



# **Specialist Consultancy Services for Environmental Impact Study at Tengah Town**

Executive Summary

D3332600/F/4

3 November 2021

**Housing and Development Board (HDB)**



## Specialist Consultancy Services for Environmental Impact Study at Tengah Town

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## Acronyms and Abbreviations

amsl	Metres above sea level
ASR	Air Sensitive Receiver
BOD	Biological Oxygen Demand
C&D	Construction and Demolition
CCNR	Central Catchment Nature Reserve
CO	Carbon Monoxide
COD	Chemical Oxygen Demand
COP	Code of Practice
CS	Conservation Significance
ED	Earth Drain
EIS	Environmental Impact Study
EMMP	Environmental Management and Monitoring Plan
EPM	Environmental Protection and Management
etc.	et cetera
HDB	Housing and Development Board
i.e.	<i>id est</i>
L <sub>Aeq</sub>	A-weighted equivalent continuous sound level
m	Metre
MND	Ministry of National Development
NO <sub>2</sub>	Nitrogen Dioxide
NSR	Noise Sensitive Receiver
O <sub>3</sub>	Ozone
PM <sub>10</sub>	Particulate Matter of Diameter 10 Micrometres or Less
PM <sub>2.5</sub>	Particulate Matter of Diameter 2.5 Micrometres or Less
RAC	Recommended Area of Conservation
SAAQT	Singapore Ambient Air Quality Target
SO <sub>2</sub>	Sulphur Dioxide
TSS	Total Suspended Solids
URA	Urban Redevelopment Authority
VSR	Visually Sensitive Receptor

## Introduction

The Housing and Development Board (HDB) is planning to develop the Project (HDB's Phase 3 development) within the EIS Study Area in a broader Tengah Town development boundary. The EIS Study Area (Figure 1) with an area of 166 ha sits within the Tengah site, which is Singapore's largest remaining patch of forest that lies outside a protected area. It is a critical point of connection for fauna moving between the Central Catchment Nature Reserves (CCNR) and Western Water Catchment Area. As such, it facilitates the dispersal of forest-dependent species moving between these two biodiversity hotspots.

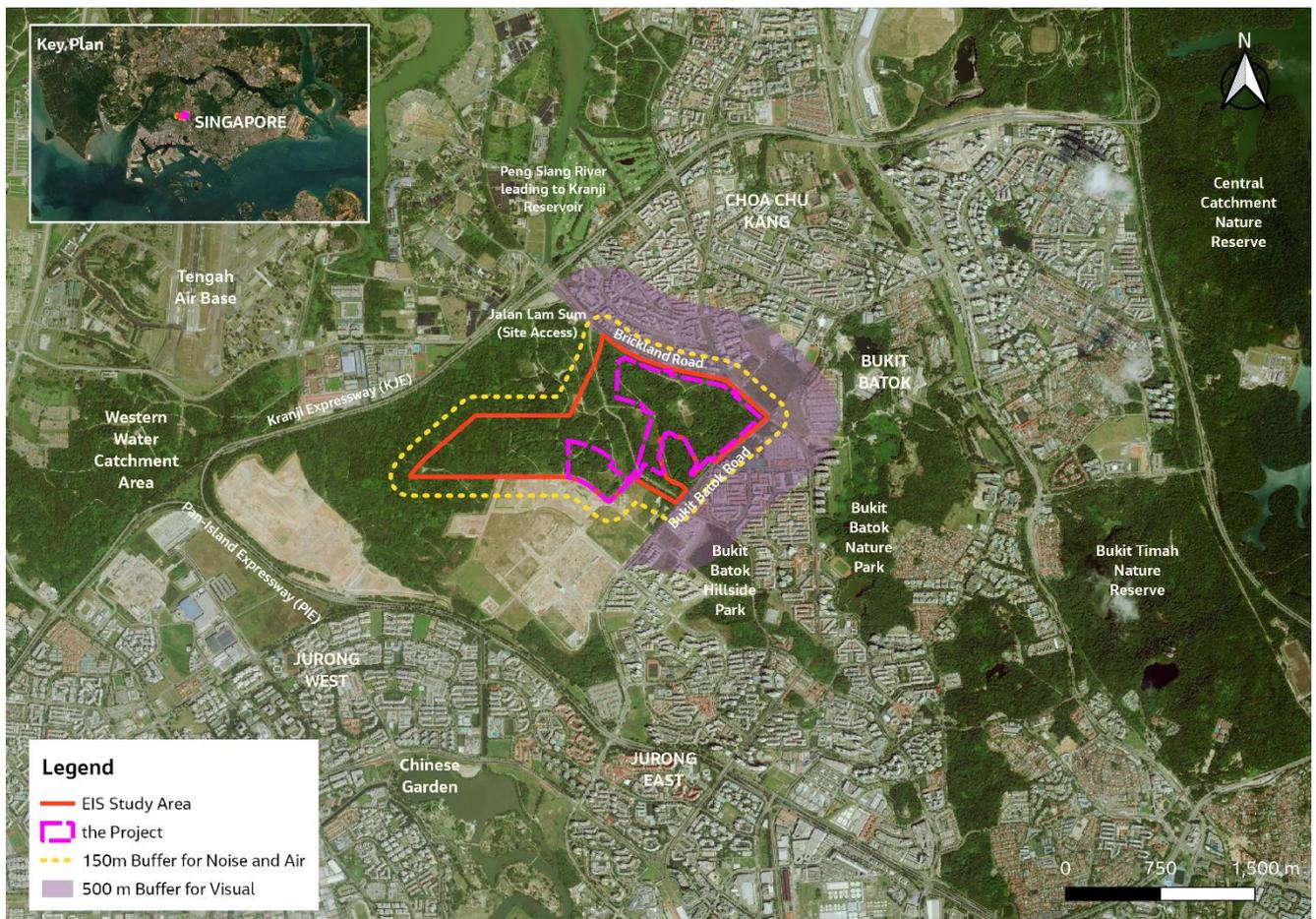


Figure 1: EIS Study Area and the Proposed Buffer Area

Base Map: ESRI

## EIS Objectives, Scope of Works and Limitation

The purpose of this EIS is to provide an assessment of the nature and extent of potential environmental impacts and cumulative impacts arising from the development of the Project within the EIS Study Area against the Tengah Master Plan 2019 gazetted by Urban Redevelopment Authority (URA). This is assessed in association with the existing/ committed/ planned or known potential developments by other stakeholders/ agencies on environmental sensitive receptors, located within and in close proximity of the EIS Study Area.

## Project Description

The main housing districts in the Project, to be built in the future, are Brickland District and a portion of Park District. Based on the land use planning gazetted under the Tengah Master Plan 2019, the Project will have residential, educational institution and commercial buildings with other public utilities and amenities such as

road, parks, schools, places of worship, health and medical care clinics, and community halls as illustrated in Figure 2.

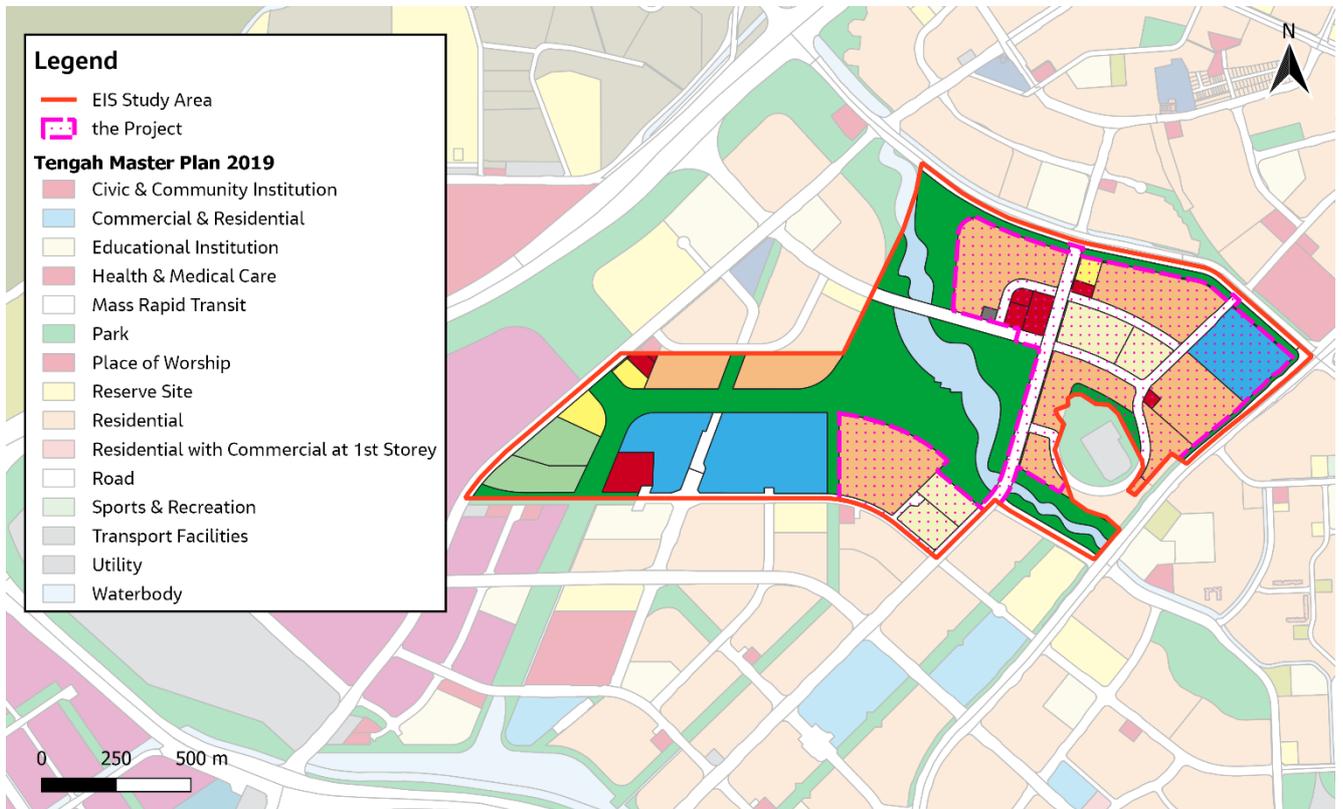
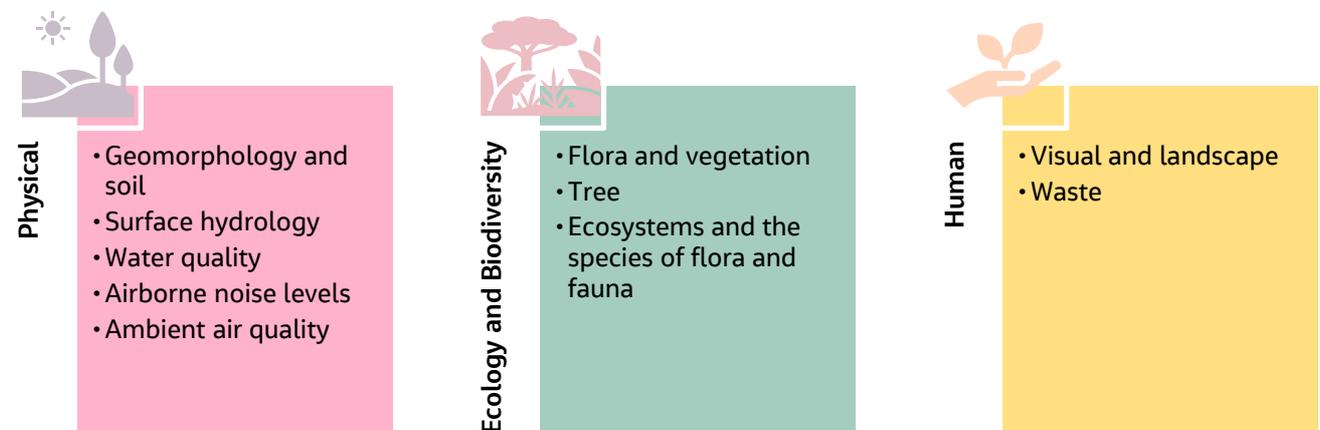


Figure 2: Tengah Master Plan 2019 for EIS Study Area

Source: Base Map obtained from Tengah Master Plan 2019 gazetted by URA

## Environmental Baseline Findings

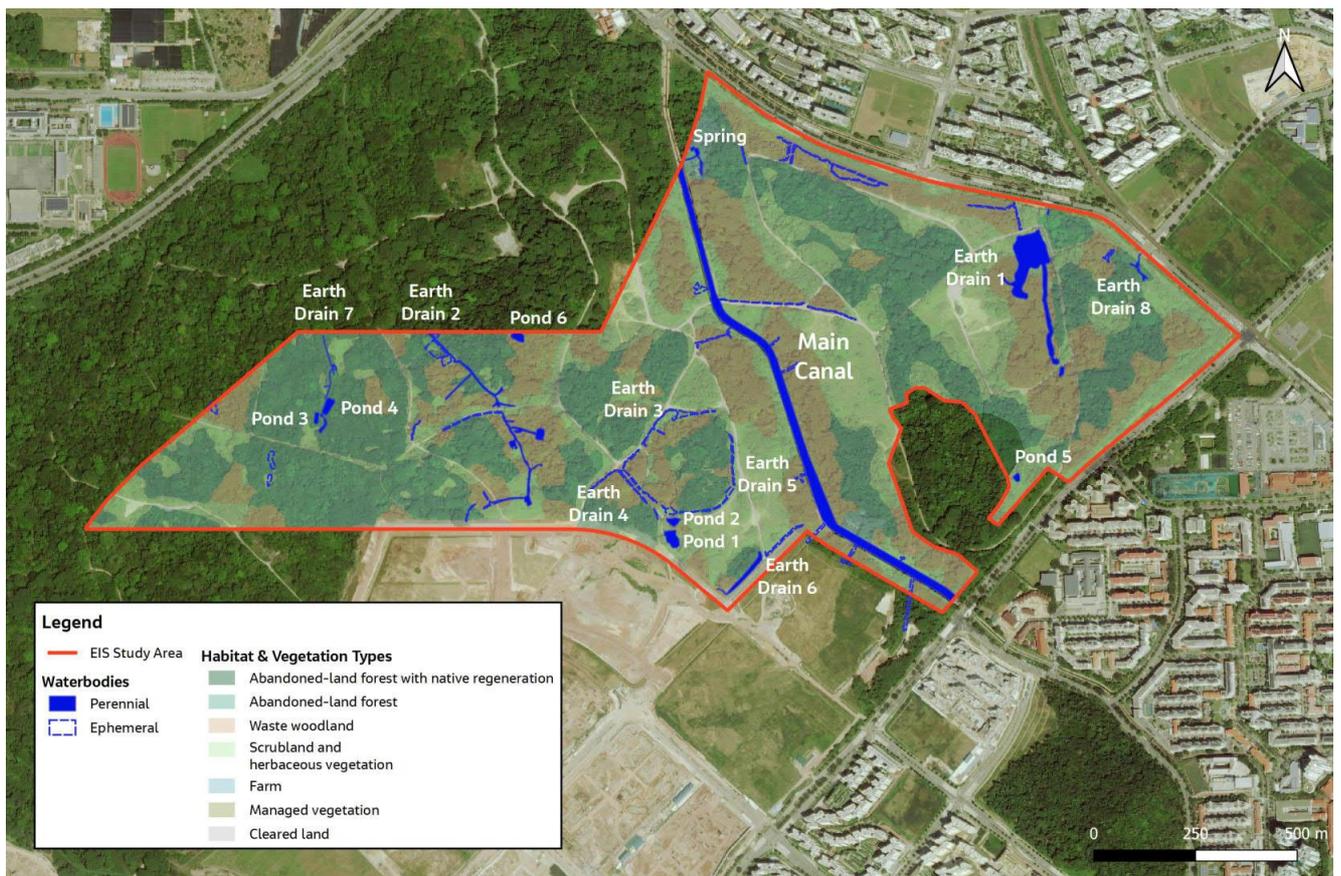
The EIS assessed the following baseline components:



A summary of the findings is provided below and detailed information can be obtained from the main report in Sections 4 to 11.

### Key Findings for Ecology and Biodiversity Aspects

Four main vegetation and habitat types are present within the EIS Study Area and are as follows: abandoned-land forest (57.20 ha; 34.4%), scrubland and herbaceous vegetation (49.95 ha; 30.0%), waste woodland (45.47 ha; 27.3%) and abandoned-land forest with native regeneration (1 ha; 0.6%). The remaining area consists of farms, managed vegetation, cleared land and non-vegetated areas which make up 9.77 ha (5.9%). A variety of waterbodies such as closed canopy forest streams (i.e. Earth Drain (ED) 2 and ED7), open-country streams (i.e. Spring, ED1, ED3, ED4, ED5, ED6, ED7 and ED8), closed-canopy & semi open-country ponds (i.e. Pond3, Pond4, Pond5, Pond6) and open country ponds (i.e. Pond1, Pond2) are present. The Main Canal occupies about 1.8% (2.96 ha) of the EIS Study Area.



**Figure 3: Vegetation and Waterbodies Map**

Base Map: ESRI

A total of 332 plant species and 6 species groups belonging to 93 families and 1 unknown Pteridophyte species are recorded from the floristic surveys. About half of the species are native and 51 are of conservation significance (CS). Key floristics findings include *Leea angulata*, *Glochidion zeylanicum var zeylanicum*, *Ficus apiocarpa* and *Mucuna biplicata*.

The faunistic field findings recorded 297 species with more than half of the recorded assemblage dominated by bird (86 species) and butterfly (73 species) species. Of all species recorded, 31 species of CS were recorded including the straw-headed bulbul (*Pycnonotus zeylanicus*), Sunda pangolin (*Manis javanica*) and bamboo bats (*Tylonycteris* spp.). Habitats found on site support the populations of these species of CS including providing breeding habitats for species such as the red-wattled lapwing (*Vanellus indicus*) and the blue-winged pitta (*Pitta moluccensis*). The forest streams also provide habitats for aquatic species such as the common walking catfish (*Clarias cf. batrachus*), dwarf wisp (*Agriocnemis nana*) and variable featherlegs (*Copera vittata*).

**Key Findings for Non-Ecology and Biodiversity Aspects**

The key findings for non-ecology and biodiversity aspects within the EIS Study Area are described below:

**Geomorphology/ Soil**



- Terrain elevation ranged from 5 to 35 m amsl
- 10% of the EIS Study Area has high-angle slopes (9-21°)
- Underlain by Tengah and Queenstown Facies of Jurong Formation that comprises of sequence of sedimentary rocks
- Major soil type: sandy silt and sandy clay

**Hydrogeology**



- A total of eight water standpipes were established
- General groundwater flow from ridge system towards valley area and other lower elevation regions
- Minimum variance between groundwater flow during wet and dry seasons
- Presence of perennial spring, active groundwater aquifer

**Surface Hydrology**



- Various features of waterbodies were identified: Main Canal, Spring Area, eight earth drains and six ponds
- 94.8% falls in Kranji Catchment, with 5.2% at the southwestern tip in Jurong Catchment
- Water drains to Peng Siang River and ultimately to Kranji Reservoir in northerly direction

**Water Quality**



- A total of 71 dry and 83 wet water samples were collected
- A few samples had Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total Suspended Solids (TSS) and pH exceeded the limits for discharge into a controlled watercourse *EPM (Trade Effluent) regulations*

**Airborne Noise**



- Baseline noise level measurement for parameters  $L_{Aeq}$  5-min, 1-hour and 12-hour was conducted at three affected community noise sensitive receiver (NSR) clusters (N1, N2 and N3) and two affected fauna NSR (N4 and N5)
- Maximum permissible noise levels are generally exceeded for community NSRs
- Noise levels for fauna NSRs are high compared to thresholds found in literature reviews

**Ambient Air Quality**



- Baseline particulate matter 10  $\mu m$  and 2.5  $\mu m$  ( $PM_{10}$  and  $PM_{2.5}$ ) sampling was carried out at three air sensitive receiver (ASR) clusters (A1 to A3) within a 150 m buffer from the EIS Study Area
- Both  $PM_{10}$  and  $PM_{2.5}$  at A1 and A2 complied with the Singapore Ambient Air Quality Target (SAAQT) by 2020
- $PM_{10}$  at A3 exceeded the SAAQT by 2020

**Landscape and Visual**



- Majority of the views consist of dense forest with several large tall trees and scattered scrublands throughout
- Visually sensitive receivers (VSRs) such as residents and pedestrians with a range of limited to expansive views who may be visually sensitive to natural landscapes

**Waste**



- Remnant general waste from previous land use are present on site
- Types of waste expected to be produced include tree trunks/branches, construction and demolition debris, hazardous/toxic industrial waste, domestic refuse and sewage

## Impact Assessment, Recommended Mitigation Measures and Residual Impacts

A range of potential environmental impacts was identified from this EIS with the following summary given on the assessment findings and conclusions made for each environmental aspect/ receptor. Key recommended mitigation measures can be found below and the full measures in the main report from **Sections 4 to 11**.

### *Geomorphology, Soil and Hydrogeology*

It was found that there are three main impacts on geomorphology and soil from the Project including changes to soil infiltration capacity, soil loss and erodibility and changes to hydrogeology. The impacts are expected to range from minor to moderate negative. Mitigation measures will help to recover and sustain some of the ground water areas and ameliorate the soil, helping to reduce the impacts to slight negative to minor negative impacts.

<b>Key Recommended Mitigation Measures:</b>	<ul style="list-style-type: none"><li>▪ Undertake a programmatic Excavation, Cut and Fill and Earthmoving plan.</li><li>▪ Engage a Qualified Person/ Professional Engineer to conduct a slope stability and soil compaction study in areas of concern.</li><li>▪ Assign the Recommended Area of Conservation (RAC) as buffer zones or design buffer zones with vegetation cover within the EIS Study Area to compensate for the loss of open surface areas where permanent infrastructures will be built.</li><li>▪ Alternative in-situ recharge zones can be designated within the remaining conservation areas to compensate for permanent loss of recharge areas that will be disturbed by the placement of at-grade and subsurface infrastructures.</li></ul>
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### *Surface Hydrology*

The Project development will involve significant land use change across the EIS Study Area, from the current green spaces into residential, commercial, institutional and infrastructure. This will require the diversion of existing streams, canals and earth drains in addition to the general ground disturbance in construction or working areas. Such activities will cause moderate negative impacts to surface water flow direction and flow rates, causing issues such as higher flood risks and loss of key water features on site. Mitigation measures including adaptation to new conditions, diversion intervention and proper design can help to reduce the impacts to minor negative impacts.

<b>Key Recommended Mitigation Measures:</b>	<ul style="list-style-type: none"><li>▪ Undertake a detailed hydrological assessment to refine the conditions considered in the proposed design and placement of storm drains prior to the construction of these structures.</li><li>▪ Designation of non-disturbance zones or buffer zones with vegetation cover in conjunction with RAC within the EIS Study Area to compensate for the loss of open surface areas serving as recharge zones upon Project completion.</li><li>▪ Minimise the disturbance area affected by excavation and earthworks to what is only necessary in accordance with the Site Development Plan.</li><li>▪ Placement of temporary diversion channels strategically placed within construction or work areas to manage and direct surface flows.</li></ul>
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### *Water Quality*

The baseline water quality survey found exceedances in pH, TSS, BOD and COD in several waterbodies present in the EIS Study Area, which may be further aggravated by the construction activities planned. Four main water quality deterioration impacts from soil erosion, sewage, chemical and trade effluent discharge were identified to have moderate negative impacts. Mitigation measures that have been practiced successfully across constructions sites in Singapore will aid in bringing these impact significances down to minor to moderate negative.

<b>Key Recommended Mitigation Measures:</b>	<ul style="list-style-type: none"> <li>▪ Provide storage tanks or reservoirs with additional 20% capacity and number to temporarily store/ contain muddy surface runoff before treatment.</li> <li>▪ Establish a regular maintenance work schedule to check and maintenance cleanliness and functionality of sanitary facilities on site.</li> <li>▪ Chemical storage areas should be adequate, on paved ground, bunded, sheltered and located away from waterways and drains.</li> <li>▪ Any soil contaminated with chemicals or oils shall be removed from site and sent to a licensed third-party toxic industrial waste collector for offsite disposal.</li> </ul>
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**Ecology and Biodiversity**

The habitat receivers mentioned above were assessed for pre-mitigation impact significance during the construction phase and operational phase of the Project works. Habitats of high ecological value were identified, including the abandoned-land forest with native regeneration, abandoned-land forest and closed-canopy streams (ED2 & ED7). Accordingly, a preliminary RAC that amounts to 68.8 ha (41.5% of the EIS Study Area) was identified. Following intensive consultations and robust discussion with agencies and Nature Groups (NGs), a revised RAC was developed considering the land use limitations, incorporating as much of the area as possible and providing compensatory measures where possible, to amount to 48.9 ha (29.5% of the EIS Study Area). It stretches across the western, central and north-eastern part of the EIS Study Area to provide habitats and enhance connectivity across the site, as well as connectivity towards Bukit Batok/ Gombak forests along Bukit Batok Avenue 5 and towards Bukit Batok Hillside Park along Bukit Batok Avenue 2.

During the construction phase, impacts are expected to range from mostly moderate to major negative with some minor negative impacts, in terms of habitat loss, pollution and degradation, loss of ecological connectivity and changes in fauna/ flora species composition. While the loss of habitat during the construction phase cannot be mitigated, it may be minimised by retaining the RAC and implementing the Environmental Monitoring and Management Plan (EMMP). Compensatory measures such as temporary wildlife crossings and enhancement plantings can be considered to minimise impacts. These are summarised below and shown in **Figure 4**.

<b>Key Recommended Mitigation Measures:</b>	<p><b><u>Avoidance</u></b></p> <ul style="list-style-type: none"> <li>▪ Complete retention of abandoned-land forest with native regeneration by realigning the boundary of existing land parcel to avoid this cluster and its 30-m buffer. Roads to be redesigned to end before the cluster, go over the cluster, or go around the Tengah Service Reservoir.</li> <li>▪ Retain closed-canopy forest streams together with its catchment area as this habitat type is uncommon and an important habitat for threatened aquatic fauna found in this stream. Re-parcellation of land will be considered to expand the Forest Corridor to encompass this stream.</li> </ul> <p><b><u>Reduction/ Minimisation</u></b></p> <ul style="list-style-type: none"> <li>▪ Re-parcellation of development land use to avoid RAC with connectivity.</li> <li>▪ Minimise clearance of abandoned-land forest by retaining forest patch in the western corridor of areas of high conservation value.</li> <li>▪ Maintain RAC as a forested corridor within the Central Park.</li> <li>▪ Salvaging clusters or individuals of flora of conservation significance affected by the Project works. They may be transplanted/ harvested/ propagated (depending on suitability) and can be re-planted to other unaffected areas in the EIS Study Area.</li> <li>▪ Bamboos of value to bamboo bats to be retained as much as possible. If unable to retain, relocation of bamboo clusters may be considered although success rate cannot be pre-determined.</li> </ul> <p><b><u>Compensation/ Enhancement</u></b></p> <ul style="list-style-type: none"> <li>▪ Re-create a wetland/ pond habitat similar to the open-country pond (Pond1 and Pond2) as an ABC water feature. Ideally, the new habitat should be created before the clearance of the existing habitat to allow time for the fauna to colonise the new habitat.</li> <li>▪ Enhance connectivity to the Bukit Batok/ Gombak forests in the northeastern part and Bukit Batok Hillside Park in the eastern part.</li> </ul>
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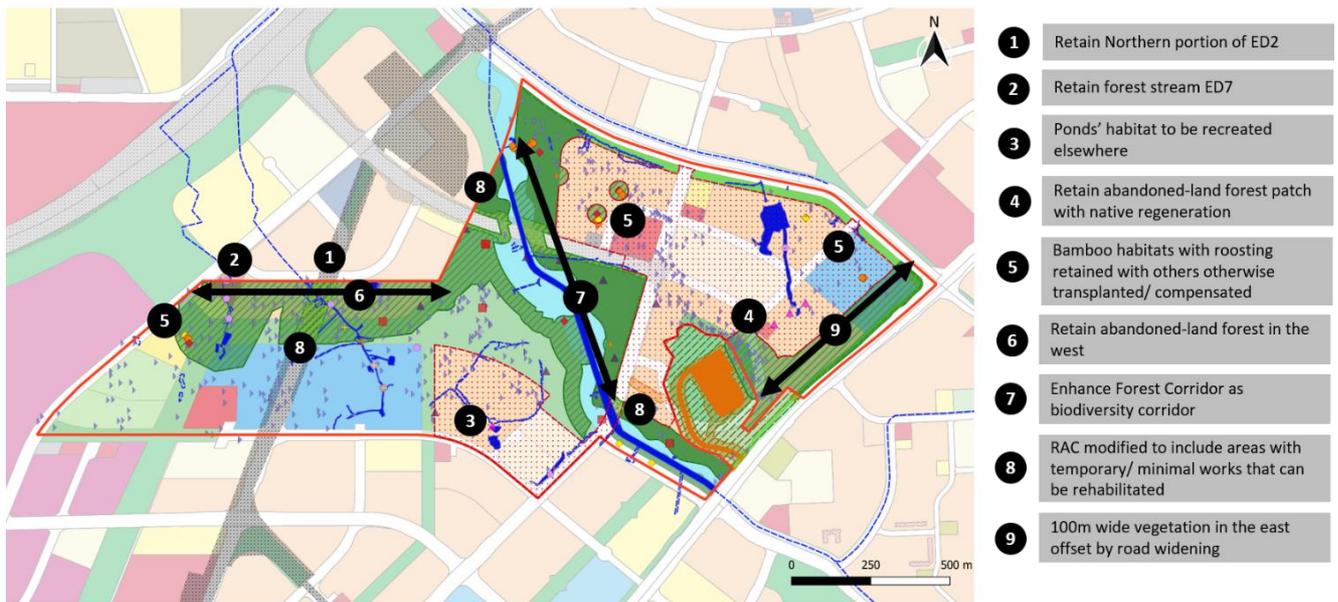


Figure 4: Recommended Area of Conservation with Summary of Ecological Considerations

Source: Base Map obtained from Tengah Master Plan 2019 gazetted by URA

**Note:**

- RAC with Temporary Works refers to areas which are required to be cleared, have infrastructure built or used as working space, but which should be revegetated with native species as soon as works are completed.
- For the purposes of this EIS, the figure shows an indicative revised boundary assuming that agencies will avoid the RAC. Agencies are studying possible changes to the land use plan to balance conservation and development in response to the RAC.

With the complete retention of the RAC and associated mitigation strategies, the residual impact significance for habitat loss at construction phase will still be moderate to major negative for almost all habitats (but with lower environmental score than unmitigated impact significance), except for the abandoned-land forest with native regeneration which is expected to be fully retained. The loss of ecological connectivity represents a moderate to major negative impact for most habitat types.

During the operational phase, impacts were assessed for changes in plant species composition and habitat degradation outside of the Project boundary. Most impacts are expected to be minor to moderate negative, although major negative impacts are expected for the abandoned-land forest. These impacts can be mitigated by avoiding encroachment and clearance of vegetation, enhancing conserved habitats and buffer, minimising access of sensitive habitats to residential users, and educating on biodiversity awareness. Monitoring surveys can

also be conducted to better advise management measures, provide wildlife crossings to reduce injury and mortality, and enhance connectivity of the site and the use of wildlife-friendly design strategies. Most operational impacts may hence be reduced to minor negative impacts.

### Airborne Noise

Unmitigated noise impact significance of the affected community can be considered minor due to the distance from affected community and construction site as well as high background noise. With noise barriers, additional noise control and good site practice implemented to reduce noise impacts, the mitigated noise impact significance for the affected community is expected to be minor (with lower environmental score than unmitigated noise impact significance). Noise impact significance for ground-dwelling/ understory and arboreal fauna ranged from minor to major negative, with greater impacts on fauna which are more noise-sensitive. With mitigation measures, noise levels can be significantly reduced, resulting in lower noise impacts although some fauna will still face moderate to major negative impacts due to their sensitivity towards noise.

<b>Key Recommended Mitigation Measures:</b>	<ul style="list-style-type: none"> <li>▪ Prepare a noise management plan to help to implement noise mitigation measures.</li> <li>▪ Use engineering methodologies to control noise at source such as noise enclosures, noise screens/ panels, portable noise barriers and quieter construction methodologies.</li> <li>▪ Use noise barrier with minimum 6 m high along the site boundary facing affected NSRs.</li> <li>▪ Conduct continuous real time noise monitoring using Type 1 sound level meter with data logging at the affected NSRs. When noise level exceeds the maximum adjusted noise level, contractor should investigate and apply appropriate mitigation measures.</li> <li>▪ Avoid noisy construction activities at night. Sundays and public holidays.</li> </ul>
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### Ambient Air Quality

Fugitive dust emissions from construction activities and exhaust emissions from fuel burning equipment/ machinery/ vehicle have the potential to result in adverse impacts on the ambient air quality (i.e. moderate negative impact and minor negative impact, respectively). With the implementation of the recommended mitigation measures, the residual impact for both fugitive dust emissions and exhaust emissions are predicted to be minor negative.

<b>Key Recommended Mitigation Measures:</b>	<ul style="list-style-type: none"> <li>▪ Installation and proper maintenance of dust screen, fencing or hoarding along construction site perimeter to reduce dust deposition at adjacent areas.</li> <li>▪ Contractor should keep extent of excavation and soil exposure areas to minimum required for construction.</li> <li>▪ Exposed site shall be properly treated by compaction, turfing, vegetation planting or sealing with bituminous materials, concrete or other suitable materials as soon as practicable upon works completion.</li> <li>▪ Ambient air quality parameters sulphur dioxide (SO<sub>2</sub>), nitrogen dioxide (NO<sub>2</sub>), carbon monoxide (CO), ozone (O<sub>3</sub>), PM10 and PM2.5 at location A1, A2 and A3 are recommended to be measured prior to and during construction period under the southwest monsoon season (June to September) where the downwind receptors are likely to be impacted. However, if the construction schedule does not permit this, monitoring shall be carried out during the inter-monsoon period (late March-May).</li> <li>▪ If the ambient air quality level during construction exceeds the SAAQT, contractor should investigate the cause and implement more stringent mitigation measures.</li> <li>▪ If there be any complaints from the community with regards to air quality during construction, additional ambient air quality monitoring shall be conducted.</li> </ul>
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### Visual and Landscape

It was found that visual impacts on the visually sensitive receivers based on 10 key viewpoints surrounding the EIS Study Area ranged from minor to moderate negative with one viewpoint having a minor positive impact from the naturalisation of the concrete canal. The residual impact from following the recommended prevention and mitigation/ enhancement measures resulted in the Project causing no change for two viewpoints and a minor positive impact from the previously negative impacts. The other viewpoints remained as initially assessed.

<b>Key Recommended Mitigation Measures:</b>	<ul style="list-style-type: none"> <li>▪ Selective thinning of perimeter vegetation should be done to continue to screen views into the Project development within the EIS Study Area.</li> <li>▪ Conservation of the RAC and the rehabilitation of these sites into more well-forested areas could also provide positive visual influence.</li> <li>▪ Phased felling should be undertaken to spread out the impact from the reduction of forest and vegetation.</li> <li>▪ Construction perimeter hoardings along Brickland Road and Bukit Batok Road should be built higher, potentially following the height of the noise barrier at 6 m, to block out roadside and lower floor views into the EIS Study Area where the Project is located during the construction phase. This will reduce a portion of views into strikingly contrasting sights such as construction works.</li> <li>▪ Construction perimeter hoarding could display visuals of the new town development or use green walls in order to create a more visually pleasant outer boundary.</li> </ul>
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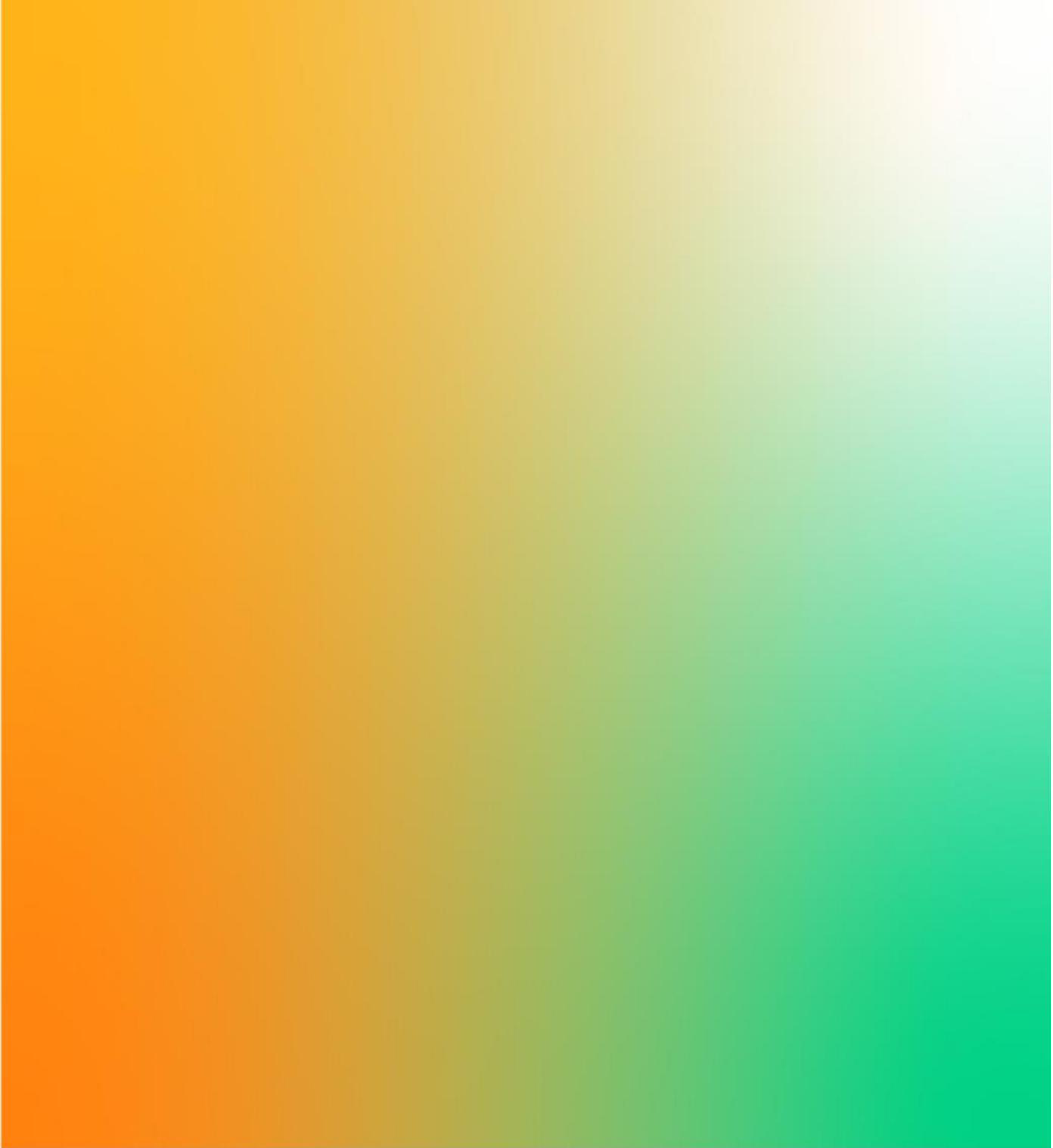
### Waste

The large amount of area being developed in Tengah results in a large amount of waste being produced and subsequently proportionate environmental impacts. The expected types of waste include wood, Construction and Demolition (C&D), hazardous, municipal and sewage. Their waste impacts range from minor to moderate negative with the majority of waste impacts during the construction phase being moderate negative. The transboundary carbon emission impact of tree felling was found to have a critically negative impact. The implementation of the recommended mitigation measures will help to reduce the volume produced and associated hazards although a large amount of waste is likely to still be produced. Most waste impacts can be mitigated to a slight to minor negative impact, but the climate change impacts from wood waste can only be mitigated to be of major negative significance.

<b>Key Recommended Mitigation Measures:</b>	<ul style="list-style-type: none"> <li>▪ Develop a waste management strategy to focus on waste elimination and to identify and communicate responsibilities for waste minimisation between developer; designer; project manager; contractors and suppliers.</li> <li>▪ Apply waste minimisation techniques and good practices on site following waste management hierarchy.</li> <li>▪ Examine the possibilities of using materials from the removal of woody trees in the EIS Study Area.</li> <li>▪ Build for deconstruction and design to standard material sizes to allow future modification or decommissioning occurs.</li> <li>▪ Waste concrete from demolition could also be recycled into recycled concrete aggregate which is made up of 70% demolition concrete waste with natural aggregates and used in buildings and roads in Tengah.</li> </ul>
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### Environmental Management and Monitoring Plan

Following the establishment of baseline conditions and the assessments of impact significance, mitigation/ enhancement measures were incorporated into an EMMP, which was formulated as a tool for contractors to adopt during the construction phase of the Project. More details can be referred to **Section 12** of the main EIS report.



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