures.

Table 12.4.1 Control of noise source from worksites

Type of Equipment	Equipment	Reduction in Sound Power Level, dB(A) [1]	Description of Source Control
Compressors & Generators	Generators	-20	Acoustic dampening of metal casing of body shell; acoustic enclosure or screen between the generator and receptor. The acoustic casing for the generator shall be proprietary product supplied by the generator manufacturer. The screen, if used, shall be as close as possible to the generator and it shall be of a solid construction (minimum STC 20 or surface density > 20kg/m^2) with no gaps at the bottom or in-between panels.
Hacking major structures	Excavator with Rock Breaker	-15	Use of an acoustic shed with adequate ventilation for the machine and bit.
Earth-moving Plant	Crane	-10	Manufacturer'' enclosure panels to be kept closed. The engines of these vehicles shall not be exposed and clad with the manufacturer'' enclosure to reduce noise break-out. Manufacturer-supplied silencers for the engine exhausts shall be installed and maintained.
	Dump Truck	-10	
	Excavator with Rock Breaker	-10	

Type of Equipment	Equipment	Reduction in Sound Power Level, dB(A) [1]	Description of Source Control
	Excavator	-10	
	Concrete Mix Truck	-10	
	Lorry	-10	
Pumps	All Pumps	-10 to -20	Use of acoustic enclosure.
Note: [1] The noise reduction level makes reference to BS 5228-1:2009 Code of practice for noise and vibration control on construction and open sites – Part 1: Noise			

Based on the Singapore Standards Code of Practice for Noise Control at Construction Sites, 2014 (SS602:2014), the typical materials used for noise barriers and acoustic shed/enclosures is given below:

Acoustic Shed/Enclosure:

A typical machine acoustic enclosure covers the machine as fully as possible (with/without ventilation), providing adequate sound insulation that noise energy does not readily pass through it. In addition, it could also have a sound absorbing material lining, to avoid the build-up of sound energy inside. In general, an acoustic enclosure could include:

- Outer cover material made up of brickwork, fibreboard, or plasterboard. Thickness of the insulating cover depends on the material used;
- Inner lining of sound absorbing material such as glass fibre, mineral wool, straw slabs, wood wool slabs can be used. A thickness of at least 25 mm is to be provided in case of high frequency sound, whereas a 12 mm thick lining would suffice for low frequency sound; and
- Perforated sheet coverings can be used to protect the inner lining material, especially if it is glass wool or mineral wool-based lining.

In the case of a more permanent or substantial machine enclosure or acoustic shed, concrete breezeblock and open textured blockwork can be more effective alternatives as these are known to be durable, inexpensive, and quick to assemble, and provide a useful degree of sound absorption.

Figure 12.4.2 illustrates several examples of acoustic sheds and enclosures, as outlined in the LTA Guidebook for Best Environmental Practices (Noise Control at LTA Sites) [R-53].



Figure 12.4.2 Example of acoustic enclosures for noisy parts of construction equipment

In addition to the above measures, an EMMP with airborne noise monitoring program is proposed to assess the effectiveness of minimum control measures and recommended mitigation measures on site during construction phase of the Project, as detailed in Section 15.12.

12.4.2 Operational Phase

At this stage, following mitigation measures have been proposed for consideration as reflected in Table 12.4.2 below.

Table 12.4.2 Proposed mitigation measures–operational phase (Human impacts)

Potential Noise Sources	Proposed Mitigation Measures
Air conditioning and mechanical ventilation systems	Noise attenuators and other Best Available Technology (BAT) and Best Environmental Practice (BEP) noise control measures shall be utilised.
	Ample setback of developments with ACMV systems fronting noise sensitive receptors (if applicable) should be provided such as provision of park areas/ ecological setback to ensure that operational noise sources are at a distance away from the receptors.
Increase road traffic in vicinity of developments	Traffic noise at drop-off points and parking areas shall be mitigated with low-speed postings, speed humps and speed limit signages. The addition of these speed control measures will likely lower noise levels for traffic as the vehicles would be cruising at lower speeds.
	Application of low-noise pavement mix can be considered for the road sections facing NSRs.
Additional road traffic noise from new road networks	Alternative siting/ alignment of roads should be considered during road design to propose road siting/ alignment away from existing noise sensitive development.

Due to the lack of literature regarding the possible impacts of operational noise arising from the operation of ACMV systems and increased traffic noise on the ecological receptors, the approach to mitigate operational noise impacts on human receptors have been adopted to mitigate noise impacts on the ecological receptors. It was assumed that

due to the potential noise sources arising from human activities as part of the operational phase, it is likely that ecological receptors with higher mobility (e.g. birds, butterflies, bats) will migrate westwards towards less disturbed areas of Clementi Forest away from the disturbances brought about by operational noise. The approach to mitigate noise arising from ACMV systems and increased road traffic as per Table 12.4.2 is recommended to be employed to mitigate operational noise where possible.

Noise monitoring programme for the operational phase have not been proposed as information required regarding ACMV system designs and traffic volumes are unavailable. Usually conducted by an appointed Noise Consultant during the detailed design stage, AECOM recommends the works for ACMV boundary noise impact assessment and TNIA to be conducted in the later stages of the development in accordance with *NEA Technical Guideline on Boundary Noise Limits for Air Conditioning and Mechanical Ventilation Systems in Non-Industrial Buildings, 2018* [R-38] and *NEA Technical Guideline for Land Traffic Noise Impact Assessment, 2016* [R-37].

13 Residual Impacts

The residual impacts, which are the impacts after implementation of the mitigation measures, are assessed in this section.

13.1 Biodiversity

13.1.1 Construction Phase

While there is little change in the in impacts to habitats, the shift in development footprint has resulted in the retention of the RAC and with it, the locally critically endangered straggly rush orchid, *Dendrobium lobbii* and other species such as the *Nepenthes x trichocarpa*, a CS hybrid pitcher plant species.

13.1.1.1 Habitats

Table 13.1.1 shows a summary of residual impacts on habitat receptors after the implementation of additional mitigation measures such as the retention of the RAC.

Table 13.1.1 Summary of residual construction phase impacts on habitat types in the Study Area

Habitat receptor	Priority level	Residual direct impact (% of total habitat type within Study Area)	Residual indirect impact (% of total habitat type within Study Area)	Residual % Change in Perimeter-to-Area ratio post-development	Residual Impact type and significance
Scrubland	Priority 1	2.71 ha (68.6%)	0.59 ha (14.9%)	**0%**	**Habitat loss -** Major **Habitat degradation -** Minor **Formation of edge effects -** Negligible
Abandoned land forest	Priority 2	NA	NA	**0%**	**Habitat loss -** Negligible **Habitat degradation -** Negligible **Formation of edge effects -** Negligible
Exotic-dominated secondary forest	Priority 2	1.56 ha (65.0%)	0.30 ha (12.5%)	**-33.3%**	**Habitat loss -** Major **Habitat degradation -** Minor **Formation of edge effects –** Negligible
Managed vegetation	Priority 3	3.86 ha (73.4%)	1.11 ha (21.1%)	**+33.3%**	**Habitat loss -** Minor **Habitat degradation -** Minor **Formation of edge effects* –** Negligible

*While managed vegetation experiences an increase in perimeter-to-area ratio, the increase in edge effects are negligible as this habitat is manicured and maintained.

Note: Number in brackets represent the number of species impacted before mitigation measures.

13.1.1.2 Flora

The species with **Major** impacts to mortality are *Nepenthes rafflesiana* and exotic species earleaf acacia (*Acacia auriculiformis*) and albizia tree (*Falcataria falcata*). The retention of the RAC greatly reduced the mortality for conservation significant species such as the locally critically endangered straggly rush orchid (*Dendrobium lobbii*) and some *Nepenthes* species from **Major** to **Negligible**. However, the retention of these species come with the risk of them being poached, as such they would experience elevated impact significances from poaching, increased from **Negligible** before the retention of the RAC, to **Moderate** after the retention. Similarly, the retention of these species also means they are likely to experience stresses from changes in the microclimate and hydrology during

the construction phase, resulting in **Minor** impacts. A summary of residual impacts on fauna receptors during the construction phase can be found in **Table 13.1.2**.

Table 13.1.2 Summary of construction phase residual impacts on flora receptors

Impact Type	No. of Species			
	Major	Moderate	Minor	Negligible
Mortality	3 (5)	0 (1)	0 (2)	5 (0)
Decline in plant health and survival	0 (0)	0 (0)	3 (4)	5 (4)
Poaching*	0 (0)	3 (0)	0 (4)	5 (4)

*While the impact assessment matrix outputs *Nepenthes rafflesiana* as experiencing **Minor** poaching impacts, since there are no remaining specimens within the 30m boundary from the worksite, the impact significance is reduced to **Negligible**.
Note: Number in brackets represent the number of species impacted before mitigation measures.

13.1.1.3 Fauna

After the implementation of mitigation measures, there are no **Major** impacts on fauna receptors during the construction phase. A summary of residual impacts on fauna receptors during the construction phase can be found in **Table 13.1.3**.

Only two impacts - loss/reduction of ecological connectivity and human disturbances, have **Moderate** impacts on fauna. Majority of species affected by both impacts are bird species such as the Straw-headed bulbul, Swinhoe's white eye, and one reptile species, the Malayan softshell turtle.

Table 13.1.3 Summary of construction phase residual impacts on fauna receptors

Impact Type	No. of Species			
	Major	Moderate	Minor	Negligible
Accidental injury or mortality	0 (3)	6 (3)	12 (32)	114 (94)
Human-wildlife conflict	0 (0)	0 (6)	6 (5)	126 (121)
Loss/reduction of ecological connectivity for faunal movement	0 (16)	75 (86)	54 (27)	3 (3)
Human disturbances	0 (11)	56 (56)	55 (64)	21 (1)
Light disturbances	0 (0)	0 (0)	33 (33)	99 (99)
Increased invertebrate mortality from fumigation	0 (0)	0 (10)	0 (62)	72 (0)
Decline in invertebrate health from fumigant runoff and residue	0 (0)	0 (55)	0 (11)	72 (6)

Note: Number in brackets represent the number of species impacted before mitigation measures.

13.1.2 Operational Phase

13.1.2.1 Habitats

With the RAC, the area experiencing degradation was changed slightly and can be found below in **Table 13.1.4**. However, as impacts experienced by habitats in the operational phase are **Minor** at most, no additional mitigation measures were recommended and therefore the residual impact and unmitigated impacts remain the same with no changes.

Table 13.1.4 Summary of operational phase impacts (RAC) on habitat receptors

Habitat receptor	Priority level	Indirect impact (% of total habitat type within Study Area)	Habitat degradation significance
Scrubland	Priority 1	0.59 ha (14.9%)	Minor (Minor)
Abandoned land forest	Priority 2	NA	Negligible (Negligible)
Exotic-dominated secondary forest	Priority 2	0.30 ha (12.5%)	Negligible (Minor)
Managed vegetation	Priority 3	1.11 ha (21.1%)	Negligible (Negligible)

Note: Number in brackets represent the number of species impacted before mitigation measures.

13.1.2.2 Flora

Assuming the implementation of the recommended mitigation measures, poaching has been included as an additional impact on flora receptors in the operational phase as the retention of the RAC keeps the CS species out of the development boundary. The orchid and pitcher plant species face **Moderate** impacts from the risk of poaching, and **Minor** impacts due to stresses from permanent changes in the microclimate and hydrology. A summary of the residual operational phase impacts on flora species can be found below in **Table 13.1.5**.

Table 13.1.5 Summary of operational phase impacts (RAC) on flora receptors

Impact Type	No. of Species			
	Major	Moderate	Minor	Negligible
Decline in plant health and survival	0 (0)	0 (0)	3 (4)	5 (4)
Poaching*	0 (0)	3 (0)	0 (4)	5 (4)

*While the impact assessment matrix outputs *Nepenthes rafflesiana* as experiencing **Minor** impacts, since there are no remaining specimens within the 30m boundary from the worksite, the impact significance is reduced to **Negligible**.
Note: Number in brackets represent the number of species impacted before mitigation measures.

13.1.2.3 Fauna

With the proper implementation of mitigation measures in the operation phase, there are no **Major** impacts on fauna receptors. A summary of residual impacts on fauna receptors during the construction phase can be found in **Table 13.1.6.**

Only two impacts - loss/reduction of ecological connectivity and human disturbances, have **Moderate** impacts on fauna. Majority of species affected by both impacts are bird species such as the Straw-headed bulbul, Swinhoe's white eye, and one reptile species, the Malayan softshell turtle.

Table 13.1.6 Summary of construction phase residual impacts on fauna receptors

Impact Type	No. of Species			
	Major	Moderate	Minor	Negligible
Accidental injury or mortality	0 (0)	0 (7)	23 (8)	109 (117)
Human-wildlife conflict	0 (0)	0 (6)	6 (5)	126 (121)
Loss/reduction of ecological connectivity for faunal movement	0 (0)	9 (86)	95 (43)	28 (3)
Human disturbances	0 (0)	0 (60)	72 (70)	60 (2)
Light disturbances	0 (0)	0 (20)	33 (13)	99 (99)
Increased invertebrate mortality from fumigation	0 (0)	0 (10)	70 (62)	2 (0)
Decline in invertebrate health from fumigant runoff and residue	0 (0)	0 (55)	61 (11)	11 (6)

Note: Number in brackets represent the number of species impacted before mitigation measures.

13.2 Hydrology and Water Quality

13.2.1 Construction Phase

Residual impacts are assessed with the assumption that mitigation measure listed in Section 12.2.1 are implemented.

For the rest of the construction phase, the likelihood of impacts from stormwater runoff would be reduced to **Less Likely/Rare**. Thus, through the larger capacity of ECM ponds/tanks, the overall impact significance would be **Minor** for the local residents and visitors.

Table 13.2.1 Summary of impact evaluation during construction phase

Impact Source	Receptor	Receptor Sensitivity	Impact Intensity	Impact Consequence	Likelihood	Impact Significance
Hydrology						
Liquid effluents and stormwater run-off generation	Ecological Receptors					
	Waterbodies supporting Clementi Forest	Priority 1	Low	Low	Unlikely/ Remote	Negligible
	Freshwater marsh	Priority 1	Negligible	Very Low	Unlikely/ Remote	Negligible
	Human Receptors					
	Future residents and visitors in the	Priority 2	Low	Very Low	Less Likely/ Rare	Negligible

Impact Source	Receptor	Receptor Sensitivity	Impact Intensity	Impact Consequence	Likelihood	Impact Significance
	vicinity of the Study Area developments					
Water Quality						
Stormwater run-off generation	Ecological Receptors					
	Waterbodies supporting Clementi Forest (site clearance)	Priority 1	Medium	Medium	Less Likely/ Rare	Minor
	Waterbodies supporting Clementi Forest (rest of construction phase)	Priority 1	Low	Low	Less Likely/ Rare	Minor
	Freshwater marsh	Priority 1	Low	Low	Unlikely/ Remote	Negligible
	Human Receptors					
	All local residents and visitors	Priority 1	Low	Low	Unlikely/ Remote	Minor
Construction wastewater generation	Ecological Receptors					
	Waterbodies supporting Clementi Forest	Priority 1	Low	Low	Less Likely/ Rare	Minor
	Freshwater marsh	Priority 1	Low	Low	Unlikely/ Remote	Negligible
	Human Receptors					
	All local residents and visitors	Priority 1	Low	Low	Unlikely/ Remote	Negligible
Accidental spills and leaks of pollutants	Ecological Receptors					
	Waterbodies supporting Clementi Forest	Priority 1	Medium	Medium	Less Likely/ Rare	Minor
	Freshwater marsh	Priority 1	Medium	Medium	Unlikely/ Remote	Negligible
	Human Receptors					
	All local residents and visitors	Priority 1	Medium	Medium	Unlikely/ Remote	Negligible
	Ecological Receptors					

Impact Source	Receptor	Receptor Sensitivity	Impact Intensity	Impact Consequence	Likelihood	Impact Significance
Solid waste generation	Waterbodies supporting Clementi Forest	Priority 1	Low	Low	Less Likely/ Rare	Minor
	Freshwater marsh	Priority 1	Low	Low	Unlikely/ Remote	Negligible
	Human Receptors					
	All local residents and visitors	Priority 1	Low	Low	Unlikely/ Remote	Negligible

13.2.2 Operational Phase

Unmitigated impact was rated as negligible to minor hence no mitigation measures were recommended and therefore the residual impact and unmitigated impacts remain the same with no changes.

13.3 Air Quality

13.3.1 Construction Phase

Residual Impact Assessment assumes that the mitigation measures within Section 12.3.1 are implemented within the construction footprint. The worksite option with smaller footprint (i.e., Mitigated Scenario) is preferred. Smaller construction footprint would reduce the potential air quality impact to the neighbouring receptors. The impacts from dust emissions from earthworks, construction and trackout was assessed in this phase. With recommended area of conservation being conserved, the biodiversity receptors come closer to the construction footprint with more sensitivity to it. Provided that mitigation measures within construction worksites are strictly implemented, the Likelihood of occurrence of a significant adverse impact would be classified as **Rare**, subject to relevant mitigation measures identified being implemented. This Likelihood is combined with Impact Consequence, resulting in **Minor** Impact Significance for the construction footprint as listed in Table 13.3.1 below.

Table 13.3.1 Residual impacts of dust risk assessment (after mitigation)

Key Parameter - Earthworks			Impact Assessment							
Total Site Area (m^2) [1]	No. of Vehicles Moving Within the Site	Earthworks Material	Impact Intensity	Sensitivity of the Area		Overall Consequence / Dust Risk		Likelihood	Impact Significance	
				Ecological Receptor	Human Receptor	Ecological Receptor	Human Receptor		Ecological Receptor	Human Receptor
18,000-110,000	>10	Moderately dusty	High	Priority 1	Priority 3	High	Low	Rare	**Minor**	**Minor**
Key Parameter - Construction			**Impact Assessment**							
Total Building Volume (m^3) [1]	Construction Material	No. of On-Site Concrete Batching Plant	Impact Intensity	Sensitivity of the Area		Overall Consequence / Dust Risk		Likelihood	Impact Significance	
				Ecological Receptor	Human Receptor	Ecological Receptor	Human Receptor		Ecological Receptor	Human Receptor
>75,000	Potentially dusty (e.g., concrete)	0	High	Priority 1	Priority 3	High	Low	Rare	**Minor**	**Minor**
Key Parameter - Trackout			**Impact Assessment**							
No. of Outward Trucks Movement Per Day [1]	Road surface material	Unpaved Road Length (m) [1]	Impact Intensity	Sensitivity of the Area		Overall Consequence / Dust Risk		Likelihood	Impact Significance	
				Ecological Receptor	Human Receptor	Ecological Receptor	Human Receptor		Ecological Receptor	Human Receptor
>50	Potentially dusty	<50	High	Priority 1	-	High	High	Rare	**Minor**	-

Note:

1. The numbers are based on estimation and are subject to further changes.
2. The HDVs are expected to travel along the existing paved road along Holland Road, Holland Plain, Old Holland Road and Blackmore Drive for access to the Project Site, hence an unpaved road length of 0 m (<50 m) is considered in this air quality impact assessment.

Impact assessment from gaseous emissions from construction equipment, vehicle and off-road vehicle exhaust was also assessed. With the implementation of mitigation measures outlined in Table 12.3.2, such as ensure all vehicles and engine powered equipment comply with the legislative requirements, switch off vehicles and equipment engines when stationary, avoid the use of diesel- or petrol-powered generators among many others, the Likelihood of the impact is expected to reduce from **Regular** to **Rare**, resulting in **Minor** Impact Significance after consideration of the **Low** Impact Consequence as evaluated in Section 11.3.1.2. The Impact Intensity, Impact Consequence and Impact Significance are outlined in Table 13.3.2.

Table 13.3.2 Residual impacts of gaseous emissions assessment (after mitigation)

Impact Intensity	Sensitivity of the Area		Impact Consequence		Likelihood	Impact Significance	
	Ecological Receptor	Human Receptor	Ecological Receptor	Human Receptor		Ecological Receptor	Human Receptor
Low	Priority 1	Priority 1	Low	Low	Rare	**Minor**	**Minor**

13.3.2 Operational Phase

As discussed in Section 11.3.2, the potential impact significance due to increased traffic is considered to be **Minor**, hence not requiring further mitigation measures. No residual impact assessment is required for operational phase.

13.4 Airborne Noise

13.4.1 Construction Phase

13.4.1.1 Residual Ecological Impacts

This section discusses on the residual construction noise impacts on the identified ecological receptors, qualitatively assessed based on matrices defined in Section 5.4.1 under the assumption that mitigation measures proposed in Section 12.4.1 have been implemented. The proposed noise barriers would reduce the noise experienced by ground dwelling NSRs to some extent. As a result, impact intensity was reduced from **Very Low – High to Negligible - Medium** (refer to Table 5.4.1) due to the predicted noise exceedances, corresponds to an Impact Consequence ranging from **Very Low – Medium** for Priority 1 and **Imperceptible – Low** for Priority 2 and 3 (refer to Table 5.4.2). When relating the Impact Consequence to a Likelihood of Occurrence of **Certain/Continuous**, the maximum overall Impact Significance arising from the proposed construction activities associated with the assessment scenarios was ranged from **Minor - Major** for Priority 1 , **Negligible** – **Moderate** for Priority 2, and **Negligible** – **Minor** for Priority 3 (refer to Table 5.4.7). It is worth mentioning that when construction works will be carried out predominantly in the north-eastern area, the noise from construction is anticipated to have a **Negligible** to **Minor** impact on ecologically sensitive receptors since the noise sensitive receptors were sighted primarily in north-western and south-western of the study area. However, when construction takes place closer to north-western and south-western, the significance of the impact significance stemming from the construction activities is anticipated to escalate to a **Moderate** to **Major** level. Nevertheless, due to limited information available during this preliminary phase, accurately estimating the noise reduction provided by noise barriers is not feasible. AECOM recommends that quantitative noise impact assessment with and without barrier through noise modelling by a 3D simulating software such as SoundPLAN and CadnaA be conducted by Noise Consultant(s) appointed by Contractor (s) be it for roadworks/ earthworks/ construction contractor prior to commencement of construction works as required by NEA regulations for human impacts for residents, or for ecological receptors and embed that part in the contract-specific EMMP for this site to be submitted to NParks before commencement of construction works.

Table 13.4.1 Summary of construction noise impact on ecological receptors (mitigated)

Assessment Scenario	L_{Aeq}, dB(A)	Receptor Priority	Impact Intensity	Impact Consequences	Likelihood of Occurrence	Impact Significance
Scenario 01: Foundation	$L_{Aeq(12\ hours)}$	Priority 1	Negligible – -Medium	Very Low - Medium	**Certain/ Continuous**	**Minor - Major**

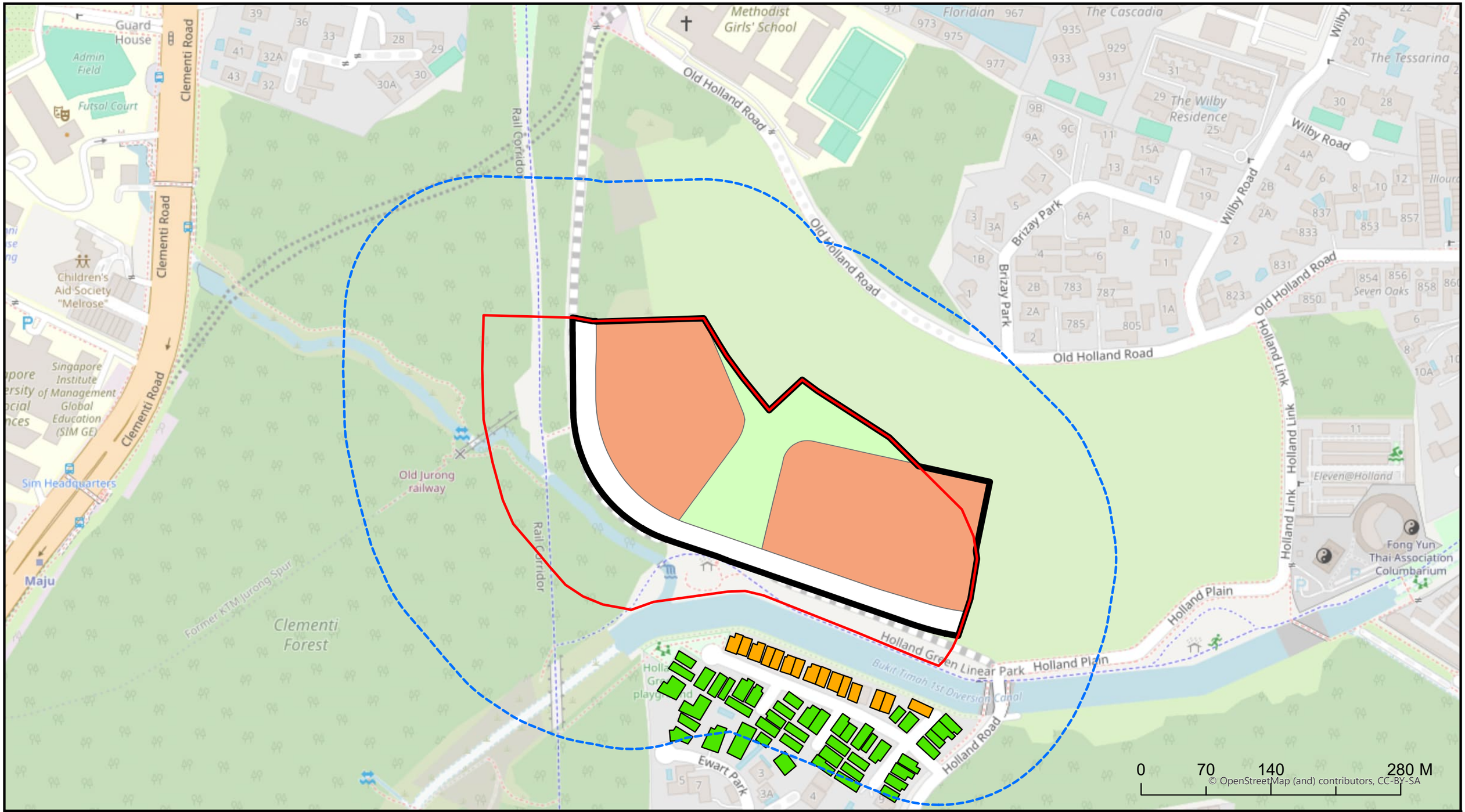
Assessment Scenario	L_{Aeq}, dB(A)	Receptor Priority	Impact Intensity	Impact Consequences	Likelihood of Occurrence	Impact Significance
and Earthworks – Day Time (7 am -7 pm)		Priority 2	Negligible – -Medium	Imperceptible – Low		**Negligible - Moderate**
		Priority 3	Negligible – -Medium	Imperceptible – Very Low		**–Negligible - Minor**
	$L_{Aeq(5 mins)}$	Priority 1	Negligible – -Medium	Very Low - Medium	**Certain/ Continuous**	**Minor - Major**
		Priority 2	Negligible – -Medium	Imperceptible – Low		**Negligible - Moderate**
		Priority 3	Negligible – -Medium	Imperceptible – Very Low		**–Negligible - Minor**

13.4.1.2 Residual Human Impacts

Residual Impact Assessment assumes that the mitigation measures within Section 12.4.1 are implemented within the construction footprint. The proposed noise barriers may reduce the noise experienced by human NSRs to some extent. However, due to limited information available during this preliminary phase, accurately estimating the noise reduction provided by noise barriers is not feasible. AECOM recommends that quantitative noise impact assessment with and without barrier through noise modelling by a 3D simulating software such as SoundPLAN and CadnaA be conducted by Noise Consultant(s) appointed by Contractor (s) be it for roadworks/ earthworks/ construction contractor prior to commencement of construction works as required by NEA regulations for human impacts for residents, or ecological receptors and embed that part in the contract-specific EMMP for this site to be submitted to NParks before commencement of construction works. Nevertheless, the impact intensity was reduced from **Negligible – High** to **Negligible – Medium** since noise barrier is capable of blocking line of sight for low-rise buildings. This corresponded to an overall Impact Consequence ranging from **Imperceptible – Low**. When relating the Impact Consequence to a Likelihood of Occurrence of **Certain/Continuous**, the maximum overall Impact Significance arising from the proposed construction activities associated with the assessment scenarios would range from **Negligible - Moderate** as elaborated in Table 13.4.2.

Table 13.4.2 Summary of construction noise human receptors (mitigated)

Assessment Scenario	L_{Aeq}, dB(A)	Receptor Sensitivity	Impact Intensity	Impact Consequence	Likelihood	Impact Significance
Scenario 01: Foundation and Earthworks – Day Time (7 am -7 pm)	$L_{Aeq(12 hours)}$	Priority 2	–Low-Medium	Very Low -Low	Certain/Continuous	Minor - Moderate
			Negligible - Low	Imperceptible - Very Low		Negligible - Minor
		Priority 3	Negligible - Low	Imperceptible - Very Low		Negligible - Minor
	$L_{Aeq(5 mins)}$	Priority 2	Negligible - Low	Imperceptible - Very Low		Negligible - Minor
		Priority 3	Negligible - Low	Imperceptible - Very Low		Negligible - Minor



Legend

- Study Boundary
- Indicative residential development
- Road
- Indicative Park
- Noise Study Area (150m-buffer)
- Construction Worksite

Impact Significance

- Minor - Moderate
- Negligible - Minor

N

Rev.	Date	By	Description	Chk'd	App'd
1	NOV 2025	SHA	Holland Plain EIA	LAL	ADP
-	JAN 2025	SHA	Holland Plain EIA	LAL	ADP

Qualified Person Endorsement : NA

URA Endorsement : NA

Consultant : AECOM

Client: URA Urban Redevelopment Authority

Project Title :

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HOLLAND PLAIN
ENVIRONMENTAL IMPACT ASSESSMENT

Figure Title :

Mitigated construction noise impacts on noise sensitive receptors (Human)
Scenario 1: Foundation and Earthworks
Day Time (7 am -7 pm)
LAeq(12 hours)

Designed	Checked	Approved	Figure No. :	Rev.	Sheet
SHA	LAL	ADP	13.4.1	1	1 of 1
	Drawn SHA	Date NOV 2025	CAD File Name : NA		A3

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13.4.2 Operational Phase

13.4.2.1 Ecological Impacts

The residual operational noise impact assessment assumes that the mitigation measures proposed within Section 12.4.2 have been implemented at developments identified as potential sources for operational noise. The impact intensity at the receptors is expected to be reduced with the adoption of Best Available Technology (BAT) and Best Environmental Practice (BEP) noise control measures for ACMV systems, and measures to reduce traffic noise by introducing speed postings, humps and speed limit signages to slow down traffic. Furthermore, it was assumed the ecological receptors with higher mobility would potentially migrate north-westwards and south-westwards towards less disturbed areas of forests to distant themselves from the disturbances arising from operational noise impacts.

Based on the above assumptions, the residual operational noise impacts on the ecological receptors could be deduced to be reduced to **Negligible**.

13.4.2.2 Human Impacts

As discussed in Section 11.4.3, it is mandatory that the proposed developments comply with the *NEA Technical Guideline on Boundary Noise Limits for Air Conditioning and Mechanical Ventilation Systems in Non-Industrial Buildings, 2018* [R-38] and *NEA Technical Guideline for Land Traffic Noise Impact Assessment, 2016* [R-37]. This is usually conducted by an appointed Noise Consultant during the detailed design stage. Hence, AECOM recommends that the developer/ developing agent to appoint a Noise Consultant(s) to assess the impacts arising from the operational phase at later stages of the development, to procure a more accurate understanding of noise impacts arising from operational conditions based on updated baseline conditions.

Following the implementation of proposed mitigation measures in Section 12.4.2, the residual impact significance on human receptors can be qualitatively deduced to be **Negligible**.

14 Cumulative Impacts from Major Concurrent Projects

As there are other major development works within the vicinity of the Study Area, this section assesses the combined impact arising from this Project and the other development works.

Three projects have been identified to coincide with the developments in the Study Area:

- Development of residential areas at the northeastern and eastern half of Holland Plain;
- King Albert Park Station as part of the CRL2 construction; and
- Enhancement of Old Holland Road, Holland Link, Holland Plain, Laurel Woods Avenue and Sixth Avenue.

14.1 Biodiversity

Construction Phase

For habitats and flora, the road enhancement works could increase edge effects and habitat degradation. However, since the habitats in the vicinity of the Study Area which are bounded by Old Holland Road and Holland Link are degraded habitats, there will not be any significant deviation from the assessed impacts in Section 11.1.

For fauna, there will be an increase in human and light disturbances associated with construction works, resulting in an increase in impacts to fauna within the Study Area. This can be mitigated via proper directional site clearance (towards existing forested areas) and phasing of construction works.

Operational Phase

During operation phase, assuming the completion of other development works in the area, there will be increased light disturbance from the residential areas, as well as other human disturbances from the increased traffic around the area. Hence, this could result in a slight increase in impacts to fauna within the Study Area.

14.2 Hydrology and Water Quality

Construction Phase

It is assumed that all the concurrent developments will comply with the construction standards and environmental management and control. Therefore, it is not expected that they will increase impacts on hydrology and water quality of the waterbodies within the Study Area.

The details of associated activities are not definite at the time of writing the Report, however it is recommended for the responsible parties to liaise with each other to make sure that discharges originating from the sites do not cause significant cumulative impact to water quality.

Operational Phase

Since operational sources for hydrology and water quality are considered insignificant, cumulative impacts are also considered to be insignificant in nature given similar developments coming up in the vicinity.

14.3 Air Quality

It is known that construction activities are planned to occur in the vicinity of the Project as highlighted in Section 3.5. Hence, cumulative impacts from other relevant major concurrent development in the vicinity of the Project were assessed as below.

Construction Phase

The impact significance before mitigation for the proposed development ranges from Moderate to Major. Due to the presence of these concurrent construction sites, the construction footprint in this area is expected to be larger. More vehicles moving within the site and more spoil to be moved as part of the excavation stage are also expected. The concurrent constructions may increase cumulative air quality impact in the vicinity of Holland Plain, therefore a strict enforcement of mitigation measures will be crucial for this project in this phase.

Operational Phase

Since operational sources for air quality are considered insignificant, cumulative impacts are also considered to be insignificant in nature given similar developments coming up in the vicinity.

14.4 Airborne Noise

Construction Phase

As mentioned in Section 3.5, three projects have been identified to coincide with the developments in the Study Area. Due to the presence of these projects, the construction footprint in this area is expected to be larger. Therefore, with these concurrent construction activities, the Impact Significance is expected to be in the range of as **Negligible to Major**. The neighbouring projects are likely to contribute more to the impacts than this project owing to their closer proximity to the noise sensitive receptors, especially humans, therefore it is important that both the projects have their own noise barriers in an attempt to reduce their own generated noise levels.

Operational Phase

During operational phase, the concurrent developments may not individually result in significant impacts; however, they are anticipated to contribute to a notable increase in traffic volume. Cumulatively, the noise from traffic will increase significantly in this area, which should be assessed in NEA's mandated studies such as TNIA and mitigated according to the recommendations of these studies.

15 Environmental Monitoring and Management Plan

The Environmental Monitoring and Management Plan (EMMP) addresses the environmental impacts identified in this EIA Study for both the construction and operational phases of the Project, focusing on biodiversity, surface water resources, air quality, and noise. It outlines the implementation of mitigation measures and specifies monitoring actions to assess their effectiveness.

The EMMP also serves as a framework for project stakeholders to develop a contract-specific EMMP (CEMMP) based on their responsibilities outlined in Section 15.4. As the project evolves, the CEMMP will be updated as needed, with copies available on-site for reference at all times.

This section defines the EMMP's objectives, project organization, and roles and responsibilities for implementation. Since a detailed Project plan is not yet available, this section provides general EMMP requirements. Some elements, such as responsible parties, roles, monitoring frequency, and inspection plans, may be subject to minor adjustments throughout the Project's development.

15.1 EMMP Objectives

The Environmental Management and Monitoring Plan (EMMP) outlines how the recommended mitigation measures, identified during the impact assessment, will be implemented and achieved across various technical areas. It carefully examines construction and operational activities as they occur, using adaptable monitoring and management practices to safeguard the project's environmental values throughout these phases.

The EMMP has two main objectives:

1. **Environmental Monitoring**: Ensuring that the environmental impacts during construction and operation stay within expected levels while addressing any unforeseen impacts that might arise.
2. **Effectiveness Tracking**: Evaluating how well the recommended mitigation measures are working, allowing for adjustments or improvements to better handle challenges during the project's construction and operation.

Environmental management takes a proactive approach to protect biodiversity and human well-being by emphasising documentation, regular audits, and enforcement measures.

15.2 Project Organisation During the Construction Phase

The proposed Project organisation and lines of communication with respect to environmental protection works are presented in Figure 15.2.1.

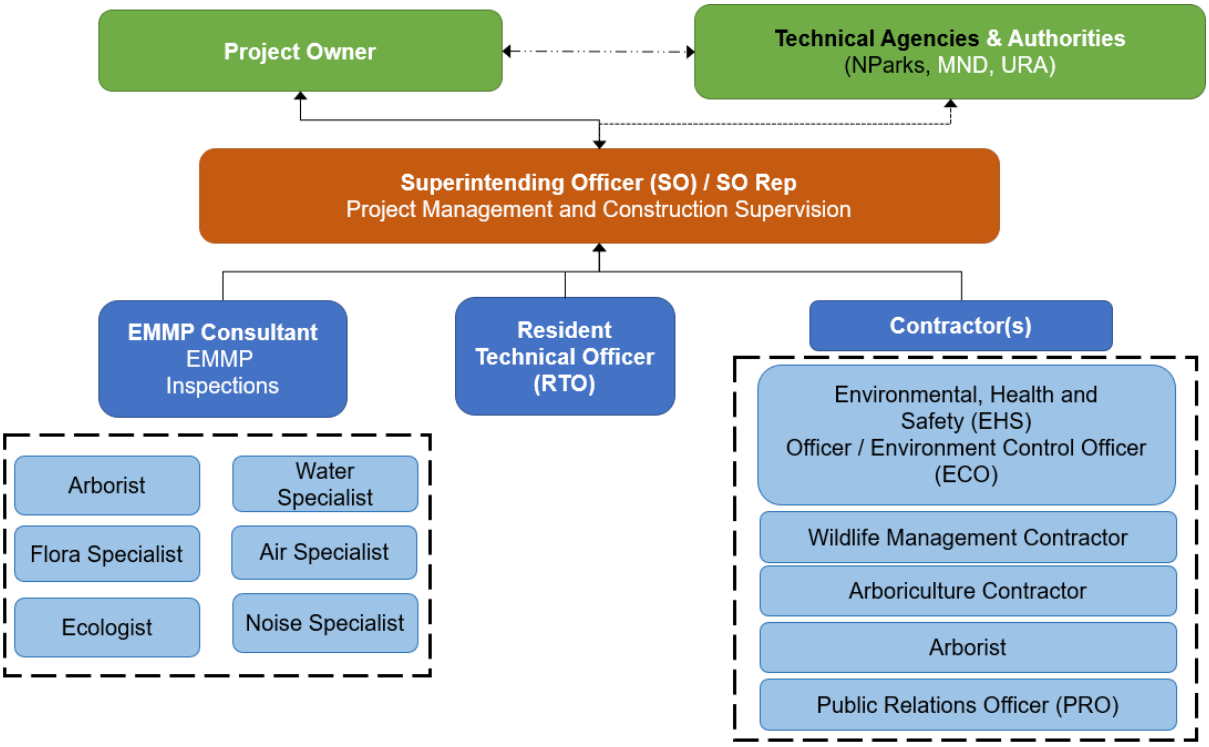


Figure 15.2.1 Project organisation and lines of communication during the construction phase

15.3 Project Organisation During the Operational Phase

The implementation of EMMP during the operational phase is highly recommended at sites close to ecologically sensitive locations (such as opposite Rail Corridor). The proposed project organisation and lines of communication concerning environmental protection works are presented in Figure 15.3.1.

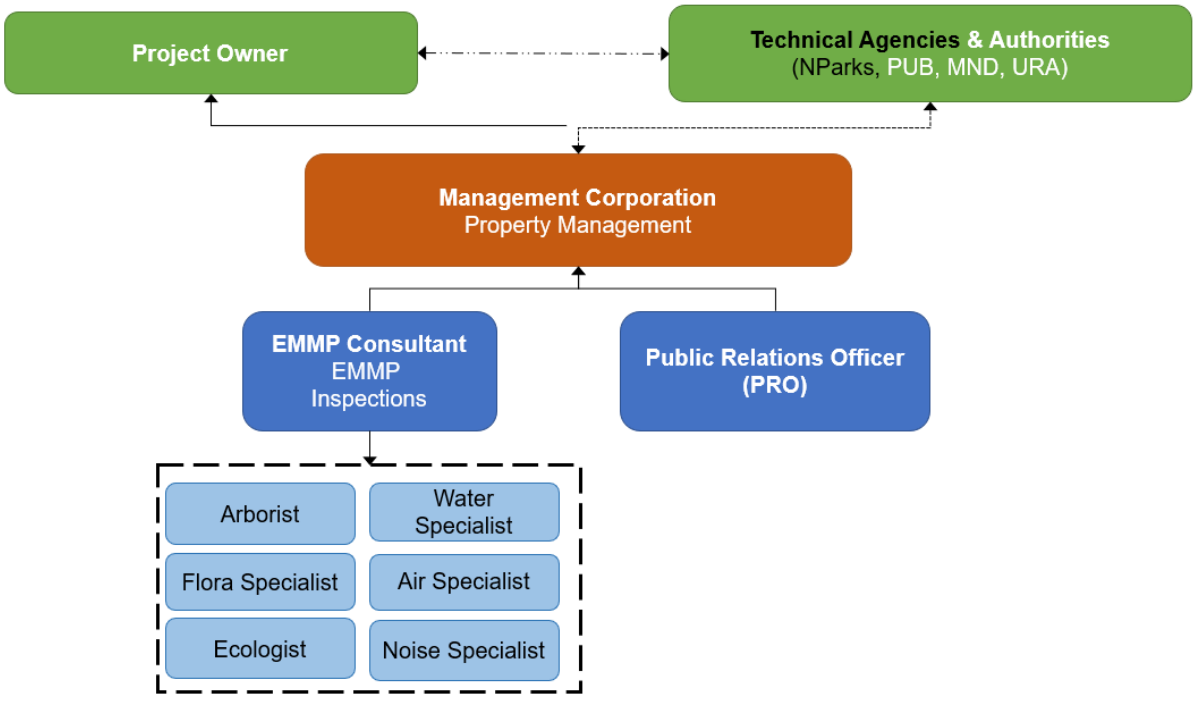


Figure 15.3.1 Project organisation and lines of communication during the operational phase

15.4 Roles and Responsibilities of the EMMP for the Construction Phase

15.4.1 Technical Agencies/Authorities

Technical agencies or authorities, including but not limited to URA/MND and NParks, are involved in the process. NParks is responsible for reviewing and approving the CEMMP for both the construction and operational phases before work begins, as well as during the project, if necessary.

15.4.2 Project Owner and Resident Technical Officer

The developer/ developing agency, being the Project Owner, will oversee the construction phase of the project in accordance with the design. In conjunction with the Resident Technical Officer (RTO), the developer/ developing agency is required to:

- Ensure resources are available to achieve all requirements of the EMMP;
- Ensure all active stakeholders have substantial understanding of the EMMP;
- Provide leadership in the development and implementation of the EMMP;
- Engage EMMP Consultant for development and implementation of the EMMP;
- Ensure all environmental incidents and near misses are promptly investigated and reported;
- Ensure all non-compliance issues are resolved promptly by the contractor;
- Record, respond to, and action any complaints from members of the public, if any, with inputs from the Technical Agencies, if required; and
- Reporting to the Technical Agencies regarding implementation of the EMMP.

15.4.3 The Superintending Officer (SO) or SO Representative (SO Rep)

The Superintending Officer (SO) or their appointed SO Representative oversees construction works performed by various staff, contractors and sub-contractors, ensuring that the construction works are performed in accordance with the approved design specification, contractual requirements, and CEMMP.

Their responsibilities include:

- Communicate approved design and CEMMP requirements to all personnel;
- Lead the implementation of the CEMMP on site with the assistance of ECO;
- Monitor compliance with contract and regulatory standards, Including the effectiveness of environmental mitigation and monitoring measures;
- Collaborate with the Contractor’s EHS Officer and ECO to implement and adhere to the environmental audit programme;
- Conduct regular site inspections for EMMP compliance;
- Coordinate and take corrective action when emission/discharge levels exceed limits;
- Investigate and resolve any non-compliance issue with contractor;
- Coordinate with the Project Owner and RTO for submission of environmental audit reports;
- Carry out any complaint investigations with the Public Relations Officer (PRO) as per Section 15.7; and
- Promote environmental awareness and lead by example for best practices.

15.4.4 The Contractor

The term “Contractor” refers to all construction contractors and sub-contractors working onsite at any time. In addition to reporting to the SO/SO Rep, the Contractor must:

- Adhere to relevant contract scope, specifications, and other tender conditions;
- Provide documents and reports to EMMP Consultant in a timely manner for monthly EMMP report preparation;
- Ensure sufficient resources for the roles of RTO, Environmental Control Officer (ECO) and Certified Arborist, under guidance of the Contractor and/or the SO/SO Rep as needed;
- Carry out the pre-construction baseline and construction monitoring works;
- Implement the CEMMP;
- Take part in environmental site audits conducted by the EMMP Consultant and address any corrective actions;
- Provide adequate time and resources to implement the CEMMP as advised by the ECO and the EMMP Consultant;
- Provide updated information to the RTO, ECO, EMMP Consultant and its Certified Arborist on work activities that may create or worsen adverse environmental conditions, or any changes to the work plan
- Implement measures to address impacts when emission or discharge levels exceed permissible limits;
- Develop the CEMMP with advice from the EMMP Consultant, incorporating the relevant mitigation measures and monitoring works recommended in the EIA report and seek Technical Agencies' approval prior to the commencement of any works together with EMMP Consultant;
- Ensure the CEMMP includes at least the following Standard Operating Procedure (SOP):
  - Handling and storage of hazardous chemicals;
  - Biodiversity management plan;
  - Individual environmental management plans as detailed in the NEA's SHE Specifications (air, vector, waste, noise, water pollution management plans);
  - Monitoring plans (including but not limited to noise, air, waste, ecology and water pollution);
  - Compliance with existing legislation and environmental best practices; and
  - Emergency contingency planning.
- Engage a certified Qualified Erosion Control Professional (QECP) to prepare an Erosion Control Plan (ECP) and obtain approval from the Public Utilities Board (PUB) before site clearance.
- Before site clearance begins, the Contractor must:
  - Map onsite trees and employ a certified arborist to assess tree health, species, size, and conservation value for removal or retention;
  - Secure approval from NParks for the Tree Felling Plan through SO Rep;
  - Transplant trees or flora prior to site clearance, if necessary; and
  - Consult an ecologist under the EMMP Consultant for wildlife-rich areas, prepare a directional clearance plan, obtain NParks' approval, and execute the plan before or during site clearance.

15.4.5 Arboriculture Contractor

The Arboriculture Contractor employed by Contractor should meet NParks' safety requirements for work at height and LTA's requirements for temporary works along roadsides. All arboriculture workers engaged by the Arboriculture Contractor to perform tree climbing and chainsaw work shall possess a valid basic tree climbing certification based upon demonstrated competence in the Workforce Skills Qualifications (WSQ) module conducted by Centre for Urban Greenery and Ecology (CUGE) or an equivalent WSQ-approved training organisation; and the arboriculture crew deployed by the Arboriculture Contractor for the Contract shall possess the following valid competences:

- Operation of chainsaw for ground work (LS-MT-103E-1);
- Chainsaw safety and maintenance (LS-MT-102E-1);
- Perform formative pruning of young trees (LS-MT-114E-1);

- Provide Arboriculture support on site (LS-MT-116E-1);
- Workplace safety and health – operators (ES-WSH-101G-1);
- Respond to Emergency (LS-HM-208E-1);
- Perform advance rigging and climbing techniques (LS-HM-308S-1);
- Perform aerial tree access and aerial rescue skills (LS-HM-204S-1);
- Implement and apply appropriate risk and safety management to sector practices (LS- BP-301S-1);
- Prepare risk assessment report (LS-HM-406S-1); and
- Operate and work from an elevated work platform (CUGE-ARB-3501).

The certified arboriculture contractor shall be responsible for pruning and maintenance of retained trees, as well as felling of trees during the construction phase of this Project.

15.4.6 Wildlife Management Contractor

The wildlife management contractor employed by Contractor would be responsible in carrying out animal rescue, trapping and transport of large fauna if any human-wildlife conflicts are encountered during construction phase on site. The wildlife management contractor shall be listed under NParks' public register of certified wildlife management contractors and have experience carrying out animal rescue, trapping and transport of large fauna.

The key responsibilities of a qualified Wildlife Management Contractor during construction phase include but not limited to:

- Carry out fauna rescue and translocation in consultation with attending Ecologist and NParks; and
- Propose trapping of fauna in consultation with attending Ecologist and NParks to satisfy Section 10 Wildlife Act.

15.4.7 EMMP Consultant

The EMMP Consultant should be engaged by Project Owner to develop a CEMMP for implementation by all parties, including Contractors, SO/SO Rep., ECO, and relevant workers on site. The appointed EMMP Consultant may be required to provide environmental advisory services for the Project Owner, and to liaise with the Contractor, Technical Agencies, authorities, stakeholders and/or any EMMP Auditor from Project Owner during external audit (see Sections 15.4 and Section 15.5), when necessary.

The key responsibilities of an EMMP Consultant during construction phase include but not limited to:

- Ensure that the roles of required Environmental Consultant Team (e.g., Flora Specialist, Ecologist, Certified Arborist, Surface Water Resource Specialist, Air Quality Specialist, and Airborne Noise Specialist, if required) are adequately resourced;
- Lead the development and submission of a CEMMP Report for its approval by Project Owner, Technical Agencies, Authorities if required;
- Carry out the routine site inspection and review the monthly EMMP Report for Project Owner and relevant Technical Agencies' approval during construction phase; and
- Liaise with Project Owner, Contractor, relevant Technical Agencies, authorities, stakeholders, etc. for any EMMP related matters.

15.4.7.1 Flora Specialist

A Flora Specialist shall possess previous work experience in developments of similar size or complexity who is able to demonstrate capability in implementing flora management plans.

The key responsibilities of a qualified Flora Specialist include but not limited to:

- Review soil investigation locations (if any) and proposed site access to minimise excessive vegetation removal;

- Identify plant species (e.g., climbers, shrubs, epiphytes, ferns) of value that can be extracted for propagation and harvesting;
- Recommend weed and invasive species management if necessary;
- Review planting palette of reforestation works and ensure that the specifications for planting are met;
- Carry out monthly flora inspection with emphasis on the health of the CS species and habitat within the RAC; and
- Reporting of findings to NParks.

15.4.7.2 Ecologist

For this Project, an Ecologist (if required especially for development near the green areas) plays an important role in the implementation of fauna-related EMMP measures as part of the biodiversity monitoring program during both construction and operational phases of this Project. The Ecologist shall possess a degree (or equivalent) in ecology-related fields with experience in implementing fauna management plans. In addition, at least two (2) valid certifications of the following:

- Animal Management Professional Certification Programme (PCP) – Basic Module (CUGE-PCP-7006A)
- Animal Management PCP – Intermediate Elective Module – Mammals (CUGE-PCTP-7006C)
- Animal Management PCP – Intermediate Elective Module – Reptiles (CUGE-PCP-7006B)

The key responsibilities of the qualified Ecologist are listed as follows:

- Implement fauna management during site clearance;
- Carry out pre-felling fauna inspections;
- Carry out monthly fauna inspection and reporting; and
- Facilitate the implementation of the fauna response plan.

15.4.7.3 Arborist

An Arborist certified by the International Society of Arboriculture (ISA) should be employed by EMMP Consultant (if required especially for development with any activities of tree assessment involved). The Arborist shall possess previous work experience in developments of similar size or complexity who is able to demonstrate capability in monitoring and managing all matters related to the adequate and successful conservation of trees and flora within and adjacent to the contract boundary. A detailed description of biodiversity monitoring programme is provided in Section 15.9, where the key responsibilities of the Arborist are listed as follows:

The key responsibilities of an ISA-certified Arborist during construction phase include but not limited to:

- Carry out tree mapping and assessment;
- Implement tree protection plans;
- Provide advice on tree transplanting;
- Review Contractor's method statements for site clearance, tree felling and setting up of tree protection zones (TPZ);
- Assess forest edge effects and its associated changes;
- Implement tree maintenance and care; and
- Carry out monthly tree inspection and reporting.

15.4.7.4 Surface Water Resource Specialist

Surface Water Resource Specialist (if required) should oversee/ lead/ guide hydrology and surface water quality monitoring and inspection on the construction site, and to ensure it is carried out according to guidelines and standards. The specialist should advise the ECO, to perform and/or ensure implementation of EMMP, mitigation measures and minimum control measures related to hydrology and surface water quality on site (refer to Section 15.10).

15.4.7.5 Air Quality Specialist

Air Quality Specialist (if required) should oversee/ lead/ guide air quality monitoring and inspection on the construction site, and to ensure it is carried out according to guidelines and standards. The specialist should advise the ECO, to perform and/or ensure implementation of EMMP, mitigation measures and minimum control measures related to air quality on site (refer to Section 15.11).

15.4.7.6 Airborne Noise Specialist

Airborne Noise Specialist (if required) should oversee/ lead/ guide airborne noise quality monitoring and inspection on the construction site, and to ensure it is carried out according to guidelines and standards. The specialist should advise the ECO, to perform and/or ensure implementation of EMMP, mitigation measures and minimum control measures related to airborne noise on site (refer to Section 15.12).

15.5 Roles and Responsibilities of the EMMP for the Operational Phase

During operational phase, the EMMP may or may not be required and its required duration may vary during operational phase. For example, if the development is the in vicinity of any green areas in this EIA Study Area, it may require three (3) to twelve (12) months' EMMP implementation during operational phase.

15.5.1 Technical Agencies/Authorities

Technical Agencies/Authorities constitute but are not limited to NParks, and MND/ URA. NParks shall assess and approve the CEMMP for the construction and operational phases, prior to commencement of works and, where required, during the course of the Project.

15.5.2 Project Owner

The developer/ developing agent is responsible for overseeing and managing the environmental monitoring detailed in the EMMP for the operational phase. The developer/ developing agent is required to:

- Ensure resources and appropriate personnel are available to achieve the requirements of the EMMP;
- Provide leadership in the implementation of the EMMP;
- Ensure all environmental incidents and near misses are promptly investigated and reported;
- Resolve any non-compliance issues;
- Record, respond to, and action any complaints from members of the public, if any, with inputs from the Technical Agencies, if required; and
- Reporting to the Technical Agencies regarding implementation of the EMMP.

15.5.3 EMMP Consultant

The EMMP Consultant should be engaged by Project Owner to develop a CEMMP for implementation by all parties on site. The appointed EMMP Consultant shall perform the recommended environmental monitoring works throughout the operational phase, as well as to provide environmental advisory services for the Project Owner, and to liaise with Technical Agencies, authorities, stakeholders and/or any EMMP Auditor from Project Owner during external audit when necessary.

The key responsibilities of an EMMP Consultant during operational phase include but not limited to:

- Ensure that the roles of required Environmental Consultant Team (e.g. Flora Specialist, Ecologist, Certified Arborist, Surface Water Resource Specialist, Air Quality Specialist, Airborne Noise Specialist, and Groundwater Specialist, if required) are adequately resourced. However, it should be noted at the time of Report writing, the Project is at master planning stage. Therefore, all potentially required specialists are listed here. Depending on the actual development and its location, the requirement of different specialists may vary;

- Lead the development and submission of a contract-specific EMMP Report for its approval by Project Owner, Technical Agencies, Authorities if required;
- Carry out or support Project Owner to carry out the routine monitoring works during operational phase;
- Carry out the routine site inspection and prepare the monthly EMMP Report for Project Owner and relevant Technical Agencies' approval during operational phase; and
- Liaise with Project Owner, relevant Technical Agencies, authorities, stakeholders, etc. for any EMMP related matters.

15.5.3.1 Flora Specialist

A Flora Specialist (if required especially for development near the green areas) shall possess previous work experience in developments of similar size or complexity who is able to demonstrate capability in implementing flora management plans. A detailed description of biodiversity monitoring programme is provided in Section 15.14, where the key responsibilities of the Flora Specialist are listed as follows:

The key responsibilities of a qualified Flora Specialist during operational phase include but not limited to:

Recommend additional weed and invasive species management if necessary; and

Carry out monthly flora inspection (with emphasis on the health of the CS species and habitat within the RAC) and reporting.

15.5.3.2 Ecologist

An Ecologist (if required especially for development near the green areas) should be engaged for the implementation of fauna-related EMMP measures as part of the biodiversity monitoring program during operational phase of this Project. The Ecologist shall possess a degree (or equivalent) in ecology-related fields with experience in implementing fauna management plans. In addition, at least two (2) valid certifications of the following:

- Animal Management Professional Certification Programme (PCP) – Basic Module (CUGE-PCP-7006A)
- Animal Management PCP – Intermediate Elective Module – Mammals (CUGE-PCTP-7006C)
- Animal Management PCP – Intermediate Elective Module – Reptiles (CUGE-PCP-7006B)
- A detailed description of biodiversity monitoring programme is provided in Section 15.14, where the key responsibilities of the Ecologist are listed as follows:
- The key responsibilities of a qualified Ecologist during operational phase include but not limited to:
- Carry out fauna monitoring surveys including terrestrial transect surveys, aquatic sampling and camera trapping; and
- Carry out monthly fauna inspection and reporting.

15.5.3.3 Arborist

An Arborist certified by the International Society of Arboriculture (ISA) should be employed by EMMP Consultant (if required especially for development with any activities of tree assessment involved). The arborist shall possess previous work experience in developments of similar size or complexity who is able to demonstrate capability in monitoring and managing all matters related to the adequate and successful conservation of trees and flora within and adjacent to the contract boundary. A detailed description of biodiversity monitoring programme is provided in Section 15.9, where the key responsibilities of the Arborist are listed as follows:

The key responsibilities of an ISA-certified Arborist during operational phase include but not limited to:

- Implement tree maintenance and care; and
- Carry out monthly tree inspection and reporting.

15.5.3.4 Surface Water Resource Specialist

Surface Water Resource Specialist (if required) should oversee/ lead/ guide hydrology and surface water quality monitoring and inspection on the development site, and to ensure it is carried out according to guidelines and standards. The specialist should, who shall assist the ECO, to perform and/or ensure implementation of EMMP, mitigation measures and minimum control measures related to hydrology and surface water quality on site (refer to Section 15.10).

15.5.3.5 Air Quality Specialist

Air Quality Specialist (if required) should oversee/ lead/ guide air quality monitoring and inspection on the development site, and to ensure it is carried out according to guidelines and standards. The specialist should, who shall assist the ECO, to perform and/or ensure implementation of EMMP, mitigation measures and minimum control measures related to air quality on site (refer to Section 15.11).

15.5.3.6 Airborne Noise Specialist

Airborne Noise Specialist (if required) should oversee/ lead/ guide airborne noise quality monitoring and inspection on the development site, and to ensure it is carried out according to guidelines and standards. The specialist should, who shall assist the ECO, to perform and/or ensure implementation of EMMP, mitigation measures and minimum control measures related to airborne noise on site (refer to Section 15.12).

15.6 Site Inspections

15.6.1 Construction Phase

15.6.1.1 Internal Site Inspection by ECO

Site surveillance is crucial to ensure that environmental protection and pollution control measures meet contract specifications and the Environmental Management and Monitoring Plan (EMMP). The Environmental Compliance Officer (ECO) must regularly inspect construction activities to confirm that mitigation measures are promptly and effectively implemented as per the EMMP. With clear pollution control measures and an efficient remedial action reporting system, site inspections help maintain acceptable environmental performance.

The ECO is responsible for conducting environmental site inspections, identifying deficiencies, and managing the remedial action reporting system. After consulting with the project's Supervising Officer (SO) or SO Representative, the ECO should establish an inspection procedure, address deficiencies, and outline reporting requirements. This procedure must be agreed upon by the Resident Technical Officer (RTO) and Contractor representative and approved by the Project Owner within 21 days of starting the construction contract.

Inspections should occur daily during construction, covering all work areas. They should assess onsite environmental conditions, pollution control, and mitigation measures, as well as offsite conditions potentially impacted by onsite activities. Observations, including recommendations for improvement or corrective actions, should be documented and submitted to the Project Owner.

15.6.1.2 Site Inspection by EMMP Consultant

The EMMP Consultant should conduct routine inspections to verify the Contractor's compliance with the EMMP throughout the construction period.

15.7 Complaint Handling

The Public Relation Officer (PRO) is responsible for handling complaints and managing feedback and investigative work.

15.7.1 Construction Phase

The Public Relations Officer (PRO) will be supported by the Project Owner, RTO, SO/SO Representative, ECO, Contractor, and other relevant parties. Upon receiving a complaint during the construction phase, the PRO should follow these steps:

Log the complaint, record the date in the complaint database, and notify the Project Owner, SO/SO Representative, and ECO immediately.

Investigate the complaint with the ECO to confirm its validity and determine if it is related to construction activities.

If the complaint is valid and construction-related:

- Collaborate with the ECO to identify mitigation measures and seek approval from the SO/SO Representative.

- Review the situation and the implementation of mitigation measures by the ECO and SO/SO Representative.
- Engage the ECO for additional monitoring and inspections if necessary, and revise work methods, procedures, or equipment to prevent recurrence.
- Submit a complaint report, including mitigation measures and their effectiveness, to the Project Owner, RTO, and SO/SO Representative.
- Record the complaint, investigation, follow-up actions, and results in environmental audit reports.

The ECO and SO/SO Representative must provide the PRO with all necessary information and assistance for the investigation. The Contractor must promptly implement mitigation measures, while the PRO and SO/SO Representative ensure proper execution. The Contractor, RTO, and SO/SO Representative are responsible for reporting the investigation results and follow-up actions to the Project Owner. A complaint investigation report and corrective action plan must be prepared and approved by the Project Owner or relevant authorities within 24 hours of receiving the complaint.

15.7.2 Operational Phase

The PRO shall be supported by the Project Owner, EMMP Consultant and any other relevant parties.

During the operational phase, upon receipt of complaints, the PRO should undertake the following procedures:

Log the complaint and record the date when the complaint is received onto the complaint database and inform the Project Owner and EMMP Consultant immediately;

Investigate the complaint with the Project Owner and EMMP Consultant to determine its validity and assess whether the source of the problem is due to operational works;

If a complaint is valid and due to operational works:

- Liaise with the EMMP Consultant on the mitigation measures and seek agreement from the Project Owner;
- Review the current situation and the implementation of the mitigation measures;
- Engage the EMMP Consultant to undertake monitoring works for inspection purpose as well as to verify the complaint if necessary. Ensure that any valid reasons for complaints do not re-occur by revising the work methods, procedures, machines and/or equipment, etc.;
- Submit a complaint report (as well as the implementation of mitigation measures and the effectiveness of the mitigation measures as advised by the EMMP Consultant) to the Project Owner; and
- Log a record of the complaint, investigation, follow-up actions and the results in the environmental inspection report.

The PRO should work with the Project Owner and EMMP Consultant to gather all the necessary information and resources necessary to complete a complaint investigation. Following the investigation, the Project Owner and EMMP Consultant shall undertake appropriate mitigation measures. Follow-up is required by the PRO to ensure that the mitigation measures have been appropriately implemented. The complaint investigation report and corrective action plan should be prepared and approved by Project Owner and/or other relevant Authorities within 24 hr upon receipt of complaints.

15.8 Submission of Monthly Reports to Technical Agencies

During the construction phase, monthly reports on the implementation of construction EMMP and operational EMMP (if any) should be submitted by the Contractor to the EMMP Consultant for review and to Technical Agencies for record purposes. The reports shall include, but is not limited to the following:

- Results of environmental monitoring programme, or any required changes to meet the requirements of the EMMP;
- Results of monthly tree, flora and fauna inspections;

- Records of environmental site inspections, deficiencies/non-compliance issues and its corresponding remedial action;
- Records of all environmental incidents and near-misses, as well as their investigation and follow-up; and
- Records of complaints, as well as the investigation, follow-up actions/implementation of mitigation measures and the effectiveness of these measures.

15.9 Biodiversity Monitoring Programme Requirement

15.9.1 Construction Phase

At the construction phase, robust monitoring efforts for both flora and fauna are essential in minimising construction impacts, especially if the development is in the vicinity of any forested sites within the EIA Study Area.

15.9.1.1 Flora and Arboriculture Monitoring Programme

The flora and arboriculture monitoring aims to assess the impacts of construction on vegetation and habitat, such as tree health, unauthorised and/or excessive vegetation removal, edge effects, habitat degradation from soil erosion, and rubbish dumping.

The arboriculture monitoring programme should include the following:

- Monitoring of the condition of trees at the new forest edge to determine the physiological health and structural stability of trees as edge effects can lead to die back of canopies, and branch and structural failures.
- Review of method statements of construction works in proximity to retained trees within the Project worksite, if any, to determine if additional tree removal is required post-site clearance.
- Recommendation of solutions such as design changes, reduction of working space, reduction of TPZ area and reassessment of trees in cases of conflict with proposed works.
- Assessment of physiological health, vigour and structural stability of retained trees. Recommend additional mitigating measures if necessary.
- Assessment of the condition of retained trees, if any, to ensure that there has been no deterioration or mechanical damage and to determine if additional tree removal is required.
- Where a tree exhibits signs of stress, the Arborist should inspect the tree and advise on strategies to reduce further impacts and rehabilitation measures. Where monitoring indicates that drying out or edge impacts are occurring, remediation measures shall be undertaken. These measures may be temporary (such as carrying out watering when there is seven continuous days without rainfall). Long-term solutions shall be investigated and implemented.
- Inspection of the integrity of TPZs.
- Identification of excessive or unauthorised tree removal.

The flora monitoring programme should include the following works:

- Monthly flora inspections shall be conducted within the RAC; within the worksite boundary; and in forested areas adjacent to the worksite up to 15 m from the hoarding.
- Assessment of the health of retained CS species and habitat within the RAC; and reporting observations of declines in health to NParks.
- Identification of any unauthorised removal of flora within areas of conservation or beyond the demarcated Project worksite (Figure 3.2.1).
- Identification of direct/indirect impacts to sensitive vegetation and habitats. Such impacts include soil erosion and degradation that have resulted from construction activities, and unauthorized dumping of waste material, construction debris or oil/chemical leakage.
- Identification of forest edge effects and recommendation of mitigation measures where necessary.

- Assessment of the status of invasive flora species and weeds and recommendation to remove them where necessary.
- Inspection of areas cleared of weeds to detect any seedlings of invasive species.
- Monitoring of the health of all retained and planted flora, including identification of diseases and recommendations for treatment.



Figure 15.9.1 Monitoring of vegetation and trees along the hoarding line for unauthorised vegetation clearance and forest edge effects

15.9.1.2 Flora and Arboriculture Management Programme

The flora and arboriculture management programme aims to manage all matters related to the adequate and successful conservation of trees and vegetation within and adjacent to the contract boundary (up to 15 m from the contract boundary). The programme should include the following works:

Arboriculture Management Programme should include the following works:

Tree Mapping and Assessment

- Trees within the worksite boundary, including any construction access roads, shall be mapped and assessed by the Arborist before work commencement.
- Trees within the worksite boundary, including any construction access roads, shall be mapped and assessed by the Arborist. These specimens shall be tagged with a unique serial number.
- The physiological health, presence of pests and diseases, and structural stability shall be assessed for all trees, single-stemmed palms and strangling Ficus species of ≥ 1.0 m girth or spread, respectively.
- Species of conservation significance—i.e., listed in Red data book 3 as nationally Vulnerable, Endangered, Critically Endangered or Presumed Extinct (which indicates a rediscovery)— of ≥ 0.3 m girth or spread shall also be assessed. The locations, girth/spread, and height of these specimens shall also be recorded. These specimens shall be tagged with a unique serial number.
- The trees to be felled or retained shall be determined by the Arborist.
- A photographic report shall be provided for the trees affected by the proposed works.
- No trees shall be felled without prior approval from NParks.

Tree Protection

- Where there are trees to be retained within the worksite, specifications shall be formulated by the Arborist for the setting up of tree protection zones (TPZ) to meet NParks requirements

Sapling Harvesting

- Viable saplings and conservation significant trees that are suitable for harvesting shall be identified by the Arborist. Saplings or trees suitable for transplanting should:
  - Exhibit good physiological health and vigour
  - Have no structural defects
  - Have good branch form
- The root ball size to be extracted shall be based on the girth of the saplings or trees to be harvested as specified in Table 15.9.1.
- Prior to transplanting, dead branches and climbers shall be cleared from the plant and canopy load and spread will be reduced where necessary, in consultation with the Arborist.
- Manual trenching shall be carried out to determine the shape and size of root ball to be extracted. Where possible, feeder roots shall be retained without cutting.
- The root ball shall be burlapped with cellophane sheet to reduce desiccation effects. When directed by the Flora specialist or Arborist, leaves of the canopy may also need to be enclosed and covered by cellophane or clear plastic bags.
- The root ball shall be secured to the trunk to reduce risk of root ball disintegrating.
- When handling/carrying the plant, care shall be taken not to damage any vegetative parts.

Tree Transplanting

- Where trees and vegetation are moved or translocated within the Project area, the Arborist shall review the method statement proposed by the tree transplanting contractor and advise on additional recommendations necessary to ensure the tree's health during transplanting. The transplanting contract shall ensure in their best effort, intact and secured root balls at the point of extraction, during the lifting processes and during the installation at the receiving site. The transplant effort shall be documented for each individual tree to show intact root balls at all the stages mentioned. Transplanted trees shall be managed through adequate watering and monitoring of their health to ensure their long-term survival. Advice shall be sought from the Arborist if the tree exhibit signs of stress, e.g. peeling bark, withered leaves.

Site Clearance and Tree Felling

- The Contractor's method statements for site clearance, tree felling and setting up of TPZ shall be reviewed by the Arborist to ensure compliance to the specifications. The site clearance and tree removal method statements shall consider directional felling methods with a hinge and back cut. Trees shall not be removed by pushing with an excavator or other heavy machinery. Cranes shall be deployed to offset the tension of trunks in the direction of the drop. Interlocking canopy branches shall be pruned prior to tree felling.
- In cases where design changes may affect additional trees or the retained trees, the Arborist shall work with the structural engineers and recommend solutions that will meet NParks guidelines.
- Whenever reasonable and practicable, cleared vegetation at sloped areas shall be covered with mulch or with 100% biodegradable fauna-friendly ECBs to control erosion of exposed soil. Closed turfing to the exposed areas where possible and maintain proper storage of soil stockpiles to stabilise surfaces and minimise re-entrainment of dust and potential for erosion of waste spoil to watercourses.
- Clearance activities on-site shall not occur during rainfall or when storm events are forecast to occur within the vicinity to protect forest edge from wind throw. Where forest edges are exposed to wind, temporary measures (e.g., additional hoarding) shall be discussed with the Arborist, and put in place to protect the forest edge during storm events.
- During site clearance, care will be taken when removing trees in riparian zones to reduce impacts to the bed and banks of waterways.

- Where practicable, saplings, seeds and seed banks will be retained within the soil profiles for use in forest restoration.
- Horticultural waste shall be removed on the same day. This is essential to reduce risk of fauna taking refuge within the cleared waste if left overnight.

Tree Maintenance and Care

- Where disease outbreaks are identified, the Arborist and/or Flora Specialist shall advise measures to manage them. Measures can include using selected insecticides/fungicides to control outbreaks; reduction of stressors (dust, water, etc.). The plant may be removed or quarantined if it poses a threat to surrounding individuals.
- Where forest edges are exposed following site clearance and where impacts to vegetation are evident (e.g., vegetation shows signs of drying out), additional watering shall be carried out to improve moisture differentials around forest edges.
- The use of herbicides, pesticide shall be minimised. If herbicides or pesticides are used within the Project area, techniques that limit spray or non-target spray drift shall be used. These techniques include but are not limited to cut and paint techniques and drilling injection. All use of herbicides and pesticides shall be conducted in accordance with the relevant Material Safety Data Sheet (MSDS). Any incidents of off label use, spillage or damage to non-target species shall be reported and investigated.
- When the site experiences seven continuous days without rainfall, the Contractor shall carry out additional watering of conserved trees within the TPZs and at the forest edge (up to 10 m) around the development boundary.

Post heavy rainfall, any snapped hanging branches that pose imminent hazards to workers within the site should be removed immediately.

Table 15.9.1 Minimum root ball diameter to girth requirements

Girth (m)	Minimum root ball diameter to extract (m)
<0.1	0.4
0.1–0.2	0.6
0.2–0.3	0.8
0.3–0.4	1.2
0.4–0.5	1.5
>0.5	To be determined by Arborist

Flora Management Programme should include the following works:

Verification and Review of Footprints for Hoarding, Access Roads and Soil Investigation Works

- After the worksite hoarding has been installed, the Flora Specialist shall conduct and inspection to verify that the footprint is as proposed, and that no excessive vegetation and tree removal has occurred because of deviations in the hoarding alignment.
- The Flora Specialist shall review the proposed locations for the soil investigation works and the alignment of the construction access roads with the Client/Contractor. Feasible alternatives, if possible, shall be proposed to minimise vegetation and tree clearance.

Weed and Invasive Species Management

- Weeds and invasive species shall be cleared from the Project area progressively and shall be separated and transported to an appropriate disposal location. Transport shall occur within a covered vehicle to ensure seed/vegetative matter does not dislodge. All vegetative matter and seeds will be rendered inert at the disposal location through incineration at a licensed waste disposal facility. The Project area shall be carefully cleared of all remaining vegetative matter from the weeds/invasive species. Herbicides may be used to render any stumps/root systems inert. The cleared area shall be inspected monthly to detect any seedlings of invasive species. These seedlings shall be killed using approved herbicides or removed by hand weeding. Any seedlings or vegetative matter that may sprout will be disposed of at a licensed waste management facility.
- Specific measures shall be undertaken to control and manage flora species within the Project area that have been identified to be invasive (i.e., Spathodea campanulata, Cecropia pachystachya, Falcataria

falcata). The Ecologist shall be consulted when managing Falcataria falcata groves as tall trees may serve as nesting sites for birds of prey. The Ecologist shall also be consulted for other weed and invasive species that may also provide important foraging resources. Material imported into the Project area shall be checked for contamination from weeds/invasive species seeds/vegetative matter at source. This is particularly important for imported building materials, such as clay and soil. Source site shall be inspected to determine presence of weeds/invasive species. Where weeds or invasive species are identified, alternative supply sources or decontamination shall occur before the material is transported to site.

Reforestation Planting Palette and Plant Salvaging for Reforestation And Landscaping

- The planting palette including all flora and grasses used for reforestation and other landscape planting shall be from native indigenous stock or non-native species that are not listed as weeds or invasive species or have a low seeding rate.
- All trees transplanted into the Project area shall have local provenance or will be from within the Johor region for all SRDB and IUCN listed species. Other species shall be obtained within the larger Sunda region. Due diligence shall be conducted on suppliers to ensure that the trees are obtained by legal means and are able to be exported/imported to Singapore. All imported trees shall be inspected and/or undergo quarantine if required to reduce the chance of transmission of weeds and soil pathogens.
- The success of planting within landscape features shall be monitored. Where a planting strategy is not working, an alternative planting strategy shall be developed suitable for the location. Temporary measures shall be employed to reduce stress on planted individuals. The removal of sources of stress (such as dust) may also be required. If disease outbreaks are present, methods shall be used to control the outbreak or remove the diseased individual.
- The flora specialist shall also identify other plant material, including ferns, epiphytes, orchids, shrubs, grasses, etc. that are of conservation value and work with NParks for the extraction of these plants by NParks to other sites.
- The flora specialist shall formulate a salvaging protocol in consultation with NParks if salvaging of plant material is being carried out on site.

The flora specialists, arborists and the arboriculture contractor engaged should meet the expected qualifications as described in Section 15.4.5 and Section 15.5 respectively.

Additionally, the Contractor should fulfil the following:

- The Contractor and the attending arborist shall complete the ‘Verification of Tree Protection Checklist’ prior to the start of site clearance; and
- The Contractor shall instil discipline and raise awareness amongst all personnel on measures and mitigations to prevent damage to retained and protected trees throughout construction by including reminders on tree conservation guidelines within their daily toolbox briefings to workers and crane/excavator operators.

15.9.1.3 Fauna Monitoring Programme

Fauna monitoring surveys should comprise of transect surveys and site inspection surveys conducted together, at within and outside of hoarded areas. The programme should include the conducting of monthly diurnal and nocturnal fauna and site inspection surveys beginning one month prior to construction and ending two months after reinstatement. This includes both faunistic surveys, monthly fauna site inspections, and daily roadkill surveys. The requirement or necessity of the type and taxon to be surveyed should be decided in consultation with NParks.

15.9.1.3.1 Faunistic Surveys

Faunistic surveys are recommended to be conducted along terrestrial sampling routes, and should target the following fauna groups: odonates (dragonflies and damselflies), butterflies, herpetofauna (amphibians and reptiles), birds, and mammals. Comparison of species presence can be made with the baseline studies, where appropriate, to provide an indication of the changes in fauna diversity.

The methodology for the faunistic surveys should closely follow that implemented for this EIA, so as to ensure that the data collected can be used to compare against the baseline data.

Further details of the surveys should be determined in consultation with NParks and should consider construction phases, final construction footprint, final development hoarding plan, and baseline studies.

15.9.1.3.2 Site Inspections

The following should be inspected for during monthly fauna site inspections (Figure 15.9.2):

- Visual inspection of sensitive habitats in the vicinity (e.g., streams, forests) to determine if the construction has damaged or affected them
- Presence of trapped/injured/dead fauna
- Potential fauna entrapments (e.g., ECBs, TPZs, pits, drains, ponds, trenches, tanks)
- Gaps in hoarding that may allow entry of ground-dwelling fauna
- Improperly disposed/stored food and food packaging
- Degradation of adjacent sensitive habitats (e.g., streams, forest)
- Reporting and documentation of all findings and recommendations



Figure 15.9.2 Photographs showing monthly fauna monitoring and inspection on-site

15.9.1.3.3 Daily Roadkill Surveys

Daily roadkill surveys shall be conducted by the ECO along roads adjacent to the worksite, up to 500 m from the worksite boundary. A roadkill and investigation register shall be maintained. Appropriate mitigation measures shall be implemented where necessary.

15.9.1.4 Fauna Management Programme

Fauna management programme is applicable within and around all designated work areas. This includes pre-site clearance inspections and continued biodiversity awareness training for the site team, tree felling inspections, and fauna response plan in event of animal encounters. The objectives of fauna management are as follows:

- Minimise negative impacts to fauna, particularly to species of conservation interest;
- Inspect hoarded areas for breaches that may allow smaller animals to enter;
- Prevent human-wildlife conflicts;
- Monitor presence of trapped, injured, or dead fauna inside hoarded areas;
- Track and compare presence of targeted fauna groups within and outside of hoarded areas; and
- Complete the Fauna Inspection Form during each survey

15.9.1.4.1 Biodiversity Awareness Training

The Ecologist shall conduct toolbox briefings on biodiversity awareness to inform site personnel of but not limited to the following:

- Ecological value of the site and its surrounding habitats
- Types of fauna present
- Biodiversity protection strategies
- Site personnel's responsibilities towards biodiversity
- How to respond to fauna encounters
- No feeding of wildlife
- Prevention of roadkills
- Inspection of trees before felling
- All site personnel shall undergo biodiversity awareness training prior to commencing work at on-site, and regularly (every six months) throughout the duration of the construction. Documentation of such trainings and briefings shall be maintained.

15.9.1.4.2 Pre-site Clearance Inspection

Pre-site clearance inspection should be adopted together with mitigating measures of directional site clearance. During the site preparation phase, passive wildlife shepherding and tree-felling inspection should be done. The site clearance should be executed outside of the key bird breeding season (December to July) where possible. The protocol specified in the Wildlife shepherding and pre-felling inspection technical notes published by NParks [P-58] must be followed.

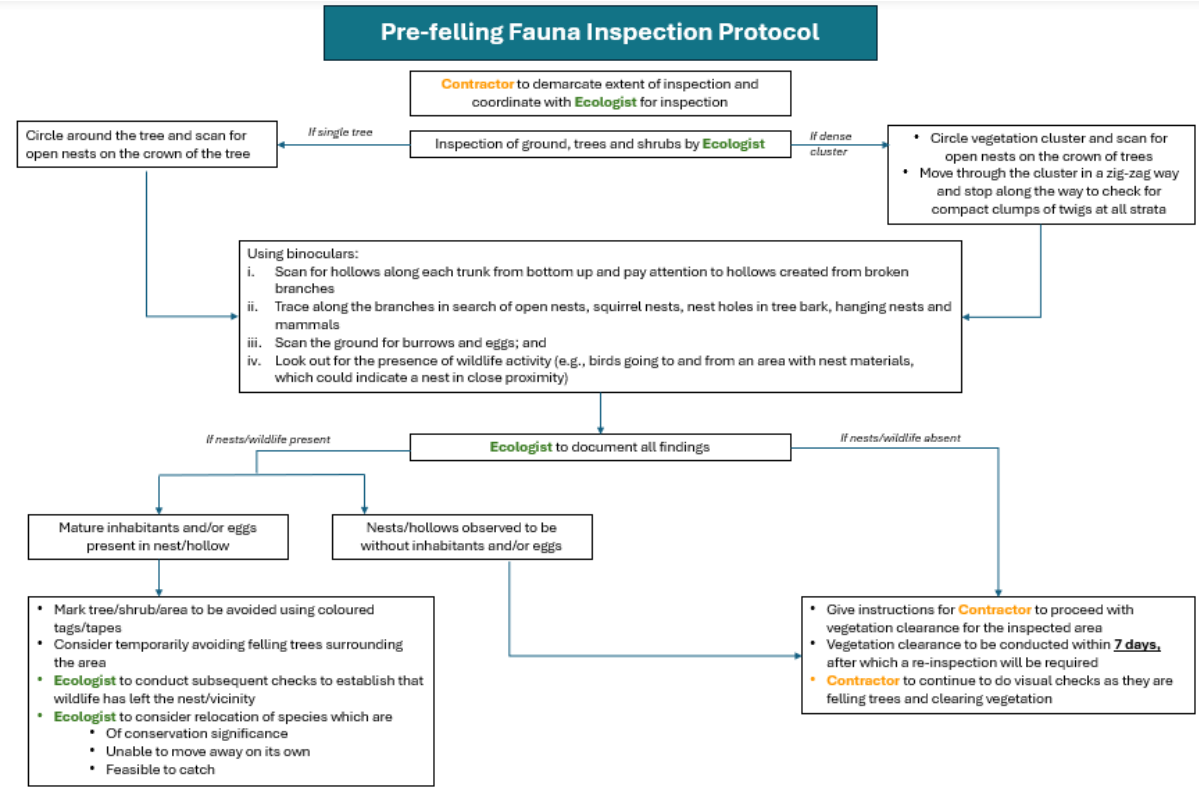


Figure 15.9.3 Pre-felling inspection protocol

15.9.1.4.3 Wildlife Response Plan

The Wildlife Response Plan (Figure 15.9.4) should be activated when encountering trapped, injured, dead or dangerous animal around or within the worksite. The plan aims to minimise animal injury and mortality by responding appropriately to various scenarios, which should be highlighted during toolbox briefings. All wildlife encounters must be documented within 24 hours using the Wildlife Incident Form (Appendix N).

If species of conservation significance are affected by the development, relocation efforts should be planned (e.g., bamboo bats). An unobstructed escape route should be designed to channel wildlife out of the development site without trapping them through proper directional clearance. Wildlife exits should be installed at every 30 m interval along the forested edge as part of the designed escape route (Figure 15.9.5) [P-58].

In scenarios where certain animal groups are encountered around or within the worksite, certified wildlife management specialists should be contacted to handle the animal according to the public registry by NParks [W-33].

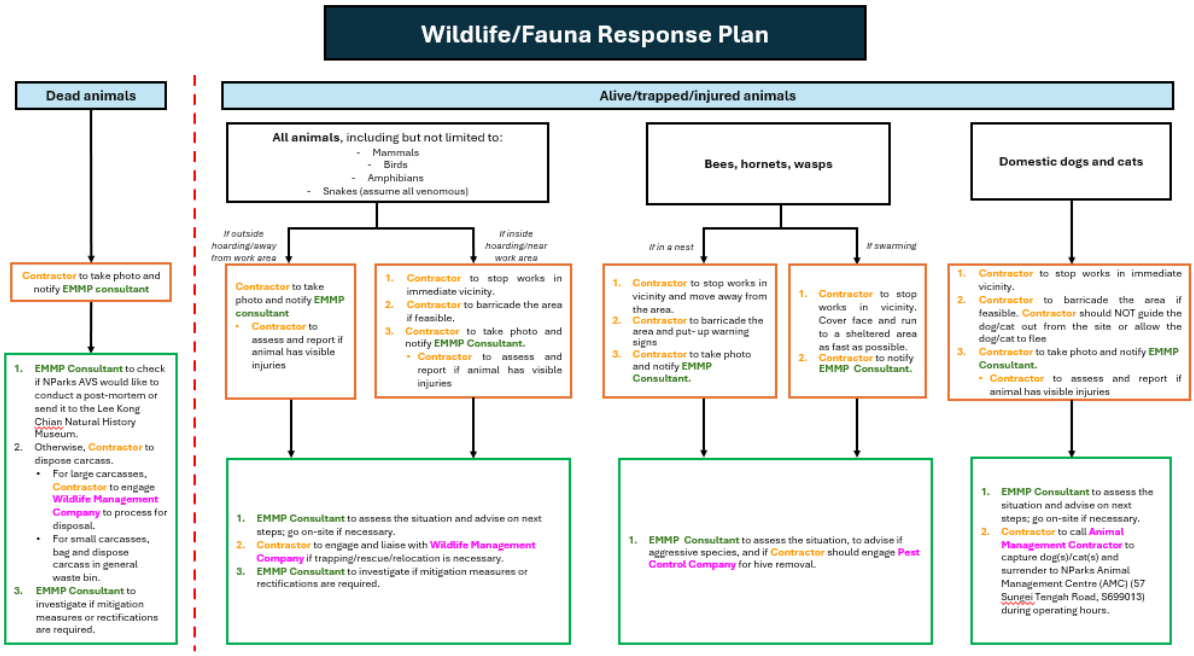


Figure 15.9.4 A flowchart of the wildlife response plan

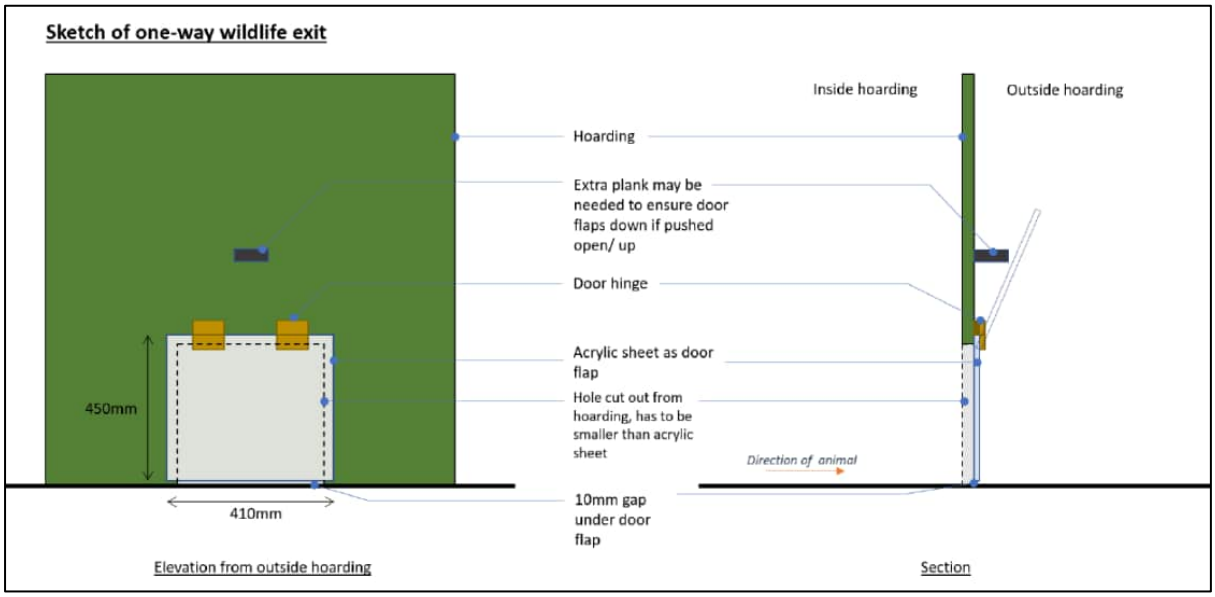


Figure 15.9.5 Example of one-way flap door to allow fauna to exit independently

15.9.2 Operational Phase

The implementation of biodiversity related operational EMMP only be required when the development site is in the vicinity of green areas in this EIA Study Area.

At the operational phase, arboriculture services are normally not under the Contractor. Subsequently, the management of flora and fauna are also not expected of the Contractor. However, flora and fauna monitoring might still be expected of Contractor. More importantly, it is still important to monitor flora and fauna during post-construction through to at least a year into the operational phase to account for seasonality. This will allow contractor to review the effectiveness of mitigation measures proposed during design phase and rectify biodiversity problems that arise due to operational works.

15.9.2.1 Flora Monitoring Programme

The flora monitoring aims to assess the impacts of operational works to surrounding vegetation and/or adjacent forest, and rectify issues when identified. The programme should include the following:

- Assess impact of operational on the physiological health and structural stability of CS species, habitat, and trees within the RAC and in proximity to the development;
- Determine whether there has been poaching of CS species within the RAC or excessive and unauthorised removal of vegetation and trees beyond the development boundary;
- Monitor and assess potential edge effects (e.g., predictable failures, accelerated growth of climbers on canopy, change in species composition at the edge) within vegetation adjacent to the development;
- Determine if there was unauthorised dumping of rubbish (e.g., food materials), construction debris and materials, oil/chemical leakage that may contaminate soil waterbodies, from post-construction water bodies post-construction.

15.9.2.2 Fauna Monitoring Programme

The fauna monitoring aims to assess the impacts of operational works to fauna residing within adjacent forest, and rectify issues when identified. The programme should include faunistic surveys. Faunistic surveys are recommended to be conducted along terrestrial sampling routes and aquatic sampling points, and should target the following fauna groups: odonates (dragonflies and damselflies), fish, butterflies, herpetofauna (amphibians and reptiles), birds, and mammals. The methodology for the faunistic surveys should closely follow that implemented for this EIA, so as to ensure that the data collected can be used to compare against the baseline data and data from construction monitoring. Comparison of species presence can be made with the baseline studies, where appropriate, to provide an indication of the changes in fauna diversity.

However, it should be noted that at the time of report writing, the Project is at master planning stage. Depending on the actual development and its location, the requirement of monitoring may vary and should be decided in consultation with NParks.

15.10 Hydrology and Water Quality Monitoring Programme Requirement

15.10.1 Construction Phase

In order to ensure that procedures are followed appropriately, the construction phase of the projects should be accompanied by an EMMP. Water quality monitoring is essential as discharge of excess contaminants, especially pH, nutrients and heavy metals, may lead to severe consequences (e.g. algae blooms).

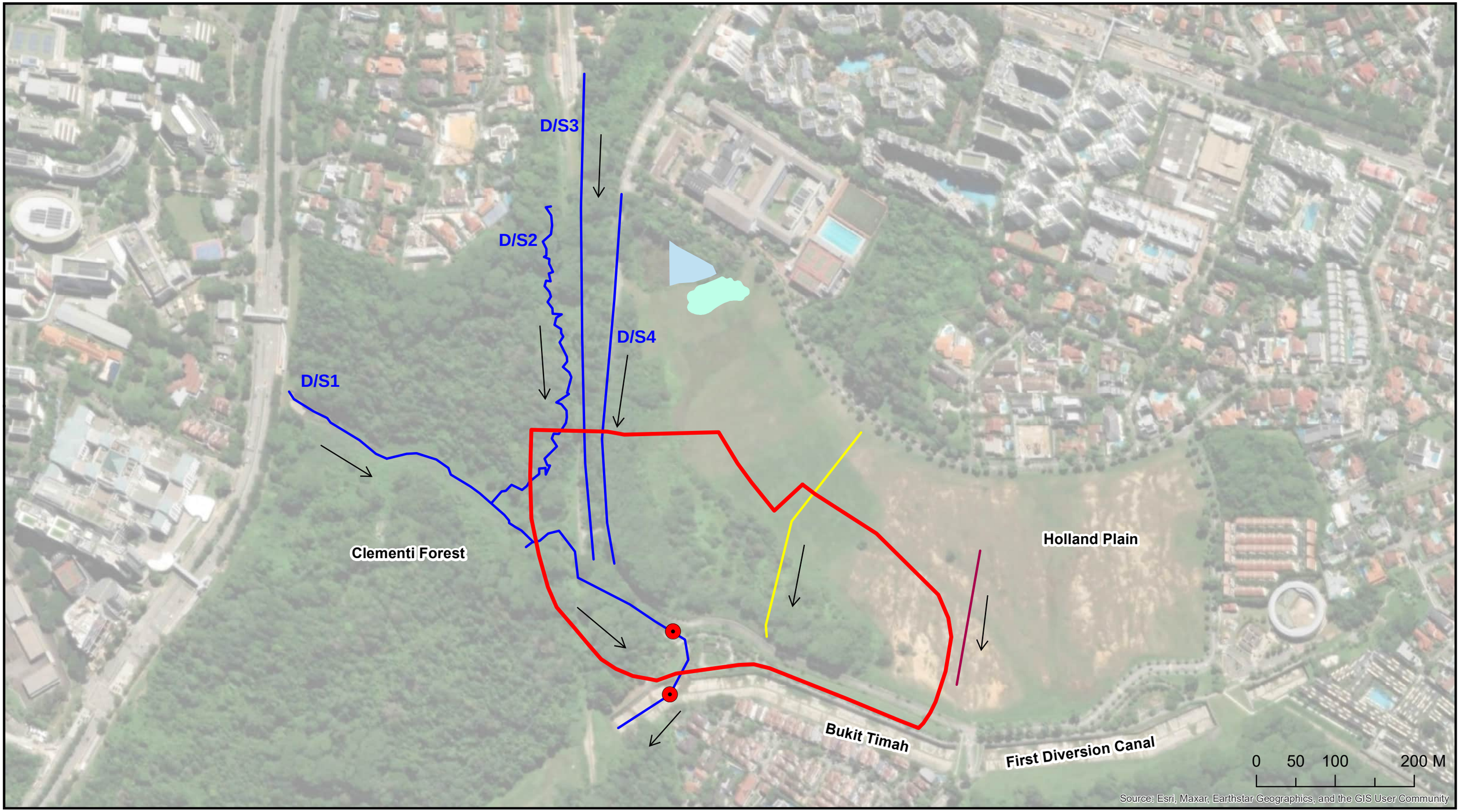
Discharges via settling ponds will take place during the construction phase, therefore monitoring of ECM discharge waters was recommended to be undertaken to ensure compliance with the relevant standards. It was also recommended to monitor their water quality throughout the construction period to ensure minor construction impacts on their water quality. For all discharge points from construction worksites, it is recommended to monitor water quality following Singapore NEA's Allowable Limits for Trade Effluent Discharge to Sewer/Watercourse/Controlled Watercourse. Meanwhile, the water quality of sensitive natural streams should also be recorded and compared with the water quality criteria for aquatic life as listed in Table 15.10.1 to make sure the aquatic condition will not be impacted by the construction activities.

Table 15.10.1 Recommended monitoring program during construction phase (surface water quality)

Test	Parameters	Monitoring Recommendation and Frequency
In-situ	Temperature	Online real time monitoring for TSS at the discharge point location(s) at all the construction sites throughout the construction period. Monthly monitoring for temperature, pH, conductivity, TDS and DO at all the discharge point locations at the construction sites throughout the construction period. and also at nearby ecologically sensitive watercourse D/S1 and downstream of Bukit Timah Diversion Canal (refer to Figure 15.10.1).
	pH	
	Conductivity	
	Total Dissolved Solids (TDS)	
	Turbidity and Total Suspended Solids (TSS)	
	Dissolved Oxygen (DO)	
Ex-situ	Biochemical Oxygen Demand (BOD_5)	

Test	Parameters	Monitoring Recommendation and Frequency
	Chemical Oxygen Demand (COD)	Monthly monitoring for all the ex-situ parameters at the discharge point location(s) if discharging during the construction period. and also at watercourse D/S1 and downstream of Bukit Timah Diversion Canal (refer to Figure 15.10.1).
	Total Nitrogen (TN)	
	Nitrate (NO_3-N)	
	Total Phosphorus (TP)	
	Orthophosphate (PO_4)	
	Total Organic Carbon (TOC)	
	Oil & Grease (Total)	
	Oil & Grease (Hydrocarbon)	
	Lead (Pb)	
	Zinc (Zn)	
	Mercury (Hg)	
	Aluminium (Al)	
	Antimony (Sb)	
	Arsenic (As)	
	Barium (Ba)	
	Beryllium (Be)	
	Boron (B)	
	Cadmium (Cd)	
	Chromium (Cr)	
	Copper (Cu)	
	Cyanide	
	Iron (Fe)	
	Manganese (Mn)	
	Molybdenum (Mo)	
	Nickel (Ni)	
	Selenium (Se)	
	Silver (Ag)	
	Sulphide	
	Tin (Sn)	
	Enterococcus	

Beside the water quality monitoring, hydrological conditions of drainage system within construction site and at immediate vicinity should also be closely monitored during construction phase. Before draining to public drains or waterbodies, surface runoff from the construction site should be drained to the ECM treatment system to be filtered and to reduce peak runoff. The hoarding and perimeter drains should be inspected daily to ensure no surface runoff flowing out from the site untreated and no clogging which would affect the flow capacity of the drains/streams. During heavy storm event, site inspection should be carried out to ensure no flooding. Monthly inspection on the site should also be carried out by EMMP Consultant.



Legend

- Study Area
- Indicative EMMP monitoring points
- Waterbodies
- Planned drain
- Planned interim drain
- Retained old marsh
- New Freshwater Marsh

N

Rev.	Date	By	Description	Chk'd	App'd
1	MAY 2025	LHN	Holland Plain EIA	LAL	ADP
-	MAC 2025	LHN	Holland Plain EIA	LAL	JAG

Qualified Person Endorsement : NA

URA Endorsement : NA

Consultant : AECOM

Client: URBAN REDEVELOPMENT AUTHORITY

Project Title :

CONTRACT URA/T/23/048
HOLLAND PLAIN
ENVIRONMENTAL IMPACT ASSESSMENT

Figure Title :

Indicative EMMP monitoring points during construction phase

Designed	Checked	Approved
LHN	LAL	ADP
	Drawn: LHN	Date: MAY 2025

Figure No. : 15.10.1 | Rev. 1 | Sheet 1 of 1

CAD File Name : NA | A3

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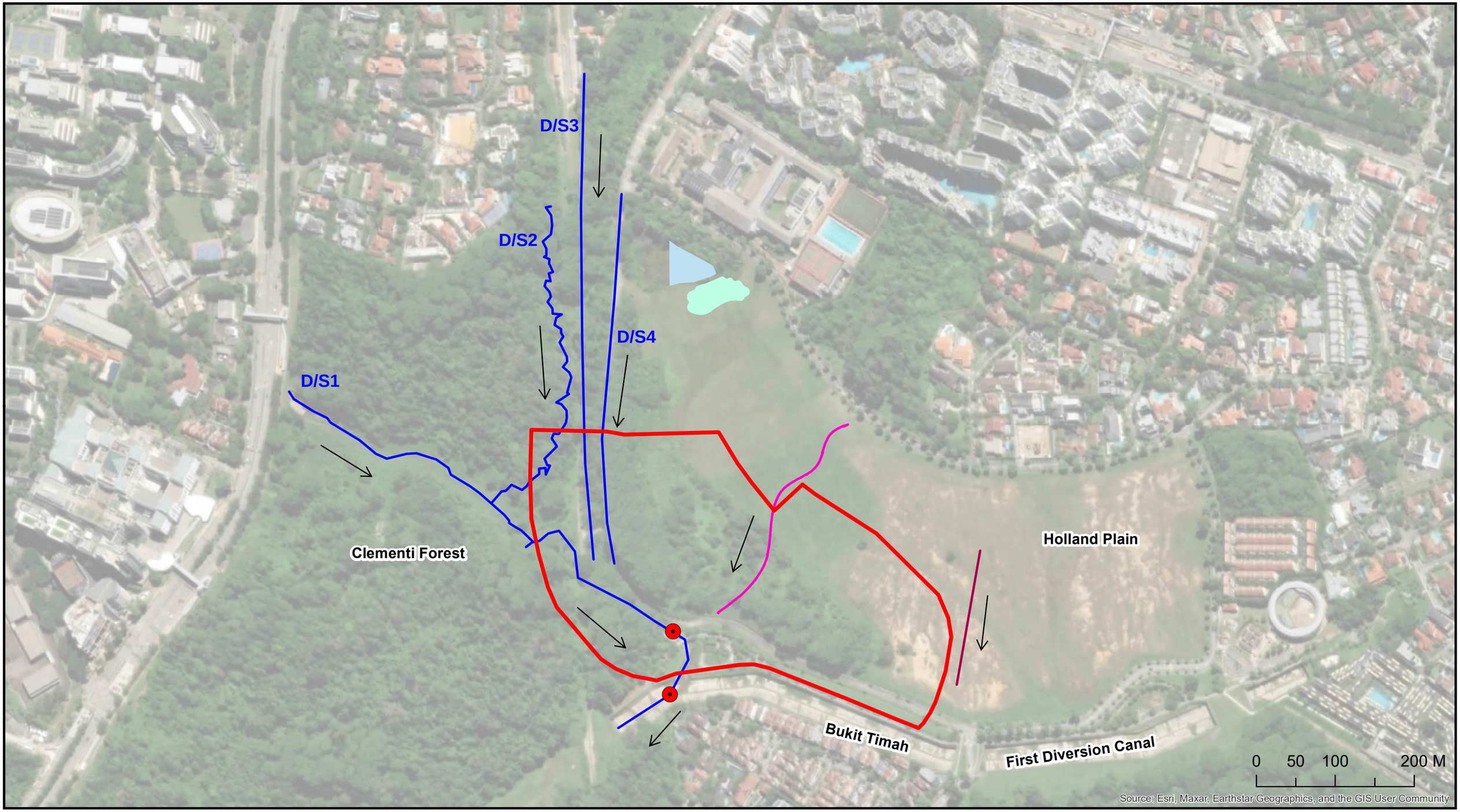
15.10.2 Operational Phase

The operational phase of the projects should be accompanied by an EMMP to ensure the proposed development will have minor impact on the surrounding watercourses, which will only be required when the development site is in the vicinity of green areas in this EIA Study Area. Water quality monitoring is essential as discharge of excess contaminants, especially pH and suspended solids may lead to severe consequences (e.g. water with less clearance) due to the operational activities. It was recommended to monitor their water quality during the first three (3) months of operational period to ensure minor operational impacts on their water quality. For main outlets/drains of the Project footprint, it is recommended to monitor water quality following Singapore NEA's Allowable Limits for Trade Effluent Discharge to Sewer/Controlled Watercourse. Meanwhile, the water quality of sensitive natural streams should also be recorded and compared with the water quality criteria for aquatic life as listed in Table 7.2.1 to make sure the aquatic condition will not be impact by the operational activities.

Table 15.10.2 Recommended monitoring program during operational phase (surface water quality)

Test	Parameters	Monitoring Recommendation and Frequency
In-situ	Temperature	Monthly monitoring for all the in-situ parameters at the main outlets/drains and at ecologically-sensitive watercourse D/S1 and downstream of Bukit Timah Diversion Canal (refer to Figure 15.10.2), during the first three (3) months of operation period.
	pH	
	Conductivity	
	Total Dissolved Solids (TDS)	
	Turbidity and Total Suspended Solids (TSS)	
	Dissolved Oxygen (DO)	
Ex-situ	Biochemical Oxygen Demand (BOD_5)	Monthly monitoring for all the ex-situ parameters at the main outlets/drains and at ecologically-sensitive watercourse D/S1 and downstream of Bukit Timah Diversion Canal during the first (3) months of operation period.
	Chemical Oxygen Demand (COD)	
	Total Nitrogen (TN)	
	Nitrate (NO_3-N)	
	Total Phosphorus (TP)	
	Orthophosphate (PO_4)	
	Total Organic Carbon (TOC)	
	Oil & Grease (Total)	
	Oil & Grease (Hydrocarbon)	
	Lead (Pb)	
	Zinc (Zn)	
	Mercury (Hg)	
	Aluminium (Al)	
	Antimony (Sb)	
	Arsenic (As)	
	Barium (Ba)	
	Beryllium (Be)	
	Boron (B)	
	Cadmium (Cd)	
	Chromium (Cr)	
	Copper (Cu)	
	Cyanide	
	Iron (Fe)	
	Manganese (Mn)	
	Molybdenum (Mo)	
	Nickel (Ni)	
	Selenium (Se)	
	Silver (Ag)	
	Sulphide	
	Tin (Sn)	
	Enterococcus	

For the hydrological condition monitoring during operational phase, drainage system within the site and at immediate vicinity should be inspected especially during heavy storm event to ensure no flooding. Monthly inspection on the site should be carried out by EMMP consultant during the first three (3) months of operation period if required.



Legend

- Study Area
- Indicative EMMP monitoring points
- Waterbodies
- Planned drain
- Planned bioswale
- Retained old marsh
- New Freshwater Marsh

N

Rev.	Date	By	Description	Chk'd	App'd
1	MAY 2025	LHN	Holland Plain EIA	LAL	ADP
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Qualified Person Endorsement : NA

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Consultant : AECOM

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Project Title :

CONTRACT URA/T/23/048
HOLLAND PLAIN
ENVIRONMENTAL IMPACT ASSESSMENT

Figure Title :

Indicative EMMP monitoring points during operational phase

Designed	Checked	Approved
LHN	LAL	ADP
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Figure No. : 15.10.2 | Rev. : 1 | Sheet : 1 of 1

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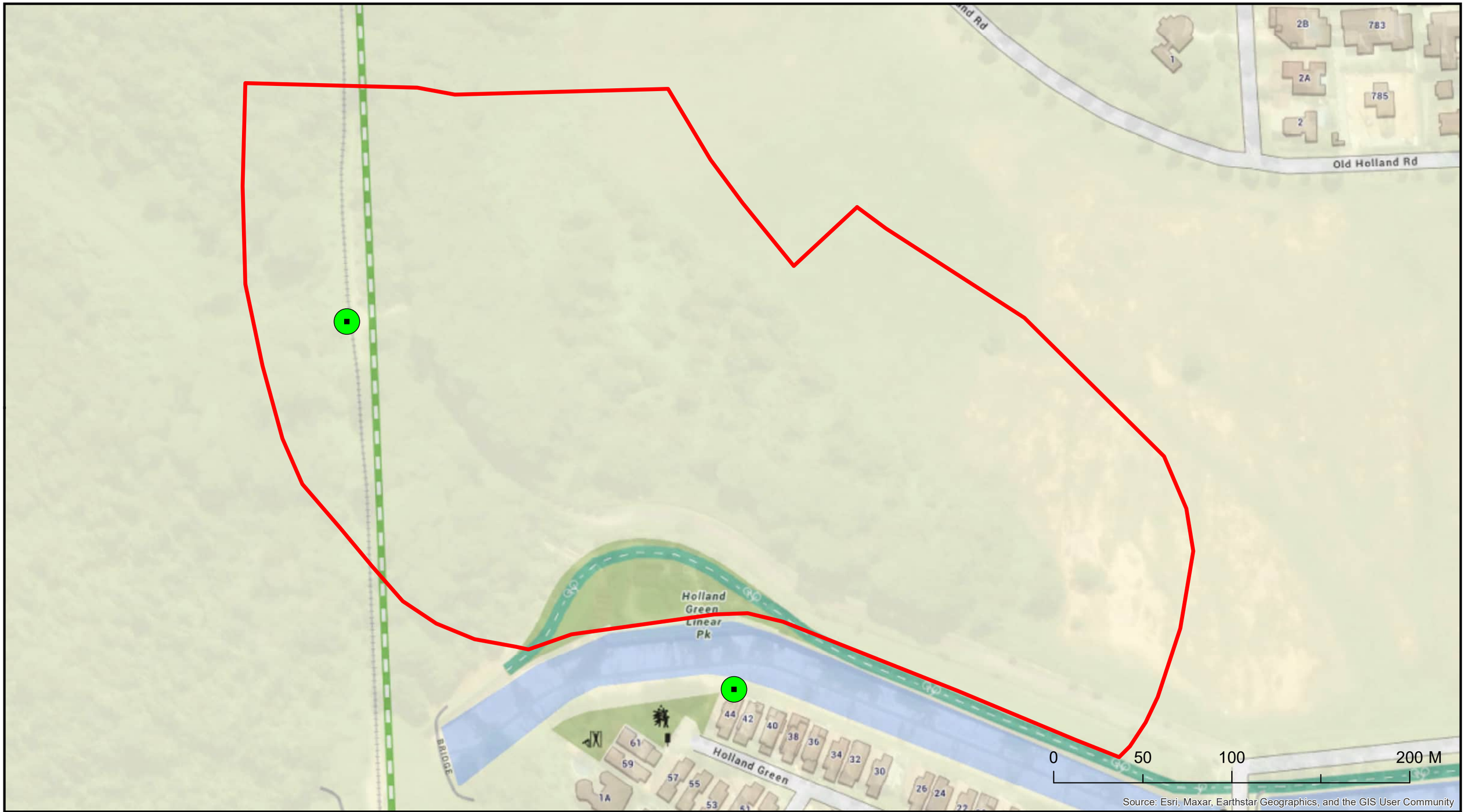
15.11 Air Quality Monitoring Programme Requirement

15.11.1 Construction Phase

As noted in the mitigation measures (Section 12.3.1), continuous dust monitoring shall be undertaken during the construction phase. Continuous PM_{10} and $PM_{2.5}$ monitoring is recommended due to the potential of High consequence dust impact conducted within the ecological sensitive receptors and also a few human receptors during construction phase. Based on a review of sensitive receptors around the construction worksite areas, a continuous monitoring program as per Table 15.11.1 is proposed to be conducted during project construction at the indicative locations. The selected indicative locations are chosen as representative locations, for ecological and human receptors near the Project Site, which are required to be monitored during construction phase. The indicative locations shall be assessed and confirmed by the appointed EMMP consultant prior to the monitoring.

Table 15.11.1 Recommended monitoring program during construction phase (air quality)

Location	Parameters	Frequency and Duration	Triggers
• Rail corridor near the Project Site • 44 Holland Green	PM_{10} and $PM_{2.5}$	1-week monitoring of mentioned parameters at each selected location before commencement of construction phase	Investigation and corrective actions to be taken, when any of the following documentation are found inadequate / missing: • Air Pollution Control Plan; Compliance certificate of an Off-Road Diesel engine; or Monitoring Log. • If the monitored parameters exceed Singapore long term air quality targets. • If complaints are received due to project activities. • If visual non-compliance to any of the minimum control or mitigation measures are observed on-site.
• Rail corridor near the Project Site	Dust monitoring	Continuous dust monitoring during site clearance and earthworks stages	
• 44 Holland Green	PM_{10} and $PM_{2.5}$	Continuous monitoring of mentioned parameters during site clearance and earthworks stages Bi-annual 1-month monitoring of mentioned parameters at each selected location during construction phase after completion of earthworks and site clearance stages (i.e., during roadworks and building construction works)	



Legend

- Indicative EMMP Air Monitoring Location
- Study Area

N

Rev.	Date	By	Description	Chk'd	App'd
-	MAR 2025	TTR	Holland Plain EIA	KAM	JAG

Qualified Person Endorsement : NA

URA Endorsement : NA

Consultant : AECOM

Client: Urban Redevelopment Authority

Project Title :

CONTRACT URA/T/23/048
HOLLAND PLAIN
ENVIRONMENTAL IMPACT ASSESSMENT

Figure Title :

Indicative EMMP air monitoring locations

Designed	Checked	Approved	Figure No. :	Rev.	Sheet
TTR	KAM	JAG	15.11.1	-	1 of 1
	Drawn TTR	Date MAR 2025	CAD File Name : NA		A3

Note: Source of basemap - Onemap

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15.11.2 Operational Phase

During operational phase, ambient air quality monitoring may not be required.

15.12 Airborne Noise Monitoring Programme Requirement

15.12.1 Construction Phase

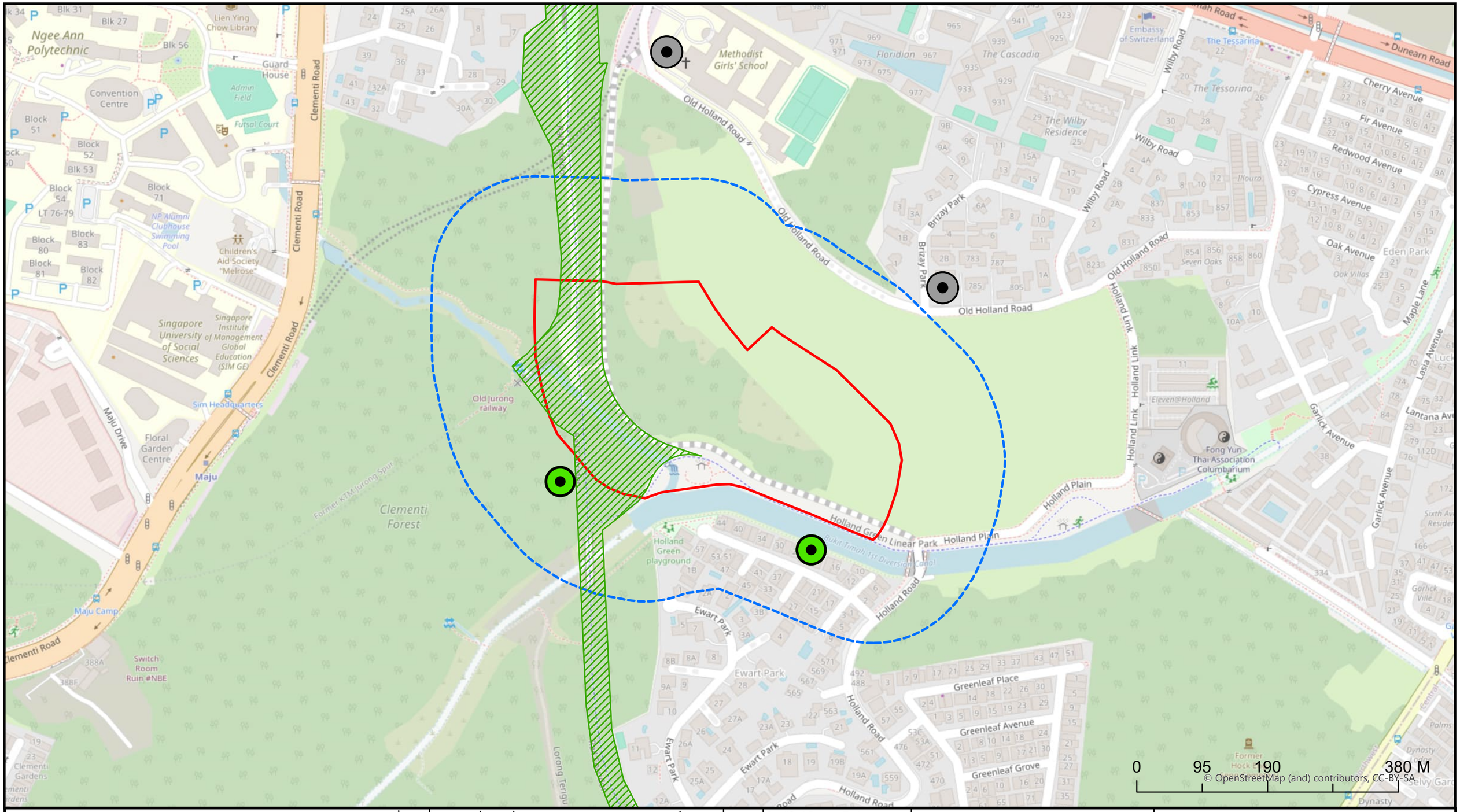
As noted in Section 12.4.1, airborne noise monitoring programme can be implemented if required. Based on a review of sensitive receptors around the Project construction worksite, a continuous monitoring program as per Figure 15.12.1 is proposed to be conducted at the minimum during Project construction. NM01 has been chosen to represent the noise levels experienced by noise-sensitive ecological receptors within the forested area in the southwest portion of the Project site. Similarly, NM02 has been selected to represent the noise levels experienced by human NSRs residing near Holland Green. As quantitative noise impact assessment was not conducted at the pre-design stage, AECOM recommends that the developer/ developing agent engage an Airborne Noise Consultant(s) to conduct quantitative noise impact assessment as mandated by law at the detailed design stage. Two noise monitoring locations on the northern side of the study area are also depicted in Figure 15.12.1 due to the presence of NSRs in the northern region. However, concurrent projects, such as the development of residential areas in the northeastern half of Holland Plain and the construction of King Albert Park Station as part of the CRL2 project, will commence earlier than this project and are expected to have a greater noise impact on the NSRs in the northern area due to their closer proximity to the receptors. Therefore, responsibility for these two northern noise monitoring locations should fall under the jurisdiction of the contractors for those projects.

Table 15.12.1 Recommended airborne noise monitoring programme during construction phase

No.	Location	Parameters	Frequency and Duration
1	Forested area in the south-west of the Project Site (NM01)	$L_{Aeq(12\ hours)}$, $L_{Aeq(1\ hour)}$ and $L_{Aeq(5\ mins)}$	For construction phase: pre-construction baseline and continuous monitoring for the entire duration of the construction phase of the aforementioned parameters at all locations.
2	20 Holland Green (NM02)		

15.12.2 Operational Phase

No noise monitoring programme were proposed for the operational phase due to the lack of information required regarding the air conditioning and mechanical ventilation (ACMV) system designs and traffic volumes. Usually conducted by an appointed Noise Consultant, AECOM recommends that the works for ACMV boundary noise impact assessment and traffic noise impact assessment be conducted as part of the detailed design process of the Project in accordance with the NEA guidelines as discussed in Section 12.4.2.



Legend

- Study Boundary
- Noise Study Area (150m-buffer)
- Rail Corridor Boundary
- Indicative Airborne Noise Monitoring Location
- Probable Noise Monitoring Locations for Concurrent Projects

N

Rev.	Date	By	Description	Chk'd	App'd
-	JAN 2025	SHA	Holland Plain EIA	LAL	JAG

Qualified Person Endorsement : NA

URA Endorsement : NA

Consultant : AECOM

Client: Urban Redevelopment Authority

Project Title :

CONTRACT URA/T/23/048
HOLLAND PLAIN
ENVIRONMENTAL IMPACT ASSESSMENT

Figure Title :

Indicative EMMP
airborne noise monitoring locations
during construction

Designed	Checked	Approved	Figure No. :	Rev.	Sheet
SHA	LAL	JAG	15.12.1	-	1 of 1
	Drawn SHA	Date JAN 2025	CAD File Name : NA		A3

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15.13 Vector Monitoring Programme Requirement

This section provides a vector monitoring programme to minimise the occurrence of potential impacts of vector populations near the Project Site during the construction and operational phase, whose occurrence and growth may be a result of the Project activities. Vectors are defined as any insect, including its egg, larva or pupa, and any rodent, including its young, carrying or causing, or capable of carrying or causing any disease to human beings. As such, they pose a risk to public health and should be controlled and eliminated.

In recent years, virulent vector problems have been mostly attributed to mosquitoes and rats. Mosquitoes are the most widely known disease vector, that can transmit the dengue virus. The common breeding habitats in a construction site that can cause the accumulation of stagnant water would include material storage area, site office, empty containers at workers area, water tanks at construction area and so on. If left uncontrolled, it may lead to mosquito breeding. Hence, as an effective and targeted approach, it is important to reduce/eliminate conditions that create these suitable breeding habitats in order to control the mosquito population within the Project Site. Rodent (including rats) infestations are problematic as they can spread diseases through their urine and droppings and chew up wires, pipes and insulation [W-34]. They tend to find new habitats easily and can repopulate quickly at locations with ample food, water and shelter available – which are typically found in hawker centres and vicinity of food waste bins. The removal of potential food sources and areas of harbourages can help prevent the nesting and breeding of rodents, and thus prevents rodent infestations [W-18]. At a construction worksite, there may be poorly maintained food-waste bins, poor refuse management and a lack of housekeeping practices onsite. As such, rodents may thrive in these environments as food, water and shelter are readily available. This section will focus on preventing the creation of such breeding grounds for these two types of vectors.

15.13.1 Construction Phase

This vector monitoring program is dedicated for the construction worksites of this Project only. Areas outside of the Project Site is not within the Project's authority and minimum control measures shall be carried out by each household or its housing/ school/ building/ public committee and other relevant party according to the stipulated legislations and guidelines. All construction worksites were identified to be the potential sources of vector impact due to accumulation of stagnant water, poor housekeeping and improper waste handing, transfer and storage of waste onsite. Vector-breeding may lead to severe consequences such as the spread of virulent diseases (e.g. dengue fever) both to the workers onsite and to other people near the worksite.

Aligning with NEA's Code of Practice for Vector Control Operator, Technician and Worker [W-21] and NEA's Mosquito and Rodent Control Measures [W-18, W-19], the Contractor shall submit a site-specific Vector Control Plan upon contract award, which encompassing the following elements:

Pre-existing Conditions: To conduct a site assessment and establish vector baseline, which serves to identify high-risk areas for vectors-breeding and eliminate pre-existing vector issues before starting work. Information on the existing dengue clusters and areas with higher Aedes aegypti mosquito population can be reviewed on NEA' websites [W-22, W-23].

Vector Control Plan: To develop plan in case that any person found on site is discovered to be a carrier of vector-borne disease, and when outbreak of dengue or mosquito breeding ground is detected on site.

For the implementation of Vector Control Plan, the Contractor shall provide competent personnel on site as follows:

A registered ECO who undergone relevant trainings (e.g. Joint ITE-NEA Certificate in Pest Management for ECO or equivalent) shall be appointed by the Contractor to assist in investigating vector-borne disease on site as part of the ECO's responsibilities stated in NEA's Code of Practice for Environmental Control Officers (ECO) [W-21].

An in-house pest control team with competent personnel who have undergone relevant trainings (e.g. ITE-NEA Certificate in Control for in-house pest control team or equivalent) shall be formed to carry out vector control and surveillance at least once a week. The in-house pest control team shall be able to identify potential vector-breeding grounds and propose measures to prevent propagation of vectors on site.

An external NEA-licensed PCO shall be engaged to supplement the weekly in-house vector control and surveillance routine.

The in-house pest control team shall develop a vector control program to conduct a daily routine of “Search and Destroy 6” activities at each construction site.

The recommended monitoring program for vectors is summarised in Table 15.13.1 below.

Table 15.13.1 Recommended vector monitoring programme

Location	Parameters	Frequency and Duration
All construction worksites (including storage and resting areas).	Inspection of potential mosquito breeding grounds (stagnant water), rodent burrows and droppings of other vectors (e.g. cockroaches, flies).	Daily inspection and housekeeping to be conducted across the construction site; and Weekly inspection by an external NEA-licensed Pest Control Operator.

15.13.2 Operational Phase

Minimum control measures shall be carried out by each household or its housing/ school/ building/ public committee and other relevant party according to the Control of Vectors and Pesticides Act and NEA guidelines [R-42, W-18, W-20].

15.14 Proposed EMMP

The framework for the proposed EMMP is detailed below; however, it is important to note that this is not an exhaustive list of potential impacts, monitoring requirements, and triggers. This EMMP is intended to be a living document and should be reviewed thoroughly by the Client/ Project Owner and the Contractor (CT) prior to implementation. Development of the following inputs, that have not been addressed in this report, by the CT are also required, including but not limited to:

- Stakeholder Communications Plan;
- Air Pollution Control Plan;
- Waste Management Plan;
- Erosion Control Plan;
- Noise Management Plan;
- Site log for all monitoring activities and complaints;
- Construction Logistics Plan;
- Standard Operating Procedures for processes identified in Table 15.14.1 and Table 15.14.2 below;
- Emergency Response Plan;
- Inventory of wastewater streams;
- Training protocols for staff, where appropriate; and
- Maintenance and Audit Schedules.

6 This refers to the search for and destruction of potential mosquito breeding grounds. This includes clearing of stagnant water, removal of unwanted water-bearing receptacles and eliminating conditions that are prone to water stagnation.

15.14.1 Construction Phase

The EMMP for construction phase of the Project is described in table below.

Table 15.14.1 Proposed environmental monitoring and management plan for the construction phase

Environmental Parameter	Environmental Issue	Minimum Control Measures	Mitigation Measures	Monitoring Parameter	Monitoring Locations	Recommended Frequency of Monitoring	Monthly Reporting	Site Responsibility	Triggers
Biodiversity	Minimisation of construction impacts to flora/vegetation	• Mark out site boundary • Set up Tree Protection Zones (TPZs) around trees or other plant specimens to be retained within the worksites • Tag trees (with or without TPZs) meant to be protected or transplanted to avoid accidental removal	• Record locations, species and quantity of transplant candidates that are affected by construction	Flora and Arboriculture	Within development boundary	Prior to site clearance	-	CT, ECO,	N/A
		• Establishment of TPZs • Inspect the integrity of the TPZ hoarding • Assess tree physiological health and vigour • Check for mechanical damage on trees that may impair stability • Review method statements of construction works in proximity to retained trees • Implement soil erosion control measures as soon as vegetation has been removed and soil is exposed	• Identify excessive or unauthorised tree removal • Identify trees that require management and maintenance such as tree care and pruning • Determine if there are any unauthorized removal of flora within areas of conservation (if any) or beyond the demarcated worksite • Identify areas with soil erosion and degradation that have resulted from construction activities • Determine if there are unauthorized dumping of waste material, construction debris or oil/chemical leakage that may contaminate the soil and waterbodies, and/or be detrimental to the vegetation • Identify areas that are responding poorly due to the development impacts, with emphasis on the health of the CS species and habitat within the RAC		Within development boundary and 15 m beyond hoarding line	Monthly for duration of construction	To be included in monthly report	CT, ECO	
	Minimisation of construction impacts to fauna	-	Implementation of directional clearing Implementation of pre-site clearance fauna inspection	Fauna	Within development boundary	Prior to site clearance	To be included in monthly report	CT, ECO	
		Ensure proper storage of machineries likely to leech harmful chemicals and fuel-powered equipment; Store the aforementioned equipment away from waterbodies and/or sensitive habitats.	Assess habitat quality (e.g., water quality, excessive vegetation removal); Check for presence of trapped/injured/dead fauna, potential fauna entrapments and gaps in site hoarding; and Conduct toolbox briefings on biodiversity awareness.		Within development boundary	Monthly for duration of construction	To be included in monthly reports.	CT, ECO	
		Ensure that noise minimum control measures (as detailed in the Airborne Noise section below) are adhered to.	Conduct biodiversity survey to monitor construction impacts on fauna activity and presence		Adjacent to development boundary	Monthly for duration of construction	To be included in monthly report	CT, ECO	
			Recording of number of number of occurrences of human-wildlife conflict		Within development boundary	Daily monitoring and record-keeping	To be included in monthly report	CT, ECO	When fauna is encountered within development boundary
Hydrology and Surface Water Quality	Stormwater runoff generation and contamination Chemical substances Domestic wastes Construction wastewater	• Runoff within, upstream of, and adjacent to the work site will be effectively drained away without causing flooding in the vicinity. • Potential increase of peak-flow due to the change in the land use at the worksite can be mitigated by providing detention tanks or ponds within the worksite. Detention tanks or ponds can capture stormwater during heavy storm events to reduce the peak runoff. • Geotechnical aspect of site's slope stability (such as Earth Retaining and Stabilising structures (ERSS)) to be	• Increase capacity of ECM tanks/ponds by 25% to contain stormwater runoff from Project Site and possible runoff from other concurrent projects • Use of standby tarp to cover bare soil when not in use or during rain events	All water quality parameters identified in Table 15.10.1. And any flooding issues should be	At discharge outlet(s) and at the nearby sensitive natural watercourses/ bodies (refer to Figure 15.10.1).	Permanent TSS monitor installed at every discharge outlet; Implementation of CCTV including a SIDS at every discharge outlet to monitor the surface	To be included in monthly report	CT, ECO	Investigation and corrective actions to be taken, when: • The following documentation are found inadequate/missing : • ECM Plan;

Environmental Parameter	Environmental Issue	Minimum Control Measures	Mitigation Measures	Monitoring Parameter	Monitoring Locations	Recommended Frequency of Monitoring	Monthly Reporting	Site Responsibility	Triggers
	Solid wastes	included in detailed design engineering for the construction stage. • The design engineers for detailed design may need to ensure that ERSS are proposed when the site is cleared and excavated. Concurrently the ECO must ensure that these measures are implemented in the construction phase, as cutting of slopes may result in slope instability. • ECM measures include but are not limited to minimisation of formation of bare soil, coverage of all bare/erodible surfaces, concrete cut-off drains, silt fences/traps along the perimeter cut-off drain, turbidity curtains for works adjacent to watercourses (drains and streams), etc. • Adequate drainage, piping and/or channelling of stormwater runoff to be assured through detailed design for capture and treatment at ECM tanks/ponds before discharge into watercourses. • Regular and dedicated procedures for the inspection and maintenance of stormwater collection, storage, and treatment infrastructure, such as pipes, oil water separation, silt screens, etc. • Regular and dedicated procedures for the management of stormwater collection, settling, testing and eventual discharge of 'clean' water to watercourses. This should also include associated measures required to prevent high sediment concentration stormwater drainage to watercourses. • Development of Standard Operation Procedure (SOP) for safe handling, transfer and storage of toxic waste; housekeeping checks once a day to ensure all toxic waste is cleared from site. • Appropriate tests to ascertain the presence/absence of contamination of the excavated earth and sand. • Appropriate fully sheltered storage area with storage volume to be 110% of the largest volume of chemical substances to be stored (kerb up and enclosed on at least 3 sides, covered and with adequate ventilation). • Appropriate construction material for toxic waste storage containers with leak detection tests conducted periodically. • Provision of secondary containment for all toxic waste stored in bulk as per the requirements in the COPPC/SS593. • Preparation of an emergency response plan, training of the emergency response team (ERT) to be competent in the response mechanism and provision of response kits for any spillages. • Consignment notification/tracking system and transport emergency response plan for transport of toxic waste. • Appropriate disposal of toxic waste as per required in the Environmental Public Health (Toxic Industrial Waste) Regulations by licensed waste operator/collector. • Provision of portable toilets and on-site septic tank. • Regular cleaning of the portable toilets and clearing of sanitary waste. • Appropriate location of toilet facilities away from any nearby watercourse. • Inspections and audits to ascertain the hygienic conditions on-site.		recorded and inspected.		run-off discharges from the sites; Monthly water quality monitoring for all discharge point locations and nearby drains/streams during construction phase; Intensity of the laboratory analysis will be increased (e.g. fortnightly, weekly) if in-situ measurements and/or monthly laboratory results indicate deterioration in the water quality. Intensified monitoring will be carried out until in-situ measurements and/or laboratory results indicate 'normality'/consistency with earlier monitored conditions; and Daily inspection on perimeter drains to ensure no surface runoff flowing out from the site untreated done by the site officer with monthly inspection done by EMMP consultant.			• Monitoring Log; • Training Log; • Audit Reports; • If the monitored parameters exceed applicable values of NEA Trade Effluent Limits at discharge point(s) (refer to Table 7.2.1); • If the monitored parameters exceed applicable values of Aquatic Criteria or the baseline (whichever is higher) at natural/naturalised stream/ ponds (refer to Figure 7.2.1); • If any flooding or clogging issues observed; • If complaints are received due to project activities; and • If visual non-compliance to any of the minimum control or mitigation measures are observed on-site.

Environmental Parameter	Environmental Issue	Minimum Control Measures	Mitigation Measures	Monitoring Parameter	Monitoring Locations	Recommended Frequency of Monitoring	Monthly Reporting	Site Responsibility	Triggers
		• The toilet facilities will be placed at least 30 m away from any nearby watercourse. • Training of workers on the best practices to contribute to environmental protection. • Appropriate disposal of any waste listed in the Environmental Public Health (General Waste Collection) Regulations by licensed waste operator/collector regardless the wastes to be disposed off-site or discharged to public sewer. • No unmanaged discharge of wastewater stream permitted. • Reduce, reuse, and recycle hierarchy principle to be applied to wastewater on-site. • Regular audits on environmental management procedures will be carried out on-site. • No hazardous liquids to be sent to the detention pond/tank. • Hazardous wastewater, such as oily water, thinners, solvents, or paints, should be stored on hard stand, under shelter with a kerb around the storage area. The wastewater should be removed for treatment and disposal off-site by an approved Waste Management Contractor. Hazardous liquids to be handled as Hazardous Waste. • Containment pond/kerbs will be of impervious material and be designed with sufficient capacity to hold volumes of wastewater produced on-site and potential fire-fighting wastewater. • ECM tanks/ponds will be designed in sufficient capacity to hold the turbid stormwater prior to treatment at the ECM treatment plant. • Temporary storage volumes should be provided for overflow situations of untreated wastewater. Temporary storage with sufficient capacity will capture any expected additional volumes ensure untreated wastewater is not released to watercourses unless it complies with Singapore NEA Guidelines on trade effluent discharge concentrations. • A responsible person (e.g. ECO) to be assigned to oversee the efficient operation of the containment pond/kerbs where ‘Good Housekeeping’ practices would be adhered to. Also, the area would be carefully managed to avoid spills, leaks, and odour issues, with the containment pond/kerbs checked at least daily to ensure proper functionality. • Daily record volume of wastewater, as well as volumes of sludge and other produced wastes. • Contractor will need to seek approval from relevant authorities (i.e. PUB & NEA) as per PUB Sewerage and Drainage (Trade Effluent) Regulations if the wastewater will be disposed to public sewer or NEA’s Trade Effluent Discharge Limits to controlled watercourse if the treated trade effluent will be disposed to surface watercourses. If such discharges are not approved, the trade effluent will be stored, treated or recycled on site and finally disposed off-site. • Contractor will seek for comment and approval from relevant authorities (e.g. SCDF and NEA) on the treated wastewater to be used for firefighting purposes.						

Environmental Parameter	Environmental Issue	Minimum Control Measures	Mitigation Measures	Monitoring Parameter	Monitoring Locations	Recommended Frequency of Monitoring	Monthly Reporting	Site Responsibility	Triggers
		• The discharge of pumped dewatered groundwater or other wastewaters to sensitive aquatic habitats will be prohibited. • The containment pond/kerbs, as well as wastewater generating areas on-site, to be equipped with spill clean-up kits. • Adequate drainage, cut-off drains sump pit, road kerb, piping and toe wall will be designed for channelling of construction process wastewater streams (e.g., concrete batching, wash water, etc.) and stormwater runoff separately through detailed design for capture and treatment in the containment pond/kerbs. Where applicable (e.g., in the vicinity of liquid storage or refuelling areas), this infrastructure will include oil-water separators to capture inadvertent spills or leaked oils or greases. • Implement a construction EMMP and ensure full preparation of associated plans and procedures including the following: • EMMP to include SOPs, an Emergency Response Plan (ERP), an inventory of wastewater streams, training of staff as well as an inspection, maintenance and audit schedule; and • Full development of EMMP Wastewater Management Procedures to include dedicated management and monitoring procedures that covers all eventualities related to the proper operation of containment pond/kerbs, or any other wastewater discharge location/equipment. • Regular and dedicated procedures for the inspection and maintenance of wastewater (i.e. trade effluent) collection, storage, and treatment infrastructure, such as pipes, oil water separators, silt screens, etc. • A training programme for all on-site workers, including sub-contractors, in relation to their obligations for ensuring proper water quality management. • Development of a SOP for safe handling, transfer, storage and disposal of solid waste. • Effective ECM and monitoring implemented as recommended in the Code of Practice on Surface Water Drainage to ensure that discharge into the stormwater drainage system does not contain TSS in concentrations greater than the prescribed limits under the Sewerage and Drainage (Surface Water Drainage) Regulations. • ECM measures include but are not limited to minimisation of formation of bare soil, coverage of all bare/erodible surfaces, slope stability, concrete cut-off drains, silt fences/traps along the perimeter cut-off drain, turbidity curtains for works adjacent to watercourses, etc. • Implementation of CCTV including SIDS at the public drain to monitor the surface runoff discharges from the sites as per the PUB's circular on Preventing Muddy Waters from the Construction Sites (October 2015). • Provision of enclosed bins and waste disposal facilities cleared up as often as necessary to prevent build-up. Housekeeping checks will be carried out once a day to ensure all litter is cleared from site.						

Environmental Parameter	Environmental Issue	Minimum Control Measures	Mitigation Measures	Monitoring Parameter	Monitoring Locations	Recommended Frequency of Monitoring	Monthly Reporting	Site Responsibility	Triggers
		• Hazardous substances and toxic wastes should be stored on hard stand, under shelter with a kerb around the storage area. • All wastes will be disposed only in the designated waste disposal facilities and appropriately separated, i.e. by trained workers to properly sort and label the different types of waste (reusable and recyclable waste, toxic and non-toxic waste, etc.). • Surface Water Drainage, to be endorsed by a QECP and submitted to PUB. • Implementation of the ECM plan before the start of any construction work. • Manholes should always be adequately covered and temporarily sealed. • Protection of stockpiles with erosion blanket coverage and proper scheduling of the demolition and earthworks to reduce the quantity of stockpiles to be stored on-site. • Coverage of temporary/open storage of excavated materials. • All vehicles should run via wheel washing process before leaving the site to ensure no earth, mud, debris, etc., is deposited on roads; and the wastewater hence generated should be stored and removed for treatment and disposal off-site by an approved Waste Management Contractor.							
Air Quality	Air quality impact from dust nuisance from the construction activities and gaseous emissions from the construction equipment and vehicles	• The construction footprint shall be hoarded on all sides; • No demolition of permanent structure is expected as part of the project; • No concrete batching plant to be located on-site; • Vehicles entering and leaving sites to be fully covered; and • Access road construction or expansion is recommended to be completed first and paved before the construction of other development commences.	**General mitigation measures to be implemented by the Contractor throughout construction period**. <u>Communications:</u> • Develop and implement a stakeholder communications plan that includes community engagement before work commences on site. • Display the name and contact details of person(s) accountable for air quality and dust issues on the site boundary. This may be the environment manager/engineer or the site manager. • Develop and implement an Air Pollution Control Plan (APCP), refer to Section 12.3.1 for details on APCP. <u>Site Management:</u> • Record all dust and air quality complaints, identify cause(s), take appropriate measures to reduce emissions in a timely manner, and record the measures taken. • Make the complaints log available to the local authority when asked. • Record any exceptional incidents that cause dust and/or air emissions, either on-site or off- site, and the action taken to resolve the situation in the logbook. • Hold liaison meetings with other high-risk construction sites within 500 m of the site boundary, if any, to ensure plans are co-ordinated and dust and particulate matter emissions are minimised. <u>Monitoring:</u> • Undertake regular (daily frequency recommended) on-site and off-site inspections and record results. The log should be made	PM_{10}, $PM_{2.5}$, dust	• Rail corridor near the Project Site • 44 Holland Green	• 1-week monitoring of mentioned parameters at each selection location before commencement of construction phase • Continuous monitoring of PM_{10} and $PM_{2.5}$ during site clearance and earthworks stages: • 44 Holland Green • Bi-annual 1-month monitoring of mentioned parameters at each selected location during construction phase, except for earthworks and site clearance stages: • 44 Holland Green	To be included in monthly report	CT, ECO	Investigation and corrective actions to be taken, when • Any of the following documentation are found inadequate / missing: Air Pollution Control Plan; Compliance certificate of an Off-Road Diesel engine; or Monitoring Log. • If the monitored parameters exceed Singapore long term air quality targets. • If complaints are received due to project activities. • If visual non-compliance to any of the minimum control or mitigation measures are observed on-site.

Environmental Parameter	Environmental Issue	Minimum Control Measures	Mitigation Measures	Monitoring Parameter	Monitoring Locations	Recommended Frequency of Monitoring	Monthly Reporting	Site Responsibility	Triggers
			available to the NEA or other Government Agencies if required. Inspections should include regular dust soiling checks of surfaces such as street furniture, cars and windowsills within 100 m of site boundary. Cleaning should be provided if necessary. • Carry out regular site inspections to monitor and record compliance with the Air Pollution Control Plan. • Increase the frequency of site inspections during prolonged dry or windy conditions. • Conduct monitoring for PM_{10} and $PM_{2.5}$ at suitable locations (refer to Section 15.11.1) <u>Preparing and maintaining the site:</u> • Plan site layout so that machinery and dust causing activities are located away from receptors, where possible. • Erect hoarding around dusty activities and at the site boundary wherever possible. Boundary screens should be at least as high as any stockpiles or dust emission sources on site. • Fully enclose specific activities where there is a known high potential for dust production and the site will be active for an extensive period. • Keep site fencing, barriers, and scaffolding clean by cleaning regularly using wet methods (dry methods may give rise to fugitive dust). • Remove materials that have the potential to produce dust from site as soon as possible, unless being re-used on site. If they are being re-used on-site, stockpiled material should be covered, seeded, fenced or enclosed to prevent fugitive dust formation. • After excavation, put metal sheets / canvas sheet / turfing to cover the exposed area. <u>Operating vehicle/machinery and sustainable travel:</u> • Ensure all vehicles and engine powered equipment comply with the legislative requirements of Singapore. • Ensure all vehicles and equipment switch off their engines when stationary – i.e. no idling vehicles or engines. Clear signs shall be erected at site entrance to inform all visitors. • Where practicable, avoid the use of diesel- or petrol-powered generators and use mains electricity or battery powered equipment. • Impose and signpost a maximum-speed-limit of 25 km/hr on paved or surfaced haul roads and 15 km/hr on unpaved haul roads and work areas. • Produce a Construction Logistics Plan to manage the sustainable delivery of goods and materials. <u>Construction Operations:</u> • Only use cutting, grinding or sawing equipment fitted with, or in conjunction with, suitable dust suppression techniques such as water sprays or local extraction e.g. local exhaust ventilation system. • Ensure an adequate water supply on the site for effective dust/particulate matter			• Continuous dust monitoring during site clearance and earthworks stages • Rail corridor near the Project Site			

Environmental Parameter	Environmental Issue	Minimum Control Measures	Mitigation Measures	Monitoring Parameter	Monitoring Locations	Recommended Frequency of Monitoring	Monthly Reporting	Site Responsibility	Triggers
			suppression/mitigation, using non-potable water where possible and appropriate. • Use enclosed chutes and conveyors and covered skips wherever possible. • Minimise drop heights from conveyors, loading shovels, hoppers and other loading or handling equipment and use fine water sprays on such equipment wherever appropriate. • A stringent “Clean as you go” Policy should be implemented on site to ensure no loose dry material is left exposed when not in use. Equipment should be readily available on site to clean and dry spillages, and cleaning should be conducted as soon as reasonably practicable after the event using wet cleaning methods. <u>Waste Management:</u> • Avoid burning of waste or other materials.						
			MITIGATION MEASURES FOR EARTHWORKS • Closed turfing to the exposed areas where possible and maintain proper storage of soil stockpiles to stabilise surfaces as soon as practicable. When a particular work is finished in an area, the soil will need to be reinstated upon completion, before moving on to different areas. • Use Hessian, mulches or soil tackifiers where it is not possible to re-vegetate or cover with topsoil, as soon as practicable. Soil erosion blankets may also be used as an alternative. • Only remove the cover in intended working areas and not all at once.						
			MITIGATION MEASURES FOR CONSTRUCTION • Avoid scabbling (roughening of concrete surfaces) if possible. • Ensure sand and other aggregates are stored in bunded areas and are not allowed to dry out, unless this is required for a particular process, in which case ensure that appropriate additional control measures are in place. • Ensure bulk cement and other fine powder materials are delivered in enclosed tankers and stored in silos with suitable emission control systems to prevent escape of material and overfilling during delivery. • For smaller supplies of fine power materials ensure bags are sealed after use and stored appropriately to prevent dust.						
			MITIGATION MEASURES FOR TRACKOUT • Use water-assisted dust sweeper(s) on the access and affected local roads, to remove, as necessary, any material tracked out of the site. This may require the sweeper being continuously in use. • Avoid dry sweeping of large areas. • Inspect on-site haul routes for integrity and instigate necessary repairs to the surface as soon as reasonably practicable. • Record all inspections of haul routes and any subsequent action in a site log book. • Install hard surfaced haul routes, which are regularly damped down with fixed or mobile						

Environmental Parameter	Environmental Issue	Minimum Control Measures	Mitigation Measures	Monitoring Parameter	Monitoring Locations	Recommended Frequency of Monitoring	Monthly Reporting	Site Responsibility	Triggers
			sprinkler systems, or mobile water bowsers and regularly cleaned. • Implement a wheel washing system (with rumble grids to dislodge accumulated dust and mud prior to leaving the site where reasonably practicable). • Ensure there is an adequate area of hard surfaced road between the wheel wash facility and the site exit, wherever site size and layout permits. • Site access gates to be located at least 10 m from receptors where possible						
Airborne Noise	Noise from construction machines and equipment, especially rotational and vibratory equipment (e.g. dozers, cranes, excavators, trailers, generators, etc.)	• It is recommended to reduce noise impact to avifauna by various administrative controls at the Study Area. For example, avoid breeding seasons (March to July) for the activity, or to avoid early morning daytime noisy activities between 7 – 9 am as far as possible on site. This may reduce some impacts on this fauna on behavioural aspects and communication. Machines (such as trucks) that may be in intermittent use should be shut down between work periods or should be throttled down to a minimum; • Only well-maintained construction plants should be utilised on-site, and construction plants should be serviced regularly during the entire construction period; • The number of PMEs should be reduced as far as practicable when construction works are carried out at areas close to the noise sensitive receivers: • Silencers or mufflers on construction equipment if incorporated in a machine should be properly maintained; • Behavioural practices including no shouting, no loud stereos/ radios on site, no dropping of materials from height, no throwing of metal items should be ensured; • Construction respite: Restrict high noise generating drilling activities only in continuous blocks, not exceeding 3 hours each, with a minimum respite period of one hour between each block, if possible; • Periodic noise monitoring by an independent third party, to establish compliance with requirements and to advise on equipment causing concern, and additional potential mitigation measures; • Night works, apart from advance works/ site clearance if approved by Agencies, will be prohibited after 6 pm to minimise noise disturbance to nocturnal animals; • Plan the layout of the site by considering using materials and other large structural equipment as noise barriers; • Construction plants known to emit noise strongly in one direction should, wherever possible, be orientated	MITIGATION MEASURES FOR GENERAL CONSTRUCTION NOISE CONTROL: • Control of noise sources at the source from construction site – Analyse construction inventory list and check equipment causing high noise levels. The equipment with lower noise level shall be prioritised; and • Where controlling noise sources at the source is not feasible, acoustic enclosures or sheds are to be introduced to mitigate noise at the source. Typical acoustic enclosure covers the machine as fully as possible (with or without ventilation where applicable) to provide sound insulation. MITIGATION MEASURES FOR CONSTRUCTION NOISE: During design strategies: • Consider buildings of staggered heights with lower buildings designed for build near noise sensitive areas to reduce duration of noise impacts; and • Avoid placement of access routes near noise sensitive receptors or facing noise sensitive receptors to prevent sound leak along worksite boundaries with proposed noise barriers and prevent increase in noise from road traffic by potential increase of heavy-duty vehicles (HDVs) volume. During construction: • Noise barriers should be proposed at the construction boundary fronting noise sensitive receptors or RAC areas based on noise modelling and management plan submitted for contract specific purposes;	$L_{Aeq(12\ hours)}$, $L_{Aeq(1hour)}$ and $L_{Aeq(5\ mins)}$	• Forested area in the north-west of the Project Site • Forested area in the south-west of the Project Site • 20 Holland Green	Records on noise levels from construction sites should be properly kept and produced when requested.	To be included in monthly report	CT, ECO	Investigation and corrective actions to be taken, when • Any of the following documentation are found inadequate / missing:Construction Noise Management Plan and Monitoring Log. • If the monitored parameters exceed applicable values of EPM regulations. • If complaints are received due to project activities. • If visual non-compliance to any of the minimum control or mitigation measures are observed on-site. • If there are any cracks / leaks present on the noise barrier erected.

Environmental Parameter	Environmental Issue	Minimum Control Measures	Mitigation Measures	Monitoring Parameter	Monitoring Locations	Recommended Frequency of Monitoring	Monthly Reporting	Site Responsibility	Triggers
		so that the noise is directed away from the nearby noise sensitive receptors; • Material stockpiles and other structures will be effectively utilised, wherever practicable, in screening noise from on-site construction activities; • All handheld percussive breakers and air compressors used on site will comply with local legislation and requirements; • Activities may be scheduled to minimise noise generated at certain areas during periods which may be particularly sensitive to noise; • Works using machines or vehicles that generate noise should be prohibited in the night and the dawn; • Appropriate hearing protectors should be used by personnel operation the plant or equipment, the hearing protector must attenuate the exposure of the user to sound pressure levels below 85dB (A). Signage to remind personnel to put on hearing protection will be put up at work areas that emit excessive noise. Choice of hearing protector such as ear plugs (for < 100 dB (A)), earmuffs (for 100 dB (A) to 120 dB (A), ear plugs and earmuffs (for > 120dB (A)) in various noise exposure level; • Noise awareness briefing should be conducted regularly and highlighted the noise mitigation measures such as position of machinery, making use of portable noise barriers and dos and don'ts for use of machinery at night; and • If noise remains an issue even after implementation of recommended mitigation measures such as noise barriers, contractor should consider implementation of proprietary noise barriers of high noise reduction capabilities to further reduce noise to acceptable levels.						
Vectors	Accumulation of stagnant water, poor housekeeping and improper handling/ disposal of solid waste (especially food waste)	• Adhere to Control of Vector and Pesticide Act (CVPA) and ensure good housekeeping on-site. • Preparation and implementation of an effective vector control plan and measures as required under NEA's Code of Practice for Environmental Control Officers. (See Section 15.13.1) • Ensure water-bearing receptacles, gaps on grounds and equipment (e.g. openings at concrete barriers), as well as stockpiled areas are covered or sheltered, especially during the northeast monsoon season between November to January. • Scheduled daily housekeeping to ensure clearance of stagnant water and unwanted items are discarded properly. • Site entrance shall be paved to avoid ground depression. • Milled waste can be used to level the ground before laying steel plates.	Not Applicable.	Inspection of potential mosquito breeding grounds (water ponding) Inspection of rodent burrows Inspection of cockroaches and flies' droppings	Within and/or at boundary of construction worksites, as well as any other temporary and permanent utilities diversion work areas or any other relevant work areas associated with this Project.	Daily inspection and housekeeping to be conducted across the construction site; and Weekly inspection by an external NEA-licensed PCO.	To be included in monthly report	ECO personnel, CT	Investigation and corrective actions (i.e. Stop Work Orders) to be taken, when: Worksite is found to have vector-breeding habitats. There is an occurrence of suspected dengue outbreak cases.

Environmental Parameter	Environmental Issue	Minimum Control Measures	Mitigation Measures	Monitoring Parameter	Monitoring Locations	Recommended Frequency of Monitoring	Monthly Reporting	Site Responsibility	Triggers
		• Provide movable roof over shaft to prevent rainwater ingress. • Pump shall be deployed to clear water at areas where drainage is not possible, as well as for larger recessed surfaces. • Install pitched roof on top and/or seal up bottom of site container office. • After trees clearance, top of tree stumps has to be either removed thoroughly or patched up. • Pipette can be used for larvae-checking at the hard-to-reach parts of a tree. • Food disposal should be clearly allocated and disposed of on a daily basis to discourage rodents from establishing nests on site and to prevent cockroaches/ flies' infestation. • Store food in rodent proof storage containers/ cabinets with at least 60 cm clearance above ground level. • Thermal Fogging is not recommended onsite, due to its proximity to areas of high ecological value. Instead, preventive methods such as inspection and good housekeeping practices should be adhered to instead, in order to ensure no mosquito breeding occurs onsite.						

15.14.2 Operational Phase

The EMMP for operational phase of the Project is described in Table 15.14.2.

Table 15.14.2 Proposed environmental monitoring and management plan for the operational phase

Environmental Parameter	Environmental Issue	Minimum Control Measures	Mitigation Measures	Monitoring Parameter	Monitoring Locations	Recommended Frequency of Monitoring	Site Responsibility	Triggers
Biodiversity	Minimisation of operational impacts to flora/vegetation	-	Identify areas that are responding poorly due to operational activities, with emphasis on the health of the CS species and habitat within the RAC Ensure that post-construction planting is responding well to development surrounding	Flora and Arboriculture	Softscape of operational boundary	Monthly for duration of 1 year	Project Owner	N.A.
		-	Ensure integrity of adjacent forest (if any) Identify signs of edge effects on new forest edge of adjacent forest (if any)		Adjacent forest to development boundary			
	Minimisation of operational impacts to fauna	Ensure water quality minimum control measures listed below are adhered to.	Assessment of habitat quality (e.g., water quality, excessive vegetation removal) Inspection for presence of trapped/injured/dead fauna, potential fauna entrapments and gaps in site hoarding Recording of number of number of occurrences of human-wildlife conflict Conduct biodiversity survey to monitor construction impacts on fauna activity and presence	Fauna	Adjacent forest to development boundary		Project Owner	
Hydrology and Surface Water Quality	Stormwater run-off generation and contamination Improper management of liquid and solid wastes	• Regular and dedicated procedures for the inspection and maintenance of stormwater collection, storage, and treatment infrastructure, such as pipes, oil water separation, silt screens, etc.; • Regular and dedicated procedures for the management of stormwater collection, settling, testing and eventual discharge of 'clean' water to surface waters. This should also include associated measures required to prevent high sediment concentration stormwater drainage to surface waters; • Potential increase of peak-flow due to the change in the land use at the new developments can be mitigated by providing detention ponds within the Project Site. Detention ponds can capture stormwater during heavy storm events to reduce the peak runoff. Stored water can then be discharged back to the system after the storm event. As required by PUB, the storage system needs to be in place to reduce the peak flow at the operational phase to be the same or less than that of the existing condition. • Providing more softscape area should be considered in the design of the development to reduce the run-off coefficient which will help to reduce the peak flow and reduce flood risk at downstream area; • Provide more pervious areas to increase the seepage of surface water into the soil; • Geotechnical aspect of site's slope stability (such as ERSS) to be included in detailed design engineering for the operational stage; • To prepare sufficient disposal bins surrounding of the Project to avoid improper disposal of waste;	None	All parameters identified in Table 15.10.2. And any flooding issues should be recorded and inspected.	At the main outlets/drains of the Project Site, as well as the sensitive natural streams in the vicinity of proposed project.	Monthly inspection for the surface water quality and hydrology, especially during heavy storm event for hydrological conditions during first three (3) month of operational period.	Project Owner	Investigation and corrective actions to be taken, when: • If the monitored parameters of all discharge points exceed applicable values of NEA Limits at discharge point (refer to Table 7.2.1); • If the monitored parameters of natural streams/pond exceed applicable values of Aquatic Criteria natural stream (refer to Figure 7.2.1) or its baseline, the higher of the two; • If any flooding issues observed; • If complaints are received due to project activities; and • If visual non-compliance to any of the minimum control or mitigation measures are observed on-site.

Environmental Parameter	Environmental Issue	Minimum Control Measures	Mitigation Measures	Monitoring Parameter	Monitoring Locations	Recommended Frequency of Monitoring	Site Responsibility	Triggers
		• To conduct regular inspection on wastes' storage system and chemical storage area, if any, of the Project; • To monitor the proposed water features and its surroundings with CCTV surveillance regularly to ensure no contamination occurred; • To develop an emergency response plan and conduct adequate training to maintenance workers to cope the accidental water contamination; and • Raising awareness of various stakeholders with community/stakeholder engagement (e.g. signage boards, warning signs, etc.).						
Air Quality	Air Quality impact from dust nuisance from emissions from vehicle exhaust due to increased traffic volume	No minimum control has been assumed.	No additional mitigation measures needed.	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
Airborne Noise	Noise from Air-conditioning and Mechanical Ventilation, Traffic Noise	MINIMUM CONTROLS FOR ACMV NOISE: Minimum Controls below should be applied at the prelim design stage of the development by the appointed M&E consultants. An appointed Noise consultant should validate the noise in accordance with *NEA's Technical Guideline on Boundary Noise Limits for Air Conditioning and Mechanical Ventilation Systems in Non-Industrial Building.* In addition, mitigation measures will be provided by the appointed Noise Consultants during the prelim design stage. • Use low air-conditioning and mechanical ventilation system equipment; • Ensure that any exhaust outlet or intake from the mechanical ventilation system is designed to be adequately set back as far as possible from the boundary line of the development; • Acoustic treatment if any to be designed and implemented; • AC system to be designed with the AHU units placed at appropriate locations as set back from the boundary line of the development as possible; and • Acoustic enclosures for outdoor equipment. MINIMUM CONTROLS FOR TRAFFIC NOISE: • Consider alternative siting of new road networks away from noise sensitive receptors at pre-design stage; • Due to the lack of information at this juncture of reporting, assessment, minimum controls, and mitigation will be provided by the appointed Noise Consultant during the prelim design stage and in accordance with Technical Guideline for Land Traffic Noise Impact Assessment. Note: As current means of noise impact assessment were only performed qualitatively, quantitative noise impact assessment must be conducted by the developer/ developing agent at a later stage to assess noise impacts arising from the operational phase related activities as mandated by law at later stages of the Project.	MITIGATION MEASURES FOR ACMV NOISE: • Noise attenuators and other Best Available Technology (BAT) and Best Environmental Practice (BEP) noise control measures shall be utilised; and • Ample setback of developments with ACMV systems fronting noise sensitive receptors should be provided such as provision of park areas to ensure that operational noise sources are at a distance away from the receptors. MITIGATION MEASURES FOR TRAFFIC NOISE: • Traffic noise at drop-off points and parking areas shall be mitigated with low speed postings, speed humps and speed limit signages. The addition of these speed control measures will likely lower noise levels for traffic as the vehicles would be cruising at lower speeds; and • Consider alternative siting of roads away from areas with noise sensitive receptors. • Application of low-noise pavement mix can be considered for the road sections facing NSRs.	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
Vector	Accumulation of stagnant water, poor housekeeping and improper handling/	• Adhere to Control of Vector and Pesticide Act (CVPA) and ensure good housekeeping on-site/in the development. • Weekly inspections for potential breeding sites should be conducted for areas such as unused containers in open areas and under bushes, open	No mitigation measures required to be proposed, as minimum controls for vectors should be practised as advised by NEA.	Not applicable	Not applicable	Not applicable	Each household or its housing/ school/ building/	Not applicable

Environmental Parameter	Environmental Issue	Minimum Control Measures	Mitigation Measures	Monitoring Parameter	Monitoring Locations	Recommended Frequency of Monitoring	Site Responsibility	Triggers
	disposal of solid waste (especially food waste)	and closed drains, gully traps, tree holes and bifurcations between branches, leaf axils of banana trees, Travellers Palms and other palms, outdoor litter bins etc; • Fortnightly application of sand granular insecticides gully traps, manhole cover handle depressions, lightning conductor pits, stop-cock pits, valve chambers, and sumps; • Immediate application of insecticide should be conducted to destroy breeding habitats identified during inspections and to immediately eliminate the identified potential breeding habitats (i.e. source of stagnant water or waste). Proper recording of these incidents should also be conducted once the breeding habitats or potential breeding grounds have been eliminated; • Thermal Fogging is not recommended, due to its proximity to areas of high ecological value. Instead, preventive methods such as inspections and good housekeeping practices should be adhered to instead, in order to ensure no mosquito breeding occurs onsite. Monthly routine pest control checks should be conducted at all locations;					public committee and other relevant party	

16 Conclusion

Table 16.1 Summary of potential impact during construction phase

Environmental Parameter	Impact Significance with Minimum Controls	Key Mitigations Measures (if any)	Residual Impact Significance with Mitigation Measures
Biodiversity	Negligible to Major	• **General:** Conduct regular inspections to ensure contractor compliance, in consultation with NParks • **General:** Ensure silt and other erosion control measures are installed and properly maintained • **Flora:** Mark out RAC and plants with conservation value to prevent unnecessary clearance • **Habitat and Flora:** Ensure no works and disturbances to areas outside the worksite • **Fauna:** Avoid tree felling and vegetation clearance during bird breeding season (March to July) • **Fauna:** Perform bamboo emergence surveys and pre-felling checks for bamboo clusters • **Fauna:** Conduct Biodiversity Awareness Training for all site personnel	Negligible to Major
Hydrology and Surface Water Quality	Ecology: Negligible to Minor Human: Negligible to Moderate	• Direct discharge to Bukit Timah First Diversion Canal rather than D/S1 • Increased capacity of ECM tanks/ponds to contain stormwater runoff from Project Site and possible runoff from other concurrent projects • Use of standby tarp to cover bare soil when not in use or during rain events	Ecology: Negligible to Minor Human: Negligible to Minor
Air Quality	Ecology: Moderate to Major Human: Moderate to Major	• Implement dust control measures e.g., dust screens, etc. • Install hard surfaced haul routes. • Only use cutting, grinding and sawing equipment with dust suppression water spray mechanisms. • Erect hoarding around dusty activities and site boundary. • Impose and signpost maximum speed-limit of 25 km/hr on paved roads and 15 km/hr on unpaved roads and work areas. • No burning of waste allowed on site. • Revegetate earthworks and exposed areas/ soil stockpiles. • Implement a wheel washing system.	Ecology: Minor Human: Minor
Airborne Noise	Ecology: Negligible to Major	During design Strategies:	Ecology: Negligible to Major

Environmental Parameter	Impact Significance with Minimum Controls	Key Mitigations Measures (if any)	Residual Impact Significance with Mitigation Measures
	Human: Negligible to Major	• Staggered building heights should be considered to reduce duration of noisy activities near receptors; and • Access routes should avoid facing receptors; During construction: • Use equipment with lower noise levels; and • Noise barriers should be installed along boundary of worksites facing noise sensitive receptors (where necessary) Note: As current means of noise impact assessment were only performed qualitatively, quantitative noise impact assessment must be conducted by the developer/ developing agent at a later stage to assess noise impacts arising from the construction phase related activities as mandated by law at later stages of the Project.	Human: Negligible to Moderate

Table 16.2 Summary of potential impact during operational phase

Environmental Parameter	Impact Significance with Minimum Controls	Key Mitigations Measures (if any)	Residual Impact Significance with Mitigation Measures
Biodiversity	Negligible to Moderate	• Conduct monthly post-construction monitoring for the initial year • Planting only native flora species for landscaping and streetscaping • Restrict access to the RAC via implementation of raised boardwalks and railings to minimise risk of poaching • Installation of signboards with warnings for prosecution and fines • Install educational signboards • Deploy wildlife-proof bins • Implement traffic-calming measures to minimise roadkill • Implement measures to maintain local microclimate and hydrology of RAC (e.g. water retention features in future park)	Negligible to Moderate
Hydrology and Surface Water Quality	Ecology: Negligible to Minor Human: Negligible	Not required	N.A.
Air Quality	Ecology: Minor Human: Minor	Not required	N.A.
Airborne Noise	Ecology: Negligible to Moderate Human: Negligible to Minor	• Utilise noise attenuators and other Best Available Technology (BAT) and Best Environmental Practice (BEP) to mitigate potential noise from air conditioning and mechanical ventilation (ACMV) systems; • Utilise low speed postings, speed humps, speed limit signages at drop-off points and parking areas to mitigate noise from increased road traffic; and	Ecology: Negligible Human: Negligible

Environmental Parameter	Impact Significance with Minimum Controls	Key Mitigations Measures (if any)	Residual Impact Significance with Mitigation Measures
		• Consider alternative siting of roads away from areas with noise sensitive receptors. Note: As current means of noise impact assessment were only performed qualitatively, quantitative noise impact assessment must be conducted by the developer/ developing agent at a later stage to assess noise impacts arising from the operational phase related activities as mandated by law at later stages	

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Appendix A
List of Recorded and Probable Faunal Species

Delivering a better world

Species Recorded within Study Area					
Scientific Name	**Common Name**	**Taxa**	**Origin**	**SRDB3 Status**	**Priority Level**
Apis cerana	Asian honey bee	Aculeata	Not Listed	Not Listed	Priority 3
Apis florea	Dwarf honey bee	Aculeata	Uncertain	NA	Priority 3
Liostenogaster varipicta	-	Aculeata	Native	NE	Priority 2
Parischnogaster mellyi	-	Aculeata	Native	NE	Priority 2
Ropalidia sumatrae	-	Aculeata	Native	LC	Priority 2
Thyreus ceylonicus	-	Aculeata	Not Listed	Not Listed	Priority 3
Xylocopa latipes	Broad-handed carpenter bee	Aculeata	Native	LC	Priority 2
Chalcorana labialis	Copper-cheeked frog	Amphibian	Native	LC	Priority 2
Duttaphrynus melanostictus	Asian toad	Amphibian	Native	NA	Priority 2
Eleutherodactylus planirostris	Greenhouse frog	Amphibian	Introduced	Not Listed	Priority 3
Fejervarya limnocharis	Field frog	Amphibian	Native	LC	Priority 2
Kaloula pulchra	Banded bull frog	Amphibian	Introduced	Not Listed	Priority 3
Limnonectes blythii	Malayan giant frog	Amphibian	Native	LC	Priority 2
Microhyla butleri	Painted chorus frog	Amphibian	Native	LC	Priority 2
Microhyla heymonsi	Dark-sided chorus frog	Amphibian	Native	LC	Priority 2
Microhyla mukhlesuri	Mukhlesur's narrow-mouthed frog	Amphibian	Native	Not Listed	Priority 2
Polypedates leucomystax	Common tree frog	Amphibian	Native	LC	Priority 2
Acridotheres javanicus	Javan myna	Bird	Introduced	NA	Priority 3
Aegithina tiphia	Common iora	Bird	Native	LC	Priority 2
Aerodramus sp.	Swiftlet	Bird	Native	-	Priority 2
Amaurornis phoenicurus	White-breasted waterhen	Bird	Native	LC	Priority 2
Anthreptes malacensis	Brown-throated sunbird	Bird	Native	LC	Priority 2
Aplonis panayensis	Asian glossy starling	Bird	Native	LC	Priority 2
Cacatua goffiniana	-	Bird	Introduced	NA	Priority 3
Caprimulgus macrurus	Large-tailed nightjar	Bird	Native	LC	Priority 2
Centropus sinensis	Greater coucal	Bird	Native	NT	Priority 2
Chalcophaps indica	Common emerald dove	Bird	Native	LC	Priority 2
Chrysophlegma miniaceum	Banded woodpecker	Bird	Native	LC	Priority 2
Cinnyris jugularis	Olive-backed sunbird	Bird	Native	LC	Priority 2
Dicaeum cruentatum	Scarlet-backed flowerpecker	Bird	Native	LC	Priority 2
Dicrurus paradiseus	Greater racket-tailed drongo	Bird	Native	LC	Priority 2
Dinopium javanense	Common flameback	Bird	Native	LC	Priority 2
Eudynamys scolopaceus	Asian koel	Bird	Native	LC	Priority 2
Eurystomus orientalis	Oriental dollarbird	Bird	Native	LC	Priority 2
Ficedula zanthopygia	Yellow-rumped flycatcher	Bird	Native	LC	Priority 2
Gallus gallus	Red junglefowl	Bird	Native	NT	Priority 2
Garrulax leucolophus	White-crested laughingthrush	Bird	Introduced	NA	Priority 3
Geopelia striata	Zebra dove	Bird	Native	LC	Priority 2
Halcyon smyrnensis	White-throated kingfisher	Bird	Native	LC	Priority 2
Haliaeetus leucogaster	White-bellied sea eagle	Bird	Native	LC	Priority 2
Haliastur indus	Brahminy kite	Bird	Native	LC	Priority 2
Hirundo rustica	Barn swallow	Bird	Native	NT	Priority 2
Loriculus galgulus	Blue-crowned hanging parrot	Bird	Native	LC	Priority 2
Merops sp.	-	Bird	Native	-	Priority 2
Mixornis gularis	Pin-striped tit-babbler	Bird	Native	LC	Priority 2
Muscicapa dauurica	Asian brown flycatcher	Bird	Native	LC	Priority 2
Ninox scutulata	Brown hawk-owl	Bird	Native	LC	Priority 2
Oriolus chinensis	Black-naped oriole	Bird	Native	LC	Priority 2
Orthotomus atrogularis	Dark-necked tailorbird	Bird	Native	LC	Priority 2
Orthotomus ruficeps	Ashy tailorbird	Bird	Native	LC	Priority 2
Orthotomus sericeus	Rufous-tailed tailorbird	Bird	Native	NT	Priority 2
Orthotomus sutorius	Common tailorbird	Bird	Native	LC	Priority 2
Otus lempiji	Sunda scops owl	Bird	Native	LC	Priority 2
Pericrocotus divaricatus	Ashy minivet	Bird	Native	LC	Priority 2
Pernis ptilorhynchus	Crested honey buzzard	Bird	Native	LC	Priority 2
Phylloscopus borealis	Arctic warbler	Bird	Native	LC	Priority 2
Picus vittatus	Laced woodpecker	Bird	Native	LC	Priority 2

Psilopogon haemacephalus	Coppersmith barbet	Bird	Native	LC	Priority 2
Psilopogon lineatus	Lineated barbet	Bird	Introduced	NA	Priority 3
Psittacula alexandri	Red-breasted parakeet	Bird	Introduced	NA	Priority 3
Psittacula krameri	Rose-ringed parakeet	Bird	Introduced	NA	Priority 3
Psittacula longicauda	Long-tailed parakeet	Bird	Native	NT	Priority 2
Pycnonotus goiavier	Yellow-vented bulbul	Bird	Native	LC	Priority 2
Pycnonotus jocosus	Red-whiskered bulbul	Bird	Introduced	NA	Priority 3
Pycnonotus plumosus	Olive-winged bulbul	Bird	Native	LC	Priority 2
Pycnonotus zeylanicus	Straw-headed bulbul	Bird	Native	EN	Priority 1
Rallina fasciata	Red-legged crake	Bird	Native	NT	Priority 2
Rhipidura javanica	Malaysian pied fantail	Bird	Native	LC	Priority 2
Spilopelia chinensis	Spotted dove	Bird	Native	LC	Priority 2
Treron vernans	Pink-necked green pigeon	Bird	Native	LC	Priority 2
Trichoglossus haematodus	Coconut lorikeet	Bird	Introduced	NA	Priority 3
Zosterops simplex	Swinhoe's white-eye	Bird	Native + Introduced	VU	Priority 1
Acraea terpsicore	-	Lepidoptera	Native	LC	Priority 2
Caltoris cormasa	Full stop swift	Lepidoptera	Native	LC	Priority 2
Euchrysops cnejus cnejus	Gram blue	Lepidoptera	Native	LC	Priority 2
Junonia hedonia ida	Chocolate pansy	Lepidoptera	Native	LC	Priority 2
Mycalesis perseus cepheus	Dingy bush brown	Lepidoptera	Native	LC	Priority 2
Neptis sp.	-	Lepidoptera	-	-	Priority 2
Polytremis lubricans lubricans	Contiguous swift	Lepidoptera	Native	LC	Priority 2
Troides helena cerberus	Common birdwing	Lepidoptera	Native	VU	Priority 1
Zizula hylax pygmaea	-	Lepidoptera	Native	LC	Priority 2
Eurema sp.	-	Lepidoptera	-	-	Priority 2
Iambrix salsala salsala	Chestnut bob	Lepidoptera	Native	LC	Priority 2
Mycalesis mineus macromalayana	Dark brand bush brown	Lepidoptera	Native	LC	Priority 2
Mycalesis perseoides perseoides	Perseoides bush brown	Lepidoptera	Uncertain	LC	Priority 3
Mycalesis visala phamis	Long brand bush brown	Lepidoptera	Native	NT	Priority 2
Papilio polytes romulus	Common mormon	Lepidoptera	Native	LC	Priority 2
Pelopidas mathias mathias	Small branded swift	Lepidoptera	Native	LC	Priority 2
Potanthus omaha omaha	Lesser dart	Lepidoptera	Native	LC	Priority 2
Ypthima horsfieldii humei	Malayan five ring	Lepidoptera	Native	LC	Priority 2
Ypthima sp.	-	Lepidoptera	-	-	Priority 2
Callosciurus notatus	Plantain squirrel	Mammal	Native	LC	Priority 2
Cynopterus brachyotis	Lesser short-nosed fruit bat	Mammal	Native	LC	Priority 2
Pteropodidae sp.	-	Mammal	-	-	Priority 2
Rhinolophus lepidus	Blyth's horseshoe bat	Mammal	Native	Not Listed	Priority 2
Scotophilus kuhlii	Lesser Asian house bat	Mammal	Native	LC	Priority 2
Agrionoptera insignis	Grenadier	Odonata	Native	LC	Priority 2
Brachydiplax chalybea	Blue dasher	Odonata	Native	LC	Priority 2
Ceriagrion cerinorubellum	Ornate coraltail	Odonata	Native	LC	Priority 2
Copera marginipes	Yellow featherlegs	Odonata	Native	LC	Priority 2
Crocothemis servilia	Common scarlet	Odonata	Native	LC	Priority 2
Gynacantha sp.	-	Odonata	-	-	Priority 2
Lathrecista asiatica	Scarlet grenadier	Odonata	Native	LC	Priority 2
Nesoxenia lineata	Striped grenadier	Odonata	Native	LC	Priority 2
Neurothemis fluctuans	Common parasol	Odonata	Native	LC	Priority 2
Orthetrum chrysis	Spine-tufted skimmer	Odonata	Native	LC	Priority 2
Orthetrum glaucum	Common blue skimmer	Odonata	Native	LC	Priority 2
Pantala flavescens	Wandering glider	Odonata	Native	LC	Priority 2
Rhyothemis phyllis	Yellow-barred flutterer	Odonata	Native	LC	Priority 3
Tholymis tillarga	White-barred duskhawk	Odonata	Native	LC	Priority 2
Bronchocela cristatella	Green crested lizard	Reptile	Native	LC	Priority 2
Dendrelaphis pictus	Painted bronzeback	Reptile	Native	LC	Priority 2
Dogania subplana	Malayan softshell turtle	Reptile	Native	CR	Priority 1
Eutropis multifasciata	Many-lined sun skink	Reptile	Native	LC	Priority 2

High-priority Species of Probable Occurance					
Scientific Name	**Common Name**	**Taxa**	**Origin**	**SRDB3 Status**	**Priority Level**
Pycnonotus brunneus	Asian red-eyed bulbul	Bird	Native	VU	Priority 1
Ardea purpurea	Purple heron	Bird	Native	EN	Priority 1
Collocalia affinis	Plume-toed swiftlet	Bird	Native	VU	Priority 1
Corvus macrorhynchos	Large-billed crow	Bird	Native	VU	Priority 1
Ketupa ketupu	Buffy fish owl	Bird	Native	VU	Priority 1
Lanius cristatus	Brown shrike	Bird	Native	VU	Priority 1
Nisaetus cirrhatus	Changeable hawk-eagle	Bird	Native	VU	Priority 1
Ptilinopus jambu	Jambu fruit dove	Bird	Native	VU	Priority 1
Strix seloputo	Spotted wood owl	Bird	Native	VU	Priority 1
Treron curvirostra	Thick-billed green pigeon	Bird	Native	VU	Priority 1
Astictopterus jama jama	Forest hopper	Butterfly	Native	EN	Priority 1
Virachola kessuma deliochus	Pitcher blue	Butterfly	Native	EN	Priority 1
Betta imbellis	Crescent betta	Fish	Native	EN	Priority 1
Eonycteris spelaea	Cave nectar bat	Mammal	Native	VU	Priority 1
Lutrogale perspicillata	Smooth-coated otter	Mammal	Native	EN	Priority 1
Manis javanica	Sunda pangolin	Mammal	Native	CR	Priority 1
Ceriagrion chaoi	Fiery coraltail	Odonata	Native	VU	Priority 1
Indothemis limbata	Restless demon	Odonata	Native	VU	Priority 1

Appendix B
Biodiversity Impact Assessment

Delivering a better world

Appendix for Contruction Phase Impacts (Biodiversity)

Habitat

Criterion	Abandoned Land Forest	Exotic-dominated Secondary Forest	Infrastructure	Managed Vegetation	Scrubland / Grassland
Flora and Fauna Richness	2	2	0	0	1
Irreplacability	1	1	0	0	1
National Rarity of Habitat	2	2	0	1	1
Unique Flora and Fauna Species	1	1	0	0	2
Total Score	6	6	0	1	5
Ecological value (Sensitivity)	Medium (Priority 2)	Medium (Priority 2)	Low (Priority 3)	Low (Priority 3)	Low (Priority 3)

Habitat Priority	Criterion
Priority 1	Overall score > 7
Priority 2	6 ≤ Overall score ≤ 7
Priority 3	Overall score < 6

Habitats	Total Area (ha)	Area within development boundary (ha)\	% of Area within boundary	Area within 30m Buffer (ha)	% of Area within Buffer
Abandoned Land Forest	0.64	0	0.00%	0	0.00%
Exotic-dominated Secondary Forest	2.4	1.56	65.00%	0.643	26.79%
Infrastructure	0.74	0.16	21.62%	0.301	40.68%
Managed Vegetation	5.26	3.86	73.38%	0.198	3.76%
Scrubland/Grassland	3.95	3.05	77.22%	0.461	11.67%

Habitat Loss - Construction

Habitat areas within the development boundary:	Priority	Area	% of study area	Impact Intensity	Impact Consequence	Likelihood	Impact Significance
Abandoned land	P2	0	0.00%	Negligible	Imperceptible	Continuous	Negligible
Exotic-dominated Secondary Forest	P2	1.56	65.00%	High	Medium	Continuous	Major
Managed vegetation	P3	3.86	73.4%	High	Low	Continuous	Moderate
Scrubland	P1	3.05	77.2%	High	High	Continuous	Major

Habitat Degradation - Construction

within 30m of the development boundary	Priority	Area	% of study area	Impact Intensity	Impact Consequence	Likelihood	Impact Significance
Abandoned land	P2	0	0.0%	Negligible	Imperceptible	Remote	Negligible
Exotic-dominated Secondary Forest	P2	0.3	12.5%	Medium	Low	Regular	Moderate
Managed vegetation	P3	1.12	21.3%	Medium	Very low	Rare	Negligible
Scrubland	P1	0.26	6.6%	Low	Low	Rare	Minor

Formation of Edge Effects - Construction

within 30m of the development boundary	Priority	PA pre-development	PA post-development	% Change in PA Ratio	Impact Intensity	Impact Consequence	Likelihood	Impact Significance
Abandoned land	P2	0.13	0.13	0.00%	Negligible	Imperceptible	Remote	Negligible
Exotic-dominated Secondary Forest	P2	0.24	0.12	-50.00%	Negligible	Imperceptible	Remote	Negligible
Managed vegetation	P3	0.26	0.16	-38.46%	Negligible	Imperceptible	Remote	Negligible
Scrubland	P1	0.28	0.94	235.71%	High	High	Remote	Negligible

Fauna Priority	Criterion
Priority 1	Conservation significant fauna
Priority 2	Native fauna
Priority 3	Exotic or cryptogenic fauna

Fauna

Accidental injury or mortality

Taxa	Priority	No. species	Impact intensity	Impact Consequen	Likelihood	Impact Significance	Residual Intensity	Residual Consequence	Residual likelihood	Residual Signifi	Comments
Mammals	P1	2	High	High	Regular	Major	High	High	Occassional	Moderate	Sunda pangolin and Smooth coated otter
Reptiles	P1	1	High	High	Regular	Major	High	High	Occassional	Moderate	
	P2	3	High	Medium	Regular	Moderate	High	Medium	Occassional	Moderate	
Amphibians	P2	8	Medium	Low	Occassional	Minor	Medium	Low	Rare	Minor	
	P3	3	Medium	Very low	Occassional	Minor	Medium	Very low	Rare	Negligible	
Less volant birds	P2	3	Medium	Low	Occassional	Minor	Medium	Low	Rare	Minor	Junglefowl, Banded Rail, White breasted waterhen
Mammals	P2	1	Medium	Low	Occassional	Minor	Medium	Low	Rare	Minor	Plantain squirrel
Fish	P1	1	Low	Low	Rare	Minor	Low	Low	Remote	Negligible	
Birds	P1	12	Low	Low	Rare	Minor	Low	Low	Remote	Negligible	
	P2	40	Low	Very low	Rare	Negligible	Low	Very low	Remote	Negligible	
	P3	11	Low	Very low	Rare	Negligible	Low	Very low	Remote	Negligible	
Odonates	P1	1	Low	Low	Rare	Minor	Low	Low	Remote	Negligible	
	P2	12	Low	Very low	Rare	Negligible	Low	Very low	Remote	Negligible	

Appendix for Contruction Phase Impacts (Biodiversity)

	P3	2	Low	Very low	Rare	Negligible	Low	Very low	Remote	Negligible	
Butterflies and Moths	P1	3	Low	Low	Rare	Minor	Low	Low	Remote	Negligible	Included pitcher blue
	P2	14	Low	Very low	Rare	Negligible	Low	Very low	Remote	Negligible	
	P3	4	Low	Very low	Rare	Negligible	Low	Very low	Remote	Negligible	

Human-wildlife conflict

Taxa	Priority	No. species	Impact intensity	Impact Consequen	Likelihood	Impact Significance	Residual Intensity	Residual consequence	Residual likelihood	Residual Signifi	Comments
Mammals	P1	1	Medium	Medium	Regular	Moderate	Medium	Medium	Rare	Minor	Smooth coated otter
Aculeata	P2	4	Medium	Low	Regular	Moderate	Medium	Low	Rare	Minor	
	P3	3	Medium	Very low	Regular	Minor	Medium	Very low	Rare	Negligible	
Snake	P2	1	Medium	Low	Regular	Moderate	Medium	Low	Rare	Minor	Common bronzeback
Other reptiles	P1	1	Low	Low	Rare	Minor	Low	Low	Remote	Negligible	Malayan softshell turtle
	P2	2	Low	Very low	Rare	Negligible	Low	Very low	Remote	Negligible	
Amphibians	P2	8	Low	Very low	Rare	Negligible	Low	Very low	Remote	Negligible	
	P3	3	Low	Very low	Rare	Negligible	Low	Very low	Remote	Negligible	
Bats	P1	1	Low	Low	Rare	Minor	Low	Low	Remote	Negligible	Cave nectar bat
	P2	3	Low	Very low	Rare	Negligible	Low	Very low	Remote	Negligible	

Loss of/Reduction in ecological connectivity

Taxa	Priority	No. species	Impact intensity	Impact Consequen	Likelihood	Impact Significance	Residual Intensity	Residual Consequence	Residual likelihood	Residual Signifi	Comments
Aculeata	P2	4	Low	Very low	Regular	Minor	Low	Very low	Occassional	Minor	
	P3	3	Low	Very low	Regular	Minor	Low	Very low	Occassional	Minor	
Amphibians	P2	8	High	Medium	Continuous	Moderate	High	Medium	Regular	Moderate	
	P3	3	High	Low	Continuous	Moderate	High	Low	Regular	Moderate	
Birds	P1	12	High	High	Continuous	Major	High	High	Occassional	Moderate	
	P2	43	High	Medium	Regular	Moderate	High	Medium	Occassional	Moderate	
	P3	11	Medium	Very low	Regular	Minor	Medium	Very low	Occassional	Minor	
Butterflies	P1	3	Medium	Medium	Continuous	Major	Medium	Medium	Regular	Moderate	Included pitcher blue
	P2	14	Medium	Low	Regular	Moderate	Medium	Low	Occassional	Minor	
	p3	4	Medium	Very low	Regular	Minor	Medium	Very low	Occassional	Minor	
Mammals (squirrel)	P2	1	Medium	Low	Continuous	Moderate	Medium	Low	Regular	Moderate	
Mammals (bats)	P1	1	Low	Low	Regular	Moderate	Low	Low	Occassional	Minor	
	P2	3	Low	Very low	Regular	Minor	Low	Very low	Occassional	Minor	
Odonates	P1	1	Medium	Medium	Regular	Moderate	Medium	Medium	Occassional	Moderate	
	P2	12	Medium	Low	Regular	Moderate	Medium	Low	Occassional	Minor	
	P3	2	Medium	Very low	Continuous	Minor	Medium	Very low	Regular	Minor	
Reptiles	P1	1	High	High	Regular	Major	High	High	Occassional	Moderate	
	P2	3	High	Medium	Regular	Moderate	High	Medium	Occassional	Moderate	

Human disturbances: Increase in human traffic flow, such as from workers, residents and visitors

Taxa	Priority	No. species	Impact intensity	Impact Consequen	Likelihood	Impact Significance	Residual Intensity	Residual Consequence	Residual likelihood	Residual Signifi	Comments
Aculeata	P2	4	High	Medium	Occassional	Moderate	High	Medium	Rare	Minor	
	P3	3	High	Low	Occassional	Minor	High	Low	Rare	Minor	
Amphibians	P2	8	Low	Very low	Regular	Minor	Low	Very low	Occassional	Minor	
	P3	3	Low	Very low	Regular	Minor	Low	Very low	Occassional	Minor	
Birds	P1	12	High	High	Regular	Major	High	High	Occassional	Moderate	
	P2	43	High	Medium	Regular	Moderate	High	Medium	Occassional	Moderate	
	P3	11	Low	Very low	Regular	Minor	Low	Very low	Occassional	Minor	
Butterflies	P1	3	Low	Low	Occassional	Minor	Low	Low	Rare	Minor	Included pitcher blue
	P2	14	Low	Very low	Occassional	Minor	Low	Very low	Rare	Negligible	
	p3	4	Low	Very low	Occassional	Minor	Low	Very low	Rare	Negligible	
Mammals	P1	3	Low	Low	Regular	Moderate	Low	Low	Occassional	Minor	
Mammals	P2	4	Low	Very low	Regular	Minor	Low	Very low	Occassional	Minor	
Odonates	P1	1	Low	Low	Regular	Moderate	Low	Low	Occassional	Minor	
	P2	12	Low	Very low	Regular	Minor	Low	Very low	Occassional	Minor	
	P3	2	Low	Very low	Occassional	Minor	Low	Very low	Rare	Negligible	
Reptiles	P1	1	Medium	Medium	Regular	Moderate	Medium	Medium	Occassional	Moderate	
	P2	3	Medium	Low	Regular	Moderate	Medium	Low	Occassional	Minor	

Light disturbances

Taxa	Priority	No. species	Impact intensity	Impact Consequen	Likelihood	Impact Significance	Residual Intensity	Residual Consequence	Residual likelihood	Residual Signifi	Comments
Aculeata	P2	4	Low	Very low	Rare	Negligible					

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Aculeata	P3	3	Low	Very low	Rare	Negligible		
Amphibians	P2	8	Medium	Low	Rare	Minor		
	P3	3	Medium	Very low	Rare	Negligible		
Birds	P1	2	High	High	Rare	Minor		(spotted wood and buffy fish owl)
	P1	10	Medium	Medium	Rare	Minor		
	P2	39	Low	Very low	Rare	Negligible		
	P2	4	High	Medium	Rare	Minor		Nocturnal birds
	P3	11	Low	Very low	Rare	Negligible		
Butterflies	P1	3	Low	Low	Rare	Minor	No residual significances as pre-mitigation impact significances are Minor and below	Included pitcher blue
	P2	14	Low	Very low	Rare	Negligible		
	p3	4	Low	Very low	Rare	Negligible		
Mammals (squirrel)	P2	1	Low	Very low	Rare	Negligible		
Mammals (bats)	P1	1	High	High	Rare	Minor		
Mammals (bats)	P2	3	High	Medium	Rare	Minor		
Odonates	P1	1	Low	Low	Rare	Minor		
	P2	12	Low	Very low	Rare	Negligible		
	P3	2	Low	Very low	Rare	Negligible		
Reptiles	P1	1	Low	Low	Rare	Minor		
	P2	3	Low	Very low	Rare	Negligible		

Increased invertebrate mortality from fumigation	Priority	No. species	Impact intensity	Impact Consequen	Likelihood	Impact Significance	Residual Intensity	Residual Consequenc	Residual Likelihood	Residual Signifi	Comments
Odonates	P1	2	Medium	Medium	Occassional	Moderate	Medium	Medium	Remote	Negligible	
	P2	25	Medium	Low	Occassional	Minor	Medium	Low	Remote	Negligible	
	P3	2	Medium	Very low	Occassional	Minor	Medium	Very low	Remote	Negligible	
Butterflies	P1	3	Medium	Medium	Occassional	Moderate	High	High	Remote	Negligible	
	P2	25	Medium	Low	Occassional	Minor	High	Medium	Remote	Negligible	
	p3	4	Medium	Very low	Occassional	Minor	High	Low	Remote	Negligible	
Aculeata	P2	5	HIgh	Medium	Occassional	Moderate	High	Medium	Remote	Negligible	
	P3	6	High	Low	Occassional	Minor	High	Low	Remote	Negligible	

Decline in invertebrate health from fumigant runoff and residue	Priority	No. species	Impact intensity	Impact Consequen	Likelihood	Impact Significance	Residual Intensity	Residual Consequenc	Residual Likelihood	Residual Significance	
Odonates	P1	2	High	High	Occassional	Moderate	High	High	Remote	Negligible	
	P2	25	High	Medium	Occassional	Moderate	High	Medium	Remote	Negligible	
	P3	2	High	Low	Occassional	Minor	High	Low	Remote	Negligible	
Butterflies	P1	3	High	High	Occassional	Moderate	High	High	Remote	Negligible	
	P2	25	High	Medium	Occassional	Moderate	High	Medium	Remote	Negligible	
	p3	4	High	Low	Occassional	Minor	High	Low	Remote	Negligible	
Aculeata	P2	5	Medium	Low	Rare	Minor	Medium	Low	Remote	Negligible	
	P3	6	Medium	Very low	Rare	Negligible	Medium	Very low	Remote	Negligible	

For fumigation impacts to invertebrates, 14 odonate species, 14 butterfly species and 4 aculeata species of probable occurrence were added from the Holland Marsh

Appendix for Contruction Phase Impacts (Biodiversity)

Flora Priority	Criterion
Priority 1	Conservation significant species, Large specimens or Keystone species
Priority 2	Native species
Priority 3	Exotic or cryptogenic species

Flora

Mortality

Species list (development boundary)	Origin	Status	Large	CS	Species of value	Priority	Total no. in Study Area	No. inside Dev Boundary	Proportion inside Dev Boundary (%)	No. in 30m Buffer	Proportion inside 30m	Impact intensity	Impact Consequence	Likelihood	Impact Significance
Acacia auriculiformis	Exotic	LC	Y			P1	2	1	50.00%	1	50.00%	Medium	Medium	Continuous	Major
Bambusa heterostachya	Exotic	LC			Y	P1	1	0	0.00%	1	100.00%	Negligible	Very low	Continuous	Minor
Dendrobium lobbii	Native	CR		Y		P1	2	2	100.00%	0	0.00%	High	High	Continuous	Major
Falcataria moluccana	Exotic	LC	Y			P1	5	1	20.00%	4	80.00%	Low	Low	Continuous	Moderate
Nepenthes ampullaria	Native	VU		Y		P1	3	3	100.00%	0	0.00%	High	High	Continuous	Major
Nepenthes rafflesiana	Native	VU		Y		P1	4	4	100.00%	0	0.00%	High	High	Continuous	Major
Nepenthes x trichocarpa	Native	VU		Y		P1	2	2	100.00%	0	0.00%	High	High	Continuous	Major
Phytocrene bracteata	Native	VU		Y		P1	1	0	0.00%	1	100.00%	Negligible	Very low	Continuous	Minor

Decline in plant health

Species list (development boundary)	Origin	Status	Large	CS	Species of value	Priority	Total no. in Study Area	No. inside Dev Boundary	Proportion inside Dev Boundary (%)	No. in 30m Buffer	Proportion inside 30m	Impact intensity	Impact Consequence	Likelihood	Impact Significance
Acacia auriculiformis	Exotic	LC	Y			P1	2	1	50.00%	1	50.00%	Medium	Medium	Rare	Minor
Bambusa heterostachya	Exotic	LC			Y	P1	1	0	0.00%	1	100.00%	High	High	Rare	Minor
Dendrobium lobbii	Native	CR		Y		P1	2	2	100.00%	0	0.00%	Negligible	Very low	Rare	Negligible
Falcataria moluccana	Exotic	LC	Y			P1	5	1	20.00%	4	80.00%	Medium	Medium	Rare	Minor
Nepenthes ampullaria	Native	VU		Y		P1	3	3	100.00%	0	0.00%	Negligible	Very low	Rare	Negligible
Nepenthes rafflesiana	Native	VU		Y		P1	4	4	100.00%	0	0.00%	Negligible	Very low	Rare	Negligible
Nepenthes x trichocarpa	Native	VU		Y		P1	2	2	100.00%	0	0.00%	Negligible	Very low	Rare	Negligible
Phytocrene bracteata	Native	VU		Y		P1	1	0	0.00%	1	100.00%	High	High	Rare	Minor

Poaching

Species list (development boundary)	Origin	Status	Large	CS	Species of value	Priority	Total no. in Study Area	No. inside Dev Boundary	Proportion inside Dev Boundary (%)	No. in 30m Buffer	Proportion inside 30m	Impact intensity	Impact Consequence	Likelihood	Impact Significance
Acacia auriculiformis	Exotic	LC	Y			P1	2	1	50.00%	1	50.00%	Medium	Medium	Remote	Negligible
Bambusa heterostachya	Exotic	LC			Y	P1	1	0	0.00%	1	100.00%	High	High	Remote	Negligible
Dendrobium lobbii	Native	CR		Y		P1	2	2	100.00%	0	0.00%	Negligible	Very low	Continuous	Minor
Falcataria moluccana	Exotic	LC	Y			P1	5	1	20.00%	4	80.00%	Medium	Medium	Remote	Negligible
Nepenthes ampullaria	Native	VU		Y		P1	3	3	100.00%	0	0.00%	Negligible	Very low	Regular	Minor
Nepenthes rafflesiana	Native	VU		Y		P1	4	4	100.00%	0	0.00%	Negligible	Very low	Regular	Minor
Nepenthes x trichocarpa	Native	VU		Y		P1	2	2	100.00%	0	0.00%	Negligible	Very low	Regular	Minor
Phytocrene bracteata	Native	VU		Y		P1	1	0	0.00%	1	100.00%	High	High	Remote	Negligible

* Although the IA matrix outputs 'Minor' for Nepenthes species and Dendrobium, since all of the specimens are within the development boundary, they would not be at risk of poaching and hence should be assigned the significance of 'Negligible'

Appendix for Contruction Phase Impacts (Biodiversity)

Mortality

Species list (development boundary)	Origin	Status	Large	CS	Species of value	Priority	Total no. in Study Area	Residual no. inside dev boundary	Proportion inside Dev Boundary (%)	Residual intensity	Residual consequence	Residual likelihood	Residual significance
Acacia auriculiformis						P1	2	2	100.0%	High	High	Continuous	Major
Bambusa heterostachya						P1	1	0	0.0%	Negligible	Very low	Continuous	Minor
Dendrobium lobbii				y		P1	2	0	0.0%	Negligible	Very low	Remote	Negligible
Falcataria moluccana						P1	5	3	60.0%	Medium	Medium	Continuous	Major
Nepenthes ampullaria				y		P1	3	0	0.0%	Negligible	Very low	Remote	Negligible
Nepenthes rafflesiana				y		P1	4	4	100.0%	High	High	Continuous	Major
Nepenthes x trichocarpa				y		P1	2	0	0.0%	Negligible	Very low	Remote	Negligible
Phytocrene bracteata				y		P1	1	0	0.0%	Negligible	Very low	Continuous	Minor

Decline in plant health

Species list (development boundary)	Origin	Status	Large	CS	Species of value	Priority	Total no. in Study Area	Residual no. in 30m buffer	Proportion inside 30m	Residual intensity	Residual consequence	Residual likelihood	Residual significance
Acacia auriculiformis						P1	2	0	0.0%	Negligible	Very low	Rare	Negligible
Bambusa heterostachya						P1	1	0	0.0%	Negligible	Very low	Rare	Negligible
Dendrobium lobbii				y		P1	2	1	50.0%	Medium	Medium	Rare	Minor
Falcataria moluccana						P1	5	0	0.0%	Negligible	Very low	Rare	Negligible
Nepenthes ampullaria				y		P1	3	2	66.7%	Medium	Medium	Rare	Minor
Nepenthes rafflesiana				y		P1	4	0	0.0%	Negligible	Very low	Rare	Negligible
Nepenthes x trichocarpa				y		P1	2	2	100.0%	High	High	Rare	Minor
Phytocrene bracteata				y		P1	1	0	0.0%	Negligible	Very low	Rare	Negligible

Poaching

Species list (development boundary)	Origin	Status	Large	CS	Species of value	Priority	Total no. in Study Area	Residual no. in 30m buffer	Proportion inside 30m	Residual intensity	Residual consequence	Residual likelihood	Residual significance
Acacia auriculiformis						P1	2	0	0.0%	Negligible	Very low	Remote	Negligible
Bambusa heterostachya						P1	1	0	0.0%	Negligible	Very low	Remote	Negligible
Dendrobium lobbii				y		P1	2	1	50.0%	Medium	Medium	Regular	Moderate
Falcataria moluccana						P1	5	0	0.0%	Negligible	Very low	Remote	Negligible
Nepenthes ampullaria				y		P1	3	2	66.7%	Medium	Medium	Occassiona	Moderate
Nepenthes rafflesiana				y		P1	4	0	0.0%	Negligible	Very low	Occassiona	Minor
Nepenthes x trichocarpa				y		P1	2	2	100.0%	High	High	Occassiona	Moderate
Phytocrene bracteata				y		P1	1	0	0.0%	Negligible	Very low	Remote	Negligible

* Although the IA matrix outputs 'Minor' for Nepenthes species and Dendrobium, since all of the specimens are within the development boundary, they would not be at risk of poaching and hence should be assigned the significance of 'Negligible'

Appendix for Operational Phase Impacts (Biodiversity)

Habitat

Criterion	Abandoned Land Forest	Exotic-dominated Secondary Forest	Infrastructure	Managed Vegetation	Scrubland / Grassland
Flora and Fauna Richness	2	2	0	0	1
Irreplacability	1	1	0	0	1
National Rarity of Habitat	2	2	0	1	1
Unique Flora and Fauna Species	1	1	0	0	2
Total Score	6	6	0	1	5
Ecological value (Sensitivity)	Medium (Priority 2)	Medium (Priority 2)	Low (Priority 3)	Low (Priority 3)	Low (Priority 3)

Habitat Priority	Criterion
Priority 1	Overall score > 7
Priority 2	6 ≤ Overall score ≤ 7
Priority 3	Overall score < 6

Habitats	Total Area (ha)	Area within development boundary (ha)\	% of Area within boundary	Area within 30m Buffer (ha)	% of Area within Buffer
Abandoned Land Forest	0.647	0	0.00%	0	0.00%
Exotic-dominated Secondary Forest	2.4	1.56	65.00%	0.643	26.79%
Infrastructure	0.743	0.158	21.27%	0.301	40.51%
Managed Vegetation	0.252	0.054	21.43%	0.198	78.57%
Scrubland/Grassland	3.95	3.05	77.22%	0.461	11.67%

Habitat Degradation - Operational											
within 30m of the development boundary	Priority	Area	% of study area	Impact Intensity	Impact Consequence	Likelihood	Impact Significance	New Area (w RAC)	% of study area	Likelihood	
Abandoned land	P2	0	0.0%	Negligible	Imperceptible	Remote	Negligible	No change		Remote	
Exotic-dominated Secondary Forest	P2	0.643	26.8%	Medium	Low	Rare	Minor			Remote	
Managed vegetation	P3	0.198	78.6%	High	Low	Remote	Negligible			Remote	
Scrubland	P1	0.461	11.7%	Medium	Medium	Rare	Minor	2.261	57.2%	Rare	

Fauna

Fauna Priority	Criterion
Priority 1	Conservation significant fauna
Priority 2	Native fauna
Priority 3	Exotic or cryptogenic fauna

Accidental injury or mortality											
Taxa	Priority	No. species	Impact intensity	Impact Consequence	Likelihood	Impact Significance	Residual Intensity	Residual Consequen	Residual likelihood	Residual Significance	Comments
Mammals	P1	3	High	High	Occassional	Moderate	High	High	Rare	Minor	Sunda pangolin, Macaque and Smooth coated otter
Reptiles	P1	1	High	High	Occassional	Moderate	High	High	Rare	Minor	
	P2	3	High	Medium	Occassional	Moderate	High	Medium	Rare	Minor	
Birds	P2	4	Medium	Low	Regular	Moderate	Medium	Low	Occassional	Minor	Pink necked green pigeon, spotted dove, white-throated kingfisher, asian glossy starling
Amphibians	P2	8	Medium	Low	Rare	Minor	Medium	Low	Remote	Negligible	
	P3	3	Medium	Very low	Rare	Negligible	Medium	Very low	Remote	Negligible	
Less volant birds	P2	3	Medium	Low	Remote	Negligible	Medium	Low	Remote	Negligible	Junglefowl, Banded Rail, White breasted waterhen
Mammals	P2	1	Medium	Low	Remote	Negligible	Medium	Low	Remote	Negligible	Plantain squirrel
Fish	P1	1	Low	Low	Remote	Negligible	Low	Low	Remote	Negligible	
Birds	P1	12	Low	Low	Remote	Negligible	Low	Low	Rare	Minor	
	P2	36	Low	Very low	Remote	Negligible	Low	Very low	Rare	Negligible	
	P3	11	Low	Very low	Remote	Negligible	Low	Very low	Rare	Negligible	
Odonates	P1	1	Low	Low	Remote	Negligible	Low	Low	Remote	Negligible	
	P2	12	Low	Very low	Remote	Negligible	Low	Very low	Remote	Negligible	
	P3	2	Low	Very low	Remote	Negligible	Low	Very low	Remote	Negligible	
Butterflies	P1	3	Low	Low	Remote	Negligible	Low	Low	Remote	Negligible	
	P2	14	Low	Very low	Remote	Negligible	Low	Very low	Remote	Negligible	
	P3	4	Low	Very low	Remote	Negligible	Low	Very low	Remote	Negligible	
Human-wildlife conflict											
Taxa	Priority	No. species	Impact intensity	Impact Consequence	Likelihood	Impact Significance	Residual Intensity	Residual consequend	Residual likelihood	Residual Significance	Comments
Mammals	P1	1	Medium	Medium	Regular	Moderate	Medium	Medium	Rare	Minor	Smooth coated otter
Aculeata	P2	4	Medium	Low	Regular	Moderate	Medium	Low	Rare	Minor	
	P3	3	Medium	Very low	Regular	Minor	Medium	Very low	Rare	Negligible	

Appendix for Operational Phase Impacts (Biodiversity)

Snake	P2	1	Medium	Low	Regular	Moderate	Medium	Low	Rare	Minor	Common bronzeback
Other reptiles	P1	1	Low	Low	Remote	Negligible	Low	Low	Remote	Negligible	Malayan softshell turtle
	P2	2	Low	Very low	Rare	Negligible	Low	Very low	Remote	Negligible	
Amphibians	P2	8	Low	Very low	Rare	Negligible	Low	Very low	Remote	Negligible	
	P3	3	Low	Very low	Rare	Negligible	Low	Very low	Remote	Negligible	
Bats	P1	1	Low	Low	Rare	Minor	Low	Low	Remote	Negligible	Cave nectar bat
	P2	3	Low	Very low	Rare	Negligible	Low	Very low	Remote	Negligible	

Loss of/Reduction in ecological connectivity											
Taxa	Priority	No. species	Impact intensity	Impact Consequence	Likelihood	Impact Significance	Residual Intensity	Residual consequenc	Residual likelihood	Residual Significance	Comments
Aculeata	P2	4	Low	Very low	Occassional	Minor	Low	Very low	Rare	Negligible	Besides sp with high impact intensity, likelihood for others shifted to regular
	P3	3	Low	Very low	Occassional	Minor	Low	Very low	Rare	Negligible	
Amphibians	P2	8	High	Medium	Regular	Moderate	High	Medium	Occassional	Moderate	
	P3	3	High	Low	Regular	Moderate	High	Low	Occassional	Minor	
Birds	P1	12	High	High	Occassional	Moderate	High	High	Rare	Minor	
	P2	43	High	Medium	Occassional	Moderate	High	Medium	Rare	Minor	
	P3	11	Medium	Very low	Occassional	Minor	Medium	Very low	Rare	Negligible	
Butterflies	P1	3	Medium	Medium	Occassional	Moderate	Medium	Medium	Rare	Minor	
	P2	14	Medium	Low	Occassional	Minor	Medium	Low	Rare	Minor	
	p3	4	Medium	Very low	Occassional	Minor	Medium	Very low	Rare	Negligible	
Mammals (squirrel)	P2	1	Medium	Low	Occassional	Minor	Medium	Low	Rare	Minor	
Mammals (bats)	P1	1	Low	Low	Occassional	Minor	Low	Low	Rare	Minor	
	P2	3	Low	Very low	Occassional	Minor	Low	Very low	Rare	Negligible	
Odonates	P1	1	Medium	Medium	Regular	Moderate	Medium	Medium	Occassional	Moderate	
	P2	12	Medium	Low	Regular	Moderate	Medium	Low	Occassional	Minor	
	P3	2	Medium	Very low	Regular	Minor	Medium	Very low	Occassional	Minor	
Reptiles	P1	1	High	High	Occassional	Moderate	High	High	Rare	Minor	
	P2	3	High	Medium	Occassional	Moderate	High	Medium	Rare	Minor	

Human disturbances: Increase in human traffic flow, such as from workers, residents and visitors											
Taxa	Priority	No. species	Impact intensity	Impact Consequence	Likelihood	Impact Significance	Residual Intensity	Residual Consequenc	Residual likelihood	Residual Significance	Comments
Aculeata	P2	4	High	Medium	Occassional	Moderate	High	Medium	Rare	Minor	
	P3	3	High	Low	Occassional	Minor	High	Low	Rare	Minor	
Amphibians	P2	8	Low	Very low	Occassional	Minor	Low	Very low	Rare	Negligible	
	P3	3	Low	Very low	Occassional	Minor	Low	Very low	Rare	Negligible	
Birds	P1	12	High	High	Occassional	Moderate	High	High	Rare	Minor	
	P2	43	High	Medium	Occassional	Moderate	High	Medium	Rare	Minor	
	P3	11	Low	Very low	Occassional	Minor	Low	Very low	Rare	Negligible	
Butterflies	P1	3	Low	Low	Occassional	Minor	Low	Low	Rare	Minor	
	P2	14	Low	Very low	Occassional	Minor	Low	Very low	Rare	Negligible	
	p3	4	Low	Very low	Occassional	Minor	Low	Very low	Rare	Negligible	
Mammals	P1	3	Low	Low	Occassional	Minor	Low	Low	Rare	Minor	
Mammals	P2	4	Low	Very low	Occassional	Minor	Low	Very low	Rare	Negligible	
Odonates	P1	1	Low	Low	Occassional	Minor	Low	Low	Rare	Minor	
	P2	12	Low	Very low	Occassional	Minor	Low	Very low	Rare	Negligible	
	P3	2	Low	Very low	Occassional	Minor	Low	Very low	Rare	Negligible	
Reptiles	P1	1	Medium	Medium	Occassional	Moderate	Medium	Medium	Rare	Minor	
	P2	3	Medium	Low	Occassional	Minor	Medium	Low	Rare	Minor	

Light disturbances											
Taxa	Priority	No. species	Impact intensity	Impact Consequence	Likelihood	Impact Significance	Residual Intensity	Residual consequenc	Residual likelihood	Residual Significance	Comments
Aculeata	P2	4	Low	Very low	Rare	Negligible	Low	Very low	Rare	Negligible	
	P3	3	Low	Very low	Rare	Negligible	Low	Very low	Rare	Negligible	
Amphibians	P2	8	Medium	Low	Rare	Minor	Medium	Low	Rare	Minor	
	P3	3	Medium	Very low	Rare	Negligible	Medium	Very low	Rare	Negligible	
Birds	P1	2	High	High	Occassional	Moderate	High	High	Rare	Minor	(spotted wood and buffy fish owl)
	P1	10	Medium	Medium	Occassional	Moderate	Medium	Medium	Rare	Minor	
	P2	39	Low	Very low	Rare	Negligible	Low	Very low	Rare	Negligible	
	P2	4	High	Medium	Occassional	Moderate	High	Medium	Rare	Minor	Nocturnal birds
	P3	11	Low	Very low	Rare	Negligible	Low	Very low	Rare	Negligible	
Butterflies	P1	3	Low	Low	Rare	Minor	Low	Low	Rare	Minor	
	P2	14	Low	Very low	Rare	Negligible	Low	Very low	Rare	Negligible	
	p3	4	Low	Very low	Rare	Negligible	Low	Very low	Rare	Negligible	

Appendix for Operational Phase Impacts (Biodiversity)

Mammals (squirrel)	P2	1	Low	Very low	Rare	Negligible	Low	Very low	Rare	Negligible	
Mammals (bats)	P1	1	High	High	Occassional	Moderate	High	High	Rare	Minor	
Mammals (bats)	P2	3	High	Medium	Occassional	Moderate	High	Medium	Rare	Minor	
Odonates	P1	1	Low	Low	Rare	Minor	Low	Low	Rare	Minor	
	P2	12	Low	Very low	Rare	Negligible	Low	Very low	Rare	Negligible	
	P3	2	Low	Very low	Rare	Negligible	Low	Very low	Rare	Negligible	
Reptiles	P1	1	Low	Low	Rare	Minor	Low	Low	Rare	Minor	
	P2	3	Low	Very low	Rare	Negligible	Low	Very low	Rare	Negligible	

Appendix for Operational Phase Impacts (Biodiversity)

Increased invertebrate mortality from fumigation	Priority	No. species	Impact intensity	Impact Consequence	Likelihood	Impact Significance	Residual Intensity	Residual Consequen	Residual Likelihood	Residual Significance	Comments
Odonates	P1	2	Medium	Medium	Occassional	Moderate	Medium	Medium	Rare	Minor	
	P2	25	Medium	Low	Occassional	Minor	Medium	Low	Rare	Minor	
	P3	2	Medium	Very low	Occassional	Minor	Medium	Very low	Rare	Negligible	
Butterflies	P1	3	Medium	Medium	Occassional	Moderate	High	High	Rare	Minor	
	P2	25	Medium	Low	Occassional	Minor	High	Medium	Rare	Minor	
	p3	4	Medium	Very low	Occassional	Minor	High	Low	Rare	Minor	
Aculeata	P2	5	HIgh	Medium	Occassional	Moderate	High	Medium	Rare	Minor	
	P3	6	High	Low	Occassional	Minor	High	Low	Rare	Minor	

Decline in invertebrate health from fumigant runoff and residue	Priority	No. species	Impact intensity	Impact Consequence	Likelihood	Impact Significance	Residual Intensity	Residual Consequen	Residual Likelihood	Residual Significance	Comments
Odonates	P1	2	High	High	Occassional	Moderate	High	High	Rare	Minor	
	P2	25	High	Medium	Occassional	Moderate	High	Medium	Rare	Minor	
	P3	2	High	Low	Occassional	Minor	High	Low	Rare	Minor	
Butterflies	P1	3	High	High	Occassional	Moderate	High	High	Rare	Minor	
	P2	25	High	Medium	Occassional	Moderate	High	Medium	Rare	Minor	
	p3	4	High	Low	Occassional	Minor	High	Low	Rare	Minor	
Aculeata	P2	5	Medium	Low	Rare	Minor	Medium	Low	Remote	Negligible	
	P3	6	Medium	Very low	Rare	Negligible	Medium	Very low	Remote	Negligible	

For fumigation impacts to invertebrates, 14 odonate species, 14 butterfly species and 4 aculeata species of probable occurrence were added from the Holland Marsh

Flora Priority	Criterion
Priority 1	Conservation significant species, Large specimens or Keystone species
Priority 2	Native species
Priority 3	Exotic or cryptogenic species

Flora

Decline in plant health

Species list (development boundary)	Origin	Status	Large	CS	Species of value	Priority	Total no. in Study Area	No. inside Dev Boundary	Proportion inside Dev Boundary (%)	No. in 30m Buffer	Proportion inside 30m	Impact intensity	Impact Consequence	Likelihood	Impact Significance
Acacia auriculiformis	Exotic	LC	Y			P1	2	1	50.00%	1	50.00%	Medium	Medium	Rare	Minor
Bambusa heterostachya	Exotic	LC			Y	P1	1	0	0.00%	1	100.00%	High	High	Rare	Minor
Dendrobium lobbii	Native	CR		Y		P1	2	2	100.00%	0	0.00%	Negligible	Very low	Rare	Negligible
Falcataria moluccana	Exotic	LC	Y			P1	5	1	20.00%	4	80.00%	Medium	Medium	Rare	Minor
Nepenthes ampullaria	Native	VU		Y		P1	3	3	100.00%	0	0.00%	Negligible	Very low	Rare	Negligible
Nepenthes rafflesiana	Native	VU		Y		P1	4	4	100.00%	0	0.00%	Negligible	Very low	Rare	Negligible
Nepenthes x trichocarpa	Native	VU		Y		P1	2	2	100.00%	0	0.00%	Negligible	Very low	Rare	Negligible
Phytocrene bracteata	Native	VU		Y		P1	1	0	0.00%	1	100.00%	High	High	Rare	Minor

Appendix for Operational Phase Impacts (Biodiversity)

Decline in plant health

Species list (development boundary)	Origin	Status	Large	CS	Species of value	Priority	Total no. in Study Area	Residual no. in 30m buffer	Proportion inside 30m	Residual intensity	Residual consequence	Residual likelihood	Residual significance
Acacia auriculiformis	Exotic	LC	Y			P1	2	0	0.0%	Negligible	Very low	Rare	Negligible
Bambusa heterostachya	Exotic	LC			Y	P1	1	0	0.0%	Negligible	Very low	Rare	Negligible
Dendrobium lobbii	Native	CR		Y		P1	2	1	50.0%	Medium	Medium	Rare	Minor
Falcataria moluccana	Exotic	LC	Y			P1	5	0	0.0%	Negligible	Very low	Rare	Negligible
Nepenthes ampullaria	Native	VU		Y		P1	3	2	66.7%	Medium	Medium	Rare	Minor
Nepenthes rafflesiana	Native	VU		Y		P1	4	0	0.0%	Negligible	Very low	Rare	Negligible
Nepenthes x trichocarpa	Native	VU		Y		P1	2	2	100.0%	High	High	Rare	Minor
Phytocrene bracteata	Native	VU		Y		P1	1	0	0.0%	Negligible	Very low	Rare	Negligible

Poaching

Species list (development boundary)	Origin	Status	Large	CS	Species of value	Priority	Total no. in Study Area	Residual no. in 30m buffer	Proportion inside 30m	Residual intensity	Residual consequence	Residual likelihood	Residual significance
Acacia auriculiformis						P1	2	0	0.0%	Negligible	Very low	Remote	Negligible
Bambusa heterostachya						P1	1	0	0.0%	Negligible	Very low	Remote	Negligible
Dendrobium lobbii				y		P1	2	1	50.0%	Medium	Medium	Regular	Moderate
Falcataria moluccana						P1	5	0	0.0%	Negligible	Very low	Remote	Negligible
Nepenthes ampullaria				y		P1	3	2	66.7%	Medium	Medium	Occassional	Moderate
Nepenthes rafflesiana				y		P1	4	0	0.0%	Negligible	Very low	Occassional	Minor
Nepenthes x trichocarpa				y		P1	2	2	100.0%	High	High	Occassional	Moderate
Phytocrene bracteata				y		P1	1	0	0.0%	Negligible	Very low	Remote	Negligible

Appendix C
Wildlife Incident Form

Delivering a better world

WILDLIFE INCIDENT FORM

Date (YYYY/MM/DD):	Time:
Description of Location:	GPS Coordinates:
Wildlife Observed:	Animal Condition: ☐ Alive ☐ Killed ☐ Dead ☐ Injured Animal Activity: ☐ Moving ☐ Resting ☐ Trapped
Photographs Taken: ☐ Yes ☐ No	NParks Notified: ☐ Yes ☐ No Name of NParks Staff Notified: _____
Describe Incident (e.g., activities being carried out; what animal was doing; personnel involved):	
Actions Taken:	
Reported by: _____ Contact #: _____	Reported to: _____ Contact #: _____
Remarks:	

Appendix D
Air Quality Sensitive Receptor List

Delivering a better world

Air Quality Sensitive Receptors

Distance	Land Use	Number of Receivers	Sensitivity of the Area
For Earthworks			
Within 20m	-	-	Priority 2
Between 20m to 50m	Residential: 1. 10, 16, 18, 20, 22, 24, 26, 28, 30, 32, 34, 36, 38, 40, 42, 44 Holland Green	10 - 100	
Between 50m to 100m	Residential: 1. 2, 4, 6, 8, 12, 14, 17, 19, 21, 23, 35, 37, 39, 41, 49, 51, 53, 55, 57, 59, 61 Holland Green 2. 1A Ewart Park	10 – 100	
Between 100m to 250m	Residential: 1. 1, 1B, 2, 2A, 2B, 3, 3A Brizay Park 2. 1, 1B, 2, 2A, 3, 3A, 3B, 4, 5, 6, 7, 8, 8A, 8B, 22, 28 Ewart Park 3. 2, 3, 4, 5, 6, 7, 8, 9, 11, 15, 17, 19, 21, 23, 25, 27, 29, 31, 33 Greenleaf Place 4. 1, 3, 5, 7, 9, 11, 13, 15, 25, 27, 29, 31, 33, 43, 45, 47 Holland Green 5. 57, 480, 482, 484, 486, 488, 490, 492, 563, 565, 567, 569, 571 Holland Road 6. 783, 785, 805 Old Holland Road Educational: 1. Methodist Girls' School	10 – 100 >100	
For Construction			
Within 20m	-	-	Priority 3
Between 20m to 50m	-	-	
Between 50m to 100m	Residential: 1. 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32, 34, 36, 38, 40, 42, 44 Holland Green	10 - 100	
Between 100m to 250m	Residential: 1. 1, 2, 4, 1B, 2A, 2B Brizay Park 2. 1, 2, 3, 4, 5, 6, 7, 1A, 1B, 2A, 3A, 3B Ewart Park 3. 3, 5, 7, 9, 11, 15, 17, 19, 21, 23, 25, 27, 29 Greenleaf Place 4. 1, 2, 3, 4, 5, 7, 9, 11, 13, 15, 17, 19, 21, 23, 25, 27, 29, 31, 33, 35, 37, 39, 41, 43, 45, 47, 49, 51, 53, 55, 57, 59, 61 Holland Green 5. 486, 488, 490, 492, 567, 569, 571 Holland Road 6. 783, 785, 805 Old Holland Road Educational: 1. Methodist Girls' School	>100 >100	
For Trackout			

Air Quality Sensitive Receptors

Distance	Land Use	Number of Receivers	Sensitivity of the Area
Within 20m	Residential: 1. Eleven @ Holland Unit 1, 2, 3, 4, 5, 6, 7 Educational: 1. Methodist Girls' School Place of Worship: 1. Fong Yun Thai Association	1 - 10 >100 10 - 100	Priority 1
Between 20m to 50m	Residential: 1. Eleven @ Holland Unit 8, 9, 10, 11, 12, 34, 35, 36, 37, 38, 39, 40, 57, 58, 59, 60, 61, 62, 63, 64, 71, 72, 73, 74 2. 997 Bukit Timah Rd	10 - 100	

Appendix E
Airborne Noise Sensitive Receptor List (Ecology)

Delivering a better world

S/N	Scientific Name	Taxa	Auditory Sensitivity
1	Chalcorana labialis	Amphibian	Priority 1
2	Duttaphrynus melanostictus	Amphibian	Priority 1
3	Eleutherodactylus planirostris	Amphibian	Priority 1
4	Fejervarya limnocharis	Amphibian	Priority 1
5	Hylarana erythraea	Amphibian	Priority 1
6	Kaloula pulchra	Amphibian	Priority 1
7	Limnonectes blythii	Amphibian	Priority 1
8	Limnonectes malesianus	Amphibian	Priority 1
9	Microhyla butleri	Amphibian	Priority 1
10	Microhyla heymonsi	Amphibian	Priority 1
11	Microhyla mukhlesuri	Amphibian	Priority 1
12	Polypedates leucomystax	Amphibian	Priority 1
13	Pulchrana laterimaculata	Amphibian	Priority 1
14	Acridotheres javanicus	Bird	Priority 1
15	Aegithina tiphia	Bird	Priority 1
16	Aerodramus sp.	Bird	Priority 1
17	Aethopyga siparaja	Bird	Priority 1
18	Amaurornis phoenicurus	Bird	Priority 1
19	Anthracoceros albirostris	Bird	Priority 1
20	Anthreptes malacensis	Bird	Priority 1
21	Aplonis panayensis	Bird	Priority 1
22	Ardeola sp.	Bird	Priority 1
23	Bubulcus coromandus	Bird	Priority 1
24	Cacatua goffiniana	Bird	Priority 1
25	Caprimulgus affinis	Bird	Priority 1
26	Caprimulgus macrurus	Bird	Priority 1
27	Cecropis daurica	Bird	Priority 1
28	Centropus sinensis	Bird	Priority 1
29	Chalcophaps indica	Bird	Priority 1
30	Chrysococcyx xanthorhynchus	Bird	Priority 1
31	Chrysophlegma miniaceum	Bird	Priority 1
32	Cinnyris jugularis	Bird	Priority 1
33	Corvus splendens	Bird	Priority 1
34	Dicaeum cruentatum	Bird	Priority 1
35	Dicrurus paradiseus	Bird	Priority 1
36	Dinopium javanense	Bird	Priority 1
37	Eudynamys scolopaceus	Bird	Priority 1
38	Eurystomus orientalis	Bird	Priority 1
39	Ficedula zanthopygia	Bird	Priority 1
40	Gallus gallus	Bird	Priority 1
41	Garrulax leucolophus	Bird	Priority 1
42	Geopelia striata	Bird	Priority 1
43	Gracula religiosa	Bird	Priority 1
44	Halcyon smyrnensis	Bird	Priority 1
45	Haliaeetus leucogaster	Bird	Priority 1
46	Haliastur indus	Bird	Priority 1
47	Hirundo rustica	Bird	Priority 1
48	Hirundo tahitica	Bird	Priority 1

S/N	Scientific Name	Taxa	Auditory Sensitivity
49	Lalage nigra	Bird	Priority 1
50	Lanius cristatus	Bird	Priority 1
51	Larvivora cyane	Bird	Priority 1
52	Lewinia striata	Bird	Priority 1
53	Loriculus galgulus	Bird	Priority 1
54	Merops viridis	Bird	Priority 1
55	Micropternus brachyurus	Bird	Priority 1
56	Mixornis gularis	Bird	Priority 1
57	Muscicapa dauurica	Bird	Priority 1
58	Ninox scutulata	Bird	Priority 1
59	Nisaetus cirrhatus	Bird	Priority 1
60	Oriolus chinensis	Bird	Priority 1
61	Orthotomus atrogularis	Bird	Priority 1
62	Orthotomus ruficeps	Bird	Priority 1
63	Orthotomus sericeus	Bird	Priority 1
64	Orthotomus sutorius	Bird	Priority 1
65	Otus lempiji	Bird	Priority 1
66	Pericrocotus divaricatus	Bird	Priority 1
67	Pernis ptilorhynchus	Bird	Priority 1
68	Phylloscopus borealis	Bird	Priority 1
69	Picus vittatus	Bird	Priority 1
70	Psilopogon haemacephalus	Bird	Priority 1
71	Psilopogon lineatus	Bird	Priority 1
72	Psittacula alexandri	Bird	Priority 1
73	Psittacula krameri	Bird	Priority 1
74	Psittacula longicauda	Bird	Priority 1
75	Pycnonotus goiavier	Bird	Priority 1
76	Pycnonotus jocosus	Bird	Priority 1
77	Pycnonotus plumosus	Bird	Priority 1
78	Pycnonotus zeylanicus	Bird	Priority 1
79	Rallina fasciata	Bird	Priority 1
80	Rhipidura javanica	Bird	Priority 1
81	Spilopelia chinensis	Bird	Priority 1
82	Spilornis cheela	Bird	Priority 1
83	Terpsiphone affinis	Bird	Priority 1
84	Todiramphus chloris	Bird	Priority 1
85	Treron vernans	Bird	Priority 1
86	Trichoglossus haematodus	Bird	Priority 1
87	Vanellus indicus	Bird	Priority 1
88	Zapornia fusca	Bird	Priority 1
89	Zosterops simplex	Bird	Priority 1
90	Cynopterus brachyotis	Mammal	Priority 1
91	Myotis muricola	Mammal	Priority 1
92	Paradoxurus musangus	Mammal	Priority 1
93	Rhinolophus lepidus	Mammal	Priority 1
94	Saccolaimus saccolaimus	Mammal	Priority 1
95	Scotophilus kuhlii	Mammal	Priority 1
96	Tylonycteris spp.	Mammal	Priority 1

Appendix F
Airborne Noise Sensitive Receptor List (Human)

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Receptor	Priority	Building Type	Storey	Approximate distance from construction worksite (m)	Height (m)	Relevant Noise Monitoring Location	Criteria (dB(A))
1 Ewart Park	2	Residential	2	172	6.4	N14	75
1B Ewart Park	2	Residential	2	146	6.4	N14	75
1A Ewart Park	2	Residential	2	137	6.4	N14	75
59 Holland Green	2	Residential	3	122	9.6	N14	75
61 Holland Green	2	Residential	3	110	9.6	N14	75
57 Holland Green	2	Residential	3	116	9.6	N14	75
55 Holland Green	2	Residential	3	117	9.6	N14	75
53 Holland Green	2	Residential	3	118	9.6	N14	75
47 Holland Green	2	Residential	3	138	9.6	N14	75
49 Holland Green	2	Residential	3	116	9.6	N14	75
51 Holland Green	2	Residential	3	113	9.6	N14	75
44 Holland Green	2	Residential	3	71	9.6	N14	75
42 Holland Green	2	Residential	3	72	9.6	N14	75
40 Holland Green	2	Residential	3	72	9.6	N14	75
38 Holland Green	2	Residential	3	73	9.6	N14	75
36 Holland Green	2	Residential	3	73	9.6	N14	75
34 Holland Green	2	Residential	3	75	9.6	N14	75
32 Holland Green	2	Residential	3	75	9.6	N14	75
30 Holland Green	2	Residential	3	75	9.6	N14	75
28 Holland Green	2	Residential	3	75	9.6	N14	75

Receptor	Priority	Building Type	Storey	Approximate distance from construction worksite (m)	Height (m)	Relevant Noise Monitoring Location	Criteria (dB(A))
26 Holland Green	2	Residential	3	76	9.6	N14	75
24 Holland Green	2	Residential	3	76	9.6	N14	75
22 Holland Green	2	Residential	3	80	9.6	N14	75
20 Holland Green	2	Residential	3	80	9.6	N14	75
18 Holland Green	2	Residential	3	79	9.6	N14	75
14 Holland Green	2	Residential	3	88	9.6	N14	75
16 Holland Green	2	Residential	3	79	9.6	N14	75
10 Holland Green	2	Residential	3	77	9.6	N14	75
12 Holland Green	2	Residential	3	91	9.6	N14	75
2 Ewart Park	2	Residential	3	160	9.6	N14	75
45 Holland Green	2	Residential	3	147	9.6	N14	75
43 Holland Green	2	Residential	3	137	9.6	N14	75
41 Holland Green	2	Residential	3	125	9.6	N14	75
39 Holland Green	2	Residential	3	112	9.6	N14	75
37 Holland Green	2	Residential	3	117	9.6	N14	75
35 Holland Green	2	Residential	3	118	9.6	N14	75
33 Holland Green	2	Residential	3	143	9.6	N14	75
31 Holland Green	2	Residential	3	156	9.6	N14	75
Service Facility (Power)	3	Service Facility	1.5	115	4.8	N14	75

Receptor	Priority	Building Type	Storey	Approximate distance from construction worksite (m)	Height (m)	Relevant Noise Monitoring Location	Criteria (dB(A))
23 Holland Green	2	Residential	3	123	9.6	N14	75
21 Holland Green	2	Residential	3	117	9.6	N14	75
19 Holland Green	2	Residential	3	125	9.6	N14	75
17 Holland Green	2	Residential	3	128	9.6	N14	75
25 Holland Green	2	Residential	3	141	9.6	N14	75
15 Holland Green	2	Residential	3	151	9.6	N14	75
13 Holland Green	2	Residential	3	164	9.6	N14	75
2 Holland Green	2	Residential	3	113	9.6	N14	75
4 Holland Green	2	Residential	3	104	9.6	N14	75
1 Holland Green	2	Residential	3	137	9.6	N14	75
6 Holland Green	2	Residential	3	93	9.6	N14	75
8 Holland Green	2	Residential	4	85	12.8	N14	75
27 Holland Green	2	Residential	3	154	9.6	N14	75
29 Holland Green	2	Residential	3	166	9.6	N14	75
3B Ewart Park	2	Residential	3	174	9.6	N14	75
11 Holland Green	2	Residential	4	175	12.8	N14	75
7 Holland Green	2	Residential	3	174	9.6	N14	75

Receptor	Priority	Building Type	Storey	Approximate distance from construction worksite (m)	Height (m)	Relevant Noise Monitoring Location	Criteria (dB(A))
5 Holland Green	2	Residential	3	161	9.6	N14	75
3 Holland Green	2	Residential	3	148	9.6	N14	75
2 Ewart Park (Part 2)	2	Residential	2	163	6.4	N14	75
1 Ewart Park	2	Residential	2	187	6.4	N14	75
2A Ewart Park	2	Residential	1	171	3.2	N14	75

Appendix G
Construction Equipment Inventory

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				DAY - LAeq(12hrs)				DAY - LAeq(5mins)			
				Activities 7:00am - 7:00pm				Activities 7:00am - 7:00pm			
No.	Phase of Construction	PME	Approximate no of months for this activity [in months]	No [Quantity of that particular construction equipment used for that particular construction activity]	On-time(%) / daily working hours [how long in percentage that particular equipment will be used in a day]	PWL, dB(A)	10^(Lw/10)	No [Quantity of that particular construction equipment used for that particular construction activity]	On-time(%) / daily working hours [how long in percentage that particular equipment will be used in a day]	PWL, dB(A)	10^(Lw/10)
1. Site Clearance and Earthworks - **30 months**											
1	Site Clearance and Earthworks to prepare platform	Excavator	30	2	50%	106	39810717055	2	100%	109	79621434111
		Lorry	30	15	50%	116	3.7589E+11	15	100%	119	7.51781E+11
		Generator	30	2	50%	106	39810717055	2	100%	109	79621434111
		Concrete Vibrator	30	1	50%	94	2505936168	1	100%	97	5011872336
		Air Compressor	30	1	50%	100	9976311575	1	100%	103	19952623150
2	Construction Access	Lorry	6	1	50%	104	25059361681	1	100%	107	50118723363
		Excavator	6	1	50%	98	6294627059	1	100%	101	12589254118
							117				120
2. Foundation Work (Substructures including piles and pile caps) - **30 months**											
1	Erection of crawler crane & boring rig	Mobile Crane	6	1	90%	110	90000000000	1	100%	110	1E+11
2	Installation of Casing	Crawler Crane	27	2	90%	117	4.5214E+11	2	100%	117	5.02377E+11
3	Boring Work	Bored Piling Machine	27	4	90%	123	1.80427E+12	4	100%	123	2.00475E+12
4	Rebar Cage & Tremix Pipe Installation	Crawler Crane	27	2	90%	117	4.5214E+11	2	100%	117	5.02377E+11
5	Concreting works	Ready Mix Concrete Truck & Crawler Crane	27	2	90%	110	90213702053	2	100%	110	1.00237E+11
6	Pile Head hacking	Excavator via breaker and 40 pounds breaker	27	2	90%	109	71659290700	2	100%	109	79621434111
7	Hot works - welding of steel beams, brackets, etc	Welding Equipment	27	1	90%	101	11330328706	1	100%	101	12589254118
8	Delivery of Steel sections	40 ft Trailer	27	2	90%	111	1.13572E+11	2	100%	111	1.26191E+11
9	Hoisting of Waler & Struts	Excavator with lifting appliance	27	1	90%	106	35829645350	1	100%	106	39810717055
10	Stage excavation for walers & struts	Excavator with lifting appliance	27	1	90%	106	35829645350	1	100%	106	39810717055
11	Stage Excavation	Excavator	27	4	90%	112	1.43319E+11	4	100%	112	1.59243E+11
		Mini Excavator	27	2	90%	99	7165929070	2	100%	99	796214341
12	Spoil and slurry removal	Dump trucks	27	2	90%	110	90213702053	2	100%	110	1.00237E+11
							125				126
3. Superstructure (Prefab installation) - **36 months**											
1	Pumping of water from ground or rain	Temporary Water Pump	36	2	90%	96	3591472167	2	100%	96	3990524630
2	Power supply for lighting, pumps and temporary ventilation fa	Generator	36	2	90%	109	71659290700	2	100%	109	79621434111
3	Excavation below surface for working platform	Excavator	36	4	90%	112	1.43319E+11	4	100%	112	1.59243E+11
4	Stage Excavation to prepare Lean concrete	Mini Excavator	36	2	90%	99	7165929070	2	100%	99	796214341
5	Excavation below surface - removal of spoil	Crane	36	2	90%	101	11357232201	2	100%	101	12619146890
6	Spoil removal	Dump Trucks	36	2	90%	110	90213702053	2	100%	110	1.00237E+11
7	Air compressor for cleaning formwork before casting	Compressor	36	1	90%	103	17957360835	1	100%	103	19952623150
8	Handle re-bar & hoisting of false work, scaffolding, temporary	Mobile Crane	36	1	90%	110	90000000000	1	100%	110	1E+11
9	For Casting	Ready Mix Concrete Truck	36	2	90%	110	90213702053	2	100%	110	1.00237E+11
		Concrete pump	36	1	90%	106	35829645350	1	100%	106	39810717055
							117				118
4. Landscape Works - **24 months**											
1	Landscape works	Generator	24	2	90%	109	71659290700	2	100%	109	79621434111
		Excavator mounted sheet pile vibrator	24	2	90%	119	7.16593E+11	2	100%	119	7.96214E+11
		Mobile Crane, 50T	24	2	90%	98	5692099788	2	100%	98	6324555320
		welding/cutting equipment	24	4	90%	107	45321314825	4	100%	107	50357016472
							119				120
5. Remove all temporary works and re-instatement - **24 months**											
1	Removal of ERSS	Generator	24	2	90%	109	71659290700	2	100%	109	79621434111
		Excavator mounted sheetpile vibrator	24	2	90%	119	7.16593E+11	2	100%	119	7.96214E+11
		Mobile Crane, 50T	24	2	90%	98	5692099788	2	100%	98	6324555320
		Welding/Cutting equipment	24	4	90%	107	45321314825	4	100%	107	50357016472

				DAY - LAeq(12hrs)				DAY - LAeq(5mins)			
				Activities 7:00am - 7:00pm				Activities 7:00am - 7:00pm			
2	Reininstate working area to original condition or required condition	Lorry	24	2	90%	110	90213702053	2	100%	110	1.00237E+11
							120				120
Road Construction - **30 months**											
1	Clearing and Excavation	Excavator	18	1	50%	103	19905358528	1	100%	106	39810717055
2	Mounting	Excavator	18	1	50%	103	19905358528	1	100%	106	39810717055
3	Fine Grading/Surface Levelling	Grader	12	1	50%	103	19905358528	1	100%	106	39810717055
4	Aggregrate Base (Aggregate Laying Truck)	Concrete Truck	12	1	50%	104	25059361681	1	100%	107	50118723363
5	Asphalt Paving	Roller	12	1	50%	98	6294627059	1	100%	101	12589254118
							110				113

Appendix H
Construction Noise Impact Assessment (Human)

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Unmitigated Noise Impact Significance (LAeq(12 hours)) for Scenario 01: Foundation and Earthworks - Daytime (7am-7pm)

Sl No.	Receptor	Priority	Building Type	Storey	Approximate distance from construction worksite (m)	Height (m)	Criteria (dB(A))	Impact Intensity	Receptor Sensitivity	Imapct Consequence	Likelihood	Impact Significance
1	1 Ewart Park	2	Residential	2	172	6.4	75	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
2	1B Ewart Park	2	Residential	2	146	6.4	75	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
3	1A Ewart Park	2	Residential	2	137	6.4	75	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
4	59 Holland Green	2	Residential	3	122	9.6	75	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
5	61 Holland Green	2	Residential	3	110	9.6	75	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
6	57 Holland Green	2	Residential	3	116	9.6	75	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
7	55 Holland Green	2	Residential	3	117	9.6	75	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
8	53 Holland Green	2	Residential	3	118	9.6	75	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
9	47 Holland Green	2	Residential	3	138	9.6	75	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
10	49 Holland Green	2	Residential	3	116	9.6	75	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
11	51 Holland Green	2	Residential	3	113	9.6	75	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
12	44 Holland Green	2	Residential	3	71	9.6	75	Medium - High	Medium Sensitivity	Medium - High	Certain/Continuous	Moderate - Major
13	42 Holland Green	2	Residential	3	72	9.6	75	Medium - High	Medium Sensitivity	Medium - High	Certain/Continuous	Moderate - Major
14	40 Holland Green	2	Residential	3	72	9.6	75	Medium - High	Medium Sensitivity	Medium - High	Certain/Continuous	Moderate - Major
15	38 Holland Green	2	Residential	3	73	9.6	75	Medium - High	Medium Sensitivity	Medium - High	Certain/Continuous	Moderate - Major
16	36 Holland Green	2	Residential	3	73	9.6	75	Medium - High	Medium Sensitivity	Medium - High	Certain/Continuous	Moderate - Major
17	34 Holland Green	2	Residential	3	75	9.6	75	Medium - High	Medium Sensitivity	Medium - High	Certain/Continuous	Moderate - Major
18	32 Holland Green	2	Residential	3	75	9.6	75	Medium - High	Medium Sensitivity	Medium - High	Certain/Continuous	Moderate - Major
19	30 Holland Green	2	Residential	3	75	9.6	75	Medium - High	Medium Sensitivity	Medium - High	Certain/Continuous	Moderate - Major
20	28 Holland Green	2	Residential	3	75	9.6	75	Medium - High	Medium Sensitivity	Medium - High	Certain/Continuous	Moderate - Major

Sl No.	Receptor	Priority	Building Type	Storey	Approximate distance from construction worksite (m)	Height (m)	Criteria (dB(A))	Impact Intensity	Receptor Sensitivity	Imapct Consequence	Likelihood	Impact Significance
21	26 Holland Green	2	Residential	3	76	9.6	75	Medium - High	Medium Sensitivity	Medium - High	Certain/Continuous	Moderate - Major
22	24 Holland Green	2	Residential	3	76	9.6	75	Medium - High	Medium Sensitivity	Medium - High	Certain/Continuous	Moderate - Major
23	22 Holland Green	2	Residential	3	80	9.6	75	Medium - High	Medium Sensitivity	Medium - High	Certain/Continuous	Moderate - Major
24	20 Holland Green	2	Residential	3	80	9.6	75	Medium - High	Medium Sensitivity	Medium - High	Certain/Continuous	Moderate - Major
25	18 Holland Green	2	Residential	3	79	9.6	75	Medium - High	Medium Sensitivity	Medium - High	Certain/Continuous	Moderate - Major
26	14 Holland Green	2	Residential	3	88	9.6	75	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
27	16 Holland Green	2	Residential	3	79	9.6	75	Medium - High	Medium Sensitivity	Medium - High	Certain/Continuous	Moderate - Major
28	10 Holland Green	2	Residential	3	77	9.6	75	Medium - High	Medium Sensitivity	Medium - High	Certain/Continuous	Moderate - Major
29	12 Holland Green	2	Residential	3	91	9.6	75	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
30	2 Ewart Park	2	Residential	3	160	9.6	75	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
31	45 Holland Green	2	Residential	3	147	9.6	75	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
32	43 Holland Green	2	Residential	3	137	9.6	75	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
33	41 Holland Green	2	Residential	3	125	9.6	75	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
34	39 Holland Green	2	Residential	3	112	9.6	75	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
35	37 Holland Green	2	Residential	3	117	9.6	75	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
36	35 Holland Green	2	Residential	3	118	9.6	75	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
37	33 Holland Green	2	Residential	3	143	9.6	75	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
38	31 Holland Green	2	Residential	3	156	9.6	75	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
39	Service Facility (Power)	3	Service Facility	1.5	115	4.8	75	Negligible - Medium	Low Sensitivity	Imperceptible – Very Low	Certain/Continuous	Negligible - Minor

Sl No.	Receptor	Priority	Building Type	Storey	Approximate distance from construction worksite (m)	Height (m)	Criteria (dB(A))	Impact Intensity	Receptor Sensitivity	Imapct Consequence	Likelihood	Impact Significance
40	23 Holland Green	2	Residential	3	123	9.6	75	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
41	21 Holland Green	2	Residential	3	117	9.6	75	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
42	19 Holland Green	2	Residential	3	125	9.6	75	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
43	17 Holland Green	2	Residential	3	128	9.6	75	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
44	25 Holland Green	2	Residential	3	141	9.6	75	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
45	15 Holland Green	2	Residential	3	151	9.6	75	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
46	13 Holland Green	2	Residential	3	164	9.6	75	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
47	2 Holland Green	2	Residential	3	113	9.6	75	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
48	4 Holland Green	2	Residential	3	104	9.6	75	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
49	1 Holland Green	2	Residential	3	137	9.6	75	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
50	6 Holland Green	2	Residential	3	93	9.6	75	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
51	8 Holland Green	2	Residential	4	85	12.8	75	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
52	27 Holland Green	2	Residential	3	154	9.6	75	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
53	29 Holland Green	2	Residential	3	166	9.6	75	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
54	3B Ewart Park	2	Residential	3	174	9.6	75	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
55	11 Holland Green	2	Residential	4	175	12.8	75	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
56	7 Holland Green	2	Residential	3	174	9.6	75	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor

Sl No.	Receptor	Priority	Building Type	Storey	Approximate distance from construction worksite (m)	Height (m)	Criteria (dB(A))	Impact Intensity	Receptor Sensitivity	Imapct Consequence	Likelihood	Impact Significance
57	5 Holland Green	2	Residential	3	161	9.6	75	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
58	3 Holland Green	2	Residential	3	148	9.6	75	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
59	2 Ewart Park (Part 2)	2	Residential	2	163	6.4	75	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
60	1 Ewart Park	2	Residential	2	187	6.4	75	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
61	2A Ewart Park	2	Residential	1	171	3.2	75	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor

Unmitigated Noise Impact Significance (LAeq(5 mins)) for Scenario 01: Foundation and Earthworks - Daytime (7am-7pm)

Sl No.	Receptor	Priority	Building Type	Storey	Approximate distance from construction worksite (m)	Height (m)	Criteria (dB(A))	Impact Intensity	Receptor Sensitivity	Imapct Consequence	Likelihood	Impact Significance
1	1 Ewart Park	2	Residential	2	172	6.4	90	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
2	1B Ewart Park	2	Residential	2	146	6.4	90	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
3	1A Ewart Park	2	Residential	2	137	6.4	90	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
4	59 Holland Green	2	Residential	3	122	9.6	90	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
5	61 Holland Green	2	Residential	3	110	9.6	90	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
6	57 Holland Green	2	Residential	3	116	9.6	90	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
7	55 Holland Green	2	Residential	3	117	9.6	90	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
8	53 Holland Green	2	Residential	3	118	9.6	90	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
9	47 Holland Green	2	Residential	3	138	9.6	90	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
10	49 Holland Green	2	Residential	3	116	9.6	90	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
11	51 Holland Green	2	Residential	3	113	9.6	90	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
12	44 Holland Green	2	Residential	3	71	9.6	90	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
13	42 Holland Green	2	Residential	3	72	9.6	90	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
14	40 Holland Green	2	Residential	3	72	9.6	90	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor

Sl No.	Receptor	Priority	Building Type	Storey	Approximate distance from construction worksite (m)	Height (m)	Criteria (dB(A))	Impact Intensity	Receptor Sensitivity	Imapct Consequence	Likelihood	Impact Significance
15	38 Holland Green	2	Residential	3	73	9.6	90	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
16	36 Holland Green	2	Residential	3	73	9.6	90	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
17	34 Holland Green	2	Residential	3	75	9.6	90	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
18	32 Holland Green	2	Residential	3	75	9.6	90	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
19	30 Holland Green	2	Residential	3	75	9.6	90	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
20	28 Holland Green	2	Residential	3	75	9.6	90	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
21	26 Holland Green	2	Residential	3	76	9.6	90	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
22	24 Holland Green	2	Residential	3	76	9.6	90	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
23	22 Holland Green	2	Residential	3	80	9.6	90	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
24	20 Holland Green	2	Residential	3	80	9.6	90	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
25	18 Holland Green	2	Residential	3	79	9.6	90	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
26	14 Holland Green	2	Residential	3	88	9.6	90	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
27	16 Holland Green	2	Residential	3	79	9.6	90	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
28	10 Holland Green	2	Residential	3	77	9.6	90	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor

Sl No.	Receptor	Priority	Building Type	Storey	Approximate distance from construction worksite (m)	Height (m)	Criteria (dB(A))	Impact Intensity	Receptor Sensitivity	Imapct Consequence	Likelihood	Impact Significance
29	12 Holland Green	2	Residential	3	91	9.6	90	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
30	2 Ewart Park	2	Residential	3	160	9.6	90	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
31	45 Holland Green	2	Residential	3	147	9.6	90	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
32	43 Holland Green	2	Residential	3	137	9.6	90	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
33	41 Holland Green	2	Residential	3	125	9.6	90	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
34	39 Holland Green	2	Residential	3	112	9.6	90	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
35	37 Holland Green	2	Residential	3	117	9.6	90	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
36	35 Holland Green	2	Residential	3	118	9.6	90	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
37	33 Holland Green	2	Residential	3	143	9.6	90	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
38	31 Holland Green	2	Residential	3	156	9.6	90	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
39	Service Facility (Power)	3	Service Facility	1.5	115	4.8	90	Negligible - Medium	Low Sensitivity	Imperceptible – Very Low	Certain/Continuous	Negligible - Minor
40	23 Holland Green	2	Residential	3	123	9.6	90	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
41	21 Holland Green	2	Residential	3	117	9.6	90	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
42	19 Holland Green	2	Residential	3	125	9.6	90	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor

Sl No.	Receptor	Priority	Building Type	Storey	Approximate distance from construction worksite (m)	Height (m)	Criteria (dB(A))	Impact Intensity	Receptor Sensitivity	Imapct Consequence	Likelihood	Impact Significance
43	17 Holland Green	2	Residential	3	128	9.6	90	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
44	25 Holland Green	2	Residential	3	141	9.6	90	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
45	15 Holland Green	2	Residential	3	151	9.6	90	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
46	13 Holland Green	2	Residential	3	164	9.6	90	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
47	2 Holland Green	2	Residential	3	113	9.6	90	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
48	4 Holland Green	2	Residential	3	104	9.6	90	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
49	1 Holland Green	2	Residential	3	137	9.6	90	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
50	6 Holland Green	2	Residential	3	93	9.6	90	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
51	8 Holland Green	2	Residential	4	85	12.8	90	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
52	27 Holland Green	2	Residential	3	154	9.6	90	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
53	29 Holland Green	2	Residential	3	166	9.6	90	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
54	3B Ewart Park	2	Residential	3	174	9.6	90	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
55	11 Holland Green	2	Residential	4	175	12.8	90	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
56	7 Holland Green	2	Residential	3	174	9.6	90	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor

Sl No.	Receptor	Priority	Building Type	Storey	Approximate distance from construction worksite (m)	Height (m)	Criteria (dB(A))	Impact Intensity	Receptor Sensitivity	Imapct Consequence	Likelihood	Impact Significance
57	5 Holland Green	2	Residential	3	161	9.6	90	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
58	3 Holland Green	2	Residential	3	148	9.6	90	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
59	2 Ewart Park (Part 2)	2	Residential	2	163	6.4	90	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
60	1 Ewart Park	2	Residential	2	187	6.4	90	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
61	2A Ewart Park	2	Residential	1	171	3.2	90	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor

Mitigated Noise Impact Significance (LAeq(12 hours)) for Scenario 01: Foundation and Earthworks - Daytime (7am-7pm)

Sl No.	Receptor	Priority	Building Type	Storey	Approximate distance from construction worksite (m)	Height (m)	Criteria (dB(A))	Impact Intensity	Receptor Sensitivity	Imapct Consequence	Likelihood	Impact Significance
1	1 Ewart Park	2	Residential	2	172	6.4	75	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
2	1B Ewart Park	2	Residential	2	146	6.4	75	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
3	1A Ewart Park	2	Residential	2	137	6.4	75	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
4	59 Holland Green	2	Residential	3	122	9.6	75	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
5	61 Holland Green	2	Residential	3	110	9.6	75	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
6	57 Holland Green	2	Residential	3	116	9.6	75	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
7	55 Holland Green	2	Residential	3	117	9.6	75	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
8	53 Holland Green	2	Residential	3	118	9.6	75	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
9	47 Holland Green	2	Residential	3	138	9.6	75	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
10	49 Holland Green	2	Residential	3	116	9.6	75	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
11	51 Holland Green	2	Residential	3	113	9.6	75	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
12	44 Holland Green	2	Residential	3	71	9.6	75	Low - Medium	Medium Sensitivity	Very Low - Low	Certain/Continuous	Minor - Moderate
13	42 Holland Green	2	Residential	3	72	9.6	75	Low - Medium	Medium Sensitivity	Very Low - Low	Certain/Continuous	Minor - Moderate
14	40 Holland Green	2	Residential	3	72	9.6	75	Low - Medium	Medium Sensitivity	Very Low - Low	Certain/Continuous	Minor - Moderate
15	38 Holland Green	2	Residential	3	73	9.6	75	Low - Medium	Medium Sensitivity	Very Low - Low	Certain/Continuous	Minor - Moderate
16	36 Holland Green	2	Residential	3	73	9.6	75	Low - Medium	Medium Sensitivity	Very Low - Low	Certain/Continuous	Minor - Moderate
17	34 Holland Green	2	Residential	3	75	9.6	75	Low - Medium	Medium Sensitivity	Very Low - Low	Certain/Continuous	Minor - Moderate
18	32 Holland Green	2	Residential	3	75	9.6	75	Low - Medium	Medium Sensitivity	Very Low - Low	Certain/Continuous	Minor - Moderate
19	30 Holland Green	2	Residential	3	75	9.6	75	Low - Medium	Medium Sensitivity	Very Low - Low	Certain/Continuous	Minor - Moderate
20	28 Holland Green	2	Residential	3	75	9.6	75	Low - Medium	Medium Sensitivity	Very Low - Low	Certain/Continuous	Minor - Moderate

Sl No.	Receptor	Priority	Building Type	Storey	Approximate distance from construction worksite (m)	Height (m)	Criteria (dB(A))	Impact Intensity	Receptor Sensitivity	Imapct Consequence	Likelihood	Impact Significance
21	26 Holland Green	2	Residential	3	76	9.6	75	Low - Medium	Medium Sensitivity	Very Low - Low	Certain/Continuous	Minor - Moderate
22	24 Holland Green	2	Residential	3	76	9.6	75	Low - Medium	Medium Sensitivity	Very Low - Low	Certain/Continuous	Minor - Moderate
23	22 Holland Green	2	Residential	3	80	9.6	75	Low - Medium	Medium Sensitivity	Very Low - Low	Certain/Continuous	Minor - Moderate
24	20 Holland Green	2	Residential	3	80	9.6	75	Low - Medium	Medium Sensitivity	Very Low - Low	Certain/Continuous	Minor - Moderate
25	18 Holland Green	2	Residential	3	79	9.6	75	Low - Medium	Medium Sensitivity	Very Low - Low	Certain/Continuous	Minor - Moderate
26	14 Holland Green	2	Residential	3	88	9.6	75	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
27	16 Holland Green	2	Residential	3	79	9.6	75	Low - Medium	Medium Sensitivity	Very Low - Low	Certain/Continuous	Minor - Moderate
28	10 Holland Green	2	Residential	3	77	9.6	75	Low - Medium	Medium Sensitivity	Very Low - Low	Certain/Continuous	Minor - Moderate
29	12 Holland Green	2	Residential	3	91	9.6	75	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
30	2 Ewart Park	2	Residential	3	160	9.6	75	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
31	45 Holland Green	2	Residential	3	147	9.6	75	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
32	43 Holland Green	2	Residential	3	137	9.6	75	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
33	41 Holland Green	2	Residential	3	125	9.6	75	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
34	39 Holland Green	2	Residential	3	112	9.6	75	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
35	37 Holland Green	2	Residential	3	117	9.6	75	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
36	35 Holland Green	2	Residential	3	118	9.6	75	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
37	33 Holland Green	2	Residential	3	143	9.6	75	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
38	31 Holland Green	2	Residential	3	156	9.6	75	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
39	Service Facility (Power)	3	Service Facility	1.5	115	4.8	75	Negligible - Medium	Low Sensitivity	Imperceptible – Very Low	Certain/Continuous	Negligible - Minor

Sl No.	Receptor	Priority	Building Type	Storey	Approximate distance from construction worksite (m)	Height (m)	Criteria (dB(A))	Impact Intensity	Receptor Sensitivity	Imapct Consequence	Likelihood	Impact Significance
40	23 Holland Green	2	Residential	3	123	9.6	75	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
41	21 Holland Green	2	Residential	3	117	9.6	75	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
42	19 Holland Green	2	Residential	3	125	9.6	75	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
43	17 Holland Green	2	Residential	3	128	9.6	75	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
44	25 Holland Green	2	Residential	3	141	9.6	75	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
45	15 Holland Green	2	Residential	3	151	9.6	75	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
46	13 Holland Green	2	Residential	3	164	9.6	75	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
47	2 Holland Green	2	Residential	3	113	9.6	75	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
48	4 Holland Green	2	Residential	3	104	9.6	75	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
49	1 Holland Green	2	Residential	3	137	9.6	75	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
50	6 Holland Green	2	Residential	3	93	9.6	75	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
51	8 Holland Green	2	Residential	4	85	12.8	75	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
52	27 Holland Green	2	Residential	3	154	9.6	75	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
53	29 Holland Green	2	Residential	3	166	9.6	75	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
54	3B Ewart Park	2	Residential	3	174	9.6	75	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
55	11 Holland Green	2	Residential	4	175	12.8	75	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
56	7 Holland Green	2	Residential	3	174	9.6	75	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor

Sl No.	Receptor	Priority	Building Type	Storey	Approximate distance from construction worksite (m)	Height (m)	Criteria (dB(A))	Impact Intensity	Receptor Sensitivity	Imapct Consequence	Likelihood	Impact Significance
57	5 Holland Green	2	Residential	3	161	9.6	75	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
58	3 Holland Green	2	Residential	3	148	9.6	75	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
59	2 Ewart Park (Part 2)	2	Residential	2	163	6.4	75	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
60	1 Ewart Park	2	Residential	2	187	6.4	75	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor
61	2A Ewart Park	2	Residential	1	171	3.2	75	Negligible - Low	Medium Sensitivity	Imperceptible - Very Low	Certain/Continuous	Negligible - Minor