

# Specialist Consultancy Services at HDB Development (Choa Chu Kang)

Housing & Development Board (HDB)

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## Quality information

| Prepared by | Checked by | Verified by | Approved by |
|---|---|---|---|
| Grujica Sarenac<br>Leela Guvvala<br>*(Water Resources Specialist)*<br><br>Hanzel Lalitan<br>Tiffany Tan<br>*(Air Quality Specialist)*<br><br>Phyo Zay Naing<br>Sim Yi Ting<br>*(Airborne Noise Specialist)*<br><br>Tan Kai Ren<br>*(Biodiversity Specialist)* | Dr. Liang<br>*(Water Resources Technical Reviewer)*<br><br>Jagriti Dawra<br>*(Air Quality and Airborne Noise Technical Reviewer)*<br><br>Ashley Welch<br>*(Biodiversity Technical Reviewer)* | Jagriti Dawra<br>*(Environment Department Head and Project Director)* | Ashley Welch<br>*(Project Manager)* |

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## Prepared for:

Housing & Development Board
HDB Hub
480 Lorong 6 Toa Payoh
Singapore 310480

## Prepared by:

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

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Appendix C Wildlife Incident Form

Appendix D Environmental Incident Form

Appendix E Feedback Management Form

Appendix F Dust Control Plan

Appendix G Noise Management Plan

Appendix H Public Communication Plan

Appendix I Lighting Management Plan

Appendix J Hoarding Plan

Appendix K Earth Control Measures Plan

Appendix L Site Environmental Control Plan

# List of Acronyms

| Acronym | Definition |
|---|---|
| **AECOM** | AECOM Singapore Pte. Ltd. |
| **AGOL** | ArcGIS Online |
| **APSG** | Aviation Park Staging Ground |
| **BCA** | Building and Construction Authority |
| **BOD** | Biochemical Oxygen Demand |
| **BTNR** | Bukit Timah Nature Reserve |
| **BTO** | Built-To-Order flats |
| **CCK N1** | Choa Chu Kang Neighbourhood 1 |
| **CCNR** | Central Catchment Nature Reserve |
| **CCTV** | Closed-circuit Television |
| **COPPC** | Code of Practice for Pollution Control |
| **CVPA** | Control of Vectors and Pesticide Act |
| **dBA** | A-weighted decibels (dBA) |
| **DIV** | Dutch Intervention Value |
| **ECB** | Erosion Control Blanket |
| **ECM** | Earth Control Measures |
| **ECO** | Environmental Control Officer |
| **EDMS** | Environmental Data Management System |
| **EHSO** | Environmental, Health and Safety Officer |
| **EIA** | Environmental Impact Assessment |
| **EMMP** | Environmental Management and Monitoring Plan |
| **EOD** | Explosive Ordnance Disposal |
| **EQO** | Environmental Quality Objectives |
| **ERP** | Emergency Response Plan |
| **ERSS** | Earth Retaining and Stabilising Structures |
| **ESC** | Erosion and Sediment Control |
| **FRMs/FEMs** | Federal Reference Methods/Federal Equivalent Methods |
| **HDB** | Housing & Development Board, Singapore |
| **HVP** | Heavy Vehicle Parking |
| **IAQM** | Institute of Air Quality Management |
| **ISA** | International Society of Arboriculture |
| **LTA** | Land Transport Authority |
| **LWC** | Licensed Waste Collector |
| **NEA** | National Environment Agency |
| **NMP** | Noise Management Plan |
| **NParks** | National Parks Board |
| **NSR** | Noise sensitive receptor |
| **PE** | Professional Engineer |
| **PDF** | Portable Document Format |
| **PM** | Particulate Matter |
| **PP** | Project Proponent |
| **PME** | Powered mechanical equipment |
| **POC** | Potential of Contamination |
| **PUB** | Public Utility Board |
| **PRO** | Public Relations Officer |
| **QECP** | Qualified Erosion Control Professional |
| **QP** | Qualified Professional |
| **RAC** | Recommended Area of Conservation |
| **RTO** | Resident Technical Officer |
| **SAAQT** | Singapore Ambient Air Quality Long Term Targets |
| **SDS** | Safety Data Sheets |
| **SDCF** | Singapore Civil Defence Force |
| **SECP** | Site Environment Control Plan |

| | |
|---|---|
| **SECR** | Site Environment Control Report |
| **SI** | Soil Investigation |
| **SIDS** | Silty Imagery Detection System |
| **SLM** | Sound Level Meter |
| **SOP** | Standard Operating Procedure |
| **SO Rep.** | Superintending Officer Representative |
| **SPF** | Singapore Police Force |
| **TMSG** | Tanah Merah Staging Ground |
| **TPZ** | Tree Protection Zone |
| **TSS** | Total Suspended Solids |
| **URA** | Urban Redevelopment Authority |
| **USEPA** | United States Environmental Protection Agency |
| **UXO** | Unexploded Explosive Ordnance |
| **VCO** | Vector Control Operator |
| **VCT** | Vector Control Technician |
| **VCW** | Vector Control Worker |
| **WHO** | World Health Organization |

# 1 Introduction

AECOM Singapore Pte. Ltd. has been appointed by the Housing & Development (HDB), through the Letter of Acceptance dated 23 March 2023, to carry out the development of Environmental Management and Monitoring Plan (EMMP) specifications for the proposed developments located in Choa Chu Kang (CCK) Neighbourhood 1 (N1) (hereafter referred to as the "Project"). The Choa Chu Kang N1 (hereafter referred to as 'CCK N1') is a 16 hectares (ha) site located in between Pang Sua Canal and Woodlands Road with Kranji Expressway in the north. The proposed development to be constructed within CCK N1 includes residential developments and parks.

Prior to the start of this Project, an Environmental Impact Assessment (EIA) [Appendix A] was conducted for the project site. An area of minimum 2 ha was proposed to be retained as the Recommended Area of Conservation (RAC). In consideration of the ecological sensitivity of these areas as well as the proximity of this site to residential areas and educational institution, this EMMP details how recommended mitigation measures should be implemented to reduce ecological and human impacts as well as specify the monitoring measures required to assess the effectiveness of these mitigation measures, in order to ensure that the construction activities are carried out with minimal impacts to the surrounding ecological and human sensitive receptors.

An EMMP was developed for CCK N1 to provide management and monitoring requirements for biodiversity, surface water quality and groundwater quality and levels, air quality, airborne noise, vector control and waste management. This EMMP is an adaptive document that will be updated when there is a need to revise measures or a change in Project components due to unforeseen or unavoidable circumstances. Copies of the EMMP specification must be kept on-site for reference at all times. Detailed EMMP addendums will be produced for each stage of works (e.g., earthworks and clearance, and construction) outlining all stage specific measures and plans where they differ or provide new information from what has been presented in this Specification.

# 2 Summary of Environmental Impact Study

## 2.1 EIA Project Site

The EIA Project Site included an area of 16 ha, located in the northwest part of mainland Singapore, in the vicinity to the Central Catchment Nature Reserve (CCNR), Bukit Mandai and Bukit Gombak Forest. This location represents a critical point of ecological connectivity for north-south migration of fauna moving from the Bukit Timah Nature Reserve, Bukit Batok Nature Park, and Bukit Gombak Forest in the south to Bukit Mandai and Western Water Catchment Area through the Kranji Reservoir.




**Figure 2-1 EIA Project Site (source: CCK N1 EIA Report [Appendix A])**

## 2.2 Summary of Baseline Findings

The environmental baseline findings for biodiversity, hydrology and surface water quality, groundwater levels, air quality and airborne noise have been summarised in Table 2-1 below.

**Table 2-1 Summary of Key Baseline Findings from EIA (Source: CCK N1 EIA Report [Appendix A])**

| Environmental Parameter | Baseline Findings |
|---|---|
| **Habitats and Vegetation Distribution**<br><br>**(Figure 2-2)** | • CCK N1 site mainly constitutes managed vegetation, comprising clusters of various tree species planted for landscaping purposes (9.62 ha; 45.2%) which occupies approximately half of the Study Area, and turf area (5.36 ha; 25.2%). The existing canal and infrastructure, such as the heavy vehicle carpark and defunct bus terminal comprise 6.32 ha (29.6%) of the Study Area. |
| **Biodiversity**<br><br>**(Figure 2-3; Figure 2-4)** | • The floristic assessment identified a total of 119 species of plants from 46 families, of which, the majority are exotic (81 species; 68.1%). Furthermore, only 27 recorded species (22.7%) are native and 11 (9.2%) are cryptogenic (i.e., species that has unknown or uncertain origins). Only one nationally Vulnerable climber species, *Bridelia stipularis*, is considered to be a species of conservation significance[1]. Ninety-one large plant specimens were recorded in the Study Area, which is largely dominated by Senegal Mahogany (*Khaya senegalensis*) and Rain Tree (*Samanea saman*). Other specimens of value consist of two keystone species with two |

[1] The conservation status of *Bridelia stipularis* has since been revised down from Vulnerable in Red Data Book Version 2 (RDB2) to Least Concern in Red Data Book Version 3.

| Environmental Parameter | Baseline Findings |
|---|---|
| | specimens respectively: Malayan Banyan (*Ficus microcarpa*) and Weeping Fig (*Ficus benjamina*), with a spread that ranges from 3 m - 8 m. In addition, a bamboo cluster, *Bambusa cf. heterostachya* with a spread of 2.5 m, were also identified to be possible roosting habitat for Bamboo Bats.<br>• The faunistic field findings recorded 78 species, with more than half of the assemblage dominated by birds (29 species) and butterflies (18 species). No species of conservation significance were recorded.<br>• While not considered of conservation significance, several other uncommon fauna species were also recorded. This includes the uncommon Dingy Duskhawker (*Gynacantha subinterrupta*) which is usually found in forested areas; and two moderately rare butterflies: Evening Brown (*Melanitis leda leda*), which is usually sighted in grasslands, thickets, or among dense vegetation, and Common Redeye (*Matapa aria*), which is usually sighted in which bamboo clusters are present e.g., in urban parks, wastelands and nature reserves. [W-1].<br>• Nine migratory bird species were also recorded, including the rare Yellow-browed Warbler (*Phylloscopus inornatus*) and uncommon migrant species, Yellow-rumped Flycatcher (*Ficedula zanthopygia*). These records show the value of the Study Area in supporting these uncommon species and migratory birds.<br>• Other species of conservation significance that may utilise the Study Area to move between habitats include the globally Critically Endangered and nationally Endangered Straw-headed Bulbul (*Pycnonotus zeylanicus*), the globally Vulnerable Smooth-coated Otter (*Lutrogale perspicillata*), and the globally and nationally Critically Endangered Sunda Pangolin (*Manis javanica*) [P-1; P-2]. These species have been recorded in surrounding green spaces and may disperse to the Study Area. The watercourse within the Study Area is poor in aquatic life and is more likely to be used by fauna to move between habitats. |
| **Water Resources**<br>**(Hydrology)**<br>**(Figure 2-5)** | • Four (4) catchment areas within the Study Area mainly contribute to four (4) watercourses within the Study Area.<br>• The perennial Pang Sua Canal D1 is located along the western and southern lengths of the Study Area. Perennial concrete drain D2 is located at the northeast corner of the site. Ephemeral concrete drain D3 cuts across the centre of the site, discharging into Pang Sua Canal D1 through a culvert. Ephemeral concrete drain D4 begins at the southern portion of the site and runs approximately parallel to Rail Corridor alignment before it discharges into drain D2 at northeast part of the site. |
| **Water Resources**<br>**(Surface Water Quality)**<br>**(Figure 2-5)** | • Six (6) sampling stations were identified for the Study Area<br>• Generally, surface water quality parameters in Canal D1 and drain D2 exceeded the aquatic life criteria, aligning with the poor aquatic life along Pang Sua Canal during the time of field survey. High pH, Total Suspended Solids (TSS), turbidity, nutrient concentrations, and elevated *Enterococcus* counts were reported in both Canal D1 and drain D2. These detections are likely due to anthropogenic activities in the surrounding upstream area. |
| **Water Resources**<br>**(Groundwater Level)** | • Based on the review of publicly available data, the groundwater level within the Study Area was assessed to be around 2 meters below ground level (m bgl). |
| **Air Quality**<br>**(Figure 2-6)** | • Primary baseline air quality monitoring was conducted at five (5) representative locations, i.e., AQ1 (Villa Verde Estate), AQ2 (Jurong Pioneer Junior College), AQ3 (HDB Blk 162 Teck Whye Neighbourhood), AQ4 (West View Primary School), and AQ5 (HDB Blk 634 Senja Road). The measured 24-hours average $PM_{10}$ concentration at all monitoring locations were well below the Long-Term Singapore Ambient Air Quality Targets, however, the results of 24-hours average $PM_{2.5}$ at both AQ1, AQ2 and AQ3 exceeded the Long-Term Singapore Ambient Air Quality Targets. The monitoring results trend is in line with the trend of secondary data, with a spike of 24-hours average $PM_{2.5}$ during the monitoring period. |
| **Airborne Noise (Figure 2-7)** | • Baseline monitoring was carried out at six (6) locations within the 150 m Airborne Noise Study Area at NM01 (Villa Verde Estate), NM02a-c (HDB Block 635A Senja Road - Ground Level, Level 15, and Level 34), NM03 (West View Primary School), NM04a-c (HDB Block 162 Jalan Teck Whye - Ground Level, Level 7, and Level 13), NM05 and NM06 (at Green Area within Study Area). The baseline noise levels captured at the monitoring locations were generally found to be in exceedance of the maximum permissible noise limits established by NEA for construction sites due to noise levels being dominated by heavy road traffic along KJE and Woodlands Road with the exception of NM02a-c and NM04a-c in the daytime. |

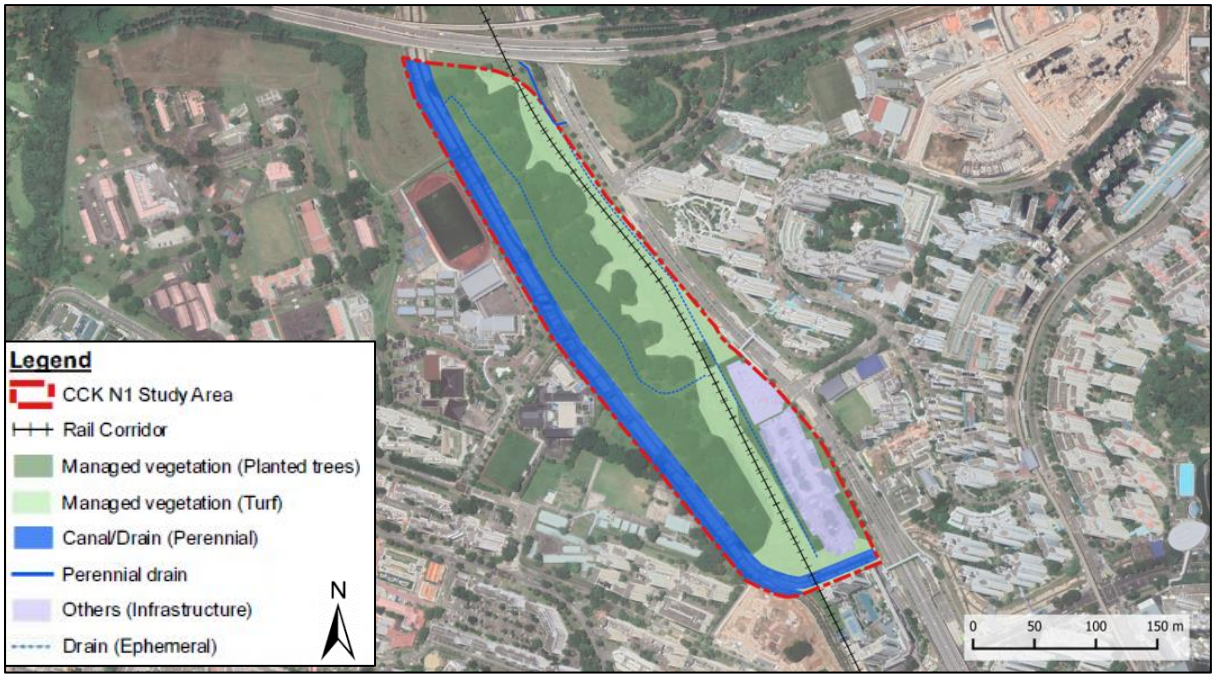



**Figure 2-2 Managed Vegetation (source: CCK N1 EIA Report [Appendix A])**

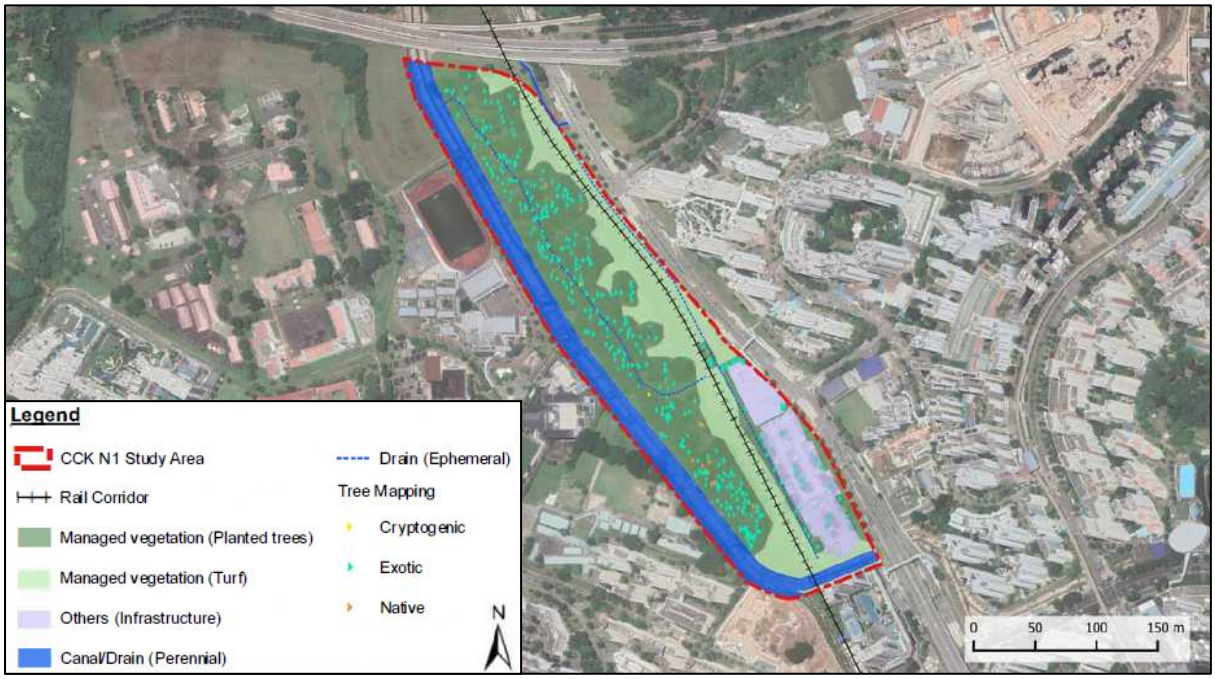



**Figure 2-3 Distribution of Trees According to Their Origin Recorded in CCK N1 Study Area (source: CCK N1 EIA Report [Appendix A])**

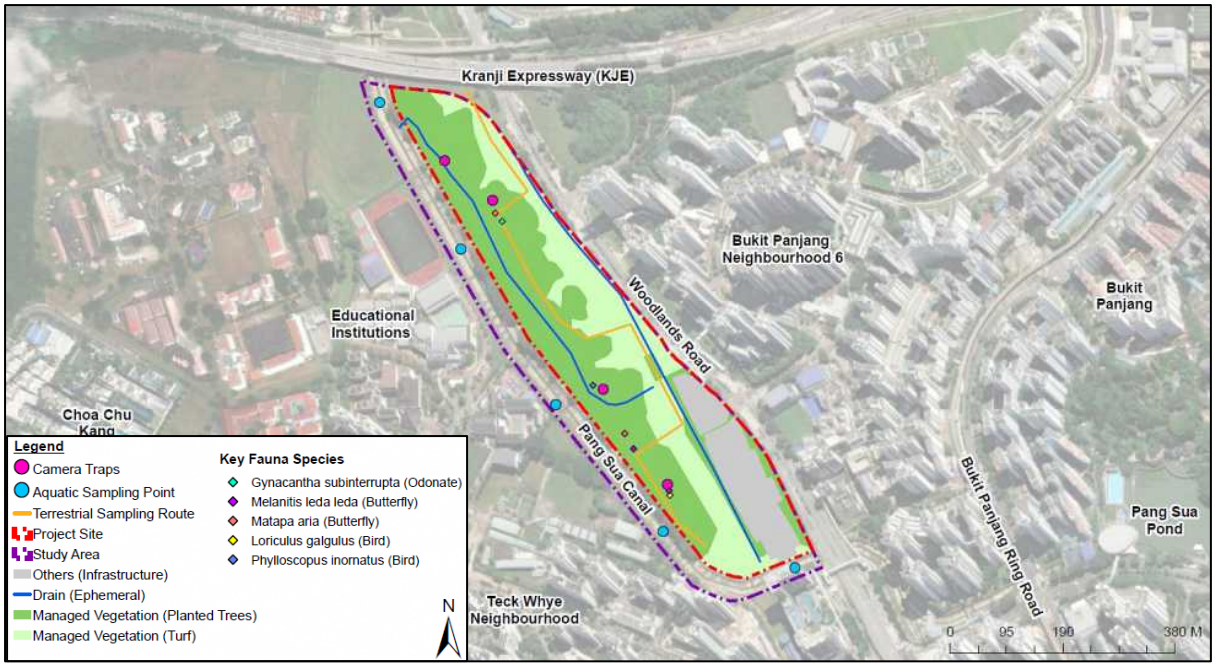



**Figure 2-4 Locations of Rare Fauna Species (source: CCK N1 EIA Report [Appendix A])**

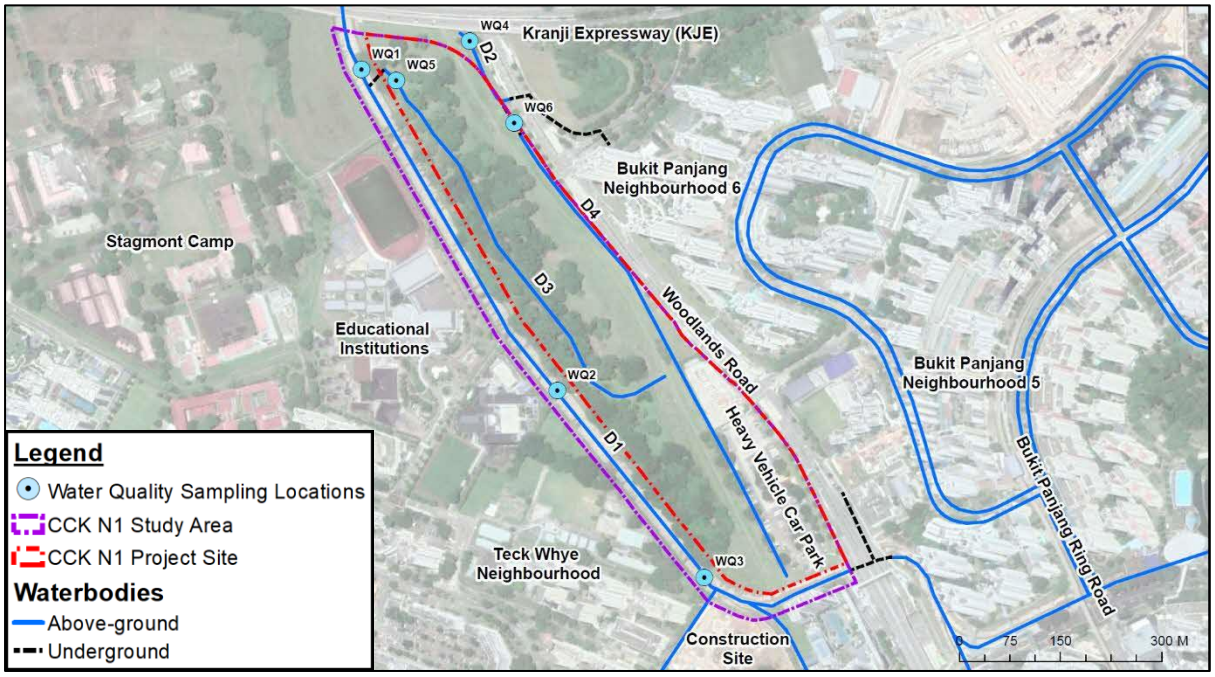



**Figure 2-5 Watercourses Within The Study Area and Surface Water Quality Sampling Locations (source: CCK N1 EIA Report [Appendix A])**

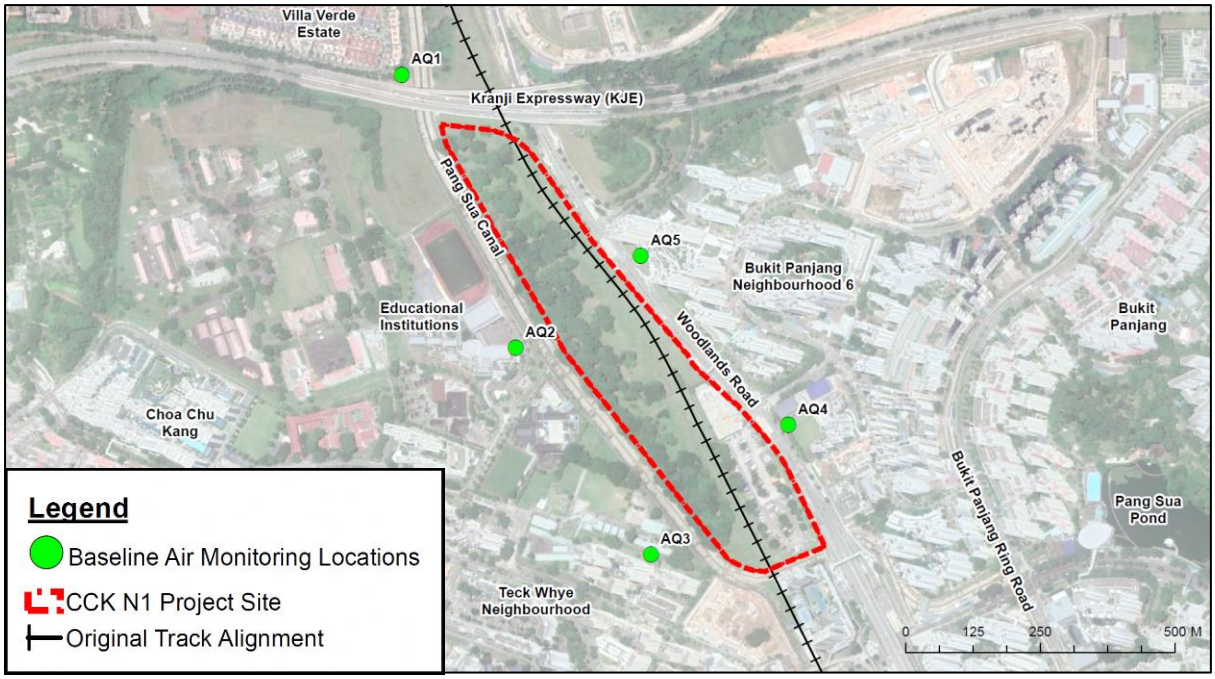



**Figure 2-6 Location of Baseline Air Quality Monitoring Locations (source: CCK N1 EIA Report [Appendix A])**

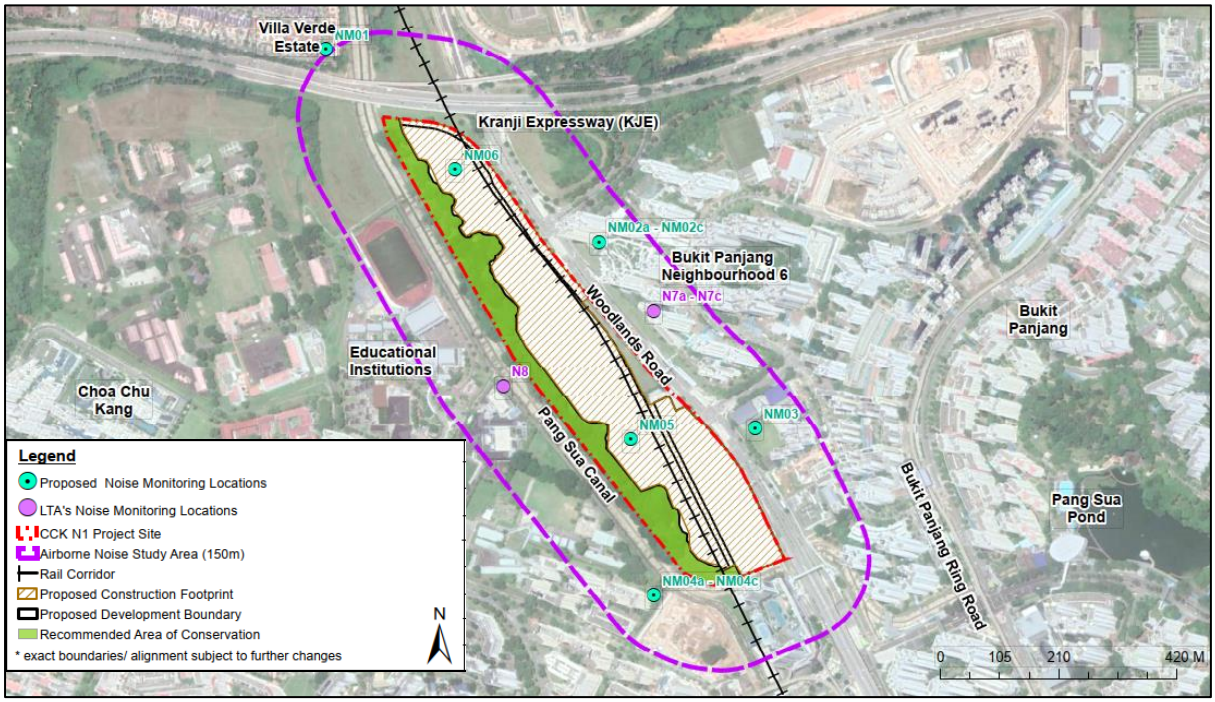



**Figure 2-7 Location of Baseline Noise Monitoring Locations (source: CCK N1 EIA Report [Appendix A])**

## 2.3 Summary of Impact Assessment Findings

An overview of impact assessment findings from the construction phase on the biological environment (biodiversity), humans, directly or indirectly via hydrology, surface water quality, groundwater level and quality, air quality and airborne noise, proposed mitigation measures, and its residual impacts from the EIA are summarised in Table 2-2.

**Table 2-2 Summary of Impacts During Construction Phase and Key Mitigation Measures (Source: CCK N1 EIA Report [Appendix A])**

| Environmental Parameter | Potential Environmental Impacts | Minimum Controls | Key Mitigation Measures (If any) | Residual Impact Significance |
|---|---|---|---|---|
| **Biodiversity** | • Loss and degradation of habitat;<br>• Increased mortality and declined in health for plants;<br>• Pollution and degradation;<br>• Loss of ecological connectivity;<br>• Changes in fauna/ flora species composition | <u>Pre-construction Stage</u><br>• Arborist to clearly mark out Tree Protection Zones (TPZs) for trees to be retained. The TPZs are to be set up in accordance with National Parks Board (NParks) guidelines and no works are to be allowed here;<br>• Prior to vegetation removal, pre-felling fauna inspection should be conducted by an Ecologist to identify wildlife or nesting features that are actively used. E.g., bird nests, tree hollows and burrows;<br>• Execute wildlife response plan; and<br>• Implement soil erosion control measures.<br><u>Earthworks, Site Clearance, Soil Investigation / Construction Stage</u><br>• Implement soil erosion control measures;<br>• Situate machineries and materials that may leach harmful chemicals away from waterbodies or sensitive habitats (streams and ponds);<br>• Dust and noise levels are within approved limits; and<br>• Avoid fogging by implementing preventive measures for mosquito to remove sources of stagnant water or water-bearing receptables, e.g.: providing well-maintained pitched rood, clearing discarded items daily, store materials appropriately, level up ground depression/uneven surfaces, effective drainage flow; and daily checks on site. | <u>Avoidance</u><br>• Clear demarcation of extent of work boundary to avoid the Recommended Area of Conservation (RAC) (see Figure 2-8). Do not encroach into conserved habitats. Review development plans and construction methods to minimise impacts;<br>• Restrict entry of site personnel into the RAC/ Ecological Corridor; and<br>• Set up Tree Protection Zones (TPZs) for any trees that will be retained within the Project site, when needed.<br><u>Minimisation</u><br>• Practise due diligence in proper storage and handling of machinery to prevent leeching of oil or harmful materials such as bentonite slurry; store and handle harmful materials well away from waterbodies;<br>• Ensure minimum control measures as well as engineering controls are in place to prevent contamination and siltation into the RAC/ Ecological Corridor;<br>• Conduct regular inspections to ensure contractor compliance to the EMMP;<br>• Minimise night-time works to prevent disturbances to nocturnal fauna; restrict working hours to 0700 h –1900 h;<br>• Where night-time works are not avoidable, review construction method statements and site lighting plan with the EMMP Specialist and Ecologist, and update the EMMP with the approved lighting management plan before the commencement of nights works; | Negligible – Major<br><br>(Major from loss of vegetation, Mortality (Flora), Loss of/or Reduction in Habitats and Food Sources) |

| Environmental Parameter | Potential Environmental Impacts | Minimum Controls | Key Mitigation Measures (If any) | Residual Impact Significance |
|---|---|---|---|---|
| | | | • Use only fully biodegradable erosion control blankets (ECB) to avoid trapping fossorial fauna such as snakes;<br>• Reduce light spillage into adjacent areas during night work by:<br>  ○ Using opaque dark-coloured hoarding where possible;<br>  ○ Increasing the height of hoarding;<br>  ○ Ensuring lighting is only used where necessary;<br>  ○ Ensuring lighting to be directed downwards; and<br>• Use wildlife-friendly lighting instead of high ultraviolet/broad spectrum lights. | |
| **Water Resources**<br><br>**(Hydrology)** | • Altered dry and wet weather flow conditions (e.g., water levels, flow velocity, etc.) within watercourses;<br>• Increased flooding risk of areas adjacent to watercourses due to altered flow conditions;<br>• Hydrological changes have a potential to cause adverse effects to aquatic habitats and communities. | • Develop stormwater conveyance system that will effectively drain away runoff originating within, upstream of and adjacent to the work site. Proposed system should not cause flooding in its vicinity;<br>• Drain diversion for the watercourses impacted by this development (i.e., drains D2 and D4) should be provided before the commencement of construction works.<br>• Potential increase of runoff peak flow within the site may be mitigated by providing detention tanks or ponds within the Project site. These tanks/ ponds should be designed to have enough of capacity to capture estimated peak runoff during heavy stormwater events. Furthermore, to avoid significant increases in peak flows of downstream watercourses it is recommended that the timing of detention basin outflows be coordinated;<br>• Development of temporary routes to be used by heavy vehicles/ machinery aiming to reduce the compaction of soil (and therefore soil permeability) as much as possible;<br>• Geotechnical aspect of site's slope stability (such as Earth Retaining Stabilising Structures [ERSS] to be included in detailed design engineering for the construction phase;<br>• The design engineers responsible for detailed design may need to ensure that ERSS are proposed when the site is cleared and excavated. Concurrently, the Environmental Control Officer (ECO) must ensure that these measures are | • No additional mitigation measures have been proposed. | Negligible to Minor Negative |

| Environmental Parameter | Potential Environmental Impacts | Minimum Controls | Key Mitigation Measures (If any) | Residual Impact Significance |
|---|---|---|---|---|
| | | successfully implemented in the construction phase, as cutting of slopes may result in slope instability;<br>• Plan soil dewatering in phases to avoid generating large quantities of water to be discharged into receiving watercourses. Furthermore, soil dewatering in phases will reduce the groundwater drawdown and minimise the reduction of baseflow feeding the stream;<br>• Provide detention basins (e.g., detention tanks, detention ponds) within the Project site with controlled outlet. By controlling the outflow from the basins, it is possible to reduce the stress on the receiving watercourses by distributing the discharge more evenly;<br>• Regular maintenance of stormwater and drainage systems to prevent obstruction of channels and consequent flooding of adjacent areas;<br>• Develop detailed emergency evacuation plan in the event of flash floods within the site. To develop early warning system, where applicable; and<br>• Provide pumping stations to extract the excess water ponded within the site after heavy rainfall events. | | |
| **Water Resources**<br><br>**(Surface Water Quality)** | • Water quality deterioration from soil erosion, sewage, chemical and trade effluent discharge;<br>• Water quality deterioration due to accidental spills and leaks of chemical substances stored and used on site | • Drain diversion for the watercourses impacted by this development (i.e., drains D2 and D4) should be provided before the commencement of construction works;<br>• A full inventory of all anticipated wastewater streams and volumes should be finalised before the onset of the construction works;<br>• Daily record volume of wastewater, as well as volumes of sludge and other produced wastes;<br>• No unmanaged discharge of wastewater stream permitted;<br>• Reduce, reuse, and recycle hierarchy principle to be applied to wastewater on-site;<br>• Regular and dedicated procedures for the inspection and maintenance of wastewater collection, storage, and treatment infrastructure, such as pipes, oil water separators, silt screens, etc.<br>• Hazardous wastewater, such as oily water, thinners, solvents, or paints, are to be stored and removed for treatment and disposal off-site by an approved Waste Management Contractor. Hazardous liquids to be handled as Hazardous Waste;<br>• No hazardous liquids to be sent to the detention pond; | • No additional mitigation measures have been proposed. | Negligible to Minor Negative |

| Environmental Parameter | Potential Environmental Impacts | Minimum Controls | Key Mitigation Measures (If any) | Residual Impact Significance |
|---|---|---|---|---|
| | | • Settling ponds will be of impervious material and be designed with sufficient capacity to hold volumes of wastewater produced on-site, as well as allowance for stormwater run-off and potential fire-fighting wastewater;<br>• Temporary storage volumes should be provided for overflow situations. Temporary storage to be of sufficient capacity to capture any additional volumes that may be expected to ensure untreated wastewater is not released to watercourses unless it complies with Singapore NEA Guidelines on trade effluent discharge concentrations;<br>• A responsible person (e.g., ECO) to be assigned to oversee the efficient operation of the detention ponds where 'Good Housekeeping' practices would be adhered to. Also, the area would be carefully managed to avoid spills, leaks, and odour issues, with the settling ponds checked at least daily to ensure proper functionality;<br>• The settling ponds, as well as wastewater generating areas on-site, to be equipped with spill clean-up kits;<br>• Adequate drainage, cut-off drains sump pit, road kerb, piping, and toe wall for channelling of construction process wastewater streams (e.g., wash water, etc.) and stormwater runoff separately to be assured through detailed design for capture and treatment in the settling ponds. 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;<br>• Implement an EMMP during the construction stage and ensure full preparation of associated plans and procedures including the following:<br>  ○ EMMP to include Standard Operating Procedures (SOPs), an Emergency Response Plan (ERP), an inventory of wastewater streams, training of staff as well as an inspection, maintenance and audit schedule;<br>  ○ Full development of EMMP Wastewater Management Procedures to include dedicated management and monitoring procedures that covers all eventualities related to the proper operation of the containment pond/ kerbs, or any other wastewater discharge location/ equipment.<br>• Regular and dedicated procedures for the management of stormwater collection, settling, testing and eventual discharge of 'clean' water to watercourses. This should also include | | |

| Environmental Parameter | Potential Environmental Impacts | Minimum Controls | Key Mitigation Measures (If any) | Residual Impact Significance |
|---|---|---|---|---|
| | | associated measures required (e.g., silt curtains) to prevent high sediment concentration stormwater drainage to watercourses;<br>• A training programme for all on-site workers, including sub-contractors, in relation to their obligations for ensuring proper water quality management;<br>• Adequate drainage and piping for channelling of stormwater run-off to be assured through detailed design for capture and treatment before discharge into surface watercourses;<br>• Sizing of sediment/ detention pond and its associate structures will strictly comply with the criteria required in Earth Control Measures (ECM), i.e., design to cater for at least 5-year return period storm event;<br>• 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.;<br>• 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 water;<br>• Effective ECM and monitoring implemented as required 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) Regulation;<br>• 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.;<br>• Implementation of Closed-circuit Television (CCTV) including SIDS at the public drain to monitor the surface runoff discharges from the sites as per the Public Utility Board's (PUB) circular on Preventing Muddy Waters from the Construction Sites (October 2015);<br>• 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 | Potential Environmental Impacts | Minimum Controls | Key Mitigation Measures (If any) | Residual Impact Significance |
|---|---|---|---|---|
| | | • 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.);<br>• Appropriate disposal of any waste listed in the Environmental Public Health (General Waste Collection) Regulations by licensed waste operator/ collector;<br>• All vehicles and plant 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;<br>• Development of SOP for safe handling, transfer and storage of toxic waste; housekeeping checks once a day to ensure all toxic wastes cleared from site;<br>• Appropriate tests to ascertain the presence/ absence of contamination of the excavated soil;<br>• Store generated toxic chemical waste under shelter within concrete bund walls or in storage containers with good ventilation. Spill trays shall be provided for all waste containers Spill trays shall be regularly maintained to prevent rain from washing out the pollutive substances;<br>• Appropriate construction material for toxic waste storage containers with leak detection tests conducted periodically;<br>• Provision of secondary containment for all toxic waste stored in bulk as per the requirements in the Code of Practice for Pollution Control SS593;<br>• Ensure all hazardous substance and chemical containers are labelled its movement is recorded and returned to the designated storage areas when not in use;<br>• Remove any hazardous substance or chemical if there are safer alternatives;<br>• Ensure all activities involving repair, servicing, engine overhaul works, etc. shall be carried out on an area which is appropriately contained (e.g., concreted area and with proper containment/sumps) and all wastes are channelled for appropriate treatment or disposal to meet the regulations;<br>• Consignment notification/ tracking system and transport emergency response plan for transport of toxic waste; | | |

| Environmental Parameter | Potential Environmental Impacts | Minimum Controls | Key Mitigation Measures (If any) | Residual Impact Significance |
|---|---|---|---|---|
| | | • Appropriate disposal of toxic waste as per required in the Environmental Public Health (Toxic Industrial Waste) Regulations by licensed waste operator/ collector;<br>• Provision of portable toilets and on-site septic tanks;<br>• Regular cleaning of the portable toilets and clearing of sewage waste;<br>• Appropriate location of toilet facilities away from any nearby watercourses;<br>• Inspections and audits to ascertain the hygienic conditions onsite;<br>• Training of workers on the best practices to contribute in environmental protection;<br>• Surface Water Drainage, to be endorsed by a Qualified Erosion Control Professional (QECP) and submitted to PUB;<br>• Implementation of the ECM plan before the start of any construction work;<br>• Manholes should always be adequately covered and temporarily sealed;<br>• Protection of stockpiles with erosion blanket coverage and proper scheduling of the demolition and earthworks to reduce the quantity of stockpiles to be stored onsite;<br>• Coverage of temporary/ open storage of excavated materials; and<br>• Appropriate permits for discharge to be obtained from relevant authority prior to discharge. No trade effluent other than that of a nature or type approved by NEA Director-General will be discharged into any watercourse or land. | | |
| **Water Resources**<br><br>**(Groundwater Quality and Level)** | • Decreased surface water infiltration into the ground;<br>• Groundwater extraction during construction activities that require soil dewatering;<br>• Seepage of contaminants from excavated contaminated soil and groundwater (if encountered) into the underlying soil and groundwater;<br>• Seepage of contaminants into underlying soil and | • Install piezometers to monitor the changes in groundwater level in compliance with Building Control Regulations 2003 as part of its instrumentation and monitoring plan to be endorsed by the Qualified Professional (QP);<br>• Proper Earth Retaining Stabilising Structures (ERSS) should be selected and designed to limit groundwater settlement;<br>• Plan soil dewatering in phases to avoid as much as practicably possible groundwater drawdown;<br>• Identify all types of solid waste and implement comprehensive waste management system at the site in order to ensure proper disposal and prevent pollution to the environment. This contractor should conduct a construction risk assessment and prepare a comprehensive construction health, safety, and environment plan. If health impacts to workers are foreseen due | • No additional mitigation measures have been proposed. | Negligible to Minor Negative |

| Environmental Parameter | Potential Environmental Impacts | Minimum Controls | Key Mitigation Measures (If any) | Residual Impact Significance |
|---|---|---|---|---|
| | groundwater due to accidental spills and leaks of chemical substances stored and used on site | to the handling of such waste, necessary precautionary measures as per the Safety Data Sheets (SDS) including personal protective equipment should be implemented on site;<br>• Use approved materials, of the same or better quality as the surrounding area, for backfilling works. All backfilled material shall be free of debris, and of good material soil;<br>• Handle and dispose excavated soil following the procedure shown in Figure 8-8 of the EIA (Appendix A). The flow chart explains how to handle excavated soils and identify potential areas of contamination as well as potential of contamination (POC) in excavated soils. If the POC soils are tested for exceedance in Dutch Intervention Values (DIVs), the soils can be disposed of to toxic waste collectors or undergo soil treatment. If contaminated soils were sent for treatment to an acceptable standard such as the DIV, the treated soil can be disposed in the staging ground or through a general waste collector, depending on the level of the contaminants during the staging ground testing;<br>• Upon receipt of results on the tested parameters (chemicals, heavy metals) exceeding the regulatory limits, the construction contractor should further assess the potential inhalation and dermal contact impacts of the exceeded parameters to the site workers exposed to areas where soil and/or groundwater contamination is identified. The risk assessment should be conducted before the commencement of construction activities and the findings incorporated into the contractors' construction risk assessment and health, safety, and environment plan. If health impacts to workers are foreseen, necessary precautionary measures, as per the respective chemical SDS, should be implemented on site;<br>• A site management plan should include plans of safe handling, transfer and storage of excavated soils following the procedure; and<br>• Discharge of extracted groundwater shall be to an area approved for such disposal by the NEA and the proposed location. It is recommended that the construction contractor to be vigilant of site conditions and extracted groundwater to be tested at regular intervals, especially for extracted groundwater with oily sheens or noticeable odour. If a contaminant concentration in excess of the DIV is detected, the contractor shall assess the potential inhalation and dermal impacts of the chemical identified and assess potential health and safety considerations for exposure to groundwater before | | |

| Environmental Parameter | Potential Environmental Impacts | Minimum Controls | Key Mitigation Measures (If any) | Residual Impact Significance |
|---|---|---|---|---|
| | | commencement of construction activities. Such contaminated wastewater may need to be disposed of to a licenced toxic waste collector. | | |
| **Air Quality** | • Dust emissions generated by earthworks processes and construction of new structures, as well as from the transport of dust and dirt by dumper trucks (trackout); and<br>• Gaseous emissions generated from equipment and vehicle exhausts, including the use of off-road diesel generators on-site. | • The construction footprint shall be hoarded on all sides;<br>• No demolition of permanent structures is expected as part of the project, with the exception of a single storey structure within the Heavy Vehicle Parking (HVP);<br>• No concrete batching plant to be located on-site; and<br>• Access road construction or expansion is recommended to be completed first and paved before the construction of other development commences. | • Implement dust control measures e.g., dust screens, etc;<br>• Install hard surfaced haul routes;<br>• Only use cutting, grinding and sawing equipment with dust suppression water spray mechanisms;<br>• Soft strip inside buildings before demolition (retaining walls and windows in the rest of the building) where possible, to provide a screen against dust.<br>• Ensure effective water suppression is used during demolition operations.<br>• Avoid explosive blasting, using appropriate manual or mechanical alternatives.<br>• Erect hoarding around dusty activities and site boundary min. 1.8m height in line with Building and Construction Authority (BCA) guideline;<br>• Impose and signpost maximum speed-limit of 25km/hr on paved roads and 15 km/hr on unpaved roads and work areas;<br>• No burning of waste allowed on site;<br>• Revegetate or cover earthworks and exposed areas/ soil stockpiles;<br>• If the ambient air quality level during construction exceeds the Singapore Ambient Air Quality Long Term Targets (SAAQT) [W-3], contractor should investigate the cause and implement more stringent mitigation measures; and<br>• If there be any complaints from the community with regards to air quality during construction, additional ambient | Minor Negative |

| Environmental Parameter | Potential Environmental Impacts | Minimum Controls | Key Mitigation Measures (If any) | Residual Impact Significance |
|---|---|---|---|---|
| | | | air quality monitoring shall be conducted. | |
| **Airborne Noise** | Impacts to Human Receptors | • Only well-maintained powered mechanical equipment (PME) should be operated onsite and shall be serviced regularly during construction;<br>• Reduce the number of PMEs as far as practicable when construction works are carried out near NSRs; and<br>• PME (such as trucks and cranes) that may be in intermittent use shall be shut down between work periods or shall be throttled down to a minimum if possible. | • Prepare a noise management plan to help to implement noise mitigation measures;<br>• Use engineering methodologies to control noise at source such as noise enclosures, noise screens/ panels, portable noise barriers and quieter construction methodologies;<br>• Use noise barrier with minimum 3m and 12m height along the site boundary facing affected Noise Sensitive Receivers (NSRs);<br>• 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; and<br>• Avoid noisy construction activities at night, Sundays and public holidays. | Negligible to Moderate |
| | Impacts to Ecological Receptors | | | Moderate to Major |

## 2.4 Recommended Area of Conservation

The Recommended Area of Conservation (RAC) was developed with reference to the proposed ecological corridor boundary based on findings from Environmental Baseline Studies and Environmental Impact Assessment, along with recommendations, and consultations with agencies and Interest Groups. It is not to be taken as final but subject to further changes based on detailed studies such as design, on-site conditions, arborist's assessment, etc. Generally, the RAC aims to conserve a minimum of 2 ha of the total Study Area. Since the completion of the EIA report, HDB had updated the land use plan featuring a more regularised boundary for the ecological corridor. The comparison of the land use plan featuring the differences in the ecological corridor on the RAC and regularised ecological corridor are as shown in Figure 2-8. The ecological corridor in the new land use plans has a smoother edge and connects to the rail corridor in the south of the Project Site.

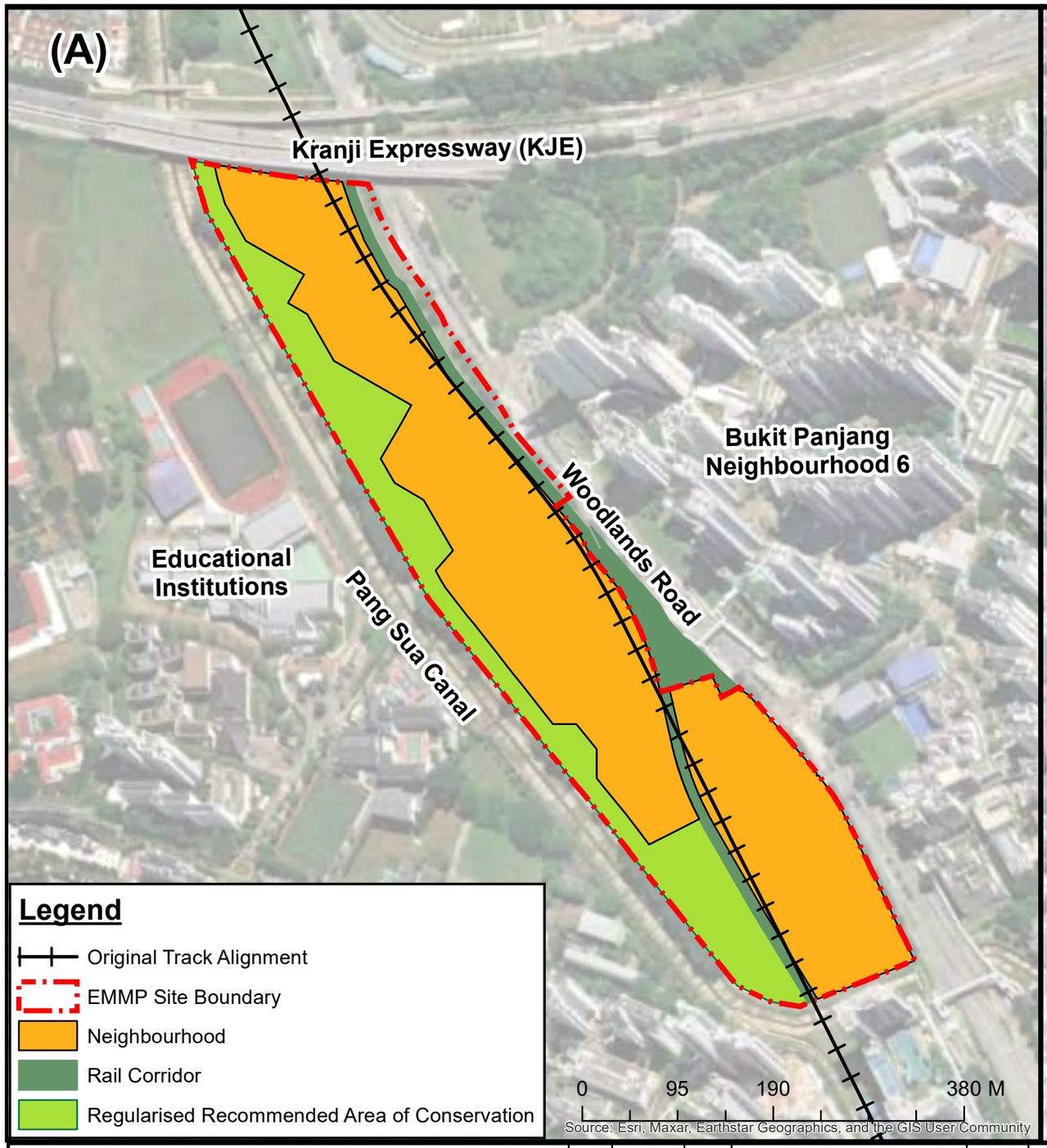
The ecological receptors that will be retained within the regularised ecological corridor (Figure 2-8 [A]) includes 38.9% (3.40 ha) of the Priority 1 habitat (i.e., managed vegetation with planted trees), of which, clusters of large Rain Trees (*Samanea saman*) that are generally located in the south and the centre portion of the Study Area will be retained alongside other large specimens of *Tabebuia rosea* and Senegal Mahogany (*Khaya senegalensis*). Other Priority 1 flora receptors that are also proposed to be retained are three Fig Stranglers and the nationally Vulnerable climber, *Bridelia stipularis*[2]. Around 7.37% (0.40 ha) of the Priority 2 habitat type (i.e., turf area) will also be conserved. The retention of all plant receptors mentioned above is subjected to arborist's assessment of tree/ plant health.

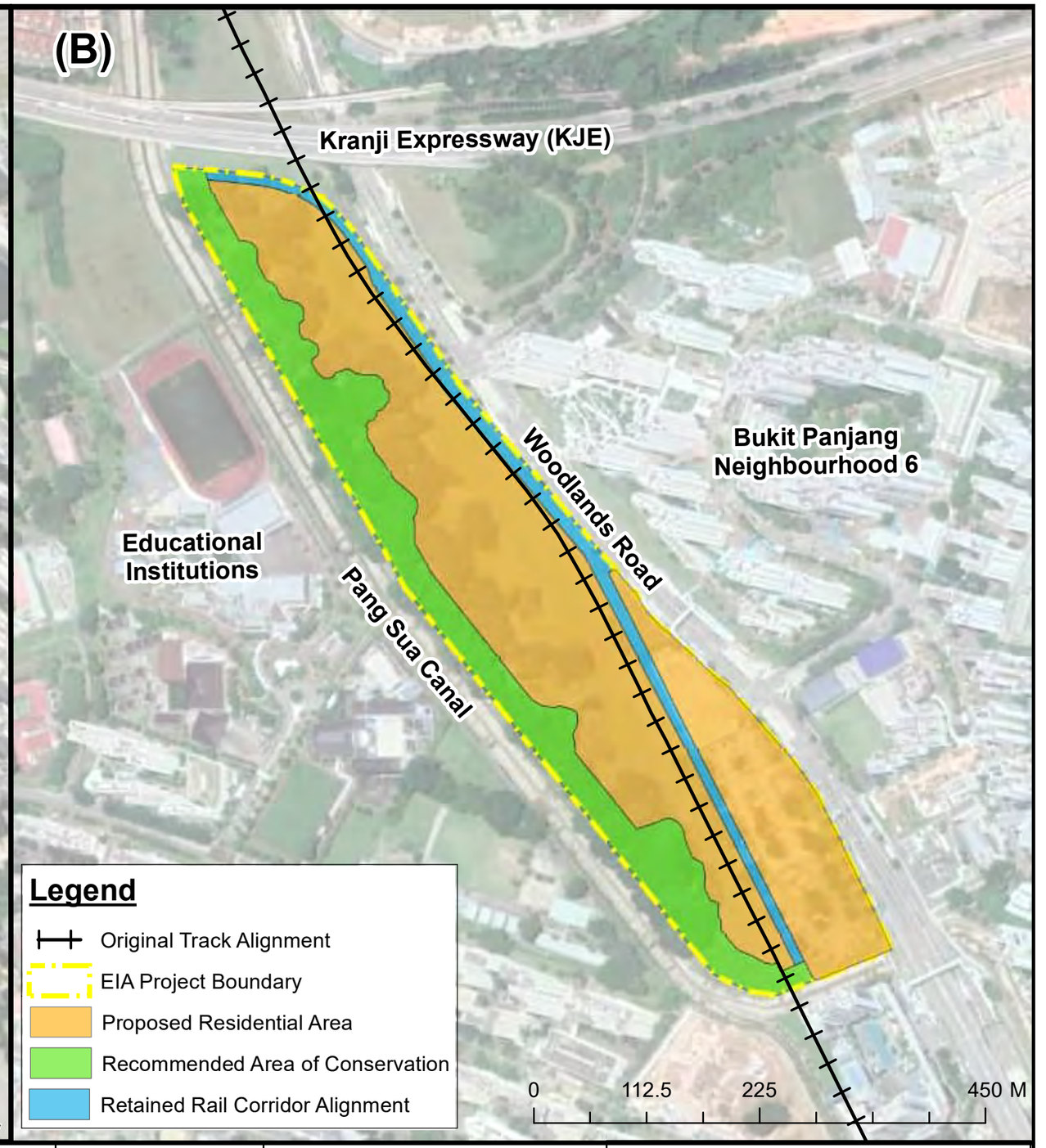
Currently, the proposed width of this Ecological Corridor will range from approximately 20 m and up to 85 m in certain areas where more clusters of trees are proposed to be retained. This provides an average width of approximately 50 m in most areas of the ecological corridor which may satisfy the minimum width requirement to maintain faunal connectivity [P-3;W-2]. The width of the Ecological Corridor is subjected to further changes based on detailed studies such as design, on-site conditions, arborist's assessment etc.

By retaining this strip of linear greenery, this would provide a vegetated corridor for ground-dwelling fauna species to travel to other habitat patches located up north of the Study Area and/ or south towards Hillview and Bukit Timah Nature Reserve (BTNR) during the construction and operational phase of CCK N1. It is also to note that the RAC should also be accompanied with enhancement strategies and detailed design treatment to increase the ecological value of the corridor and to create smaller forms of habitat that could possibly cater for various fauna species and increase the effectiveness of an ecological corridor.

The existing alignment of the Rail Corridor will also be retained and to be incorporated with the future residential estate (Figure 2-8). Generally, the Rail Corridor will be enhanced as corridor to facilitate pedestrian movement, with landscaping, heritage elements and community spaces such as playgrounds and fitness corner to enhance the character of the Rail Corridor.

[2] The conservation status of *Bridelia stipularis* has since been revised down from Vulnerable in Red Data Book Version 2 (RDB2) to Least Concern in Red Data Book Version 3.




| Rev. | Date | By | Description | Chk'd | App'd |
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| - | JUL 2023 | KRT | EMMP Specification | ASH | JAG |

N

Qualified Person Endorsement :
NA

LTA Endorsement :
NA

Consultant : AECOM

Client : HOUSING & DEVELOPMENT BOARD

Project Title :
**Specialist Consultancy Services at HDB Development (Choa Chu Kang)**

Figure Title :
**(A) Revised Land Use Plan by HDB**
**(B) Proposed Land Use Plan in CCK N1 EIA**

| Designed | Checked | Approved | Figure No. : | Rev. | Sheet |
|---|---|---|---|---|---|
| KRT | ASH | JAG | 2 - 8 | - | 1 of 1 |
| | Drawn KRT | Date JUL 2023 | CAD File Name : NA | | A3 |

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## 2.5 EIA Updates and Reassessment of Impacts

As more information regarding the developments have become available since the finalisation of the CCK N1 EIA Report (refer to Appendix A), certain assumptions that were used in the EIA Report have been changed, notably a change in boundary regulation.

As detailed in the previous section (i.e., Section 2.3), the boundary of RAC has been regularised in such a way for the ease of land demarcation for the future maintenance and optimising development area. Due to these changes, the total area of the RAC has changed from 4.18 ha (in EIA stage) to 3.82 ha (in EMMP stage). The width of the proposed RAC will range from 20 m to 85 m, with an average width of approximately 50 m along the corridor. In addition, it can be observed that the southern portion of the RAC has been increased (compared to the land use plan during EIA stage, refer to Figure 2-8) and is adjacent to proposed future Rail Corridor.

Furthermore, through a comparison of the arborist report prepared by Garden Works Pte. Ltd. on 27 Oct 2022 and the survey data used in the CCK N1 EIA Report, it was found that several trees have since been removed from the site. The trees that have been removed in this interim period have not been visualised within any of the plans within this EMMP Specification; instead, an on-site ground truthing exercise will be undertaken between the EMMP Consultant and Contractor to confirm the missing trees. Once complete, a plan will be produced indicating the location of the removed trees to aid the Contractor during site clearance.

## 2.6 Ecological Enhancement Measures Under Consideration

Due to the fact that strategies and designs are still being considered by respective Technical Agencies, several ecological enhancement measures outlined within the EIA have not been factored into this EMMP Specification. It is expected that decisions related to strategy, design and implementation will be provided during pre-construction and construction stages of the development. The ecological enhancement measures include:

- Measures to enhance the permeability of the landscape through the green corridor, external to the site, including the areas to the north and south of the site boundary. This includes the potential for the creation of a bridge linking the site with the corridor to the south behind Junction 10 that would provide connectivity for both wildlife and pedestrians;
- Measures to enhance the Recommended Area of Conservation (RAC) to create a more naturalistic habitat that is more beneficial to biodiversity, and which enhances the RAC's effectiveness as an ecological corridor; and,
- The potential to inhibit or limit human traffic from the existing dirt track adjacent to the canal within the RAC and redirecting the traffic towards the designated pedestrian path across the Pang Sua Canal, to minimise human-wildlife conflict during and potentially after the construction period.

# 3 Proposed Construction Activities and Timeline

The overall construction activities to be carried out within the project site includes soil investigation, site clearance, earthworks, drainage works and development works. The regularise ecological corridor in the new land use plan (Figure 2-8 [A]) will be retained and would not be cleared during construction. Detailed sequences of each sub-activities are still under discussion with NParks. Agencies are working closely on the details and extent of ecological corridor to be retained.

For the purpose of the EMMP, the mitigation measures later described in this report are outlined for one of three stages:

- Pre-construction: activities that are to be undertaken before any site works are to commence;
- Earthworks, Site Clearance and Soil Investigation (SI) works: following pre-construction, the works will include clearance of vegetation, undertaking earthworks and SI works. No building construction is undertaken at this stage; and,
- Building Construction: construction of Built-To-Order flats (BTOs) and all proposed infrastructure commences.

## 3.1 Overall Construction Timeline

The staging plan for all construction activities has been summarised in Table 3-1. The detailed descriptions of the construction activities are listed in Table 3-2. EMMP Addendums will be produced for each activity described below where the information and measures pertaining to the activity differ or require further detail as is included within this Specification.

**Table 3-1 Overall Construction Activities**

| No | Future Activities which may Require EMMP Addendums | Land Area | Project Duration |
|---|---|---|---|
| 1 | Earthworks and Site Clearance | 16 ha | 14 months |
| 2 | Detailed Soil Investigation works | 12.85 ha | 6 months |
| 3 | Detailed Soil Investigation and Building Construction of future residential area | 12.85 ha | Building Construction: 48 months |

## 3.2 Key Potential Impacts Identified from Construction Method Statements

A summary of activities and potential environmental impacts during the construction phase are provided as follows:

**Table 3-2 Summary of Construction Activities during Each Construction Phase**

| Construction Works | Detailed Activities | Potential Impacts/ Pollution |
|---|---|---|
| **Site Clearance and Soil Investigation** | • Tree felling, land/ vegetation clearance<br>• Site preparation (e.g., site office, worker dormitories and mobile toilets, etc.), erection of mitigation measures (i.e., Earth Control Measures facilities and noise barriers);<br>• General works (i.e., machinery maintenance, machinery/ construction material delivery, waste generation, temporary storage prior to disposal);<br>• Soil and geotechnical investigation. | • Human-wildlife conflict;<br>• Waste management<br>• Silty runoff;<br>• Chemical spill;<br>• Trampling impact on vegetation;<br>• Soil and water contamination;<br>• Dust emission;<br>• Vegetation waste;<br>• Loss of habitat/ wildlife mortality;<br>• Noise pollution;<br>• Changes to ambient temperature;<br>• Changes to ambient humidity;<br>• Loss of tree cover;<br>• Changes in hydrology and water table of surrounding ground area; and<br>• Sediment tracked onto public roads. |
| **Earthworks** | • Demolition of existing structures;<br>• Drainage and utilities diversion;<br>• Cut and fill/ regrading/ levelling/ platforming, excavation;<br>• Installing sheet pile/ soldier pile/ soil nail; and<br>• General works (i.e., machinery maintenance, machinery/ construction material delivery, waste generation, temporary storage prior to disposal). | • Human-wildlife conflict;<br>• Dust emission;<br>• Noise pollution;<br>• Chemical spill;<br>• Waste management;<br>• Silty runoff, discharge of effluent;<br>• Excavated material;<br>• Changes in hydrology and water table of surrounding ground area; and<br>• Sediment tracked onto public roads. |
| **Infrastructure works** | • Road works;<br>• Drainage and sewerage works;<br>• Mechanical and electrical works; and<br>• General works (i.e., machinery maintenance, machinery/ construction material delivery, waste generation, temporary storage prior to disposal). | • Dust Emission;<br>• Noise Pollution;<br>• Silty runoff, discharge of effluent;<br>• Excavated material; and<br>• Sediment tracked onto public roads. |
| **Building Construction** | • Bottom up construction – substructure foundation and base slap casting;<br>• Bottom up construction – superstructure prefabrication and installation;<br>• Finishing and exterior work; and<br>• General works (i.e., machinery maintenance, material and precast deliveries storage and handling, waste management). | • Dust Emission;<br>• Noise Pollution;<br>• Construction waste;<br>• Pollution and changes in water chemistry of groundwater and surface runoff;<br>• Sediment tracked onto public roads;<br>• Lighting pollution from construction activities, if night works are carried out. |

## 3.3 Concurrent Construction Activities

The CCK N1 development will have an overlapping construction timeline with a future development project near HDB Senja for approximately 4 years. CCK N1 involves the construction of HDB residential buildings which is expected to take place for approximately 6 years.

The timelines for both projects are as follows:

- HDB CCK N1: Q4 2023 onwards
- Future development by other agency: 2024 onwards

Construction works for future development will be situated directly adjacent to the CCK N1 development boundary along Woodlands Road.

# 4 Applicable Environmental Legislation and International References

This section provides a summary of relevant regulatory framework for EMMP. There are cases below where local environmental legislation do not define a criterion, and it was either defined and approved by technical agencies in the previous EIA conducted for the CCK N1 or are sourced from relevant international standards. In such cases, the referenced publication is provided in the sections below as it is deemed applicable in context. During implementation of EMMP, the EMMP Consultant and Contractor should adhere to the regulatory framework presented as follows:

## 4.1 Biodiversity

The relevant regulations that govern the adherence by the Developer and Contractor to the biodiversity-related measures stipulated in the EMMP are given in Table 4-1.

**Table 4-1 Relevant Environmental Legislation**

| Applicable Legislation | Summary of Relevant Legal Requirement |
|---|---|
| Wildlife Act, 2020 [R-2] | • An Act for the protection, preservation, and management of wildlife for the purposes of maintaining a healthy ecosystem |
| Parks and Trees Act, 2020 [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;<br>• No tree with a girth exceeding one meter (when measured 1-m from the ground) should be cut or damaged without the prior approval of the relevant authorities; and<br>• No tree or plant will be cut or damaged if located within the heritage road green buffer. |

## 4.2 Water Resources

The legislations governing water pollution control at construction worksite are provided as in Table 4-2.

**Table 4-2 Water Pollution Control Relevant Legislation Requirement**

| Applicable Legislation | Summary of Relevant Legal Requirement |
|---|---|
| Environmental Protection and Management Act (Chapter 9A), 2020 [R-4] | • Any discharge (i.e., trade effluent, oil, chemical, sewage, or other polluting matters) into a watercourse should obtain a written permission from the Director-General;<br>• Any trade effluent shall be treated before discharge or dispose as per granted written permission;<br>• Any plant of treating trade effluent shall be used, worked, or operated and maintained in the manner that as required by the Director-General; and<br>• Any toxic substance or hazardous substance shall not be discharged/caused/permitted to be discharged into any inland water. |
| Sewerage and Drainage Act, 2020 [R-13] | • Any storm water drainage system or drain shall not be constructed, altered, discontinued, or closed up without obtaining a clearance certificate or the approval of PUB;<br>• Any works which affect or are likely to affect direct or indirectly any storm water drainage system, drain or drainage reserve:<br>○ shall obtain and comply the clearance certificate or the approval of the PUB;<br>○ shall notify PUB in written format before the commencement of the works; |

| Applicable Legislation | Summary of Relevant Legal Requirement |
|---|---|
| | ○ shall provide adequate silt control measures in accordance with any standards or guidelines issued by the PUB before the commencement and for the duration of the works;<br>• Any works which could lead to discharge of silt direct or indirectly into any storm water drainage system, drain or drainage reserve:<br>○ shall obtain and comply the clearance certificate or the approval of the PUB;<br>○ shall notify PUB in written format before the commencement of the works; and<br>○ shall provide adequate silt control measures in accordance with any standards or guidelines issued by the PUB before the commencement and for the duration of the works. |
| Singapore Standards 593:2013 Code of Practice for Pollution Control (COPPC) [R-19] | • All the wastewaters are to be discharged into a public sewer shall obtain a written waiver from the relevant authority;<br>• Any trade effluent containing Biochemical Oxygen Demand (BOD) and Total Suspended Solids (TSS) exceeding the allowable limits may be discharged into a public sewer shall obtain the approval of relevant authority;<br>• Secondary containment facilities should be provided for storage tanks containing oils and chemicals to contain accidental release. The containment facility should be designed based on the volume of the largest storage tank; and<br>• The occupier or owner shall take immediate mitigating measures to control and contain any accidental release, leakage or spillage from its premises and shall notify relevant authority immediately. The occupier or owner shall clean up any land, watercourses or other areas contaminated by such release, leakage, or spillage. All wastes generated from the clean-up activities shall be treated and disposed of safely. |
| Ministerie van Volkshuisvesting, Ruimtelijke Ordening en Milieubeheer. Target Values, Soil Remediation Intervention Values, and Indicative Levels for Serious Contamination, 2020 [R-20] | • A guideline for when groundwater contamination is suspected on site (e.g., step-by-step risk assessment plan) and procedure on remediation in order to minimise the risks of spreading of contamination.<br>• In view of the objective to minimise the risks of spreading of contaminations in the groundwater, the following aspects are important:<br>○ The use of the soil because of the direct connection with the presence of vulnerable objects within the area that may be affected by the groundwater contamination. This concerns the risks due to spreading.<br>○ The condition of the soil because of the direct connection with the presence of floating layers, sinking layers, and/ or the spreading itself. This mainly concerns the risks of spreading as such, which may cause an uncontrollable situation. |

## 4.3 Air Quality

The legislations governing air quality control at construction worksite are provided as in Table 4-3.

**Table 4-3 Air Quality Control Relevant Legislation Requirement**

| Applicable Legislation | Legal Requirement |
|---|---|
| Environmental Protection and Management Act, 2018 [R-5] | • The occupier of any industrial or trade premises must maintain any fuel burning equipment and any air pollution control equipment installed in or on the premises in an efficient condition;<br>• The occupier of any industrial or trade premises must ensure that any air pollution control equipment installed in or on the premises is working in a proper and efficient manner whenever the industrial plant or fuel burning equipment is being used; and<br>• Any owner or occupier of any industrial or trade premises who carries on any trade or industrial process or operates any fuel burning equipment or industrial plant in or on the premises in any manner that causes, permits, or allows the emission of air impurities in excess of the standard of concentration or rate of emission prescribed in respect of that industry, process, fuel burning equipment or industrial plant shall be guilty of an offence. |

| Applicable Legislation | Legal Requirement |
|---|---|
| Environmental Protection and Management (Air Impurities) Regulations 2015 [R-6] | • Every occupier of any industrial or trade premises in or on which any industrial plant or fuel burning equipment is situated shall, if required by the Director-General to do so, provide, or install such instrument, equipment, or device in or on the premises;<br>• The instrument, equipment or device must be of such type and installed in such manner as will enable any person in charge of the industrial plant or fuel burning equipment to readily ascertain at all times and without leaving the boiler room, furnace room or control room, whether smoke is being discharged from any chimney on the industrial or trade premises; and<br>• The standards of concentration of air impurities that must be complied with in the conduct of any trade, industry or process or the operation of any fuel burning equipment or industrial plant shall be those specified in the Schedule. |
| Environmental Protection and Management (Off-Road Diesel Engine Emissions) Regulations 2012 [R-7] | • No owner of an off-road diesel engine shall use the off-road diesel engine, or cause or permit the off-road diesel engine to be used, if it does not conform to any of the standards for exhaust emission specified in the Schedule. |
| Environmental Protection and Management (Vehicular Emissions) Regulations 2008 [R-8] | • No person shall use or cause or permit to be used on any road any motor vehicle from which any smoke or visible vapour is emitted; and<br>• The driver of every motor vehicle shall, when the vehicle is stationary for reasons other than traffic conditions, stop the engine of or other machinery attached to or forming part of the vehicle. |
| Environmental Protection and Management (Prohibition on the Use of Open Fires) Order 2008 [R-9] | The use of open fires in any industrial or trade premises is prohibited, except where such open fires are used for:<br>• the purpose of firefighting practices; or<br>• the disposal of tail gases from industrial plants. |
| Singapore Ambient Air Quality Targets (Long Term Targets) [W-3] | • Stipulates the recommended limit values for ambient concentrations of $NO_2$, $SO_2$, $PM_{10}$, $PM_{2.5}$, CO and $O_3$. Target values are based on World Health Organisation (WHO) 2005 Air Quality Guidelines. |
| UK Institute of Air Quality Management (IAQM) Guidance on the Assessment of Dust from Demolition and Construction [R-1] | • The document provides guidance for developers, their consultants and environmental health practitioners on mitigation measures to be carried out during different activities (including demolition and earthworks). |

# 4.4 Airborne Noise

The legislations governing airborne noise control at construction worksite are provided as in Table 4-4 which apply for impact assessment and monitoring / criteria applicable for human receptors in the vicinity.

There are currently no guidelines or standards available to assess the noise from construction phases of the project on the respective ecological receptors. It is to be noted that ecological receptor noise impact will be assessed against project specific criteria - average baseline noise level as the noise criterion in this project. Unattended noise monitoring (1 week) will be conducted by the Contractor (refer to Section 8.1) prior to commencement of site clearance to have a full representation of baseline noise level within/ surroundings of construction worksites. The data will be shared to the EMMP consultant for criteria calculation and re-establish project criteria to apply in all construction stages.

**Table 4-4 Airborne Noise Control Relevant Legislation Requirement**

| Applicable Legislation | Summary of Relevant Legal Requirement |
|---|---|
| Environmental Protection and Management Act, Environmental Protection | • The owner or occupier of any construction site shall ensure that the level of noise emitted from his construction site does not exceed the maximum permissible noise levels set out in the Second Schedule; |

| Applicable Legislation | Summary of Relevant Legal Requirement |
|---|---|
| and Management (Control of Noise at Construction Sites) Regulations, 2008 [R-10] | • The Director-General may, if satisfied that there is justifiable technical reason to do so in any particular case, by notice in writing require the owner or occupier of the construction site;<br>• To ensure that the level of noise emitted from his construction site does not exceed such other maximum permissible noise levels as the Director-General may specify; and<br>• To comply with such other terms and conditions as the Director-General may think fit to impose.<br>• Noise level readings shall be taken —<br>• One (1) metre away from the outside of any affected building regardless of the distance between the affected building and the boundary of the construction site; or<br>• If a suitable location cannot be found one (1) metre away from the outside of any affected building, at such other location as the Director-General may specify.<br>• If there are other sources of noise affecting the measurement of the level of noise emitted from a construction site, the maximum permissible noise levels set out in the First and Second Schedules shall be adjusted in accordance with the Third Schedule and the adjusted value shall be taken as the maximum permissible noise level.<br>• Construction work shall be deemed to have commenced on the date specified in a permit to carry out structural works in that construction site granted by the Commissioner of Building Control under the Building Control Act (Cap. 29).<br>• The Director-General may, by notice in writing, require the owner or occupier of any construction site—<br>• to set up equipment to measure and record the level of noise emitted from his construction site over such duration as may be directed by the Director-General; and<br>• to submit the records of the noise level readings, including all relevant facts which may influence the values of the noise level readings.<br>• The owner or occupier of any construction site located less than 150 metres from any hospital, home for the aged sick or residential building shall ensure that no construction work is carried out at his construction site on the days and during the times specified in the Fourth Schedule.<br>• Director-General may, if he is satisfied that it is necessary in the public interest or for justifiable technical reason to do so in any particular case, permit in writing any construction work to be carried out during a prohibited period specified in the Fourth Schedule.<br>• Any person who fails to comply with regulation 3(1) or 4A(1), or any notice issued by the Director-General under regulation 3(2) or 4, or any term or condition of a permit granted under regulation 4A(2), shall be guilty of an offence and shall be liable on conviction to a fine not exceeding $40,000 and, in the case of a continuing offence, to a further fine not exceeding $1,000 for every day or part thereof during which the offence continues after conviction.<br>• Third schedule highlight the adjusted value for the maximum permissible noise level shall be obtained by adding the correction factor corresponding to the difference between the maximum permissible noise level in the First and Second Schedules and the background noise level, set out in the Table below, to the higher of the 2 noise levels. [refer to the table from R-11]<br>• Forth schedule highlight the prohibited periods for construction work commenced on or after 1st September 2011 are as follow;<br>• From 10 p.m. every Saturday to 7 a.m. on the following Monday.<br>• From 10 p.m. on the eve of a public holiday to 7 a.m. on the day following the public holiday. |
| SS602:2014 Code of practice for noise control on construction and demolition site [R-11] | • To reduce noise from construction sites, particular attention should be paid to the noise levels from the site equipment (Annex E) and to the recommended method of calculating the expected levels of noise from the construction or demolition site (see Annex B). These should, as far as possible, be consistent with what could reasonably be achieved by observance of the requirements of this Code. |
| SS593:2013 | • Specific recommended pollution control requirement and good practices for preventions of noise impacts. |

| Applicable Legislation | Summary of Relevant Legal Requirement |
|---|---|
| Code of practice for pollution control (COPPC) [R-19] | |

## 4.5 Vector Control

The legislations governing vector control at construction worksite are provided as in Table 4-5.

**Table 4-5 Vector Control Relevant Legislation Requirement**

| Applicable Legislation | Summary of Relevant Legal Requirement |
|---|---|
| Control of Vectors and Pesticides Act (Chapter 59), [R-14] | • Any condition which favourable to the propagation or harbouring of vectors shall be not created or caused or permitted; and<br>• Regulates the qualification of vector control operators, vector control technicians and vector control workers. |
| Part 3 Control of Infectious Diseases within Singapore, Infectious Diseases Act, 2020 [R-22] | • Regulates the destruction and disposal of infected animals, food, and water. |
| Hydrogen Cyanide (Fumigation) Regulations, 2020 [R-21] | • Provides guidelines on using the hydrogen cyanide for the fumigation and its residual disposal. |

## 4.6 Waste Management

The legislations governing waste management at construction worksite are provided as in Table 4-6.

**Table 4-6 Waste Management Relevant Legislation Requirement**

| Applicable Legislation | Summary of Relevant Legal Requirement |
|---|---|
| Environmental Public Health Act (Chapter 95), 2020 [R-15] | • A guideline which describing the prohibition against:<br>– dropping, scattering, etc., certain substances in public place;<br>– dumping and disposing in a public place;<br>– disposal of industrial waste in unauthorised places; and<br>• Proper storage of industrial waste should be provided as established in the regulation. |
| Environmental Public Health Act (General Waste Collection) Regulations, 2000 [R-16] | • Regulate the cleansing and maintenance of general waste collection points; and<br>• Provide guidelines on disposal of recyclable waste, incinerable waste and non-incinerable waste and the requirement of engaged disposal licensee. |
| Environmental Public Health (Public Cleansing) Regulations, 2000 [R-17] | • Provide the disposal guideline on carcases of any animal. |

# 5 Environmental Management and Monitoring Organisation

This section describes the EMMP organisation, its reporting lines, roles, and responsibilities of the parties involved at EMMP stage and the overarching environmental management principles that are to be applied throughout the construction period. The overall responsibility of the parties involved in the EMMP should:

1. To ensure that the EMMP requirements are planned, implemented and maintained throughout the project in accordance with the regulations drawn by the relevant authorities;
2. To implement the procedures on monitoring and measures the effectiveness of mitigation measures undertaken;
3. To implement corrective or preventive action measures to eliminate non-compliance and environmental incidents; and
4. To ensure action is taken on the impact to environment pollution issues.

## 5.1 Organisation Chart

- The roles and responsibilities of the various parties responsible for implementing the EMMP during the construction phase are outlined in Figure 5-1. Descriptions of each responsible party are outlined below; a full list of responsibilities are provided in subsequent subsections:

- Superintending Officer Representative (SO Rep.): responsible for supervising and overseeing the construction works undertaken by various personnel, contractors and subcontractors;
- EMMP Consultant: responsible for overseeing the implementation of the EMMP by all responsible parties (e.g., Contractors);
- Environmental Control Officer: responsible for following and implementing NEA's Code of Practice for Environmental Control Officers for Construction, and to ensure all work is undertaking by all other parties in line with the Code of Practice; and
- Contractor: any construction contractors and subcontractors working on site at any time who are responsible for implementing the EMMP.

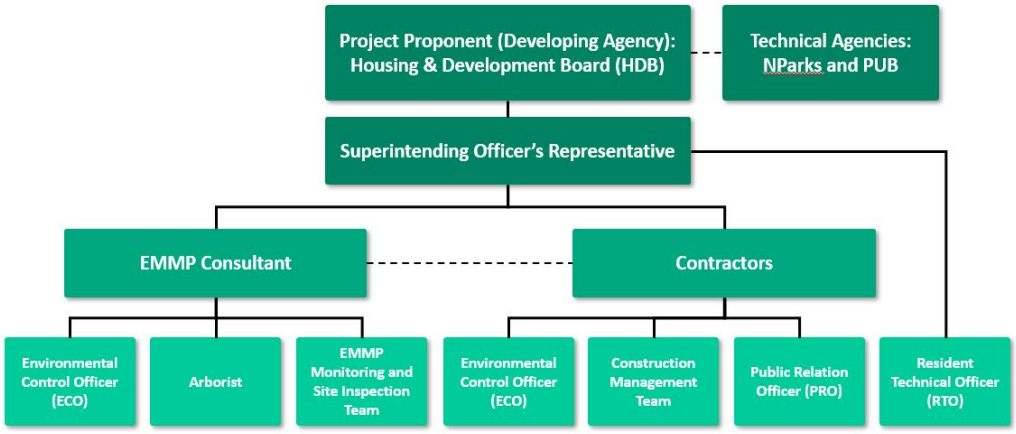



**Figure 5-1 Project EMMP Implementation Organisation Chart**

### 5.1.1 Project Proponent

The Project Proponent (PP) or the Client, is Housing & Development Board (HDB), should regularly liaise with the Project Management to review all compliances status during the EMMP implementation. HDB as PP to oversee the construction phase of the project in accordance with the design, and their responsibility include:

- To ensure resources are available to achieve the requirements of the EMMP;
- To provide guidance and advise on development and implementation of the EMMP;
- To ensure all environmental incidents and near misses are promptly investigated and reported;
- To resolve any non-compliance issues;
- To record, respond to, and action any complaints from members of the public, if any, with inputs from the Technical Agencies, if required; and
- To update the Technical Agencies regarding implementation of the EMMP.

### 5.1.2 Superintending Officer Representative

The Superintending Officer Representative (SO Rep.) is responsible for supervising and overseeing the construction works undertaken by various personnel, contractors, and subcontractors. The SO Rep. should ensure that the construction works are performed by the contractors and personnel in accordance with the specification, contractual requirements, and EMMP. The SO Rep. should also:

- To communicate the requirements of this plan to all staff, contractors and subcontractors;
- To monitor all staff, contractor's and subcontractor's compliance with contract specifications and regulatory requirements, including the implementation of the environmental mitigation and monitoring measures and ensure their effectiveness, and other aspects of the environmental audit program;
- To coordinate with the project's Environmental, Health and Safety Officer (EHSO) to monitor and participate in the implementation of the environmental audit program, with assistance from the ECO, and ensure that the requirements in the environmental audit program are correctly followed;
- To appoint third party environmental auditor to check and audit the environmental performance monitoring;
- To ensure and confirm measures, to reduce impacts where emission/discharge levels are exceeded, are executed by the Contractor. The SO Rep. also acts as a point of contact between the Contractor and EMMP Consultant and should ensure all communications are passed between parties without delay;
- To coordinate with the Project Proponent and Resident Technical Officer for submission of environmental audit reports;
- To carry out any complaint investigations and report to Project Proponent;
- To resolve any non-compliance issues; and
- To promote environmental awareness and responsibility and lead by example.

### 5.1.3 EMMP Consultant

The responsibilities of the EMMP Consultant are as follow:

- To oversee the implementation of the EMMP by all responsible parties (refer to the Organisation Chart in Section 5.1);
- To provide advice on environmental issues, where appropriate, or possible;
- To ensure the EMMP Consultant's subcontractors and ECO understand their responsibilities as outlined within the EMMP;
- To advise all parties (e.g., Contractors ECO, Site Engineers, Site Supervisors, Subcontractors and Site Workers, etc.) on matters related to environmental management and promote awareness within the site;
- To prepare and deliver monthly EMMP reporting to SO Rep., PP and Technical agencies (e.g., NParks, if required) based on discussed timeline;

- To carry out bi-weekly environmental site inspection by relevant specialists (air, noise, ecologists, water quality etc) depending on the ongoing activities on site;
- To discuss and resolve/mitigate any non-compliance or irregularities with PP/SO Rep./Technical Agencies; and,
- To coordinate with PP/SO Rep./Technical Agencies on environment matters.

#### 5.1.3.1 EMMP Site Inspection Team

The EMMP Inspection Team formed by the EMMP Consultant will include ECO on site primarily. When required, environmental personnel with experience covering biodiversity, water resources, noise, air quality, waste, and vector control specialists can be called upon to assist.

The role of the EMMP Site Inspection Team will be to carry out the specific aforementioned tasks listed above for the EMMP Consultant e.g., carry out bi-weekly environmental site inspections to support ECO when required.

#### 5.1.3.2 EMMP Consultant's Environmental Control Officer (ECO)

The Environmental Control Officer (ECO) appointed by the EMMP Consultant for this Project must comply and follow NEA's Code of Practice for Environmental Control Officers for Construction Sites [R-12]. The roles and responsibilities of an ECO include:

- To assist the EMMP Consultant in undertaking the Project in an environmentally sustainable manner;
- To oversee/audit and manage the environmental impacts of the work sites and to ensure all works comply with the environmental requirements;
- To supervise the mitigation measures implemented by Contractors, identify gaps and to provide recommendation on monitoring and mitigation amendments (if any) to the plan where necessary to the EMMP Consultant;
- To train and educate all site personnel to work in a manner as to respect the surrounding environment e.g., toolbox talk;
- To identify, reporting and record potential and presenting environmental issues on site to the EMMP Consultant;
- To limit or advise to stop any Project activities if potential or presenting environmental issues are identified until rectified;
- To ensure site personnel working in the vicinity of forested area are regularly trained by specialists for biodiversity awareness;
- To notify EMMP Consultant of any such observation that's worthy of environmental concern;
- To discuss all environment incidences which may arise with the EMMP Consultant. ECO will work alongside EMMP Consultant to address incidences; and
- To inform EMMP Consultant and Contractors to notify NParks/PUB/NEA in the event of environmental emergency (e.g., roadkill, injured animal, and oil/chemical spill).

#### 5.1.3.3 Arborist

The EMMP Consultant shall engage an Arborist of good standard and certified by the International Society of Arboriculture (ISA). The Arborist plays an important role as part of the biodiversity monitoring programme during the construction of this Project. The Arborist is a personnel experienced monitoring and managing all matters related to adequate and successful conservation of trees and flora within and adjacent to the site boundary. The key responsibilities of the Arborist during the Construction Phase are listed as follows:

- Carry out tree mapping and assessment based on up-to-date topographical plan prepared by the Contractor;
- 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.

### 5.1.4 Contractor

The 'Contractor' refers to any construction contractors and subcontractors working on site at any time; this also includes the ECO appointed by the Contractor. Throughout this report, where the ECO is appointed by the Contractor, this is specifically stated.

In addition to reporting to the SO Rep., the Contractors should:

- Responsible for executing the approved EMMP and mitigation measures on site, whilst ensuring that the requirements outlined in Section 8.3.3, related to standard mitigation measures and requirements are followed;
- Work under the relevant contract scope, approved EMMP specifications;
- Responsible to carry out works in a manner ensuring compliance to all applicable environmental legislation, environmental policy, mitigation/enhancement measures recommended in the EIA, etc., set by relevant authorities and the Project Proponent;
- Establish method statements according to recommended mitigation measures, provide relevant information to Contract Specific EMMP Team on potential activities that create adverse environmental conditions;
- Submit proposal for mitigation measures should there be an exceedance or environmental incident/ complaint;
- Appoint a Public Relation Officer (PRO) to support the SO Rep. to carry out complaint log, investigation and relating corrective actions to relevant parties;
- Visually inspect the worksite for wildlife prior to the start of construction activities each day;
- Maintain the integrity of the worksite hoarding and repair any damages/breaches on a timely basis;
- Respond in accordance with the Wildlife Response Plan (Section 9.3) upon encountering trapped/injured/dead/dangerous fauna;
- Ensure that all personnel and external visitors limit their movements and activities (including non-work activities such as resting and eating) to within the worksite boundary. There shall be strictly no movements into adjacent forested areas;
- Participate in the required environmental site audits (via the SO Rep.) undertaken by third party independent Environmental Performance Auditor and undertake corrective actions instructed by the Environmental Performance Auditor;
- Undertake all monitoring and implement all mitigation measures recommended by the Arborist, Flora Specialist, and Ecologist, as far as practicable;
- Post the graphical representations of but not limited to the following around the worksite:
    - No feeding of wildlife;
    - No fishing;
    - No littering;
    - No food or drinks (outside designated eating areas);
    - No cutting of trees or plants;
    - No smoking (outside designated smoking areas);
- Deploy only 100% biodegradable Erosion Control Blankets (ECBs);
- Provide designated sheltered eating areas that are wildlife-proof;
- Ensure that all pits, drains, ponds, trenches, tanks that are potential fauna entrapments are suitably covered (e.g., using plywood, mesh, tarpaulin) to prevent fauna from falling in;
- Trim overhanging vegetation above the worksite hoarding to prevent arboreal fauna from entering the worksite;

- Besides, for site and/or vegetation clearance before the commencement of actual construction, the Contractor +shall engage a certified Qualified Erosion Control Professional (QECP) to prepare an Erosion Control Plan (ECP) and obtain approval from the Public Utilities Board (PUB). Appoint an ECO for designing and implementing erosion control measures and related works as stipulated in the Code of Practice for Environmental Control Officers [R-12];
- Obtain approval from relevant authorities before the removal of any trees;
- Fulfil all relevant authorities' requirements including the submission of a monthly brief report for EMMP by first week of following month to SO Rep.;
- Undertake trial trenching for the SO Rep.'s assessment, where necessary;
- Install a 3m noise barrier along the RAC and a 12m noise barrier along the site boundary that abuts noise sensitive receptors; and
- Install a continuous hoarding along the rest of the contract boundary and to submit details of the barrier and supporting structure with PE endorsement to the SO Rep. and relevant Authorities for approval and to sign-off the Certificate of Supervision.

#### 5.1.4.1 Contractor's ECO

The Contractor's ECO should provide all the necessary information and assistance to the PRO in order to complete the complaint investigation. Following the investigation, the Contractor should promptly undertake the mitigation measures. The PRO and SO Rep. must ensure that the measures have been appropriately implemented. The Contractor, RTO, and SO Rep. will also be responsible for the leading and reporting of complaint investigation results and followed up actions to the Project Owner.

#### 5.1.4.2 Public Relations Officer

The Public Relation Officer (PRO) is responsible for handling complaints and managing feedback and investigative work. The PRO shall be supported by the Project Owner, EMMP Consultant's ECO, Contractor representatives, and any other relevant party.

During the construction 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, SO Rep., and EHSO immediately;
- Investigate the complaint with the Contractor's ECO to determine its validity and assess whether the source of the problem is due to construction works (the target time for response to the complainant is proposed to be 48 hours);
- If a complaint is valid and due to construction works, liaise with the ECO and EHSO on the mitigation measures and seek agreement from SO Rep.;
- Review the current situation and the ECO's and SO's implementation of the mitigation measures;
- Engage the ECO to undertake additional monitoring and auditing 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 complaint report (as well as the implementation of mitigation measures and the effectiveness of the mitigation measures as advised by the ECO) to the Project Owner, RTO, and the SO Rep.; and
- Log a record of the complaint, investigation, follow-up actions and the results in the environmental audit report. Management Feedback Form which should be used to capture complaints can be found in Appendix E.

#### 5.1.4.3 Construction Management Team

The Construction Management Team are responsible for overseeing and coordinating activities to ensure compliance with environmental regulations and the EMMP. By effectively managing construction operations, the team aims to minimize environmental impacts, mitigate risks, and promote sustainable practices, thereby contributing to the overall success of the project. Their responsibilities include:

- Coordinate and supervise construction activities in accordance with the EMMP and environmental regulations;

- Ensure the integrity of Tree Protection Zone, prevent excessive or unauthorised vegetation clearance by ensuring construction works are prohibited within the RACs and TPZs;
- Implement measures to prevent or minimize environmental pollution, such as dust control, noise management, and sedimentation control;
- Ensure proper handling, storage, and disposal of construction waste and hazardous materials;
- Conduct regular inspections to identify any potential environmental risks or non-compliance issues;
- Collaborate with subcontractors and suppliers to ensure their adherence to environmental requirements; and
- Maintain records and documentation related to environmental compliance and reporting.

#### 5.1.4.4 Resident Technical Officer

The Resident Technical Officer (RTO) responsible for monitoring and overseeing construction activities to ensure compliance with environmental regulations and project specifications. The RTO identifies and addresses any potential environmental risks or non-compliance issues, facilitating the adoption of sustainable practices and protecting the environment throughout the construction process. The RTO should:

- Monitor and oversee construction activities to ensure compliance with the EMMP, project specifications, and environmental regulations;
- Conduct daily site inspections to verify the implementation of environmental mitigation measures;
- Address and resolve any environmental concerns or issues raised by the SO Rep., EMMP Consultant, technical agencies, or the public by seeking advice from EMMP Consultant/SO Rep.; and
- Provide guidance and support to the construction management team in implementing environmental best practices.

# 6 Environmental Plans and Site Personnel Training

The EIA report produced for the Project outlines the impact assessment undertaken for a range of different environmental parameters that may impact biodiversity and/or human receptors within the site or within the vicinity of the site. Mitigation measures to be included within the EMMP were recommended as part of the EIA report, all of which must be implemented in order to reduce the environmental impact as stipulated in the EIA.

In order to effectively ensure that all mitigation measures and environmental controls are effectively implemented, a series of environmental plans must be produced by the Contractor that outlines how the measures are to be implemented. Further to this, a range of training sessions are required to be held at different stages of the Project to aid site personnel through the EMMP process, and ensure they have the knowledge and confidence to follow all protocols.

## 6.1 Environmental Plans

It is the responsibility of the Contractor to devise and submit a number of environmental plans prior to the commencement of site activities. The content and information that needs to be included in each plan is provided within the respective subsections of the Recommended EMMP section of the EIA report, provided in Appendix A. Plans required include the following:

- Flora and Fauna Management and Monitoring Plan – for review, comment, and compliance checks. To include all relevant information regarding flora and fauna, wildlife shepherding plans, and tree felling plans for both the flora planned to be removed within the site as well as the RAC and flora being conserved or retained;
- Earth Control Measures Plan - as submitted to PUB (for review and comments), final approved plan (for compliance checks) and final PUB approval letter (for compliance checks);
- Water Pollution Management Plan - for review, comments and compliance checks;
- Dust Control Plan - for review, comments and compliance checks;
- Airborne Noise Management Plan - for review, comments and compliance checks;
- Waste Management Plan - for review, comments and compliance checks;
- Hoarding Plan - for review, comments and compliance checks;
- Light Management Plan – if night works are to be undertaken; and,
- Vector Control Plan - for review, comments and compliance checks.

The plans provided in the various appendices of this report are generic and have not been developed to be site specific. The aforementioned plans are to build upon those provided in the appendices, using them as a basis to create site-specific plans.

The Contractor shall submit the following documents to the EMMP consultant on a monthly basis on 20$^{th}$ of every month or the last working day before this date:

- Log of number of trucks transporting soil, horticultural waste on the site;
- Log of water sprinkler tankers employed in the month on site;
- Water quality monitoring results of collected water sample;
- Log of on-site waste disposal;
- Site Environment Control Plan (SECP);
- Site Environment Control Report (SECR);
- PRO Feedback Complaints Logbook;
- Log of training sessions provided to Contractor;

- Biodiversity and arboriculture monthly monitoring records, including roadkill logbook; and,
- Air quality, noise monthly monitoring records.

Aside from the above, Contractor shall work with the EMMP Consultant to provide online real time link for Environmental Data Management System (EDMS) dashboard for the water TSS monitoring data, air quality monitoring data, and noise monitoring results to be uploaded on a centralised platform in ArcGIS Online (AGOL). All rectification and corrections made on site pursuant to daily and biweekly checks and inspections by the EMMP Consultant must be achieved within appropriate timeframes to ensure ongoing compliance. Where corrections are required, a discussion shall be held between the EMMP Consultant, SO Rep., Contractor and relevant site staff, where a plan to rectify/correct any issues will be devised; this will include timeframe for correction and course of action. All required actions ascertained from inspections will be taken with evidence to be uploaded to the system online with AECOM.

## 6.2 Training for Site Personnel

The following subsections outline the different training that site personnel must undergo before undertaking site works. In some cases, training may need to be provided on an ongoing basis or be carried out on multiple occasions during pre-construction and construction stages. These are outlined below.

#### 6.2.1.1 EMMP Training

A training session that outlines the purpose of the EMMP and all associated aspects of the EMMP will be conducted for all site personnel prior to the start of site works, so that all site personnel are fully equipped to undertake site works under the correct protocols and know how to proceed in the event of any unforeseen environmental issues occurring on site.

#### 6.2.1.2 Biodiversity Awareness Training

The EMMP Consultant's ecologists shall conduct toolbox briefings to inform site personnel of, but not limited to, the following topics:

- Ecological value of the site and its surrounding habitats;
- Types of fauna present;
- Biodiversity protection strategies (e.g., Wildlife Response Plan);
- Site personnel's responsibilities towards biodiversity;
- How to respond to fauna encounters;
- No feeding of wildlife;
- Prevention of roadkill; and
- Inspection of trees before felling.

Toolbox briefings will be conducted once pre-construction. During construction, toolbox briefings will be conducted monthly, or as needed as works progress. 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.

#### 6.2.1.3 Water Resources Management Training

The training will be conducted for all the site personnel that will aim to equip them with sufficient knowledge to adequately manage water resources on the side. Such trainings will include, but not limited to, the following aspects:

- Inspection of on-site drains to prevent clogging of the drains and potential localized flooding;
- Site inspections for visual and olfactory indicators of changes in water quality;
- Identification of potential areas with higher probability of spillage/ leakage of chemicals on site and prevention measures;
- Site inspection for ECM measures;
- Identification of other potential on-site sources of pollution (e.g., food waste, sanitary facilities) and prevention measures; and

- Emergency response plan in the case of chemical spillages and/ or leakages.

The training should be conducted one pre-construction. All site personnel must undergo water resources management training prior to commencing any work on-site. During the construction phase, refresher trainings for existing personnel should be carried out every 6 months.

#### 6.2.1.4 Waste Management Training

The training should be provided in monthly basis, if necessary, in order to ensure all the site personnel are well-trained and able to manage the construction waste accordingly on-site.

The Contractor shall implement a comprehensive waste management system at the worksite to ensure:

- Proper disposal of waste;
- Illegal disposal of construction waste shall be strictly prohibited;
- Littering of food waste and food packaging shall be strictly prohibited and enforced by the Contractor;
- Disposal of construction wastes (wastewater and solid wastes) into streams, storm water channels or other waterbodies shall be strictly prohibited;
- The Contractor shall provide sufficient fully covered food waste bins that are secured in a manner that is wildlife-proof;
- All food waste shall be cleared from the worksite at least once a day;
- Where fauna is found to be active around waste disposal areas, the Contractor shall implement measures to reduce the source of the attractant in consultation with the Ecologist;
- The Contractor shall submit a Waste Management Plan as part of the contract specific EMMP detailing the:
- Types of waste generated;
- Location and types of waste management facilities (e.g., food waste bins);
- Frequency of disposal; and
- Information of waste management contractors.

#### 6.2.1.5 Vector Control Training

The trainings should be provided on a monthly basis, if necessary, in order to ensure all the site personnel are well-trained and able to manage vectors accordingly on-site. The hierarchy of vector control shall be as follows:

- Source reduction, i.e., eradicate water ponding through proper housekeeping to eliminate potential breeding grounds;
- Monitor Dengue situation, i.e., regular screening of worker (temperature checks), quarantine measures, etc.;
- Deter breeding, i.e., search and destroy efforts, inspections, *Bacillus thurigiensis israelensis* (Bti) application, etc.;
- Thermal fogging shall not be carried out to prevent unintended impacts to invertebrate fauna residing in the surrounding habitats;
- No chemical insecticides, pesticides and rodenticides shall be used for pest control; and
- No sticky traps shall be used for pest control.
- Environmentally friendly applications such as the use of Bti shall be used to supplement source reduction.

# 7 Monitoring Data Centralisation

Data recording of the Environmental Quality Objectives (EQOs), commonly known as monitoring indicators, in compliance with the EMMP are labour extensive, and could be open to human errors. To ensure that all monitoring drivers are recorded and managed in a timely manner, a system will be engaged to collect all required data which will be used for data monitoring, reporting and presentation, and analysis, for the purpose of understanding how Construction Works can impact the ecosystem and mankind and to support improved decision making.

An Environmental Data Management System (EDMS) would be developed, that requires the usage of digital software, personnel, and documentation. Implementing a database management strategy will determine the usability of the database, as the dynamic plan is to be managed without the need for additional management input.

Visualization of the EDMS will be implemented through a third-party web-based software (ArcGIS®) is used to proactively manage and confirm that any potential impacts of the Construction Works do not exceed the EQOs for the project. The all-in-one system provides layers of data that is easily accessible and saves large amounts of time and effort. Other benefits of having an EDMS to manage all monitoring data include:

- Consolidate monitoring and compliance details;
- Protect sensitive habitats in close proximity to the Construction Works;
- Avoid unnecessary delays or work stoppages due to monitoring triggers that are not originated from the Construction Works;
- Provide transparency and confidence to stakeholders;
- Secure online access, with customizable access and/or features;
- Provide real-time alerts and warnings to relevant parties so that appropriate actions can be taken; and
- Minimize the likelihood of copy/paste errors, duplication, and other human errors.

Among the EQOs that will be monitored through the ArcGIS® Dashboard for the duration of the Project include:

- Biodiversity;
- Surface Water and Groundwater Quality;
- Air Quality;
- Airborne Noise;
- Vector Control;
- Hazardous Materials and Waste Management;
- Stakeholder Engagement;
- Construction Progress Tracking; and
- Incident Reporting.

Inputs as shown in Table 7-1 to monitor the EQOs include field data collection applications powered by ArcGIS including Collector and Survey123, raw excel data sheets, and geospatial data setup on ArcMap. These can be uploaded on a centralized platform in ArcGIS Online (AGOL) which can auto-generate reports, maintain excel databases in SharePoint and consolidate the data spatially on an Operations Dashboard. The workflow is presented in Figure 7-1.




**Figure 7-1 Workflow for Data Collection and Monitoring**

**Table 7-1 Required Data Format for the Monitoring Data**

| Environmental Component | Data Format and Frequency | Data Provider |
|---|---|---|
| Hydrology and Surface Water Quality | <u>Surface Water Quality: Online-real time TSS monitoring data</u><br>• To provide embed website link<br>• TSS data format in mg/L<br>• Data will be auto updated in the system from time to time<br>• To provide monthly compiled TSS data (i.e., timeseries TSS data with 1 minute interval) in the form of editable excel sheet<br>• To provide supporting documents (not limited to photos) for any exceedance of TSS | Contractor |
| | <u>Surface Water Quality Monitoring</u><br>• In-situ water quality data:<br>▪ Photos of each water quality sample taken by Contractor every time<br>▪ Data unit based on provided parameters in Section 8.2.7<br>▪ The in-situ data results (measured monthly during the construction stage) to be noted manually in designated, editable excel sheet by the Contractor<br>▪ EMMP Consultant to update EDMS, based on the data provided by the Contractor in designated excel sheet<br>• Ex-situ water quality data:<br>▪ Data unit based on provided parameters in Section 8.2.7<br>▪ The ex-situ data results (measured monthly during the construction stage) to be provided to EMMP Consultant by the Contractor in the form of Portable Document Format (PDF) and editable Excel sheet, received from laboratory testing report<br>▪ EMMP Consultant to update EDMS, based on the data provided by the Contractor | Contractor |
| | • Any report in PDF format (e.g., complaint, incident, inspection, monitoring and audit)<br>• Coordinate of watercourse(s) (i.e., in SVY21 coordinate system format) and photo if available where any complaint/ incident happened or when conducted any inspection/ monitoring/ audit | Contractor/ EMMP Consultant's ECO/ EMMP Consultant |
| Groundwater | <u>Groundwater Level Monitoring</u><br>• Data unit in meter<br>• The groundwater level data results (measured monthly during the construction stage to be provided by the Contractor in the form of designated editable excel sheet by the Contractor<br>• EMMP Consultant to update EDMS, based on the data provided by the Contractor | Contractor |
| | <u>Groundwater Quality Monitoring</u><br>• Data unit based on provided parameters in Section 8.2.8<br>• The ex-situ data results (measured only prior to groundwater discharge into the public drain) to be provided to EMMP Consultant by the Contractor in the form of PDF and editable Excel sheet, received from laboratory testing report<br>• EMMP Consultant to update EDMS, based on the data provided by the Contractor | Contractor |
| | • Any report in PDF format (e.g., complaint, incident, inspection, monitoring and audit)<br>• Coordinate of watercourse(s) (i.e., in SVY21 coordinate system format) if available where any complaint/ incident happened or when conducted any inspection/ monitoring/ audit | Contractor |
| Air Quality | <u>Air Quality Monitoring</u> | Contractor |

| Environmental Component | Data Format and Frequency | Data Provider |
|---|---|---|
| | To monitor the real-time 24-hr average concentration of $PM_{10}$ and $PM_{2.5}$ in $\mu g/m^3$ using online web-based system<br>The data result of pre-construction stage to be updated manually<br>The data result of construction stage will be auto updated in the system from time to time | |
| | • Any report in PDF format (e.g., complaint, incident, inspection, monitoring and audit)<br>• Coordinates (i.e., in SVY21 coordinate system format) if available where any complaint/ incident happened or when conducted any inspection/ monitoring/ audit | Contractor/ EMMP Consultant's ECO/ EMMP Consultant |
| Noise | <u>Noise Monitoring</u><br>To monitor the real-time noise levels in terms of $L_{Aeq5min}$, $L_{Aeq1hr}$, and $L_{Aeq12hr}$ using online web-based system<br>The data result of pre-construction stage to be updated manually<br>The data result of construction stage will be auto updated in the system from time to time | Contractor |
| | • Any report in PDF format (e.g., complaint, incident, inspection, monitoring and audit)<br>• Coordinates (i.e., in SVY21 coordinate system format) if available where any complaint/ incident happened or when conducted any inspection/ monitoring/ audit | Contractor/ EMMP Consultant's ECO/ EMMP Consultant |
| Vector Control | • Any report in PDF format (e.g., complaint, incident, inspection, monitoring and audit)<br>• Coordinates (i.e., in SVY21 coordinate system format) and photo if available where any complaint/ incident happened or when conducted any inspection/ monitoring/ audit | Contractor/ EMMP Consultant's ECO/ EMMP Consultant |
| Waste Management | • Any report in PDF format (e.g., complaint, incident, inspection, monitoring and audit)<br>• Coordinates (i.e., in SVY21 coordinate system format) and photo if available where any complaint/ incident happened or when conducted any inspection/ monitoring/ audit | Contractor/ EMMP Consultant's ECO/ EMMP Consultant |
| Biodiversity | • Monthly site inspection report in PDF format<br>• Coordinates and photo if any when conducted site inspection | Contractor/ EMMP Consultant |
| Others | • Project relevant information such as construction stages, timeline (i.e., progress of construction activities), detailed of contractor information<br>• Map/Image of worksites progress (e.g., from USGS or Google Satellite) to be updated manually from time to time | Contractor/ SO Rep. |

As the EMMP is a live document, the report will include potential site-specific impacts, mitigation measures that should be implemented, adaptive monitoring and inspection programs as well as reporting and requirement based on the EIA for CCK N1. Furthermore, the EQOs developed will be reviewed and updated/tailored as needed over the course of implementation, e.g., new Works are identified or changes in the overall Project scope are made through the Project duration.

Management of tasks in the EDMS is based on the "Plan-Do-Check-Act" principle. To ensure that the EDMS is structured accordingly, management of its data inputs requires the involvement and/or collaboration of the Contractors, Environmental Control Officer(s) ("ECO"), biodiversity specialists, and EMMP consultants. All involved parties stated above will be briefed on the requirements of the EDMS, including the need to inform the EMMP consultant if data inputs were not recorded on time.

Data inputs to the EDMS will be done through the use of a mobile device with pre-loaded field forms for each EQO, following which, the data will be automatically and immediately checked for compliance to regulatory and/or EMMP limits. The field forms will adequately address the monitoring dates, observations, issues identified, and resolutions undertaken. Through the EDMS, further checking can be done by the EMMP consultants by comparing the various data against one another with interpretation tools such as infographics, maps, graphs, reports, etc.

Following detection of a compliance breach through alerts and warnings, appropriate mitigation actions shall be undertaken by the responsible party(ies) in a swift manner, to avoid any plausible harmful environmental events. The mitigation measures implemented should be recorded in the EDMS by the responsible party(ies) through the pre-developed forms to close-out the findings.

The EDMS will aid the EMMP consultant in the preparation of the bi-weekly report which will be submitted to the Superintending Officer Representative (SO Rep.). The report would summarize the data inputs of the EQOs, exceedances and/or issues encountered, resolutions undertaken, effectiveness of mitigation measures and lessons learned (if applicable), and would include attachments such as photos, verification reports, etc.

The commitment of the stakeholders responsible for the implementation of the EMMP is bound by the conditions of contract set forth in the contract of the Contractor. As such, the contract of the contractors shall contain the appropriate environmental management provisions that will be used in for the EDMS.

# 8 Environmental Management and Monitoring Plan Stages

## 8.1 Pre-construction Stage Activities

The Contractor must submit the following documents prior to site clearance commencing any site works, ensuring that all plans are developed to consider site-specific constraints. Standard guidance on the scope of these documents is provided in the Project's EIA Report (Appendix A):

- Flora & Fauna Management and Monitoring Plan;
- Earth Control Measures Plan;
- Water Pollution Control Plan;
- Dust Control Plan;
- Airborne Noise Management Plan;
- Waste Management Plan;
- Hoarding Plan;
- Lighting Management Plan; and,
- Vector Control Plan.

Contractor must make appropriate arrangements beforehand so that facilitation of the following are smooth when the relevant equipment are installed at a later stage.

Data request from SO Rep:

- Compliance of ground water settlement as observed from markers/ instrumentation on site on a monthly basis;
- RTO sign off of the compliance progress on site on a weekly basis;
- Approval of source location of Soil sourced for backfilling;
- Settlement markers and compliance with authorities' criteria on rate of settlement observed in instruments employed on site;
- Groundwater level observed in instrumentation every month;
- QECP/ PUB approval of ECM in place, as and when available; and
- All permits / approvals relevant to environment.

### 8.1.1 Training

The following training sessions should be carried out prior to site clearance commencing:

- EMMP Training;
- Biodiversity Awareness Training;
- Water Resources Management Training;
- Vector Control Training; and,
- Waste Management Training.

Detailed information pertaining to each training type is provided in Section 6.2.

## 8.1.2 Pre-site Clearance Fauna Inspection

The pre-site clearance fauna inspection should be conducted based on the specifications as detailed in Section 11.10.1.3 of the CCK N1 EIA Report [Appendix A]. Thorough inspections should be done to ensure minimal impact towards species of conservation significance present on site. For all wildlife encounters, the Wildlife Response Plan (Section 9.3) should be referred to.

## 8.1.3 Tree Protection Zones

Arborist to clearly mark out Tree Protection Zones (TPZs) for trees to be retained. The TPZs are to be set up in accordance with NParks guidelines and no works are to be allowed here. Regular inspections and monitoring should be conducted to ensure compliance with the tree protection measures, and any deviations or potential risks should be promptly addressed.

## 8.1.4 Pre-Construction Monitoring

All standard measures as described in EMMP Recommendation Section of the CCK N1 EIA Report [Appendix A] should be followed when applicable during pre-construction stage.

If visual non-compliance to any of the minimum control or mitigation measures are observed by the EMMP Consultant's ECO on-site, the EMMP Consultant's ECO should inform Contractor. The Contractor should conduct necessary investigation and corrective actions should be taken if necessary.

Note, that no pre-construction monitoring has been proposed for water resources as the habitats within and in the vicinity of the site are expected to have low dependency on the groundwater level and as there are no records of historical contamination.

### 8.1.4.1 Water Resources

In accordance with the CCK N1 EIA report [Appendix A], the Contractor shall monitor sedimentation pond effluent to ensure that the surface water quality will be in 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's NEA Allowable Limits for Trade Effluent Discharge to Sewer/ Watercourse/ controlled Watercourse.

During pre-construction stage, the Contractor shall confirm the monitoring locations according to the PUB-approved ECM plan. Moreover, hydrological conditions of drainage system within construction site and at immediate vicinity should also be closely planned according to the site conditions.

### 8.1.4.2 Air Quality

Based on the CCK N1 EIA report [Appendix A], the contractor shall carry out one-week monitoring of $PM_{10}$ and $PM_{2.5}$ at nearby ecological and human receptors prior to site clearance averaged over 1-day period to have a full representation of the construction area. The four (4) locations proposed for pre-construction monitoring are as follows:

- A1: HDB Block 635A Senja Road;
- A2: Pacific Healthcare Nursing Home II @ Bukit Panjang;
- A3: Jurong Pioneer Junior College; and
- A4: Proposed Ecological Corridor (natural area to be retained within Project site).

The proposed monitoring locations are presented in Figure 8-2.

### 8.1.4.3 Airborne Noise

In accordance with the CCK N1 EIA report [Appendix A], the Contractor will be responsible for conducting one (1) week (inclusive of weekdays and weekends) unattended noise monitoring using NEA-approved Type 1 Sound Level Meter (SLM) to capture pre-construction baseline noise levels over time periods of 12 hours (long term), 1 hour, and 5 minutes (short term) at each location to provide the representative baseline noise levels prior to the commencement of site clearance.

A total of seven (7) airborne noise monitoring locations (as shown in Figure 8-1) were proposed for pre-construction monitoring as follows:

- NM1: Villa Verde Estate
- NM2: HDB Block 635A Senja Road;
- NM3: Within Green Area;
- NM4: West View Primary School
- NM5: HDB Block 162 Jalan Teck Whye;
- NM6: HDB Block 632A Senja Road; and
- NM7: Near Teck Whye Secondary School facing Pang Sua Canal.

The Contractor shall use the pre-construction baseline to calculate and establish the Project criteria in accordance with the noise legislation stated in *Environmental Protection and Management (Control of Noise at Construction Sites) Regulations, 2008* [R-10] which shall apply for construction works in all stages. This data will be shared with the SO Rep, HDB, and the EMMP Consultant.

There are currently no guidelines or standards available to assess noise from construction phases of the Project on the respective ecological receptors. It should be noted that ecological receptor noise impact will be assessed against the average baseline noise level as the noise criterion.

The current guidelines and standards available are used to assess the respective noise impacts to humans only and will be adopted in this study for the purpose of establishing the criteria and assessing noise impacts to the identified noise sensitive receptors (human). In determining the impact of the construction noise to sensitive receptors, the baseline noise level captured during pre-construction stage will be included in the calculation to derive a background noise correction factor to establish the maximum permitted noise level from the construction activities in accordance with the noise legislation stated in *Environmental Protection and Management (Control of Noise at Construction Sites) Regulations, 2008* [R-10].

A set of maximum allowable noise limits are prescribed for different time periods of the day and for different types of affected premised under *Environmental Protection and Management (Control of Noise at Construction Sites) Regulations, Second Schedule* (refer to Table 8-1).

**Table 8-1 Maximum Permissible Noise Levels for Construction Works**

| Period | Types of Affected Buildings | Maximum Permissible Noise Levels in A-weighted decibels (dBA) | | |
|---|---|---|---|---|
| | | 7am-7pm | 7pm-10pm | 10pm-7am |
| Monday to Saturday | (a) Hospitals, schools, institutions of higher learning, homes for the aged or sick etc. | 60 ($L_{Aeq12hr}$) | 50 ($L_{Aeq12hr}$) | |
| | | 75 ($L_{Aeq5min}$) | 55 ($L_{Aeq5min}$) | |
| | (b) Residential buildings located less than 150 m from the construction site where the noise is being emitted | 75 ($L_{Aeq12hr}$) | 65 ($L_{Aeq1hr}$) | 55 ($L_{Aeq1hr}$) |
| | | 90 ($L_{Aeq5min}$) | 70 ($L_{Aeq5min}$) | 55 ($L_{Aeq5min}$) |
| | Buildings (other than those in paragraphs (a) and (b)) | 75 ($L_{Aeq12hr}$) | 65 ($L_{Aeq12hr}$) | |
| | | 90 ($L_{Aeq5min}$) | 70 ($L_{Aeq5min}$) | |
| Sunday and Public Holiday | (a) Hospitals, schools, institutions of higher learning, homes for the aged or sick etc. | 60 ($L_{Aeq12hr}$) | 50 ($L_{Aeq12hr}$) | |
| | | 75 ($L_{Aeq5min}$) | 55 ($L_{Aeq5min}$) | |
| | (b) Residential buildings located less than 150 m from the construction site where the noise is being emitted | 75 ($L_{Aeq12hr}$) | - | |
| | | 75 ($L_{Aeq5min}$) | 55 ($L_{Aeq5min}$) | |
| | (c) Buildings (other than those in paragraphs (a) and (b)) | 75 ($L_{Aeq12hr}$) | 65 ($L_{Aeq12hr}$) | |
| | | 90 ($L_{Aeq5min}$) | 70 ($L_{Aeq5min}$) | |

As per the legislation, if there are other sources of noise affecting the measurement of noise emitted from the construction site, the maximum permissible noise levels for construction sites are supposed to be adjusted 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 level, and the background noise level and is presented in Table 8-2. The differences in the noise levels are then added to the higher of the two noise levels (background noise/ criteria as appropriate) to give the applicable noise criteria for the specified construction area.

**Table 8-2 Maximum Permissible Noise Levels for Construction Works**

| 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 4 | 2 |
| 4 to 10 | 1 |
| 10 and above | Nil |




## Legend

- EMMP Site Boundary
- Proposed Noise Monitoring Locations (Pre-Construction Stage)
- Rail Corridor

N

| Rev. | Date | By | Description | Chk'd | App'd |
|---|---|---|---|---|---|
| - | JUL 2023 | SYT | EMMP Specification | SYT | JAG |

Qualified Person Endorsement : NA

HDB Endorsement : NA

Consultant : AECOM

Client: HOUSING & DEVELOPMENT BOARD

Project Title :

**Specialist Consultancy Services at HDB Development (Choa Chu Kang)**

Figure Title :

**Proposed Airborne Noise Monitoring Locations during Pre-Construction Stage**

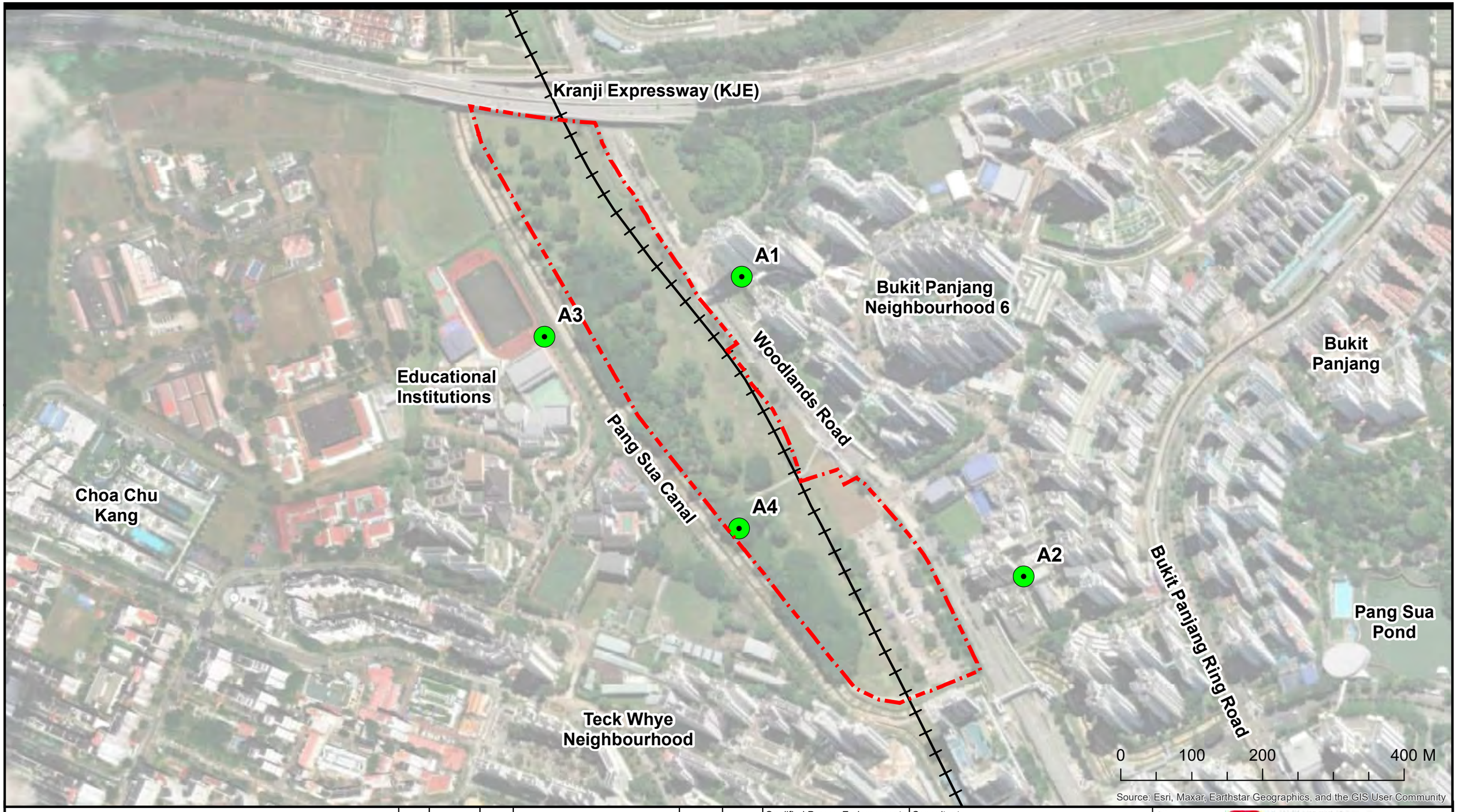
| Designed | Checked | Approved |
|---|---|---|
| SYT | PNZ | JAG |
| | Drawn | Date |
| | SYT | JUL 2023 |

Figure No. : 8-1 | Rev. 01 | Sheet 1 of 1

CAD File Name : NA | A3

Note: Source of basemap - Google Earth Map

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## Legend

- EMMP Site Boundary
- Proposed Air Monitoring Locations
- Rail Corridor

N

| Rev. | Date | By | Description | Chk'd | App'd |
|---|---|---|---|---|---|
| - | JUL 2023 | TTR | EMMP Specification | HHL | JAG |

Qualified Person Endorsement : NA

HDB Endorsement : NA

Consultant : AECOM

Client: HOUSING & DEVELOPMENT BOARD

Project Title :

**Specialist Consultancy Services at HDB Development (Choa Chu Kang)**

Figure Title :

**Proposed Air Monitoring Locations during Pre-construction and Construction Stages**

| Designed | Checked | Approved | Figure No. : | Rev. | Sheet |
|---|---|---|---|---|---|
| TTR | HHL | JAG | 8 - 2 | - | 1 of 1 |
| | Drawn TTR | Date JUL 2023 | CAD File Name : NA | | A3 |

Note: Source of basemap - Google Earth Map

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#### 8.1.4.4 Vector Control

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-4] and NEA's Mosquito and Rodent Control Measures [W-5,W-6], 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;
- Zoning Method (see example in Figure 8-6): To divide the construction site into a maximum of three (3) zones for vector control and surveillance activities which to be conducted at least one (1) zone per day, where each zone will be combed at least twice a week;
- Dengue Contingency Plan: to develop a response plan in case any person found on site is discovered to be a carrier of vector-borne disease, and when an outbreak of dengue or mosquito breeding ground is detected on site.

#### 8.1.4.5 Waste Management

Prior to construction, the appointed Contractor should submit a site-specific waste strategy and management plan to SO Rep. prior to execution with the aim of waste minimisation and mapping of waste types, volume, and treatment methods. The plan shall provide a framework for the following:

- Specific types and projected volume of waste expected to be produced throughout the construction period;
- Recycling targets aligned with the Singapore's 2030 Recycling Target for each type of waste;
- Storage location and capacity of each type of waste/recyclables and the specific precautions taken to prevent spillage/contamination;
- List of licensed waste collector contracted and schedule of collection for each waste type;
- Treatment methods or each type of waste (i.e., recycled, incinerated) on-site and off-site; and
- Information of waste management contractors.

## 8.2 Site Clearance/ Earthworks/ SI Stage Activities

### 8.2.1 Daily Report

Daily online reporting to be facilitated to be connected in digital database of AECOM:

- TSS online data from TSS sensor;
- Noise monitoring data from sound level meters deployed online;
- CCTV/ SIDS imagery; and
- Corrective actions submission for the reported issues by the EMMP consultant on the online EDMS system and discuss with ECO on closeout in the stipulated timeframe as given in the Section 7.

Daily submissions:

- Aerial photograph of complete site to demonstrate all exposed areas are covered at the end of each day;
- Air monitoring data as recorded by the device on daily basis;
- Vibration monitoring records (if used); and
- Reasoning for exceedances observed in the SIDS data each day.
- Weekly data submission
- Noise exceedances with reasoning for the exceedance observed;
- Air quality data exceedances with activity associated with exceedance if any;

- Method statement for any significant works on or in vicinity of surface water bodies or groundwater (i.e., excavations), as and when required;
- Licenced waste collector loads log collected from site for Soil Investigation (SI) slurry waste;
- End of the week signoff of site progress by RTO on site; and
- Weekly submission of truck loads ferry carrying soil, horticultural waste.

### 8.2.2 Monthly Report

The Contractor is to provide a series of data and information compiled into a report that is to be used by the EMMP Consultant for compliance purposes. Note, that all items listed below are to be provided on an ongoing monthly basis throughout all Site Clearance/Earthworks/SI Stage and Construction Stage. Monthly submission of data from 21st of previous month to 20th of current month to be submitted on 21st of each calendar month or working day before this date, whichever is earlier. This must include but is not limited to:

- Log of number of trucks transporting soil, horticultural waste on the site;
- Log of water sprinkler tankers employed in the month on site;
- Water quality monitoring results of collected water sample;
- Monthly water quality results for both in situ and ex situ monitoring;
- Air quality and noise monitoring data;
- Sanitary servicing record data;
- Log of on-site waste disposal;
- Site Environment Control Plan (SECP);
- Site Environment Control Report (SECR);
- PRO Feedback Complaints Logbook;
- Log of training sessions provided to Contractor;
- Biodiversity and arboriculture monthly monitoring records; and,
- Air quality, noise monthly monitoring records.

### 8.2.3 Fauna Management During Site Clearance

The following sub-sections detail the workflow for site clearance. Directional site clearance should proceed northwards, and into the recommended areas of conservation. Directional site clearance shall be carried out as detailed in Section 11.10.1.3 of the CCK N1 EIA Report. Clearance should take place sequentially, according to the recommended sequence in Figure 8-3.

### 8.2.4 Hoarding Installation

Hoarding should first be set up to demarcate the entire earthworks areas. It is recommended for the areas slated for clearance at this stage to be subdivided into smaller site clearance parcels. Five site clearance subzones have been recommended, as shown in Figure 8-3. The installation of hoarding is to be completed by the Contractor following the specifications in Section 11.10.1.3 of the CCK N1 EIA Report, and the detailed hoarding sequence is detailed in Appendix J. It should be noted that the directional clearance plan has been amended since the production of the EIA to reflect further site-specific factors; it is imperative that the Contractor, therefore, works closely alongside the EMMP Consultant to achieve this plan.

In the process of removing the hoarding to make way for the noise barrier, the amount of hoarding removed each day should be no more than what can realistically be replaced with a noise barrier in any given day; this is to ensure that no gaps occur between hoarding and noise barriers. For example, if only 10m of hoarding can be replaced a day no more than 10m of hoarding should be removed.

This must be followed to ensure no gaps within the hoarding boundary occur during the replacement of hoarding with noise barriers. If gaps occur between noise barriers and hoarding due to the noise barrier being slightly offset from the hoarding line, temporary measures, such as the installation of screens to block the gaps should be implemented. Hoarding removal and noise barrier installation teams must communicate to ensure no major gaps occur.

As displayed in Appendix J, temporary hoarding is proposed to be placed around two narrow segments of the RAC to facilitate drainage works. These works will only take place in conjunction with the clearance of Zones 3 and 4 to ensure wildlife shepherding can be executed appropriately and not to block passage of fauna into the RAC. Following the completion of drainage works, all hoarding will be removed reinstating connectivity within the RAC.

### 8.2.5 Site Inspection

Biweekly site inspections focusing on flora and arboriculture will be conducted at the worksite and its surrounding area throughout the construction phase by AECOM team. Regular biodiversity monitoring results on fauna will be submitted by the Contractors along with findings of other environmental parameters.




## Legend

- Temporary Hoarding Opening (one way wildlife exit at regular intervals of 30m to be sealed after site clearance completes for each parcellation)
- Hoarding
- Recommended Area of Conservation
- EMMP Site Boundary
- Direction of clearance
- Hoarding around drainage works

N

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Qualified Person Endorsement : NA

HDB Endorsement : NA

Consultant : AECOM

Client: HOUSING & DEVELOPMENT BOARD

Project Title :

**Specialist Consultancy Services at HDB Development (Choa Chu Kang)**

Figure Title :

**Recommended Directional Site Clearance**

| Designed | Checked | Approved |
|---|---|---|
| KRT | ASH | JAG |
| | Drawn KRT | Date SEP 2023 |

Figure No. : 8 - 3

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## 8.2.6 Construction Stage Monitoring Measures

The following subsections outline the monitoring plans required to be implemented during the construction stage of the Project. Further information relating to associated mitigation measures and inspections associated with the monitoring plans are outlined in Section 8.4.

Furthermore, visual non-compliance to any of the minimum control or mitigation measures are observed by the EMMP Consultant's ECO on-site, the EMMP Consultant's ECO should inform Contractor. The Contractor should conduct necessary investigation and corrective actions should be taken if necessary.

## 8.2.7 Hydrology and Surface Water Quality

The surface water quality sampling location(s) will be selected based on the location(s) of the discharge outlets onsite. Each month during the construction phase, one (1) round of sampling should be conducted at those locations to assess the water quality of the treated ECM effluent that is being discharged to public drains. As currently there are no information regarding exact locations of ECM and discharge(s), the monitoring locations will be confirmed at the later stages of the Project. All the discharge points from construction worksites should follow the NEA's Allowable Limits for Trade Effluent Discharge to Controlled Watercourse [W-7]. The water quality at selected location should be sampled in monthly frequency and additional parameters to be sampled monthly at every construction discharge outlet as shown in Table 8-3.

In addition, the surface runoff should be directed into an Earth Control Measures (ECM) pond and treated before being discharged into any watercourse as recommended in EIA Report [Appendix A]. ECM should be inspected and maintained by Contractor and QECP throughout the construction programmed by the QECP which will be reviewed in tandem with the progress of works. This may involve replacement of silt fences and erosion control blankets, repaving of concrete surfaces, etc. Real-time monitoring of Turbidity or TSS, and implementation of CCTV including a SIDS installed at every discharge outlet should be conducted by the Contractor throughout the construction stage.

The hydrological conditions of drainage system within construction worksite and at immediate vicinity should be inspected daily by the EMMP Consultant's ECO especially during heavy storm event to ensure no flooding. Daily inspections of TSS conditions at discharge points should also be carried out to ensure that the discharged water does not exceed the set-up criteria. EMMP Consultant/ EMMP Consultant's ECO should conduct audit on the water quality and hydrology conditions at the worksite monthly.

If any exceedance in monitored water quality parameters found from in-situ or ex-situ measurement (refer to Table 8-3) as well as any flooding or clogging issue observed on site, the EMMP Consultant's ECO and Contractor should conduct an investigation and corrective actions should be taken immediately.

**Table 8-3 Summary of Water Quality Sampling Parameters and Frequency**

| Parameter | Unit | Guideline Used | Guideline Value | Method |
|---|---|---|---|---|
| Dissolved Oxygen | mg/L | - | - | In-situ sampling using multiparameter probe |
| Turbidity | NTU | - | - | |
| Conductivity | µS/cm | - | - | |
| Salinity | mg/L | - | - | |
| pH | - | NEA's Allowable Limits for Trade Effluent Discharge to Controlled Watercourse [W-8] | 6 – 9 | |
| Temperature | °C | | 45 | |
| Biochemical Oxygen Demand | mg/L | | 20 | Ex-situ using grab sampling techniques and send to accredited lab for analysis |
| Chemical Oxygen Demand | mg/L | | 60 | |
| Total Suspended Solids | mg/L | | 30 | |
| Total Dissolved Solids | mg/L | - | 1,000 | |
| Phosphate ($PO_4$) as P | mg/L | NEA's Allowable Limits for Trade Effluent Discharge to | 2 | |

| Parameter | Unit | Guideline Used | Guideline Value | Method |
|---|---|---|---|---|
| | | Controlled Watercourse [W-7 ] | | |
| Total Phosphorus | mg/L | - | - | |
| Nitrate ($NO_3$) as N | mg/L | NEA's Allowable Limits for Trade Effluent Discharge to Controlled Watercourse [W-7] | 20 | |
| Total Nitrogen | mg/L | - | - | |
| Total Alkalinity | mg/L | - | - | |
| Total Organic Carbon | mg/L | - | - | |
| Ammoniacal Nitrogen | mg/L | - | - | |
| *Enterococcus* | CFU/100mL | NEA Water Quality Guidelines for Recreational Beaches and Fresh Water Bodies[Note 1] [W-8] | 200 | |
| Lead | mg/L | NEA's Allowable Limits for Trade Effluent Discharge to Controlled Watercourse [W-7] | 0.1 | |
| Zinc | mg/L | | 0.5 | |
| Mercury | mg/L | | 0.001 | |
| Arsenic | mg/L | | 0.01 | |
| Barium | mg/L | | 1 | |
| Tin | mg/L | | 5 | |
| Iron | mg/L | | 1 | |
| Beryllium | mg/L | | 0.5 | |
| Boron | mg/L | | 0.5 | |
| Manganese | mg/L | | 0.5 | |
| Cadmium | mg/L | | 0.003 | |
| Chromium | mg/L | | 0.5 | |
| Copper | mg/L | | 0.1 | |
| Nickel | mg/L | | 0.1 | |
| Silver | mg/L | | 0.1 | |
| Metals in Total | mg/L | | 0.5 | |

Note:
"-" indicates no guideline to be referred for the parameter.
**Note 1** – NEA Water Quality Guidelines for Recreational Beaches and Fresh Water Bodies is to be used as a reference, in the absence of the local guidelines regarding allowable *Enterococcus* concentrations in water.

## 8.2.8 Groundwater Quality and Level

During construction period, the groundwater level monitoring should be conducted monthly at proposed two (2) locations (i.e., MW1 and MW2) as shown in Figure 8-4 to understand the change of groundwater level nearby the worksites and RAC due to the ongoing construction activities.

Contractor should also monitor the groundwater level and quality as required in Singapore Building Control Regulations 2003 [R-23] weekly during dewatering process at where the excavation takes place. Groundwater should be sampled and tested as per list of parameters shown in Table 8-4 prior to any discharge into public drains. If any significant change of groundwater level found on site, an investigation and corrective actions should be taken by the EMMP Consultant's ECO and the Contractor immediately. The tolerance limit for groundwater level change

(i.e., ± 3m) to be confirmed by the Qualified Professionals who engaged by the Contractor when developing the piezometers installation and monitoring plan.

Contractor should conduct investigation and take corrective actions if any exceedance in groundwater quality based on guidelines listed in Table 8-4.




## Legend

- EMMP Site Boundary
- Proposed monitoring well locations
- Rail Corridor

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Qualified Person Endorsement : NA

HDB Endorsement : NA

Consultant : AECOM

Client: HOUSING & DEVELOPMENT BOARD

Project Title :

**Specialist Consultancy Services at HDB Development (Choa Chu Kang)**

Figure Title :

**Proposed Monitoring Well Locations**

| Designed | Checked | Approved |
|---|---|---|
| TYL | SAG | JAG |
| | Drawn TYL | Date JUL 2023 |

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**Table 8-4 Parameters for Groundwater Quality Monitoring**

| Parameter | Unit | Guideline Used | Guideline Value | Sampling Method |
|---|---|---|---|---|
| Dissolved Oxygen | mg/L | - | - | In-situ sampling using multiparameter probe |
| Turbidity | NTU | - | - | |
| Conductivity | µS/cm | - | - | |
| Salinity | mg/L | - | - | |
| pH | - | NEA's Allowable Limits for Trade Effluent Discharge to Controlled Watercourse [W-7] | 6 – 9 | |
| Temperature | °C | | 45 | |
| Biochemical Oxygen Demand | mg/L | | 20 | Ex-situ using grab sampling techniques and send to accredited lab for analysis |
| Chemical Oxygen Demand | mg/L | | 60 | |
| Total Suspended Solids | mg/L | | 30 | |
| Total Dissolved Solids | mg/L | - | 1,000 | |
| Phosphate ($PO_4$) as P | mg/L | NEA's Allowable Limits for Trade Effluent Discharge to Controlled Watercourse [W-7] | 2 | |
| Total Phosphorus | mg/L | - | - | |
| Nitrate ($NO_3$) as N | mg/L | NEA's Allowable Limits for Trade Effluent Discharge to Controlled Watercourse [W-7] | 20 | |
| Total Nitrogen | mg/L | - | - | |
| Total Alkalinity | mg/L | - | - | |
| Total Organic Carbon | mg/L | - | - | |
| Ammoniacal Nitrogen | mg/L | - | - | |
| *Enterococcus* | CFU/100mL | NEA Water Quality Guidelines for Recreational Beaches and Fresh Water Bodies[Note1] [W-8] | 200 | |
| Lead | mg/L | NEA's Allowable Limits for Trade Effluent Discharge to Controlled Watercourse [W-7] | 0.1 | |
| Zinc | mg/L | | 0.5 | |
| Mercury | mg/L | | 0.001 | |
| Arsenic | mg/L | | 0.01 | |
| Barium | mg/L | | 1 | |
| Tin | mg/L | | 5 | |
| Iron | mg/L | | 1 | |
| Beryllium | mg/L | | 0.5 | |
| Boron | mg/L | | 0.5 | |
| Manganese | mg/L | | 0.5 | |
| Cadmium | mg/L | | 0.003 | |
| Chromium | mg/L | | 0.5 | |
| Copper | mg/L | | 0.1 | |
| Nickel | mg/L | | 0.1 | |

| Parameter | Unit | Guideline Used | Guideline Value | Sampling Method |
|---|---|---|---|---|
| Silver | mg/L | | 0.1 | |
| Metals in Total | mg/L | | 0.5 | |
| Note:<br>"-" indicates no guideline to be referred for the parameter.<br>**Note 1** – NEA Water Quality Guidelines for Recreational Beaches and Fresh Water Bodies is to be used as a reference, in the absence of the local guidelines regarding allowable *Enterococcus* concentrations in water. | | | | |

## 8.2.9 Air Quality

Contractor and EMMP Consultant shall review the workplan and conduct a site measurement as detailed in this section during construction works. If any of the Air Pollution Control Plan, Compliance certificate of an Off-Road Diesel engine, and Monitoring Log is found inadequate or missing, or visual non-compliance to any of the minimum control or mitigation measures are observed on-site, EMMP Consultant shall investigate, and contractor shall take corrective actions. If there be any complaints from the community with regards to air quality during construction, additional ambient air quality monitoring shall be conducted for validation purpose. Stringent mitigation measures, such as increasing the frequency of water spraying on ground, and servicing of the vehicles/ machinery on site to reduce diesel fumes nuisance, shall be implemented by the contractor.

During earthworks and site clearance phase, real-time continuous monitoring of $PM_{10}$ and $PM_{2.5}$ using non-United States Environmental Protection Agency (USEPA) Federal Reference Methods/Federal Equivalent Methods (FRMs/FEMs) equipment shall be carried out by the contractor at the proposed locations.

The monitoring data shall be shared with the EMMP Consultant for data analysis, and to be included in the monthly report. The EMMP Consultant shall conduct data analysis and compare the results with the Singapore Ambient Air Quality Long Term Targets (SAAQT) [W-3]. In the event that the air quality does not meet the SAAQT, the contractor shall investigate the cause and implement more stringent mitigation measure.

Based on the proximity to emission source, three (3) closest human receptors and one (1) ecological receptor are proposed for both continuous monitoring of $PM_{10}$ and $PM_{2.5}$ during earthworks and site clearance phase. The four (4) proposed locations are as follows:

- A1: HDB Block 635A Senja Road;
- A2: Pacific Healthcare Nursing Home II @ Bukit Panjang;
- A3: Jurong Pioneer Junior College; and
- A4: Proposed Ecological Corridor (natural area to be retained within Project site).

The proposed monitoring locations are presented in Figure 8-2

# 8.2.10 Airborne Noise

## 8.2.10.1 Site-specific measures

Mitigation measures proposed in the CCK N1 EIA report [Appendix A], shall be implemented by the Contractor. The Contractor will use the pre-construction baseline (detailed in Section 8.1.4.3) to calculate and set the Project criteria which shall apply for construction works in all stages. This data will be shared with the SO Rep., HDB, and the EMMP Consultant. Daily inspection by the EMMP Consultant's ECO should also be carried out on entire boundary facing the noise sensitive receptors. EMMP Consultant may also conduct site investigations when deemed necessary.

## 8.2.10.2 Noise Barriers

The noise barriers to be installed along the Recommended Area of Conservation should be 3m, whereas 12m height along the site boundary facing affected Noise Sensitive Receivers (NSRs) as shown in the Figure 8-5. The detailed sequence of the noise barrier installation should refer to Section 8.2.4 to ensure there will not be gaps on the outer boundary of the construction site.

## 8.2.10.3 Monitoring Plan

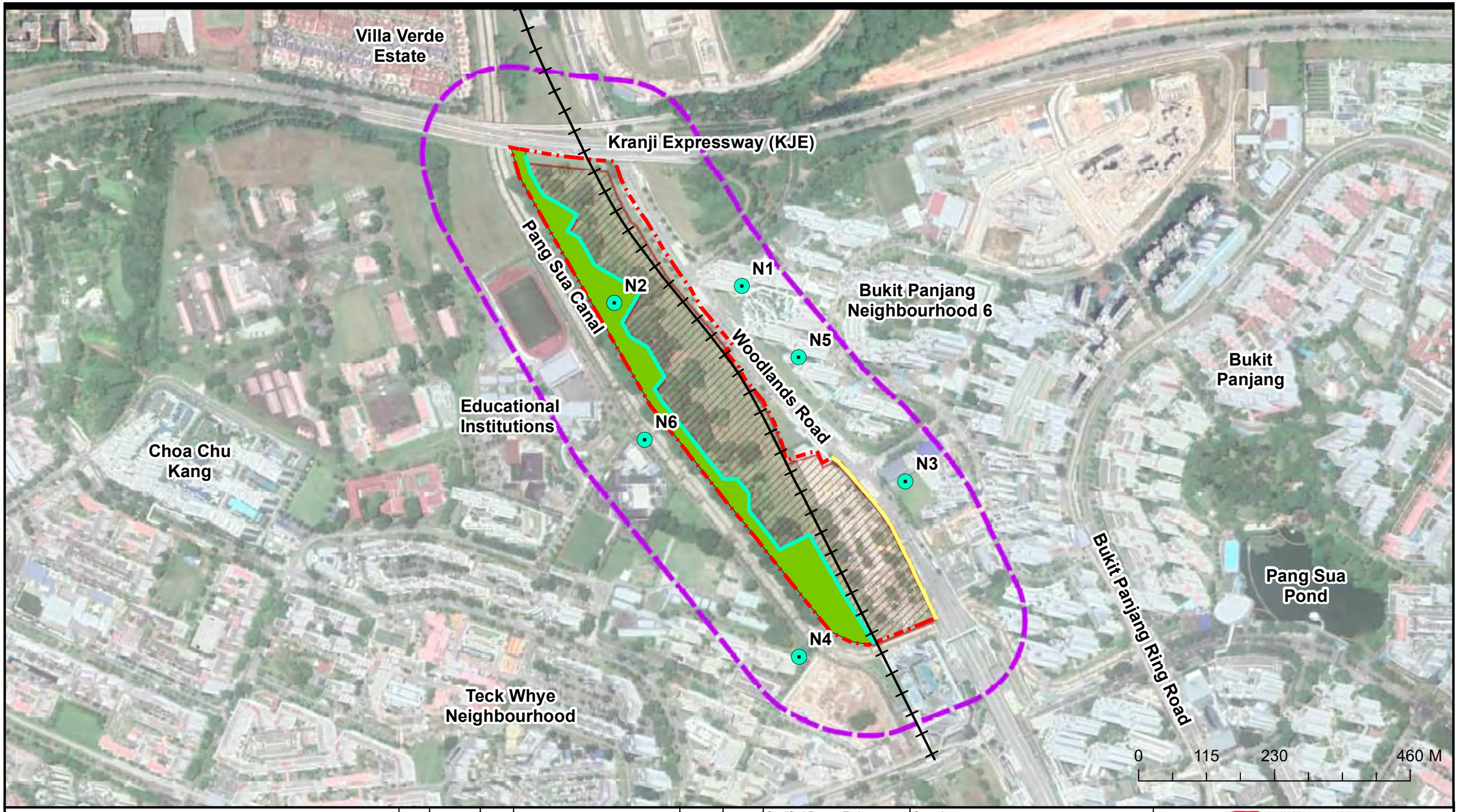
Six (6) locations as shown in Figure 8-5 are proposed for continuous real-time noise monitoring during the construction stage based on review of noise sensitive receptors around the Project construction site and predicted noise impact in CCK N1 EIA report [Appendix A]. Continuous real-time noise monitoring will be conducted by the Contractor during the entire construction stage and data will be shared with the SO Rep., HDB, and the EMMP Consultant for data analysis.

The six (6) proposed locations are as follows:

- N1: HDB Block 635A Senja Road;
- N2: Within RAC;
- N3: West View Primary School
- N4: HDB Block 162 Jalan Teck Whye;
- N5: HDB Block 632A Senja Road; and
- N6: Near Teck Whye Secondary School facing Pang Sua Canal.

The result will then be compared with the "adjusted maximum permitted noise level" from the construction activities in accordance with noise legislation stated in *Environmental Protection and Management (Control of Noise at Construction Sites) Regulations, 2008* [R-10]. It is to be noted that ecological receptor noise impact will be assessed against the average baseline noise level as the noise criterion.

In the event of any noise level exceedance than the Project criteria, the Contractor shall investigate the cause and implement more stringent mitigation measure if any applicable. Contractor and the EMMP Consultant's ECO shall also conduct an investigation and site measurement using portable equipment to ensure the noise level meets the Project criteria during construction works. If there are any complaints from the community with regards to noise during construction, additional noise monitoring shall be conducted by the Contractor.




**Legend**

- Rail Corridor
- Proposed Noise Monitoring Locations (Construction Stage)
- Proposed 3m Noise Barrier
- Proposed 12m Noise Barrier
- EMMP Site Boundary
- 150m Airborne Noise Study Area
- Proposed Construction Footprint
- Recommended Area of Conservation

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Qualified Person Endorsement : NA

HDB Endorsement : NA

Consultant : AECOM

Client: HOUSING & DEVELOPMENT BOARD

Project Title :

**Specialist Consultancy Services at HDB Development (Choa Chu Kang)**

Figure Title :

**Proposed Airborne Noise Monitoring and Hoarding Locations during Construction Stage**

| Designed | Checked | Approved |
|---|---|---|
| SYT | PNZ | JAG |
| | Drawn: SYT | Date: AUG 2023 |

Figure No. : 8-5 | Rev. 01 | Sheet 1 of 1

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# 8.2.11 Vector Control

#### 8.2.11.1.1 Submission of Vector Baseline Report

As per NEA's sample contract specifications for mosquito and rodent control [W-5,W-6], the Contractor shall submit a full Vector Baseline Report with photographs (where applicable) to SO Rep./NEA by the second week after the commencement of the contract or at the beginning of each construction stage. The Vector Baseline Report shall be able to:

- Identify all potential mosquito breeding habitats and/or other relevant environmental irregularities (e.g., stagnant water, public litters at bus stop near worksite) in the required format as shown in the Annex C1 of the NEA's sample contract specifications; and
- Identify all rat/rodent burrows, activity and/or other relevant environmental irregularities (e.g., signs of rub marks, live rodents) in the required format as shown in the Annex C2 of the NEA's sample contract specifications.

#### 8.2.11.1.2 Submission of Vector Service Report(s)

As per NEA's sample contract specifications for mosquito and rodent control [W-5,W-6], the Contractor shall submit a Vector Service Report to SO Rep./NEA at the end of each mosquito and rodent/rat control services. The Vector Service Report shall:

- Report the performance of all mosquito control services conducted in the format as shown in Annex D1 of the NEA's sample contract specifications;
- Report the performance of all rodent/rat control services conducted in the format as shown in Annex D2-1 of the NEA's sample contract specifications. Recommend specific solutions to prevent mosquito breeding and rat/rodent infestation (e.g., building design details, repairs, housekeeping programmes, user habits) and any other factors that have direct bearing on mosquito breeding and rat/rodent infestation;
- Photos of each vector-breeding location (e.g., mosquito-breeding area, rodent burrow) or structural defect and the respective treatment shall be taken from different perspectives/angles and included in the report; and
- In specific for rat/ rodent control, a Monthly Service Report shall be submitted to the SO Rep. at the end of each month, with consolidated findings and the outcomes of relevant actions undertaken for the month.

#### 8.2.11.1.3 Implementation of Vector Control Plan and Vector Monitoring Programme on Site

For the implementation of Vector Control Plan, the licensed personnel on site should be provided as follows:

- **A NEA-licensed ECO** shall be appointed by the EMMP Consultant to draw up and implement an effective vector control programme, which outlines vector surveillance and control measures to eliminate, reduce and/or manage vector risks as stated in NEA's *Code of Practice for Environmental Control Officers (ECO)* [R-12]. The ECO which appointed by EMMP Consultant shall assist the Contractor in engaging external NEA-licensed VCO to undertake vector control measures on site.
- **A NEA-registered VCO (Vector Control Operator),** which is a registered company formed by a team of NEA-licensed Vector Control Technicians (VCTs) and NEA-certified Vector Control Workers (VCWs), shall be engaged by the Contractor to undertake vector control measures as per the *Code of Practice for Vector Control Operator, Technician and Worker* [W-4], as well as to carry out vector control and surveillance at least once a week on site. The VCO shall lead and/or provide guidance for in-house vector control programme, if required to be formed by the Contractor, SO Rep., HDB and/or relevant authorities. The registered VCO, licensed VCT and/or certified VCW shall be able to identify potential vector-breeding grounds and propose measures to prevent propagation of vectors on site.
- **An in-house vector control team** should be led by an NEA-licensed VCT, joined by NEA-certified VCWs and/or a supporting group of individuals who have undergone vector control trainings provided by the NEA-registered VCO, NEA-licensed VCT and/or have passed other equivalent trainings (e.g., *Joint ITE-NEA Certificate in Pest Management*).

  *Note:* Under the *Control of Vectors and Pesticide Act (CVPA)* [R-14], only registered VCO, licensed VCT or certified VCW under NEA can be engaged to carry out vector control works on site. The employment of any unlicensed/ uncertified vector control technicians/workers may be a potential breach of the CVPA Chapter 59.
- **An external NEA-licensed VCO** shall be engaged by the Contractor/SO Rep. to supplement the weekly in-house vector control and surveillance routine.

Noted as one of the minimum control measures on site, Gravitraps will normally be employed to prevent mosquito breeding. The in-house vector control team shall develop a vector control program (see example in Figure 8-6) to conduct a daily routine of "Search and Destroy[3]" activities at each zone, as well as to monitor and maintain Gravitraps using the Zoning Method.

The recommended monitoring program for vectors is summarised in Table 8-5 below.

Investigation and corrective actions (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.

**Table 8-5 Recommended Monitoring Programme during Construction Phase (Vector Control)**

| Location | Parameters | Frequency and Duration |
|---|---|---|
| Contractor to define vector zones (see example in **Figure 8-6**) for construction worksite (including storage and resting areas) | Inspection of potential mosquito breeding grounds (stagnant water), rat/ rodent burrows and droppings of other vectors (e.g., cockroaches) | Daily inspection across different zones by in-house vector control team (see example in Figure 8-6) and their respective Gravitraps, with each zone inspected at least twice a week;<br><br>Weekly vector control and surveillance by the NEA-registered VCO, NEA-licensed VCT and/or NEA-certified VCWs. |

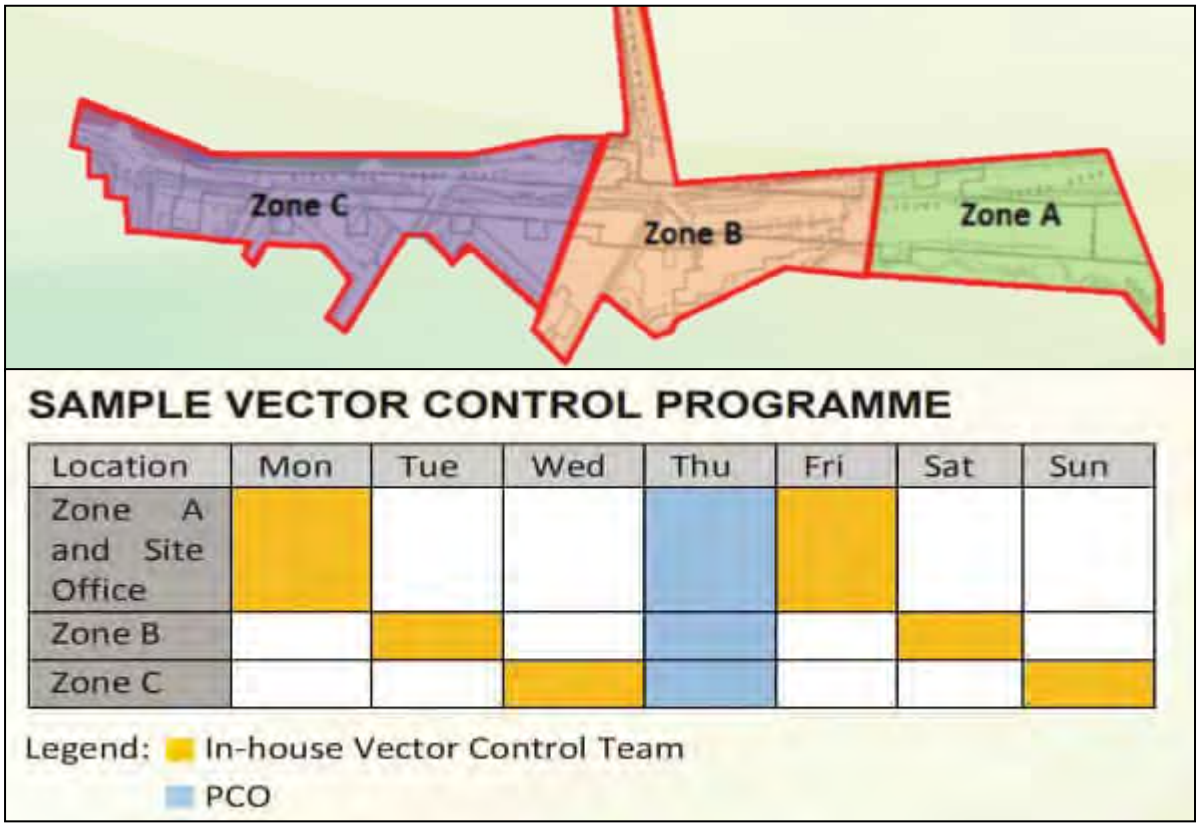



**Figure 8-6 Example of Zoning Method and Vector Control Programme [R-18]**

[3] According to *LTA's Guidebook in Vector Control at LTA Sites*, "Search and Destroy" 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.

### 8.2.12 Waste Management

An on-site waste management team should be appointed by the Contractor to implement daily waste management/ housekeeping works according to the established waste strategy and management plan.

A monitoring, review and reporting protocol for waste generated during construction should be developed by the Contractor to track the amount of recycling and disposal (e.g., general non-toxic, toxic and construction waste) done with a monthly report to be submitted within the periodic environmental performance monitoring reports. The report shall be used to identify gaps in standards and targets and areas of improvement and highlight waste generations areas which may have been overlooked or were more serious than expected.

Contractor should inspect daily on proper disposal of organic waste, hazardous waste, other wastes as well as any oil/chemical spill at site.

Contractor should prepare log sheet for disposal of hazardous waste if required and should inspect the hazardous chemical/substances storage condition weekly during construction phase.

Monthly audit should be conducted by EMMP Consultant/ECO to ensure the waste management quality are maintained based on established management plan.

Investigation and corrective actions to be taken, when:

- There are no/ poor records of toxic chemical waste amount and type; and
- There is evidence of poor handling/ storage of toxic chemical waste and hazardous chemical.

## 8.3 Building Construction

### 8.3.1 Refresher Training & Toolbox Meetings

The following refresher training sessions and toolbox meetings should be carried out throughout the Building Construction stage at different intervals:

- Biodiversity:
    - Toolbox briefings are to be held for all site personnel on a monthly basis, or as necessary as works progress, focusing on the key potential issues that could be encountered in the coming work activities; and
    - Biodiversity Awareness Training: refresher sessions to be given to all site personnel once every six months, relevant to planned activities in the period ahead.
- Water Resources Management Training:
    - Toolbox briefings are to be held for all site personnel on a monthly basis, relevant to planned activities in the period ahead; and
    - Water Resources Training: refresher sessions to be given to all site personnel once every six months.
- Vector Control Training:
    - Toolbox briefings to be held monthly for all site personnel if deemed necessary, to ensure all site personnel are well trained and able to manage potential vector risks; accordingly.
- Waste Management Training:
    - Toolbox briefings to be held monthly for all site personnel if deemed necessary, to ensure all site personnel are well trained and able to manage construction waste accordingly.

Detailed information pertaining to each training type is provided in Section 6.2.

## 8.3.2 Monthly Data and Document Submission

During the Building Construction Stage, all monthly data requirements undertaken for the earthworks/site clearance and SI Stage activities (Section 8.2), should also be carried out and submitted during the Building Construction Stage in relevant formats and documents.

## 8.3.3 Environmental Monitoring & Site-Specific Measures

The information pertaining to site-specific measures and environmental monitoring follows on from those outlined for the earthworks/site clearance and Soil Investigation (SI) Stage activities.

If visual non-compliance to any of the minimum control or mitigation measures are observed by the EMMP Consultant's ECO on-site, the EMMP Consultant's ECO should inform Contractor. The Contractor should conduct necessary investigation and corrective actions should be taken if necessary.

### 8.3.3.1 Biodiversity and Arboriculture

The monitoring tasks undertaken for biodiversity and arboriculture during site clearance stage, outlined in Section 8.2, should be continued during the Construction Stage, with the exception of fauna management during site clearance which should have been complete.

### 8.3.3.2 Hydrology and Surface Water Quality

#### 8.3.3.2.1 Site Specific Measures

All standard and site-specific measures outlined in Sections 8.4.2 and 8.5.2.

In addition, EMMP Consultant's ECO should conduct daily inspection of drainage, water quality of surface runoff and any abnormalities inside drainage systems (e.g., fish kill).

In order to provide comprehensive water quality data into Environmental Data Management System as described in Section 7, the Contractor should provide real-time Total Suspended Solids (TSS) monitoring data to EMMP Consultant based on discussion during pre-construction stage as described in Section 8.1.

If visual non-compliance to any of the minimum control or mitigation measures are observed by EMMP Consultant's ECO on-site, EMMP Consultant's ECO should inform the Contractor. The Contractor should conduct necessary investigation and corrective actions should be taken if necessary.

#### 8.3.3.2.2 Monitoring Plan

The sampling outlined for the earthworks stage under Section 8.2.7 should be continued for the Construction Stage.

### 8.3.3.3 Groundwater Quality and Level

During the construction Stage, all site-specific measures and monitoring should follow the information outlined in Section 8.2.6.

### 8.3.3.4 Air Quality

#### 8.3.3.4.1 Site-specific measures

Following on from the monitoring undertaking from the Earthworks Stage, during building construction phase, bi-annual 1-month monitoring of $PM_{10}$ and $PM_{2.5}$ using non-USEPA FRM/FEM equipment shall be carried out by the contractor at the proposed locations.

#### 8.3.3.4.2 Monitoring Plan

The sampling outlined for the earthworks stage under Section 8.2.9 should be continued for the Construction Stage.

#### 8.3.3.5 Airborne Noise

##### 8.3.3.5.1 Site-specific measures

All standard and site-specific measures outlined in Section 8.4.4.

Upon commencement of any works, unattended continuous real-time noise monitoring of $L_{Aeq(12\ hours)}$, $L_{Aeq(1\ hour)}$, and $L_{Aeq(5\ mins)}$ using NEA-approved Type 1 Sound Level Meter shall be carried out by the contractor at the proposed locations in 8.2.10.3.

##### 8.3.3.5.2 Monitoring Plan

The site-specific measures outlined in Section 8.2.10 should be implemented upon commencement of any works.

#### 8.3.3.6 Vector Control

During the construction Stage, all site-specific measures and monitoring should follow the information outlined in Section 8.2.11.

#### 8.3.3.7 Waste Management

During the construction Stage, all site-specific measures and monitoring should follow the information outlined in Section 8.2.12.

# 8.4 Standard and Site-specific Measures and the Responsible Parties

The clauses listed in the tables outlined in this section refer to standardised clauses set by AECOM. Clause numbering is determined by section, with SS values representing site specific clauses relating to mitigation measures and associated inspection tasks that are to be carried out on site.

## 8.4.1 Biodiversity

| Activity | Potential Environmental Impacts | Clause | Mitigation Measures to be Implemented by Contractor | Inspection Tasks to be Carried out by the EMMP Consultant |
|---|---|---|---|---|
| **Biodiversity: Flora and Arboriculture** | | | | |
| Major Impact:<br>• Site clearance<br>• Earth works Tree-felling works<br>Minor Impact:<br>• Pre-construction survey<br>• Soil Investigation works<br>• Hoarding works<br>• Road works Proposed outlet drain constructions | • Loss of vegetation/habitat<br>• Habitat pollution and degradation<br>• Change in species composition<br>• Disturbances to Flora within site, RAC and TPZs | AB.1 | Prior to commencement of site works, the salvaging procedures, and the flora monitoring, and management plan should be crafted in consultation with NParks. | Check with Contractor if in the approvals provided by NParks and HDB on any salvaging/ transplantation required. If yes, then to check them being followed one week before site clearance. |
| | | AB.2 | Salvaging of viable saplings of conservation significance by relevant authorities should be carried out before site clearance begins. | |
| | | AB.3 | Prior to commencement of site works, the tree transplantation procedures and tree protection protocol, should be crafted in consultation with NParks. | |
| | | AB.4 | Prevent excessive or unauthorised vegetation clearance by ensuring construction works are prohibited within the RACs and TPZs. | Conduct Integrity check of hoarding to safeguard RAC and TPZ to safeguard trees meant for retention and also to see signs of forest edge effect, if any. This should include checks for physical damage to the hoarding and in relation to the correct hoarding placement once erected. |
| | | AB.5 | Monitor sensitive habitats (i.e., RAC) for forest edge effects and competition from exotic or invasive flora species at the new forest edges. | |
| | | AB.6 | Monitor trees at the new forest edges within 15 m from the hoarding boundary or trees along the RAC. | |
| | | AB.7 | Minimise construction impacts on sensitive vegetation (i.e., RAC). | Conduct pre-felling inspection of each area before clearance of the site. Follow the procedure as approved by NParks in this matter. Pre-felling fauna inspection validity remains 7 days from inspection unless otherwise indicated by NParks. |

| Activity | Potential Environmental Impacts | Clause | Mitigation Measures to be Implemented by Contractor | Inspection Tasks to be Carried out by the EMMP Consultant |
|---|---|---|---|---|
| | | AB.8 | Implement Flora Monitoring and Management plan. | Check that the Site-Specific Flora Monitoring and Management Plan has been effectively implemented on site by the Contractor. |
| **Biodiversity: Fauna** | | | | |
| Major Impact:<br>• Site clearance<br>• Earth works<br>• Tree-felling works<br><br>Minor Impact:<br>• Pre-construction survey<br>• Soil Investigation works<br>• Hoarding works<br>• Road works<br>• Proposed outlet drain construction | Major Impact:<br>• Site clearance<br>• Earth works<br>• Tree-felling works<br><br>Minor Impact:<br>• Pre-construction survey<br>• Soil Investigation work<br>• Hoarding works<br>• Road works<br>• Proposed outlets drain construction | AB.9 | Implement the Wildlife Response Plan, Roadkill Response Plan, pre-felling procedures and directional site clearance plan. | Check that the Wildlife Response Plan, Roadkill surveys logbook, Response Plan, pre-felling procedures and directional site clearance plans are implemented effectively. |
| | | AB.10 | Pre-felling fauna inspection to minimise injury and mortality of fauna as a result of vegetation clearance. | Check that the pre-felling fauna inspection has been undertaken prior to giving the go ahead for vegetation clearance to commence. Where fauna is present, check that the Wildlife Response Plan is implemented, and that any adaptive advice provided by the EMMP Consultant is implemented |
| | | AB.11 | Camera trap monitoring for wildlife presence to be conducted after hoarding installation is completed to determine if any large fauna such as Eurasian wild boars or civet cats are trapped within the hoarding boundary. | Check an appropriate number of camera traps have been placed around the site, once hoarding installation is complete, and check that footage is being monitored, at a minimum on a monthly basis, with this being more numerous prior to vegetation clearance of each area. |
| | | AB.12 | Directional site clearance must be adhered to during site clearance to minimise fauna injury and mortality. | Check the Contractor and ECO are implementing directional site clearance as per the agreed protocol. |
| | | AB.13 | As construction works occur adjacent to the RAC and TPZ, hoarding directly adjacent to the RAC should not have gaps to prevent entry of animals, and noise and light measures must be adhered to. Hoarding along the construction site perimeter must also reduce dust at adjacent areas and must be as high as any stockpiles or dust emission sources on site. | Inspect all hoarding once erected checking for gaps that could allow entry by animals, and ensure all hoarding is of the correct dimensions and materials to prevent excessive dust, noise, and light from escaping from the compound soil. |
| | | AB.14 | Biodiversity Awareness Training to be carried out to ensure workforce complies to the fauna response procedures, general housekeeping and understands the ecological value of site. | Check Biodiversity Awareness Training has been undertaken and is presented to all site staff, by the EMMP Consultant, prior to site works commencing. |

| Activity | Potential Environmental Impacts | Clause | Mitigation Measures to be Implemented by Contractor | Inspection Tasks to be Carried out by the EMMP Consultant |
|---|---|---|---|---|
| | | AB.15 | Technical agencies of this project and other concurrent projects to communicate and coordinate in the execution of wildlife corridors.<br><br>Wildlife corridors to be established and monitored via camera traps in order to ensure continued ecological connectivity. | Check to ensure that camera traps have been implemented within the wildlife corridor. |
| | | AB.16 | Site inspections to be conducted daily to minimise fauna entrapment, ensure proper ECM measures are in place, and ensure cleanliness of site. | Undertake daily inspection to check for fauna entrapment within the compound. If fauna is discovered, the EMMP Consultant should be contacted immediately.<br><br>Check that ECM measures have been implemented and the site is clean. |
| | | AB.17 | Site inspections to be conducted once every two weeks to minimise potential environmental impacts to fauna. | Check site inspections are undertaken by the EMMP Consultant, biweekly. |
| | | AB.18 | Prior to closure of the wildlife corridor, Contractor to walk along the entire length of the corridor to ensure that no fauna is trapped within the corridor. | Check that the Contractor has walked along the entire length of the corridor and confirm that no fauna has been trapped within the corridor prior to each closure of the wildlife corridor. |
| | | AB.19 | Practise due diligence in proper storage and handling of machinery to prevent leeching of oil or harmful materials such as bentonite slurry; store and handle harmful materials well away from waterbodies;<br><br>Any slurry waste generated from Soil Investigation (SI) works shall be removed from site and sent to a third-party toxic industrial waste collector for offsite disposal. | Check that all machinery is stored in proper locations/conditions away from waterbodies.<br><br>Check consignment notes and truck delivery of SI slurry waste on site on weekly/ monthly basis as available. See the accumulation on site during site inspection and comment if the wastes disposal frequency is adequate on a weekly/monthly basis as appropriate. |
| | | AB.20 | Contractor to implement lighting management plan.<br><br>Where night-time works are not avoidable, review construction method statements and site lighting plan with the EMMP Consultant and Ecologist, and update the EMMP with the approved lighting management plan before the commencement of nights works. | Check whether nightworks are planned at the start of each week. If planned, check with the Contractor whether they are unavoidable. If unavoidable, check that the method statements, site lighting plan and measures are in place, and have been reviewed by the EMMP Consultant's Ecologist. |

## 8.4.2 Water Resources

| Activity | Potential Environmental Impacts | Clause | Mitigation Measures to be Implemented by Contractor | Inspection Tasks to be Carried out by the EMMP Consultant |
|---|---|---|---|---|
| **Water Resources: Standard Measures** | | | | |
| **Site clearance, spillage of oil, fuel and lubricant from vehicle and machinery, oil drips from generator, chemical spill, proposed outlet drain construction works.** | • Water quality deterioration from soil erosion, sewage, chemical and trade effluent discharge;<br>• Water quality deterioration due to accidental spills and leaks of chemical substances stored and used on site;<br>• Decreased surface water infiltration into the ground;<br>• Groundwater extraction during construction activities that require soil dewatering;<br>• Seepage of contaminants from excavated contaminated soil and groundwater (if encountered) into the underlying soil and groundwater;<br>• Seepage of contaminants into underlying soil and groundwater due to accidental spills and leaks of chemical substances stored and used on site. | AW.1 | Keep record of latest approved ECM plan and ECO does daily check if any deviation to the approved plan. | Check that the implemented ECM on site corresponds to the latest approved ECM Plan during site inspection as much as possible and check compliance approvals by RTO/ QECP sign off. |
| | | AW.2 | Any earth works should be in tandem with ECM provision. Biodegradable erosion blankets shall be provided to the areas with bare soil surface (includes stockpiles) within the same day of the soil is exposed. Use only fully biodegradable erosion control blankets (ECB) to avoid trapping fossorial fauna such as snakes.<br><br>Open canopy areas where continued soil loss may occur may need replacement of Erosion and Sediment Control (ESC) structures to capture eroded soil that can be returned back to the buffer zones for amelioration. ESC structures can likewise be strategically built adjacent to cut and fill, excavation and stockpiling sites. | Check that all exposed areas are covered with fully biodegradable erosion control blankets at the end of each day.<br>Request Contractor to submit a photo of the site aerial view each evening.<br><br>To discuss with contractor on movement of soil within site during site inspections. |
| | | AW.3 | Contractor shall provide the CCTV/SIDS and online real-time TSS/turbidity records to EMMP Consultant to ensure that all discharged effluent meets the NEA Allowable Limits for Trade Effluent Discharge to Controlled Watercourse with regards to TSS concentration. | Check that the CCTV/SIDS and TSS sensors are adequately located and functioning on a daily basis.<br><br>Check the records and compare to NEA Allowable Limits for Trade Effluent Discharge to Controlled Watercourse. Investigate reasons for exceedances with the Contractor on daily basis and discuss corrective actions and room for improvement in practices on site. |
| | | AW.4 | All existing drains and the newly constructed drains within the worksite shall be free of any blockage and siltation. Contractor's ECO shall conduct daily inspection to minimise the occurrence of any potential flooding and surface runoff within the worksite and the vicinity outside of the worksite.<br><br>The Contractor shall take all precautionary measures and/or protections needed for the construction of the proposed temporary roads, drains, sewers, and manholes if any, | Check for any blockages in the water flow within the existing and newly constructed drains.<br><br>Check for integrity, maintenance level (e.g., siltation) within all drains/ other infrastructure directly or indirectly impacting sound water flow or water quality on site during site inspections.<br><br>Check for any signs of flooding or surface runoff within and in vicinity of worksite during site inspections. |

| Activity | Potential Environmental Impacts | Clause | Mitigation Measures to be Implemented by Contractor | Inspection Tasks to be Carried out by the EMMP Consultant |
|---|---|---|---|---|
| | | | earthworks, and temporary works, to ensure the proposed works and existing structures (including those mentioned above) are safe, sound and in functioning conditions. | |
| | | AW.5 | Sediment Control Plan should be prepared to include but not limited to the sealing of site hoarding, a berm shall be provided along the site hoarding to prevent silty water to leak out from the site and ramp/curb at site entrance. | Daily check of integrity and adequacy of silt fence and berms are constructed where planned/ required during site inspections.<br><br>Conduct hoarding checks to ensure no silty water is leaking out of site premises during site inspections. |
| | | AW.6 | In view of the deep excavation for the construction of drains, sewers and manhole if any, earthworks, all associated temporary works (shoring/ protection works), methods of excavation, construction sequences and contingency plans are to be designed and duly endorsed by the Contractor's appointed Professional Engineer (Civil) [referred to as PE (Civil)] and Professional Engineer (Geotechnical) [referred to as PE (Geo)], if necessary and required under BCA Statutory Acts. The PE (Civil) and PE (Geo) shall submit plans, work-methods, safety measures, temporary works, monitoring (movement, vibration, settlement cracks, etc.) and work procedures as required by the relevant Authorities. | Confirm with SO Rep./ RTO if necessary, approvals are sought from relevant agencies for all designs implemented on site for the Earthworks related works and weekly check RTO's signing off on compliance of design to works done on site. |
| | | AW.7 | The Contractor shall be required to set up adequate settlement benchmarks as deemed necessary by SO Rep. to monitor the settlement of the existing or adjoining properties/structures, if any, throughout the piling operation and excavation. The monitoring programme of the surveying works on settlement benchmarks shall be submitted to the SO Rep. for approval.<br><br>When any of the following criteria is reached irrespective of whether damage has occurred, the Contractor shall notify the SO Rep. immediately:<br>• 5mm settlement or movement between consecutive readings; and<br>• 15mm total settlement of any part of a building/structure. | Check with SO Rep. on settlement markers observation and any concern on rate of settlement on a monthly basis. |

| Activity | Potential Environmental Impacts | Clause | Mitigation Measures to be Implemented by Contractor | Inspection Tasks to be Carried out by the EMMP Consultant |
|---|---|---|---|---|
| | | AW.8 | The Contractor shall design, supply, install and maintain real-time CCTV camera & monitors including operation, relocations, recordings & maintenance, along Site Boundary. Proposed locations & relocations of the CCTV camera shall be submitted to SO Rep. and HDB for approval before installation on site. It is recommended to export and back up the online available CCTV recordings on a weekly or biweekly basis to ensure no accidental erasure throughout the construction period.<br><br>Whenever possible, segregate clean water flow from silty water flow to maximize the sedimentation tank holding capacity. | Check daily record of CCTV silty imagery, provided by Contractor, to spot exceedance and notify the Contractor site officer immediately to record reason for exceedance and discuss corrective actions. |
| | | AW.9 | Undertake a programmatic Excavation, Cut and Fill and Earthmoving plan. The construction work should be done accordingly in stages and programmed segments to minimise the area disturbed at any given time. By minimising the disturbance area affected by excavation and earthworks to what is only necessary, potential erosion and topsoil loss may be reduced.<br><br>For drains or streams that originate within site boundary and will be affected by the works within the site, perimeter drains will need to be set up within the site to channel any surface runoff to be treated before discharge. Whereas for drains that do not originate within the site boundary and partially cut across the site and are affected by the works, proper drain diversion needs to be provided to connect the upstream and downstream of the affected part of the drain or stream and maintain continuous flow. | Request and check contractors' method statement in case of any temporary measures such as drain diversion, etc. that impacts hydrology of the site and its vicinity significantly.<br><br>Where drain diversions are applicable, check for continuous flow from upstream to downstream of the diverted part of the drain or stream. |
| | | AW.10 | Use approved materials, of the same or better quality as the surrounding area, for backfilling works. All backfilled material will be free of debris, and of good material soil. | Confirm with SO Rep/ Contractor sourcing of soil record that it is from approved location for backfilling. |

| Activity | Potential Environmental Impacts | Clause | Mitigation Measures to be Implemented by Contractor | Inspection Tasks to be Carried out by the EMMP Consultant |
|---|---|---|---|---|
| | | AW.11 | Monitoring wells and recharge:<br>• Install piezometers to monitor the changes in groundwater level in compliance with Building Control Regulations 2003 as part of its instrumentation and monitoring plan to be endorsed by Qualified Professionals (QP);<br>• Implement piezometers and monitoring wells adjacent to proposed subsurface structures, where groundwater hydrostatic pressure is potentially high. Shoring and dewatering with pumps should be undertaken, when necessary, during construction, where increased hydrostatic pressure is expected to cause leaching into construction areas. Automatic pumps should be installed to operate when critical piezometric levels are exceeded;<br>• Alternative in-situ recharge zones can be designated within the remaining conservation areas or green-belts to compensate for permanent loss of recharge areas that will be disturbed by the placement of at-grade and subsurface infrastructures;<br>• Utilise and implement artificial recharge through installation of groundwater or diversion reinjection wells to replace the loss of surface water infiltration;<br>• Prior to any discharge into the public drains, the Contractor will seek approval from relevant technical agencies (i.e. PUB, NEA). The Contractor should ensure that the extracted groundwater is stored adequately in designated holding areas (e.g. tanks). The holding areas should be waterproof to prevent any seepage of groundwater into the surrounding area and of adequate size to store the required volume of groundwater. Prior to discharge, groundwater should be tested for the parameters detailed in Table 8-4. | Check with SO Rep. on piezometer readings on site. With groundwater drawdown observed at greater than 1 m per month, to discuss recharge options and plans.<br><br>EMMP Consultant to check records of piezometer readings during site inspections.<br><br>If any recharge wells are made at any stage of construction, to check its working by observing groundwater levels maintenance/ rise in the results from instrumentation results.<br><br>In the event of discharge of groundwater in the public drains, EMMP Consultant to check the compliance of laboratory results with the guidelines and to review if appropriate approvals have been obtained.<br><br>To confirm that the Contractor has received approval from PUB/NEA where necessary.<br><br>Monthly groundwater monitoring at proposed monitoring wells north and west of the site to check that there is no significant groundwater level drop due to construction activities. |
| | | AW.12 | Provide sufficient numbers of proper sanitary facilities. It is recommended that there be one portable toilet per 10 pax and serviced 3 times per week. Appoint a NEA's Licensed | Check sanitary servicing records on a monthly basis. |

| Activity | Potential Environmental Impacts | Clause | Mitigation Measures to be Implemented by Contractor | Inspection Tasks to be Carried out by the EMMP Consultant |
|---|---|---|---|---|
| | | | Water Collector (LWC) to conduct regular collection of sewage discharges for disposal. | |
| | | AW.13 | Portable toilets are recommended to be installed on paved ground and bunded. | Check if portable toilets are installed on paved ground and bund is constructed surrounding the toilets. |
| | | AW.14 | Establish a regular maintenance work schedule to check and maintenance cleanliness and functionality of sanitary facilities on site, at least once a week, depending on the number of sanitary facilities. | Check on site or request Contractor for maintenance work schedule for proper cleanliness of sanitary facilities within site. |
| | | AW.15 | Chemical waste containers shall be labelled following the Globally Harmonised System of Classification and Labelling of Chemicals in the four national languages (i.e., English, Chinese, Malay, and Tamil) and other commonly used languages on site to avoid accidents. There shall also be clear instructions showing what action to take in the event of an accident.<br><br>Not applicable if no chemical waste on site. | Where applicable, check all chemical waste containers within the site. All containers should be appropriately labelled. |
| | | AW.16 | Any wastewater generated onsite, not limited to dewatering wastewater, chemical spills, oil and/or fuel spills, vehicle washing wastewater, etc., shall be disposed off-site by licensed third-party industrial waste collector, or treated to levels prescribed by NEA/ PUB if discharged to public drains/ sewer (written approval from NEA/ PUB must first be obtained for any discharge on-site). | Request Contractor for NEA/PUB approval letters for approved discharge of treated wastewater into the public drains or sewers.<br><br>Check all wastewater generated on site is treated/ routed to ECM pond before discharged into public drain/sewer. |
| | | | | For untreatable wastewater i.e., includes chemical/fuel, check that it is disposed off-site by licensed third-party industrial waste collector. Request Contractor for records made of all off-site disposals and check the records. |
| | | AW.17 | Secondary containment with capacity of more than 10% volume for single large container and 25% of the total volume of multiple containers should be used for all chemical stores and diesel generators to minimize spillages and contamination of soil and surface water. Care should be taken around water channels to avoid toxic chemicals such as petrol/ diesel/ oil/ paint/ thinner leak from equipment. | Check if diesel generator has a secondary containment approximating the capacity required. Discuss with ECO on its compliance. |

| Activity | Potential Environmental Impacts | Clause | Mitigation Measures to be Implemented by Contractor | Inspection Tasks to be Carried out by the EMMP Consultant |
|---|---|---|---|---|
| | | AW.18 | Any slurry waste generated from Soil Investigation (SI) works shall be removed from site and sent to a third-party toxic industrial waste collector for offsite disposal. | Refer to AB.19. |
| | | AW.19 | Good housekeeping practices shall be implemented to minimise careless spillage and to keep the storage and the workspace in a tidy and clean condition. Where applicable, appropriate training including safety codes and relevant manuals should be given to the personnel who regularly handle the chemicals on site. | Observe housekeeping at site and spot any issues related to potential contamination of hydrological receptors. |

## 8.4.3 Air Quality

| Activity | Potential Environmental Impacts | Clause | Mitigation Measures to be Implemented by Contractor | Inspection Tasks to be Carried out by the EMMP Consultant |
|---|---|---|---|---|
| **Site clearance, machinery and generator operation, construction works, vehicle.** | Air quality impact from dust nuisance from earthworks activities, construction activities and gaseous emissions from the construction equipment and vehicles. | **GENERAL MITIGATION MEASURES TO BE IMPLEMENTED THROUGHOUT CONSTRUCTION PERIOD** | | |
| | | **Minimum Control** | | |
| | | SA.1 | No demolition of permanent structure is expected as part of the project, with the exception of a single-storey structure within the HVP. Ensure appropriate mitigation measures are implemented. | It is understood that a single-storey HVP structure will need to be demolished. The EMMP Consultant should check with the Contract that there are no plans for the demolition of any other structures on site prior to site clearance being undertaken.<br><br>During demolition period(s) check that the Contactor and site staff are adhering to the relevant mitigation measures related to demolition.<br><br>Where further demolition is required, the EMMP Consultant must be consulted. |
| | | SA.2 | No concrete batching plant to be located on-site. | Check that the Contractor has submitted site layout plans and planning details prior to site activities commencing to check that no concrete batching plant is to be located on site.<br><br>Check that there is no concrete batching plant on site. |
| | | AA.1 | Access road construction or expansion is recommended to be completed first and paved before the construction of other development commences. | Check the access roads, check they are paved. |
| | | **Communications** | | |
| | | AA.2 | Contractor should engage Public Relation Officer (PRO) to develop and implement a stakeholder communications plan that includes community engagement before work commences on site. The PRO should establish good rapport with the community, handle, and feedback complaints from the community. | Check with the Contractor, check they have engaged PRO and get the contact of the PRO from them, ensuring that the PRO is engaging with the community during periods anticipated to create high levels of dust. Check they have set up the protocol to receive complaints. |
| | | AA.3 | 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. | Check that the notice board for this information is put up on site. |
| | | AA.4 | Contractor shall develop Dust Control Plan, implement the air quality control measures in line with the Code of Practice for Environmental Control, conduct regular inspection and record compliance with the Dust | Check that all measures listed within the Dust Control Plan have been implemented on site e.g., AA.16-AA.30. |

| Activity | Potential Environmental Impacts | Clause | Mitigation Measures to be Implemented by Contractor | Inspection Tasks to be Carried out by the EMMP Consultant |
|---|---|---|---|---|
| | | | Control Plan. Frequency of site inspections should be increased during prolonged dry or windy conditions. | Check that the Contractor comply with all the measures mentioned in the Dust Control Plan. (Usually if there are any incompliance from AA.16 - AA.30, that would mean incompliance of this.) |
| | | AA.5 | Contractor to prepare the Site Environmental Control Program in accordance with NEA's guidelines, which is to be submitted by Contractor to the Director-General of Public Health of NEA two weeks before the commencement of construction. Contractor should implement Environmental Control Programme specific to the construction works undertaken by the contractor.<br><br>Contractor to prepare and submit bi-weekly Site Environmental Control Report to EMMP Consultant and SO Rep. in accordance with NEA's Code of Practice for Environmental Control Officers for Specified Construction Sites[4]. | Check that the Contractor has prepared and submitted the SECP. |
| | | **Site Management** | | |
| | | AA.6 | Contractor shall record and make log on all dust and air quality complaints, exceptional incident(s) that cause dust and/or air emissions, identify cause(s), take appropriate measures to reduce emissions in a timely manner, and record the measures taken. The log should be available to the local authority when asked. | Check the logbook on site. |
| | | AA.7 | Hold liaison meetings with other high risk construction sites within 500m of the site boundary, if any, to ensure plans are coordinated and dust and particulate matter emissions are minimised. | Check with the Contractor if they have carried out such meetings, and the records. |
| | | **Monitoring** | | |
| | | AA.8 | Conduct monitoring for dust at suitable locations. 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 100m of site boundary. Cleaning should be provided if necessary. If there be any complaints from the community with regards to air quality | Check if the monitoring is carried out at proposed locations. Check the logbook to check that regular inspections are carried out. Check the complaint logbook and check that additional monitoring has been carried out if there are any complaints. |

[4] NEA (2022). Code of Practice for Environmental Control Officers for Specified Construction Sites. 5th Edition. Available from: code-of-practice-for-eco-(scs)---5th-edition-finalad363da3b1064f94bdcf2f62f9429adf.pdf (nea.gov.sg)

| Activity | Potential Environmental Impacts | Clause | Mitigation Measures to be Implemented by Contractor | Inspection Tasks to be Carried out by the EMMP Consultant |
|---|---|---|---|---|
| | | | during construction, additional ambient air quality monitoring shall be conducted. | |
| | | AA.9 | If the ambient air quality level during construction exceeds the SAAQT, contractor should investigate the cause and implement more stringent mitigation measure. | Check the monitoring results, if the results exceed SAAQT, check with Contractor on the cause and actions to be taken. This shall be a daily/ regular check, not only during site inspection. |
| | | AA.10 | The Contractor shall plan site layout so that machinery and dust causing activities are located away from receptors, where possible and arrange his method of executing the works such that there shall be no dust nuisance created. | Check that the machineries are located away from receptors where possible. |
| | | AA.11 | Fully enclose specific activities where there is a known high potential for dust production and the site will be active for an extensive period. | Check that activities with high potential of dust production are fully enclosed. |
| | | AA.12 | Keep site fencing, barriers, and scaffolding clean by cleaning regularly using wet methods (dry methods may give rise to fugitive dust). | Check that the site fencing, barriers, and scaffolding are clean. |
| | | AA.13 | Contractor should keep extent of excavation and soil exposure areas to minimum required for construction. Remove materials that have the potential to produce dust from site as soon as possible. Exposed site shall be covered by biodegradable erosion control blankets, properly treated by compaction, turfing, vegetation planting or sealing with bituminous materials, concrete, or other suitable materials as soon as practicable. Exposed soil, dusty material, excavation areas, soil loading/unloading areas and unpaved roads shall be dampened with water regularly, with the misting frequency increased during dry periods. | Check that the excavation works are carried out in small areas and covered with ECB after excavation.<br>Check with the Contractor if they dampen the mentioned areas with water regularly. |
| | | AA.14 | The tree felling activity shall be in a way that minimise dust generation, e.g., using dust screen/ dust suppression and do not oversize the root ball trenching. | Check that the tree felling activity is done properly. |
| | | AA.15 | The Contractor shall install hard surfaced haul routes and employ suitable means of spraying with water or water-assisted dust sweepers across parts of the site and along the public roads to reduce dust nuisance to the absolute minimum. The Contractor shall maintain sufficient workers to clean all public roads where soil is deposited from the Contractor's vehicles leaving the site. If roadways are contaminated with dusty materials from construction site, clean-up shall be conducted without delay. | Check that the haul roads are paved, and water is provided to dampen the roads connecting to the public roads. Check if the public roads around the worksite are clean. |
| | | **Operating vehicle/machinery and sustainable travel** | | |

| Activity | Potential Environmental Impacts | Clause | Mitigation Measures to be Implemented by Contractor | Inspection Tasks to be Carried out by the EMMP Consultant |
|---|---|---|---|---|
| | | AA.16 | Any atmospheric pollution (in the form of smoke, fumes, vapours, dust, and other pollutants) shall be effectively controlled. Air pollution control requirements such as the concentration and rates of omission of air pollutants shall be within legal limits. The SO Rep. reserves the right to request for a newer machine or an emission control device be installed if any machine or plant is deemed to be producing excessive greyish/ black smoke. All dusty operations must be adequately shielded and/ or arrested with water at point of impact.<br><br>Maintaining all machinery, including excavators and gen-sets regularly, to minimize smoke and dust exhaust emissions. | Check that the equipment on site do not produce grey/ black smoke. Check dusty operations are shielded/ arrested with water. |
| | | AA.17 | 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. | Check if signboard is put up on site. Check if vehicles are complying - did they bring up dusts from ground when they pass by? |
| | | AA.18 | Produce a Construction Logistics Plan to manage the sustainable delivery of goods and materials. | Check if the contractor has prepared such plan. |
| | | AA.19 | Ensure all vehicles and engine powered equipment comply with the legislative requirements of Singapore with all vehicles and equipment switch off their engines when stationary – i.e., no idling vehicles or engines. Clear signs will be erected at site entrance to inform all visitors.<br><br>Ensure that all heavy or noisy machinery used throughout all stages, where operating nearby the RAC, do not idle when not in use. | Check that the vehicles and equipment on site are not idling. |
| | | AA.20 | Where practicable, avoid the use of diesel- or petrol-powered generators and use mains electricity or battery powered equipment | Check that the equipment on site do not produce grey/ black smoke. |
| | | **General activities** | | |
| | | AA.21 | 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.<br><br>Ensure an adequate water supply on the site for effective dust/particulate matter suppression/mitigation, using non-potable water where possible and appropriate. Use fine water sprays on equipment wherever appropriate. | Check that there is sufficient water supply on site. |

| Activity | Potential Environmental Impacts | Clause | Mitigation Measures to be Implemented by Contractor | Inspection Tasks to be Carried out by the EMMP Consultant |
|---|---|---|---|---|
| | | AA.22 | Use enclosed chutes and conveyors and covered skips wherever possible.<br><br>Minimise drop heights from conveyors, loading shovels, hoppers and other loading or handling equipment. | Observe on site whether enclosed chutes and covered skips are used. |
| | | AA.23 | Maintaining a minimum moisture content during any rock crushing works. | Check during relevant rock crushing activities that a minimum moisture content maintained. |
| | | **Trackout** | | |
| | | AA.24 | Load of dusty materials on a vehicle leaving a construction site shall be properly covered entirely with impervious sheeting by contractor to avoid falling of soil debris. Vehicle should not be overloaded and shall be cleaned prior to leaving the site. | Check the vehicles are not overloaded, properly covered and the wheels are clean when leaving the site. |
| | | AA.25 | 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. | Check site logbook, check the haul roads are in good condition. |
| | | AA.26 | Site access gates to be located at least 10m from receptors where possible. | Check after site set up that access gates are located more than 10m from any receptors. |
| | | AA.27 | Vehicle washing facilities with high pressure water jets shall be provided by contractor at every discernible or designated vehicle exit point from construction site. Vehicle washing area and road section between washing facilities and exit point shall be paved. | Check that vehicle washing facilities are provided and the roads in between the exit point and washing facilities are paved. |
| | | **ADDITIONAL MITIGATION MEASURES TO BE IMPLEMENTED DURING EARTHWORKS** | | |
| | | AA.28 | For stockpile or exposed areas, only remove the cover in small areas during work and not all at once. | Observation on site. |
| | | **ADDITIONAL MITIGATION MEASURES TO BE IMPLEMENTED DURING BUILDING CONSTRUCTION PHASE** | | |
| | | AA.29 | Avoid scabbling (roughening of concrete surfaces) if possible. | Observation on site/ check with Contractor. |
| | | AA.30 | 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. | Check that stored sand and aggregates are wet. |
| | | AA.31 | 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. | Check that they are delivered in enclosed tankers. |

| Activity | Potential Environmental Impacts | Clause | Mitigation Measures to be Implemented by Contractor | Inspection Tasks to be Carried out by the EMMP Consultant |
|---|---|---|---|---|
| | | AA.32 | For smaller supplies of fine power materials ensure bags are sealed after use and stored appropriately to prevent dust. | Check on site that no bags that contain fine powder materials are left open. |
| | | SA.3 | Water sprays or sprinklers will be employed at conveyor transfer points. | Check that water sprays/ sprinklers are provided. |
| | | SA.4 | Drop heights at transfer points will be minimised to lessen dust generation | Observation on site. |
| | | SA.5 | Special covered area will be provided for loading and unloading process. | Check that covered area is provided at loading/ unloading point. |
| | | SA.6 | Sand and aggregates will be delivered in a dampened stage and will be re-wetted before being dumped into storage bunker. | Check that they are in dampened stage when being transferred and re-wetted before being stored. |
| | | SA.7 | Vent will be provided with efficient fixed filter bags to comply with the dust emissions criteria. | Check that vent is provided. |
| | | SA.8 | Silos will not be filled up with cement more than 90% of its loading capacity, to avoid overfilling. | Check that the silos are not filled up to more than 90%. |
| | | SA.9 | Silos will be equipped with overfill protection: audible high level sensor alarm and automatic shut-down switch, which could be activated to close when a problem is detected. | Check with the contractor to ensure that the silos have such function. |

## 8.4.4 Airborne Noise

| Activity | Potential Environmental Impacts | Clause | Mitigation Measures to be Implemented by Contractor | Inspection Tasks to be Carried out by the EMMP Consultant |
|---|---|---|---|---|
| **Airborne noise impact from site preparation for earthworks, foundation works, superstructure, landscape works, and removal of temporary re-instatement.** | Noise from construction machines and equipment, especially rotational and vibratory equipment (e.g., dozers, cranes, excavators, trailers, generators, etc.) | **Airborne Noise: PRE-CONSTRUCTION PERIOD** | | |
| | | AN.1 | Contractor to prepare a Noise Management Plan (NMP) to help to implement noise mitigation measure. The suggested NMP template is indicated in Annex H of SS602:2014 | Check that the Contractor prepare NMP in accordance with template in Annex H of SS602:2014, request for NMP Report. |
| | | **BASELINE NOISE MONITORING** | | |
| | | AN.2 | Contractor to conduct unattended noise monitoring one (1) week prior to commencement of site clearance for establishment of latest baseline using Type 1 Sound Level Meter with data logging at the affected Noise Sensitive Receptors.<br><br>The proposed locations are as follows:<br>• NM1: Villa Verde Estate<br>• NM2: HDB Block 635A Senja Road;<br>• NM3: Within RAC;<br>• NM4: West View Primary School<br>• NM5: HDB Block 162 Jalan Teck Whye;<br>• NM6: HDB Block 632A Senja Road; and<br>• NM7: Near Teck Whye Secondary School facing Pang Sua Canal. | Check that the Contractor conducted noise monitoring with appropriate equipment approved by NEA at proposed locations. |
| | | **Airborne Noise: CONSTRUCTION PERIOD** | | |
| | | AN.3 | Contractor to conduct site investigation and implement corrective actions to be taken when any of the following documentation are found inadequate/ missing:<br>• Construction Noise Management Plan (AN.1);<br>• Monitoring Log (AN.4).<br>1. If the monitored parameters exceed applicable values of Environmental Protection and Management Regulations.<br>2. If complaints are received due to project activities.<br>3. If visual non-compliance to any of the minimum control or mitigation measures are observed on-site.<br>4. If there are any cracks / leaks present on the noise barrier erected. | Check with Contractor on adherence to AN.3. |
| | | **CONTINUOUS NOISE MONITORING** | | |

| Activity | Potential Environmental Impacts | Clause | Mitigation Measures to be Implemented by Contractor | Inspection Tasks to be Carried out by the EMMP Consultant |
|---|---|---|---|---|
| | | AN.4 | Conduct continuous real time noise monitoring during construction using Type 1 Sound Level Meter with data logging at the affected Noise Sensitive Receptors.<br><br>The proposed locations are as follows:<br>• N1: HDB Block 635A Senja Road;<br>• N2: Within Green Area;<br>• N3: West View Primary School<br>• N4: HDB Block 162 Jalan Teck Whye;<br>• N5: HDB Block 632A Senja Road; and<br>• N6: Near Teck Whye Secondary School facing Pang Sua Canal. | Check that the Contractor conducts continuous real time noise monitoring with appropriate equipment approved by NEA at proposed locations. |
| | | AN.5 | When noise level exceeds the maximum adjusted noise level, Contractor should investigate and apply appropriate mitigation measures. | Check with Contractor on site investigation findings when noise level exceeds maximum adjusted noise level. |
| | | AN.6 | Records on noise levels from construction sites should be properly kept and produced upon request. | Check with Contractor for records on noise levels from construction sites. |
| | | **GENERAL MITIGATION MEASURES TO BE IMPLEMENTED THROUGHOUT CONSTRUCTION PERIOD** | | |
| | | **Minimum Control** | | |
| | | AN.7 | 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. | Observation on site/ check with Contractor that machines being intermittently used are shut down between work periods. |
| | | AN.8 | Only well-maintained construction plants should be utilized on-site, and construction plants should be serviced regularly during the entire construction period. | Check and inspect construction plants utilized on-site.<br>Update on maintenance and servicing of construction plants to be provided upon request. |
| | | AN.9 | 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. | Observation on site/ check with Contractor on distribution of PMEs at areas close to noise sensitive receptors. |
| | | AN.10 | Silencers or mufflers on construction equipment should be utilized and should be properly maintained during the construction programme. | Check and inspect silencers/ mufflers on construction equipment. |
| | | AN.11 | 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. | When walking the site observe whether houting, loud stereos/radios are used on site and check no materials are dropped from height or throwing of metal items occurs. |

| Activity | Potential Environmental Impacts | Clause | Mitigation Measures to be Implemented by Contractor | Inspection Tasks to be Carried out by the EMMP Consultant |
|---|---|---|---|---|
| | | AN.12 | 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. | Observation on site/ check with Contractor on construction respite. |
| | | AN.13 | 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. | Engage third-party sub-contractor to conduct periodic noise monitoring (proposed 2 days per month). |
| | | AN.14 | Night works unless approved by relevant Agencies will be prohibited after 6 pm to minimise noise disturbance to nocturnal animals. | Check with Contractor on permits for night works (if any). |
| | | AN.15 | Plan the layout of the site by considering using materials and other large structural equipment as noise barriers. | Check with Contractor on site layout. |
| | | AN.16 | 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.<br><br>Stationary equipment or machinery that emits strong noise should be stationed away from the RAC. | Check and observe whether construction plants known to emit noise are orientated away from noise sensitive receptors. |
| | | AN.17 | Material stockpiles and other structures will be effectively utilized, wherever practicable, in screening noise from on-site construction activities. | Observation on site/ check with Contractor on utilization of structures wherever practicable in screening noise from on-site construction activities. |
| | | AN.18 | All handheld percussive breakers and air compressors used on site will comply with local legislation and requirements. | Check for compliance of handheld percussive breakers/ air compressors used on site/ check with Contractor. |
| | | AN.19 | Activities may be scheduled to minimise noise generated at certain areas during periods which may be particularly sensitive to noise. | Check with Contractor on scheduling of activities during periods particularly sensitive to noise. |
| | | AN.20 | Works using machines or vehicles that generate noise should be prohibited in the night and at dawn unless permitted by relevant Agencies. | Check with Contractor on permits for night works (if any). |
| | | AN.21 | 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). | Observation on site/ check with Contractor if appropriate hearing protectors employed. |

| Activity | Potential Environmental Impacts | Clause | Mitigation Measures to be Implemented by Contractor | Inspection Tasks to be Carried out by the EMMP Consultant |
|---|---|---|---|---|
| | | AN.22 | 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. | Observation on site/ check with Contractor if appropriate signages have been put up. |
| | | AN.23 | 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. | Check with Contractor on documentation of training. |
| | | AN.24 | 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. | Observation on site/ check with Contractor on implementation of proprietary noise barriers etc.. |
| | | AN.25 | Contractor to use/ implement noise barrier with minimum height of 3m along Recommended Area of Conservation for ecological receptors, and 12m along Woodlands Road fronting human receptors such as West View Primary School, Senja Care Home, Vanguard Senior Care Senja Centre (minimum STC35). | Observation on site/ check with Contractor on implementation of noise barriers at proposed locations. |
| | | **ADDITIONAL MITIGATION MEASURES TO BE IMPLEMENTED DURING CONSTRUCTION PHASE** | | |
| | | AN.26 | 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 prioritized. | Check NMP report for predicted noise sources<br>Check equipment specification brochure (to be provided by Contractor on request).<br>Check and compare equipment inventory with NMP reported equipment inventory list and noise data. |
| | | AN.27 | 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. | Check first month EMMP report for noise exceedances and proposed implementation of additional noise source control measures. Contractor to provide noise data and site investigation findings upon request.<br><br>Observation on site if proposed additional mitigation measures are implemented/ check with Contractor. |

## 8.4.5 Vector Control

| Activity | Potential Environmental Impacts | Clause | Mitigation Measures to be Implemented by Contractor | Inspection Tasks to be Carried out by the EMMP Consultant |
|---|---|---|---|---|
| **Vector** | | | | |
| **General construction activities** | • Vector breeding<br>• Spread of virulent diseases | AC.1 | Preparation and implementation of an effective vector control plan and measures as required under NEA's Code of Practice for Environmental Control Officers. | Check that the vector control plan and associated measures have been implemented by the Contractor |
| | | AC.2 | The Contractor should clear and dispose of all rubbish, debris in the worksite, drains and side tables, surplus excavated earth, materials etc. and those arising from his works to approved disposal sites; Upon completion of works, contractor to leave site in clean condition. | Check that the Contractor has disposed of all rubbish, debris in the worksite, drains and side tables, in addition to surplus excavated earth, materials etc., and those arising from works to disposal sites.<br><br>Upon completion of all works, check that the Contractor has left the site clean. |
| | | AC.3 | Contractor should adhere to Control of Vectors and Pesticides Act (CVPA) [R-14] and ensure good housekeeping on-site; Scheduled daily housekeeping to ensure clearance of stagnant water and unwanted items are discarded properly. | Check the Contractor has scheduled daily housekeeping prior to the start of the project and check that this is being implemented, by Contractor upon start of construction works. |
| | | AC.4 | 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. | Check that all water-bearing receptacles, gaps on grounds and equipment (e.g., openings at concrete barriers), as well as stockpiled areas are covered or sheltered on a regular basis. |
| | | AC.5 | Site entrance shall be paved to avoid ground depression. | Check that the site entrance is paved prior to start of pre-construction works. |
| | | AC.6 | Milled waste can be used to level the ground before laying steel plates. | Check that milled waste has been used to level the ground before any steel plates are laid. |
| | | AC.7 | Pump shall be deployed to clear water at areas where drainage is not possible, as well as for larger recessed surfaces. | Check that a pump has been deployed prior to the start of construction, in areas where drainage is not possible, and for larger recessed areas. |
| | | AC.8 | Install pitched roof on top and/or seal up bottom of site container office. | Check that a pitched roof and/or sealed up bottom has been installed on the site officer container. |
| | | AC.9 | After trees clearance, top of tree stumps has to be either remove thoroughly or patched up. | Following tree clearance, check that all tree stumps have been removed or patched up. |
| | | AC.10 | Pipette can be used for larvae-checking at the hard-to-reach parts of a tree. | Following tree clearance, check that no vector larvae are present using pipettes in hard-to-reach parts of the tree. Check all visible parts of the tree. |

| Activity | Potential Environmental Impacts | Clause | Mitigation Measures to be Implemented by Contractor | Inspection Tasks to be Carried out by the EMMP Consultant |
|---|---|---|---|---|
| | | AC.11 | Food disposal should be clearly allocated and disposed of on a daily basis to discourage rodents from establishing nests on site and to prevent cockroach infestation. | Before pre-construction stage, check that a food disposal bin is provided on site at an appropriate location(s).<br><br>On a daily basis, check that all food waste is properly being disposed of. |
| | | AC.12 | Store food in rodent proof storage containers/ cabinets with at least 60 cm clearance above ground level. | Before pre-construction stage, check that rodent proof containers/cabinets are provided to the precise specification. |
| | | AC.13 | Regular Fogging is not recommended, as it may build up mosquitoes' resistance over time. Priority focus to be given on elimination of mosquito breeding sources e.g., stagnant water on site. If outbreak already occurred, localised treatment methods such as oiling and misting are preferred over fogging. | Check that fogging is not undertaken regularly and breeding sources i.e., stagnant water observed on site, is eliminated immediately. |

## 8.4.6 Waste Management

| Activity | Potential Environmental Impacts | Clause | Mitigation Measures to be Implemented by Contractor | Inspection Tasks to be Carried out by the EMMP Consultant |
|---|---|---|---|---|
| **Waste** | | | | |
| **General construction activities (including disposal of construction waste from site and adjacent roads and walkways, Disposal of organic waste, disposal of toxic waste as defined in the EPHA and EPH (Toxic Industrial Wastes) Regulations)** | • Waste generation and disposal | AM.1 | The Contractor shall dispose demolished materials, debris and unsuitable excavated materials including Waste materials and Contaminated materials within the Project Boundary to disposal sites subjected to SO Rep.'s approval.<br><br>Avoid burning of waste or other materials. | Check that the Contractor is disposing of all demolished materials, debris, and unsuitable excavated materials within designated disposal sites on a regular basis. |
| | | AM.2 | The use or disposal for excavated earth from the proposed work site shall be as follows:<br>• Good Earth suitable for use as approved material for filling and approved by the SO Rep. shall be used for site filling up to the required platform in accordance with Section 5 of the Standard Specifications for Civil Engineering Works (2019 Edition);<br>• Soft Clay acceptable by the operator of Aviation Park Staging Ground (APSG) or Tanah Merah Staging Ground (TMSG) shall be transported to Aviation Park Staging Ground (APSG) or Tanah Merah Staging Ground (TMSG); and<br>• Excavated earth/material that is deemed unsuitable by SO Rep. for filling or disposal at HDB's Staging Grounds shall be transported to Contractor's own disposal sites approved by the authorities. | Observation on site or check with Contractor if proper use and disposal of excavated earth is carried out. |
| | | AM.3 | The Contractor shall permit access by approved soil testing laboratories in Singapore and/or personnel from approved disposal sites to the Contractor's work site to evaluate the suitability of the excavated materials for disposal at the approved disposal sites. | Check with Contractor that the excavated earth from all sites has been tested within a laboratory in Singapore and/or by personnel from approved disposal sites, to evaluate the suitability of the materials for disposal at approved disposal sites. |

| Activity | Potential Environmental Impacts | Clause | Mitigation Measures to be Implemented by Contractor | Inspection Tasks to be Carried out by the EMMP Consultant |
|---|---|---|---|---|
| | | AM.4 | The Contractor shall take all reasonable measures to avoid mixing different types of spoils. Should two or more different types of spoils get mixed during the course of the excavation/ loading, the spoils which arrived at approved disposal sites, shall take the classification of the component that appears lowest on the following list:<br>• Good Earth;<br>• Soft Clay;<br>• Waste Material; and<br>• Contaminated Material.<br>The Contractor shall conduct all necessary classification tests including the density tests (as per required and subjected to approval by SO Rep.). | Check that the Contractor has undertaken all necessary classification tests including density tests to all excavated material.<br><br>Check that the Contractor is aware that mixing of different spoils must be avoided, prior to the start of excavation works and that all suitable measures are implemented. |
| | | AM.5 | In the event artificial obstructions and/or Unexploded Explosive Ordnance (UXO) are found during the course of Construction Works the Contractor shall immediately inform the Singapore Police Force (SPF), relevant authorities and the SO Rep. He shall also immediately follow up on appropriate safety measures and provision of security personal if required by SPF, relevant authorities and/or SO Rep. to ensure site safety. | If an artificial obstruction and/or UXO is found on site during construction, check that the Contractor has informed the Singapore Police Form, relevant authorities and the SO Rep., and check that all appropriate safety measures and provision of safety personnel have been met. |
| | | AM.6 | If the discovered UXO is classified by SPF or relevant Authorities as "unsafe" to remove, the removal shall be managed by SPF or relevant Authorities, working closely with the Contractor and/or SO Rep.. | N/A |
| | | AM.7 | If the discovered UXO is classified by SPF or relevant Authorities as "safe" to remove, the Contractor shall engage an Explosive Ordnance Disposal (EOD) specialist with Arms and Explosive (A&E) License registered by the SPF to remove UXO. The EOD specialist shall investigate and identify the UXO correctly, evaluate, classify, and obtain necessary approvals/ permits for removal, transfer, temporary storage, and disposal of UXO according to the requirements by SPF or relevant Authorities. | In the instance a UXO is discovered and deemed "safe" to remove, check that the contractor has engaged an EOD specialist with A&E License registered by the SPF. |

| Activity | Potential Environmental Impacts | Clause | Mitigation Measures to be Implemented by Contractor | Inspection Tasks to be Carried out by the EMMP Consultant |
|---|---|---|---|---|
| | | AM.8 | All historical artefacts etc. discovered within the site are the property of the Employer and shall not be removed from the site and shall be left in an un-disturbed as far as feasible. In the event any historical artefacts such as granite boundary marker etc. is discovered on site, the Contractor shall immediately inform the SO Rep. and Employer. The Contractor shall immediately implement the necessary protection measures within the demarcated area to prevent any damage to the artefacts and shall ensure no work is carried out until the artefacts are extracted completely with proper care. Any protection and extraction measures given by the relevant Authorities shall be complied with accordingly. | In the instance a historical artefact is found on site, check that the Contractor has implemented all necessary protection measures within the demarcated area to prevent damage to said artefacts.<br><br>Check that advice from relevant Authorities is being complied with. |
| | | AM.9 | Applying waste minimisation techniques and good practices on site following waste management hierarchy, i.e., source reduction, waste exchange, recycling, reuse, and waste segregation. Implement strict waste handling, storage, collection, and disposal practices to prevent leakages. | Check that waste minimisation techniques and good practice is implemented on site. Check for the following: source reduction, waste exchange, recycling, reuse, and waste segregation. Implement strict waste handling, storage, collection, and disposal practices to prevent leakages. |
| | | AM.10 | Plan for timely on-site separation and collection of materials with waste stream specific schedules in place; Construction waste should be properly segregated and have set storage locations to extract recoverable and recyclable materials which can then be reused or recycled. | Check that on-site separation and collection of materials with waste stream specific schedules are in place prior to the start of the construction phase.<br><br>Routinely check that waste is properly segregated and that set storage locations are present on site. |
| | | AM.11 | All horticultural waste should be transported off-site to specialized horticultural recycling facilities where they can be grinded into wood ships which can be turned into mulch or compost. Where possible, wood recycling as wood chips into new wood products by mixing it with binders should be prioritized. As an alternative, horticultural waste which is not suitable to be recycled should be used as fuel in biomass power plants. | Check that the Contractor has a suitable plan in place, prior to site clearance, for the disposal of horticultural waste to horticultural recycling facilities. |
| | | AM.12 | 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. | Check that the Contractor has a plan in place to recycle any waste concrete, prior to construction. |

| Activity | Potential Environmental Impacts | Clause | Mitigation Measures to be Implemented by Contractor | Inspection Tasks to be Carried out by the EMMP Consultant |
|---|---|---|---|---|
| | | AM.13 | Separate the different forms of hazardous waste, provide treatment on site if applicable and set up protocols for spillage. Used absorbent materials should be disposed through a licensed third-party toxic industrial waste disposal contractor. | Check that the Contractor has separate disposal containers for hazardous waste, clearly marked and labelled.<br><br>Check that a protocol is in place to deal with spillages of hazardous waste prior to site works commencing. |
| | | AM.14 | Biodigesters or composting stations could be introduced onsite to deal with food waste generated by workers, converting it into grey water or compost which can then be reused onsite. These stations are usually well sealed which also reduces the hazard of wildlife being attracted to the area. | N/A |
| | | AM.15 | Provide adequate garbage/ trash bins with tight lid (animal-proof bin) to prevent animals from getting into it. | Check prior to site works and on a regular basis that enough garbage bins are provided on site, in suitable locations, ensuring they are animal proof. |
| | | AM.16 | Recycling bins should be provided alongside every trash bin with well-labelled signs and examples of common recyclables items to help workers sort their waste. | Check prior to site works and on a regular basis that recycling bins are provided alongside each trash bin, with well labelled signage detailing which items can be recycled. |
| | | AM.17 | Provide sufficient and maintain proper sanitary facilities at the worksite and connect discharge points to septic tanks and or the public sewage for disposal. | Check prior to site works and on a regular basis that there are sufficient sanitation facilities on site, that are kept in good condition, and which discharge to septic tanks/public sewage. |
| | | AM.18 | Sewage not connected to the main sewage system should have sufficient storage capacity and a clearance schedule that matches the volume being produced. | Check prior to site works and ongoing throughout the project that any sewage not connected to the main sewage system has sufficient storage capacity and an appropriate clearance schedule that matches the volume being produced. |
| | | AM.19 | Identify all types of solid waste and implement comprehensive waste management system at the site to ensure proper disposal and prevent pollution to the environment. | Check that a comprehensive waste management system has been implemented at the site prior to site works commencing. |
| | | AM.20 | The Contractor should conduct a construction risk assessment and prepare a comprehensive construction health, safety, and environment plan. If health impacts to workers are foreseen due to the handling of such waste, necessary precautionary measures as per the safety data sheets (SDS) including personal protective equipment should be implemented on site. | Check that the Contractor has conducted a construction risk assessment and prepared a comprehensive construction health, safety, and environment plan, prior to site works commencing.<br><br>Check that this is being implemented effectively on an ongoing basis. |
| | | AM.21 | Proper waste disposal guidelines of construction waste and hazardous material should be strictly adhered to, in order to prevent habitat pollution which impedes seedling recruitment. | Check that waste disposal guidelines of construction waste and hazardous materials are strictly adhered to, on an ongoing basis. |

# 8.5 Summary of Monitoring Plan and the Responsible Parties

## 8.5.1 Biodiversity

| Activity | Monitoring Plan | Frequency | Trigger for Corrective Actions | Rectification Timeline | Implementation Responsibility | Inspection Responsibility |
|---|---|---|---|---|---|---|
| **Biodiversity: Flora** | | | | | | |
| Major Impact:<br>• Site clearance<br>• Earth works<br>• Tree-felling works<br><br>Minor Impact:<br>• Pre-construction survey<br>• Soil Investigation works<br>• Hoarding works<br>• Road works<br>• Proposed outlet drain constructions | **Monthly Flora Inspection**<br>Visual inspection for the presence of forest edge effects and new invasive weed species | Monthly throughout the construction phase | Corrective actions will need to be taken if:<br>• Invasive flora species has excessively colonised the existing forest that are pre-dominantly native; and<br>• Removal of these invasive weed species along new forest edge is required. | N/A | Contractors' ECO | EMMP Consultant |
| | **Monthly Flora Inspection**<br>Visual inspection for habitat degradation (e.g., any rubbish and/or construction waste) within 15m of the RAC or the new forest edge from proposed construction activities | Monthly throughout the construction phase | Corrective actions will need to be taken if:<br>• The EMMP Consultant finds that habitat degradation has taken place; recommendations tailored to the finding should be adhered to. | 48 hours | EMMP Consultant | SO Rep.* |
| | **Monthly Flora Inspection**<br>Excessive clearance of vegetation beyond the hoarding line of the Project Area | Monthly throughout the construction phase | Corrective actions will need to be taken depending on the extent of the excessive clearance:<br>• Report to SO Rep. for downstream reporting to NParks. | N/A | N/A | EMMP Consultant |
| **Biodiversity: Arboriculture** | | | | | | |
| Major Impact:<br>• Site clearance<br>• Earth works<br>• Tree-felling works<br><br>Minor Impact:<br>• Pre-construction survey<br>• Soil Investigation works | **Monthly Tree Inspections**<br>Visual inspection of the trees along 15m from the hoarding line. Some factors that will be inspected are: Physiological health and structural stability of trees.<br>Identify and assess trees that requires removal for the safety of the workers. | Monthly throughout the construction phase | Corrective actions will need to be taken if:<br>• The structure and health of the trees along the new forest edge has deteriorated and are deemed unsafe by an appointed Arborist;<br>• Removal of these trees may be required; and<br>• Encroachment into or removal of TPZs resulting in impairment of structural stability and/or physiological health of trees. | 24 hours | EMMP Consultant/ Appointed Arborist | Appointed Arborist |

| Activity | Monitoring Plan | Frequency | Trigger for Corrective Actions | Rectification Timeline | Implementation Responsibility | Inspection Responsibility |
|---|---|---|---|---|---|---|
| • Hoarding works<br>• Road works<br>• Proposed outlet drain constructions | | | | | | |
| **Biodiversity: Fauna** | | | | | | |
| Major Impact:<br>• Site clearance<br>• Earth works<br>• Tree-felling works<br><br>Minor Impact:<br>• Pre-construction survey<br>• Soil Investigation works<br>• Hoarding works<br>• Road works<br>• Proposed outlet drain constructions | **Monthly Fauna Monitoring**<br>Conduct fauna monitoring within the Forest Corridor to monitor for construction impacts on fauna activity and presence. | Once during pre-construction phase<br>Monthly throughout construction phase | Corrective actions will need to be taken if:<br>• Excessive disturbance generated by construction activities is detected | 24 hours | EMMP consultant | SO Rep.* |
| | **Daily Roadkill Surveys**<br>Surveys to monitor for roadkill incidences at major roadways adjacent to the site. | Daily throughout construction phase | Corrective actions will need to be taken if:<br>• More than two roadkill incidents involving targeted species (Sunda Pangolin, Leopard Cat and Eurasian Wild Boar) occur within 7 days of each other;<br>• Contractor to check the integrity of the hoarding line along Woodlands Road, and carry out rectification, if any. | 24 hours | Contractor | EMMP Consultant |
| | **Wildlife Corridor Camera Trap Monitoring**<br>• Conduct continuous camera trapping, with monthly data retrieval, to monitor for wildlife utilising the corridor. | Monthly data retrieval | Corrective actions will need to be taken if:<br>• If the wildlife corridor operation protocol is not adhered to, a report will be submitted to NParks by SO Rep. | 24 hours for findings that may result in fauna mortality. | EMMP Consultant | SO Rep.* |
| Note:<br>* The EMMP Consultant should inform and instruct the Contractor if any issue is found from the implemented measures. The EMMP Consultant should also inform the SO Rep. for further follow-up action if necessary. | | | | | | |

## 8.5.2 Water Resources

| Activity | Monitoring Plan | Frequency | Triggers | Implementation Responsibility | Inspection Responsibility |
|---|---|---|---|---|---|
| Site clearance, spillage of oil, fuel and lubricant from vehicle and machinery, oil drips from generator, chemical spill, proposed outlet drain construction works. | • Earth Control Measures (ECM) Implementation<br>Earth Control Measures should be inspected and maintained throughout the construction programmed by the QECP which will be reviewed in tandem with the progress of works. This may involve replacement of silt fences and erosion control blankets, repaving of concrete surfaces, etc. | All stages | Investigation and corrective actions to be taken, when:<br>• The following documentation are found inadequate/missing:<br>o ECM Plan;<br>o Monitoring Log;<br>o Training Log;<br>o Audit Reports;<br>• If the monitored parameters exceed applicable values of NEA Trade Effluent Discharge Limits to Controlled Watercourse;<br>• If groundwater level change of ± 3m (to be confirmed by Qualified Professionals);<br>• If any flooding or clogging issues observed;<br>• If complaints are received due to project activities; and<br>• If visual non-compliance to any of the minimum control or mitigation measures are observed on-site. | Contractor/QECP | EMMP Consultant & EMMP Consultant's ECO |
| | • Earth Control Measures (ECM) Implementation<br>Real-time monitoring of Turbidity or TSS, and implementation of CCTV including a SIDS installed at every discharge outlet | Continuous monitoring | | Contractor/QECP | EMMP Consultant/ EMMP Consultant's ECO |
| | • Surface Water Monitoring<br>Water quality sampling at all discharge outlets of construction site to ensure the discharge water quality in accordance with NEA's Allowable Limits for Trade Effluent Discharge in a controlled watercourse. | Monthly monitoring at construction discharge points for additional parameters during construction phase. | | Contractor | EMMP Consultant/ EMMP Consultant's ECO |
| | • Groundwater Monitoring<br>Groundwater quality monitoring. | Prior to any discharge of extracted groundwater into the public drains. | | Contractor | EMMP Consultant/ EMMP Consultant's ECO |
| | • Groundwater Monitoring<br>• Groundwater level monitoring. | Monthly at MW1 and MW2 throughout construction phase. | | Contractor | EMMP Consultant/ EMMP Consultant's ECO |

| Activity | Monitoring Plan | Frequency | Triggers | Implementation Responsibility | Inspection Responsibility |
|---|---|---|---|---|---|
| | • Groundwater Monitoring<br>Groundwater level and quality monitoring as required in Singapore Building Control Regulations 2003 [R-23] during dewatering process at where the excavation take place. | Weekly throughout construction phase. | | Contractor | EMMP Consultant/ EMMP Consultant's ECO |
| | • Daily inspection on perimeter drains to ensure no surface runoff flowing out from the site untreated with monthly audit. | Daily inspection; monthly audit | | Contractor | EMMP Consultant/ EMMP Consultant's ECO |
| Note: * The EMMP Consultant should inform and instruct the Contractor if any issue is found from the implemented measures. The EMMP Consultant should also inform the SO Rep. for further follow-up action if necessary. | | | | | |

## 8.5.3 Air Quality

| Activity | Monitoring Plan | Frequency | Triggers | Implementation Responsibility | Inspection Responsibility |
|---|---|---|---|---|---|
| Site clearance, machinery and generator operation, vehicle. | Monitoring of $PM_{10}$ and $PM_{2.5}$ at four (4) locations | 1-week baseline prior to start of construction works. | Prior to start of construction works. | Contractor | EMMP Consultant/ EMMP Consultant's ECO |
| | | Real-time continuous monitoring during earthworks and site clearance phase. | When earthworks and site clearance activity start. | | |
| | | Bi-annual one month monitoring during building construction phase, except for earthworks and site clearance phase. | After earthworks and site clearance phase, during building construction phase. | | |
| | Carry out bi-weekly site inspection during construction phase. | Bi-weekly | - | N/A | EMMP Consultant |
| Note:<br>* The EMMP Consultant should inform and instruct the Contractor if any issue is found from the implemented measures. The EMMP Consultant should also inform the SO Rep. for further follow-up action if necessary. | | | | | |

## 8.5.4 Airborne Noise

| Activity | Monitoring Plan | Frequency | Triggers | Implementation Responsibility | Inspection Responsibility |
|---|---|---|---|---|---|
| Airborne noise impact from site preparation for earthworks, foundation works, superstructure, landscape works, and removal of temporary re-instatement. | Monitoring of $L_{Aeq(12\ hr)}$ $L_{Aeq(1\ hr)}$ and $L_{Aeq(5min)}$ at seven (7) locations by Contractor;<br><br>Compare the monitoring result with the adjusted maximum permitted noise level from the construction activities in accordance with the noise legislation stated in Environmental Protection and Management (Control of Noise at Construction Sites) Regulations, 2008. Ecological receptor noise impact will be assessed against the baseline noise level as the noise criterion. | Before commencement of any construction works (including site clearance)<br>• One-time airborne noise monitoring for 1 week at the seven (7) proposed locations (see Figure 8-1), for establishment of latest baseline.<br><br>During Construction Phase<br>• Continuous monitoring at the six (6) proposed locations (see Figure 8-5) for the entire duration of construction.<br>• Records on noise levels from construction sites should be properly kept and produced when requested. | Noise sensitive human and ecological receptors are next to construction site | Contractor | EMMP Consultant/ EMMP Consultant's ECO |
| | Daily inspection by ECO on entire boundary facing residential areas, as well as internal for ecological sensitive receptors. | • Daily | - | Contractor's ECO | EMMP Consultant/ EMMP Consultant's ECO |
| | ECO will carry out ad-hoc noise monitoring during the daily site inspection. | • Daily | - | Contractor's ECO | EMMP Consultant/ EMMP Consultant's ECO |
| | Carry out bi-weekly site inspection during construction phase. | • Bi-weekly | - | Contractor's ECO | EMMP Consultant's ECO |

| Activity | Monitoring Plan | Frequency | Triggers | Implementation Responsibility | Inspection Responsibility |
|---|---|---|---|---|---|
| Note:<br>* The EMMP Consultant should inform and instruct the Contractor if any issue is found from the implemented measures. The EMMP Consultant should also inform the SO Rep. for further follow-up action if necessary. | | | | | |

## 8.5.5 Vector Control

| Activity | Monitoring Plan | Frequency | Triggers | Implementation Responsibility | Inspection Responsibility |
|---|---|---|---|---|---|
| General construction activities | Site inspection [potential mosquitoes breeding grounds (water ponding), rat/ rodent burrows, cockroaches droppings, etc.] | Daily during construction phase | Investigation and corrective actions (i.e., Stop Work Orders) to be taken, when:<br>• Worksite is found to have vector-breeding habitats; and<br>• There is an occurrence of suspected dengue outbreak cases. | In-house vector control team | Contractor's ECO |
| | Vector control and surveillance [potential mosquitoes breeding grounds (water ponding), rat/ rodent burrows, cockroaches droppings, etc.] | Weekly during construction phase | | Contractor's ECO | Contractor/EMMP Consultant's ECO/EMMP Consultant/ SO Rep.* |
| | Submission of Vector Control Plan | Prior construction | | Contractor's ECO | Contractor/ Contractor's ECO |
| | Submission of Vector Baseline Report | At the beginning of each construction stage | | Contractor's ECO | EMMP Consultant's ECO/EMMP Consultant/ SO Rep.* |
| | Submission of Vector Service Report | At the end of each mosquito and rodent/rat control services | | Contractor's ECO | EMMP Consultant's ECO/EMMP Consultant/ SO Rep.* |

| Activity | Monitoring Plan | Frequency | Triggers | Implementation Responsibility | Inspection Responsibility |
|---|---|---|---|---|---|
| Note:<br>* The EMMP Consultant should inform and instruct the Contractor if any issue is found from the implemented measures. The EMMP Consultant should also inform the SO Rep. for further follow-up action if necessary. | | | | | |

## 8.5.6 Waste Management

| Activity | Monitoring Plan | Frequency | Triggers | Implementation Responsibility | Inspection Responsibility |
|---|---|---|---|---|---|
| General construction activities (including disposal of construction waste from site and adjacent roads and walkways, Disposal of organic waste, disposal of toxic waste as defined in the EPHA and EPH (Toxic Industrial Wastes) Regulations) | Site-specific waste strategy and management plan (including monitoring, review, and reporting protocol) | Prior construction | Investigation and corrective actions to be taken, when:<br>• There are no/ poor records of toxic chemical waste amount and type; and<br>• There is evidence of poor handling/ storage of toxic chemical waste and hazardous chemical. | Contractor | EMMP Consultant's ECO/ EMMP Consultant/ SO Rep.* |
| | Waste management/housekeeping works | Daily during construction phase | | On-site waste management team | Contractor/ EMMP Consultant's ECO/ EMMP Consultant/ SO Rep.* |
| | Environmental performance monitoring | Monthly during construction phase | | Contractor | EMMP Consultant's ECO/ EMMP Consultant/ SO Rep.* |
| | Inspection on proper disposal of organic waste, hazardous waste, other wastes and any oil/chemical spill and preparation of log sheet if required | Daily during construction phase | | Contractor | EMMP Consultant's ECO/ EMMP Consultant/ SO Rep.* |
| | Inspection on hazardous chemical/substances storage | Weekly during construction phase | | Contractor | EMMP Consultant's ECO/ EMMP Consultant/ SO Rep.* |

| Activity | Monitoring Plan | Frequency | Triggers | Implementation Responsibility | Inspection Responsibility |
|---|---|---|---|---|---|
| | Audit on waste management/housekeeping works | Monthly during construction phase | | EMMP Consultant/ EMMP Consultant's ECO | EMMP Consultant/ SO Rep.* |
| Note:<br>* The EMMP Consultant should inform and instruct the Contractor if any issue is found from the implemented measures. The EMMP Consultant should also inform the SO Rep. for further follow-up action if necessary. | | | | | |

# 9 Emergency Response Plan

## 9.1 Objective

In order to safeguard the environment and workers health and safety, an emergency preparedness and response plan for any emergency/ incidents/ accidents happen during construction according to the regulations/ guidelines (e.g., Environmental Protection and Management Act, Environmental Public Health Act, Building Control Act, Control of Vectors and Pesticides Act, Code of Practice on Surface Water Drainage, National Heritage Board Act, Parks and Trees Act and Sewerage and Drainage Act).

The Emergency Response Plan (ERP) was developed to provide guidance and strategies for wildlife encounter and other environmental incidents. If any environmental incident happened on site, the Contractor/EMMP Consultant's ECO should conduct the investigation on the incident immediately and should record and report the incident using the attached form as in Appendix D. The ERP include information regarding procedures on encounter of specific animal, procedure during forest fire and procedure during chemical/hazardous substance spill as provided in following sections.

## 9.2 Emergency Contact Summary for Environmental Incident

**Table 9-1 Summary of Responsible Parties for Environmental Incident**

| Incident | Responsible Person |
|---|---|
| All environmental incident | • Contractor<br>• Contractor's ECO<br>• EMMP Consultant's ECO<br>• EMMP Consultant |
| Encounter of dead animals | • Contractor<br>• Contractor's ECO<br>• EMMP Consultant's ECO<br>• EMMP Consultant |
| Encounter of injured animals | • EMMP Consultant<br>• Animal Response Centre |
| Fire event | • Singapore Civil Defence Force (SDCF) |
| Chemical/Oil spill | • Contractor<br>• Contractor's ECO<br>• EMMP Consultant's ECO<br>• EMMP Consultant |

## 9.3 Wildlife Response Plan

The Wildlife Response Plan will be activated whenever a trapped/injured/dead/dangerous animal is encountered around or within the worksite. The objective of the Wildlife Response Plan is to minimise animal injury and mortality by responding appropriately to the different scenarios in Figure 9-1. This will be emphasized during the toolbox briefings (Section 6.2.1.2). All wildlife incidents shall be reported and documented in a Wildlife Incident Form (Appendix C).

Where species of conservation significance are affected by development, relocation works may be planned (e.g., bamboo bats; see Section 11.10.1.3 of the CCK N1 EIA Report). Where fauna is trapped on-site, species-specific methods (e.g., partitioning site, one-way flap doors) shall be formulated to remove them, in consultation with NParks.

If any wild boar is spotted at or around the Site at any time during the Project, NParks must be notified as soon as possible at nparks_wildlife_management@nparks.gov.sg. An approved wild boar removal contractor must also be engaged to trap and remove the said wild boar. Do note that the trapping and removal process may take about 4-8 weeks.

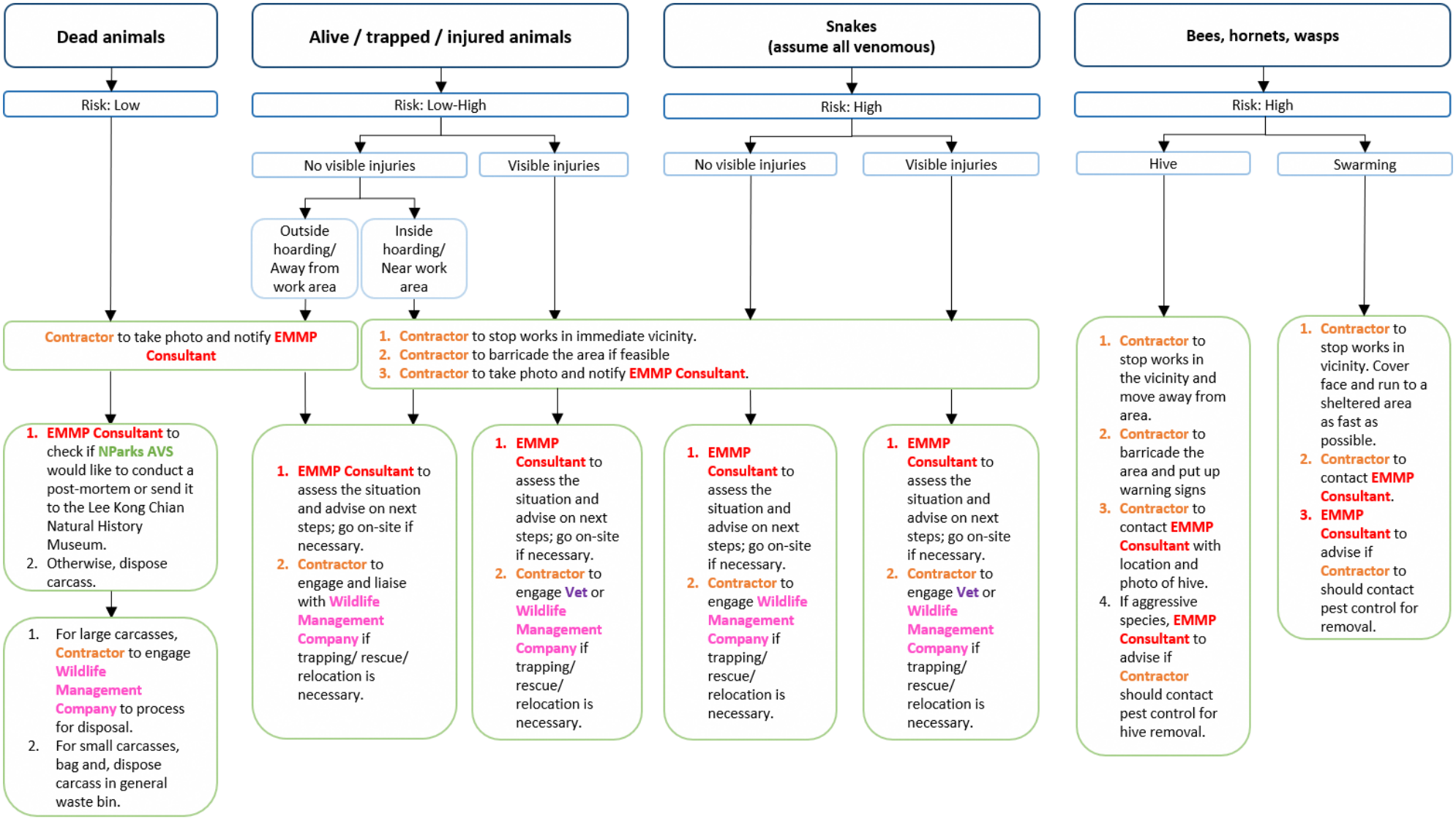



**Figure 9-1 A Flowchart of The Wildlife Response Plan. An Approved Wildlife Management Company [W-9] Needs to be Engaged by the Contractor**

# 9.4 Roadkill Response Plan

The Roadkill Response Plan will be activated whenever an injured animal or animal carcass is encountered either opportunistically or during roadkill surveys at public roads directly adjacent to the worksite. The objective of the Roadkill Response Plan is to minimise animal injury and mortality by responding appropriately to the different scenarios (Figure 9-2). All wildlife incidents shall be reported and documented on the EDMS platform (Section 7).

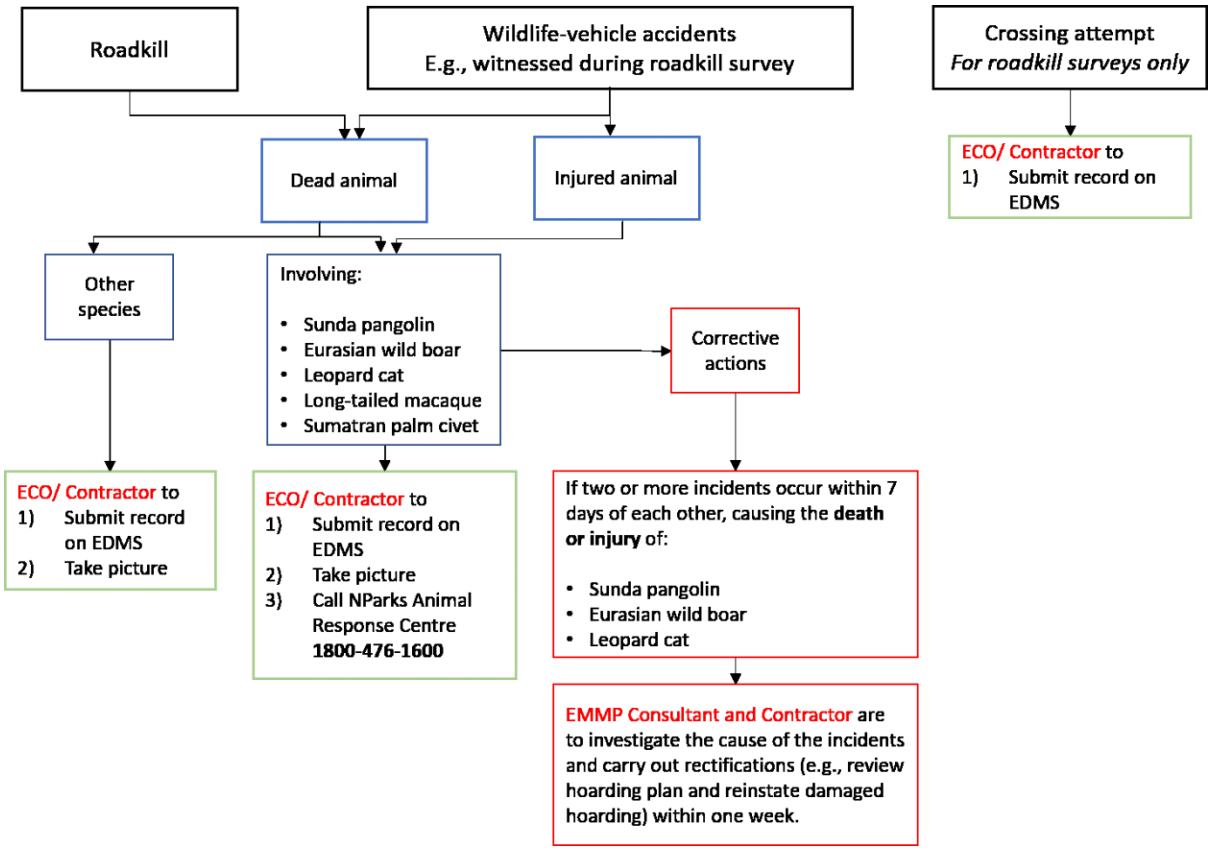



**Figure 9-2 Response Plan and Corrective Actions to be Taken for Three Wildlife-Vehicle Scenarios**

# 9.5 Response Plan for Drainage, Surface Water and Groundwater Incidents

The response plan (refer to Figure 9-3) will be initiated when there is any relevant drainage, surface water or groundwater incidents occurred around or within the worksite. All incidents should be reported and documented in an Incident Form (Appendix C).

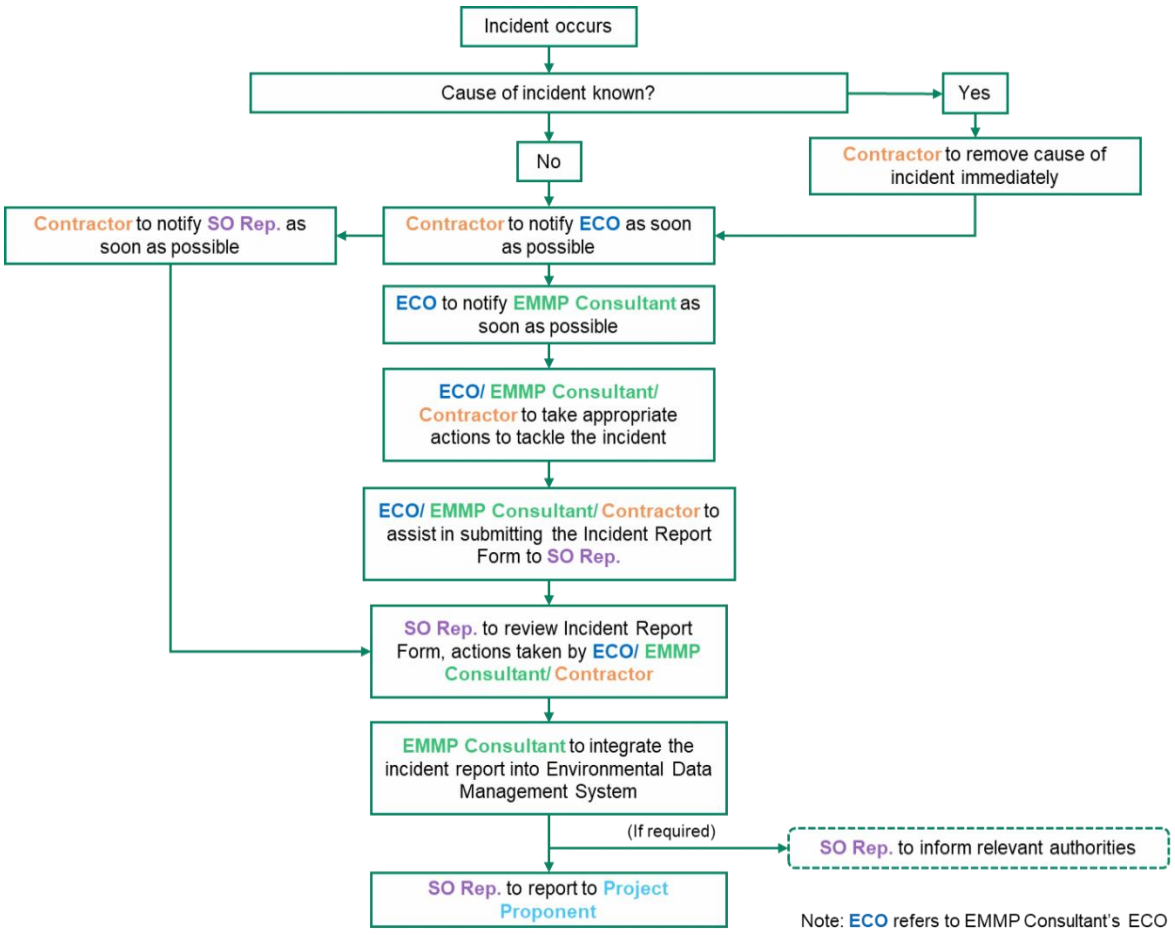



**Figure 9-3 Flowchart of Drainages, Surface Water and Groundwater Incidents Response Plan**

# 9.6 Response Plan for Relevant Air Quality Incidents

In the event that an abnormal amount of smoke/ dust/ odour is released from the project site, the Contractor shall follow the procedure as shown in Figure 9-4. The template of the Incident Report Form is as attached in Appendix D. The report shall be submitted to the SO Rep. by EMMP Consultant.

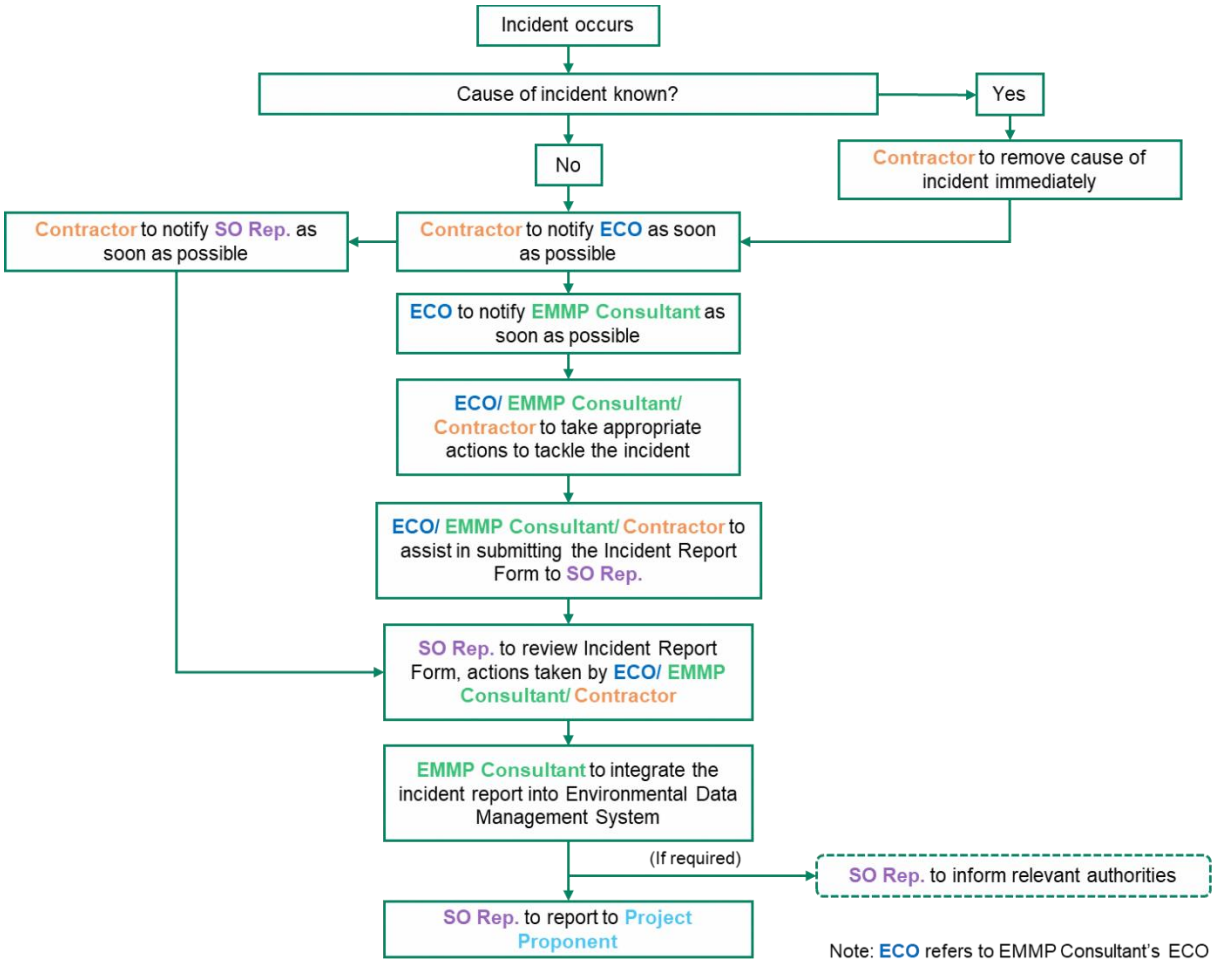



**Figure 9-4 Flowchart of Relevant Air Quality Incident Reporting**

# 9.7 Response Plan for Relevant Airborne Noise Incidents

In the event that an abnormal level of airborne noise is felt from the project site, the Contractor shall follow the procedure as shown in Figure 9-5. The template of the Incident Report Form is as attached in Appendix D. The report shall be submitted to the SO Rep. by the EMMP Consultant's ECO/EMMP Consultant.

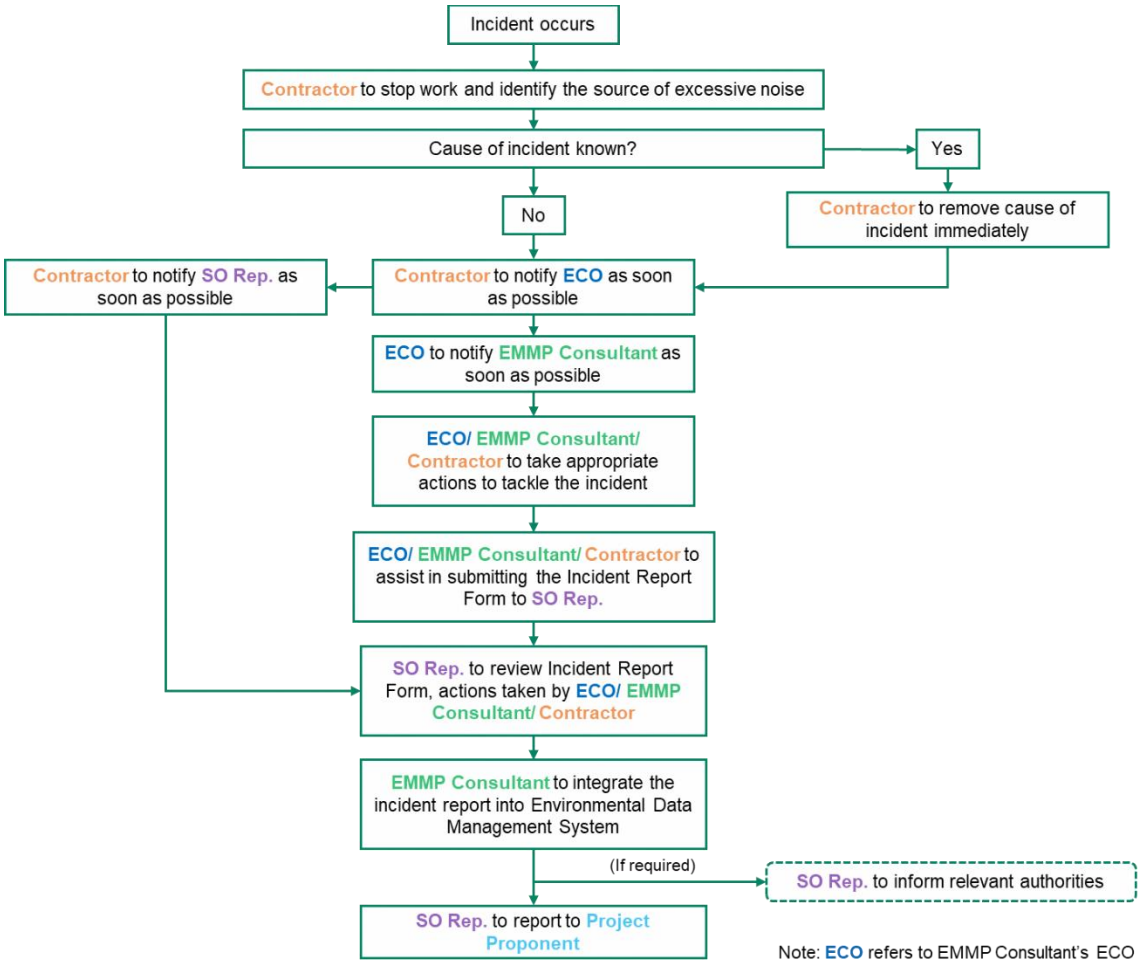



**Figure 9-5 Flowchart of Relevant Airborne Noise Incident Reporting**

# 10 Conclusion

The overall EMMP has been developed based on the completed EIA of CCK N1, discussion with SO Rep., HDB and Technical Agencies (i.e., NEA, NParks and PUB) and the available information from the Client. The environmental impact study conducted for the project has identified key findings regarding the baseline conditions and impact assessment. The study highlights the importance of conservation efforts and recommends specific areas for conservation.

The overall timeline for the whole construction is approximately sixty-seven (67) months. The proposed construction activities and timeline have been outlined, along with potential impacts and mitigation measures. Applicable environmental legislation and international references have been considered, covering various aspects such as biodiversity, hydrology, air quality, noise, vector control, and waste management. The regularised ecological corridor will be retained and would not be cleared during construction.

The EMMP is a 'live document' that detailed the identification of potential site-specific impacts, mitigation measures that should be implemented, adaptive monitoring and inspection programs as well as reporting and requirement based on the EIA for Choa Chu Kang N1. It has taken into account the baseline conditions at the work site, Project components, activities and experience in similar development projects.

Standard mitigation measures for construction activities and environmental training have been specified to minimise adverse effects. These measures encompass biodiversity, hydrology, surface water, groundwater, air quality, airborne noise, vector control, and waste management. Environmental training is mandatory for site personnel to enhance awareness and compliance. Site-specific measures and responsible parties are identified, along with a comprehensive monitoring plan. An emergency response plan is included, outlining objectives and response procedures for environmental incidents, wildlife incidents, roadkill, drainage incidents, air quality incidents, and airborne noise incidents.

To ensure the information in the EMMP is up to date in the event of any possible changes, it is recommended that the EMMP be updated when necessary for use by all parties involved in this Project.

The environmental management governing this Project shall set up a proper policy that displays their commitment to ensuring the environment is properly preserved and taken care of whilst the Project is carried out. The appointed Contractors should ensure that all the compulsory environmental controls and measures are implemented accordingly during the construction of the Project.

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# Appendix A

## AECOM Singapore Pte Ltd, Environmental Impact Assessment (EIA) on Choa Chu Kang N1 - Revision 01, Singapore 2023

Delivering a better world



# Environmental Impact Assessment (EIA) on Choa Chu Kang N1

## Final Report Rev 01

**Housing & Development Board (HDB)**

**Project reference: L/05/21**

**Project number: 60651709**

**March 21, 2023**

Delivering a better world

## Quality information

| Prepared by | Checked by | Verified by | Approved by |
|---|---|---|---|
| Grujica Sarenac (*Water Resources Specialist*)<br><br>Hanzel Lalitan<br>Tiffany Tan<br>(*Air Quality Specialists*)<br><br>Phyo Zay<br>Yi Ting Sim<br>(*Airborne Noise Specialist*)<br><br>Siti Zaleha Abdullah<br>Joys Tan<br>(*Biodiversity Specialists*) | Grujica Sarenac (*Deputy Project Manager*)<br><br>Dr. Hoai Thanh Nguyen (*Water Resources Technical Reviewer*)<br><br>Jagriti Dawra (*Air Quality and Airborne Noise Technical Reviewer*)<br><br>Ashley Welch (*Biodiversity Technical Reviewer*)<br><br>Derek Yap (*Biodiversity Team Lead*) | Jagriti Dawra (*Project Director*) | Dr. Hoai Thanh Nguyen (*Project Manager*) |

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## Prepared for:

Housing & Development Board (HDB)
HDB Hub
480 Lorong 6 Toa Payoh
Singapore 310480

## Prepared by:

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

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# List of Acronyms

| Acronym | Definition |
|---|---|
| **ABC** | Active, Beautiful, Clean |
| **ACMV** | Air Conditioning and Mechanical Ventilation |
| **AECOM** | AECOM Singapore Pte. Ltd. |
| **AHU** | Air Handling Unit |
| **ALARP** | As low as reasonably practicable |
| **ANZECC** | Australian and New Zealand Environment and Conservation Council |
| **ANZGFMW** | Australian and New Zealand Guidelines for Fresh and Marine Water |
| **ASR** | Air Sensitive Receptor |
| **BAT** | Best Available Technology |
| **BCA** | Building Construction Authority |
| **BEP** | Best Environmental Practice |
| **BIA** | Biodiversity Impact Assessment |
| **BTNR** | Bukit Timah Nature Reserve |
| **CBD** | Central Business District |
| **CCK** | Choa Chu Kang |
| **CCNR** | Central Catchment Nature Reserve |
| **CCS** | Central Control System |
| **CCTV** | Closed-Circuit Television |
| **CFU** | Colony Forming Unit |
| **CITES** | The Convention on International Trade in Endangered Species of Wild Fauna and Flora |
| **COD** | Chemical Oxygen Demand |
| **COPC** | Chemicals of Potential Concern |
| **COPPC** | SS 593: Code of Practice for Pollution Control, 2013 |
| **COVID-19** | Coronavirus disease identified since Year 2019 |
| **CUGE** | Centre for Urban Greenery and Ecology |
| **CR** | Critically Endangered |
| **CS** | Conservation Significance |
| **CCS** | Central Control System |
| **dB** | Decibel |
| **DGPS** | Differential Global Positioning System |
| **DO** | Dissolved Oxygen |
| **DOE** | Department of Environment (Malaysia) |
| **EBS** | Environmental Baseline Study |
| **EC** | Electrical Conductivity |
| **ECB** | Erosion Control Blanket |
| **ECM** | Earth Control Measures |
| **ECO** | Environmental Control Officer |
| **ECP** | Erosion Control Plan |
| **EHS** | Environmental Health and Safety |
| **EIA** | Environmental Impact Assessment |
| **EMMP** | Environmental Management and Monitoring Plan |
| **EN** | Endangered |
| **ERP** | Emergency Response Plan |
| **ERSS** | Earth Retaining and Stabilising Structures |
| **ERT** | Emergency Response Team |
| **EU** | European Union |
| **GNSS** | Global Navigation Satellite System |
| **GPS** | Global Positioning System |
| **ha** | Hectare(s) |
| **HASP** | Health and Safety Plan |
| **HDB** | Housing & Development Board |
| **HDV** | Heavy Duty Vehicles |
| **HK EIAO TM** | Hong Kong Environmental Impact Assessment Ordinance – Technical Memorandum |

| Acronym | Definition |
|---|---|
| **IAQM** | UK Institute of Air Quality Management |
| **IUCN** | International Union for Conservation of Nature |
| **KJE** | Kranji Expressway |
| **KTM** | Keretapi Tanah Melayu |
| **LOEL** | Lowest Observed Effect Level |
| **LTA** | Land Transport Authority |
| **m** | Meter(s) |
| **M&E** | Mechanical and Electrical Works |
| **m bgs** | Meters Below Ground Surface |
| **MEP** | Mechanical/ Electrical/ Plumbing |
| **mm** | Millimetre(s) |
| **MLS** | Marchwood Laboratory Services Pte Ltd |
| **MND** | Ministry of National Development, Singapore |
| **mRL** | Meters Reduced Level |
| **MRT** | Mass Rapid Transit |
| **MSDS** | Material Safety Data Sheet |
| **MSS** | Meteorological Service Singapore |
| **NAAQS** | USEPA National Ambient Air Quality Standards |
| **NAS** | National Archives of Singapore |
| **NBSAP** | National Biodiversity Strategy and Action Plan |
| **NEA** | National Environment Agency |
| **NG** | Nature Groups |
| **NParks** | National Parks Board |
| **NSR** | Noise Sensitive Receptor |
| **NSS** | Nature Society (Singapore) |
| **NTU** | Nephelometric Turbidity Units |
| **NUS** | National University of Singapore |
| **NUSLHMSG** | NUS Libraries Historical Maps of Singapore |
| **ORP** | Oxidation and Redox Potential |
| **PCP** | Professional Certification Programme |
| **pcu/hr** | Passenger Car Unit per Hour |
| **PH** | Public Holiday |
| **PHILMINAQ** | Mitigating Impact from Aquaculture in the Philippines |
| **PM** | Particulate Matter |
| **PME** | Powered Mechanical Equipment |
| **PRO** | Public Relations Officer |
| **PSI** | Pollution Standard Index |
| **PSU** | Practical Salinity Unit |
| **PUB** | Public Utilities Board |
| **PVC** | Polyvinyl Chloride |
| **QECP** | Qualified Erosion Control Professional |
| **QP** | Qualified Professional |
| **RAC** | Recommended Area of Conservation |
| **RMS** | Root Mean Square |
| **RTO** | Resident Technical Officer |
| **SAAQT** | Singapore Ambient Air Quality Targets |
| **SAC** | Singapore Accreditation Council |
| **SDS** | Safety Data Sheets |
| **SFA** | Singapore Food Agency |
| **SIDS** | Silty Imagery Detection System |
| **SING** | Singapore Botanic Gardens' Herbarium |
| **SINGLAS** | Singapore Laboratory Accreditation Scheme |
| **SLA** | Singapore Land Authority |
| **SLM** | Sound Level Meter |
| **SO** | Superintending Officer |
| **SOP** | Standard Operation Procedure |

| Acronym | Definition |
|---|---|
| **SRDB** | Singapore Red Data Book |
| **TAQMMS** | Telemetric Air Quality Monitoring and Management System |
| **TBM** | Tunnel Boring Machine |
| **TDS** | Total Dissolved Solids |
| **TIW** | Toxic Industrial Waste |
| **TN** | Total Nitrogen |
| **TNIA** | Traffic Noise Impact Assessment |
| **TOC** | Total Organic Carbon |
| **TOL** | Temporary Occupation Licence |
| **TOR** | Terms of Reference |
| **TP** | Total Phosphorus |
| **TPZ** | Tree Protection Zone |
| **TSS** | Total Suspended Solids |
| **UHI** | Urban Heat Island |
| **UK** | United Kingdom |
| **UNECE** | United Nations Economic Commission for Europe |
| **URA** | Urban Redevelopment Authority |
| **US** | United States of America |
| **USEPA** | United States Environmental Protection Agency |
| **VO** | Variation Order |
| **VOC** | Volatile Organic Compounds |
| **VU** | Vulnerable |
| **WHO** | World Health Organisation |

# List of Glossary

| Term | Definition | References for Definition |
|---|---|---|
| **Casual** | Exotic species that do not form self-replacing populations and rely on repeated introductions or limited asexual reproduction for persistence | Chong et al., 2009 [P-12]; Pyšek et al., 2004 [P-42] |
| **Common** | **(Flora)** Native species that have more than 1,000 mature individuals locally | Chong et al. [P-12], 2009; SRDB [P-2] |
| **Critically Endangered** | Species facing an extremely high risk of extinction in the wild/ in Singapore (with < 50 mature individuals or < 250 total individuals) | SRDB [P-2]; IUCN [P-13] |
| **Cryptogenic** | Plant of uncertain origin. Species without biogeographical or historical evidence of being non-native, but are restricted to only human-modified or human disturbed habitats | Chong et al., 2009 [P-12]; Pyšek et al., 2004 [P-42] |
| **Cultivated Only** | **(Flora)** Exotic species that persist locally as a result of cultivation or other direct human care | Chong et al., 2009 [P-12]; Pyšek et al., 2004 [P-42] |
| **Endangered** | Species facing a very high risk of extinction in the wild/ in Singapore (with < 250 mature individuals) | SRDB [P-2]; IUCN [P-13] |
| **Exotic** | Species whose presence is a result of either intentional or unintentional human involvement | Chong et al., 2009 [P-12]; Pyšek et al., 2004 [P-42] |
| **Native** | Species that have originated in a given area without human involvement or have arrived there without intentional or unintentional intervention of humans from an area in which they are native | Chong et al., 2009 [P-12]; Pyšek et al., 2004 [P-42] |
| **Naturalised** | Exotic species that form self-replacing, usually sexually reproducing populations | Chong et al., 2009 [P-12]; Pyšek et al., 2004 [P-42] |
| **Managed Vegetation** | **(Flora)** Area consisting vegetation that are actively managed, i.e. pruned regularly. It is now the most common type of vegetation in Singapore, owing to a government commitment to plant up the landscapes surrounding residential, industrial and commercial areas | Yee et al. 2019 [P-45] |
| **Presumed Nationally Extinct (NE)** | **((Flora)** Species that has not been recorded within Singapore for the last 30 years | SRDB [P-2] |
| | **(Fauna)** Species that has not been recorded within Singapore for the last 50 years | SRDB [P-2] |
| **Probable** | A list of faunal species that are likely to occur at the site (termed thereafter in the report as “species of probable occurrence”) | - |
| **Rarity** | This definition differs for each faunal taxon. The rarity for each taxa are reference to those listed in Singapore Red Data Book (SRDB), and other more updated local checklists, where available, such as Soh et al. 2019 for odonates and Jain et al. 2018 for butterflies. The global conservation status references the Red List of Threatened Species by the International Union for Conservation of Nature (IUCN, 2021) | SRDB [P-2]; Soh et al. 2019 [P-43]; Jain et al. 2018 [P-44]; IUCN [P-13] |
| **Threatened** | **Flora** | |
| | Flora species that were listed as nationally Vulnerable, Endangered, Critically Endangered, or Presumed Extinct (which indicates a rediscovery).<br><br>**Vulnerable (VU)**: More than 250 but fewer than 1,000 mature individuals<br><br>**Endangered (EN)**: Fewer than 250 mature individuals<br><br>**Critically Endangered (CR)**: Fewer than 50 mature individuals or more than 50, but fewer than 250 mature individuals | SRDB [P-2]; Chong et al., 2009 [P-12] |

| Term | Definition | References for Definition |
|---|---|---|
| | **Presumed Nationally Extinct (NE)**: No record of flora species within the last 30 years since its last record | |
| | **Fauna** | |
| | Threatened species of fauna are those listed as nationally or globally Vulnerable, Endangered, Critically Endangered, or Extinct.<br><br>**National Status**<br><br>**Vulnerable (VU)**: Species with < 1,000 mature individuals and > 250 total individuals<br><br>**Endangered (EN)**: Species with < 250 mature individuals<br><br>**Critically Endangered (CR)**: Species with < 50 mature individuals or < 250 total individuals<br><br>**Presumed Nationally Extinct (NE)**: No record of fauna species within the last 50 years since its last record<br><br>**Global IUCN List**<br><br>**Vulnerable (VU)**: Species facing a high risk of extinction in the wild<br><br>**Endangered (EN)**: Species facing a very high risk of extinction in the wild<br><br>**Critically Endangered (CR)**: Species facing an extremely high risk of extinction in the wild<br><br>**Extinct in the Wild (EW)**: Species that only survives through cultivation, captivity or as a naturalized population(s) outside its natural range<br><br>**Globally Extinct (EX)**: Globally extinct, including in captivity or through cultivation | SRDB [P-2]; Jain et al. 2018 [P-44] |
| **Uncommon** | This definition differs for each faunal taxon. The rarity for each taxa are reference to those listed in Singapore Red Data Book (SRDB), and other more updated local checklists, such as Soh et al. 2019 for odonates and Jain et al. 2018 for butterflies. The global conservation status references the Red List of Threatened Species by the International Union for Conservation of Nature (IUCN, 2021). | SRDB [P-2]; Soh et al. 2019 [P-43]; Jain et al. 2018 [P-44]; IUCN [P-13] |

# 1 Executive Summary

## Project Description and Objectives

AECOM Singapore Pte. Ltd. was appointed by Housing and Development Board (HDB), through the Authorisation Order dated 27 May 2022, to carry out *Environmental Impact Assessment (EIA) on Choa Chu Kang N1* as a variation order (VO) to previously carried out Environmental Baseline Study (EBS) (Contract No L/025/21). An EIA is required to be undertaken to establish current air quality and airborne noise baseline conditions and to assess the potential environmental impacts (i.e., biodiversity, water resources [hydrology, surface water quality, groundwater quality and level], air quality and airborne noise) arising from, and associated with, the construction and operational phases of proposed residential development (hereafter referred to as 'the Project') planned to be developed within the Project site. Biodiversity, hydrological and surface water quality baseline conditions were established as a part of previously carried out EBS by AECOM [P-1] and this data was used for impact assessment.

The Project site for this EIA is estimated to be approximately 16 hectares (ha) and it is located in the northwest part of mainland Singapore. It is bounded by Kranji Expressway (KJE) in the north and Woodlands Road in the east. The majority of the site is covered by managed vegetation, while the Pang Sua Canal is located along the western and southern boundary of the site.

With the proposed future developments within the Project site, there is a need to: (1) understand the baseline ecological and other environmental conditions of the site; (2) assess potential impacts on the local biodiversity and environment associated with and/ or caused by the Project during both construction and operational phases; (3) assess potential impact on humans, their activities, safety as well as surrounding existing and future developments associated with and/ or caused by the Project during both construction and operational phases; (4) recommend mitigation measures to safeguard the existing ecological and avian connectivity, minimise potential impacts on humans and existing and future developments, and incorporate them into the future development; and (5) to develop an Environmental Management and Monitoring Plan (EMMP).

As shown in Urban Redevelopment Authority (URA)'s gazetted Master Plan 2019 (Figure 1-1), Choa Chu Kang N1 (hereafter referred to as 'CCK N1') Project site has been proposed to be developed for Residential use (Subject to Detailed Planning). The area surrounding Pang Sua Canal is categorised as 'Waterbody', implying that the canal will remain at the western and southern edges of the site after the proposed residential development is finished.




**Figure 1-1 Proposed land use of the Project site and its surroundings (Source: URA's gazetted Master Plan 2019 [M-1])**

Biodiversity baseline study, carried out as part of EBS [P-1], found that the site and its vegetation (also known as Sungei Pang Sua Woodland [P-2; P-3]) could be an important stepping stone for migratory species which travel between surrounding fragmented habitats, such as Bukit Mandai forest to the northeast, Bukit Gombak to the south and to other larger habitats including Bukit Timah Nature Reserve (BTNR) in the southeast and Mandai Mangrove in the north (Figure 1-2).




**Figure 1-2 Site context and potential connectivity between the Project site and other green patches in the proximity**

Based on the key findings of EBS [P-1] and potential for the site to support ecological connectivity, an ecological corridor was recommended to be implemented on the east of the Pang Sua Canal, adjacent to the proposed residential development, so that the wildlife can continue to use the area as a stepping stone to move between the surrounding green spaces. The proposed corridor will potentially help to facilitate the movement of faunal species, such as small mammals and volant species, even after the proposed development is established. Based on the EBS findings and recommendations, and in consultation with agencies and Interest Groups, HDB revised the conceptual land use plan for the Project site to include the proposed Ecological Corridor (Figure 1-3) east of Pang Sua Canal. The proposed boundaries of the Residential Development and Ecological Corridor should not to be taken as final, but are subject to further changes based on detailed studies such as design, on-site conditions, arborist's assessment etc.

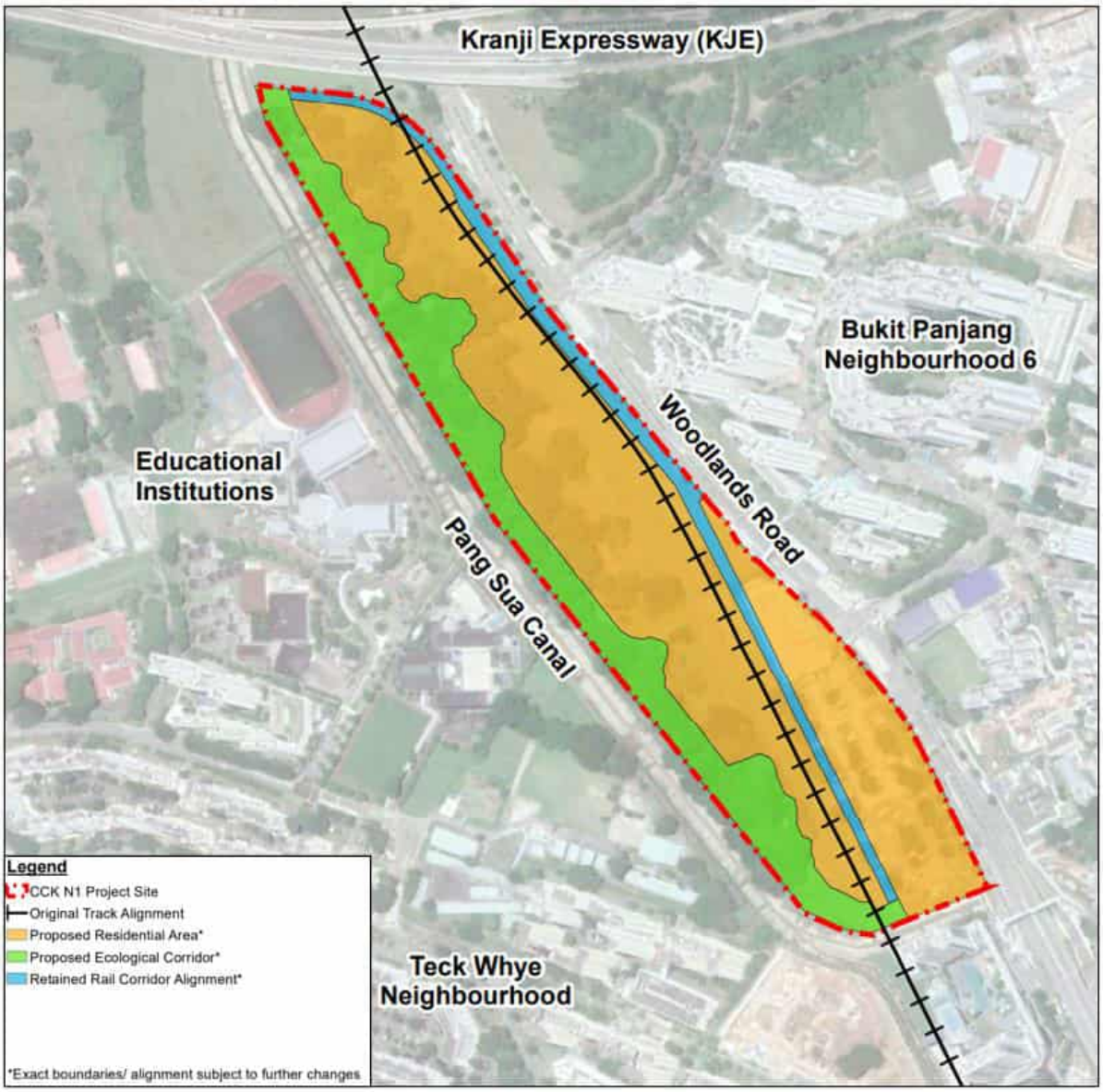



**Figure 1-3 Proposed future developments at the Project site**

## Environmental Baseline Findings

Baseline studies on biodiversity, water resources (hydrology, surface water quality, groundwater quality and level), air quality and airborne noise were conducted for the respective Study Areas, and a summary of the findings is provided below. More information can be obtained from Sections 7, 8, 9 and 10 of the Report, respectively.



Figure 1-4 Vegetation distribution in the Project site



Figure 1-5 Distribution of flora species of conservation significance and rare/ uncommon fauna species in the Project site

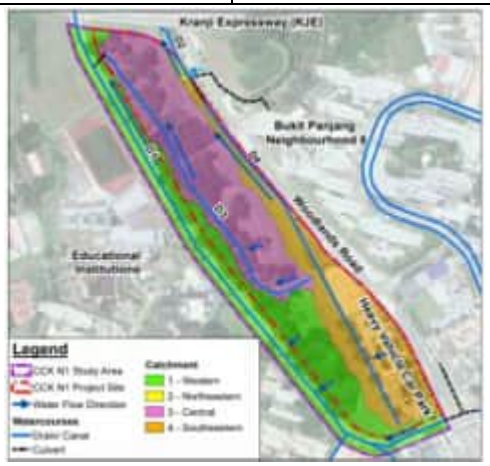



Figure 1-6 Catchment map of Project site with watercourses

- **Habitats and Vegetation Distribution** (see Figure 1-4) — CCK N1 site mainly constitutes managed vegetation, comprising clusters of various tree species planted for landscaping purposes (9.62 ha; 45.2%) which occupies approximately half of the Study Area, and turf area (5.36 ha; 25.2%). The existing canal and infrastructure, such as the heavy vehicle carpark and defunct bus terminal comprise 6.32 ha (29.6%) of the Study Area.
- **Biodiversity, Flora, Large Plant Specimens and Other Specimens of Value** (see Figure 1-5) — The floristic assessment identified a total of 119[1] species from 46 families, of which, the majority are exotic (81 species; 68.1%). Furthermore, only 27 recorded species (22.7%) are native and 11 (9.2%) are cryptogenic (i.e., species that has unknown or uncertain origins). Only one nationally Vulnerable climber species, *Bridelia stipularis*, is considered to be a species of conservation significance. Ninety-one large plant specimens were recorded in the Study Area, which is largely dominated by Senegal mahogany (*Khaya senegalensis*) and raintree (*Samanea saman*). Other specimens of value consist of two keystone species with two specimens respectively: Malayan banyan (*Ficus microcarpa*) and weeping fig (*F. benjamina),* with a spread that ranges from 3 m - 8 m. In addition, a bamboo cluster, *Bambusa* cf. *heterostachya* with a spread of 2.5 m, were also identified to be possible roosting habitat for bamboo bats.

[1] During the Environmental Impact Assessment it was noticed that some of the species count data was incorrectly displayed. As such, the data has been updated within this EIA to accurately reflect the correct data.

- **Biodiversity, Fauna** (see Figure 1-5) – The field assessment recorded 78 species, with more than half of the assemblage dominated by birds (29 species) and butterflies (18 species). No species of conservation significance were recorded.

  While not considered of conservation significance, several other uncommon fauna species were also recorded. This includes the uncommon dingy duskhawker (*Gynacantha subinterrupta*) which is usually found in forested areas; and two moderately rare butterflies: evening brown (*Melanitis leda leda*), which is usually sighted in grasslands, thickets, or among dense vegetation, and common redeye (*Matapa aria*), which is usually sighted in which bamboo clusters are present e.g., in urban parks, wastelands and nature reserves. [W-1].

  Nine migratory bird species were also recorded, including the rare yellow-browed warbler (*Phylloscopus inornatus*) and uncommon migrant species, yellow-rumped flycatcher (*Ficedula zanthopygia*). These records show the value of the Study Area in supporting these uncommon species and migratory birds.

  Other species of conservation significance that may utilise the Study Area to move between habitats include the globally Critically Endangered and nationally Endangered straw-headed bulbul (*Pycnonotus zeylanicus*), the globally Vulnerable smooth-coated otter (*Lutrogale perspicillata*), and the globally and nationally Critically Endangered Sunda pangolin (*Manis javanica*) [P-4; P-5]. These species have been recorded in surrounding green spaces and may disperse to the Study Area. The watercourse within the Study Area is poor in aquatic life and is more likely to be used by fauna to move between habitats.

- **Hydrological Conditions** (see Figure 1-6) – Four (4) water catchment areas within the vicinity of the Project mainly contribute to four (4) watercourses within the Study Area. The perennial Pang Sua Canal D1 is located along the western and southern lengths of the Study Area. Perennial concrete drain D2 is located at the northeast corner of the site. Ephemeral concrete drain D3 cuts across the centre of the site, discharging into Pang Sua Canal D1 through a culvert. Ephemeral concrete drain D4 is located along the eastern section of the Study Area.

- **Surface Water Quality** – Six (6) sampling stations were identified for the Study Area [P-1]. Generally, water quality parameters in Canal D1 and drain D2 exceeded the aquatic life criteria, aligning with biodiversity findings in Section 7 which showed the poor aquatic life along Pang Sua Canal during the time of field survey. pH in Pang Sua Canal D1 and concrete drain D2 exceeded the NEA guidelines and aquatic life criteria[2], likely due to the concrete surfaces of the surrounding urbanized area (especially from a nearby construction site), as chemicals washed off from concrete could lead to the increased pH. Relatively high Total Suspended Solids (TSS) and turbidity was observed in Pang Sua Canal D1 and concrete drain D2, which was likely due to flushing from surrounding urban areas (including a nearby construction site). The relatively high nutrient (nitrogen and phosphorus) concentrations in Pang Sua Canal D1 and concrete drain D2 indicated that both watercourses had higher eutrophication potential, which was consistent with the greenish water with algae observed during the site survey. Elevated enterococcus counted observed along the Pang Sua Canal D1 and concrete drain D2 were also likely due to stormwater carrying faecal contaminants from the surrounding residential or vegetated area.

- **Air Quality** – Primary baseline air quality monitoring was conducted at five (5) representative locations, i.e. AQ1 (Villa Verde Estate), AQ2 (Jurong Pioneer Junior College), AQ3 (HDB Blk 162 Teck Whye Neighbourhood), AQ4 (West View Primary School), and AQ5 (HDB Blk 634 Senja Road). The measured 24-hours average $PM_{10}$ concentration at all monitoring locations were well below the Long Term Singapore Ambient Air Quality Targets, however, the results of 24-hours average $PM_{2.5}$ at both AQ1, AQ2 and AQ3 exceeded the Long Term Singapore Ambient Air Quality Targets. The monitoring results trend is in line with the trend of secondary data, with a spike of 24-hours average $PM_{2.5}$ during the monitoring period.

- **Airborne Noise** – Baseline monitoring was carried out at six (6) locations within the 150 m Airborne Noise Study Area at NM01 (Villa Verde Estate), NM02a-c (HDB Block 635A Senja Road - Ground Level, Level 15 and Level 34), NM03 (West View Primary School), NM04a (HDB Block 162 Jalan Teck Whye - Ground Level, Level 7 and Level 13), NM05 and NM06 (at Green Area within Study Area). The baseline noise levels captured at the monitoring locations were generally found to be within the maximum permissible noise limits established by NEA for construction sites with the exception of noise levels captured at locations abutting KJE and Woodlands Road where noise profile was dominated by heavy road traffic.

[2] The aquatic life criteria indicate the threshold concentration of contaminants that can be present in surface waterbodies before it is likely to harm on the aquatic flora and fauna within it.

## Impact Assessment Methodology

Sections 7, 8, 9 and 10 of this EIA Report discuss the methodologies used for impact identification, prediction and assessment on environmental parameters including biodiversity, water resources (hydrology, surface water quality, groundwater quality and level), air quality and airborne noise during the construction and operational phases of the Project.

## Summary of Impact Assessment

***Biodiversity (Flora)***

The ecological value of two terrestrial habitats within the Project site were assessed, of which, managed vegetation comprising the planted trees is assessed with high ecological value (Priority 1) while the managed turf area is assessed with a medium ecological value (Priority 2). A total of 19 flora receptors (i.e., species of conservation significance, large specimens and species affected by the development) as well as 18 faunal receptors of Priority 1 were identified for impact assessment.

Three types of impact for the identified sensitive habitat receptors during the construction phase— (1) loss of vegetation, (2) habitat degradation, and (3) formation of forest edge—the impact significance ranged from **Negligible** to **Major**. Both habitat receptors will be majorly affected by vegetation clearance. For habitat degradation, both habitats are expected to face with **Moderate** impacts and for the impact of formation of forest edges, only Negligible and **Minor** impact are expected. As for the residual impact significance, the impact for loss of vegetation remains the same as land clearance is inevitable for the development of CCK N1. With mitigation measure such as conducting regular inspections to ensure contractor compliance mentioned in Section 7.8.2 on the minimum control measures listed in Section 7.8, this would reduce the impact significance of habitat degradation from **Moderate** to **Minor**. Lastly, the impact significance for formation of forest edge for both habitats remain the same (i.e., **Negligible - Minor**) as the impact has been reduced to a level that is as low as reasonably practicable.

For operational phase, two types of impacts for habitat receptors were assessed during the operational phase– (1) habitat degradation and (2) change in species composition–the impact significance was **Moderate** mainly for the area with planted trees, and **Minor** respectively. Assuming that the recommended mitigation measures are imposed (e.g., limiting the public access into the RAC/ Ecological Corridor etc) (Section 7.8.1.3), the impact for habitat degradation will be reduced to **Minor.** As for the impact of change in species composition**,** only **Minor** impact significance are expected for both habitats.

In the assessment of the two types of impact for individual species during the construction phase – (1) mortality, (2) decline in plant health and survival. Four species are likely to experience **Major** impacts owing to mortality, three species will experience **Moderate** impacts and seven species that will experience **Minor** impacts. The remaining five species will face **Negligible** impact as it will not be directly affected by vegetation clearance. As for decline in plant health, only 15 flora receptors were assessed as it is assumed that all specimens of the remaining 4 flora receptors have been already cleared. Six species are likely to experience **Moderate** impacts owing to decline in plant health, while for the remaining nine species, they are assessed with **Minor** impact significance.

The residual impact significance of mortality remains the same for all flora receptors since land clearance is inevitable for the development of CCK N1. As for the impact resulted from decline in plant health, the impact significance of six flora species receptors that were initially assessed as Moderate during the pre-mitigation impact assessment, is reduced to Minor. As for the remaining nine species, proposed mitigation measures such as in-fill planting and dense landscaping/ planting along the edges of the RAC/ Ecological Corridor (Section 7.8.1.2 and 7.8.1.3), the impact significance for six flora species receptors, is reduced to from Moderate to Minor. As for the remaining nine species, their impact significance remains as Minor since this impact cannot be mitigated further. For the operational phase, only one impact type was assessed (i.e., poaching), of which, all flora receptors were assessed with Negligible impact significance, except for one species, *Bridelia stipularis*, which was assessed with Moderate impact. Assuming the proposed mitigation measures are implemented (i.e., limiting public access in the RAC), this reduces the residual impact is expected to be lowered from Moderate to Minor for *B. stipularis*.

***Biodiversity (Fauna)***

Six construction phase impacts were identified and assessed for faunal receptors: (1) loss of/ reduction in habitats and food sources, (2) accidental injury or mortality, (3) human-wildlife conflict, (4) loss of/ reduction in ecological connectivity for faunal movement, (5) light disturbances, and (6) human disturbances. The impact significance ranged from Negligible to Major. Major impact was expected from loss of habitats from site clearance for all species but cannot be mitigated. Minor impacts were expected from light disturbances since no night works will be carried out. Moderate impacts were also expected from reduction in ecological connectivity for faunal movement, and accidental injury/ mortality. The remaining impacts are considered Minor.

With the implementation of i) lighting strategies to minimise light pollution to the Ecological Corridor, and ii) imposing speed limits, impacts from accidental injury or mortality can be reduced to **Minor**. A **Moderate** impact significance will still result from reduction of ecological connectivity. While it cannot be mitigated to a **Minor** level, compensatory measures to improve connectivity of the site could be considered. This includes widening of the RAC/ Ecological Corridor and/ or additional planting in the northern part of the site towards Villa Verde Bridge (Section 7.8.1.3). All minimum controls are assumed to be properly implemented and enforced.

Six operational phase impacts were identified and assessed for faunal receptors: (1) accidental injury or mortality, (2) human-wildlife conflict, (3) poaching, (4) loss of/ reduction in ecological connectivity for faunal movement, (5) light disturbances, and (6) human disturbances. The impact significance ranged from **Negligible** to **Moderate.** Moderate impacts were expected from reduction in ecological connectivity for faunal movement, light disturbances, accidental injury or mortality and human-wildlife conflict.

With the implementation of i) lighting strategies to reduce light pollution to RAC/ Ecological Corridor, and ii) installation of education signages to educate residents on proper behaviors around wildlife, and iii) use of wildlife-proof bins and proper waste management, impacts from light disturbances, accidental injury or mortality (from bird-building collision) and human-wildlife conflict can be reduced to **Minor.** All minimum controls are assumed to be properly implemented and enforced.

***Water Resources (Hydrology, Surface Water Quality, Groundwater Quality and Level)***

For the construction phase, it was assessed that the impacts due to hydrological changes (e.g., increase in surface water peak runoff, decreased seepage into soil, etc.) would be **Negligible** (to Turf and Planted Trees [ecological receptors] and Bukit Panjang Neighbourhoods 5 and 6, Drains D2 and D3 [socio-economic receptors]) to **Minor** (on-site construction workers and off-site residents and visitors [human receptors], Pang Sua Canal and Woodlands Road [socio-economic receptors]). This assessment was carried out under the assumption that minimum control measures such as adequately sized detention tanks and ponds, planned soil dewatering and regular maintenance of drainage system have been successfully implemented. Impacts due to changes in quality of surface water resources (e.g., improper management of solid and liquid waste, accidental spills and leaks, etc.) were assessed to be **Negligible** to ecological receptors (i.e., Planted Trees and Turf to be retained), **Negligible** to **Minor** to human receptors (i.e., on-site construction workers and off-site permanent residents and visitors in the vicinity of the site) and **Negligible** to socio-economic receptors (i.e., Pang Sua Canal, Drain D2, Drain D3 Woodlands Road and Bukit Panjang Neighbourhoods 5 & 6). Minimum controls assumed to be implemented with regards to this aspect include settling ponds, regular inspection and maintenance of wastewater and stormwater collection infrastructure, ECM measures, implementation of CCTV, etc. Upon implementation of minimum controls such as piezometers for groundwater level monitoring and proper ERSS, it was assessed that the impact due to groundwater level decrease would be **Minor** to ecological receptors and **Negligible** to human receptors. Under the assumption that appropriate management and storage of soil, extracted groundwater, waste, chemicals and other toxic material as well as other minimum controls will be implemented on the site, impacts on sensitive receptors due to groundwater quality changes were assessed to be **Negligible** to **Minor**. As none of the impacts were assessed to be Moderate or Major, no additional mitigation measures have been proposed.

During the operational phase permanent land use was identified to be the main potential source of hydrological impacts, while contaminated surface runoff and improper management of liquid and solid waste were identified as a main source of surface water quality impacts. Hydrological impacts on ecological, human and socio-economic receptors were assessed to be **Minor** (with the exception of impact on Bukit Panjang Neighbourhoods 5 and 6 and future managed vegetation which were assessed to be **Negligible**). Under the assumption that minimum controls such as regular inspections and maintenance of stormwater collection infrastructure were implemented, impacts from changes in quality of surface water resources were assessed to be **Negligible** to proposed Ecological Corridor

and **Minor** to managed vegetation within the future residential development. Furthermore, potential impact on future on-site residents, visitors and maintenance workers was assessed to be **Minor**, while on off-site permanent residents and visitors was assessed to be **Negligible**. With regards to socio-economic receptors, impacts were assessed to be **Negligible** to Woodlands Road and Bukit Panjang Neighbourhoods 5 & 6 and **Minor** to Pang Sua Canal, proposed future residential development within the site and Drains D2 and D3. Groundwater quality and level impacts on ecological and human receptors were also assessed to be **Negligible** to **Minor**. As none of the impacts were assessed to be Moderate or Major, no additional mitigation measures have been proposed.

It was assumed that all the concurrent developments would comply with the construction standards and hence their impact on hydrology and surface water quality for the watercourses was not expected to be significant.

***Air Quality***

Potential impacts to the neighbouring sensitive receptors during construction phase mainly include emissions from the heavy vehicular exhaust and dust emitted from the earthworks, construction and trackout activities. During the operational phase, emissions from vehicle exhaust due to increased traffic in the vicinity of the proposed development is identified as the predominant air emission source.

Air quality impact assessment for construction phase were undertaken in accordance with the *UK IAQM Guidance on the Assessment of Dust from Demolition and Construction*. Pursuant to which, 50 m and 350 m Study Area for ecological and human receptors respectively were considered for earthworks, construction and trackout activities. Dust generated during construction works can have adverse effects upon vegetation 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. For human receptors, the dust and gaseous emissions might cause respiratory problems and diseases in human health.

The results of the assessment show that unmitigated impacts are classified as **Moderate** to **Major** for ecological receptors and **Moderate** for human receptors, and have the potential to affect the receptors near the construction footprint unless mitigation measures are put in place (see Section 9.7 for assessment details). This is largely because of the large extent of the construction worksite located very close to the neighbouring sensitive receptors. This Report pulls together mitigation measures that can be implemented by the contractor as administrative or management measures, sourcing from best practice measures internationally, which are detailed Section 9.8, which when applied successfully, the significance of impacts is anticipated to be reduced to **Minor** for ecological and human receptors (see Section 9.9 for details). The key control and mitigation measures include but not limited to development and stringent implementation of air pollution control plan, dust control measures on site, site hoarding, planning of dust causing activities-location and timing, reinstating land upon completion of works amongst several others.

The construction contractor is recommended to prepare an air quality management plan incorporating a range of monitoring and mitigation measures in line with Section 9.8, Section 11.12 and Section 11.14.

For air quality impact assessment during operational phase, it is assumed that all new vehicles to meet their Euro emission standard. The potential source of operational air quality impacts would be due to the vehicular emissions from the high traffic volume along the existing Woodlands Road at the East of the Project site and Kranji Expressway at the North of the Project site. In addition, there will be future internal arterial roads that will be constructed within the Project site. Hence, locally the traffic within and in the vicinity of the Project site is likely to increase. It should also be noted that currently there is a significant traffic volume along the Woodlands Road and Kranji Expressway (see Section 9.7.2 for details). In this aspect with the information assessed at this stage, the air quality impact contributed from the proposed development is anticipated to be **Minor** during the operational phase. No mitigation measures are required during operational phase as no significant air quality impact is expected from Project operation.

Cumulative impacts from other major concurrent development in the vicinity of each construction worksite are presented and detailed in Section 9.10. Due to the presence of these concurrent construction sites, the overall construction footprint was 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 HDB CCK N1. For cumulative impacts during operational phase, all projects are considered to have negligible impact as compared to the increased traffic due to the future internal arterial roads. The CCK N1 development is considered to be the major contributor to the cumulative impacts during operational phase.

***Airborne Noise***

A quantitative means of assessment detailing noise levels predicted with noise models based on inputs of effective SWL of proposed PMEs was conducted for the construction phase for Scenario 1: Site Preparation for Earthworks and Scenario 2: Foundation Works. The assessment scenarios were established to determine the noise impacts arising from the construction phase during the clearance of site for the proposed construction worksites, and the worst-case noisiest scenario to represent the worst potential peak time of construction phase instead of the entire duration.

Based on the results predicted by the noise models (construction phase), two human receptors (Senja Care Home and West View Primary School) are predicted to experience noise exceedances of up to 8.4 dB(A) during Scenario 2: Foundation Works and up to 1.4 dB(A) during Scenario 1: Site Preparation for Earthworks. The resulting overall impact significance for Scenario 2 was evaluated to range from **Negligible – Moderate** (see Table 10-24), while that for Scenario 1 was evaluated as **Negligible – Minor**.

Ecological receptors subjected to noise emissions from both assessment scenarios were predicted to experience noise exceedances of up to 24 dB(A) for Scenario 1, and up to 30 dB(A) for Scenario 2. The resulting overall impact significance of both assessment scenarios were evaluated to be Moderate and **Majo**r (see Table 10-20) for the time periods of $L_{Aeq(12\ hrs)}$, and $L_{Aeq(5\ mins)}$ for 7am – 7pm respectively.

Mitigation measures were proposed to mitigate the noise impacts on ecological receptors to as low as reasonably practicable (ALARP) as discussed in Section 10.8.1. Noise barriers of 3 m and 12 m height were proposed along the construction worksites near the NSRs predicted to experienced noise exceedances.

However, due to the proximity of the noise sources (i.e., construction worksites) to the Ecological Corridor, the proposed noise barriers were found to only be effective in reducing noise Impact Significance area to a range of 0.7 ha to 0.9 ha in Scenario 1, and a range of 2.4 ha to 3.2 ha in Scenario 2. The overall residual Impact Significance remained unchanged at **Moderate** and **Major** (see Table 10-31) for Scenario 1 and 2 respectively.

Based on the residual airborne noise impact assessment below, the proposed 3m noise barrier and 12m noise barriers will be beneficial with no noise exceedance predicted for Scenario 1: Site Preparation for Earthworks. While for Scenario 2: Foundation Works, noise reduction of for Senja Care Home from 8.4 dB(A) to 6.9 dB(A), and West View Primary School from 7.6 dB(A) to 1.7 dB(A) were predicted with Impact Intensity remaining unchanged at **High** for Senja Care Home, and **Low** for West View Primary School. Although the proposed mitigation measures in Section 10.8 were not able to eliminate noise exceedances during Scenario 2, impact intensity was predicted to range from **Negligible** to **High**, and only one human receptor were experienced with **High** Impact Intensity (see Table 10-34).

During operational phase, impact significance on ecological receptors subjected to noise emissions from ACMV systems was qualitatively assessed to be **Negligible** (see Table 10-26), based on the consideration that no current non-industrial buildings are proposed to be sited and on their propensity for avoiding urbanized areas with human presence. Ecological receptors subjected to land traffic noise were qualitatively assessed to experience a **Minor** impact significance, with land traffic noise impact on fauna species found to indirectly alter habitat quality and the introduction of vehicular noise in an area previously undisturbed by anthropogenic noise permanently changing the characteristics of the area with noise impacts lasting for a long time.

Human receptors subjected to noise emissions from ACMV systems were qualitatively assessed to experience an Impact Significance ranging from **Negligible** to **Minor** (see Table 10-27) as the siting of the proposed non-industrial buildings do not immediately abut existing noise sensitive and residential premises identified in Section 10.4. Impact significance on human receptors subjected to land traffic noise was qualitatively assessed to be **Minor**, with land traffic noise impact on human receptors potentially resulting in small changes in behaviours residents choosing to close their windows to reduce indoor noise levels, which may slightly affect character of the area but not such that there is a perceived change in quality of life.

Preliminary mitigation measures were correspondingly introduced in Section 10.8.2 to mitigate the potential operational noise impacts in the form of Best Available Technology (BAT) and Best Environmental Practice (BEP) noise control measures. Since the initial impact assessment with minimum controls was considered insignificant (**Negligible to Minor**), no residual impact assessment was undertaken, hence the impact significance remained the same.

Cumulative impacts from other major concurrent developments in the vicinity of the proposed development such as an nearby future development by other agency are presented and detailed in Section 10.10. The overall Impact Significance with cumulative noise impacts from the development by other agency were predicted to remain unchanged ranging from **Moderate** to **Major** for ecological receptors and, **Negligible** to **Moderate** for human receptors. Due to the presence of these concurrent construction sites, the construction footprint in this area is expected to be larger. Therefore, the concurrent constructions may increase cumulative noise impact in the vicinity of HDB CCK N1. No cumulative impacts were considered during operational phase.

## Conclusions and Recommendations

In conclusion, the summary of unmitigated impact significance and potential residual impact significance of the assessed environmental aspects for both construction and operational phases are presented in Table 1-1.

A set of Environmental Management and Monitoring Plan (EMMP) has also been developed for each environmental parameter, which will be updated and implemented during construction and operational phases, to ensure the effectiveness of the proposed mitigation measures. The EMMP is described in Section 11 of this EIA Report.

**Table 1-1 Summary of impact significance for construction and operational phases (range if applicable)**

| Environmental Parameter | Impact Significance (with minimum controls/ best practices) | Residual Impact Significance (with additional mitigation measures) |
|---|---|---|
| **Biodiversity** | Negligible to Major[1] | Negligible to Major[2] |
| **Water Resources (Hydrology and Water Quality)** | Negligible to Minor | Negligible to Minor |
| **Water Resources (Groundwater Quality and Level)** | Negligible to Minor | Negligible to Minor |
| **Air Quality** | Moderate to Major | Minor |
| **Airborne Noise**<br>• Ecological Receptors<br>• Human Receptors | • Minor to Major<br>• Negligible to Moderate | • Minor to Major<br>• Negligible to Moderate |
| **Notes:**<br>**1** - Major from loss of vegetation and mortality of flora receptors<br>**2** - Loss of vegetation/ mortality to flora receptors is irreversible | | |

# 2 Introduction

AECOM Singapore Pte. Ltd. was appointed by Housing and Development Board (HDB), through the Authorisation Order dated 27 May 2022, to carry out *Environmental Impact Assessment (EIA) on Choa Chu Kang N1* as a variation order (VO) to previously carried out Environmental Baseline Study (EBS) (Contract No L/025/21). An EIA is required to be undertaken to establish current air quality and airborne noise baseline conditions and to assess the potential environmental impact (i.e. biodiversity, water resources [hydrology, surface water quality, groundwater quality and level], air quality and airborne noise) arising from, and associated with, the construction and operational phases of proposed residential development (hereafter 'the Project') planned to be developed within the Project site. Biodiversity, hydrological and surface water quality baseline conditions were determined as a part of previously carried out EBS [P-1] and this data will be used for subsequent impact assessment.

The Project site for this EIA is estimated to be approximately 16 hectares (ha) and it is located in the northern west part of mainland Singapore. It is bounded by Kranji Expressway (KJE) in the north and Woodlands Road in the east. Majority of the Site has trees and vegetation, while PUB's Drainage Reserve is located along the western and southern boundary of the site.

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

## 2.1 Scope of Work

The scope of this EIA was documented in the form of Inception Report Rev 01 [R-1] submitted to HDB on 26th August 2022. This EIA progressed only after acceptance of the Inception Report by HDB and other relevant Agencies (i.e., NParks, NEA, PUB).

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

- Field surveys and monitoring, including air quality monitoring and airborne noise monitoring;
- Collation of environmental baseline findings, inclusive of both newly collected field survey data (i.e., air quality and airborne noise) and data collected during previously carried out EBS [P-1] (i.e., biodiversity, hydrology and surface water quality);
- Formulation of biodiversity inventory and distribution maps;
- Prediction and evaluation of impacts for each discipline (i.e., biodiversity, water resources [hydrology, surface water quality, groundwater quality and level], air quality and airborne noise);
- Recommendation of mitigation measures and assessment of residual impacts;
- Development of Environmental Management and Monitoring Plan (EMMP); and
- Presentation of the findings of all above in an EIA Report (this Report).

This EIA assessed the development plan, design elements, construction methodology, Project components, and operational activities available at the time of writing. Understanding of the Project construction methods and operational activities has been clearly stated in Section 3.2.1 and Section 3.3, respectively. Detailed assumptions, if any, are described in individual assessment sections thereafter. Should the detailed design conducted at a later stage require modifications to these assumptions/ approaches, a revised impact assessment will be undertaken by developer/ developing agent to address these changes.

## 2.2 Report Structure

The structure of this EIA Report is as follows:

- **Section 1** – **Executive Summary** of the Project provides preliminary baseline findings as well as summary of preliminary 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, pre-construction and construction activities, operational activities and Project schedule;
- **Section 4** – **Description of the Environment** provides a definition of Study Areas for each of the environmental disciplines, general description of the site setting, historical and current land uses, historical features (if any), geology, topography, regional water catchment and climate of the area where Project site is located;
- **Section 5 – Environment Legislation, Policies, Plans, Standards and Criteria** provides the legislative requirements relevant to the Project;
- **Section 6 – EIA Approach and Methodology** provides the overview of the methodology used for the impact assessment;
- **Section 7 – Biodiversity Section** presents the methodology, baseline environment, sensitive receptors, and potential sources of impacts, minimum controls and evaluation of impacts to biodiversity within the Study Area, along with recommendations for mitigation measures;
- **Section 8 –Water Resources Section** presents the methodology, baseline environment, sensitive receptors, potential sources of impacts, minimum controls and evaluation of impacts to identified human, ecological and socio-economic sensitive receptors arising from changes in hydrology, flow characteristics of the identified watercourses and surface water quality within the Study Area, along with recommendations for mitigation measures, if any. This section also presents the evaluation of potential impacts from construction and operational phase activities to groundwater (i.e., quality and groundwater levels) and consequent impacts to identified ecological and human receptors;
- **Section 9 – Air Quality** presents the methodology, baseline environment, sensitive receptors, potential sources of impacts, minimum controls and evaluation of impacts from the Project to air quality on the human and ecological receptors within the Study Area, along with recommendations for mitigation measures;
- **Section 10 – Airborne Noise** presents the methodology, baseline environment, sensitive receptors, potential sources of impacts, minimum controls and evaluation of airborne noise impacts on noise sensitive ecological and human receptors within the Study Area, along with recommendations for mitigation measures;
- **Section 11 – Environmental Management and Monitoring Plan** details the organisational framework, stakeholder roles and responsibilities, monitoring programme requirements and detailed EMMP; and
- **Section 12 – Conclusion** provides a conclusive summary of the EIA's outcomes.

## 2.3 Study Limitations, Assumptions and Constraints

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During the EBS [P-1], there were inherent limitations associated with data acquisition in flora surveys due to the variability of vegetation communities across a site and changes to the detectability and presence of species with time. Therefore, it may be possible that some flora species occurring within the Study Area, or perhaps not visibly present during the survey period, were not recorded. However, the surveys were considered to be comprehensive as survey routes were strategically planned to cover ecologically and geographically representative samples of the Study Area, and all plant species sighted were identified and recorded to the best of the team members’ abilities. Project team members who carried out the survey and identified the species post-survey have prior experience in conducting such flora assessments in Singapore.

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

Due to the above, the statements, conclusions and opinions contained in this report are approximations of the existing environmental conditions within the Study Area, 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.

Government agencies will not be held liable for any claims arising from the conduct of the study.

# 3 Project Overview

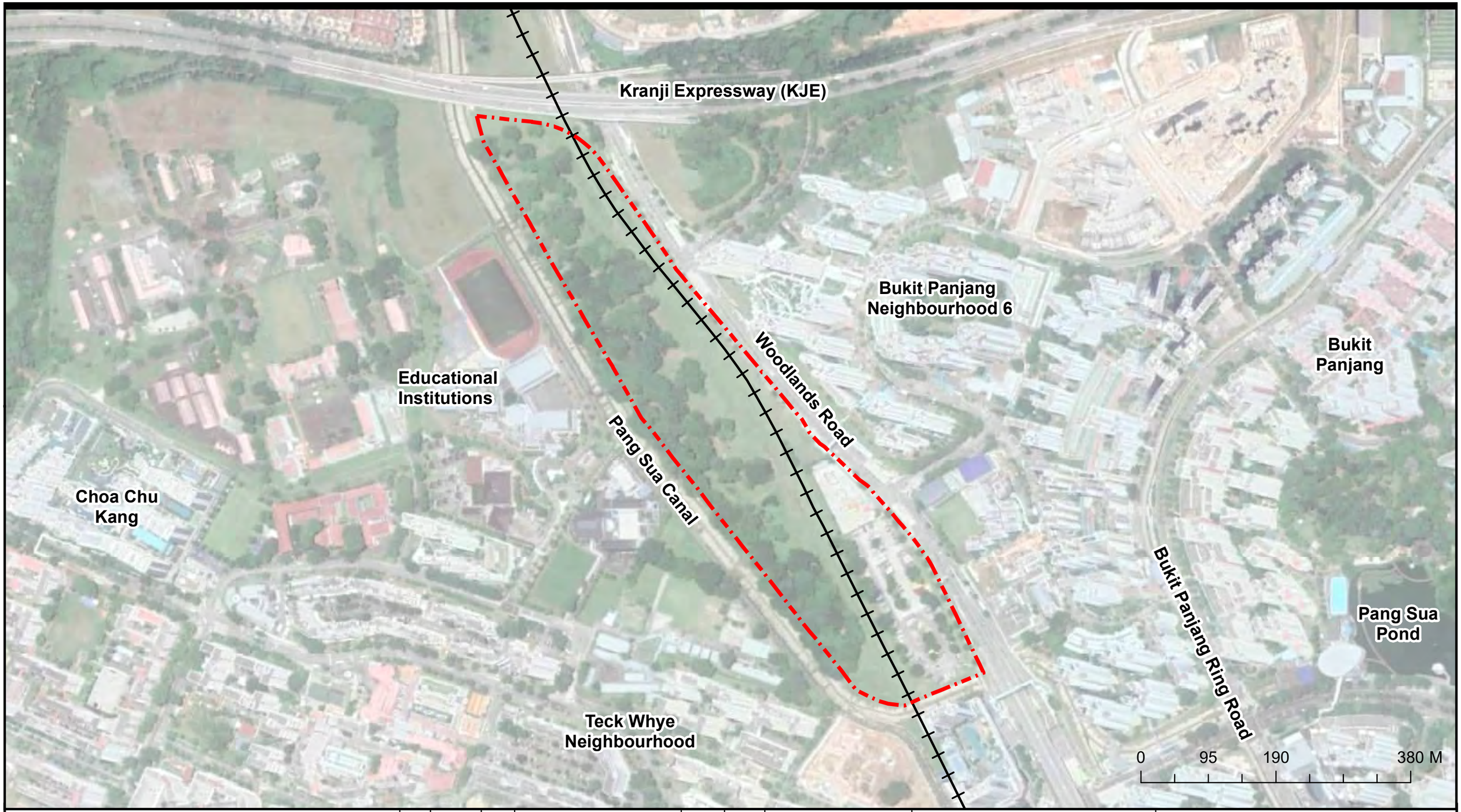
This section will provide a background overview of the Project in terms of its location, current land uses, conceptual development plan, and proposed activities during construction and operational phases of the Project.

## 3.1 Project Location

The Choa Chu Kang N1 (CCK N1) is a proposed future development to be located in the northwest of mainland Singapore and it encompasses an area of approximately 16 hectares (ha).

The Project site is bounded by Kranji Expressway (KJE) in the north, Woodlands Road in the east and Pang Sua Canal runs along the western and southern boundaries of the site. It is surrounded by HDB residential developments in Choa Chu Kang and Bukit Panjang towns, educational institutions (i.e., West View Primary School, Teck Whye Secondary School, Jurong Pioneer Junior College) and other facilities (e.g. Junction 10, Bukit Panjang MRT Station, Bukit Panjang Polyclinic, etc.). A section of the Rail Corridor alignment is located within the Project site and it runs through the whole site lengthwise (refer to Figure 3-1). Furthermore, it should be noted that the Project site is “an important part of the Green Rail Corridor between the Hill View in the south and Stagmont Ring in the north, as it is the only wooded area in-between” [P-3].

The location of the Project site and its surroundings are shown in Figure 3-1.




**Legend**

CCK N1 Project Site

Rail Corridor

N

| Rev. | Date | By | Description | Chk'd | App'd |
|---|---|---|---|---|---|
| - | JAN 2023 | SAG | Final Report | NHT | JAG |

Qualified Person Endorsement : NA

HDB Endorsement : NA

Consultant : AECOM

Client: HOUSING & DEVELOPMENT BOARD

Project Title :

**ENVIRONMENTAL IMPACT ASSESSMENT (EIA) ON CHOA CHU KANG N1**

Figure Title :

**Choa Chu Kang N1 Project site**

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| SAG | NHT | JAG | 3 - 1 | - | 1 of 1 |
| | Drawn SAG | Date JAN 2023 | CAD File Name : NA | | A3 |

Note: Source of basemap - Google Earth Map

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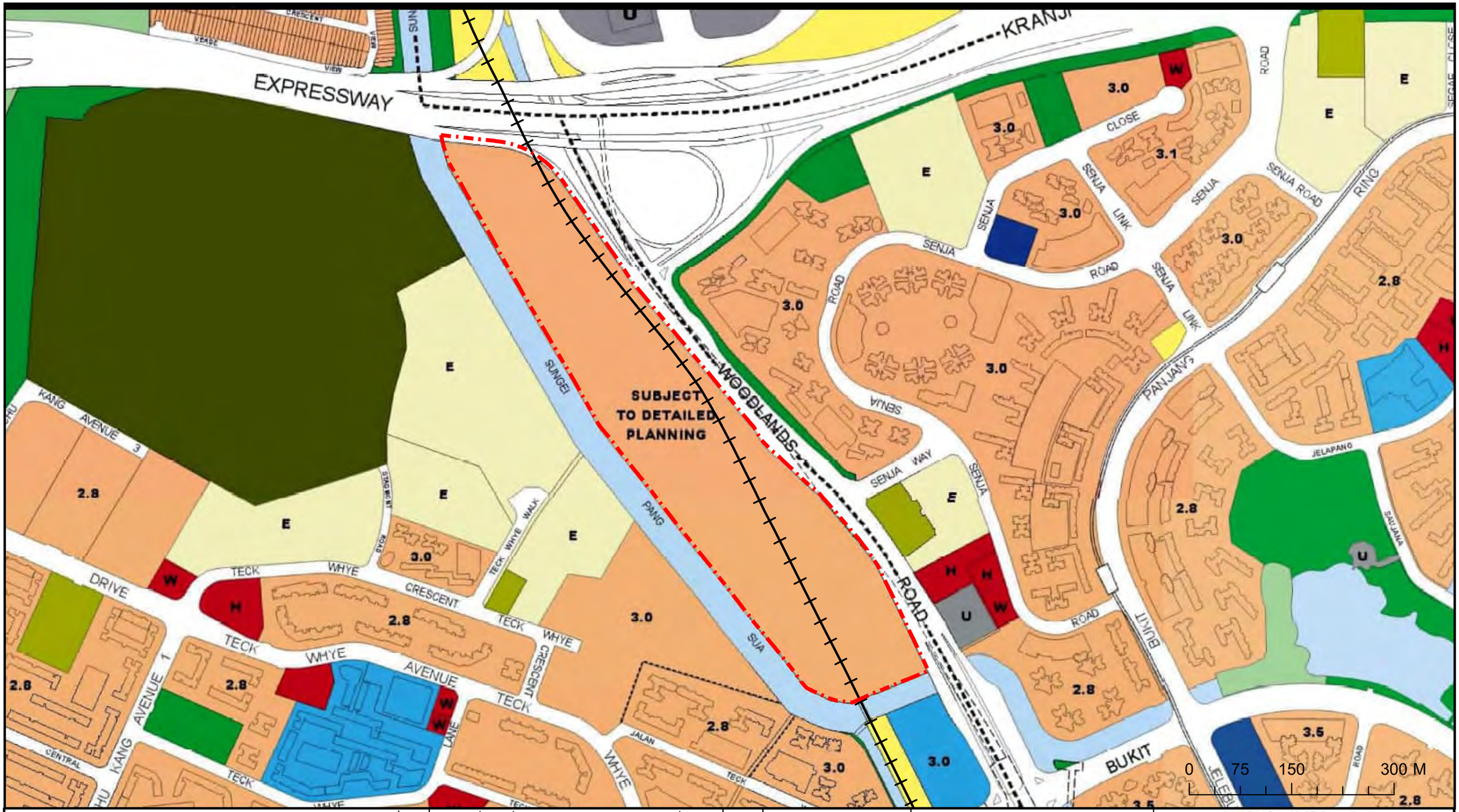
## 3.2 Project Description

Under gazetted URA's Master Plan 2019 [M-1] (Figure 3-2), the Project site has been categorised as "Residential (Subject to Detailed Planning)". The area surrounding Pang Sua Canal is categorised as "Waterbody", implying that the canal will remain at the western and southern edges of the site after the proposed residential development is developed.

Prior to this EIA study, HDB appointed AECOM to carry out EBS [P-1] on the same Project site, inclusive of Pang Sua Canal (refer to Section 1 of this Report). This EBS established baseline conditions of biodiversity and surface watercourses (i.e., hydrology, surface water quality and groundwater levels) currently present at the site. The EBS found that the Project site potentially represents an important stepping stone for movement of migratory faunal species between the surrounding green spaces (i.e., Bukit Timah Nature Reserve, Bukit Batok Nature Park, Bukit Gombak Forest and Bukit Mandai and Kranji Reservoir). Therefore, it was recommended that an Ecological Corridor should be implemented on the east of the existing Pang Sua Canal, adjacent to proposed residential development. The proposed Ecological Corridor would potentially help to facilitate the movement of wildlife (e.g., small mammals, volant species) even after the development is established.

Based on the EBS findings and recommendations and in consultation with agencies and Interest Groups, HDB revised the conceptual land use plan to include the proposed Ecological Corridor east of Pang Sua Canal, which will retain at least 2 ha of existing trees and greenery. The proposed boundaries of the Residential Area and Ecological Corridor are not to be taken as final, but are subject to further changes based on detailed studies such as design, on-site conditions, arborist's assessment, etc. Furthermore, the Rail Corridor will also be retained due to its historical and ecological value. However, it should be noted that the existing Rail Corridor track alignment will have to be removed during the construction phase (to enable obtaining required platform levels) while the final alignment (i.e., during the operational phase) will be repositioned compared to the current one (while following the original alignment as much as possible). The proposed residential development can be broadly divided into a northern and southern portion (refer to Figure 3-3).

For the purposes of this EIA, impact assessment for the construction and operational phases of the Project will be carried out based on the revised land use, as shown in Figure 3-3.




## Legend

- CCK N1 Project Site
- Rail Corridor

| | | |
|---|---|---|
| E Educational Institution | Transport Facilities | Residential |
| W Place of Worship | U Utility | Commercial & Residential |
| H Health & Medical Care | Waterbody | Commercial |
| Civic & Community Institution | Park | Sports & Recreation |
| Open Space | Reserve Site | Special Use |

N

| Rev. | Date | By | Description | Chk'd | App'd |
|---|---|---|---|---|---|
| - | JAN 2023 | SAG | Final Report | NHT | JAG |

Qualified Person Endorsement : NA

HDB Endorsement : NA

Consultant : AECOM

Client: HOUSING & DEVELOPMENT BOARD

Project Title :

**ENVIRONMENTAL IMPACT ASSESSMENT (EIA) ON CHOA CHU KANG N1**

Figure Title :

**Proposed land use of Project site and its surroundings**

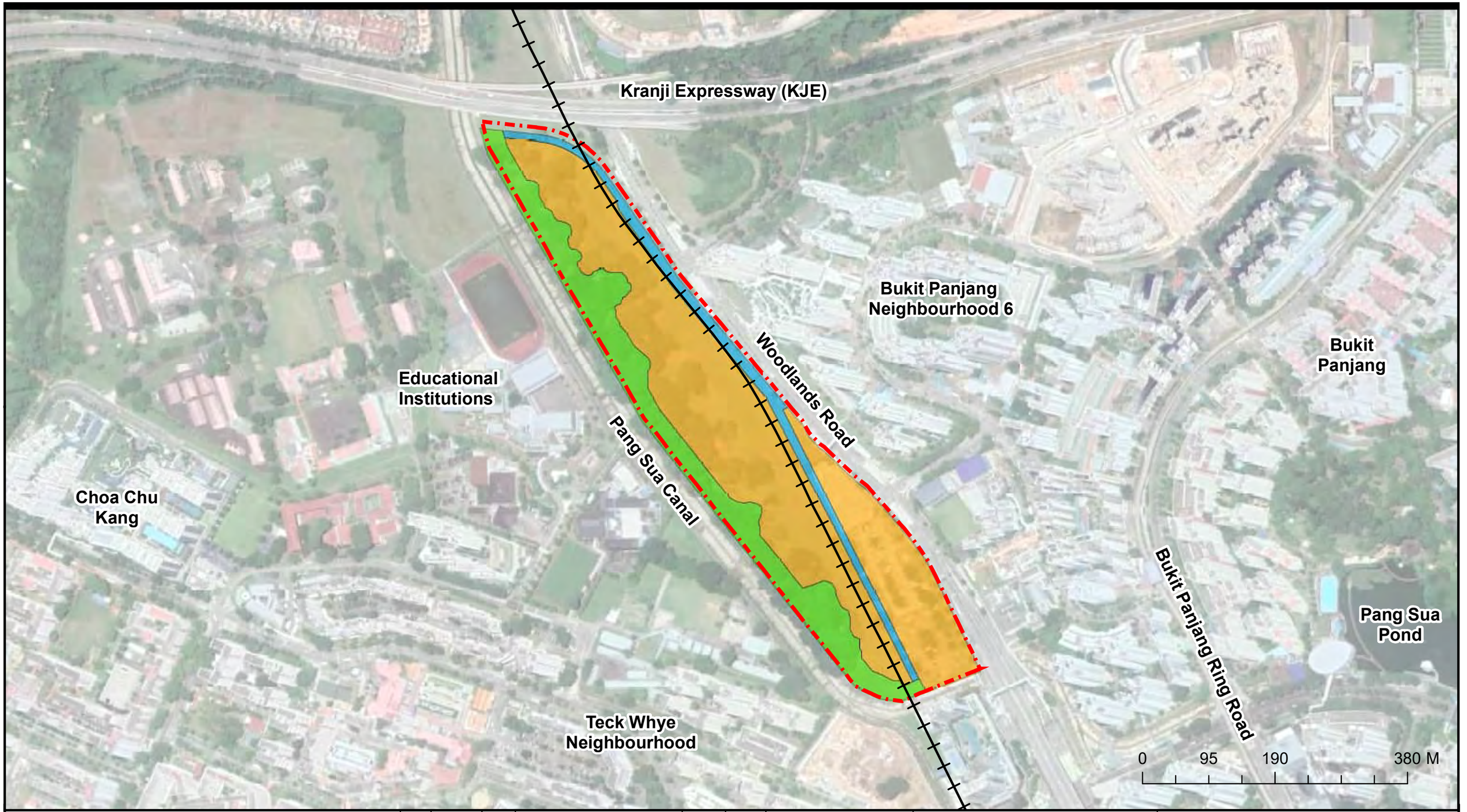
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Figure No. : 3 - 2 | Rev. : - | Sheet : 1 of 1

CAD File Name : NA | A3

Note: Source of basemap - URA Master Plan 2019

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**Legend**

- CCK N1 Project Site
- Original Track Alignment
- Proposed Ecological Corridor*
- Retained Rail Corridor Alignment*

*Exact boundaries/ alignment subject to further changes

N

| Rev. | Date | By | Description | Chk'd | App'd |
|---|---|---|---|---|---|
| 01 | NOV 2022 | SAG | Draft Final Report | NHT | JAG |
| - | OCT 2022 | SAG | Draft Final Report | NHT | JAG |

Qualified Person Endorsement : NA

HDB Endorsement : NA

Consultant : AECOM

Client: HOUSING & DEVELOPMENT BOARD

Project Title :

**ENVIRONMENTAL IMPACT ASSESSMENT (EIA) ON CHOA CHU KANG N1**

Figure Title :

**Revised proposed land use plan of the Project site**

| Designed | Checked | Approved |
|---|---|---|
| SAG | NHT | JAG |
| | Drawn SAG | Date NOV 2022 |

Figure No. : 3 - 3 | Rev. 01 | Sheet 1 of 1

CAD File Name : NA | A3

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### 3.2.1 Proposed Activities During Construction Phase

At the time of writing this Report, limited information is available regarding the activities planned during the development of the Project. The future activities expected to occur during the construction phase of the Project are further categorised into pre-construction activities and construction activities.

The pre-construction activities will take place in the initial stage of the Project development. Their main objective is to prepare the site (clear and level) so that the main construction activities (e.g. foundation works, superstructure works, etc.) can be carried out. These activities will entail site clearance (e.g. demolition of structures [e.g. existing drains, removal of original Rail Corridor track alignment] and removal of resulting debris, removal of selected existing trees and vegetation) and earthworks (e.g. soil excavation and filling within the site to achieve desirable platform levels). Furthermore, access roads and other required infrastructure for construction work machinery will be established within the site. It should be noted that activities such as site surveying, utilities surveying, and other site investigations (e.g. geotechnical investigations) are commonly carried out as a part of pre-construction activities. However, at the time of writing this Report no detailed information was available regarding timeline of these individual activities.

The construction activities will entail civil engineering activities such as foundation works, superstructure works, construction of roads and utilities/ services laying. Based on the revised land use plan (as explained in Section 3.2, and shown in Figure 3-3) the area east of the Pang Sua Canal (i.e., Ecological Corridor) is proposed to be retained and no works will be carried out within it during the construction phase of the Project. It should be noted that the proposed boundaries of the Residential Development and Ecological Corridor should not to be taken as final, but are subject to further changes based on detailed studies. Before the site becomes operational, it is assumed that temporary structures and facilities will be removed.

The identified pre-construction and construction activities and their tentative timeline (Figure 3-4) as well as construction machinery and equipment to be utilised for each of the activities have been summarized in the form of table, as shown below.

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

| Pre-Construction and Construction Activity | Related Activities | Construction Machinery and Equipment | Tentative Duration of Activity |
|---|---|---|---|
| **Pre-Construction Activities** | | | |
| Site Clearance and Earthworks to Prepare Platform | • Removal of vegetation (e.g. trees, bushes, etc.) not planned to be preserved;<br>• Soil dewatering<br>• Soil excavation, cut and fill;<br>• Site levelling to obtain planned platform levels;<br>• Soil excavation for foundations (i.e., excavation of soil to depth at which the foundations of the future structures will be placed); and<br>• Construction of access roads and other infrastructure required for construction activities | • Temporary water Pumps;<br>• Excavators;<br>• Lorries;<br>• Generators;<br>• Bulldozer;<br>• Graders;<br>• Concrete trucks<br>• Concrete vibrator; and<br>• Rollers | 14 months/ 1 year and 2 months |
| **Construction Activities** | | | |
| Foundation Works | • Delivery and erection of construction machinery (i.e., crawler crane for lifting operations and boring rig for soil drilling);<br>• Soil dewatering;<br>• Installation of bore casings;<br>• Soil boring work; | • Temporary water pumps;<br>• Mobile cranes;<br>• Crawler cranes;<br>• Bore pilling machines; | 30 months/ 2 years and 6 months |

| Pre-Construction and Construction Activity | Related Activities | Construction Machinery and Equipment | Tentative Duration of Activity |
|---|---|---|---|
| | • Installation of rebar cage and tremie pipe;<br>• Concreting works – construction of piles and pile caps;<br>• Pile head hacking/ removal;<br>• Delivery of steel sections;<br>• Hot works – welding of steel beams, brackets, etc.;<br>• Stage excavation;<br>• Hoisting of walers and struts;<br>• Stage excavation with walers and struts; and<br>• Spoil and slurry removal | • Ready-mix concrete trucks;<br>• Breakers;<br>• Welding equipment;<br>• Trailers;<br>• Excavators (with and without lifting appliance);<br>• Mini Excavators; and<br>• Dump trucks | |
| Superstructure Works (Prefab Installation) | • Soil dewatering (i.e., groundwater extraction and pumping of rainwater);<br>• Establishment of power supply (e.g. for lighting, pumps, temporary ventilation fans);<br>• Excavation below ground surface (e.g. for working platform, for preparing of lean concrete);<br>• Spoil removal;<br>• Formwork construction and cleaning before casting;<br>• Rebar handling and positioning;<br>• Hoisting of falsework;<br>• Casting of concrete;<br>• Scaffolding; and<br>• Finishing works (e.g. plastering, waterproofing, tiling, etc.) | • Temporary water pumps;<br>• Generators;<br>• Excavators;<br>• Mini excavators;<br>• Cranes;<br>• Mobile cranes;<br>• Air compressor;<br>• Dump trucks;<br>• Ready-mix concrete trucks; and<br>• Concrete pumps | 36 months/ 3 years |
| Landscape Works | • General landscaping activities; and<br>• Construction of landscape amenities/ constructions (e.g. gazebos, pathways) | • Generators;<br>• Excavators mounted sheet pile vibrator;<br>• Mobile cranes; and<br>• Welding and cutting equipment | 24 months/ 2 years |
| Removal of Temporary Structures and Reinstatement | • Removal of Earth Retaining and Stabilising Structures (ERSS); and<br>• Reinstatement of the area to original (or required) condition | • Generators;<br>• Excavators mounted sheet pile vibrator;<br>• Mobile cranes;<br>• Welding and cutting equipment; and<br>• Trucks | 24 months/ 2 years |

According to the information available at the time of writing this Report, the overall construction works (i.e. pre-construction and construction activities) will tentatively commence in the fourth quarter of Year 2023 (Figure 3-4). This timeline may be subject to changes as the Project progresses.

| Pre-Construction and Construction Activity | Tentative Duration |
|---|---|
| Site Clearance and Earthworks | 14 months |
| Foundation Works | 30 months |
| Superstructure Works | 36 months |
| Landscape Works | 24 months |
| Reinstatement | 24 months |

**Figure 3-4 Tentative Project development timeline**

Based on the available information, it is expected that the Project's development will overlap with three (3) other developments in the vicinity of Project site which were included for the purposes of cumulative impact assessment. Identified concurrent developments include:

- NParks' upcoming Bukit Panjang North Park Connector (PC) development;
- NParks' Rail Corridor North Enhancement Works; and
- Future development by other agency.

The information regarding Bukit Panjang North PC and Rail Corridor (North) enhancement works are limited at the time of writing this Report. Bukit Panjang North PC is a proposed park connector to be developed along KJE and Woodlands Rd. Construction is expected to commence in 2024. Rail Corridor (North) enhancement works include improvement works between Junction 10 and Stagmont Ring Road.

There will be construction activity for future development by other agency near the HDB Senja area, east of the Project site. The construction works for this project are expected to occur concurrently with the development of CCK N1 site.

## 3.2.2 Pre-Construction Activities

Pre-construction activities will be carried out in the initial stage of the Project and their goal is to prepare the site for the main construction works (e.g. foundation works, superstructure construction, etc.). During the site clearance, existing structures, infrastructure, vegetation and trees within the Project site that are not intended to be preserved will be demolished/ cut and resulting debris will be removed. Following this, earthworks including soil excavation and ground levelling will be carried out. Site clearance and earthworks are expected to last approximately 14 months.

### 3.2.2.1 Site Clearance

Site clearance is the first activity to be carried out as a part of site preparation for construction works. It will involve the demolition of existing structures, removal of Rail Corridor and removal of trees and vegetation not deemed to be preserved (i.e. outside of the proposed Ecological Corridor).

Removal of the trees, turf and other vegetation and topsoil from the site is also planned to be carried out during site clearance as the majority of the site will experience land use change (i.e., construction of residential developments and accompanying infrastructure such as roads). This will be done by using excavators. It should be noted that prior to removal of vegetation, arboriculture assessment of the trees should be carried out and selected trees should be transplanted. Furthermore, wildlife specialists should be consulted to develop and carry out and pre-felling inspection and wildlife shepherding, as necessary.

In addition to dust and noise, site clearance activities generally also generate substantial amounts of waste such as excavated soil (not intended to be reused, spoil material), organic material (e.g. trees, vegetation) and debris from demolished structures. Generated solid waste will be safely collected, stored and removed from the site by dump trucks and lorry cranes. Potential impacts arising from site clearance have been assessed in relevant sections of this Report.

#### 3.2.2.2 Earthworks

Following the demolition of existing structures and removal of existing vegetation and topsoil, earthworks will be carried out. This will include activities during which the soil will be excavated, transported, placed at the new location and compacted. The excess soil which is not used for backfilling will be permanently removed from the site. It should be noted that earthworks usually also require soil dewatering, to assure dry conditions of soil, which is especially important during foundation works.

##### 3.2.2.2.1 Civil Engineering Earthworks

Civil engineering earthworks will be carried out prior to or concurrently with civil engineering works and they will include foundation works (refer to Section 3.2.3.1), as well as construction of accompanying infrastructure (e.g. temporary and permanent roads, drainage and sewerage systems, etc.).

Internal temporary roads for movement of personal vehicles, heavy-vehicles and machinery are generally constructed from aggregate/ soil which is placed on the selected location and then compacted. Compaction of the material used for temporary roads may be carried out by machinery and equipment such as rollers or rammers. The information regarding the location of future site access(es) and the layout of temporary roads is not available at the time of writing this Report.

Other civil engineering earthworks (e.g. excavation of trenches for drainage and sewage systems, soil excavation for foundation) are usually carried out prior to the related main construction activity.

##### 3.2.2.2.2 Site Levelling

Currently, the Project site is mostly vegetated area (covered in managed trees and turf) with generally flat terrain with mild slopes that will be levelled for construction activities to start. This may involve cutting of the areas where proposed platform levels are lower than the existing terrain levels and filling and stabilising of slopes in areas which are currently lower than the proposed future platform levels (i.e., northern areas, future Rail Corridor alignment). In this case, geotechnical engineers will develop Earth Retaining Stabilisation Structures (ERSS) schemes to stabilise the exposed slopes in their engineering design. Environmental Control Officer (ECO) considers measures to prevent erosion of soil into the nearest watercourses (i.e., drain D2 at the northeast boundary of the site). This may or may not 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 3-5. Site levelling would involve large machineries such as excavator, lorry, concrete vibrator, grader, roller, etc.

The earthworks as described above may cause adverse impacts on biodiversity due to reduced habitats. Surface water flow conditions may be impacted due to changes in hydrology of the site (i.e., increased runoff due to decreased permeability into the soil) while the quality of the receiving watercourses may be impacted by potential contaminants from earthworks activities (e.g. historically contaminated soil and groundwater). Impacts on other environmental conditions also include elevated airborne noise due to operation of machineries, as well as dust emissions. These potential impacts have been assessed in the relevant sections of this Report.



**Figure 3-5 An example of site levelling at construction worksite in Singapore (AECOM©)**

#### 3.2.2.3 Establishment of Temporary Structures and Infrastructure

Following the earthworks, and prior to construction activities, the temporary structures and infrastructure will be set up within construction site. Usually, this entails construction and/ or installation of site features such as offices, toilets, storage areas (e.g. for materials, waste, equipment, chemicals, etc.), internal temporary roads for vehicular movement, site hoardings, noise barriers as well as waste management facilities. At the time of writing this Report no information regarding the establishment of temporary structures and infrastructure is available. However, the potential impacts arising from use of these structures (e.g. water contamination due to spills and leaks of chemicals) and related activities have been addressed in relevant sections of this Report.

### 3.2.3 Construction Activities

Once the site clearance and earthworks have been completed, construction activities are carried out through the foundation works, superstructure works, general landscaping works as well as reinstatement of the Project site (including the removal of temporary structures). Construction activities, as described in following sub-sections will be carried out outside of the proposed Ecological Corridor.

#### 3.2.3.1 Foundation Works

Once demolition works and site clearance are completed and temporary worksites are established, foundation works for substructures, including piles and pile caps will be carried out. According to the tentative Project development timeline, foundation works will firstly start at southern parcel and will last approximately 30 months. Foundation works at the northern parcel are expected to start couple of months after the foundation works at the southern parcel and are also expected to last approximately 30 months.

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

To seal the pile foundation, a pile cap is necessary. For this, steel waler and struts are required to hold the temporary formworks to proceed with pile cap concreting. The steel is delivered with a 40-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.



**Figure 3-6 An example of piling/ foundation works in Singapore (AECOM ©)**

### 3.2.3.2 Superstructure Works

Superstructure works are expected to start firstly at the southern parcel, approximately one year after the foundation works start and will last around three years. Similarly, superstructure works at the northern parcel are expected to start approximately one year after the foundation works start and will also last around 3 years.

The on-site power supply for lighting, pumps and temporary ventilation fans operation will be provided by generators. 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. Crane is used for the spoil removal as well. To construct building until the designated height, temporary formwork is necessary at each level before casting, where air compressor will be used for cleaning. During this process, mobile crane is used to transport rebar and for the hoisting of falsework, formwork, scaffolding and the construction of temporary working platforms. A concrete truck is used to transport ready mix concrete to the site and concrete pump is used for the superstructure's concreting works.

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



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

### 3.2.3.3 General Landscaping Works

As part of the proposed development, it is expected that landscaping features will be developed in order to enhance sensory (e.g., visual) experience of the future users (i.e., parks, open areas for public, future permanent residents, general public, etc). These may include planting of trees and shrubs, lawn space, etc. It should be noted that as per revised Land Use Plan (as shown in Figure 3-3), west portion of the site (along Sungei Pang Sua) will remain untouched as an Ecological Corridor. The retained Rail Corridor alignment is proposed to have a green buffer and is envisioned as a green space incorporated with community spaces/ amenities such as playgrounds and fitness corners. However, at the time of writing this Report there are no detailed plans regarding the landscape enhancements along the retained Rail Corridor alignment. General landscaping works are expected to last around two years and will start at the southern parcel first.

Generators will provide the power supply for lightning and running of machineries during landscaping works. If needed, excavator and mobile crane will be used to remove patches of soil and relocate them or transport from the site. Welding and cutting equipment are commonly used to form landscape structures. The potential environmental

impacts associated with the general landscaping works will be assessed and incorporated as a whole in the relevant sections of this Report.

#### 3.2.3.4 Removal of Temporary Structures and Reinstatement of the Project Site

As the final step towards completion of construction activities, the developer and/ or contractor will 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 development. Therefore, the potential environmental impacts associated with the removal of temporary structures and reinstatement of the Project site will be assessed and incorporated as a whole in the relevant sections of the Report. Reinstatement of the Project site will occur simultaneously with general landscaping works and is expected to last around two years.

## 3.3 Proposed Activities During Operational Phase

Following the reinstatement period, human activity will increase as the development area becomes operational. The Project site will see an associated increase in human activity such as traffic movement, lighting, and general activities. During the operational phase, the vehicular traffic volume in the vicinity is predicted to increase when the proposed public housing and its associated road network starts operating. Furthermore, the whole area is expected to see increase in visitors and passers-by due to the retained Rail Corridor alignment and its enhancements which are part of the wider route along the Rail Corridor. All of the above may cause potential air pollution, noise nuisance, water and biodiversity impacts in the vicinity of the development. In addition, more impervious surfaces are be expected due to potential change of natural landscape to urbanised area which will reduce stormwater infiltration into the ground and increase water runoff.

# 4 Description of the Environment

This section will define the Study Areas for this EIA, describe the historical land use, existing land use and environment, topographical condition, as well as geological and soil characteristics of the Project site.

## 4.1 Study Area

The Study Area is defined as a selected area of interest for the assessment of impacts with regards to a specific environmental parameter (i.e., biodiversity, water resources [hydrology, surface water quality, groundwater level, groundwater quality], air quality, airborne noise). Its extent is based on relevant legislation and international guidelines (where applicable) and should encompass the locations that could directly or indirectly be impacted by the pre-construction, construction and operational activities of the proposed developments (i.e., area of the Project influence).

The Study Area should minimally include the Project site (taking into consideration construction and operational footprints of the Project). However, as some impacts might spread beyond the boundaries of the Project site (e.g., water pollution, airborne noise, dust, etc.) it is necessary to define the Study Area in such a way to capture these transmissions, where reasonably expected. Given the fact that the medium of the impact transmission (e.g., air, water) and potentially affected sensitive receptors vary based on the environmental parameter, the Study Area is defined for each of the environmental disciplines. The Study Areas for each of the disciplines are summarized in Table 4-1. Further explanations and details of Study Areas will be discussed for each parameter in the respective chapters.

**Table 4-1 Study Area for different environmental parameters**

| Environmental Parameter | Study Area (Construction Phase) | Study Area (Operational Phase) | Justifications |
|---|---|---|---|
| **Biodiversity** | Ecological sensitive areas within the Project site[1]. | | NParks' BIA Guidelines [R-2] |
| **Water Resources (Hydrology and Surface Water Quality)** | The watercourses[1] and their catchments impacted by the Project as well as their nearby downstream area and/ or watercourses. | | Proposed land use change and expected activities during construction and operational phases of the Project may cause negative impacts (e.g. increased peak runoff, flooding, erosion of banks, water quality deterioration) on surface water resources and their baseline conditions. Consequently, these changes may cause adverse effects on nearby humans and habitats. |
| **Water Resources (Groundwater Quality and Groundwater Level)** | Habitats and humans within and in the vicinity of the Project site. | | Activities during construction and operational phases of the Project have a potential to affect humans and ecological receptors directly or indirectly. |
| **Air Quality** | • 50 m (ecological receptors); and<br>• 350 m (human receptors) from construction worksite area | 250 m from operational footprint | • *Construction phase*: Based on UK IAQM Guidance [R-31]<br>• *Operational phase*: Based on other project experiences. |

| Environmental Parameter | Study Area (Construction Phase) | Study Area (Operational Phase) | Justifications |
|---|---|---|---|
| **Airborne Noise** | 150 m around the proposed construction worksites. | Immediate boundary of the operational footprint and 70 m from roads. | *Construction phase*: Environmental Protection and Management (Control of Noise at Construction Sites) Regulations, 2008 [R-33]<br>*Operational phase*: 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] |
| **Note:**<br>**1 –** Study Area for biodiversity and water resources baseline studies corresponds to Study Area from previous EBS [P-1] which includes Project site and Pang Sua Canal. | | | |

## 4.2 Historical Land Use

As far as possible, a chronological account of the changes in land use of the Project site is provided in following paragraphs, with inferences drawn from historical resources (maps, sea charts, and aerial photographs) contained within the NUS Libraries Historical Maps of Singapore (NUSLHMSG), unless otherwise mentioned. At some point in time, trees were also planted to green up the site and was used as a tree bank (pers. comms.).

The earliest available map of the Project site dates back to 1873 and reveals a relatively untouched area with a seemingly natural stream passing through it. In the early 1900s, the original vegetation at the Project site was likely to be a mangrove swamp forest which was subsequently cleared for rubber plantations (Figure 4-1A). The Keretapi Tanah Melayu (KTM) railway track that runs towards Malaysia was later constructed across the Project site and village settlement was developed with increased public housing.

From 1958 to 1969, there seemed to be an accelerated rate of development accompanied by continuous disturbance and clearing of vegetation. Several smaller fair-weather roads were also constructed around the Study Area and linked to the railway. Within the Project site itself, although the vegetation coverage was reduced, still a large portion was used for sundry cultivation (Figure 4-1B). There is also mapped evidence of enhanced water bodies passing through the Project site that were not present in previous maps.

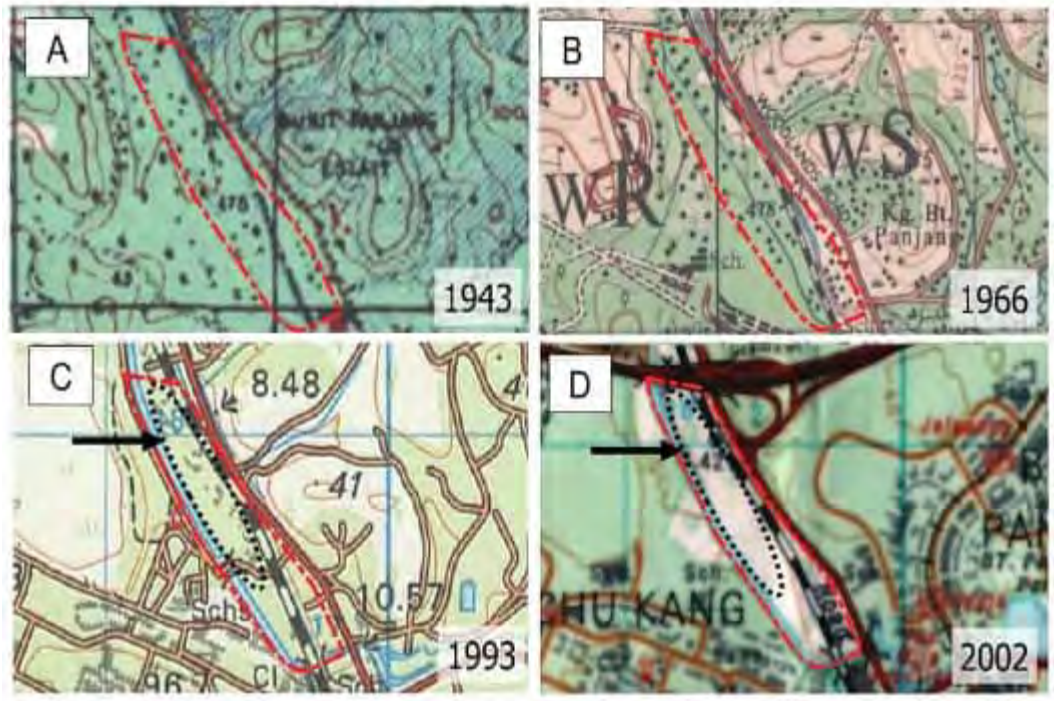
By 1974 the surrounding area had become much more inter-connected, with many motor roads passing through and linking with the railway and surrounding area. Settlements and buildings were now more organised, likely the influence of a roadmap and urban planning set forth by the government.

Around the 1980s, the watercourses that originally cut through the Project site were widened to form concrete drains, while the concrete canal (also currently known as Pang Sua Canal) was in the process of construction. The completed concrete canal was reflected in the map dated in 1993, as seen in Figure 4-1C. Following this, the KJE was completed in 1994, north of the Project site.

Towards the early 2000s, remnants of buildings were removed (Figure 4-1D), except the KTM railway track, and the area continued to regenerate into spontaneous vegetation in less than 10 years. In 2011, the KTM railway track was dismantled and converted into the Rail Corridor [P-6].

Currently, 12 ha of the Project site has trees and vegetation occupying the western side of the Rail Corridor. The southern half of the woodlands consist of mixed vegetation such as rain trees (*Samanea saman*), and other fruit trees, such as mango (*Mangifera indica*) and breadfruit (*Artocarpus altilis*). Over at the northern half, the area is occupied by mature trees of Senegal mahogany (*Khaya senegalensis*) and several trumpet trees (*Tabebuia rosea*). Wild shrubs fringe the edges, including scattered cultivated patches of banana (*Musa* sp.), tapioca (*Manihot esculenta*), and pandan (*Pandanus amaryllifolius*) [P-5].

In summary, the land use of the Project site has undergone significant changes over the years, with eventual widespread land conversion throughout. While the surrounding land area has developed significantly, with vegetation removed to make way for schools, residences, and the KJE, the Project site has been re-vegetated, following the closure of KTM Railway operations in recent years.




| 1943 | 1945 | 1958 | 1966 | 1974 | 1993 | 2002 | 2011 |
|---|---|---|---|---|---|---|---|
| Rubber plantation were cultivated within the study area with mangrove swamp forest dominating on the right next to the eastern side. Stream was also present within the Study Area (Figure 4-2A) | A single track of KTM railway was built across from north to south of the Study Area | Tree cultivation was reduced for inhabitants to reside in the area with few housing estates/buildings were built within the Study Area | Rubber plantations were cleared and a large portion of the Study Area were marked out as sundry cultivation (Figure 4-2B) | Several roads were built around the settlement area, and the number of buildings has increased. | A canal was built on the western side, cutting across the North-south line of the study area. Settlement within the site has significantly decreased, with sundry cultivation taken over an area of previous inhabitants (Figure 4-2C) | Sundry cultivation and housing were removed (as shown in Figure 4-2C), and the study area was left to revegetate (Figure 4-2D). | KTM railway track was removed and transported back to Malaysia. Railway track was then converted as part of the Rail Corridor |

**Figure 4-1 Maps showing the chronological land use of the Project site (A) Rubber plantation were cultivated within the Project site around 1943; (B) Rubber plantations were cleared and taken over by sundry cultivation. Settlements were present within the Project site, indicated by the black-dotted oval and arrow; (C) Construction of the canal was completed at the western side of Project site, cutting across from north to south of the boundary. Settlements have also decreased, indicated by the black-dotted oval and arrow; (D) Sundry cultivation and housings, indicated by the black-dotted oval and arrow were removed [M-2]**

## 4.3 Current Land Use

Presently, there are three key features within and the vicinity of the Project site – the woodland area, Pang Sua Canal and the existing Rail Corridor alignment.

Majority of the Project site is comprised of managed vegetation, which consist of clusters of trees and turfed area with spontaneous vegetation (Figure 4-2A and Figure 4-2B). Following the closure of Keretapi Tanah Melayu (KTM) Railway in 2011, the Project site has been re-vegetated and is currently covered in vegetation which varies from low grass in the eastern portion to denser vegetation and scattered trees going towards the west.

The Pang Sua Canal and PUB's existing drainage reserve are located in the west and south of the Project site. The canal flows from south to north (Figure 4-2B and Figure 4-2C). The Rail Corridor also passes through the Project site, close to the east boundary of the site (Figure 4-2D). It is currently a linear stretch of managed turf (Figure 4-2D). There are also built-up areas within the site, which includes a heavy vehicle car park and a now-defunct bus terminal (Figure 4-2D), which are located at the south-eastern portion of the Project site.

The terrain is generally flat, with elevation ranging from +0.55 mRL to +27.33 mRL, with decreasing elevations from southeast towards northwest (Figure 4-3). Slopes are generally mild, with steep slopes observed only along the banks of the watercourses (Figure 4-4).

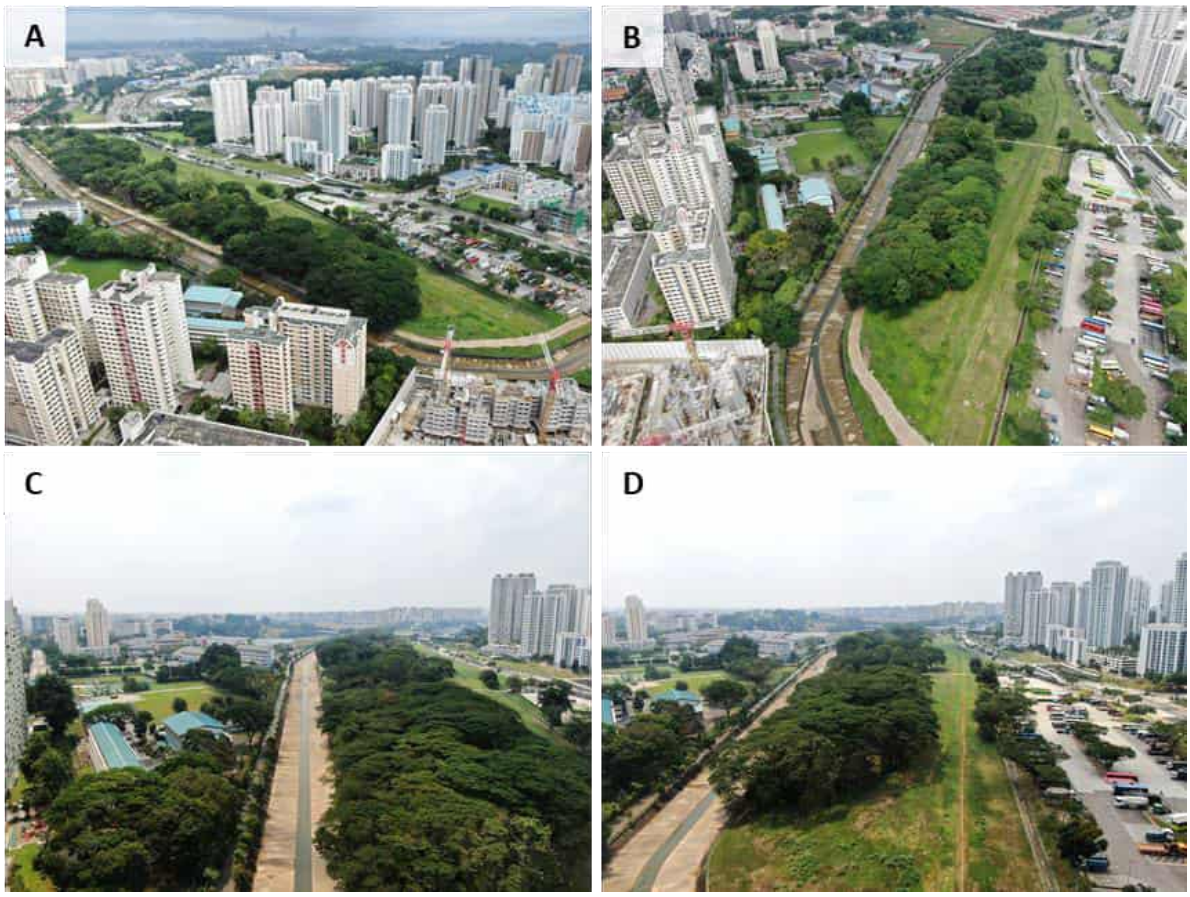
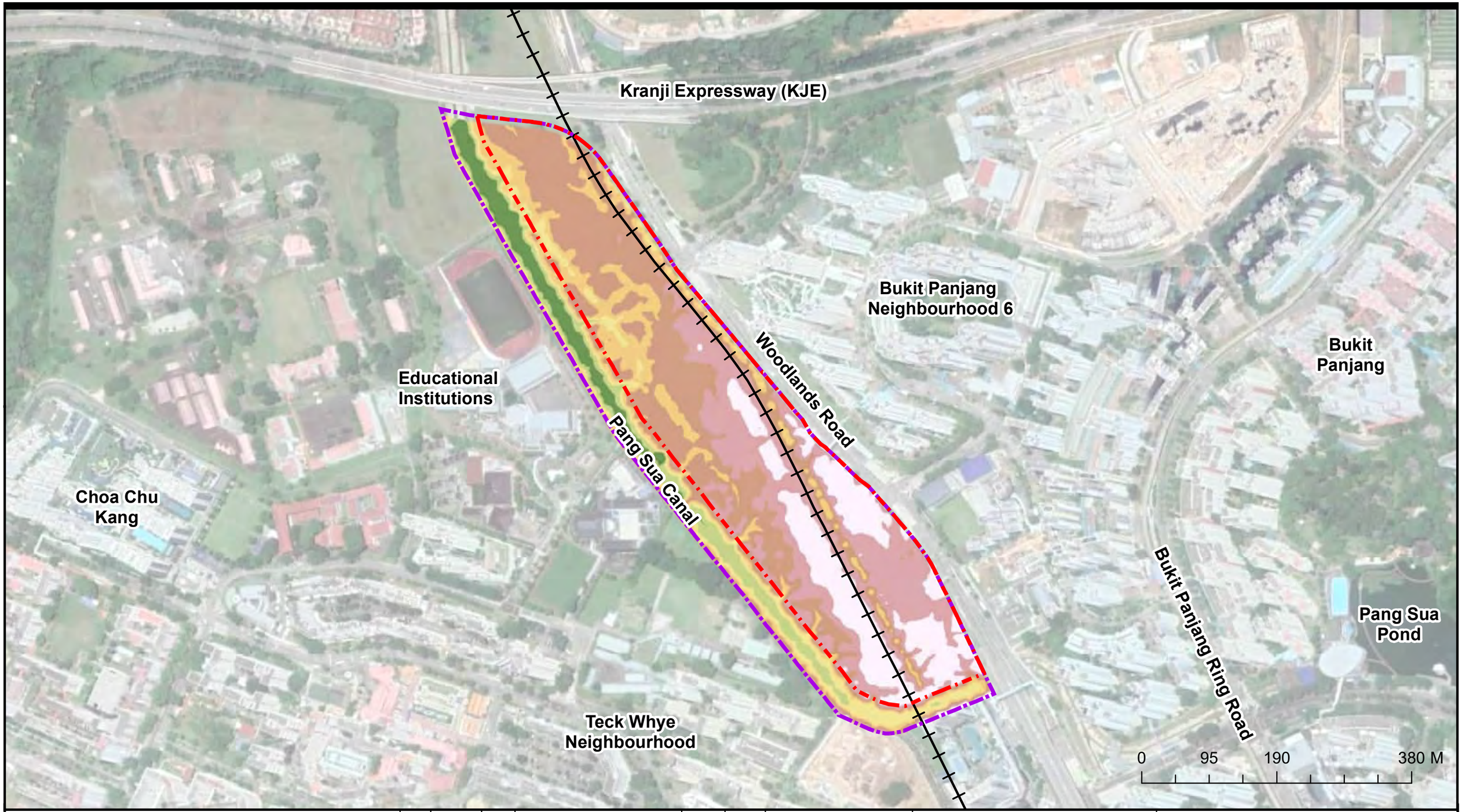



**Figure 4-2 Photos of existing site conditions in the Study Area: (A) Aerial View of the whole site, (B) Aerial View of the Pang Sua Canal located in the west and south of the site, (C) Aerial view of Pang Sua Canal and trees along western section of the site, (D) Aerial view of Rail Corridor alignment, heavy vehicle carpark and now-defunct bus terminal**




**Legend**

- CCK N1 Study Area
- CCK N1 Project Site
- Rail Corridor

**Elevation (mRL)**

- <5
- 5-6
- 6-7
- 7-8
- 8-9
- 9-10
- >10

N

| Rev. | Date | By | Description | Chk'd | App'd |
|---|---|---|---|---|---|
| - | JAN 2023 | SAG | Final Report | NHT | JAG |

Qualified Person Endorsement : NA

HDB Endorsement : NA

Consultant : AECOM

Client: HOUSING & DEVELOPMENT BOARD

Project Title :

**ENVIRONMENTAL IMPACT ASSESSMENT (EIA) ON CHOA CHU KANG N1**

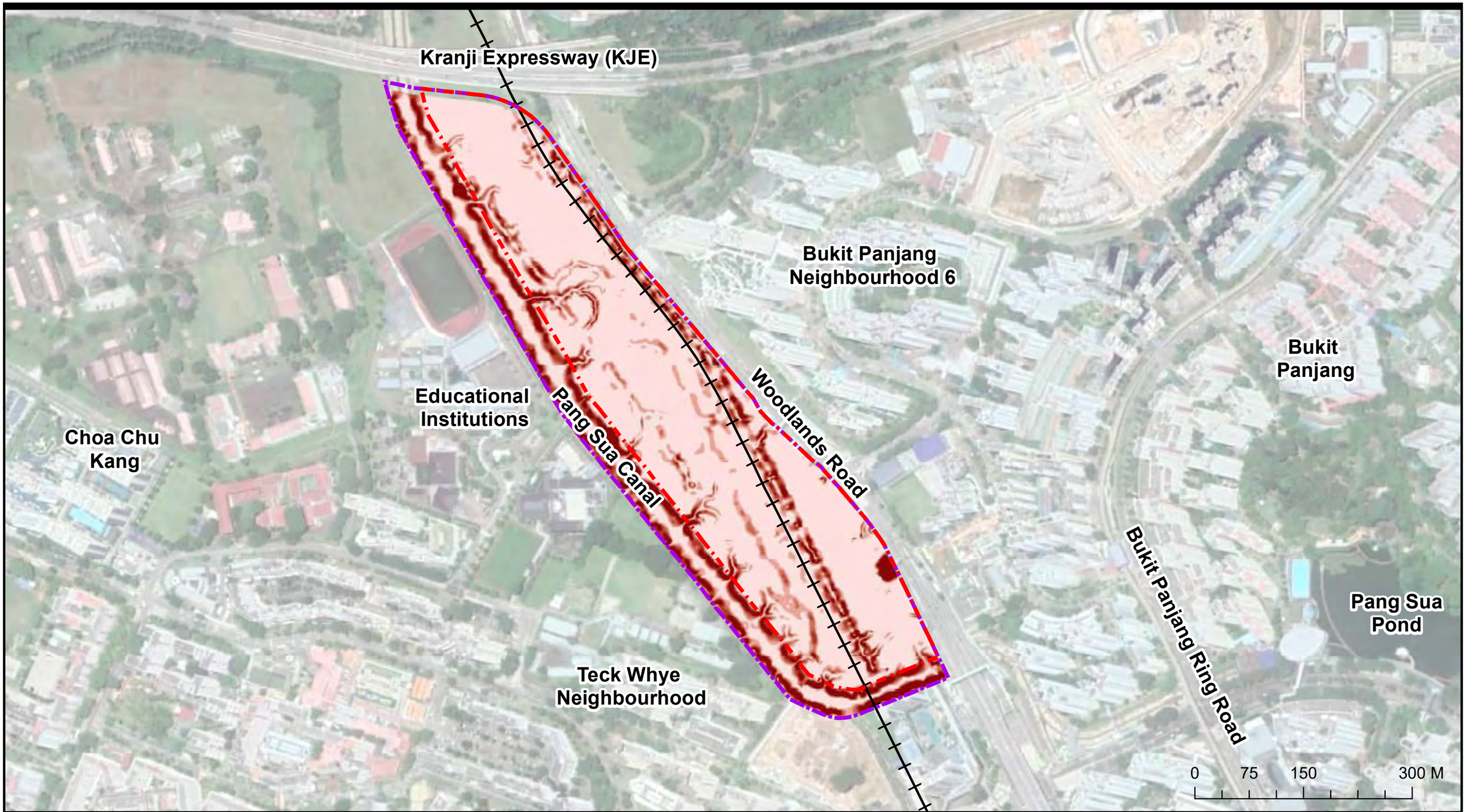
Figure Title :

**Elevation map of the Project site and Pang Sua Canal**

| Designed | Checked | Approved | Figure No. : | Rev. | Sheet |
|---|---|---|---|---|---|
| SAG | NHT | JAG | 4 - 3 | - | 1 of 1 |
| | Drawn SAG | Date JAN 2023 | CAD File Name : NA | | A3 |

Note: Source of basemap - Google Earth Map

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## Legend

- CCK N1 Study Area
- CCK N1 Project Site
- Rail Corridor

**Slope (%)**

- <10
- 10-15
- 15-20
- 20-25
- >25

N

| Rev. | Date | By | Description | Chk'd | App'd |
|---|---|---|---|---|---|
| | | | | | |
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| - | JAN 2023 | SAG | Final Report | NHT | JAG |

Qualified Person Endorsement : NA

HDB Endorsement : NA

Consultant : AECOM

Client: HOUSING & DEVELOPMENT BOARD

Project Title :

**ENVIRONMENTAL IMPACT ASSESSMENT (EIA) ON CHOA CHU KANG N1**

Figure Title :

**Slope map of the Project site and Pang Sua Canal**

| Designed | Checked | Approved | Figure No. : | Rev. | Sheet |
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| SAG | NHT | JAG | 4 - 4 | - | 1 of 1 |
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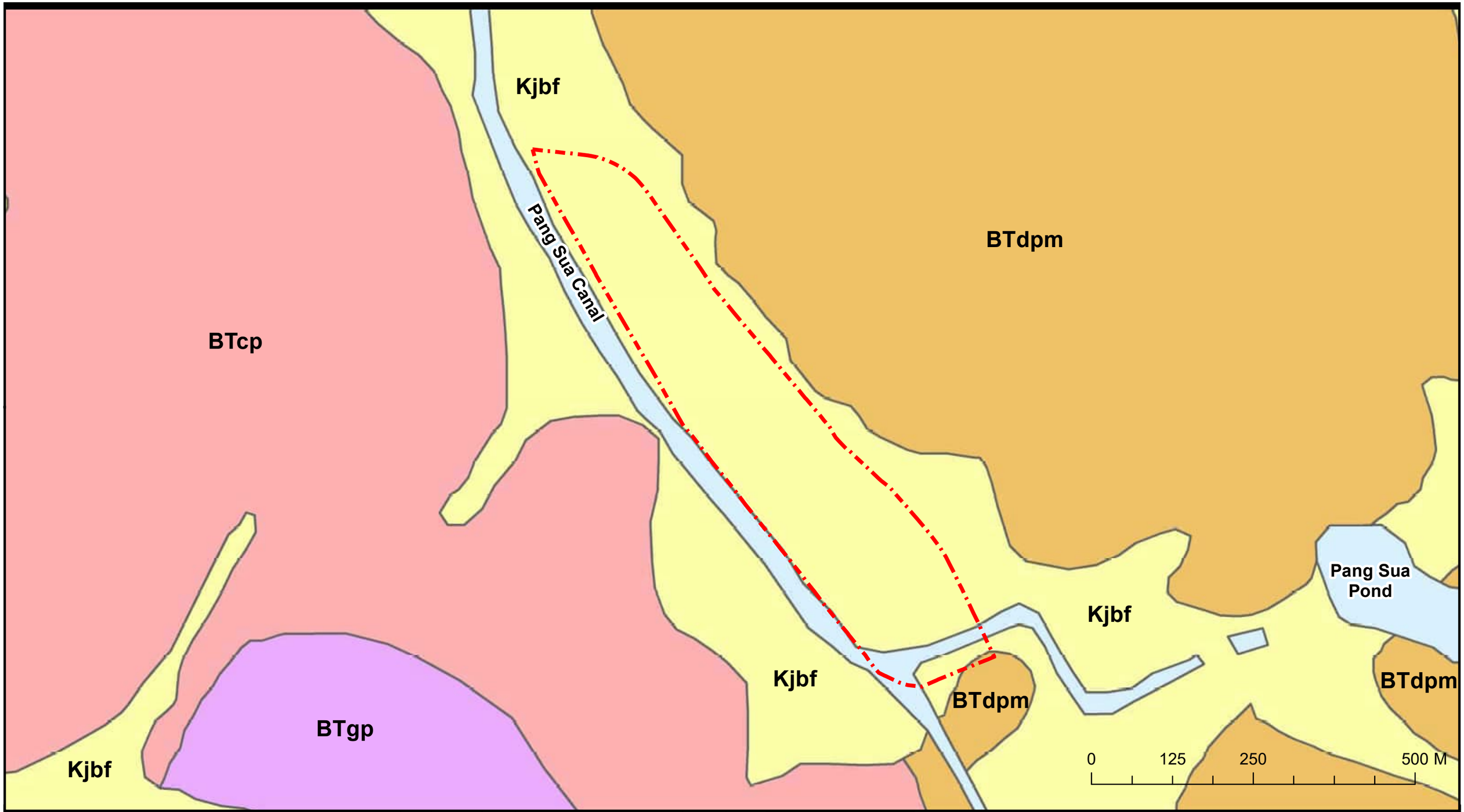
Note: Source of basemap - Google Earth Map

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## 4.4 Geology

As shown on the Geological Map of Singapore [M-3] (refer to Figure 4-5), the Project site is underlain by the Jalan Besar Formation (Kjbf), a part of the Kallang Group.

Jalan Besar Formation (Kjbf) is part of the Kallang Group strata which is the youngest of the existing geological formations of Singapore and is usually located at river valleys, river mouths, river plains, coastal areas and near offshore [O-2]. This Jalan Besar formation comprises relatively uniform-sized fluvial deposits, ranging from silty clay to coarse sand, with occasional occurrences of gravel and organic matter [P-7]. The member is usually unconsolidated but lightly consolidated beds might be found.




## Legend

- CCK N1 Project Site

**Geology**

- Kjbf — Jalan Besar Formation
- BTgp — Gombak Gabbro-granite Pluton
- BTdpm — Dairy Farm Granite-microgranite Pluton
- BTcp — Choa Chu Kang Granodiorite-tonalite Pluton
- Watercourses

N

| Rev. | Date | By | Description | Chk'd | App'd |
|---|---|---|---|---|---|
| - | JAN 2023 | SAG | Final Report | NHT | JAG |

Qualified Person Endorsement : NA

HDB Endorsement : NA

Consultant : AECOM

Client: HOUSING & DEVELOPMENT BOARD

Project Title :

**ENVIRONMENTAL IMPACT ASSESSMENT (EIA) ON CHOA CHU KANG N1**

Figure Title :

**Geological map of the Project site and its surroundings (Source: Geological Map of Singapore, 2021)**

| Designed | Checked | Approved | Figure No. : | Rev. | Sheet |
|---|---|---|---|---|---|
| SAG | NHT | JAG | 4 - 5 | - | 1 of 1 |
| | Drawn SAG | Date JAN 2023 | CAD File Name : NA | | A3 |

Note: Source of basemap - Geological Map of Singapore 2021

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# 4.5 Catchment Area

As Singapore does not have extensive natural aquifers or lakes and has limited land to store collected stormwater, it aims to maximize stormwater harvesting. Stormwater is collected through a network of rivers, canals and drains and channelled to seventeen (17) reservoirs, after which it is treated, filtered and disinfected at the water treatment plants. Stormwater is one of Singapore's main sources of drinking and industrial water. As shown in Figure 4-6, the Project site is located within the catchment area of the Kranji Reservoir. It is expected that the majority of stormwater from the Project site will be drained into the Kranji Reservoir (via discharge into Pang Sua Canal) and eventually will be used for beneficial purposes (e.g. drinking, industrial purposes). The detailed hydrology baseline conditions and catchment delineation of the Study Area are detailed in Section 8.

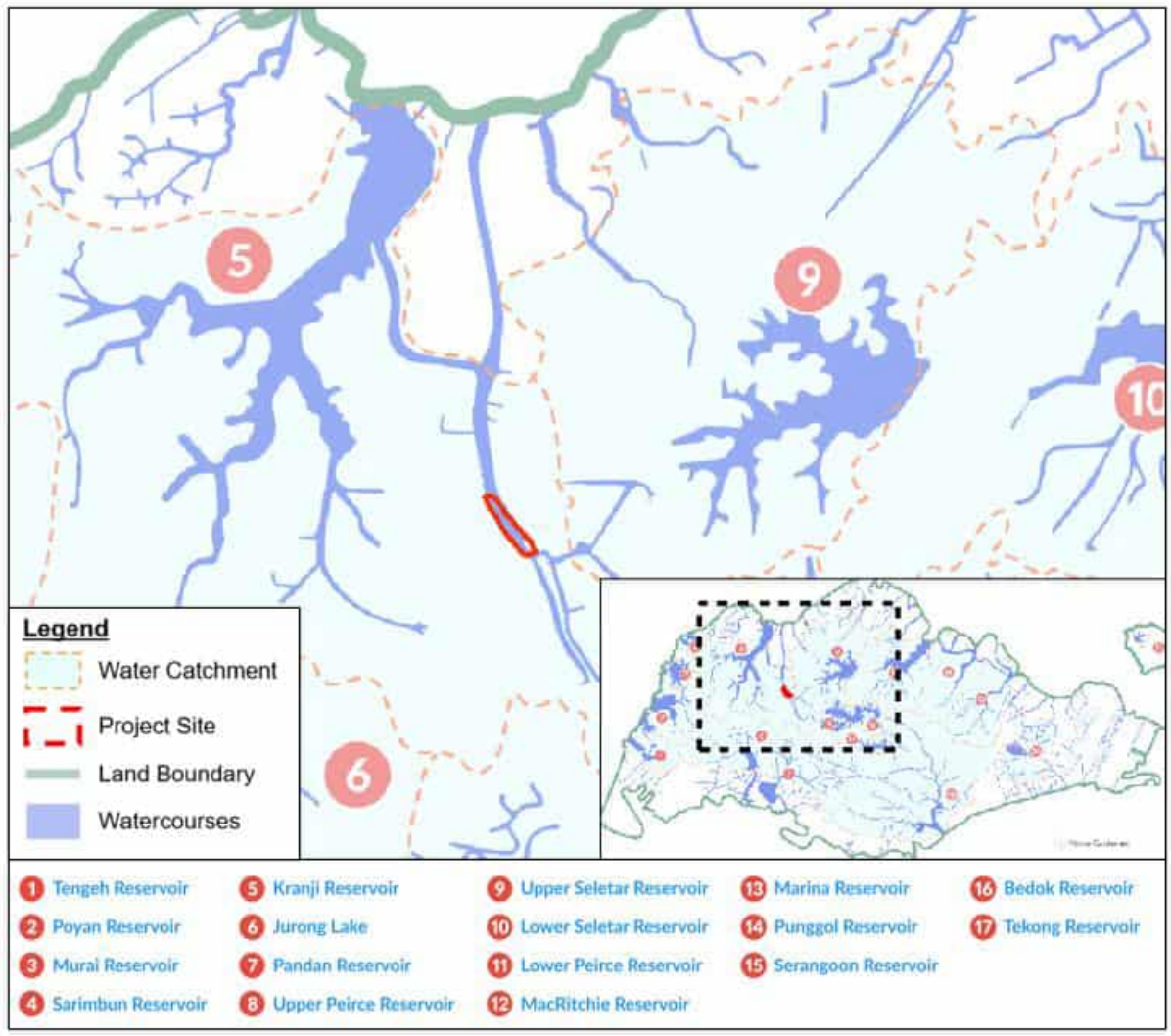



**Figure 4-6 Singapore water catchment (Source: PUB, 2020 [W-3])**

# 4.6 Climate

## 4.6.1 Rainfall

Singapore is situated near the equator and has typically tropical climate. Singapore's year-to-year rainfall is highly variable. Based on the 30-years long-term climate information (1981 – 2010) by the Meteorological Service Singapore (MSS), it rained an average of 167 days of the year [W-19]. The long-term mean annual rainfall total is 2534.4 millimetres (mm) when averaged across island-wide stations with long-term records [W-20]. Based on the findings from MSS, the annual rainfall total has increased at an average rate of 67 mm per decade, and hourly rainfall increased at the rate of 0.8 days per decade for heavy rain (>40 mm) and 0.2 days per decade for very heavy rain (>70 mm) from Year 1980 to 2019 (refer to Figure 4-7) [W-21].

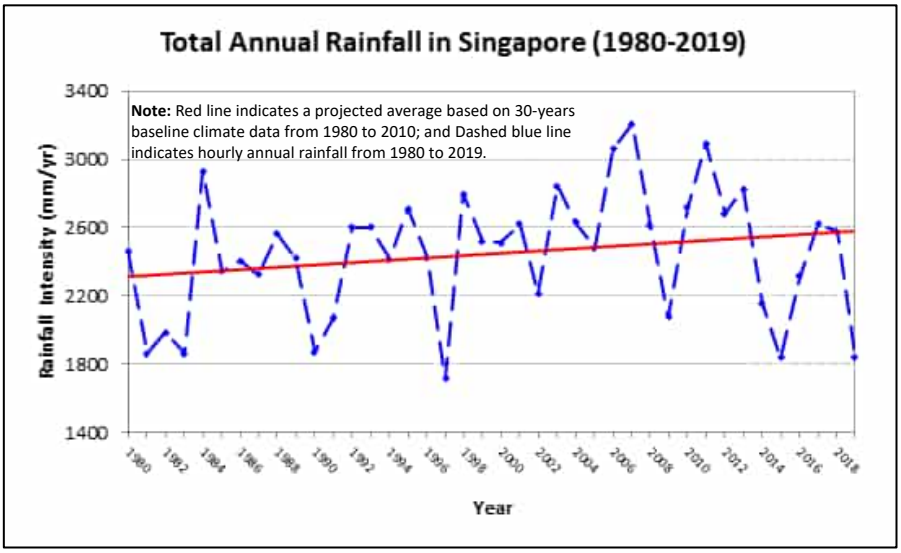



**Figure 4-7 Annual rainfall total in Singapore from 1980 to 2019 (Source: Meteorological Service Singapore [MSS] [W-21])**

In terms of spatial distribution, rainfall is higher over the northern and western parts of Singapore and decreases towards the eastern part of the island (Figure 4-8) [W-19]. The figure also shows that the Central Catchment possibly receives the maximum rainfall in Singapore. The annual average rainfall in the Project site is anticipated to be approximately 2,800 mm to 3,000 mm. Furthermore, the recent findings from MSS had shown an overall upward trend in total annual rainfall at increased average rates ranging from 3.3 mm/ year to 12.2 mm/year, during the period from 1980 to 2019 (refer to Figure 4-9) if compared to the 30-years long-term basis, except for the areas near Changi and Queenstown climate stations at the east and south of Singapore respectively [W-21].




**Figure 4-8 Annual average rainfall spatial distribution (1981 - 2010) (Source: MSS [W-19])**

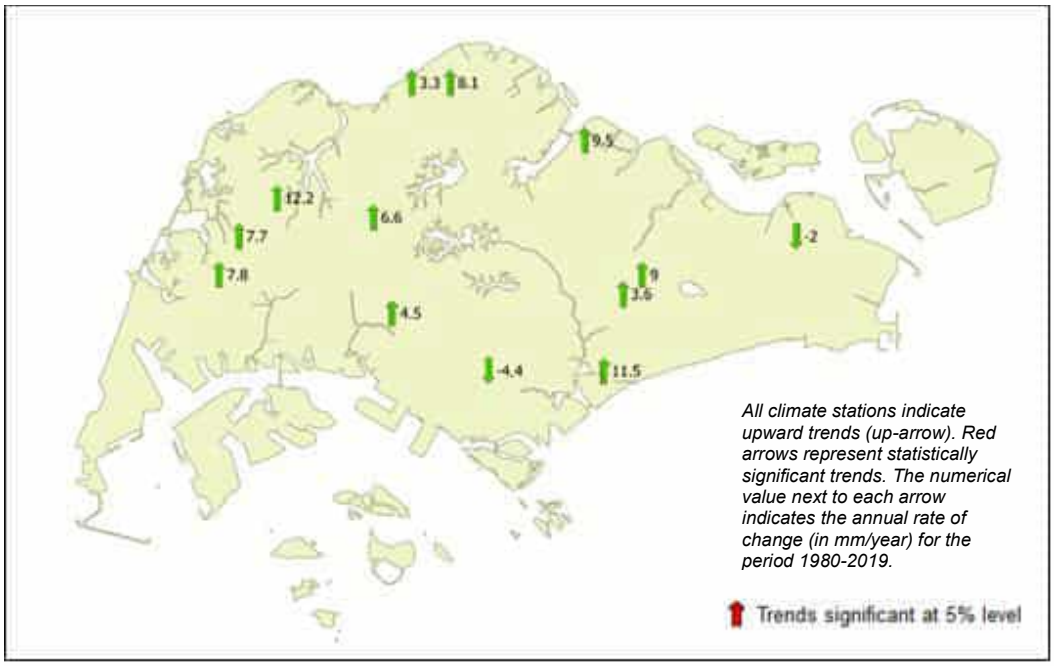



**Figure 4-9 Past trends of annual rainfall total at indicative stations (1981-2019) [W-21]**

Singapore has two monsoon seasons separated by inter-monsoonal periods, where the Northeast Monsoon occurs from December to early March and the Southwest Monsoon from June to September. It also has abundant rainfall all the year round with relatively higher mean rainy days (more than thirteen [13] days) and mean rainfall amount (more than 230 mm) from November to January every year (refer to Figure 4-10). The average rainfall in Singapore is approximately 230 mm and 180 mm during Northeast and Southwest Monsoon, respectively. Most months in 2021 had rainfall that was above average (refer to Figure 4-10).

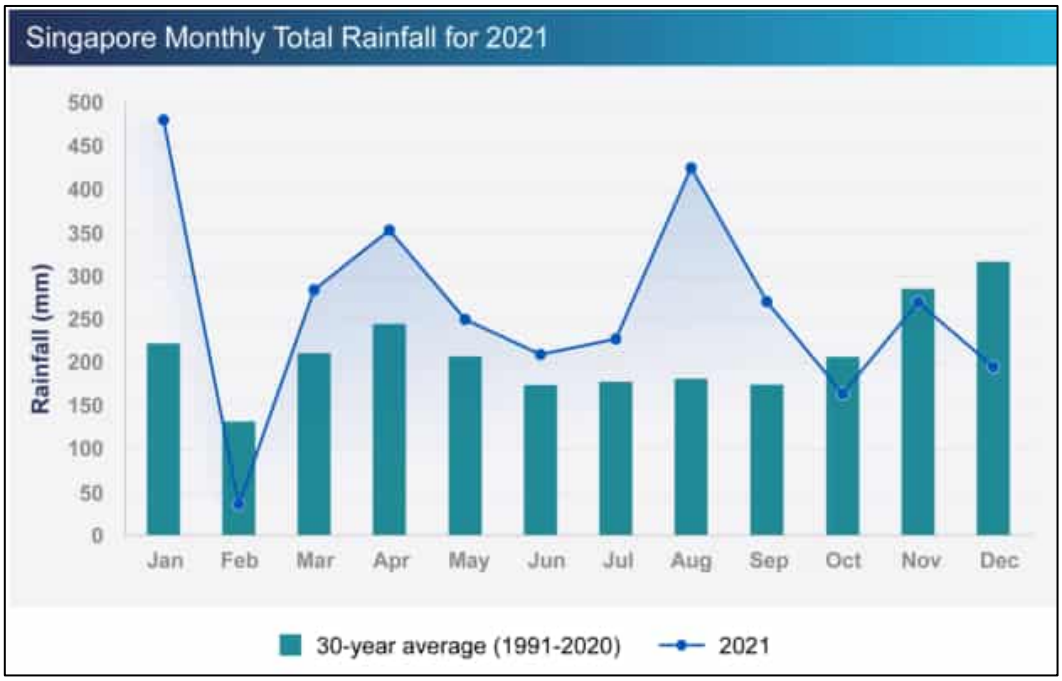



**Figure 4-10 Monthly total rainfall in Singapore for 30-year average over island-wide stations with long-term records (bars, 1991 – 2020) compared to 2021 (solid line) (Source: MSS [W-20])**

## 4.6.2 Temperature

Singapore's continuous temperature records since 1948 show that the island has warmed by an average of 0.25°C per decade, with a visible and sudden rapid increase after the mid-1970s (see Figure 4-11). This may have been due to the rapid economic development and urbanization that took place after Singapore's political reformation, as well as due to the influence of anthropogenic global warming effects. Eight (8) out of the ten (10) warmest years recorded in Singapore have occurred in the 21st century and all ten (10) occurred after 1997. This increasing trend has led to an increase in warm days and warm nights, and a decrease in cool days and cool nights.

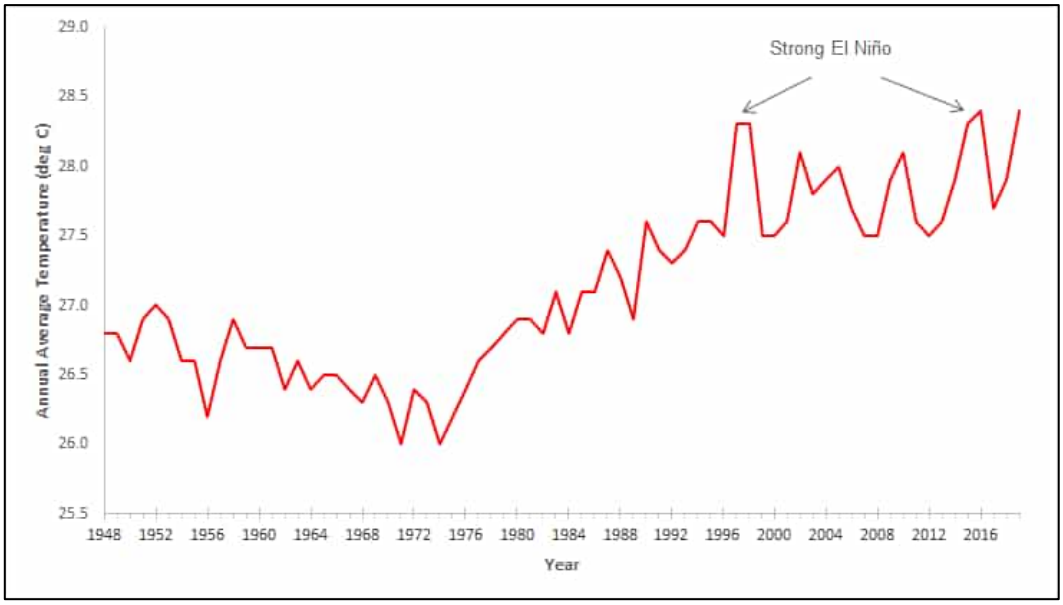



**Figure 4-11 Annual mean temperature in Singapore from 1948 to 2019 (Source: MSS [W-21])**

Generally, the temperature variation throughout the year is relatively small as compared to the mid-latitude regions [W-22]. The mean temperature from 2012 to 2021 was 27.97°C, which is 0.02°C higher than the previous record of 27.95°C for the decade from 2010 to 2019. In Year 2021, the annual mean temperature in 2021 was 27.9°C, with May 2021 being the warmest month at 28.7°C and January 2021 being the coolest month at 26°C. Overall, though the annual mean temperature of Year 2021 is 0.1°C above the long-term average of 27.8°C, however it has not exceeded the long-term monthly temperature records [W-20] as shown in figure below.

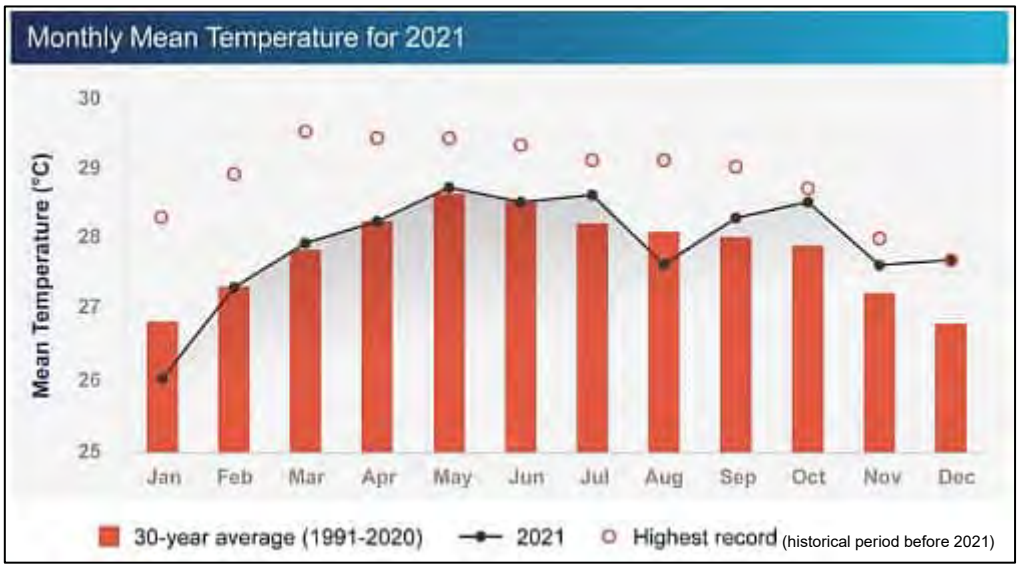



**Figure 4-12 Singapore monthly mean temperature for 30-years average from Changi Climate Station with comparison to Year 2021 monthly mean temperature [W-20]**

Although there is no distinct borderline between “urban” and “rural” areas in Singapore, maximum temperature difference of 4.01°C was observed between well-planted area, such as Lim Chu Kang area, and the Central Business District (CBD) area [P-31]. This shows the presence of an Urban Heat Island (UHI) effect in Singapore. Green areas in cities have been considered as potential measure in mitigating the UHI effect. This finding is also supported by a study conducted by Jusuf et al (2007), which shows different daytime temperature at different type of land use areas in Singapore. As observed in Figure 4-13, the daytime temperature in park areas is considerably lower compared to other type of land use areas [P-30].

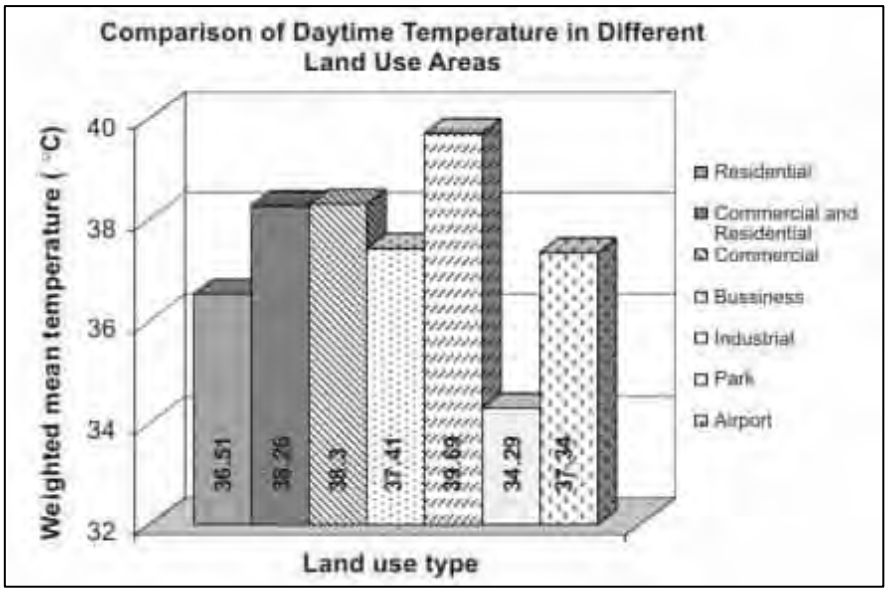



**Figure 4-13 Comparison of daytime and night time temperature in different land use areas [P-30]**

## 4.6.3 Relative Humidity

Relative humidity shows a fairly uniform pattern throughout the year and does not vary much from month to month (refer to Figure 4-14). Its daily variation is more marked, varying from more than 90% before sunrise to around 60% in the mid-afternoon on days when there is no rain. While the mean annual relative humidity is 83.9%, the relative humidity frequency reaches 100% during prolongated periods of rain.

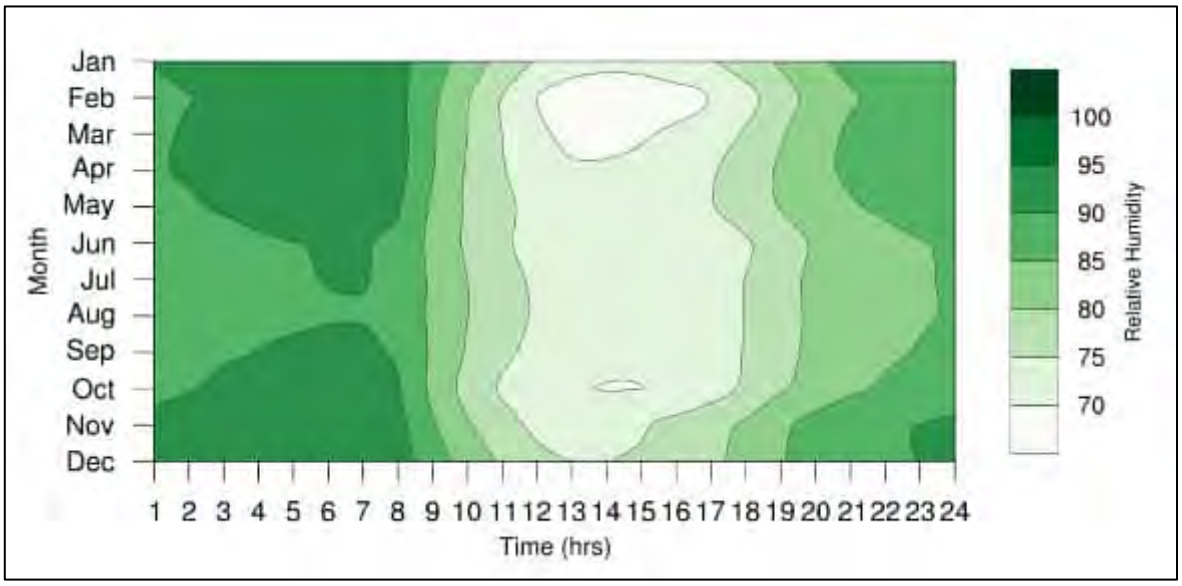



**Figure 4-14 Hourly variation of relative humidity for each month from 1981 to 2010 (Source: MSS [W-19])**

## 4.6.4 Surface Wind

Winds in Singapore are generally light, with the mean surface wind speed normally less than 2.5 m/s. An exception to this is during the presence of a Northeast Monsoon surge, where mean speeds of 10 m/s or more have been observed. Strong winds also occur during thunderstorms. Surface wind gusts are produced from thunderstorm downdrafts and from the passage of Sumatra Squall Lines. As shown in Figure 4-15, the most prominent winds in Singapore are from northeast and the south, occuring during the Northeast and Southwest Monsoon, respectively. The mean monthly wind speeds ranges from 1.5 m/s to 3 m/s [W-19].

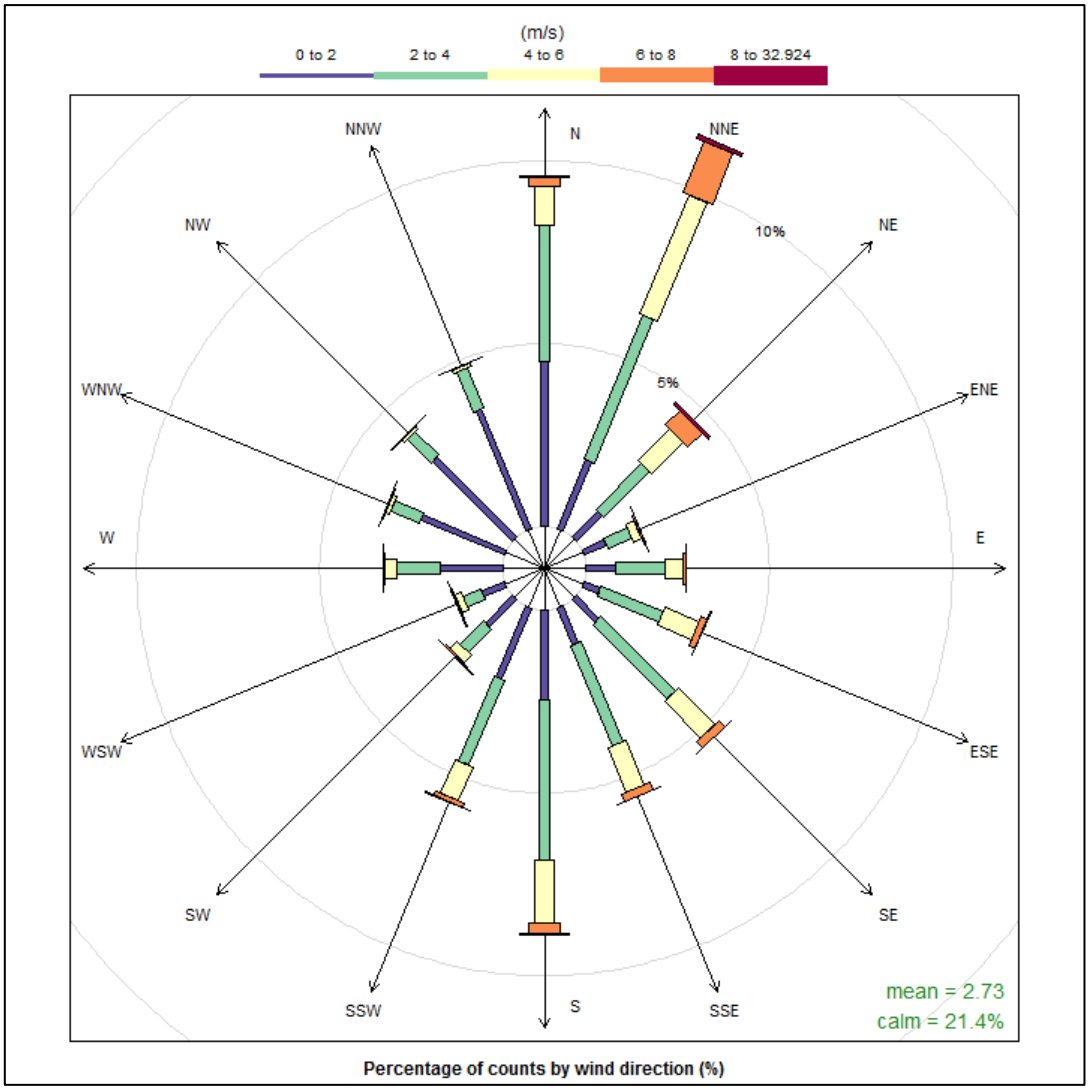



**Figure 4-15 Annual wind rose of Singapore (Source: MSS [W-19])**

# 5 Environmental Legislation, Policies, Plans, Standards and Criteria

A list of relevant legislative requirements applicable to the Project is provided in Table 5-1.

**Table 5-1 Applicable legislation**

| Environmental Parameter | Applicable Legislation, Policies, Plans, Standards and Criteria | Key Points |
|---|---|---|
| **General** | Biodiversity Impact Assessment (BIA) Guidelines NParks (2020) [R-2] | • This document is published by NParks to provide a framework guiding biodiversity impact assessments in Singapore. It recommends methods for conducting baseline survey and impact assessment, and subsequently provide information on developing the biodiversity component of an Environmental Management and Monitoring Plan (EMMP).<br>• 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).<br>• Section 4 of the BIA Guidelines detailed the impact study methods recommended for air, noise, soil, water related biodiversity impacts.<br>• Section 5 of the BIA Guidelines detailed the mitigation measures developing protocols, i.e., avoid, minimise, remedy/ repair/ restore, and compensate/ offset.<br>• Section 6 of the BIA Guidelines outlined the requirements for developing an EMMP. |
| | Singapore Environmental Protection and Management Act (1999 [2020 Revised Edition]) [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.<br>• For surface water, it regulates the discharge of trade effluent, oil chemical, sewage or other pollution onto land and drains.<br>• For air quality, it provides standards and regulations on air impurities. |
| **Biodiversity** | Flora of Singapore: Checklist and Bibliography (2022) [R-39] | • Updated checklists of all flora of Singapore that is with reference to 'A Checklist of the Total Vasular Plant Flora of Singapore' by Chong et. Al. (2009) [P-11].<br>• Published by National Parks Board.<br>• Provides the scientific name, national conservation status and the bibliographical information of each plant listed. |
| | National Biodiversity Strategy and Action Plan (NBSAP) (2019) [R-3] | • 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.<br>• A holistic approach has been adopted where the input of various public sector agencies and nature groups (NGs) have been taken into consideration in the preparation of the document. |

| Environmental Parameter | Applicable Legislation, Policies, Plans, Standards and Criteria | Key Points |
|---|---|---|
| | Singapore Wildlife Act, Chapter 351 (2000) (Act 18 as of 2020) [R-4] | • 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 $1,000 and to the forfeiture of the wild animal or bird.<br>• No person should take, destroy or has in possession the eggs if any wild bird during the specified time of the year or during the breeding season of the bird.<br>• As part of development works, the Developer shall be required to carry out any wildlife-related measure that the Director-General considers necessary to safeguard the health, welfare, safety of any wildlife or class of wildlife; public health or safety in relation to wildlife or; health of ecosystem. |
| | Singapore Parks and Trees Act (2006) [R-5] | • 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.<br>• No tree with a girth exceeding one meter (when measured 1-m from the ground) should be cut or damaged without the prior approval of the relevant authorities; and<br>• No tree or plant will be cut or damaged if located within the heritage road green buffer. |
| | Singapore Parks and Trees Act (Parks and Trees Regulations) (2006) [R-6] | Prohibitions and regulations on trees and animals within national park, nature reserve or public park. |
| | Singapore Parks and Trees (Heritage Road and Green Buffers) Order (2006) [R-7] | Lists the areas designated as heritage road green buffers. |
| | Singapore Parks and Trees (Preservation of Trees) Order (1998) [R-8] | • Lists the designated tree conservation areas.<br>• No cutting or damaging of tree having girth of more than one metre. |
| | The Singapore Red Data Book (SRDB) [P-4]; with updates from the Species List (Red Data Book List) by the National Parks Board [W-2] | • Lists the endangered plants and animals in Singapore.<br>• Published by Singapore's Nature Society.<br>• 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. |
| | Bird-Safe Building Guidelines (NParks) (2022) [R-50] | The guidelines take reference from international standards and focuses on various ways of designing bird-safe building interiors and exteriors. |
| | The International Union for Conservation of Nature and Natural Resources (IUCN) Red List of Threated Species [R-9] | Provides taxonomic, conservation status and distribution information on plants, fungi and animals that have been globally evaluated. |
| | The Hong Kong Environmental Impact Assessment Ordinance | Sets out the principles, procedures, guidelines, requirements and criteria for deciding whether the Project is environmentally acceptable. |

| Environmental Parameter | Applicable Legislation, Policies, Plans, Standards and Criteria | Key Points |
|---|---|---|
| | - Technical Memorandum (HK EIAO TM)[3] [R-10] | |
| **Water Resources** | Singapore Sewerage and Drainage Act, (1999 [2020 revised Edition]) [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.<br>• Regulates the protection, maintenance and provision of stormwater drainage system. |
| | Singapore Sewerage and Drainage (Surface Water Drainage) Regulations ( 1999 [2007 Revised Edition]) [R-16] | Regulates measures to be implemented to protect the stormwater drainage system. |
| | Singapore Sewerage and Drainage (Trade Effluent) Regulations (2007) [R-15] | Regulates trade effluent discharge into public sewerage system. |
| | Singapore Environmental Protection and Management (Trade Effluent) Regulations ( 1999 [2008 Revised Edition]) [R-12] | • Regulates the discharge of trade effluent to public watercourse.<br>• Any discharge into a watercourse has to comply with the regulatory standards established in these regulations. |
| | 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.<br>• Provides guidelines for the appropriate storage and accidental release of oils & chemicals. |
| | Code of Practice (COP) on Surface Water Drainage (PUB) (2018 [2021 Addendum]) [R-17] | 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). |
| | Circular on Preventing Muddy Water from the Construction Site (PUB) (2015) [R-18] | All new construction sites with site area of 0.2ha and above, sites with problematic ECM, and sites within sensitive areas are required to implement Closed-Circuit Television (CCTV) including a Silty Imagery Detection System (SIDS) at the public drain to monitor the surface run-off discharges from the sites. |
| | Singapore 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 |
| | Strategic Plan of Action on Water Resources Management ASEAN (2005) [R-20] | Provides a consolidated framework for the classification of water resources and associated water quality standards for each class. |
| | Standard Statistical Classification of Surface Freshwater Quality for the Maintenance of Aquatic Life, | Provides standards for water quality assessment relating to aquatic life for surface waterbodies. |

[3] 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, Policies, Plans, Standards and Criteria | Key Points |
|---|---|---|
| | New York and Geneva UNECE (1994) [R-19] | |
| | Water Quality Requirements WHO (n.d.) [R-21] | 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. |
| **Air Quality** | Environmental Protection and Management (Air Impurities) Regulations (2015) [R-28] | Regulates air emissions and impurities in Singapore. |
| | Singapore Ambient Air Quality Targets (Long Term Targets) [R-29] | Stipulates the recommended limit values for ambient concentrations of $NO_2$, $SO_2$, $PM_{10}$, $PM_{2.5}$, CO and $O_3$. Target values are based on World Health Organisation (WHO) 2005 Air Quality Guidelines. |
| | Environmental Protection and Management (Off-Road Diesel Engine Emissions) Regulations (2012) [R-30] | 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 [R-31] | The document provides guidance for developers, their consultants and environmental health practitioners on how to undertake a construction impact assessment (including demolition and earthworks). |
| **Airborne Noise** | Environmental Protection and Management (Control of Noise at Construction Sites) Regulations (2008) [R-33] | • 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.<br>• Stipulates the correction factor that needs to be applied to the applicable noise criteria based on background noise levels. |
| | Technical Guideline on Boundary Noise Limits for Air Conditioning and Mechanical Ventilation Systems in Non- | • Stipulates a set of maximum allowable noise limits for ACMV systems of non-industrial buildings for different time periods of the day and for different types of premises affected by operational noise. |

| Environmental Parameter | Applicable Legislation, Policies, Plans, Standards and Criteria | Key Points |
|---|---|---|
| | Industrial Buildings (NEA) (2018) [R-38] | • Stipulates the correction factor that needs to be applied to the applicable noise criteria based on background noise levels. |
| | Technical Guideline for Land Traffic Noise Impact Assessment (NEA) (2016) [R-37] | Stipulates a set of maximum allowable noise limits for premises affected by traffic noise. |
| | SS 593: Code of Practice for Pollution Control (COPPC) (2013) [R-13] | Specifies recommended pollution control requirements and good practices for prevention of impacts to noise. |
| | SS602:2014 Code of Practice for Noise Control on Construction and Demolition Sites [R-32] | Specifies recommendations and good practices for prevention of noise impacts from construction and demolition activities. |
| | Biodiversity 2020 (UK) [R-34] | • "Theme 3: reduce environmental pressures -integrate consideration of biodiversity within the sectors which have the greatest potential for direct influence and reduce direct pressures."<br>• The guide does not provide airborne noise criteria for biodiversity impact assessment but only serves as a reference that sets out biodiversity policies and strategies to conserve biodiversity for AECOM to consider and implement in the EIA study. |

# 6 EIA Approach and Methodology

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

## 6.1 Approach

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

- Scoping of Project (Section 6.2);
- Baseline Data Collection and Analysis (Section 6.3.1);
- Prediction of Impacts (Section 6.4.1);
- Evaluation of Impacts (Section 6.4.3);
- Recommendations of Mitigation Measures (Section 6.5); and
- Environmental Management and Monitoring Plan (Section 6.5).

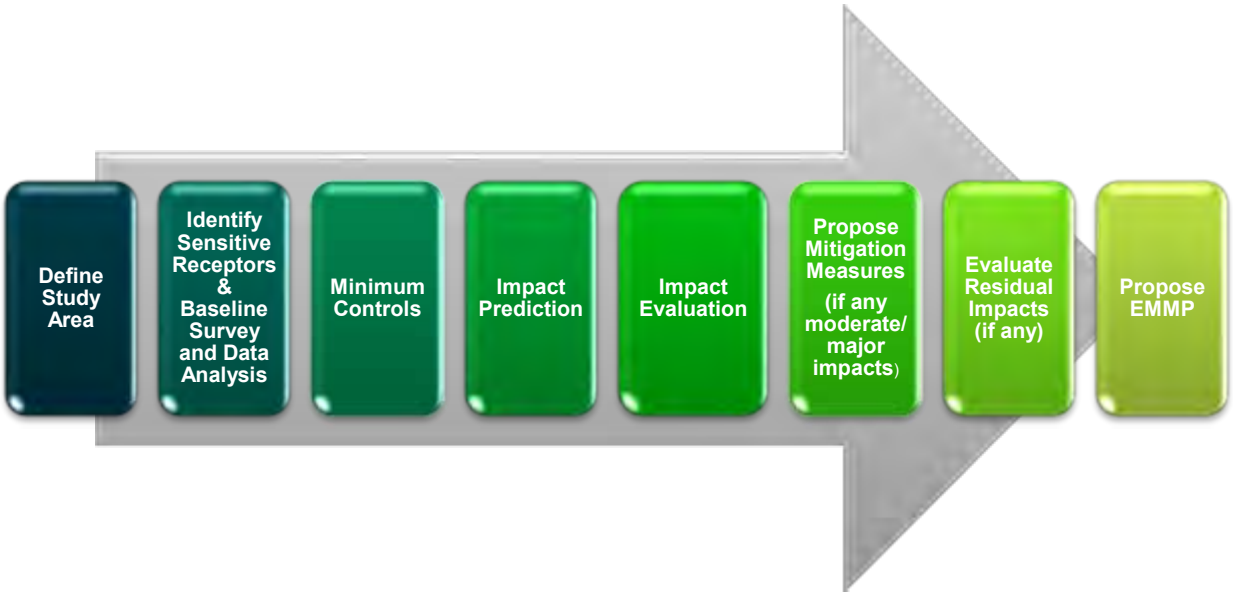



**Figure 6-1 Overall EIA workflow**

# 6.2 Scoping of Project

Referring to the Inception Report Rev 01 [R-1], the environmental impacts resulting from the activities during construction and operational phases of this Project are assessed in this EIA Report as follows:

- Biodiversity;
- Water Resources (i.e., hydrology, surface water quality, groundwater quality and level);
- Air Quality; and
- Airborne Noise.

## 6.2.1 Identification of Environmental Impact Study Area

The Study Area for this EIA includes Project site and its construction and operational footprint which is used to determine any potential environmental impacts to the nearby sensitive receptors due to pre-construction, construction and operational activities within the site. Study Area will vary, depending on the technical discipline, as summarised in Section 4.1 and will be described for each impact in the respective chapters.

## 6.2.2 Identification and Categorization of Sensitive Receptors

Sensitive receptors are those receptors that may potentially be impacted by the assumed activities during construction and operational phases of the Project. Environmentally sensitive receptors are categorised into three categories: Priority 1, Priority 2 and Priority 3 (from the most sensitive to the least) as shown in the Table 6-1 below.

**Table 6-1 Receptor sensitivity classification**

| Environmental Parameter | Receptor Sensitivity | | |
|---|---|---|---|
| | **Priority 1** | **Priority 2** | **Priority 3** |
| **Biodiversity** | Flora, fauna species and habitats of high ecological value | Flora, fauna species and habitats of moderate ecological value | Flora, fauna species and habitats of low ecological value |
| **Water Resources (Hydrology)** | **Ecological Receptors** | | |
| | • Aquatic habitats and/ or biocenosis of high ecological value (as defined in Table 7-15) that are highly dependent on surface water flow conditions and/ or quantities. Examples of fauna include fish, amphibians, odonates in aquatic or semi-aquatic habitats.<br>• Aquatic habitats and/ or biocenosis of high ecological value which would be permanently impacted by changes in surface water flow conditions. | • Aquatic habitats and/ or biocenosis of high ecological value (as defined in Table 7-15) that are resilient of changes in water quantities and water flow conditions.<br>• Terrestrial habitats of high ecological value (as defined in Table 7-15) that obtain water from multiple sources. | • Habitats and/ or biocenosis that are not of high ecological value (as defined in Table 7-15)<br>• 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 Project site whose activities would be permanently altered or prevented.<br>• Humans within and in the vicinity of the Project site whose safety would be | • Humans within and in the vicinity of the Project site whose activities would be temporarily altered or prevented.<br>• Humans within and in the vicinity of the Project site whose safety would be | • Humans within and in the vicinity of the Project site whose activities would not be altered or prevented.<br>• Humans within and in the vicinity of the Project site whose safety would not be compromised. |

| Environmental Parameter | Receptor Sensitivity | | |
|---|---|---|---|
| | **Priority 1** | **Priority 2** | **Priority 3** |
| | largely compromised (i.e. life-threatening). | moderately compromised (i.e., not life-threatening). | |
| | **Socio-Economic Receptors** | | |
| | Permanently inhabited developments (e.g. dwelling houses, public and private residential developments) and developments for essential services (e.g. ambulance, fire stations, hospitals, essential infrastructure such as primary transport and utilities distribution) within and in the vicinity of the Project site. | Temporarily occupied developments and developments for non-essential services (e.g. developments used for leisure activities, warehousing, commercial, industrial and non-residential institutions, land and buildings used for agriculture, transport and infrastructure) within and in the vicinity of the Project site. | Water-compatible developments (e.g. flood control structures, docs, navigation facilities, water-based recreational land, open space facilities). |
| **Water Resources (Surface Water Quality)** | **Ecological Receptors** | | |
| | Aquatic or semi-aquatic habitats and/ or biocenosis of high ecological value with low tolerance[4] to changes in surface water quality. | Aquatic or semi-aquatic habitats and/ or biocenosis of high ecological value with medium to high tolerance to changes in surface water quality. | • Aquatic or semi-aquatic habitats and/ or biocenosis that are not of high ecological value<br>• All terrestrial habitats and its biocenosis |
| | **Human Receptors** | | |
| | • Humans within and in the vicinity of the Project site who use surface water for beneficial purposes (e.g. irrigation, drinking purposes)<br>• Humans within and in the vicinity of the Project site that may come in contact with contaminated surface water which potentially could cause harm to their health (e.g. construction workers). | Humans within and in the vicinity of the Project site who may experience nuisance caused by the change in surface water quality (e.g. odour), but will most likely not harm their health. | Humans within and in the vicinity of the Project site that will not experience nuisance nor develop health issues due to the change in surface water quality. |
| | **Socio-Economic Receptors** | | |
| | Developments within and in the vicinity of the Project site that use surface water for beneficial purposes (e.g. irrigation, drinking purposes, industrial purposes) and require water of particular physico-chemical characteristics at the intake location. | Developments within and in the vicinity of the Project site that use surface water for beneficial purposes (e.g irrigation, drinking purposes, industrial purposes) and do not require water of particular physico-chemical characteristics at the intake location. | Developments that do not directly use surface water for beneficial purposes (e.g irrigation, drinking purposes, industrial purposes). |

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

| Environmental Parameter | Receptor Sensitivity | | |
|---|---|---|---|
| | Priority 1 | Priority 2 | Priority 3 |
| | | | |
| **Water Resources (Groundwater Quality and Level)** | **Ecological Receptors** | | |
| | Habitats and/ or biocenosis of high ecological value that are dependent of groundwater (either groundwater quality or quantity, or both). | Habitats and/ or biocenosis of high ecological value that are partly dependent of groundwater (either groundwater quantity or quality). | • Habitats and/ or biocenosis of high ecological value that are within or in the vicinity of the Study Area and that are not dependent of groundwater and/ or<br>• Habitats and/ or biocenosis within or in the vicinity of the Study Area that are not of high ecological value |
| | **Human Receptors** | | |
| | Humans or entities (e.g. companies, facilities) within or in the vicinity of the Project site that directly use groundwater for drinking purposes or irrigation | • Entities (e.g. companies, facilities) within or in the vicinity of the Project site that use groundwater for industrial purposes, but do not use it for drinking purposes or irrigation and/ or<br>• Humans within or in the vicinity of the Project site that may come in contact with groundwater | • Humans or entities (e.g. companies, facilities) within or in the vicinity of the Project site that do not use groundwater for any beneficial purpose (i.e. drinking or industrial purposes, irrigation) and/ or<br>• Humans within or in the vicinity of the Project site that will not come in contact with groundwater |
| **Air Quality (Construction)** | **Ecological Receptors**[5] | | |
| | 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.<br>• Ecological sites [6] having known sensitive communities within 20 m of construction worksite area. | • Ecological sites[5] having known sensitive communities within 20 m to 50 m of construction worksite area.<br>• Any other ecological sites[5] within the Study Area of 50 m.<br>• |
| | **Human Receptors** | | |

[5] As per UK IAQM [R-31], ecological receptor refers to any sensitive habitat affected by dust soiling. This includes direct impacts on vegetation or aquatic ecosystems of dust deposition, and the indirect impacts on fauna (e.g. on foraging habitats) if any. In terms of air quality impact assessment of this Project, only the direct impacts on flora of conservation significance or sensitive plant communities of large specimens which are the key species affected by dust deposition will be emphasized.
[6] As per UK IAQM [R-31], ecological site refers to a site with international statutory designation (i.e. Special Conservation Areas (SACs), Special Protection Areas (SPAs) designated internationally under the Habitats Directive (92/43/EEC)) and RAMSAR sites. Non-statutory sites (i.e. local wildlife sites) can be considered if appropriate.

| Environmental Parameter | Receptor Sensitivity | | |
|---|---|---|---|
| | **Priority 1** | **Priority 2** | **Priority 3** |
| | For human receptors:<br>• Sensitive receptors [7] (more than 100 receptors) within 50 m of the construction area.<br>• Sensitive receptors (1-100 receptors) within 20 m of the construction area.<br>• Office, industrial facilities, or shops (more than 10 receptors) within 20 m of the construction area. | For human receptors:<br>• Sensitive receptors (more than 100 receptors) between 50 m to 100 m of the construction area.<br>• Sensitive receptors (1-100 receptor) between 20 m to 50 m of the construction area.<br>• Office, industrial facilities, or shops (more than 10 receptors) within 20 m to 50 m of the construction area.<br>• Office, industrial facilities, or shops (1-10 receptors) within 20 m of the construction area. | For human receptors:<br>• Public footpath, playing fields and parks within 20 m from the construction area.<br>• All other buildings within the 350 m study boundary. |
| **Air Quality (Operational)** | Schools and education buildings, hospitals and medical centres, nursing homes, residential buildings, ecological sensitive site | Sport and recreation areas (outdoor) | Commercial, religious, infrastructure, industrial |
| **Airborne Noise[8]** | **Ecological Receptors** | | |
| | Animals that vocalise during important life cycle stages such as courtship, territorial claims and/ or mating. | Animals that have auditory sensory systems but do not necessarily need to vocalise during important life cycle stages. | Animals that are not likely to be affected by noise. |
| | **Human Receptors** | | |
| | Schools and Education Buildings, Hospitals and Medical Centres, Nursing Homes, Religious Buildings, etc. | Residential buildings | Other Buildings (Industrial, Commercial, Infrastructure, Sport & Recreation Areas, etc.). |

[7] 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.
[8] 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).

# 6.3 Baseline Approach and Methodology

The baseline study aims to establish the extent and conditions of the existing environment that may be potentially affected by the execution of the Project. The baseline study provides the basis for the prediction of potential impacts of the Project across each of environmental parameters.

The collection of pre-construction baseline environmental status at the Study Areas was conducted from both primary and secondary sources and was used as a basis to identify sensitive receptors. It should be noted that the baseline studies on biodiversity and water resources were carried out in a separate EBS study by AECOM [P-1], while the air quality and airborne noise baseline studies were carried out as a part of this EIA.

## 6.3.1 Data Collection and Analysis

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

### 6.3.1.1 Sample Collection and Survey Locations

The sample collection and survey locations were selected for baseline data collection based on their proximity to the project and receptor priority. These locations were confirmed during a site reconnaissance survey. Site visits were undertaken as tabulated in the following Table 6-2.

**Table 6-2 Site visits for data collection**

| Environmental Parameter | Site Visits |
|---|---|
| **Biodiversity** | Sampling dates:<br>• 1st March 2021 – 29th April 2021 (floristic and faunistic surveys)<br>• 23rd Feb – 29th April 2021 (tree mapping) |
| **Water Resources** | Site reconnaissance survey:<br>• 5th February 2021<br>Sampling dates:<br>• 08th March 2021 (dry sampling)<br>• 13th April 2021 (wet sampling)<br>• 21st April 2021 (dry sampling) |
| **Air Quality** | Site reconnaissance survey:<br>• 6th June 2022<br>• 1st September 2022<br>Monitoring dates:<br>• 2nd September – 9th September 2022 (at AQ3)<br>• 9th September – 16th September 2022 (at AQ1)<br>• 19th September – 26th September (at AQ5)<br>• 26th September – 3rd October (at AQ2 and AQ4) |
| **Airborne Noise** | Site reconnaissance survey:<br>• 6th June 2022<br>Sampling dates:<br>• 11th August 2022 – 17th August 2022 (at NM01, NM05);<br>• 29th August 2022 – 4th September 2022 (at NM02a – NM02c); and<br>• 9th September 2022 – 16th September 2022 (at NM03, NM04a – NM04c, NM06). |
| **Note:** | |

| Environmental Parameter | Site Visits |
|---|---|
| Site reconnaissance surveys, sampling and/ or monitoring for biodiversity and surface water resources were carried out as part of previous EBS [P-1]. Air quality and airborne noise site reconnaissance surveys and sampling/ monitoring were carried out for the purposes of this EIA. | |

Further information on sample collection and survey locations and parameters is provided in Section 7 (Biodiversity), Section 8 (Water Resources), Section 9 (Air Quality), and Section 10 (Airborne Noise).

#### 6.3.1.2 Secondary Data Collection

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

- Data provided by the Client:
  - Existing topographical survey data/ maps;
  - Construction/ operational boundary/ footprint/ phasing (e.g. CAD drawing format);
  - Construction/ operational schedule; and
  - Construction machinery and equipment.
- Data provided by other Government Agencies (including publicly-available data):
  - Proposed Master Plan of the Project site;
  - Current and future land uses;
  - Geological Map;
  - Existing biodiversity information of the area;
  - Weather data (rainfall, wind, humidity, evaporation); and
  - Catchment and drainage maps;
- Other publicly-available data:
  - Exiting literature, books (e.g. Singapore Red Data Book [SRDB]);
  - Previous studies in the vicinity which include groundwater level data;
  - Historical, current and future land uses and descriptions;
  - Online databases (e.g. climate, catchment, biodiversity);
  - Commercial and recreational activities; and
  - Satellite imagery;
- Other data:
  - Findings of EBS carried out within the Project site.

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

### 6.3.2 Safety Contingency Plan

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

All personnel completing the onsite baseline surveys was formally inducted with the HASP and Job Safety Risk Assessment. Sub-contractors may follow the HASP and Job Safety Risk Assessment prepared by AECOM but it is expected that they have their internal policies and procedures in terms of health and safety. The sub-contractors may adopt the HASP and Job Safety Risk Assessment prepared by AECOM at their own risk.

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

# 6.4 Impact Assessment

## 6.4.1 Definition of Minimum Controls

Minimum control measures are the standard practices that should be implemented on-site during construction and operational phases of the Project, based on legislation (where applicable), guidelines and best management practices. Examples include on-site water storage and treatment to comply with NEA Trade Effluent Criteria prior to discharging into receiving watercourses, hoarding of construction worksite on all sides, restricted working hours of noisy equipment, etc.

## 6.4.2 Prediction of Impacts

Key potential environmental impacts arising from the Project's pre-construction, construction and operational activities were assessed within the Project scope. The methodology for the prediction of impacts is as given in Table 6-3 and Table 6-4.

**Table 6-3 Methodology for prediction of construction impacts**

| Environmental Parameter | Predictive Methods | Assessment Criteria | EIA Section |
|---|---|---|---|
| **Biodiversity** | A mix of **quantitative and qualitative** assessment to evaluate the impacts of construction activities on key biodiversity sensitive receptors of floral communities, faunal species and habitats within the Study Area and its immediate surrounding (i.e Recommended Area of Conservation [RAC]; Section 7.7). | Assessment criteria broadly takes guidance from Hong Kong Environmental Impact Assessment Ordinance - Technical Memorandum Annex 8, with considerations from literature review and local biodiversity standards [R-10]. | Section 7 |
| **Water Resources (Hydrology and Surface Water Quality)** | *Hydrology*<br>**Qualitative,** analytical assessment of direct impacts on hydrology, watercourses and their catchments during construction phase of the Project. **Qualitative** assessment of impacts on identified human and ecological receptors, based on the findings and pre-determined tolerance of sensitive receptors.<br>*Surface Water Quality*<br>**Qualitative,** analytical assessment of direct impacts on surface water resources and their catchments during construction phase of the Project. **Qualitative** assessment of impacts on identified human and ecological receptors (based on pre-determined tolerance, where applicable). | • Singapore Environmental Protection and Management (Trade Effluent) regulations [R-12];<br>• Singapore NParks Biodiversity Impact Assessment (BIA) Guidelines [R-2];<br>• Water Quality Criteria for Aquatic Life from other countries and organisations including United Nations Economic Commission for Europe [R-19], ASEAN [R-20], World Health Organization [R-21], United States Environmental Protection Agency [R-22], Philippines [R-25], Australian and New Zealand Environment and Conservation Council (ANZECC) [R-23], Canadian Council of Ministers of the Environment [R-24], and Department of Environment in Malaysia (DOE) [R-26]. | Section 8 |
| **Water Resources (Groundwater Quality and Level)** | **Qualitative** assessment to identify and evaluate the potential impact of activities planned for construction phase of the Project to groundwater quality and level, that may consequently impact the local | N.A. | Section 8 |

| Environmental Parameter | Predictive Methods | Assessment Criteria | EIA Section |
|---|---|---|---|
| | vegetation, downstream watercourses and humans. | | |
| **Air Quality** | **Qualitative** assessment following dust risk assessment methodology focusing on fugitive particulate emissions (dust) from the construction site. | Assessment broadly follows "Guidance on the Assessment of Dust from Demolition and Construction" which was published by the UK Institute of Air Quality Management (IAQM) in 2014. | Section 9 |
| **Airborne Noise** | **Quantitative** assessment was adopted to assess construction noise impacts to noise sensitive ecological and human receptors. | Environmental Protection and Management (Control of Noise at Construction Sites) Regulations, 2008. | Section 10 |

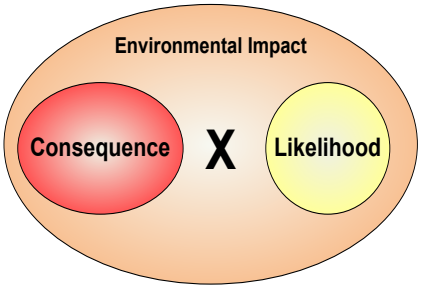
**Table 6-4 Methodology for prediction of operational impacts**

| Environmental Parameter | Predictive Methods | Assessment Criteria | EIA Section |
|---|---|---|---|
| **Biodiversity** | **Qualitative** assessment to evaluate the impacts of operational activities on key biodiversity sensitive receptors of floral communities, faunal species and habitats within the Study Area and its immediate surrounding (i.e Recommended Area of Conservation [RAC]; Section 7.7). | Assessment criteria broadly takes guidance from Hong Kong Environmental Impact Assessment Ordinance - Technical Memorandum Annex 8, with considerations from literature review and local biodiversity standards. | Section 7 |
| **Water Resources (Hydrology and Surface Water Quality)** | *Hydrology*<br>**Qualitative,** analytical assessment of direct impacts on hydrology, watercourses and their catchments due to operational activities within the Study Area. **Qualitative** assessment of impacts on identified human and ecological receptors, based on the findings and pre-determined tolerance of sensitive receptors.<br>*Surface Water Quality*<br>**Qualitative,** analytical assessment of direct impacts on surface water resources and their catchments due to operational activities within the Study Area. **Qualitative** assessment of impacts on identified human and ecological receptors (based on pre-determined tolerance, where applicable). | • Singapore Environmental Protection and Management (Trade Effluent) regulations [R-12];<br>• Singapore NParks Biodiversity Impact Assessment (BIA) Guidelines [R-2];<br>• Water Quality Criteria for Aquatic Life from other countries including ASEAN [R-20], United Nations Economic Commission for Europe [R-19], World Health Organization [R-21], United States Environmental Protection Agency [R-22], Philippines [R-25], Australian and New Zealand Environment and Conservation Council (ANZECC) [R-23], Canadian Council of Ministers of the Environment [R-24], and Department of Environment in Malaysia (DOE) [R-26]. | Section 8 |

| Environmental Parameter | Predictive Methods | Assessment Criteria | EIA Section |
|---|---|---|---|
| **Water Resources (Groundwater Quality and Level)** | **Qualitative** assessment to evaluate the groundwater impacts due to operational activities. | N.A. | Section 8 |
| **Air Quality** | **Qualitative** assessment was conducted to assess air quality impacts of the development operational phase due to increased traffic in the vicinity of the Project. | Compare the change in predicted increase in traffic volume to the Project and access routes in the vicinity of the Project. | Section 9 |
| **Airborne Noise** | **Qualitative** assessment was adopted to assess operational noise impacts to noise sensitive ecological and human receptors. | • NEA Technical Guideline on Boundary Noise Limits for Air Conditioning and Mechanical Ventilation Systems in Non-Industrial Buildings, 2018; and<br>• NEA Technical Guideline for Land Traffic Noise Impact Assessment, 2016. | Section 10 |

## 6.4.3 Evaluation of Impacts

Impacts were evaluated based on their significance, which is a measure of the weight that should be given to each impact in decision making and if it warrants impact management. It was assessed using the following two factors in the Impact Significance Assessment Matrix (refer to Table 6-5) as detailed below and in the following sections:




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

### 6.4.3.1 Impact Consequence

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

- **Receptor Sensitivity**: Categorises receptors according to their susceptibility to adverse impacts from the Project's construction and operational phases (refer to Table 6-1);
- **Impact Intensity**: Defines the magnitude of the impact and the status of the impact in relation to environmental parameters of interest, based on regulations (e.g. discharge limits), standards (e.g. environmental quality criteria) and guidelines. The criteria presented in Table 6-5 were used to categorise the impact intensity.

**Table 6-5 Evaluation of impact intensity for construction and operational phases**

| Environmental Parameters | Impact Intensity | | | |
|---|---|---|---|---|
| | Negligible | Low | Medium | High |
| **Biodiversity** | Refer to Section 7.7.1 for impact intensity definitions during construction phase and Section 7.7.2 for impact intensity definitions during operational phase. | | | |

| Environmental Parameters | Impact Intensity | | | |
|---|---|---|---|---|
| | Negligible | Low | Medium | High |
| | | | | |
| **Hydrology** | Very minor change to existing hydrology and flow | Small scale localised changes to existing hydrology or flow | Medium scale changes to existing hydrology or flow | Major changes to existing hydrology or flow |
| **Surface Water Quality** | No contamination; or Likely to be well within regulatory limits | Small scale localised contamination within regulatory limits | Medium scale contamination or just exceeds regulatory limits | Large scale contamination exceeds regulatory limits by hazardous levels |
| **Groundwater Quality and Level** | • No contamination of groundwater<br>• No reduction in groundwater level | • Small scale localised groundwater contamination which is not likely to extend beyond the Study Area and possible to remediate;<br>• Small scale localised groundwater level decrease which is not likely going to extend beyond the Study Area | • Medium scale groundwater contamination which is likely to extend beyond the Study Area but possible to remediate within the construction period time frame;<br>• Medium scale groundwater level decrease that is possibly going to extend beyond the Study Area | • Large scale groundwater contamination which is likely to extend beyond the Study Area and may require large scale remediation;<br>• Large scale groundwater level decrease that is likely going to extend far beyond the Study Area |
| **Air Quality (Construction Phase)** [1] | - | For Earthworks:<br>• Total site area <2 ,500 $m^2$<br>• Soil type with large grain size (e.g. sand)<br>• <5 heavy earth moving vehicles active at any one time<br>• Formation of bunds <4 m in height<br>• Total material moved <20,000t<br>• Earthworks during wetter months | For Earthworks:<br>• Total site area 2,500 $m^3$ – 10,000 $m^3$<br>• Moderately dusty soil type (e.g. silt)<br>• 5-10 heavy earth moving vehicles active at any one time<br>• Formation of bunds 4 m - 8 m in height<br>• Total material moved 20,000-100,000t | For Earthworks:<br>• Total site area >10,000 $m^2$<br>• Potentially dusty soil type (e.g. clay, which will be prone to suspension when dry due to small particle size)<br>• >10 heavy earth moving vehicles active at any one time<br>• Formation of bunds >8 m in height<br>• Total material moved >100,000t |
| | - | For Construction:<br>• Total building volume <25,000 $m^3$<br>• Construction material with low potential for dust | For Construction:<br>• Total building volume 25,000-100,000 $m^3$<br>• Potentially dusty | For Construction:<br>• Total building volume >100, 000 $m^3$<br>• On-site concrete batching<br>• Sandblasting |

| Environmental Parameters | Impact Intensity | | | |
|---|---|---|---|---|
| | Negligible | Low | Medium | High |
| | | release (e.g. metal cladding or timber) | construction material (e.g. concrete)<br>• On-site concrete batching | |
| | - | For Trackout:<br>• <10 Heavy Duty Vehicles (HDV) (>3.5t) outward movements in any one day<br>• Surface material with low potential for dust release<br>• Unpaved road length <50 m | For Trackout:<br>- 10-50 HDV (>3.5t) outward movements in any one day<br>- Moderately dusty surface material (e.g. high clay content)<br>- Unpaved road length 50-100 m | For Trackout:<br>• >50 HDV (>3.5t) outward movements in any one day<br>• Potentially dusty surface material (e.g. high clay content)<br>• Unpaved road length >100 m |
| | - | For Demolition (if any):<br>• Total building volume <20,000 $m^3$<br>• Construction material with low potential for dust release (e.g. metal cladding or timber)<br>• Demolition activities <10 m above ground<br>• Demolition during wetter months | For Demolition (if any):<br>- Total building 20,000 – 50,000 $m^3$<br>- Potentially dusty construction material<br>- Demolition activities 10-20 m above ground level | For Demolition (if any):<br>• Total building >50,000 $m^3$<br>• Potentially dusty construction material (e.g. concrete)<br>• On-site crushing and screening<br>• Demolition activities >20 m above ground level |
| **Air Quality (Operational Phase)** | Insignificant increase in air quality levels in the vicinity of the Project operation | Small scale increase in air quality levels in the vicinity of the Project operation | Medium scale increase in air quality levels in the vicinity of the Project operation | Large scale increase in air quality levels in the vicinity of the Project operation |
| **Airborne Noise (Construction Phase)** | Ecological Receptor:<br>The predicted noise levels are within average baseline noise criteria. | Ecological Receptor:<br>The exceedance of values compared to average baseline noise criteria is within 0-3 dB(A). | Ecological Receptor:<br>The exceedance of values compared to average baseline noise criteria is 3-6 dB(A). | Ecological Receptor:<br>The exceedance of values compared to average baseline noise criteria is greater than 6 dB(A). |
| | Human Receptor:<br>The predicted noise levels are within the regulatory noise limits. | Human Receptor:<br>The exceedance of values compared to regulatory noise limits is within 0-3 dB(A). | Human Receptor:<br>The exceedance of values compared to regulatory noise limits is within 3-6 dB(A). | Human Receptor:<br>The exceedance of values compared to regulatory noise limits is greater than 6 dB(A). |

| Environmental Parameters | Impact Intensity | | | |
|---|---|---|---|---|
| | Negligible | Low | Medium | High |
| **Airborne Noise (Operational Phase)** | Ecological Receptor:<br>No detectable change to fauna. | Ecological Receptor:<br>Potential impacts last a short duration, are reversible and/ or of a small magnitude for species with low auditory sensitivity level. | Ecological Receptor:<br>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 Receptor:<br>Potential impacts last for a long time, are non-reversible, and/or of a significant magnitude for species with high auditory sensitivity level. |
| | Human Receptor:<br>Just noticeable, non-intrusive, increase in noise levels:<br>• Noise can be heard but does not result in any change in behaviour or attitude.<br>• Can slightly affect the character of the area but not such that there is a perceived change in quality of life. | Human Receptor:<br>Noticeable, mildly intrusive, increase in noise levels:<br>• Noise can be heard and may cause small changes in behaviour and/ or attitude. Potential for non-awakening sleep disturbance.<br>• Can slightly affect the character of the area but not such that there is a perceived change in quality of life. | Human Receptor:<br>Noticeable, disruptive, increase in noise levels:<br>• Causes an important change in behaviour and/ or attitude during periods of intrusion.<br>• Potential for sleep disturbance resulting in difficulty in getting to sleep, premature awakening, and difficulty in getting back to sleep.<br>• Quality of life diminished due to change in character of area. | Human Receptor:<br>Noticeable, very intrusive, increase in noise levels:<br>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-31].
2. Heavy duty vehicles (HDV) defined as vehicles with a gross weight greater than 3.5 tonnes.
3. The Flora & Fauna Specialist will be consulted to identify the species sensitivity to the potential change to their habitat, conservation status and foraging regime.

A consequence category is then derived based on receptor sensitivity and impact intensity, as shown in Table 6-5. The air quality impact assessment uses matrices specific to the Institute of Air Quality Management (IAQM) Guidance on the assessment of dust from demolition and construction [R-31] and these are provided in Section 9.2.

**Table 6-6 Impact consequence matrix**

| 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 |

### 6.4.3.2 Likelihood

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

**Table 6-7 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 pre-construction, construction and operational activities. | Frequency of exposure < 5% to active duration of equipment over daily working period. |
| **Less Likely/ Rare** | Would less likely/ rarely occur during pre-construction, construction and operational activities. | Frequency of exposure of 5 - 15% to active duration of equipment over daily working period. |
| **Possible/ Occasional** | Would possibly/ occasionally occur during pre-construction, construction and operational activities. | Frequency of exposure of 16 – 25% to active duration of equipment over daily working period. |
| **Likely/ Regular** | Would likely to occur or would occur on a regular basis during pre-construction, construction and operational activities. | Frequency of exposure of 26 - 50% to active duration of equipment over daily working period. |
| **Certain/ Continuous** | Would be certain to occur or would occur continuously during pre-construction, construction and operational activities. | Frequency of exposure of > 50% to active duration of equipment over daily working period. |

**References:**

1. Ecological Impact Assessment (EcIA). EIANZ Guidelines for use in New Zealand: terrestrial and freshwater ecosystems. 2nd Edition. May 2018. [R-35]
2. CIEEM (2018). Guidelines for ecological impact assessment in the UK and Ireland: Terrestrial, Freshwater and Coastal. September 2018. [R-36].

### 6.4.3.3 Impact Significance

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

**Table 6-8 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).

#### 6.4.3.4 Mitigation of Significant Impacts and Residual Impact Assessment

Negligible and minor impacts are therefore deemed to be “Insignificant”. Impacts evaluated as moderate or major require the adoption of management or mitigation measures. Major impacts are therefore deemed to be “Significant” and moderate impact as “Relatively Significant”. Major impacts always require further management or mitigation measures to minimise or reduce the impact to an acceptable level.

Where the implementation of minimum controls is insufficient to alleviate any significant environmental construction and operational impacts (moderate to major impacts), Project-specific final mitigation measures, in consultation with the HDB and relevant Authorities, will be proposed.

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 exceeding 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 [R-2]:




**Figure 6-2 Mitigation hierarchy**

- **Avoid** – Where changes to the Project design and construction/ operational methodology can be made to eliminate or avoid an identified impact (e.g. optimisation or reduction of construction footprint, shift or elimination of construction site in critical areas, etc.). 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/ operational 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 e.g. a wildlife shepherding plan is put in place to allow any animals trapped on the site to escape into the surrounding vegetation;
- **Remedy/ Repair/ Restore** – Where changes to the Project design and construction/ operation cannot affect impact avoidance and impact minimization, restoration methodology can be applied after construction is completed to remedy/ repair/ restore the ecological habitat as much as possible. For e.g. after construction, appropriate trees and shrubs are replanted in appropriate locations on 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, e.g. transplanting of rare shrubs or trees to elsewhere in consultation with government authorities, etc.

An “acceptable level” is the reduction of a major impact to a moderate one after mitigation. In seeking to mitigate moderate impacts, the emphasis is on demonstrating that the impact has been reduced to a level that is as low as reasonably practicable. It will not always be practical to reduce moderate impacts to minor ones in consideration of the cost-ineffectiveness of such an approach (due to the diminishing return of a reduction of impact versus cost). Residual impact assessment will 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 will follow similar risk approach as outlined above.

## 6.5 Environmental Management and Monitoring Plan (EMMP)

Construction phase EMMP and Operational phase EMMP was formulated specifying mitigation measures, monitoring scope, methodology and location, and triggers to report and escalate the irregularities in the baseline conditions at construction/ operational phase. The basis of EMMP is provided in Section 11 which also summarises information about identified sensitive receptors, potential impacts evaluated, residual impacts (if any) and frequency of monitoring (if required), as well as close up actions.

## 6.6 Stakeholder and Public Engagement

It is known that effective communication and cooperation between various expert groups as well as the client or stakeholders will definitely minimise any risks throughout the project delivery process.

Prior to the commissioning of this variation order, stakeholder and expert group engagements were conducted for the now-published Choa Chu Kang N1 EBS, to better understand their requirements, concerns, etc. The concerns were discussed with the Client and technical agencies and appropriately taken on board while writing of this Report.

# 7 Biodiversity

## 7.1 Introduction

The Biodiversity Field Assessment aims to establish baseline biodiversity information of the proposed Study Area. Baseline information will be first gathered through reviews of past and present biodiversity records, published literature, and in consultation with taxonomic experts. Actual field surveys will then be carried out to verify and supplement the data. Through desktop and field assessments, important habitats, species of flora and fauna of conservation significance will be identified.

The Biodiversity Impact Assessment aims to evaluate the impacts of the Project on existing biodiversity resources of the Project site based on the baseline biodiversity information provided in the EBS [P-1]. The information was used to evaluate the nature and scale of potential impacts associated with the Project, based on the latest land use plans provided by HDB on 4th July 2022. Mitigation measures were recommended to avoid, reduce and/ or minimise identified impacts.

## 7.2 Methodology and Assumptions

### 7.2.1 Desktop Assessment

#### 7.2.1.1 Land Use History

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

#### 7.2.1.2 Key References

Past and present floristic as well as faunistic species composition were examined using relevant key references that include books, specifically Pang Sua Woodland: Sanctuary Unveiled along the Rail Corridor by Nature Society (Singapore) (NSS) and Cicada Tree Eco-Place [P-8] and The Green Rail Corridor: A Biodiversity and Ecological Overview published by Nature Society (Singapore) (NSS) [P-9], scientific publications, unpublished literature, and online databases. Sources of databases include The Biodiversity of Singapore by the Lee Kong Chian Natural History Museum [W-4], Flora and Fauna Web by the National Parks Board [W-5], and iNaturalist [W-6]. Other key references include the Singapore Red Data Book [P-4], Singapore Biodiversity Records, encyclopaedia on Singapore's biodiversity [P-10], and the database of flora and fauna records compiled by our biodiversity specialists.

#### 7.2.1.3 Taxonomy and Nomenclature

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

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

| Taxon | Key References |
|---|---|
| **Plants** | Chong et al., (2009) [P-11]; World Checklist of Selected Plant Families [W-1]; Plants of the World Online [W-7] |
| **Aculeate hymenopteran** | Ascher et al. (in prep) [P-8] |
| **Odonates** | Soh and Ngiam, (2019) [P-43] |
| **Butterflies** | Khew, (2015) [P-15] |
| **Freshwater decapod crustaceans** | Ng, (1997) [P-12]; Cai et al., (2007) [P-13] |

| Taxon | Key References |
|---|---|
| **Freshwater fish** | Kottelat, (2013) [P-16]; Suzuki et al., (2015) [P-17]; Ho et al., (2016) [P-5] |
| **Herpetofauna** | Baker and Lim, (2012) [P-18] |
| **Birds** | Gill and Donsker, (2020) [W-8] |
| **Mammals** | Baker and Lim, (2012) [P-18] |

#### 7.2.1.4 Species of Conservation Significance

The assessment of whether certain species are of conservation significance is important for highlighting the need and priorities for conservation.

All flora were assessed to determine their conservation significance status - i.e., listed in Chong et al. 2009 [P-11] as nationally Vulnerable, Endangered, Critically Endangered, or Presumed Extinct (which indicates a rediscovery). While the national conservation status of threatened species is true of wild populations that originate in an area without direct or indirect human intervention, some populations may be relics that persist from past cultivation or escapees from present-day cultivation that does not belong to native genetic stock. The assessment of whether a floral species is of conservation significance was based on, but not limited to, information on the following: (1) land use history; (2) presence of large parent tree(s); (3) commercial availability; (4) data from previous environmental baseline studies; (5) reforestation efforts; (6) natural range; and (7) importance for associated fauna. If the origin of a threatened species population is disputable or difficult to determine, findings from field surveys of fauna were corroborated, and/ or the more conservative approach was adopted by considering them of conservation significance. In carrying out such assessments, we are then able to prioritise conservation needs and focus resources in conserving them.

Faunal species of conservation significance include both threatened species as well as non-threatened species that are regarded as notable records. Threatened species are species listed as globally or nationally Vulnerable, Endangered Critically Endangered. Notable non-threatened species are species that do not fall within the above categories, but are deemed to be of conservation interest within the Study Area based on recent local trends observed by specialists including the following: (1) increased rarity of the species locally; (2) reduced habitat suitability for the species locally; or (3) presence of breeding sites that are uncommon or rare locally. The national conservation statuses reference the Singapore Red Data Book (SRDB; [P-4] and other more updated local checklists, where available, such as Soh et al. 2019 [P-43] for odonates, Jain et al. 2018 [P-19] for butterflies and NParks (2021) [W-2] for amphibians, reptiles, mammals and bats. The global conservation status references the Red List of Threatened Species by the International Union for Conservation of Nature (IUCN, 2021 [P-14]).

## 7.2.2 Field Assessment

### 7.2.2.1 Site Reconnaissance

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

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

### 7.2.2.2 Floristic Field Assessment

The field assessment for flora consist of (1) habitat and vegetation mapping; (2) general walking floristic surveys; and (3) tree mapping conducted from 23 February 2021 to 29 April 2021. The methodologies listed below that were

approved by various stakeholders, took into consideration of the framework for biodiversity baseline study in Singapore listed in the Biodiversity Impact Assessment (BIA) Guidelines, 2020, published by NParks [R-2].

#### 7.2.2.2.1 Habitat Mapping

A preliminary map to highlight possible habitats that could be found within the Study Area was first prepared based on visual interpretations of satellite images from Google Earth Pro 7.3.3.7786 [O-1]. Preliminary classification of the habitat types - for example, different types of managed vegetation and built-up areas - were mapped out using visual features, such as textures and colours, observed in the satellite images. Adjustments were then made to the preliminary maps according to actual observations during ground truthing. Ground truthing was then conducted throughout the survey area with the aid of a GPS receiver (Garmin GPSMap® 64s). Photographs of the different habitats were also taken. The boundaries of each habitat type were tracked on the GPS receiver and mapped out on Google Earth 7.3.3.7786 [O-1]. The classification of habitat types references to NParks [R-2].

#### 7.2.2.2.2 General Walking Surveys

All plants observed in the Study Area during floristic surveys were identified to species whenever possible. A checklist of all the plant species recorded from the present floristic surveys was compiled. The nomenclature and national conservation status follow that of Chong et al. (2009) [P-11], and/ or other published papers with information on the updated assessment of the species nomenclature and/ or conservation status. The latter is usually for one or a few individual species. Other information on the plant species was also cross-checked with online databases, namely, the National Parks Board Flora and Fauna Web and Singapore Biodiversity Online.

For plants that could not be immediately identified with certainty in the field, photographs and/ or voucher specimens were taken. They were then identified using identification keys, taxonomic descriptions, online plant photo databases, with the help of taxonomic experts, and/ or by matching the pressed and dried collected specimens with existing specimens in the Singapore Botanic Gardens' Herbarium (SING).

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

#### 7.2.2.2.3 Species of Conservation Significance

The geographic coordinates of plants of conservation significance were marked using a Global Positioning System (GPS) receiver (Garmin GPSMap® 64s), which records locations with accuracy of ± 4 m, during floristic surveys. Where there are clusters of plants of conservation significance—i.e., more than one individual occurring within 5 m or less of another individual—the geographic location of the approximate centre of the area was marked using the GPS receiver.

#### 7.2.2.2.4 Large Plant Specimens

Similarly, the GPS receiver was used to record locations of all trees of ≥ 3 m girth, as well as bamboo clusters, palm clusters, and strangling *Ficus* species of ≥ 3 m spread. Individuals were identified to species level. Their girth (for trees) and/ or estimated spread (for bamboo clusters, palm clusters, and strangling Ficus species), as well as estimated height, were recorded and these specimens were tagged with unique serial numbers.

#### 7.2.2.2.5 Other Plant Species of Value

Locations of other plants that are of value but do not meet the minimum size requirement, as detailed in the above sub-section, were recorded using the GPS receiver. Examples of such include bamboo clusters of < 3 m spread that may be important refugia for rare bamboo bats, amongst others, and keystone species. According to Lok et al., (2013), keystone species is defined as "important plants that other animal in the community depend heavily on" [P-29]. Geographic locations of all keystone species were recorded using the GPS receiver (Garmin GPSMap® 64s or/ and Differential GPS receiver).

#### 7.2.2.2.6 Tree Mapping

Mapped specimens were tagged with a unique serial number on site; this includes all trees, single-stemmed palms, and strangling *Ficus* species of ≥ 0.3 m girth. Single-stemmed palms are defined in this study as having one obvious and erect stem. Geographic locations, girth/ spread and heights were also recorded. Differential Global Positioning System (DGPS) receivers (CHC® Navigation HCE320 GNSS data controller with the CHC® Navigation i90 Pro GNSS receiver and Leica DISTO™ D510 rangefinder; Hi-Target Qmini A5 High Precision Handheld data controller with the Hi-Target V-90 GNSS receiver and Leica DISTO™ D510 rangefinder) (Figure 7-1 and Figure 7-2)—which records locations with accuracy of ± 1 m and less — were used to record geographic locations of the specimens using the SVY21 plane coordinate system. This local datum gives a more accurate representation of the areas of

coverage in Singapore compared to a global datum and is used by the Singapore Land Authority (SLA) (SLA, 2015 [W-34]. Where there are clusters of specimens of the same species occurring within 1 m – 2 m of each other, only one specimen was tagged, and its location marked using the DGPS.




**Figure 7-1 (A) CHC® Navigation HCE320 GNSS data controller (Source: Geo-Matching.Com); (B) how it is used in the field**




**Figure 7-2 (A) Hi-Target Qmini A5 High Precision Handheld data controller (Source: Geo-Matching.Com); (B) how it is being used in the field**

### 7.2.2.3 Faunistic Field Assessment

Field surveys were carried out for terrestrial and aquatic fauna communities from these taxon groups: (1) aculeate hymenopterans; (2) butterflies; (3) odonates (damselflies and dragonflies); (4) herpetofauna (amphibians and reptiles); (5) birds; and (6) mammals (including bats). The selection of targeted faunal groups references the Biodiversity Impact Assessment (BIA) Guidelines (2020) by NParks [R-2].

Table 7-2 summarises all the surveys that were carried out for fauna. Each survey was performed by at least two (maximum three) surveyors. All fauna encountered were identified to the lowest taxonomic level possible, and the location of each individual was recorded using a handheld GPS (Garmin GPSMAP 64s). The number of individuals observed was also documented. All observations of notable species from the aforementioned taxa were also be recorded if seen outside the stated survey times. The locations of sampling units and camera traps are provided in Figure 7-3 and Figure 7-4.

**Table 7-2 Summary of faunal field surveys**

| Survey Type | Taxon | Timing (h) | Duration | Sampling Unit | Technique |
|---|---|---|---|---|---|
| **Diurnal transect surveys** | Aculeate hymenopterans | 09:00–15:00 | 20–30 minutes per transect | 200-m continuous transects along a sampling route | Visual only; up to 25 m left, right, and front of surveyor |
| | Butterflies | 09:00–15:00 | 20–30 minutes per transect | 200-m continuous transects along a sampling route | Visual only; up to 25 m left, right, and front of surveyor |
| | Odonates (damselflies and dragonflies) | 09:00–15:00 | 20–30 minutes per transect | 200-m continuous transects along a sampling route | Visual only; up to 25 m left, right, and front of surveyor |
| **Diurnal and nocturnal transect surveys** | Herpetofauna (amphibians and reptiles) | 07:00–10:00; 20:00–23:00 | 20–30 minutes per transect | 200-m continuous transects along a sampling route | Visual and auditory; up to 50 m left, right, and front of surveyor |
| | Birds | 07:00–10:00; 20:00–23:00 | 20–30 minutes per transect | 200-m continuous transects along a sampling route | Visual and auditory; up to 50 m left, right, and front of surveyor |
| | Mammals (non-volant) | 07:00–10:00; 20:00–23:00 | 20–30 minutes per transect | 200-m continuous transects along a sampling route | Visual and auditory; up to 50 m left, right, and front of surveyor |
| **Aquatic point counts** | Odonates (damselflies and dragonflies) | 09:00–15:00 | 5 minutes per point | Sampling points at fresh-waterbodies (intervals vary with waterbodies) | Visual only; up to 25 m from sampling point or the extent of waterbodies, whichever is smaller |
| | Herpetofauna (amphibians and reptiles) | 20:00–23:00 | 5 minutes per point | Sampling points at fresh-waterbodies (intervals vary with waterbodies) | Visual only; up to 25 m from sampling point or the extent of waterbodies, whichever is smaller |
| **Camera trapping** | Mammals (non-volant) | 24 hours a day | 60 days | One trap per 6.25 ha. Additional traps were deployed at strategic locations. | Infrared motion sensing |
| **Bioacoustics surveys** | Mammals (bats) | 20:00–23:00 | 20–30 minutes per transect | 200-m continuous transects along a sampling route | Auditory only |

| Survey Type | Taxon | Timing (h) | Duration | Sampling Unit | Technique |
|---|---|---|---|---|---|
| **Roost emergence surveys** | Mammals (bamboo bats only) | 18:30–21:00 | - | Bamboo clusters (if any) | Visual and auditory |
| **Push and scoop netting** | Aquatic fauna (fish) | Daytime | - | Sampling points at fresh-waterbodies (intervals vary with waterbodies) | - |
| **Minnow trapping** | Freshwater aquatic fauna (fish and decapod crustaceans) | Overnight | One day one night | Traps were deployed at strategic locations along waterbodies | Baited |




**Legend**

- CCK N1 Study Area
- Rail Corridor
- Canal/Drain (Perennial)
- Drain (Ephemeral)
- Aquatic sampling points
- Terrestrial sampling route

N

| Rev. | Date | By | Description | Chk'd | App'd |
|---|---|---|---|---|---|
| - | JAN 2023 | ZA | Final Report | NHT | JAG |

Qualified Person Endorsement : NA

HDB Endorsement : NA

Consultant : AECOM

HOUSING & DEVELOPMENT BOARD

Project Title :

**ENVIRONMENTAL IMPACT ASSESSMENT (EIA) ON CHOA CHU KANG N1**

Figure Title :

**Location of terrestrial sampling route and aquatic sampling points**

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**Legend**

- CCK N1 Study Area
- Rail Corridor
- Canal/Drain (Perennial)
- Drain (Ephemeral)
- Camera trap

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HDB Endorsement : NA

Consultant : AECOM

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Project Title :

**ENVIRONMENTAL IMPACT ASSESSMENT (EIA) ON CHOA CHU KANG N1**

Figure Title :

**Location of camera traps**

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#### 7.2.2.3.1 Odonates (Dragonflies and Damselflies)

Diurnal transect surveys were carried out for adult damselflies and dragonflies along 200 m continuous transects on a sampling route, as well as 5-minutes point counts at aquatic sampling points between 09:00 h and 15:00 h. Owing to difficulties in sampling and identification, aquatic larvae and exuviae were not surveyed. Adult odonates were identified visually (with binoculars where necessary), photographed, or caught using insect nets, if required. Captured individuals were released immediately after identification.

#### 7.2.2.3.2 Aculeate Hymenopterans (Bees and Stinging Wasps, excluding Ants)

Adult bees and stinging wasps, nests, and food plants were visually surveyed along 200 m continuous transects on a sampling route. Surveys were conducted between 09:00 h and 15:00 h. Bees and wasps were identified by sight or were photographed whenever possible. Otherwise, they were captured using handheld insect nets. Individuals were released immediately after identification. When identification in the field was not possible, live specimens were collected and examined *post-hoc* under microscope. The specimens were identified to the lowest taxonomic level possible using relevant references, identification keys, or in consultation with taxonomic experts.

#### 7.2.2.3.3 Butterflies

Diurnal transect surveys were carried out for adult butterflies along 200 m continuous transects on a sampling route between 09:00 h and 15:00 h. Butterfly caterpillars, pupae, eggs, and host plants were also recorded when observed. Adult butterflies were identified visually (with binoculars where necessary), photographed, or caught using insect nets, if required. Captured individuals were released immediately after identification.

#### 7.2.2.3.4 Herpetofauna (Amphibians and Reptiles)

Diurnal (07:00 h–10:00 h) and nocturnal (20:00 h–23:00 h) surveys were carried out for amphibians and reptiles along 200 m continuous transects on a sampling route, as well as 5-minutes nocturnal point counts at aquatic sampling points. As herpetofauna occupy a wide range of habitat types, both the diurnal and nocturnal surveys also involved active searches for individuals on the ground, below rocks, logs, leaf litter, and debris, in the water, and/ or on vegetation. Torches and/ or headlamps were used to elicit eyeshine during nocturnal surveys. Vocalising fauna was also located or identified by call recognition, whenever possible. For species that are capable of quick retreats and escapes, the individuals were captured by hand, or using hooks, tongs, or dip nets for identification. Captured individuals were released immediately after identification.

#### 7.2.2.3.5 Birds

Diurnal (07:00 h–10:00 h) and nocturnal (20:00 h–23:00 h) surveys were carried out for birds along 200 m continuous transects on a sampling route with 20 minutes - 30 minutes spent per transect. Individuals observed or heard within 50 m on the left, right, and front of surveyor along a transect were recorded. Birds were identified visually (with binoculars where necessary) and photographed. Torches and/ or headlamps were used to elicit eyeshine during nocturnal surveys. Vocalising birds were also located or identified by call recognition, whenever possible. Notable behaviours (nesting, breeding, feeding, rosting) were recorded. As the main faunistic field surveys were carried out outside of the bird migratory season, additional migratory bird surveys were also conducted twice within the bird migratory season in October and November 2021, as agreed by HDB and NParks on 10 June 2021. These findings were discussed in the Choa Chu Kang N1 EBS Final Report in Section 7.3.2.9 [P-1].

#### 7.2.2.3.6 Mammals (Non-Volant)

Diurnal (07:00 h–10:00 h) and nocturnal (20:00 h–23:00 h) surveys were carried out for non-volant mammals along 200 m continuous transects on a sampling route. Both the diurnal and nocturnal surveys also involved searches in burrows and tree holes. Tracks, scats and holts were also recorded. Mammals were identified visually (with binoculars where necessary) and photographed. Torches and/ or headlamps were used to elicit eyeshine during nocturnal surveys. Vocalising mammals, such as the squirrels, were also located or identified by call recognition, whenever possible.

Camera traps were equally distributed across the Study Area (Figure 7-4). One camera trap was deployed within each grid, which amounted to four camera traps. Each camera trap was set up at approximately 20 cm – 30 cm above ground (Figure 7-5). They operated for 24 hours a day and were programmed to record 10-second footage per motion trigger with a 10-second quiet period following each trigger. Each camera trap was deployed for 60 days. The camera trap model used is Browning Dark Ops HD Pro X BTC-6HDPX.



**Figure 7-5 Example of a camera trap setup**

#### 7.2.2.3.7 Freshwater aquatic fauna (Fish and decapod crustaceans)

Surveys involved diurnal (09:00 h–15:00 h) and nocturnal (20:00 h–23:00 h) 5-minute visual point counts at aquatic sampling points.

### 7.2.2.4 Data Analyses

#### 7.2.2.4.1 Species Distribution Maps

Locations of species of conservation significance were presented on maps to show their distribution within the Study Area. All maps were prepared and generated using the mapping software QGIS 3.4.12.

#### 7.2.2.4.2 Camera Trapping

Camera trap location, species identity, and the number of individuals were recorded for each video with a positive capture of fauna. An independent detection constitutes video of one or a group of individuals of the same faunal species occurring within 60 minutes at each camera trap. The number of independent detections was used to calculate detection rate of each mammal species.

#### 7.2.2.4.3 Bat Sound File Analysis

All bat sound files were processed using Kaleidoscope v.4.5.4 (Wildlife Acoustics, Inc.) to separate extraneous noise from files with bat echolocation calls. The signal parameters for recognising a potential bat echolocation call were configured as follows: frequency range of 20–200 kilohertz (kHz), duration of 2–500 milliseconds (ms), maximum inter-syllable gap of 500 ms, and a minimum of 2 pulses. These files were visually processed to identify bat species based on call structures, peak frequency, minimum frequency, and call duration [P-50]. They were identified with reference to those in Pottie et al. (2005) [P-50], which provides echolocation signatures for bats in Singapore, and other relevant references [P-51, P-52].

#### 7.2.2.4.4 Taxon Sampling Curves

Taxon sampling curves were plotted for selected taxa with sufficient occurrences as large sample sizes are required for the estimation of sample coverage to be robust [P-53]. The observed sample of incidence data was used to estimate sample coverage and species richness. Species richness was plotted against sample coverage, as opposed to survey effort, to estimate sample completeness/ survey adequacy, i.e., how extensively we have sampled the species in the community. Sample coverage refers to “the proportion of the total number of species in a community that belongs to the species represented in the sample” [P-53]. The curve was extrapolated to provide an estimation of species richness and sample coverage if sample size was doubled. The associated standard error and 95% confidence interval were also computed. Standard error represents the range of uncertainty of the estimate, while 95% confidence interval is the interval in which there is a 0.95 probability of containing the estimated

true species richness. As some species will always remain undetected, total species richness had to be estimated via extrapolation. This was done using the Chao estimator. All statistical analyses were carried out in the statistical programming environment R version 3.4.3 using the "iNEXT" package 2.0.20 [P-52].

## 7.3 Potential Sources of Biodiversity Impact

Potential impacts to biodiversity arising from construction phase (refer to Section 3.2.1) and operational phase (refer to Section 3.3) activities were assessed in this Section. The Study Area for this impact assessment differed slightly from the boundary that was reflected in the baseline study as it excludes the Pang Sua Canal (Section 7.2.2). The proposed construction will include the construction of the residential building and amenities. It is expected that few internal roads will also be constructed within the proposed residential estate. The areas impacted (i.e., the 'worksite') are expected to total, approximately 10.9 ha. It is to note that the development boundary that was used for the impact assessment for the different ecological receptors has been delineated to take into consideration of the Recommended Area of Conservation (RAC) that was mentioned in Section 7.4.6.

Major cut and fill to prepare the site during pre-construction are expected within the worksite. Demolition works are also expected to remove the existing heavy vehicle carpark that is located on the southeast of the Project site. After which, excavation, piling and building are expected to follow. All terrestrial habitat types are likely to be impacted, while all terrestrial faunal species recorded are expected to be indirectly impacted as well, since most terrestrial fauna are mobile throughout the Project site. While habitats at least 30 m away from the worksite are not expected to be directly impacted through loss of vegetation/ habitat, indirect impacts such as habitat degradation and formation of forest edge could still occur.

As the site currently provides an ecological connectivity and conduit for volant fauna species (refer to Section 7.4.4), the removal of most of the vegetation from the Project site and the reduction of size of the existing vegetated area is expected to diminish the effectiveness of the habitat there as a stepping-stone and would result in the loss of/ reduction in ecological connectivity for faunal movement.

At the operational phase, public housing is expected to be directly adjacent to the conserved area, which will also be referred to as an Ecological Corridor. Therefore, human traffic is expected to increase significantly. Increase in human traffic would inevitably increase disturbance to surrounding biodiversity in the form of noise and light generated. Increase in waste in the form of rubbish/ litter or wastewater discharge could also potentially become an impact, if not properly managed.

The impacts were separately assessed for habitats, floral, and faunal species (Table 7-3). There are two main categories in which the impacts fall into, namely, (1) direct, i.e., impacts to habitats and species within the worksites; and (2) indirect, i.e., impacts to habitats and species outside the worksites but within the impact zone. Impact zones for habitat and species receptors are defined as areas within 30 m from worksites of the proposed development, even though there are some studies that found edge effects affecting vegetation up to 150 m from forest boundaries [P-54; P-55; P-56; P-57]. The 30-m impact zone is based on the assumption that edge effects in the forests adjacent to worksites are the greatest within 30 m from the worksites.

**Table 7-3 List of ecological impacts**

| Receptor | Impact Type | Description | Impact Category |
|---|---|---|---|
| **Construction Phase** | | | |
| **Habitats** | Loss of vegetation | Direct removal of vegetation (with extensive underground root systems that protect against soil erosion) to create space for construction activities | Direct |
| | Habitat degradation | Improper disposal of construction waste, accidental release of hazardous materials (such as construction slurry, paint, and/ or solvents), increase in dust, noise, and light levels, changes in forest hydrology | Indirect |
| | Formation of forest edge | Formation of forest edge habitats from the removal of forested areas | Indirect |

| Receptor | Impact Type | Description | Impact Category |
|---|---|---|---|
| **Plant Species** | Mortality | Direct removal of vegetation to create space for construction activities | Direct |
| | Decline in plant health and survival | Changes in microclimatic conditions (i.e., dust, noise, and light, temperature, and humidity) and hydrology | Indirect |
| **Faunal Species** | Loss of/ reduction in habitats and food sources | Loss of/ reduction in habitats and food sources | Direct |
| | Injury or mortality | Collisions with machineries, entrapments in construction materials (such as non-biodegradable erosion control blankets) and structures (such as exposed pits or drains), accidental kills by construction personnel, and/ or modifications to habitats (e.g., increased pollution levels, edge effects) that cause direct injury or mortality of fauna | Direct |
| | Loss of ecological connectivity for faunal movements | Habitat fragmentation from the removal of vegetation | Indirect |
| | Human-wildlife conflict | Negative consequences of human-wildlife interactions, such as deliberate killing and depopulation of faunal species perceived as nuisances or threats by construction personnel | Direct |
| | Light disturbances | Increase in light levels from construction activities | Indirect |
| | Human disturbances | Increase in human traffic flow, such as workers and site personnel | Indirect |
| **Operational Phase** | | | |
| **Habitat** | Change in species composition | Long-term changes in light, temperature, and humidity in habitats surrounding facility structures that favour the growth of certain exotic plants and fauna, and deliberate/ accidental introduction of exotic species (such as released/ escaped pets) | Indirect |
| | Habitat degradation | Trampling on vegetation, pollution (e.g., contamination of surface waterbodies, dust, litter) from increased human activities | Direct |
| **Plant Species** | Poaching | Stealing/ poaching of plants by humans due to ethnobotanical value (i.e., plants that have medicinal, aesthetical, economical/ commercial value, are edible or are used for culinary purposes, and/ or are rare in Singapore) | Direct |
| **Faunal Species** | Accidental injury or mortality | Navigation failures into the wrong areas and entrapment in facility structures, including bird collision into buildings (distorted perceptions of reflective surfaces on buildings as flyways, greenery, and/ or water) and collision with vehicles | Direct/ Indirect |
| | Human-wildlife conflict | Negative consequences of human-wildlife interactions, such as deliberate killing and depopulation of faunal species perceived as nuisances or threats by members of the public | Direct |
| | Poaching | Poaching of fauna by humans | Direct |

| Receptor | Impact Type | Description | Impact Category |
|---|---|---|---|
| | Loss of ecological connectivity for faunal movement | Impediment to faunal movement by presence of buildings, infrastructure, and human activity | Indirect |
| | Light disturbances | Increase in light levels from development | Indirect |
| | Human disturbances | Increase in human traffic flow, such as residents and visitors | Indirect |

# 7.4 Baseline Biodiversity Conditions

The baseline findings presented below are based on data that were collected from the floristic and faunistic surveys conducted between 1 March 2021 to 29 April 2021.

## 7.4.1 Baseline Personnel

The personnel and taxonomic experts involved in the biodiversity surveys for this Project are as follows:

**Flora**

1. Siti Zaleha Abdullah (Flora specialist);
2. Ting Ying Ying (Flora specialist);
3. Sherry Hung Ming Xuan (Flora specialist);
4. Boo Chih Min (Flora Lead);
5. Sim Eng Koon (Arborist); and
6. Derek Yap Chung Hoe (Arborist).

**Fauna**

1. Joys Tan (Lead Fauna Biologist; Mammal Specialist);
2. Choo Ruisheng (Fauna Biologist);
3. Alfred Chia (Bird Specialist);
4. Dr. Alex Figueroa (Herpetofauna Specialist);
5. Chloe Tan (Butterfly and Mammal Specialist);
6. John Lee Xinquan (Aculeate Hymenopteran Specialist);
7. Lim Kim Seng (Bird Specialist);
8. Robin Ngiam (Odonate Specialist); and
9. Tang Hung Bun (Odonate Specialist).

## 7.4.2 Floristic Baseline Results

### 7.4.2.1 Habitat Description

There are four (4) habitat types identified in the Study Area, of which, the largest habitat is managed vegetation (Figure 7-6, Table 7-4). This habitat type consists of clusters of trees (9.62 ha; 45.2%) planted for landscaping purposes. These trees occupy the majority of the Study Area. The turf area, where the Rail Corridor is located,

occupies 5.36 ha (25.2%) of the Study Area. The existing canal that is situated on the western side of the Study Area beside the woodland takes up 4.15 ha (19.4%) of the total land area (Section 7.4.2.1.3). The remaining areas are covered by non-vegetated habitats, which include infrastructure (2.17 ha; 10.2%), which can be found in the southeast of the Study Area.

**Table 7-4 Absolute (ha) and relative (%) sizes of each habitat and vegetation type in the Study Area.**

| Habitat type | Absolute size (ha) | Relative size (%) |
|---|---|---|
| **Managed vegetation** | 14.98 | 70.4 |
| Planted trees | 9.62 | 45.2 |
| Turf | 5.36 | 25.2 |
| **Canal** | 4.15 | 19.4 |
| **Others (Infrastructure)** | 2.17 | 10.2 |
| **Total** | **21.3** | **100** |

0 50 100 150 m

**Legend**

- CCK N1 Study Area
- Rail Corridor
- Managed vegetation (Planted trees)
- Managed vegetation (Turf)
- Canal/Drain (Perennial)
- Perennial drain
- Others (Infrastructure)
- Drain (Ephemeral)

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Project Title :

**ENVIRONMENTAL IMPACT ASSESSMENT (EIA) ON CHOA CHU KANG N1**

Figure Title :

**Habitats present within Choa Chu Kang N1 Study Area**

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#### 7.4.2.1.1 Managed Vegetation

Managed vegetation in this Study Area consists of two different areas: clusters of trees planted for landscaping purposes and turf vegetation (Figure 7-7). The clusters of trees are situated on the western portion of the Study Area and mainly comprise planted exotic tree species. Different portions within the area were dominated by different trees, such as raintree (*Samanea saman)*, Senegal mahogany (*Khaya senegalensis*), trumpet tree (*Tabebuia rosea*), and breadfruit (*Artocarpus altilis*). Even though the site was largely covered with exotic species, few individuals of native species, such as sea almond (*Terminalia catappa)*, wild cinnamon (*Cinnamomum iners)* and rambutan (*Nephelium lappaceum*) were found distributed across the region. Maintenance of these trees, such as pruning was observed during the survey, suggesting that the vegetation undergoes frequent maintenance.

The turf area is situated on the east portion of the Study Area, with the Rail Corridor cutting through this area (Figure 7-6). A mixture of exotic species and cryptogenic weeds were recorded in the turf area, cowgrass (*Axonopus compressus*) and lalang (*Imperata cylindrica*) were found throughout the turf area. Other common herbaceous groundcovers, such as creeping tick trefoil (*Desmodium trifolium*), sensitive plant (*Mimosa pudica*), and blue pussyleaf (*Nelsonia canescens*) were spotted as well.




**Figure 7-7 (A) Managed trees; and (B) managed turf located side by side within the Study Area**

#### 7.4.2.1.2 Others (Infrastructures)

Infrastructure within the Study Area includes a heavy vehicle carpark and a defunct bus terminal. Both areas are located beside each other at the southeast portion of the Study Area. Numerous exotic trees such as raintree (*Samenea saman*) were seen planted within and along the boundary of the heavy vehicle carpark. Clusters of an exotic shrub species, camwood (*Baphia nitida*), alongside Madagascar almond (*Terminalia mantaly*) were planted along the perimeter of the bus terminal (Figure 7-8).




**Figure 7-8 Infrastructure in CCK N1 Study Area. (A–B) *Samanea saman* (red arrow) planted within and along the boundary of the heavy vehicle carpark, respectively; (C) Overview of the defunct bus terminal; (D) *Baphia nitida* hedge (yellow arrow) along the boundary of the defunct bus terminal.**

#### 7.4.2.1.3 Watercourses

A large canal (Figure 7-9A) and three (3) concrete drains (Figure 7-6) were present within the Study Area as discussed in Section 8. One of the concrete drains (Figure 7-9B), which cuts across the centre of the Study Area, was unshaded and partially vegetated, and was found to be mostly dry during the survey period, although shallow water puddles were occasionally observed after rain. The other two concrete drains are located near the east of the Study Area.




**Figure 7-9 Watercourses present within the Study Area – (A) large canal (D1) and (B) concrete drain (D3).**

### 7.4.2.2 Overall

A total of 119 species and one species group (i.e., plants that could not be identified to species with certainty) belonging to 46 families were identified in the Study Area (Table 7-5; Appendix D). The species group consists of *Bambusa* cf *heterostachya*.

Of the 119 species recorded, majority are exotic (81 species; 68.1%), only 27 species are native (22.7%) and 11 (9.2%) are cryptogenic (i.e., species that has unknown or uncertain origins). The plant species belonging to each status category are summarised in Table 7-5.

Of the 27 native species recorded, six (5.2%) species are considered as threatened species (i.e., species with statuses of Vulnerable, Endangered, and Critically Endangered). However, some threatened species are cultivated locally and/ or are relics from past cultivation and hence may not be of conservation significance. For the overall findings, a distinction is not made as to whether these threatened species are from native wild populations or are cultivated locally and/ or were relics from past cultivation. Species belonging to the latter category may therefore not be of conservation significance even though they have been accorded with threatened conservation status. This is discussed in greater detail in Section 7.2.1.4 and Section 7.4.2.3.

**Table 7-5 Number and percentage (%) of species belonging to each status category in the Study Area**

| Origin | Status | Number of Species | Percentage (%) |
|---|---|---|---|
| **Native** | | **27** | **22.7** |
| | Common | 21 | 17.6 |
| | Vulnerable | 2 | 1.7 |
| | Endangered | 1 | 0.8 |
| | Critically Endangered | 3 | 2.5 |
| **Exotic** | | **81** | **68.1** |
| | Cultivated Only | 26 | 21.8 |
| | Casual | 16 | 13.4 |
| | Naturalised | 38 | 31.9 |
| | Not assessed | 1 | 0.8 |
| **Cryptogenic** | | **11** | **9.2** |
| **Total** | | **119** | **100.0** |

### 7.4.2.3 Species of Conservation Significance

A total of six (6) plant species that were considered as threatened species, according to Chong et al, 2009 [P-11], were found scattered across the Study Area (Figure 7-10). The number of specimens and/ or clusters of specimens of these threatened species are summarised in Table 7-6. The assessment of whether the listed threatened plant species are considered as conservation significance was based on criteria detailed in Section 7.2.1.4. According to the historical land use of the Study Area (Section 7.2.1.1), five species—*Baccaurea motleyana* (Figure 7-11A), *Epipremnum pinnatum* (Figure 7-11B), rambutan (*Nephelium lappaceum;* Figure 7-11C), *Sandoricum koetjape* (Figure 7-11D), and *Mangifera odorata* (Figure 7-11E) —are most likely relics that had persisted from the past cultivation rather than local provenance and are not considered as species of conservation significance.

Therefore, only one species is considered to be of conservation significance. This species is a nationally Vulnerable climber, *Bridelia stipularis* (Appendix E). A small cluster was found growing on a weeping fig (*Ficus benjamina*) tree in the Study Area (Figure 7-11F). This species can also usually be found in other habitats, such as in primary and secondary forests, freshwater swamp forests, mangrove forests and riverine areas.

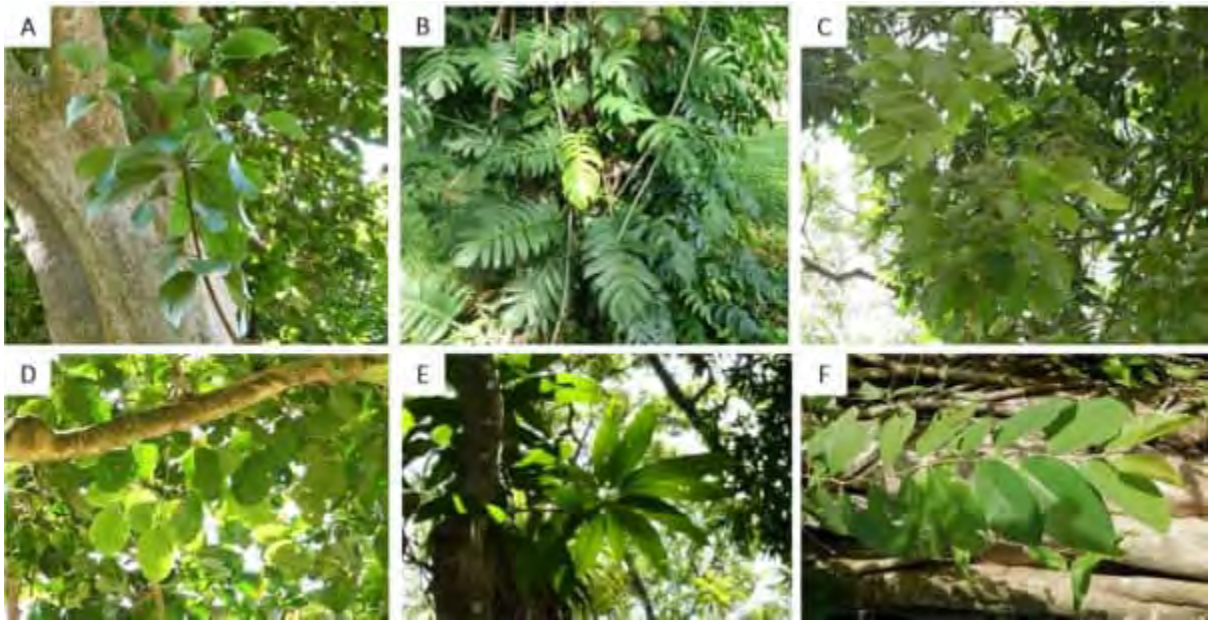



**Figure 7-10 Threatened plant species found in CCK N1 Study Area. (A) *Baccaurea motleyana*; (B) *Epipremnum pinnatum*; (C) *Nephelium lappaceum*; (D) *Sandoricum koetjape*; (E) *Mangifera odorata*; (F) species of conservation significance, *Bridelia stipularis***

**Table 7-6 Number of plant species of conservation significance**

| Species Conservation Status* | Vulnerable | Endangered | Critically Endangered | Total |
|---|---|---|---|---|
| Non-Cultivated Threatened Species | 1 | 0 | 0 | 1 |
| Cultivated Threatened Species | 1 | 1 | 3 | 5 |
| **Total** | **2** | **1** | **3** | **6** |




**Legend**

- CCK N1 Study Area
- Rail Corridor
- Managed vegetation (Planted trees)
- Managed vegetation (Turf)
- Others (Infrastructure)
- Canal/Drain (Perennial)
- Drain (Ephemeral)

CS Species

- Bridelia stipularis

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Figure Title :

**Location of species of conservation significance in Choa Chu Kang N1 Study Area**

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### 7.4.2.4 Large Specimens

Ninety-one (91) large plant specimens of ≥ 3 m were recorded in the Study Area (Table 7-7; Appendix F), of which 87 individuals are large trees with girth sizes that range from 3 m – 5.4 m girth, belonging to 5 species and 4 families. The majority of these specimens are exotic tree species. The remaining four (4) specimens are stranglers with a spread that ranges from 3.2 m – 8 m (Figure 7-12). The largest tree specimen recorded was angsana (*Pterocarpus indicus*) of 5.2 m girth. As for stranglers, a specimen of Malayan banyan (*Ficus microcarpa*) was recorded with spread of 8 m.

Plant species such as raintree (*Samanea saman*), create a biome of microhabitats within the Study Area. It can support numerous climber species such as *Epipremnum pinnatum* (Figure 7-12B) and *Syngonium podophyllum;* Figure 7-12A), and pteridophytes such as bird's nest fern (*Asplenium nidus*; Figure 7-12C) and oak leaf fern (*Drynaria quercifolia*), as well as orchid species such as pigeon orchid (*Dendrobium crumenatum*). This variety of microhabitats that can be found on *S. saman* provides a place of refuge for different species of fauna and functions as a habitat for nesting.

**Table 7-7 Number of large specimens recorded in the Study Area**

| Habit | Origin | Species | No. Of Specimens |
|---|---|---|---|
| Tree | Exotic | *Artocarpus altilis* | 1 |
| | | *Khaya senegalensis* | 37 |
| | | *Pterocarpus indicus* | 3 |
| | | *Samanea saman* | 39 |
| | | *Tabebuia rosea* | 7 |
| Strangler | Cryptogenic | *Ficus benjamina* | 2 |
| | Native | *Ficus microcarpa* | 2 |
| **Total** | | | **91** |




**Figure 7-12 Large specimens with epiphytes found growing on raintree (*Samanea saman)* in the Study Area. (A) *Syngonium podophyllum*; (B) *Epipremnum pinnatum*; (C) Bird's nest fern (*Asplenium nidus*)**




**Legend**

- CCK N1 Study Area
- Rail Corridor
- Managed vegetation (Planted trees)
- Managed vegetation (Turf)
- Others (Infrastructure)
- Canal/Drain (Perennial)
- Drain (Ephemeral)

Large Plant Specimens

- Strangler
- Tree

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Consultant : AECOM

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Project Title :

**ENVIRONMENTAL IMPACT ASSESSMENT (EIA) ON CHOA CHU KANG N1**

Figure Title :

**Distribution of large plant specimens in the Study Area**

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### 7.4.2.5 Other Specimens of Value

A small cluster of *Bambusa* cf. *heterostachya* of spread 2.5 m was found on the eastern side in the Study Area (Figure 7-14). Although no bamboo bats were detected during the roost emergence surveys, this bamboo cluster could still be a potential roost site for the nationally Critically Endangered bamboo bats (*Tylonyecteris sp.*) and provide a diet and habitat for other fauna groups (Section 7.4.3.11).

Based on the criteria listed in Section 7.2.2.2.5, two *Ficus* species in the Study Area were considered as keystone species. A total of two (2) individuals of Malayan banyan (*Ficus microcarpa*) and weeping fig (*Ficus benjamina*), respectively were recorded during the tree mapping survey (Section 7.2.2.2.6). Both stranglers are monoecious (i.e., species that bear both male and female reproductive organs within the same individuals). This characteristic allows fruits to be produced throughout the year, thus providing an important food source for frugivores in the community, especially when no other fruits are available during the time of the year [P-58; P-59]. These keystone species could also possibly encourage the recruitment and population growth of native frugivores in the Study Area [P-29]. The distribution of other plant specimens of value is reflected in Figure 7-15 (Appendix G).



**Figure 7-14 Bamboo cluster (*Bambusa cf. heterostachya*) recorded in the Study Area.**




**Legend**

- CCK N1 Study Area
- Rail Corridor
- Managed vegetation (Planted trees)
- Managed vegetation (Turf)
- Others (Infrastructure)
- Canal/Drain (Perennial)
- Drain (Ephemeral)

Other Plant Specimens of Value

- Bamboo
- Keystone species

N

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**ENVIRONMENTAL IMPACT ASSESSMENT (EIA) ON CHOA CHU KANG N1**

Figure Title :

**Distribution of other plant specimens of value in the Study Area**

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### 7.4.2.6 Tree Mapping Findings

In total, 397 tree specimens of ⩾ 0.3 m girth belonging to 26 species and 15 families were tagged and recorded (Table 7-8; Figure 7-16; Appendix H). Majority are exotic species, of which, raintree (*Samanea saman)* and Senegal mahogany (*Khaya senegalensis*) collectively made up more than 50% of the tree specimens mapped in the Study Area, with a girth range of 0.9 m – 4.8 m and 0.9 m – 4 m respectively.

**Table 7-8 Number and percentage (%) of tree species mapped in the Study Area.**

| Species | Number of Species | Percentage % |
|---|---|---|
| *Artocarpus altilis* | 8 | 2.0 |
| *Artocarpus heterophyllus* | 9 | 2.3 |
| *Artocarpus integer* | 1 | 0.3 |
| *Averrhoa carambola* | 4 | 1.0 |
| *Baccaurea motleyana* | 1 | 0.3 |
| *Canarium odontophyllum* | 1 | 0.3 |
| *Chukrasia tabularis* | 1 | 0.3 |
| *Cinamomum iners* | 1 | 0.3 |
| *Dimocarpus longan subsp. malesianus* | 6 | 1.5 |
| *Durio zibethinus* | 9 | 2.3 |
| *Ficus benjamina* | 2 | 0.5 |
| *Ficus microcarpa* | 2 | 0.5 |
| *Hura crepitans* | 1 | 0.3 |
| *Khaya senegalensis* | 124 | 31.2 |
| *Mangifera indica* | 17 | 4.3 |
| *Mangifera odorata* | 2 | 0.5 |
| *Nephelium lappaceum* | 4 | 1.0 |
| *Peltophorum pterocarpum* | 1 | 0.3 |
| *Pterocarpus indicus* | 7 | 1.8 |
| *Samanea saman* | 140 | 35.3 |
| *Sandoricum koetjape* | 2 | 0.5 |
| *Schefflera actinophylla* | 1 | 0.3 |
| *Syzygium malaccense* | 1 | 0.3 |
| *Tabebuia rosea* | 33 | 8.3 |
| *Terminalia catappa* | 3 | 0.8 |
| *Terminalia mantaly* | 16 | 4.0 |
| Grand Total | **397** | **100.0** |




**Legend**

- CCK N1 Study Area
- Rail Corridor
- Managed vegetation (Planted trees)
- Managed vegetation (Turf)
- Others (Infrastructure)
- Canal/Drain (Perennial)
- Drain (Ephemeral)

Tree Mapping

- Cryptogenic
- Exotic
- Native

N

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**ENVIRONMENTAL IMPACT ASSESSMENT (EIA) ON CHOA CHU KANG N1**

Figure Title :

**Distribution of trees according to their origin recorded in Choa Chu Kang N1 Study Area**

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## 7.4.3 Faunistic Baseline Results

### 7.4.3.1 Overall

The field assessment recorded 78 species, with more than half of the assemblage dominated by birds (29 species) and butterflies (18 species) (Table 7-9; Appendix I). No species of conservation significance were recorded. However, records of uncommon to moderately rare fauna were recorded and elaborated in the sections below. Five migratory bird species were also recorded, which mainly comprised common migrants, although one rare migrant was also recorded. This is discussed in greater detail in Section 7.4.3.9. Their presence shows the value of the Study Area in supporting uncommon species and migratory birds, some of which may have dispersed through the adjacent Rail Corridor.

Within the Study Area, areas with spontaneous vegetation along the Rail Corridor and clusters of trees in the southern part appear to provide denser canopy cover and hence, a more conducive microclimate allowing for fauna. The entire Study Area serves as a stepping stone for wildlife to travel to the surrounding green spaces and contribute to the ecological connectivity along the Rail Corridor in the area. The significance of the Study Area as a stepping stone for species moving along the Rail Corridor to surrounding green spaces is discussed in Section 7.4.4.

The watercourses within the Study Area are characterised by concretised canals, which are poor in aquatic life although fauna such as the ardeids (herons and egrets), monitor lizard (*Varanus salvator*), and smooth-coated otter (*Lutrogale perspicillata*) can use the canals as a corridor to move between habitats in the surrounding. This is also discussed in the sections below.

The full list of recorded faunal species, faunal survey data and camera trap data is available in Appendix I, Appendix J, and Appendix K, respectively.

**Table 7-9 Summary of recorded faunal species and species of conservation significance**

| Faunal Group | No. of Recorded Faunal Species | |
|---|---|---|
| | All Species | Species of Conservation Significance |
| **Odonates** | **6** | **0** |
| Dragonflies | 5 | 0 |
| Damselflies | 1 | 0 |
| **Aculeate hymenopterans** | **2** | **0** |
| Bees | 1 | 0 |
| Stinging wasps | 1 | 0 |
| **Butterflies** | **18** | **0** |
| **Freshwater fish** | **4** | **0** |
| **Herpetofauna** | **14** | **0** |
| Amphibians | 5 | 0 |
| Reptiles | 9 | 0 |
| **Birds** | **29** | **0** |
| **Mammals** | **5** | **0** |
| Non-volant mammals | 3 | 0 |
| Bats | 2 | 0 |
| **Total** | **78** | **0** |

The faunal surveys by Guttensohn & Leong (2021) [P-2] recorded 64 species, which comprised four odonates, seven butterflies, four amphibians, four reptiles, 41 birds and four non-volant mammals. No data on aculeate hymenopterans and bats were available. Seven species of migratory birds were recorded by Guttensohn & Leong (2021) [P-2], of which, three species, the Asian brown flycatcher (*Muscicapa dauurica*), crested honey-buzzard (*Pernis ptilorhynchus*), and little egret (*Egretta garzetta*), were recorded in this study.

Guttensohn & Leong (2021) [P-2] recorded five species of conservation significance, including three birds and two mammals. These were the changeable hawk-eagle (*Nisaetus cirrhatus*), red junglefowl (*Gallus gallus*), spotted

wood owl (*Strix seloputo*), long-tailed macaque (*Macaca fascicularis*) and smooth-coated otter (*Lutrogale perspicillata*). These species were not recorded in this study.

### 7.4.3.2 Taxon Sampling Curve

Along the terrestrial sampling route, the sample coverage for the faunal groups was above 80% with the exception of aculeate hymenopterans and butterflies at 66.7% and 60.4% respectively (Table 7-10; Figure 7-17). At the aquatic sampling points, the sample coverage for amphibian and fish were at 81.0% and 77.8% respectively (Table 7-10; Figure 7-18). Species with too few data points were removed from the analysis.

**Table 7-10 Result summary of taxon sampling analysis**

| Faunal group | Sample coverage (%) | Observed richness | Estimated richness (± s.e) |
|---|---|---|---|
| **Terrestrial sampling route** | | | |
| Odonates | 60.4 | 9 | 29.4 ± 7.6 |
| Aculeate hymenopterans | 66.7 | 2 | 2.5 ± 1.1 |
| Butterflies | 87.3 | 20 | 24.1 ± 4.1 |
| Reptiles | 97.3 | 6 | 6.1 ± 0.5 |
| Birds | 85.3 | 21 | 23.4 ± 19.0 |
| **Aquatic sampling points** | | | |
| Amphibian | 81.0 | 3 | 3.8 ± 1.7 |
| Fish | 77.8 | 2 | 5.4 ± 3.5 |

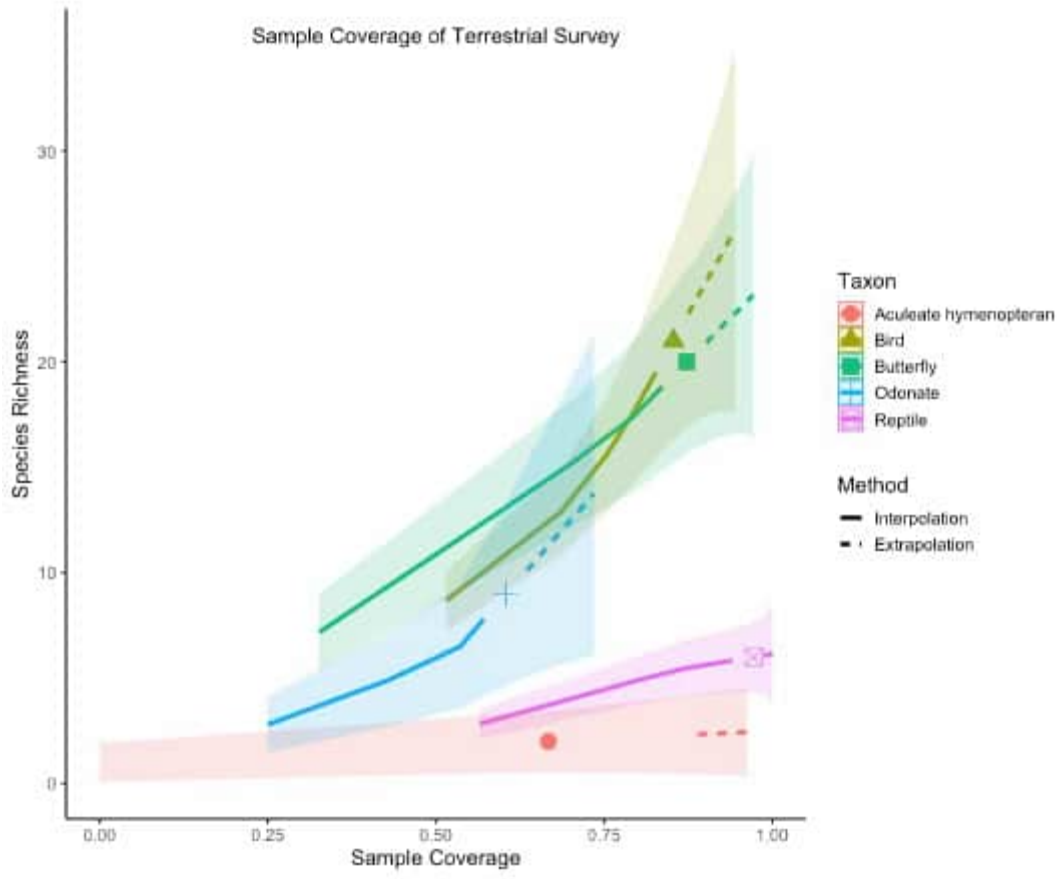



**Figure 7-17 Taxon sampling curve for terrestrial sampling route**

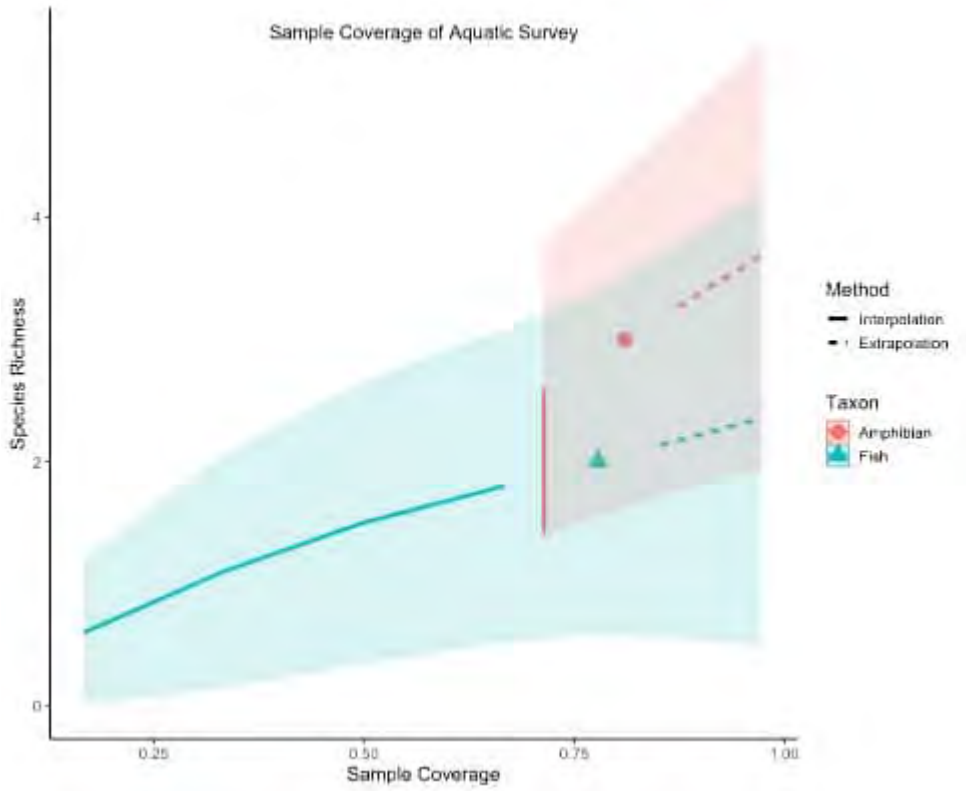



**Figure 7-18 Taxon sampling curves for aquatic sampling points**

### 7.4.3.3 Odonates

The field assessment recorded six species of odonates, none of which are of conservation significance. Five of these species are widespread and common, and frequently found in parks and gardens, as well as disturbed open habitats like canals. The remaining species were the dingy duskhawker (*Gynacantha subinterrupta*; Figure 7-19), which was an unexpected finding due to its preference for forested areas. One individual was observed within a small cluster of trees (Figure 7-20). It is a widespread but uncommon dragonfly that tends to hide within forest undergrowth during the day, emerging at dawn and dusk to forage for food [W-4]. Locations of past sightings include Bukit Timah Nature Reserve, Dairy Farm Nature Park, Upper Peirce Reservoir, and around Mandai [W-4]. Its presence may have been facilitated by the connectivity of the Study Area to the surrounding green patches or adjacent forested areas along the Rail Corridor.



**Figure 7-19 Dingy Duskhawker (*Gynacantha subinterrupta*) recorded at the Study Area**




**Legend**

- CCK N1 Study Area
- Rail Corridor
- Managed vegetation (Planted trees)
- Managed vegetation (Turf)
- Others (Infrastructure)
- Canal/Drain (Perennial)
- Drain (Ephemeral)
- Terrestrial Sampling Route
- Aquatic Sampling Point
- Gynacantha subinterrupta

N

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**ENVIRONMENTAL IMPACT ASSESSMENT (EIA) ON CHOA CHU KANG N1**

Figure Title :

**Location of uncommon odonate species**

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### 7.4.3.4 Aculeate Hymenopterans

Two species were recorded during the field assessment – the Andrew's blue-banded digger bee (*Amegilla andrewsi*) and lesser banded hornet (*Vespa affinis*). These two species are native and commonly found in urban parks and gardens.

### 7.4.3.5 Butterflies

The field assessment recorded 18 butterfly species. Most are common or moderately common, typically found in parks, gardens, and urban areas such as the great eggfly (*Hypolimnas bolina bolina*), chestnut bob (*Iambrix salsala salsala*) and autumn leaf (*Doleschallia bisaltide bisaltide*) (Figure 7-21B–D). However, two moderately rare species, the common evening brown (*Melanitis leda leda*) and common redeye (*Matapa aria*; Figure 7-21A), were recorded. The sightings were distributed across the Study Area. The common evening brown (*Melanitis leda leda*) is usually seen at grasslands, thickets, or among dense vegetation [W-10]. Although its host plant, the guinea grass (*Megathyrsus maximus*) was not present in the Study Area, the butterfly was observed twice in the southern part of the Study Area (Figure 7-22). Thus, its arrival may have been aided by the connectivity of the Study Area from adjacent grasslands. On the other hand, host plants of the common redeye (*Matapa aria*) are bamboos (*Bambusa* species), hence it is typically sighted in a variety of habitats where bamboo clusters are present, from urban parks, wastelands, to nature reserves [W-11]. It was observed at two locations in the Study Area (Figure 7-22) and may be due to the presence of one bamboo cluster in the central part of the Study Area.




**Figure 7-21 Butterflies recorded at the Study Area. (A) Common Redeye (*Matapa aria*); (B) Great Eggfly (*Hypolimnas bolina bolina*); (C) Chestnut Bob (*Iambrix salsala salsala*); (D) Autumn Leaf (*Doleschallia bisaltide bisaltide*)**




**Legend**

- CCK N1 Study Area
- Rail Corridor
- Managed vegetation (Planted trees)
- Managed vegetation (Turf)
- Others (Infrastructure)
- Canal/Drain (Perennial)
- Drain (Ephemeral)
- Terrestrial Sampling Route
- Matapa aria
- Melanitis leda leda

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**ENVIRONMENTAL IMPACT ASSESSMENT (EIA) ON CHOA CHU KANG N1**

Figure Title :

**Location of moderately rare butterfly species**

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### 7.4.3.6 Freshwater Fish

Four freshwater fish species were recorded during the field assessment. All were non-native species. This includes the guppy (*Poecilia reticulata*), bumblebee tilapia (*Heterotilapia buttikoferi*) and Malayan tiger barb (*Puntigrus partipentazona*). The last species is a goby (*Rhinogobius sp.*) that was not identified to species level.

### 7.4.3.7 Amphibians

The field assessment recorded five species, comprising three native and two non-native species. The species are the greenhouse frog (*Eleutherodactylus planirostris*), banded bull frog (*Kaloula pulchra*), painted chorus frog (*Microhyla butleri*), and Asian toad (*Duttaphrynus melanostictus*). All four are widespread and common urban species, typically found in both terrestrial and aquatic habitats. They were observed within the woodland as well as the canal (D1).

Guttensohn & Leong (2021) also documented the presence of the globally Near Threatened Malayan giant frog (*Limnonectes blythii*) within the Study Area [P-2]. This species is typically observed in a forested environment [W-12].

### 7.4.3.8 Reptiles

Nine species, comprising five lizards, three snakes and one turtle, were recorded during field assessment. None of the recorded species are of conservation significance. They are widespread and common and are typically found in urban or parkland habitats in Singapore. Species recorded include the changeable lizard (*Calotes versicolor*), painted bronzeback (*Dendrelaphis pictus;* Figure 7-23) and brahminy blind snake (*Indotyphlops braminus*).

While the reticulated python (*Malayopython reticulatus*) and Malayan water monitor (*Varanus salvator*) were not recorded, they may use the canal to travel to or from the Study Area. Guttensohn & Leong (2021) also recorded the clouded monitor (*Varanus nebulosus*) from the Study Area. It is a common native species that is restricted in distribution [P-8]. It is known to inhabit mature forests and adjacent parkland [W-12].



**Figure 7-23 Painted Bronzeback (*Dendrelaphis pictus*) recorded at the Study Area**

### 7.4.3.9 Birds

Twenty-nine species were recorded during field assessment, including 23 residents (four were introduced) and five winter visitor species. Most of the recorded species are common. No species of conservation significance were recorded.

Five migratory bird species were recorded – little egret (*Egretta garzetta*), arctic warbler (*Phylloscopus borealis*), Indian cuckoo (*Cuculus micropterus*), brown shrike (*Lanius cristatus*), and yellow-crowed warbler (*Phylloscopus inornatus*). Four of these species were not recorded by Guttensohn & Leong (2021) [P-2]. The yellow-browed warbler is a rare migrant and was recorded in the central part of the Study Area in this study (Figure 7-25). It is usually found in forest habitats and sometimes seen in parklands [P-60]. These species may have travelled from the surrounding green spaces to the Study Area, suggesting the value of the Study Area in providing habitats for migratory species. The little egret (Figure 7-24) was seen in the canal in the western edge, suggesting that the canal may function as a corridor for egrets and terrestrial bird species that utilise open spaces.

A checklist of bird species compiled in 2020 that was reflected in Guttensohn and Leong (2021) also recorded forest-associated species such as the dark-necked tailorbird (*Orthotomus atrogularis*) and rufous-tailed tailorbird (*Orthotomus sericeus*), as well as three species of conservation significance: the nationally Endangered red junglefowl (*Gallus gallus*), changeable hawk-eagle (*Nisaetus cirrhatus*) and the Nationally Critically Endangered spotted wood owl (*Strix seloputo*). These species were not recorded during the study but were expected to be present based on past records by NSS [P-2].

Notably, the globally Critically Endangered and nationally Endangered straw-headed bulbul (*Pycnonotus zeylanicus*) may also utilise the Study Area as an ecological corridor to travel between surrounding forested areas. It has been recorded in green spaces and forest patches adjacent to the Study Area, including Bukit Mandai Forest, Bukit Batok Nature Park, and Toh Tuck Forest [P-61; P-62]. Highly coveted for its melodious songs, the songbird trade has resulted in its extirpation throughout much of its range [P-61]. Fortunately, the population in Singapore is estimated to make up one-third of the global population [P-61]. This species requires wooded corridors to move between habitats [P-63; P-64]. The Study Area has the potential in serving as a stepping stone for both species of conservation significance and forest species to move to other surrounding green spaces.



**Figure 7-24 Little Egret (*Egretta garzetta*) recorded in canal (D1) at the Study Area**




**Legend**

- CCK N1 Study Area
- Rail Corridor
- Managed vegetation (Planted trees)
- Managed vegetation (Turf)
- Others (Infrastructure)
- Canal/Drain (Perennial)
- Drain (Ephemeral)
- Terrestrial Sampling Route
- Aquatic Sampling Point
- Phylloscopus inornatus

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**ENVIRONMENTAL IMPACT ASSESSMENT (EIA) ON CHOA CHU KANG N1**

Figure Title :

**Location of bird species of conservation significance and rare bird species**

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### 7.4.3.10 Mammals (Non-Volant)

The field assessment recorded four non-volant mammal species, namely the plantain squirrel (*Callosciurus notatus*), oriental house rat (*Rattus tanezumi*), common palm civet (*Paradoxurus musangus*), and feral dog (*Canis lupus familiaris*). The camera traps yielded 121 independent detections over 227 trap-nights (Table 7-11). Independent detections were not calculated for rodents, squirrels, and shrews that were unidentifiable to species level.

The plantain squirrel and common palm civet are considered widespread and common. It is a very common species that can be found in urban and parkland habitats. One individual of plantain squirrel was observed carrying nesting material, such as twigs, suggesting that the Study Area is possibly utilised by this species for nesting and breeding.

Nine independent detections were obtained for the common palm civet on three camera traps (CT01, CT03 and CT04; Table 7-12) within the Study Area.

While not recorded during field assessment, three species of conservation significance had been recorded in surrounding green spaces and may occur in the Study Area as reported in Guttensohn & Leong (2021) [P-8]. This includes the long-tailed macaque (*Macaca fascicularis*), smooth-coated otter (*Lutrogale perspicillata*), and Sunda pangolin (*Manis javanica*). The nationally widespread and common long-tailed macaque (*Macaca fascicularis*) is often observed in parkland and forest habitats, and was recently uplisted as a globally Vulnerable species due to human persecution across the rest of Southeast Asia [W-14].

The globally Vulnerable and nationally Endangered smooth-coated otter (*Lutrogale perspicillata*) has been observed using the nearby Pang Sua pond [W-6], as well as the northern part of Pang Sua canal (near Choa Chu Kang Crescent) in groups of up to six [P-2]. According to OtterWatch, a group that shares significant news of otters in Singapore, the otters sighted may have been the Pang Sua family that was first sighted in the Pang Sua estate back in 2017 [W-13]. The family has been observed to venture between Kranji Reservoir and the Pang Sua pond via Pang Sua canal [W-13], demonstrating the value of the Study Area, specifically Pang Sua Canal, in providing connectivity between disparate aquatic habitats.

Similarly, recent sightings of the globally and nationally Critically Endangered Sunda pangolin (*Manis javanica*) have been made in adjacent areas, such as in the canal south of the Study Area [P-2]. It is usually observed in nature reserves and degraded forest fragments of Singapore [P-65]. In a journal paper titled “The Sunda pangolin in Singapore- a multi-stakeholder approach to research and conservation” by Nash et al., (2020), an unpublished data by ACRES shows that this species has also been seen in public areas as some individuals, especially sub-adult males, disperse in search of a home range [P-50]. Notably, Singapore is a global stronghold for this species and is crucial in contributing to the global conservation of pangolins due to the lack of local poaching pressures, unlike in other countries where it ranges [P-50; P-58]. However, the viability of the local population is still threatened by habitat loss, degradation and fragmentation, and road-related mortality [P-58]. Increasing sustainability and connectivity between habitats is considered a key measure for the conservation of this species [P-58]. Therefore, the Study Area may provide connectivity for this species to safely travel between fragmented habitats. Other mitigating measures, such as wildlife culverts and overpass, can be implemented to help reduce road-related mortality, and contribute to the overall conservation of this species.

**Table 7-11 Summary of trap-nights and number of independent detections of mammal species at each camera trap**

| Station | No. of trap-nights | No. of species | Detection rate of mammal species |
|---|---|---|---|
| **CT01** | 72 | 3 | 0.82 |
| **CT02** | 47 | 1 | 0.04 |
| **CT03** | 36 | 3 | 1.03 |
| **CT04** | 72 | 3 | 0.31 |

**Table 7-12 Location of and number of independent detections of mammal species across all camera traps**

| Scientific name | Common name | Station | No. of independent detections |
|---|---|---|---|
| *Callosciurus notatus* | Plantain squirrel | All stations (CT01–CT04) | 83 |
| *Canis lupus familiaris* | Feral dog | CT01, CT03 and CT04 | 28 |
| *Paradoxurus musangus* | Common palm civet | CT01, CT03 and CT04 | 9 |
| *Rattus tanezumi* | Oriental house rat | CT03 | 1 |
| *Rattus* sp. | Rat | CT03 | N.A* |
| N/ A | Unidentified squirrel or treeshrew | CT01, CT03 and CT04 | N.A* |

*Independent detection cannot be calculated since it was not identified to species level

### 7.4.3.11 Mammals (Bats)

Two bat species were recorded acoustically during field assessment: the whiskered myotis (*Myotis muricola*) and the Asiatic lesser yellow house bat (*Scotophilus kuhlii*) (Figure 7-26). Both species are widespread and common, and not of conservation significance.

Based on the presence of a bamboo cluster in the central part of the Study Area, two species of bamboo bats, the – the nationally Critically Endangered lesser bamboo bat (*Tylonycteris malayana*) which is restricted and rare, and the greater bamboo bat (*Tylonycteris malayana*) which is widespread but common, were considered of probable occurrence. Both species are known to roost in bamboo internodes and are especially susceptible to injury or mortality if their roosts are removed or damaged during development, hence they are regarded as species of conservation significance. While no bamboo bats (*Tylonycteris* species) were recorded from the bamboo during roost emergence surveys, they remain as a potential habitat for these species.

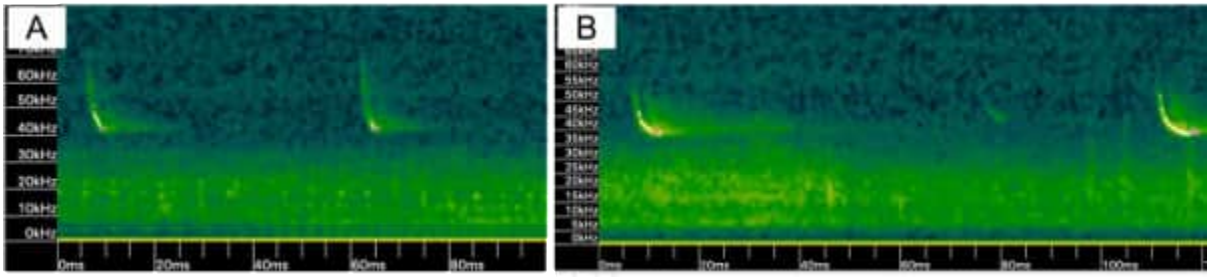
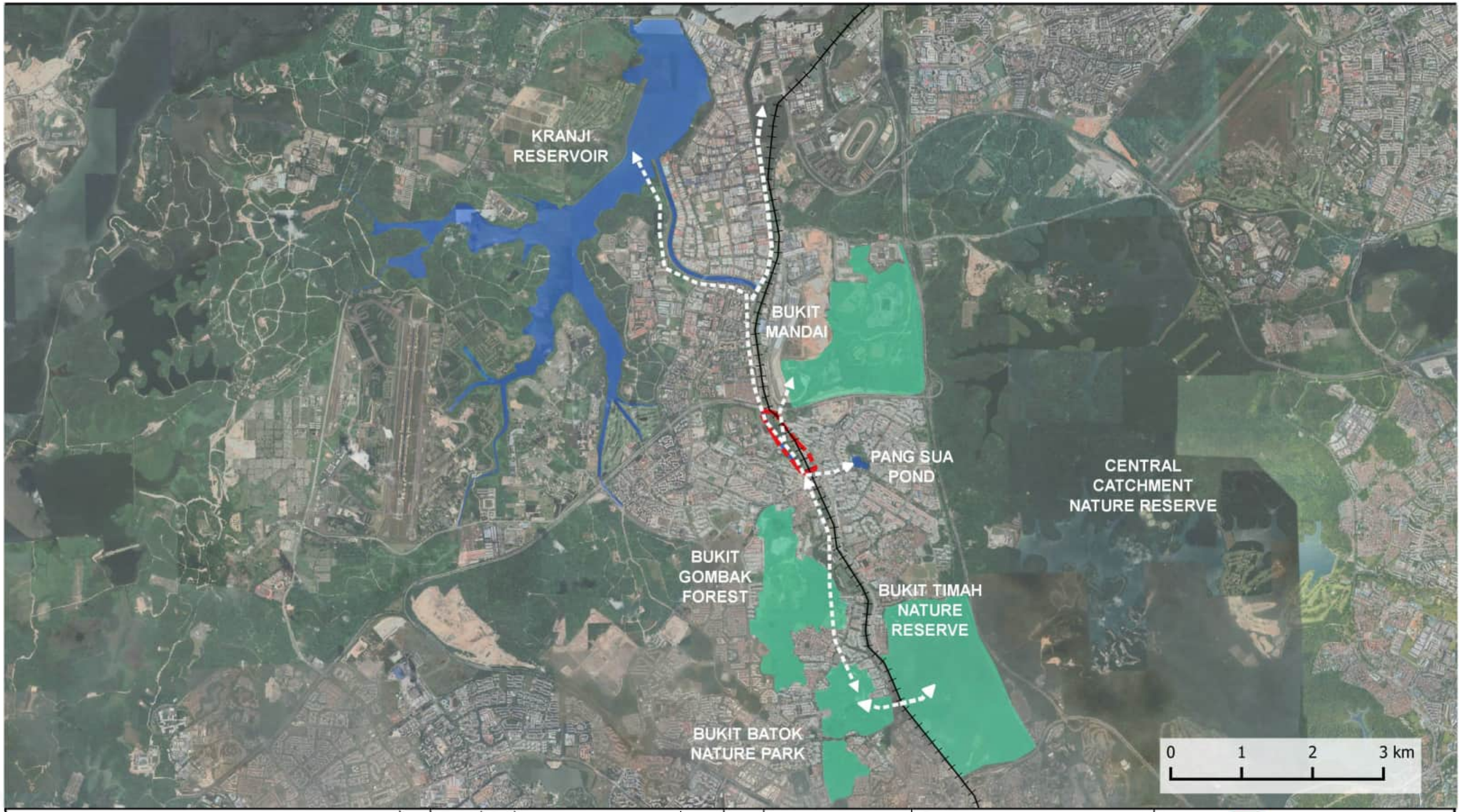



**Figure 7-26 Spectrogram of (A) Asiatic yellow house bat (*Saccolaimus saccolaimus*) and (B) Whiskered myotis (*Myotis muricola*)**

## 7.4.4 Ecological Significance and Connectivity

The 21.7 ha Study Area, Choa Chu Kang N1, is also known as the Sungei Pang Sua Woodland [P-2; P-3]. It is “an important part of the Green Rail Corridor between Hill View in the south and Stagmont Ring in the north, as it is the only wooded area in-between” [P-3]. The Study Area is also considered as “a conducive stepping stone” [P-2] (i.e., habitat patches in a landscape that facilitates movement of species between other forested patches [P-11]) and “a conduit for wildlife dispersal or movement” [P-2] that could facilitate the dispersal of fauna to the surrounding green spaces, such as Bukit Mandai forest to the northeast and Bukit Gombak forest to the south (Figure 7-27), and to other larger fragmented habitats, including Bukit Timah Nature Reserve (BTNR) in the southeast, and Mandai Mangrove and Mudflats in the north [P-2], hence, enhancing the ecological connectivity across the landscape.




**Legend**

- CCK N1 Study Area
- Rail Corridor
- Green space
- Waterbody

N

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Qualified Person Endorsement : NA

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Consultant : AECOM

HOUSING & DEVELOPMENT BOARD

Project Title :

**ENVIRONMENTAL IMPACT ASSESSMENT (EIA) ON CHOA CHU KANG N1**

Figure Title :

**Site context and potential connectivity between Study Area green patches in proximity**

| Designed | Checked | Approved | Figure No. : | Rev. | Sheet |
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Large tree specimens recorded within Study Area contribute to a myriad of ecological roles, such as regulating microclimates of the vegetated area and the surrounding environment [P-66], as well as providing shade and microhabitats for faunal communities using the Study Area. Species of conservation significance, such as the nationally Endangered red jungle fowl (*Gallus gallus*) and the nationally Critically Endangered spotted wood owl (*Strix seloputo*) have been observed by Guttensohn & Leong (2021) in the Study Area [P-2]. Forest-associated species such as the dingy duskhawker (*Gynacantha subinterrupta*) and dark-necked tailorbird (*Orthotomus atrogularis*) [P-2], as well as migratory species such as the rare yellow-browed warbler (*Phylloscopus inornatus*) were also observed in this study.

Species residing in adjacent areas, particularly volant species can use the Study Area as a stepping stone to disperse to surrounding green spaces. An example is the globally Critically Endangered straw-headed bulbul (*Pycnonotus zeylanicus*) that was recorded at the adjacent Bukit Mandai Forest, BBNP, and Toh Tuck Forest [P-61; P-62]. Species adapted to using canals can also use the canal to move through the Study Area. Some examples are the globally Vulnerable and nationally Endangered smooth-coated otter (*Lutrogale perspicillata*), as well as the globally Critically Endangered Sunda pangolin (*Manis javanica*) that have been observed to move within the canal in the vicinity of the Study Area based on the desktop assessment (Section 7.4.3.10). The presence of species of conservation significance, forest-associated species, and migrants demonstrates the value of the Study Area as a stepping stone in enhancing ecological connectivity across the landscape.

### 7.4.5 Assessment of Ecological Value

Habitats and species within the Project site were assessed for their ecological value based on the criteria described in Table 7-13 (i.e., habitats) and Table 7-14 (i.e., plant species), and write up below (i.e., for fauna species) [R-47; R-10]. Those of high ecological value were assigned the Priority 1 sensitivity level, while those of moderate or low ecological value were assigned the Priority 2 or 3 sensitivity levels, respectively.

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

**Table 7-13 Criteria for assessing the ecological value of habitats**

| Criterion | Definition | Classification | | |
|---|---|---|---|---|
| | | High | Medium | Low |
| **Size** | Area occupied by the habitat relative to the Project site or length of a stream | ≥ 40% | 10–40% | ≤ 10% |
| **Naturalness** | Degree to which the habitat has been modified or disturbed as a result of human activities | Habitat with minimal human disturbance | Moderately disturbed habitat that has been modified to some extent | Highly disturbed habitat that has been modified to a large extent |
| **Abundance of species of conservation significance** | Number of plant specimens and recorded within the habitat relative to the Project site; number of recorded faunal species of conservation significance that are known to utilise the habitat relative to the Project site | ≥ 40% | 10–40% | ≤ 10% |
| **Abundance of large and other plant specimens of value** | Number of large and other plant specimens of value recorded within the habitat relative to the Project site | ≥ 40% | 10–40% | ≤ 10% |
| **Ecological linkage** | Connectedness to a highly valued habitat | Highly connected | Moderately connected | Unconnected/ isolated |
| **Recreatability** | Level of difficulty in re-constructing the habitat through human intervention | Very difficult | Moderately difficult | Easy |

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

- Priority 1: Species of conservation significance;
- Priority 2: All other native species; and
- Priority 3: Exotic and cryptogenic species

For species that were tentatively assigned Priority 2 (i.e. all other native species) or Priority 3 (i.e. exotic and cryptogenic species) ecological value were then evaluated individually based on the criteria listed in Table 7-14. The evaluation of individual species served to either maintain or raise the pre-assigned ecological value. The following paragraphs detail how each criterion was considered in the evaluation.

**Association with important fauna (native, exotic, and cryptogenic species):** The ecological value of plant species that directly support the growth and survival of important fauna at one or various life cycle stages was raised to high, irrespective of plant species origin, cultivation intensity and effects, as well as national distribution. Examples of such plant species include caterpillar host plants for rare butterfly species and bamboos that are refugia for nationally threatened bamboo bats. The ecological value of plant species without associations with important fauna was maintained at the original level, i.e. medium or low.

**Cultivation intensity and effects (native species only):** The ecological value of all native species previously or presently cultivated and/ or with populations of relics or escapees, respectively, present in the secondary forests of

Singapore were maintained at the medium level. Otherwise, those that are associated with important fauna were raised to high ecological value.

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

There are, however, a few exceptions in which the highest ecological value was automatically assigned to species regardless of the criteria listed below. They are (1) species endemic to Singapore; and (2) keystone fig (*Ficus* sp.) as they fruit all year round and provide a steady source of food for frugivores [P-29]; and (3) species planted for reforestation and/ or previously thought to be extinct and which are planted for species reintroduction.

**Table 7-14 Criteria for assessing the ecological value of plant species**

| Criterion | Definition |
|---|---|
| **Conservation Significance** | Listed as nationally threatened, i.e., Vulnerable, Endangered, Critically Endangered, or Extinct, and are considered of conservation significance in this study. |
| **Cultivation Intensity and Effects** | Cultivated previously or presently—for various purposes such as reforestation, landscaping, species reintroduction, commercial sale, etc.—and populations of relics and/ or escapees are present/ absent in forests. |
| **National Distribution** | Extent of spread and/ or occurrence at one or multiple forest patches in Singapore. |
| **Association with Important Fauna** | Directly associated with the survival of important fauna at one or various life cycle stages. |

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

- Priority 1: Species of conservation significance;
- Priority 2: All other native, migratory bird and indeterminate species; and
- Priority 3: Exotic species.

#### 7.4.5.1 Habitats

For the purposes of this EIA, the ecological value was assessed for the two (2) terrestrial habitats present within the Project site (Figure 7-28).

Only the managed vegetation comprising the planted trees is assessed with high ecological value (Priority 1) while the managed turf area is assessed with a medium ecological value (Priority 2). A summary of the assessment of each habitat is shown in Table 7-15.

0 50 100 150 m

**Legend**

- CCK N1 Project Site
- Managed vegetation (Planted trees)
- Managed vegetation (Turf)

N

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

HDB Endorsement: NA

Consultant : AECOM

HOUSING & DEVELOPMENT BOARD

Project Title :

**ENVIRONMENTAL IMPACT ASSESSMENT (EIA) ON CHOA CHU KANG N1**

Figure Title :

**Habitat types within the Project Site**

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**I. Managed Vegetation (Planted Trees) (High Ecological Value; Priority 1)**

This habitat type is mainly concentrated in the western stretch of the Project site. It occupies 8.93 ha (54.99%) of the Project site, which is the largest of all habitat types. Although it is dominated by exotics, it houses the highest abundance of large plant specimens (i.e., 82 specimens out of 91 specimens) and other specimens of value (i.e., 4 fig stranglers and 1 bamboo cluster). The majority of these large specimens are Senegal mahogany (*Khaya senegalensis*) and raintree (*Samanea saman*). The ecological functions of these large specimens are beneficial to numerous fauna species as this habitat type is the "only wooded area in-between Hillview in the south and Stagmont Ring in the north" [P-3]. Hence, these tree specimens are able to provide shade and a refuge area for the fauna species that are either travelling up north or south of the Study Area through the existing Rail Corridor or provide as habitats for fauna species that are currently living in the Study Area. In particular, the large specimens of raintree also create a biome of microhabitats within the Study Area and support numerous climber species, such as *Epipremnum pinnatum, Syngonium podophyllum* and *Ficus punctata,* of which, it contributes to the overall biodiversity of the Study Area.

Four specimens of fig stranglers, mainly the Malayan banyan (*Ficus microcarpa;* two specimens) and weeping fig (*Ficus benjamina;* two specimens) are also recorded in this habitat type, of which, the spread of these stranglers range from 3.2 m - 8 m. These fig stranglers functions as a food source for numerous fauna species all year round and could possibly encourage the recruitment and population growth of native frugivores in the Study Area [P-29]. Finally, the presence of the only bamboo cluster, *Bambusa* cf *heterostachya*, function as a potential roost site for the nationally Critically Endangered bamboo bats (*Tylonyecteris sp.*) as well as providing a diet and habitat for other fauna groups.

The entire Study Area has a low count of species of conservation significance. In this habitat, only one flora species of conservation significance (also known as CS species), the nationally Vulnerable *Bridelia stipularis*, is present. This is also the only CS species that was recorded within the Study Area during the baseline study. As for the fauna CS species, it was reported that the previously nationally Endangered blue-crowned hanging-parrot (*Loriculus galgulus*) was recorded within this habitat type. However, the conservation status of this species has since then been revised to common and is not included for the evaluation of the ecological value of this habitat. Despite the low count of CS species, this habitat supports butterfly and odonate species that are moderately rare and uncommon, nationally, such as the common evening brown (*Melanitis leda leda*), common redeye (*Matapa aria*) and the dingy duskhawker (*Gynacantha subinterrupta*). All these species were also recorded in this habitat type during the baseline study. Numerous migratory birds were also recorded within this habitat type [P-2; Section 7.4.3.9] such as uncommon migrant, yellow-rumped flycatcher (*Phylloscopus inornatus*), which suggests the relatively high value of the Study Area in providing habitats for migratory species.

This habitat type is part of the Sungei Pang Sua Woodland which is connected to the Rail Corridor that runs north and south of the Study Area. The entire area is considered as "a conducive stepping stone" [P-3] (i.e., habitat patches in a landscape that facilitates movement of species between other forested patches [P-67])" and "a conduit for wildlife dispersal or movement" [P-2] that could facilitate the dispersal of fauna to the surrounding green spaces that are fragmented. This ecological linkage is known to be used by the globally and nationally Critically Endangered Sunda pangolin (*Manis javanica*). Although it was not recorded during the baseline study, records and sightings have been document in adjacent areas, such as in the canal south of the Study Area. Hence, the ecological connectivity of this habitat type is assessed as High.

**II. Managed Vegetation (Turf) (Medium Ecological Value; Priority 2)**

The turf area within the Project site occupies 31.65% (5.14 ha) of the Project site. It is mainly concentrated in the eastern half of the site. It is characterised by mostly turf and exotic weeds that are periodically trimmed. As the vegetation in this habitat is frequently maintained, it is considered a highly disturbed habitat. This was seen by the fact that no flora or fauna species of conservation significance were recorded nor were any large specimens or other specimens of value. Due to the characteristic of the habitat and high level of disturbance, it is also considered a habitat that is easy to recreate. However, despite the abovementioned information, the ecological linkage of this habitat is assessed as high as it is situated beside the area with planted trees and forms part of the existing Rail Corridor.

**Table 7-15 Habitat ecological assessment table for CCK N1**

| Criterion | Managed vegetation (Planted trees) | Managed vegetation (Turf) |
|---|---|---|
| **Size** | **High**:<br>54.99% (8.93 ha) | **Medium**:<br>31.65% (5.14 ha) |
| **Naturalness** | **Medium:**<br>Moderately disturbed habitat that has been modified to some extent | **Low:**<br>Highly disturbed habitat that has been modified to a large extent |
| **Abundance of species of conservation significance** | **Low:**<br>Flora: 100% (Only 1)<br>Fauna: 0% (NIL) | **Low:**<br>Flora: 0% (NIL)<br>Fauna: 0% (NIL) |
| **Abundance of large and other plant specimens of value** | **High:**<br>Large Specimens: 86<br>Bamboo: 1<br>Strangler(s): 4<br>Total: 94.8% | **Low:**<br>Large: 0<br>Bamboo: 0<br>Strangler: 0<br>Total: 0% |
| **Ecological linkage** | **High:**<br>Highly connected | **High:**<br>Highly connected |
| **Ease of recreatability** | **Low**:<br>Easy | **Low**:<br>Easy |
| **Total** | **High X3**<br>Medium X1<br>Low X2 | High X1<br>**Medium X1**<br>Low X4 |
| **Sensitivity** | **Priority 1** | **Priority 2** |

### 7.4.5.2 Flora

The ecological value of 119 plant species in the Project site was assessed. The list of species is in Appendix L.

Of the 119 species assessed for their ecological value at the Project site, 7 were assigned the value of Priority 1, 24 of Priority 2, and 88 of Priority 3. Altogether, 7 species had their ecological value raised after assessment, three from Priority 2 to Priority 1, three from Priority 3 to Priority 1, one from Priority 3 to Priority 2.

The nationally Vulnerable *Bridelia stipularis* found in the Project site was accorded the value of Priority 1 as it is not known to be locally cultivated and likely to be of native genetic stock.

Three common native species of figs (*Ficus heteropleura, F. microcarpa*, and *F. punctata*) were accorded an initial level of Priority 2, while two species of figs, including *F. benjamina* of cryptogenic origin and *F. elastica* of exotic origin, was originally accorded Priority 3. The ecological values of these five fig species were raised to Priority 1 as they are keystone species (refer to Section 7.4.2.5).

The ecological value of one bamboo species present was raised from Priority 3 to Priority 1. Albeit of exotic origin, *Bambusa* cf *heterostachya* is a potential habitat for bamboo bats that are known to reside within the bamboo internodes. Such bamboo clusters play an important role in the survival of these nationally threatened bat species. Although no bamboo bats were observed to reside in the bamboo cluster found in the Project site, retaining the bamboo cluster can benefit local bamboo bat populations that continually face the threat of habitat loss.

The exotic rain tree (*Samanea saman*) was accorded an initial ecological value of Priority 3. These large trees are known to act as a microhabitat that support a large abundance and diversity of epiphytes, which substantially contribute to overall biodiversity. Hence, the ecological value of *Samanea saman* was raised to Priority 2 after assessment.

### 7.4.5.3 Fauna

The ecological value of 73 terrestrial faunal species recorded from the baseline assessment were assessed. Freshwater fish are excluded from the assessment as the canal is not impacted. No species of conservation significance were recorded. For the remaining species, 59 species were assessed to be of Priority 2 sensitivity level, with medium ecological value, and 14 species with Priority 3 sensitivity level.

Eighteen species of conservation significance deemed of probable occurrence were also assessed to be of Priority 1 sensitivity level, with high ecological value. This list of species and its ecological value is presented in Appendix L.

## 7.4.6 Recommended Area of Conservation

The recommended area of conservation (RAC) is developed with reference to the proposed Ecological Corridor boundary developed with reference to EBS findings and recommendations, and consultations with agencies and Interest Groups. It is not taken to be final but subject to further changes based on detailed studies such as design, on-site conditions, arborist's assessment, etc.

Generally, the RAC aims to conserve a minimum of 2 haof the total Study Area (Figure 7-29). The ecological receptors that will be retained within this RAC includes 42.9% (3.83 ha) of the Priority 1 habitat (i.e., managed vegetation with planted trees), as mentioned in Section 7.4.5.1, of which, clusters of large raintrees (*S. saman*) that are generally located in the south and the centre portion of the Study Area will be retained alongside other large specimens of *Tabebuia rosea* and Senegal mahogany (*Khaya senegalensis*). Other Priority 1 flora receptors that are also proposed to be retained are three fig stranglers and the nationally Vulnerable climber, *Bridelia stipularis* (Section 7.4.5.2). 6.03% (0.31 ha) of the Priority 2 habitat type (i.e., turf area) will also be conserved. The retention of all plant receptors mentioned above is subjected to arborist's assessment of tree/ plant health.

The RAC will primarily function as an Ecological Corridor during the development and upon the establishment of residential area in CCK N1. Currently, the proposed width of this Ecological Corridor will range from approximately 20 m and up to 85 m in certain areas where more clusters of trees are proposed to be retained. This provides an average width of approximately 50 m in most areas of the ecological corridor which may satisfy the minimum width requirement to maintain faunal connectivity [P-68; W-15]. The width of the Ecological Corridor is subjected to further changes based on detailed studies such as design, on-site conditions, arborist's assessment etc.

By retaining this strip of linear greenery, this would provide a vegetated corridor for ground-dwelling fauna species to travel to other habitat patches located up north of the Study Area and/ or south towards Hillview and Bukit Timah Nature Reserve (BTNR) during the construction and operational phase of CCK N1. It is also to note that the RAC should also be accompanied with enhancement strategies and detailed design treatment to increase the ecological value of the corridor and to create smaller forms of habitat that could possibly cater for various fauna species and increase the effectiveness of an ecological corridor. This is elaborated further in Section 7.7.

The existing alignment of the Rail Corridor will also be retained and to be incorporated with the future residential estate (Figure 7-29). Generally, the Rail Corridor will be enhanced as corridor to facilitate pedestrian movement, with landscaping, heritage elements and community spaces such as playgrounds and fitness corner to enhance the character of the Rail Corridor.

.




**Legend**

- CCK N1 Project Site
- Recommended Area of Conservation (RAC)/ Ecological Corridor*
- Proposed Residential Area*
- Retained Rail Corridor Alignment*

*Exact boundaries/alignment subject to further changes

N

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HOUSING & DEVELOPMENT BOARD

Project Title :

**ENVIRONMENTAL IMPACT ASSESSMENT (EIA) ON CHOA CHU KANG N1**

Figure Title :

HDB's proposed land use plan in relation to the Recommended Area of Conservation / Ecological Corridor

| Designed | Checked | Approved | Figure No. | Rev. | Sheet |
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# 7.5 Identification of Biodiversity Sensitive Receptors

## 7.5.1 Habitats

Following the assessment of ecological value for habitats (Section 7.4.5.1), all habitats of high and medium ecological values (i.e., Priority 1 and Priority 2) within the worksite and within 30 m from the proposed worksite were identified as sensitive habitat receptors (Figure 7-30).

0 50 100 150 m

**Legend**

- CCK N1 Project Site
- Proposed Residential Area*
- Retained Rail Corridor Alignment*
- 30m Buffer

Habitat Receptors

- Managed Vegetation (Trees)
- Managed Vegetation (Turf)

Flora Receptors

- Bridelia stipularis
- Large Specimens
- Trees (< 3 m girth)

*Exact boundaries/alignment subject to further changes

N

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Project Title :

**ENVIRONMENTAL IMPACT ASSESSMENT (EIA) ON CHOA CHU KANG N1**

Figure Title :

Habitats and flora species receptors within 30 m from the proposed worksite

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### 7.5.2 Flora

Following the assessment of ecological value for all plant species (Section 7.4.5.2), some flora receptors were selected for the assessment of ecological impacts. The selection was based on the following: (1) species with specimens of conservation significance, of which, only one species was assessed (i.e., *Bridelia stipularis*), Priority 1 species that are large specimens, (2) species found inside and within 30 m from the proposed worksite area, (3) Priority 1 species that are large specimens, other specimens of value and/ or keystone species, and (4) species associated with important fauna, which includes *Bambusa* cf. *heterostachya*, in this study. A total of 19 species were included in the assessment (Appendix L).

### 7.5.3 Fauna

Following the assessment of ecological value of faunal species (Section 7.4.5.3), all species with a Priority 1 ecological value were identified as sensitive receptors. Species of conservation significance deemed of probable occurrence were also identified as sensitive receptors. No species of conservation significance were recorded from the field assessment. A total of 18 sensitive receptors, comprising species of probable occurrence, were assessed. This includes 11 birds, 3 non-volant mammals, 3 bats and 1 butterfly (Appendix L).

# 7.6 Minimum Control Measures

This section lists biodiversity-specific minimum control measures that are commonly implemented in Singapore for construction activities. These are assumed to be implemented for the purpose of the impact assessment and should be proposed in tandem with the measures proposed for other environmental receptors (e.g., hydrology, noise). Minimum controls for each potential impact occurring from the construction and operational phases are listed in Table 7-16. The main construction activities that would likely occur at all worksites include vegetation clearance and excavation, followed by below and above ground construction.

At the operational phase, the new residential estate will present new sources of disturbance (light and noise disturbance) to the surrounding habitats. However, minimum control measures will not be applicable during this phase. Mitigation measures in Section 7.7 would be more applicable and useful to help mitigate for impacts at the operational phase.

**Table 7-16 Minimum control measures for the construction and operational phase**

| Work activities | Minimum controls for construction phase |
|---|---|
| **Vegetation Clearance** | • Any trees that are to be retained within worksite would require an arborist to clearly mark out Tree Protection Zones where no works are allowed. The Tree Protection Zones should be set up in accordance with NParks guidelines; Before vegetation removal, pre-felling fauna inspection should be conducted by an Ecologist to identify wildlife or nesting structures that are being actively used such as bird nests, tree hollows, burrows, and bamboos clusters; to satisfy Section 10 Wildlife Act;<br>• Before vegetation removal, pre-felling fauna inspection should be conducted by an Ecologist to identify wildlife or nesting structures that are being actively used such as bird nests, tree hollows, burrows, and bamboos clusters; to satisfy Section 10 Wildlife Act; and<br>• Soil erosion control measures (e.g. implementation of erosion control blankets, ECM tanks etc) are to be executed once vegetation has been removed and soil is exposed as described in Section 8.6 under Water Resources. |
| **Excavation** | • Implement soil erosion control measures as described in Section 8.6 under Water Resources;<br>• Implement dust control measures as described in Section 9 under Air Quality; and<br>• Implement noise barrier as described in Section 10 under Airborne Noise. |
| **Below and Above Ground Construction** | Proper storage of materials that are likely to leech harmful chemicals and fuel-powered equipment away from waterbodies or sensitive habitats as described in Section 8 |
| **General** | • Installation of hoarding to delineate worksite;<br>• Execute wildlife response plan when a trapped/ injured/ dead/ dangerous animal is encountered around or within the worksite according to Section 10 of the Wildlife Act;<br>• Fogging is not recommended. To implement preventive measures against mosquito breeding by removing sources of stagnant water or water-bearing receptacles. E.g.,<br>  • Providing well-maintained pitched roof, clearing discarded items daily, store materials appropriately, level up ground depression/ uneven surfaces, ensure effective drainage flow; and<br>  • Daily checks by Environmental Control Officer on site. |
| **Work activities** | **Minimum controls for operational phase** |
| **General** | • Ensure noise levels are within approved limits (refer to Section 10 under Airborne Noise);<br>• Ensure dust levels are within approved limits (refer in Section 9 under Air Quality); and<br>• To implement preventive measures against mosquito breeding by removing sources of stagnant water or water-bearing receptacles e.g., Providing well-maintained pitched roof, clearing discarded items daily, store materials appropriately, level up ground depression/ uneven surfaces, ensure effective drainage flow. |

# 7.7 Prediction and Evaluation of Biodiversity Impacts

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

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

## 7.7.1 Construction Phase

The two assumptions made in defining the levels of impact intensity (Table 7-17) and likelihood (Table 7-18) for habitat receptors during the construction phase are:

1. Habitats within 30 m from the worksites are assumed to experience the greatest extent of edge effects, although some studies have shown that edge effects could be up to 150 m (refer to Section 7.3 for the definition of the impact zone).
2. The likelihood of habit degradation (i.e., improper disposal of construction waste, accidental release of hazardous materials [such as construction slurry, paint, and/ or solvents], increase in dust, noise, and light levels, changes in forest hydrology; refer to Table 7-3) is presumed to be **'Possible'** for all habitat receptors, based on the assumption that all minimum controls (Section 1.1) are adequately and properly implemented.
3. Other factors that will most likely cause habitat degradation (e.g., excessive water surface runoff during monsoon reasons, littering from construction staff, lack of general compliance by contractors) were also considered in this assumption.

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

| Impact Type | Negligible | Low | Medium | High |
|---|---|---|---|---|
| **Loss of vegetation** | The habitat does not overlap with the worksites | ≤ 10% of the habitat overlaps with the worksites | 10–40% of the habitat overlaps with the worksites | 40% of the habitat overlaps with the worksites |
| **Habitat degradation**<br>**Formation of forest edge** | The habitat does not overlap with areas 30 m from the worksites | ≤ 10% of the habitat overlaps with areas 30 m from the worksites | 10–40% of the habitat overlaps with areas 30 m from the worksites | 40% of the habitat overlaps with areas 30 m from the worksites |

**Table 7-18 Definitions of each level of likelihood for all three impact types during construction for habitat receptors**

| Likelihood | Loss of Vegetation | Habitat Degradation | Change in Species Composition |
|---|---|---|---|
| **Unlikely/ Remote** | The habitat does not overlap with the worksites | N.A. | No formation of forest edges (i.e., construction activities are fully underground and/or in existing built-up areas outside the forest) |
| **Less Likely/ Rare** | N.A. | N.A. | Formation of scrubland edges in scrubland areas only or,<br><br>Formation of some forest edges in a managed vegetation area with sparse vegetation |

| Likelihood | Loss of Vegetation | Habitat Degradation | Change in Species Composition |
|---|---|---|---|
| **Possible/ Occasional** | N.A. | N.A. (see assumption above) | Formation of some forest and scrubland edges in a mix of managed vegetation, scrubland and forested areas |
| **Likely/ Regular** | N.A. | N.A. | Formation of new forest edges (i.e., complete clearance within forested areas) |
| **Certain/ Continuous** | The habitat overlaps with the worksites | N.A. | N.A. |

The definitions for impact intensity and likelihood for plant species at construction phase are presented in Table 7-19 and Table 7-20, respectively. Assumptions made in defining the levels of impact intensity (Table 7-19) for plant species receptors during the construction phase:

1. Habitats within 30 m from the worksites are assumed to experience the greatest extent of edge effects, though some studies have shown that edge effects could be up to 150 m.

**Table 7-19 Definitions of each level of impact intensity for all four impact types during construction for plant species receptors**

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

**Table 7-20 Definitions of each level of likelihood for all four impact types during construction for plant species receptors**

| Likelihood | Mortality | Decline in plant health and survival |
|---|---|---|
| **Unlikely/ Remote** | No plant specimens of this species are within the worksites | No formation of forest edges (i.e., construction activities are fully underground and/ or in existing built-up areas outside the forest); plant specimens remain in their original forested habitats |
| **Less Likely/ Rare** | N.A. | N.A. |
| **Possible/ Occasional** | No count data and/ or locations of specimens of this species is available, but specimens could possibly be within the worksites | Formation of some forest edges in a mix of forested, scrubland and urban vegetation areas; plant specimens previously in forested areas now exposed to some edge habitat |

| Likelihood | Mortality | Decline in plant health and survival |
|---|---|---|
| **Likely/ Regular** | N.A. | Formation of new forest edges (i.e., complete clearance within forested areas); plant specimens previously in forested areas now fully exposed to edge habitats |
| **Almost Certain/ Continuous** | Plant specimens of this species are within the worksite | N.A. |

The definitions for impact intensity and likelihood for faunal species at construction phase are presented in Table 7-21 and Table 7-22, respectively.

**Table 7-21 Definitions of level of impact intensity for all six impact types during construction for faunal species receptors**

| Impact Type | Negligible | Low | Medium | High |
|---|---|---|---|---|
| **Loss of/ reduction in habitats and food sources** | No loss of original habitat, nests, or roosts | Loss of <10% of original habitat, nests, or roosts | Loss of 10–40% of original habitat, nests, or roosts | Loss of >40% of original habitat, nests, or roosts |
| **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:<br>– Volant species (e.g., odonates, butterflies, highly volant birds, raptors and most bats)<br>– 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:<br>– Less volant birds<br>– All amphibians<br>– Some mammals (e.g., squirrels, shrews) | Species with high susceptibility to accidental injury/ mortality from construction activities (large vehicles, excavation, piling, etc.) and roadkills:<br>– Reptiles<br>– Some mammals (e.g., Sunda pangolin, long-tailed macaque, smooth otter)<br>– Migratory birds<br>– Nesting birds<br>– Bamboo bats |
| **Human-wildlife conflict** | Species that are not perceived as nuisances or threats by construction personnel<br>• Odonates<br>• Butterflies<br>• Most birds<br>• Aquatic species | Species that are possibly perceived as both nuisances and threats by construction personnel, less tolerant of human presence and urban environments:<br>• Some reptiles<br>• Most amphibians<br>• 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:<br>• Smooth otter<br>• Aculeate hymenopterans | 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:<br>• Long-tailed macaque<br>• Some snakes |

| Impact Type | Negligible | Low | Medium | High |
|---|---|---|---|---|
| **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 disturbances** | Species that are not sensitive to changes in light levels: aculeate hymenopterans, most aquatic 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 |
| **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 7-22 Definitions of each level of likelihood for all six impact types during construction for faunal species receptors**

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

### 7.7.1.1 Habitats

In the assessment of the three types of impact for the identified sensitive habitat receptors during the construction phase— (1) loss of vegetation, (2) habitat degradation, and (3) formation of forest edge—the impact significance ranged from **Negligible** to **Major**. Only the most substantive impact for each impact type is presented. A summary of the key biodiversity habitat receptors impacted during construction phase is shown in Table 7-23. The detailed evaluation for each species is provided in Appendix L.

Loss of vegetation

**Major** impacts are expected to arise within both the habitat types assessed (managed vegetation with planted trees and turf area; Table 7-23). Approximately 57.1% (5.1 ha) and 94.4% (4.85 ha) of each habitat type will be cleared respectively for the proposed development. This led to their **High** impact intensity. The impact consequences for the former habitat which was assessed with high ecological value (Priority 1) is **High,** while the latter which was assessed with medium ecological value (Priority 2) was **Medium.** It is certain that both habitats will be faced with this impact type since vegetation clearance will happen for the development of the residential estate. Hence, the likelihood for this impact type was assessed as **Certain** and this resulted in the impact significance to be **Major.**

Habitat degradation

The impact significance for habitat degradation is **Moderate** for all habitats. The impact intensity for the managed vegetation with planted trees was assessed as **Medium** since approximately 3.24 ha (36.3%) is within 30 m of the worksite (Section 7.5.1; Figure 7-30). As for the turf area, only 0.26 ha (5.1%) of the habitat is within 30 m of the worksite since most of the habitat will be cleared. Therefore, the impact intensity is **Low**. Based on the assumption listed in Section 7.7.1, the likelihood for this habitat type is assessed as **Possible** and this resulted in the impact significance to be **Moderate.**

Formation of forest edge

A **Minor** impact is expected for the managed vegetation with planted trees due to the formation of forest edge. The impact intensity of this habitat type is assessed as **Medium** since 3.24 ha (36.3%) of the vegetation type will be within 30 m of the worksite. The likelihood of this occurrence is **Less likely** since the existing habitat now is not heavily vegetated as compared to a densely forested habitat and is located beside the turf area. Hence, it is assumed that this habitat type has already acclimatised to harsh climatic conditions (e.g., light, strong wind conditions, high temperature, humidity etc).

Development is expected to have a **Negligible** impact significance on the turf area as this habitat is relatively open and non-forested.

**Table 7-23 Key biodiversity habitat receptors likely to experience direct and indirect impacts within the Project site during construction phase**

| Habitat receptor | Priority level and other relevant status | Direct impact (% of total habitat type within study area) | Indirect impact (% of total habitat type within study area) | Most Severe Impact Significance and impact type |
|---|---|---|---|---|
| **Managed vegetation- Planted trees** | Priority 1 | 57.1% (5.10 ha) | 36.3% (3.24 ha) | **Major (loss of vegetation)** |
| **Managed vegetation- Turf** | Priority 2 | 94.4% (4.85 ha) | 5.1% (0.26 ha) | **Major (loss of vegetation)** |

### 7.7.1.2 Flora

In the assessment of the two types of impact for individual species during the construction phase – (1) mortality, (2) decline in plant health and survival – the impact significance was Minor, Moderate, or Major. Only the most severe impact for each species from the assessment of all two impact types is presented. A summary of the impact to flora receptors is provided in Table 7-24. The detailed evaluation for each species is provided in Appendix L.

A total of 19 sensitive flora species receptors recorded in the Project site were selected for the assessment of ecological impacts (Section 7.5.2). The significance of the impacts was assessed to be **Major** for four species, **Moderate** for three species, **Minor** for seven species, and **Negligible** for five species.

Mortality

Four species are likely to experience **Major** impacts owing to mortality. Of these four species, all specimens of *Bambusa* cf. *heterostachya*, which is a potential habitat for bamboo bats, and the native common *Cinnamomum iners* are expected to be removed from site as it is located within the development footprint, resulting in **High** impact intensity. The other two keystone species, *F. microcarpa* and *F. benjamina*, are expected to have exactly 50% (i.e., 1 out of 2 specimens respectively) of the specimens would be affected by vegetation clearance, resulting in an impact intensity of **Medium**. As it is **Certain** (likelihood) that all these specimens would be removed for construction activities, the resulting impact significance is therefore **Major**. After specimens have been affected by mortality due to site clearance, they are no longer considered in the subsequent impacts.

The three species that will experience **Moderate** impacts owing to mortality are exotic species *Averrhoa carambola* and *Hura crepitans*, and *Mangifera odorata*. All specimens of *Averrhoa carambola* and *Hura crepitans* lie within the worksite and are expected to be removed, resulting in an impact intensity of **High**. One out of two specimens (50%) of *Mangifera odorata* is expected to be affected by vegetation clearance within the worksite, resulting in an impact

intensity of **Medium**. As it is **Certain** (likelihood) that all these specimens would be removed for construction activities, the resulting impact significance is therefore **Moderate**.

Six out of seven species that will experience **Minor** impacts due to mortality are exotic or cultivated species that are expected to have some of their specimens affected by vegetation clearance in the worksite, resulting in an impact intensity of **low** or **medium**. They include *Khaya senegalensis*, angsana (*Pterocarpus indicus*), mango (*Mangifera indica*), rambutan (*Nephelium lappaceum*), durian (*Durio zibethinus*), and jackfruit (*Artocarpus heterophyllus*). Less than half of rain tree (*Samanea saman*) specimens, which are specimens of value, occur within the worksite and thus incur a **low** impact intensity. As it is **Certain** (likelihood) that all these specimens would be removed for construction activities, the resulting impact significance for these species is therefore **Minor**. The single specimen of the nationally Vulnerable *Bridelia stipularis* does not lie within the worksite and is not expected to experience direct impacts due to vegetation clearance, hence the impact intensity is **Negligible** and the resulting impact significance is **Minor**.

Five species found within 30 m of the worksite area do not have specimens that lie inside the development footprint and are not expected to be directly affected by vegetation clearance. Therefore, these species will experience **Negligible** impacts owing to mortality.

Decline in plant health

For this impact type, only 15 flora receptors were assessed as it is assumed that all specimens of the remaining 4 flora receptors have been already cleared. Due to the habitats being managed and being relatively open with no complex forest structures, it is assumed that all specimens of flora receptors in CCK N1 were already adapted to harsher microclimatic conditions (e.g., high temperature, light, wind conditions etc). Six species are likely to experience **Moderate** impacts owing to decline in plant health. The remaining specimens of these six species lie within 30 m of the worksite, resulting in an impact intensity of **High** as all the remaining specimens that are not cleared will be affected by decline in plant health. As it is **Possible** (likelihood) that these specimens will be affected by this impact type, the resulting impact significance is therefore **Moderate**. For the remaining nine species, they were assessed with an impact intensity of **Medium** and a **Possible** likelihood**,** which led their impact significance to be **Minor.**

**Table 7-24 Summary of construction phase impacts to flora species receptors**

| Impact Type | No. of Species | | | |
|---|---|---|---|---|
| | Major | Moderate | Minor | Negligible |
| **Mortality** | 4 | 3 | 7 | 5 |
| **Decline in plant health** | 0 | 6 | 9 | 0 |

### 7.7.1.3 Fauna

Six construction phase impacts were identified and assessed for faunal receptors: (1) loss of/ reduction in habitats and food sources, (2) accidental injury or mortality, (3) human-wildlife conflict, (4) loss of/ reduction in ecological connectivity for faunal movement, (5) light disturbances, and (6) human disturbances. The impact significance ranged from **Negligible** to **Major**. The more substantial impacts arising from each impact type is briefly summarised below. A summary of the impact to faunal receptors is given in Table 7-25. The detailed evaluation for each species is provided in Appendix L. In addition to this, the impacts from airborne noise to fauna during construction phase are assessed in Section 10.

The significance of the impacts is **Major** for all 18 species, particularly because of the loss of/ reduction in habitats and food sources as the clearance of >40% of the original habitat, nests, or roosts (high intensity) within the Project site is certain (likelihood) to happen. Impact significance from loss of/ reduction in of ecological connectivity for faunal movement for eight species dependent on forested habitats for movement is **Moderate**. The impact significance from light disturbances, human disturbances and human-wildlife conflict is **Minor**. For the remaining impacts, the intensities and likelihood vary for the different species, and they are discussed in detail below.

Assumptions made include:

- No night works unless for emergency situations.

- Minimum controls are properly implemented and enforced.

Loss of/ or Reduction in Habitats and Food Sources

Site clearance will affect two habitat types: managed vegetated (turf) and managed vegetation with planted trees. All probable species were deemed possible to utilise these habitat types. The impact intensity and consequence from loss of/ reduction in habitats and food sources is **High**, and likelihood **Certain.** Thus, the impact significance to all 18 faunal receptors, is **Major**.

Loss/ Reduction of Ecological Connectivity for Faunal Movement

The Study Area currently serves as a stepping-stone habitat for volant fauna moving along the Rail Corridor towards green spaces in the north Kranji area, southern Bukit Gombak and Bukit Batok, and east Bukit Mandai. The removal of vegetation from the Study Area is expected to diminish the effectiveness of the habitat there as a stepping-stone and interfere with faunal movement across the landscape. Since the retained ecological corridor largely ranges at 20 – 85 m wide, there is a reduction in ecological connectivity for faunal movement and is considered **Possible** to happen.

The intensity of the impact experienced by the different faunal species will differ based on their ability to traverse urban infrastructure. The impact intensity for four bird species that are highly dependent on connected forested habitats for dispersal, such as violet cuckoo (*Chrysococcyx xanthorhynchus*), buffy fish owl (*Ketupa ketupu*), black-crowned night heron (*Nycticorax nycticorax*) and straw-headed bulbul (*Pycnonotus zeylanicus*) is **Medium** to **High.** The impact intensity is also **Medium** for Sunda pangolin (*Manis javanica*) and **Medium or High** for the three bat species which are dependent on connected habitats for dispersal. Thus, the impact significance is **Moderate** for these eight species.

However, for three species that are adapted to traversing urban infrastructures, such as the Bengal swift (*Pelopidas agna agna*), smooth otter (*Lutrogale perspicillata*) and long-tailed macaque (*Macaca fascicularis*), impact intensity is considered **Negligible.** Impact intensity is considered Low for remaining seven bird species such as the changeable hawk-eagle (*Nisaetus cirrhatus*) and oriental magpie-robin (*Copsychus saularis*). Thus, the impact significance is **Minor** for these 10 species.

Overall, the impact significance is **Moderate** for 8 species and **Minor** for 10 species.

Accidental Injury or Mortality

Volant species such as butterflies, birds and bats (i.e., specifically cave nectar bat, *Eonycteris spelaea*) have low susceptibility to accidental injury/ mortality from construction activities and collision with vehicles/ machinery (**Low** intensity) as they can escape quickly from danger. Moreover, no raptor nests were observed in the Project Area and pre-felling fauna inspections will be conducted as part of the minimum controls to reduce the risk of injury/ mortality to the inhabitants of potential raptors' nests. Accidental injury/mortality is therefore, **Unlikely** to occur and the impact significance for butterflies, birds and cave nectar bat are assessed to be **Negligible**.

Two non-volant mammals assessed has high susceptibility to accidental injury/ mortality from construction activities (**High** intensity) due to their ground-dwelling nature which puts them at risk of getting trapped within a worksite and colliding with vehicles. The likelihood of this impact occurring was deemed **Possible**, and the resulting significance is **Moderate**. They are smooth otter (*Lutrogale perspicillata*) and Sunda pangolin (*Manis javanica*). During tree felling, pre-felling fauna inspections will be conducted as part of the minimum controls to reduce the risk of injury/ mortality. Therefore, the likelihood for this impact is **Less likely** for arboreal long-tailed macaque (*Macaca fascicularis*), and impact significance **Minor**.

Both species of bamboo bats assessed (Lesser bamboo bat; *Tylonycteris fulvida*) and Greater bamboo bat (*T. malayana*) have high susceptibility to accidental injury/ mortality during the removal of bamboo clusters in which they are roosting (**High** intensity). Bamboo bats tend to hide within the bamboo internodes where they are roosting when there is danger, instead of flying away. This puts them at risk of physical trauma when the bamboo stems fall onto the ground or break during the removal process, and when the cut bamboo stems are mulched for transport and disposal. While no bamboo bats were recorded in the bamboo present on site, likelihood is deemed **Possible**, and therefore, impact significance is **Moderate**.

Minimum control measures such as Wildlife Response Plan and pre-felling inspection are important for minimising accidental injury or mortality (see Section 7.6).

Overall, the impact significance is **Moderate** for 4 species, **Minor** for 1 species and **Negligible** for 13 species.

Light Disturbances

Considering that no night works are to take place as part of the proposed development, light disturbances are less likely to occur for all diurnal and nocturnal species. The impact significance is **Minor** for all 18 species.

Human Disturbances

Fauna is most likely to be present in the ecological corridor that will be retained on site. The corridor will be situated outside of the site hoarding. Given that biodiversity awareness training is part of the minimum controls to remind workers not to encroach into the ecological corridor, human disturbances in considered **Less likely**. Furthermore, the Study Area already receives some level of human disturbances given that it is also used by nearby residential users.

Human disturbances are expected to result in **Minor** impact intensity to Bengal swift (*Pelopidas agna agna*) and long-tailed macaque (*M. fascicularis*) as it is only slightly sensitive to human presence. They may move away from an approaching human but will not leave the habitat entirely. Impact intensity ranges between **Medium** and **High** for several bird species. Most of these birds will move away from an approaching human, and the extremely sensitive ones may leave the site entirely. The impact intensity is Medium for smooth otter and bats as they are sensitive to human presence and may avoid areas of high human traffic.

Overall, impact significance is considered **Minor** for all 18 species.

Human-wildlife Conflict

Butterflies and most birds are not perceived as nuisances or threats by construction personnel (**Negligible** intensity), and they are **Unlikely** to be implicated in human-wildlife conflict. Therefore, the impact significance for butterflies and birds is assessed to be **Negligible**. Although the bats can possibly be perceived as threats to construction personnel, their low tolerance to human presence and environments make them less susceptible to encounters with humans resulting in conflict (**Low** intensity). They are **Unlikely** to be implicated in human-wildlife conflict, and the resulting impact significance is **Negligible** for all three species.

Being highly tolerant of human presence and environments, the smooth otter (*L. perspicillata*) and long-tailed macaque (*M. fascicularis*) could stray into the worksite and be perceived as a threat by construction personnel (**Medium** and **High** intensity respectively). Given that biodiversity awareness training is part of the minimum control measures to minimise human-wildlife conflict, the likelihood of occurrence is considered **Less likely**. The resulting impact significance is expected to be **Minor** for these two species.

Overall, the impact significance is **Minor** for 2 species and **Negligible** for 16 species

**Table 7-25 Summary of construction phase impact to faunal receptors**

| Impact Type | No. of Species | | | |
|---|---|---|---|---|
| | Major | Moderate | Minor | Negligible |
| **Loss of/ reduction in habitats and food sources** | 18 | — | — | — |
| **Loss/ reduction of ecological connectivity for faunal movement** | — | 8 | 10 | — |
| **Accidental injury or mortality** | — | 4 | 1 | 13 |
| **Light disturbances** | — | — | 18 | — |
| **Human disturbances** | — | — | 18 | — |
| **Human-wildlife conflict** | — | — | 2 | 16 |

## 7.7.2 Operational Phase

The definitions for impact intensity and likelihood for habitat receptors at operational phase are presented in Table 7-26 and Table 7-27, respectively.

For habitat receptors, the calculations of habitat receptors affected by impacts are based on the proportion of areas affected against the area of remaining habitat after construction (after vegetation clearance).

**Table 7-26 Definitions of each level of impact intensity for all two impact types during operational phase for habitat receptors**

| Impact type | Negligible | Low | Medium | High |
|---|---|---|---|---|
| **Habitat degradation** | Developed area is not accessible to public and no long-term degradation is expected. E.g., core conservation areas with no public access, infrastructure works with no public access. | Developed area is designed with the 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 | Developed area is designed for members of the public to visit. E.g., parks. Degradation is expected to occur within at least 50% of the habitat. | Developed area and surroundings 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 |
| **Change in species composition** | Development footprint is temporary and/ or operational activities are fully underground (e.g., train alignment) | Development footprint is permanent and small relative to the size of the surrounding habitats, up 30 m from it (i.e., ⩽ 10%) | Development footprint is permanent and medium-sized relative to the size of the surrounding habitats, up to 30 m from it (i.e., 10-40%) | Development footprint is permanent and large-sized relative to the size of the surrounding habitats, up to 30 m from it (i.e., ≥40%) |

**Table 7-27 Definitions of each level of likelihood for all two impact types during operational for habitat receptors**

| Likelihood | Habitat Degradation | Change in Species Composition |
|---|---|---|
| **Unlikely/ Remote** | Surrounding natural habitats are not accessible to public | Development is largely green and human activity is limited (e.g., Thomson Nature Park).<br><br>The habitat is already exotic-dominated such that introduction of exotic species has no impact on the habitat. |
| **Less likely/ Rare** | Surrounding natural habitats are accessible but public use is restricted/ controlled | Development involves the building of urban structures but will be heavily landscaped (e.g., Gardens by the Bay).<br><br>The habitat is already exotic-dominated such that introduction of exotic species has some impact on the habitat. |
| **Possible/ Occasional** | Surrounding natural habitats are accessible and have infrastructure for the public to use, such as boardwalks/ pavements. | Development involves the building of structures that are designed to release heat, light, noise or dust (e.g., ventilation shafts). |

| Likelihood | Habitat Degradation | Change in Species Composition |
|---|---|---|
| | | Introducing exotic species will change the balance of exotic vs native species within the habitat. |
| **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) | Development involves the building of extensive pavements, structures, and other infrastructure with surfaces that absorb and retain heat, constantly produce dust and noise disturbances (e.g., residential estate with sparse landscaping works).<br><br>Introducing exotic species will be detrimental to the native-dominated habitat and its surrounding native-dominated habitats. |
| **Certain/ Continuous** | N.A. | N.A. |

For flora receptors, the probable impact type that these receptors would face with would be poaching. This will depend on the ethnobotanical vale of each specimen, which is referred to as having medicinal, aesthetical, economical and/ or commercial worth, being edible/ can be used for cooking, as well as is rare in Singapore. The definitions for impact intensity and likelihood for plant species receptors at operational phase are presented in Table 7-28 and Table 7-29, respectively.

**Table 7-28 Definitions of each level of impact intensity for all three impact types during operational phase for plant species receptors**

| Impact Type | Negligible | Low | Medium | High |
|---|---|---|---|---|
| **Poaching** | No plant specimens of this species could get stolen (i.e., not charismatic, no ethnobotanical value), and/ or are too big to remove (e.g., large trees) | Few plant specimens of this species could get stolen (i.e., most plant species with ethnobotanical value, or common ornamental plants), and are of small to medium sizes which can be removed | Some of all plant specimens of this species could get stolen (i.e., orchids), and are of small to medium sizes which can be removed | Most plant specimens of this species could get stolen (i.e., pitcher plants), and are of small to medium sizes which can be removed |

**Table 7-29 Definitions of each level of likelihood for all two impact types during operation for plant species receptors**

| Likelihood | Poaching |
|---|---|
| **Unlikely/ Remote** | Specimens are inaccessible to members of public |
| **Less Likely/ Rare** | Specimens are clustered/ spread out with limited access to members of public (e.g., areas with fixed operating hours, areas with no designated pathways) |
| **Possible/ Occasional** | Specimens are spread out, and accessible to members of public at all times |
| **Likely/ Regular** | Specimens are clustered, and accessible to members of public at all times |
| **Certain/ Continuous** | N.A |

The definitions for impact intensity and likelihood for faunal species at operational phase are presented in Table 7-30 and Table 7-31, respectively.

**Table 7-30 Definitions of each level of impact intensity for all six impact types during operational phase for faunal species receptors**

| Impact Type | Negligible | Low | Medium | High |
|---|---|---|---|---|
| **Accidental injury or mortality** | Species with negligible susceptibility to accidental injury/ mortality from operation activities, collision with vehicles, and collision with buildings | Species with low susceptibility to accidental injury/ mortality from operation activities, collision with vehicles, and collision with buildings:<br>– Birds with low susceptibility to collision with buildings<br>– Volant species (e.g., odonates, butterflies, raptors and bats)<br>– Aquatic species (most fishes, crabs, shrimps) | Species that are mobile but possibly susceptible to accidental injury/ mortality from operation activities and collision with vehicles, and collision with buildings:<br>– Birds that are possibly susceptible to collision with buildings (e.g., resident species with known records of bird-building collisions [P-38])<br>– All amphibians<br>– Some mammals (e.g., squirrels, shrews) | Species with high susceptibility to accidental injury/ mortality from operation activities and collision with vehicles, and collision with buildings:<br>– Birds with high susceptibility to collision with buildings (e.g., forest-edge frugivores [P-38], migratory species)<br>– Reptiles<br>– Some mammals (e.g., Sunda pangolin, long-tailed macaque, smooth otter) |
| **Human-wildlife conflict** | Species that are not perceived as nuisances or threats by members of the public<br>– Odonates<br>– Butterflies<br>– Most birds<br>– 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:<br>– Some reptiles<br>– Most amphibians<br>– 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:<br>- Smooth otter<br>- Red junglefowl<br>- 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:<br>Long-tailed macaque<br>Some snakes |
| **Poaching** | Species with negligible susceptibility to poaching | Species with low susceptibility to poaching; not commonly known to be traded as pets | Species that are possibly susceptible to poaching; commonly traded as pets | Species that are highly susceptible to poaching; listed on CITES Appendix I or II |
| **Loss of/ reduction in ecological connectivity** | Not dependent on connected habitats for dispersal and able | Slightly dependent on connected habitats for dispersal and adaptable to | Dependent on connected habitats for dispersal | Highly dependent on connected habitats for dispersal |

| Impact Type | Negligible | Low | Medium | High |
|---|---|---|---|---|
| **for faunal movement** | to traverse urban infrastructure | traverse urban infrastructure if needed | | |
| **Light disturbances** | Species that are not sensitive to changes in light levels: aculeate hymenopterans, aquatic and marine species | Species that are slightly sensitive to changes in light levels: odonates, butterflies | Species that are sensitive to changes in light levels: diurnal birds, reptiles, and mammals | Species that are highly sensitive to changes in light levels: nocturnal, crepuscular fauna |
| **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 |

**Table 7-31 Definitions of each level of likelihood for all six impact types during operational phase for faunal species receptors**

| Likelihood | Accidental injury or Mortality | Human-wildlife conflict | Poaching | Loss of/ Reduction in Ecological Connectivity for Faunal Movement | Light Disturbances | Human Disturbances |
|---|---|---|---|---|---|---|
| **Unlikely/ Remote** | Impact is not expected to happen during the operational phase of the project | | | | | |
| **Less Likely/ Rare** | Impact is not likely to happen during the operational phase of the project | | | | | |
| **Possible/ Occasional** | Impact could possibly happen or known to occur during the operational phase of the project | | | | | |
| **Likely/ Regular** | Impact is a common occurrence during the operational phase of the project | | | | | |
| **Certain/ Continuous** | Impact is a continual or repeated process during the operational phase of the project | | | | | |

### 7.7.2.1 Habitats

For operational phase, the only habitat left to assess would be those that do not overlap with the development boundary, of which, most of these habitats are also situated within the delineated recommended area of conservation (RAC) as mentioned in Section 7.5. The remaining habitats that are located 30 m from the worksite is assessed for two types of impacts for habitat receptors were assessed during the operational phase– (1) habitat degradation and (2) change in species composition–the impact significance was **Moderate** to **Minor**. Only the most severe impact significance is presented in Table 7-32. The detailed evaluation for each habitat is provided in Appendix L.

Habitat degradation

As the recommended area of conservation is in the context of a high-density residential estate, it is expected that public access would be available. Currently, there is an existing public pathway that cuts across a section of the RAC. This pathway is connected to the Pang Sua bridge, and it is assumed that this existing pedestrian connectivity will still be available during the operational phase as it connects the residents living in Teck Whye residential estate on the west of the Project site, to the major road network (i.e., Woodlands Road).

Based on the assumption above, impact intensity for all remaining areas of the two habitat types is expected to be

**High**. The likelihood for this impact type is assessed as '**Possible'** for both habitats as these habitats is always accessible. Hence, the impact significance for both habitats is assessed as **Moderate**.

Change in species composition

The impact resulting from changes in species composition to all habitats is assessed to be **Minor.** Due to relative ease of accessibility to these areas once the residential estate is completed (e.g., footpaths), residents or the public may release exotic pets or introduce non-native plants through landscaping. However, the release of exotic species is **Less Likely** (likelihood) to result in significant change in species composition as the existing habitats are pre-dominantly exotic-dominated.

**Table 7-32 Key biodiversity habitat receptors likely to experience indirect impacts within the Project site during operational phase**

| Habitat receptor | Priority level | Indirect impact (% of total habitat type within study area) | Most Severe Impact Significance and impact type |
|---|---|---|---|
| **Managed vegetation- Planted trees** | Priority 1 | 36.3% (3.24 ha) | **Moderate (habitat degradation)** |
| **Managed vegetation- Turf** | Priority 2 | 5.1% (0.26 ha) | **Moderate (habitat degradation)** |

### 7.7.2.2 Flora

Similar to the construction phase, plant species were selected for the assessment of ecological impacts at the operational phase. Flora species that were assumed to be cleared completely during the construction phase were not assessed in this section. For this assessment, the remaining 15 flora species receptors were assessed for only one impact type, poaching. The impact significance was **Negligible** for 14 species and **Moderate** for 1 species, which is *Bridelia stipularis*. A summary of the impact significance is presented in Table 7-33. The detailed evaluation for each species is provided in Appendix L.

The majority of the flora species receptors are generally large trees trees, of which, this makes it unlikely for them to be poached on site. As for *Bridelia stipularis*, due to its conservation status, it is possible that the only specimen of this species on site would get poached. To add on, for the pre-mitigating impact assessment, it is assumed that the RAC/ Ecological corridor will be open to public at all times. Hence, this also increases its likelihood to be poached and resulted its impact significance to be **Moderate.**

**Table 7-33 Summary of operational phase impacts to flora receptors**

| Impact Type | No. of Species | | | |
|---|---|---|---|---|
| | Major | Moderate | Minor | Negligible |
| **Poaching** | — | 1 | — | 14 |

### 7.7.2.3 Fauna

Six operational phase impacts were identified and assessed for faunal receptors: (1) accidental injury or mortality, (2) human-wildlife conflict, (3) poaching, (4) loss of/ reduction in ecological connectivity for faunal movement, (5) light disturbances, and (6) human disturbances. The impact significance ranged from **Negligible** to **Moderate**. The more substantial impacts arising from each impact type is briefly summarised below. A summary of the impact to faunal receptors is given in Table 7-34. The detailed evaluation for each species is provided in Appendix L.

During the operational phase, impacts to fauna are largely expected in the form of noise, light, and human presence from the surrounding residential areas. Increased road infrastructure as well as high-rise buildings may lead to accidental injury and mortality, as well as result in loss of/ reduction in ecological connectivity for all faunal species. The significance of the latter impact to the various species in the operational phase is like that in the construction

phase (**Moderate** to **Negligible**) as most of the Study Area will remain built-up, and the presence of road infrastructure, high-rise buildings, and human activity may further impede faunal movement. For the remaining impacts, the intensities and likelihood vary for the different species, and they are discussed in detail below.

Loss/ reduction of Ecological Connectivity for Faunal Movement

There is no change in the ecological connectivity during construction and operational phase. Therefore, the impact significance is the same as for construction phase. The impact significance is Moderate for 8 species and Minor for remaining 10 species.

Light Disturbances

The impact intensity varies from **Low** to **High,** depending on the susceptibility of the species to light levels. Nocturnal species such as owls (namely, buffy fish owl and spotted wood owl), black-crowned night heron, nocturnal-migrating birds (i.e., violet cuckoo), bats (namely, cave nectar bat and banboo bats) and pangolin have higher susceptibility (**High** intensity). These eight species are highly sensitive to changes in light levels (**High** intensity) as higher light levels may reduce the suitability of habitats for them, resulting in less-than-optimal conditions foraging and moving around at night. The attraction of insects that are the bats' prey to the brightly lit residential areas may affect the bats' foraging efficacy. For these species, likelihood is considered **Possible** to occur. Thus, the impact significance is **Moderate**.

The remaining species are diurnal and slightly sensitive to changes in light levels (**Medium** intensity). Higher light levels from human activities may affect their rhythmic patterns and may reduce the suitability of habitats for roosting and resting at night. They include the smooth otter, long-tailed macaque and straw-headed bulbul. The likelihood is considered **Less likely**. Thus, impact significance for these species is **Minor**. The Bengal swift has Negligible impact significance as butterflies are only slightly sensitive to changes in light levels (**Low** intensity) and **Unlikely** to occur.

Overall, the impact significance is **Moderate** for 8 species, **Minor** for 9 species and **Negligible** for 1 species.

Accidental Injury or Mortality

Volant species such as butterflies and the three bats have low susceptibility to accidental injury/ mortality from operational activities and collision with vehicles (**Low** intensity) as they can escape quickly from danger. Injury/ mortality to the is **Unlikely** to occur and the impact significance assessed is **Negligible**. Since there is no increase in roads from this development, the likelihood of roadkill of smooth otter, long-tailed macaque and Sunda pangolin is considered Less likely. Thus, impact significance is **Minor**.

In addition to the varying susceptibility of birds to accidental injury/ mortality from operational activities and collision with vehicles, birds face the additional risk of collision with buildings during the operational phase. Forest-edge frugivores (e.g., Long-tailed parakeet [*Psittacula longicauda*], Straw-headed bulbul [*Pycnonotus zeylanicus*], Violet cuckoo [*Chrysococcyx xanthorhynchus*]) are known to be highly susceptible (**High** intensity) to building collision [P-38]. Other resident bird species/ families have been recorded to collide with buildings, and these are deemed possibly susceptible (**Medium** intensity) in this assessment. Examples of species/ families that are possibly susceptible include the accipitrids, Oriental magpie-robin (*Copsychus saularis*), and the owls. The likelihood of building collisions occurring is deemed **Possible**. Overall, eight species of birds will experience **Moderate** significant impacts, and three species will experience **Minor** significant impacts owing to accidental injury or mortality.

The impact significance is **Moderate** for 8 species, **Minor** for 6 species and **Negligible** for 4 species

Human-wildlife Conflict

Only two species, the smooth otter and long-tailed macaque may be considered a nuisance to public, and possibly threats, and often implicated in human-wildlife conflict. In Singapore, there have been cases of otters feeding on ornamental fish and biting people, albeit usually in self-defence. Hence it is **Possible** this species is implicated in human-wildlife conflict and the resulting impact significance is **Moderate**. This is similar for Long-tailed macaques which are also frequently implicated, so its impact significance is **Moderate** as well.

Although bats in general can possibly be perceived as threats to members of the public (e.g., potential reservoirs of zoonotic diseases), the low tolerance of bats to human presence and environments make them less susceptible to encounters with humans resulting in conflict (**Low** intensity). Their elusive nature also makes them **Unlikely** to be implicated in human-wildlife conflict, and the resulting impact significance is **Negligible**.

For the remaining species, they are not perceived as nuisances or threats by members of the public (**Negligible** intensity) and they are **Unlikely** to be implicated in human-wildlife conflict. Therefore, the impact significance is assessed is **Negligible**.

The overall impact significance is **Moderate** for 2 species and **Negligible** for 16 species.

Human Disturbances

During operational phase, human traffic is expected to increase. Due to its proximity to residential development, humans may enter the ecological corridor, resulting in increased human disturbances. Furthermore, human activities around the ecological corridor will result in increased human disturbances. However, species present here may be tolerant to human disturbances to a certain level. The likelihood of occurrence is, therefore, **Less likely**. Impact significance is expected to be **Minor** for all 18 species.

Poaching

Most butterflies have low susceptibility to poaching and are not commonly known to be traded as pets (**Low** intensity). It is **Unlikely** that poaching of Bengal swift occurs and the resulting impact significance is **Negligible**.

Two bird species, the straw-headed bulbul (*P. zeylanicus*) and oriental magpie-robin (*C. saularis*), are susceptible to poaching for the pet trade. The Straw-headed bulbul is listed on CITES Appendix II [W-16] and is a widely traded songbird globally. It is deemed highly susceptible to poaching (**High** intensity). The Oriental magpie-robin is commonly traded as pets and are possibly susceptible to poaching (**Medium** intensity). However, the likelihood of these birds being poached is deemed **Less Likely** given the strict enforcement in Singapore. The long-tailed parakeet (*P. longicauda*) is a charismatic bird that are not commonly traded as pets but could have low susceptibility to poaching (**Low** intensity). The likelihood of these birds being poached is **Unlikely**. Overall, three species of birds will experience **Minor** significant impacts, and eight species will experience **Negligible** significant impacts owing to poaching. The Sunda pangolin is also susceptible to the illegal wildlife trade for their bushmeat and body parts. However, the strict enforcement in Singapore renders this likelihood to be Unlikely. Therefore, impact significance is **Minor**.

The remaining 14 species have negligible susceptibility to poaching (**Negligible** intensity), resulting in **Negligible** impact significance.

**Table 7-34 Summary of operational phase impacts to faunal receptors**

| Impact Type | No. of Species | | | |
|---|---|---|---|---|
| | Major | Moderate | Minor | Negligible |
| **Loss/ reduction of ecological connectivity for faunal movement** | — | 8 | 10 | — |
| **Light disturbances** | _ | 8 | 9 | 1 |
| **Accidental injury or mortality** | _ | 8 | 6 | 4 |
| **Human-wildlife conflict** | _ | 2 | _ | 16 |
| **Human disturbances** | _ | _ | 18 | _ |
| **Poaching** | _ | _ | 4 | 14 |

# 7.8 Recommended Mitigation Measures

In this section, mitigation measures for the future residential developments are discussed. Mitigation measures are implemented in the following order following the mitigation hierarchy: (1) avoidance, (2) minimisation, and (3) enhancement/ rehabilitation as well as compensation. 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/rehabilitation of remaining and/ or nearby habitats will be suggested as a form of impact mitigation.

It is important to note that the successful implementation of mitigation measures requires the commitment of contractors, arborists, and biodiversity specialists. Some of the major concerns around this Project include habitat loss, habitat connectivity and human-wildlife interactions/ conflict.

## 7.8.1 Design Phase and Pre-construction Phase

### 7.8.1.1 Avoid

Due to the nature of the plans at CCK N1, there is little chance to avoid site clearance and habitat loss within the worksite besides the Recommended Area of Conservation (RAC). As such, one of the key recommendations during the pre-construction phase is to avoid any works from encroaching into the RAC that is set to be the future Ecological Corridor. Other measures to avoid biodiversity impacts listed in Section 7.3 are provided below in Table 7-35.

**Table 7-35 Key recommended measures to avoid biodiversity impacts during the construction phase**

| Receptors | Impact Types | Mitigation Measures |
|---|---|---|
| • Habitats<br>• Flora species<br>• Faunal species | • Loss of vegetation<br>• Loss of/ reduction in habitats and food sources<br>• Injury/ Mortality | • Avoid the RAC set as future eco corridor by setting up hoardings around the perimeter of the proposed development, subject to further changes. The Project Site should be hoarded with the following baseline measures:<br><br>- The Site must be hoarded up entirely;<br><br>- The hoarding is to commence from the side of development nearest to the road, (i.e., to start hoarding from the boundary nearest to Woodlands Rd first then move inwards) to prevent any roadkill;<br><br>- The hoarding must not have any gaps between the panels and are to extend at least 300mm into the ground;<br><br>- The access gates, when shut, must not have any gaps between the panels and must be flushed as close to the ground as possible;<br><br>• Engage arborists and flora specialists to clearly mark out the boundary of the RAC. This would avoid clearing unnecessary working space; and |

| Receptors | Impact Types | Mitigation Measures |
|---|---|---|
| | | • Set up Tree Protection Zones (TPZs) for any trees that will be retained within the Project site, when needed. |

### 7.8.1.2 Minimise

The design of a development should first be considered as part of the mitigation measures as it has the potential to influence the extent and types of impacts that can influence any sensitive biological receptors at the operational phase. Different design strategies and its detailed are provided in Table 7-36. These strategies are designed to mitigate the impact types mentioned in Section 7.3 that are potentially faced by the ecological receptors.

**Table 7-36 Design strategies to reduce biodiversity impacts**

| Ecological Receptors | Design strategies / Mitigation measures | Impact Type(s) | Details |
|---|---|---|---|
| Fauna | Integrate bird-friendly design for buildings and landscaping | Accidental injury or mortality | The likelihood of bird-building collision can be reduced by substituting aspects of the building design with bird-friendly designs. A bird-safe building guideline was established by NParks; it is recommended that the guidelines outlined within this guide are considered and incorporate into building design to minimise this impact type [W-36].<br><br>Using non-reflective, dark-coloured surfaces to reduce contribution to sky glow and lighting strategies such as reduction of light spill (i.e., details can be found below under 'Integrate lighting strategies') should also be implemented. |
| Fauna | Adopt Road Calming measures | Accidental injury or mortality | It is possible that internal roads would be constructed within the proposed residential estate. Hence, by adopting road calming measures, this can help to minimise roadkill accidents during the operational phase. Examples would be:<br>• Speed bumps; and<br>• Setting restriction on speed of vehicles within the residential estate. |
| Habitat<br>Flora<br>Fauna | Limit human activities in the RAC/ Ecological Corridor | • Human disturbances to faunal species receptors<br>• Human-wildlife conflict<br>• Poaching (flora) | Major impacts to faunal species, particularly those that are sensitive to human presence, are expected owing to the increase in human traffic (e.g., residents, visitors). The increase in human traffic is also expected to pose moderate impacts to faunal species owing to human-wildlife conflict.<br><br>This measure can be implemented to minimise human disturbances and habitat degradation. By incorporating these measures, the RAC can thus serve as a more conducive refuge for wildlife. |

| Ecological Receptors | Design strategies / Mitigation measures | Impact Type(s) | Details |
|---|---|---|---|
| | | • Habitat degradation | • Any human activities within the RAC should be limited to low impact ones, such as hiking and maintenance;<br>• Entry into most parts of the RAC/ Ecological Corridor should also be restricted to daylight hours (08:00 h –18:00 h) to allow sensitive nocturnal fauna to forage and move about normally, and diurnal fauna to roost.<br>Restricting visitor entry to daylight hours may also minimise the chances of encountering nocturnal fauna that may be implicated in human-wildlife conflict, such as the Eurasian wild boar (*Sus scrofa*) and snakes. |
| | Integrate lighting strategies | • Light disturbances | Any level of artificial light above that of moonlight masks the natural rhythms of lunar sky brightness and thus, can disrupt patterns of foraging, mating, as well as the circadian rhythm [P-34]. Artificial lighting at night (ALAN) can disorient birds, bats, and insects, altering their behaviour that results in them being more vulnerable to predation and other risks.<br>For example, ALAN may repel light-adverse bats from lit areas and restrict their use of commuting or feeding space. Moderate impacts owing to light disturbances are expected during the operational phase.<br>Light disturbance impacts at the operational phase can be minimised by incorporating proper lighting strategies as detailed below and summarised in Figure 7-33.<br>• Establish “dark buffers” with no artificial illumination and vary illuminance limits from the “dark buffers” to the urban areas (Figure 7-33);<br>• Avoid artificial illumination within the RAC/ Ecological Corridor, with the exception of any pedestrian linkages that will be publicly accessible even during the nightime;<br>• Direct permanent artificial lightings away from the RAC/ Ecological corridor (Figure 7-33);<br>• Incorporate denser vegetation planting of up to 30-m wide at the edges of RAC/ Ecological Corridor by providing infill planting with a multi-layer planting strategy to act as light buffers; |

| Ecological Receptors | Design strategies / Mitigation measures | Impact Type(s) | Details |
|---|---|---|---|
| | | | • Use adaptive light controls to manage light timing, intensity, and colour and install smart controlled LED lights (Figure 7-33);<br><br>• Minimise the use of lights during hours just before dawn and after dusk when crepuscular and nocturnal animals are the most active; and<br><br>• Minimise light spills, i.e., light that falls outside the area intended to be lit;<br><br>Optimise the placement of lights by lighting only the object or area intended, and keeping lights close to the ground, directed, and shielded. Accessories such as baffles, hoods or louvres can be used to reduce light spill and direct it only to where it is needed (Figure 7-33; [P-35]);<br><br>• Configure the location, orientation, and height of buildings and structures (e.g., streetlights);<br><br>• Provide screening through landscaping or hard structures (e.g., walls, fences, bunds), especially at areas near the residential estate. Fences can be overplanted with climbers to soften its appearance and provide a vegetated feature for fauna to use, but should never be relied on as the sole means of attenuating light spill;<br><br>• Use a minimal number of luminaires while achieving the necessary lighting levels;<br><br>• Use wildlife-friendly light properties or features;<br><br>• Use low-glare lighting and lights with reduced or filtered blue, violet, and ultraviolet wavelengths;<br><br>Short wavelength light (blue) scatters more readily in the atmosphere and therefore contributes more to sky glow than longer wavelength light. Furthermore, most wildlife is sensitive to short wavelength (blue/ violet) light. Therefore, as a rule, only lights with little or no short wavelength (400–500 nm) violet or blue light should be used to avoid unintended effects; and<br><br>• Employ warm colour temperature light sources to be preferably at <2,700 Kelvin (Figure 7-33). |

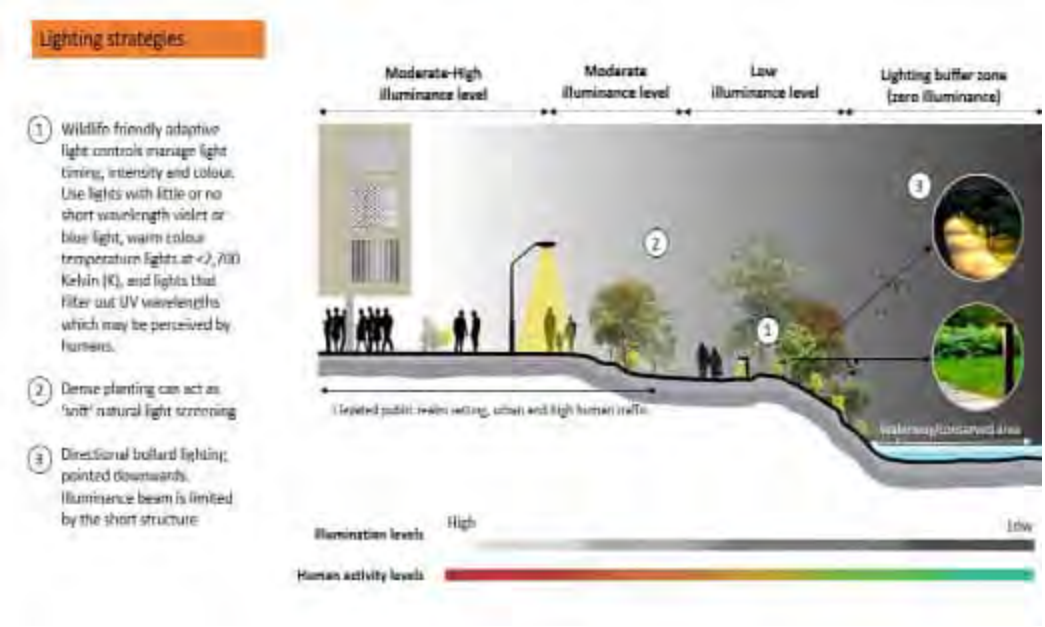



**Figure 7-31 General lighting strategies**

### 7.8.1.3 Remedy/ Repair/ Restore and Compensate

With the removal of most of the habitat within the Project site, moderate impacts are expected for faunal species that are dependent on connected forested habitats for dispersal. Certain flora species within the RAC might not be able to tolerate long-term changes in microclimate due to the urban developments and may experience decline in plant health, of which, it would eventually lead to habitat degradation. These measures aim to increase the diversity of habitats within the Project site, improve the structural complexity of the RAC/ Ecological Corridor well as to ensure that the vegetation that are currently proposed to be retained are protected from extreme changes to the microclimate. To increase the effectiveness and ecological value of the RAC, enhancement measures are recommended in Table 7-37.

Currently, there are identified gaps in ecological connectivity (Figure 7-33). These gaps were also recognised in Guttensohn & Leong (2021) [P-2] and were highlighted to improve the ecological connectivity between the Study Area and other green spaces in the vicinity:

1) Across/ under KJE to Bukit Mandai Forest; and;
2) Across Choa Chu Kang Road in the south, which leads to the southern part of the existing Rail Corridor.

Enhancing terrestrial connectivity within and beyond the Project site can help to compensate for habitat loss as well as the loss of ecological connectivity for faunal movement through improving ecological functions and at the same time, increasing the biodiversity of the site. To improve the current connectivity of the Project site to other surrounding fragmented green spaces, is it recommended to address the connectivity gaps mentioned above.

Due to existing nearby infrastructure, such as, the KJE via-duct, and the design intent of the Study Area as a future residential estate, it would be challenging to create any form of ecological linkages to bridge the Bukit Mandai Forest to the Project site. Hence, recommendations are more focused on improving the overall connectivity of the existing Rail Corridor on the south, to the Study Area. Recommendations such as: (1) providing an ecological bridge that connects the southern portion of the Project site to the green patch behind Junction 10 Shopping Centre, and (2) installing a simple ladder-like structure for ground-dwelling fauna species (e.g., Sunda pangolin and civet cats etc) to climb up from the drain to the green patch that is mentioned above, can be explored. The structure can be recessed along the bank of the existing Pang Sua Canal and is recommended to be installed at two locations to facilitate the movements of wildlife between the Ecological Corridor and the existing Rail Corridor located south after Choa Chu Kang Road. It is to note that these recommendations are subjected to detailed studies and discussions with relevant Technical Agencies. More details are provided in Table 7-37 and Table 7-38.

**Table 7-37 Design strategies to enhance the RAC and/or compensate for the loss of ecological connectivity**

| Ecological Receptors | Design strategies / Mitigation measures | Impact Type(s) | Details |
|---|---|---|---|
| Habitat<br>Flora<br>Fauna | Enhance the RAC/ Ecological Corridor | • Change in species composition<br>• Habitat degradation<br>• Light disturbances | Context-specific infill planting should be implemented to enhance the RAC (Figure 7-32; Figure 7-33). This creates resources and increases structural complexity that benefit wildlife and improve ecosystem services [P-39; P-40]. Native plants should be used in infill planting, and exotic and invasive species (e.g., *Clidemia hirta*) should be removed. Native plant species are recommended because they are genetically representative of the region's biodiversity. These plants themselves have higher conservation value. A suggested planting palette is provided in Appendix M.<br><br>Some guidelines to achieve this are:<br><br>• Make use of the existing forest framework to jumpstart succession into a more native-dominated habitat by:<br>- Retaining the existing emergent and canopy trees (Figure 7-32). Native species suitable to be planted at the understory can be incorporated. This allows the existing biodiversity to be maintained while increasing the chances of successful forest regeneration; and<br><br>- Execute in-fill planting. This is highly recommended to be carried out before the removal of any exotic vegetation, so that the plants have more time to establish, and the restored habitat can provide more conducive refugia for the displaced fauna.<br><br>• Where large trees must be removed, logs may be re-used on site to re-create habitat for fauna and to retain the organic material on site.<br><br>• To increase the food sources for fauna species, fig trees (*Ficus* sp.) can be planted in the RAC/ Ecological Corridor. These keystone species that have uncoordinated fruiting periods and fruit abundantly when in season.<br><br>• Small trees and shrubs that are fast-growing should also be planted alongside existing trees along the boundary of the RAC/ Ecological Corridor as well as areas that are currently bare (e.g., northern and southern section of the RAC/ Ecological Corridor towards Villa Verde Bridge) (Figure 7-33). This will create a 'buffer' for the existing vegetation to buffer from the increase in microclimatic conditions due to the development of residential estate as well |

| Ecological Receptors | Design strategies / Mitigation measures | Impact Type(s) | Details |
|---|---|---|---|
| | | | as buffer from the light and noise level from the residential estate during operational phase.<br>- A graded canopy line should be established as the shape is optimised to buffer against wind and rain, reducing tree failure at forest edges (Figure 7-32);<br>- This vegetative buffer will also function as a safety feature in an event of any tree failure that could potentially fail towards the direction of the proposed residential estate. The vegetation buffer should be at least 15 m from the closest tree line adjacent to the development site, although the ideal buffer width is recommended to be at least 30 m to buffer for edge effects as well [P-54; P-55; P-56; P-57].<br>- The planting of this vegetative buffer is recommended to be executed before the site clearance of the Project site to account for the temporal factor of the newly-planted vegetation to grow to its mature size. Ideally, the vegetative buffer should be more or less established during operational phase. |
| Fauna | Enhance terrestrial connectivity | • Accidental injury or mortality<br>• Human-wildlife conflict<br>• Loss of ecological connectivity for faunal movement<br>• Human disturbances | An ecological bridge is proposed to connect the southern section of the RAC across the Pang Sua Canal to the existing green patch behind Junction 10 Shopping Centre;<br>• The general width of the bridge recommended to be wide enough to accommodate targeted fauna species such as small ground-dwelling mammals as well as to incorporate some landscaping of dense shrubs and undercovers on the bridge. As a general guide, the average width of the future ecological corridor (i.e., RAC) is approximately 50 m (i.e., subject to further changes based on detailed studies). However, since the bridge is targeted mainly for small ground-dwelling fauna species, a width of 15 m is recommended (Figure 7-33). Ideally, the bridge is recommended to be catered only for wildlife usage. However, it is possible to consider the design of the mixed-use bridge suitable for pedestrian and wildlife;<br>• Both ends of the bridge can also be planted up to facilitate the movement of animals between the RAC/ Ecological Corridor to location of the proposed the ladder-like structure. Dense vegetation could be located at both sides of the entrances to provide refuge and guide the animals though the passage. This can be tied off alongside exclusion fences, especially at |

| Ecological Receptors | Design strategies / Mitigation measures | Impact Type(s) | Details |
|---|---|---|---|
| | | | the area behind Junction 10 Shopping centre to prevent animals from straying away from the intended area ;<br>- The fence is recommended to be of a smooth surface such as pre-formed vinyl sheeting or pre-casted concrete. If galvanised mesh is used, the diameter of the mesh size should be small enough to prevent mammals from being able to climb up and out of the intended area;<br>- It is recommended for the fence to be approximately 1.5 m high to prevent pangolins or civet cats from climbing out;<br>• Ladder-like structure can be implemented at two locations of the canal. These ladder-like structures will facilitate ground-dwelling animals to climb from the bottom of the canal up to either the existing green patch behind Junction 10 Shopping Centre, or the existing Rail Corridor that is located after Choa Chu Kang Road;<br>• The entry point of the ladder is ought to be placed as close to end point of the proposed ecological bridge so as to deter the targeted fauna species from straying away from the intended area.<br>• Since the canal serves as relatively larger catchment for the region, there are various considerations to account for to ensure that there would not be a major impact to the hydraulic conveyance function of the canal. Hence, this recommendation is subject to further detailed studies with relevant Technical Agencies. |

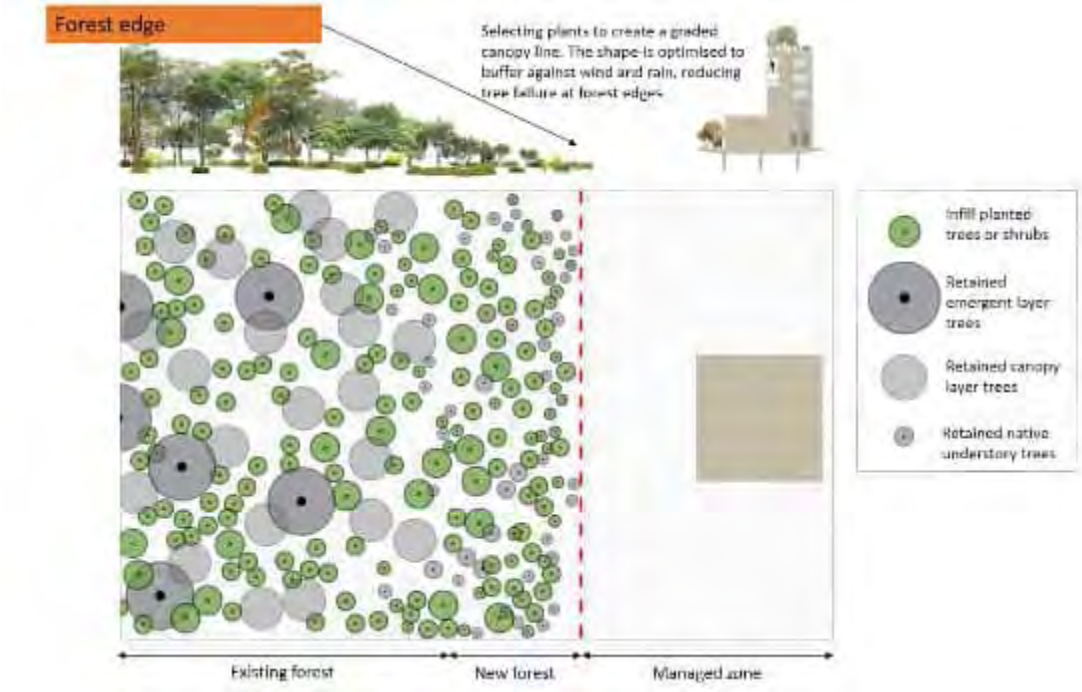



**Figure 7-32 General guideline for in-fill planting**

**Legend**

- CCK N1 IA Study Boundary
- Development Boundary
- Recommended Area of Conservation
- Planting of Bare Areas
- Rail Corridor
- Vegetative Buffers
- Enhancement Planting
- Bukit Mandai Forest
- Gaps in Connectivity
- Green Connectivity

N

| Rev | Date | By | Description | Chk'd | App'd |
|---|---|---|---|---|---|
| 01 | MAR 2023 | ZA | Final Report | NHT | JAG |
| - | JAN 2023 | ZA | Final Report | NHT | JAG |

Qualified Person Endorsement : NA

HDB Endorsement : NA

Consultant : AECOM

HOUSING & DEVELOPMENT BOARD

Project Title :

**ENVIRONMENTAL IMPACT ASSESSMENT (EIA) ON CHOA CHU KANG N1**

Figure Title :

Areas with gaps in connectivity as well as recommended areas for enhancement planting and vegetation buffers

| Designed | Checked | Approved | Figure No. | Rev. | Sheet |
|---|---|---|---|---|---|
| ZA | NHT | JAG | 7-33 | 01 | 1 of 1 |
| | Drawn : ZA | Date : MAR 2023 | CAD File Name : NA | | A3 |

Note: Source of basemap - Google Earth Map

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**Table 7-38 Design strategies to compensate for the loss of ecological connectivity for faunal movement**

| Ecological Receptors | Design strategies / Mitigation measures | Impact Type(s) | Details |
|---|---|---|---|
| Fauna | Roof gardens and skyrise greenery | Loss of ecological connectivity for faunal movement | Roof gardens, green roofs, green terraces, and green walls have the ecological potential to be functional habitats for biodiversity.<br><br>Skyrise greenery also serves as ecological stepping-stones, enhancing ecological connectivity in the broader urban landscape [P-41]. These features can be incorporated at the roofs of high rise buildings such as multi-storey carparks. A summary of the design principles for biodiversity-attracting skyrise greenery is shown in Figure 7-34 .<br><br>• A diverse planting palette is recommended within the skyrise greenery that attracts higher biodiversity. Nectar plants, fruit plants and butterfly nectar and host plants can also be incorporated. Refer to Appendix M for the recommended selection of plants.<br><br>• Skyrise gardens below 50 m height are most attractive to biodiversity. Allocate lower levels for gardens which are fauna-attracting and higher skyrise gardens for human-focused functions, where applicable.<br><br>• Artificial refugia for pollinators may be installed in the skyrise greenery at locations away from human traffic.<br><br>• Pollinator houses can attract solitary bees and wasps to take refuge, assisting their dispersal across the fragmented landscape. The pollinator houses can also serve as an educational element for residents and visitors. |

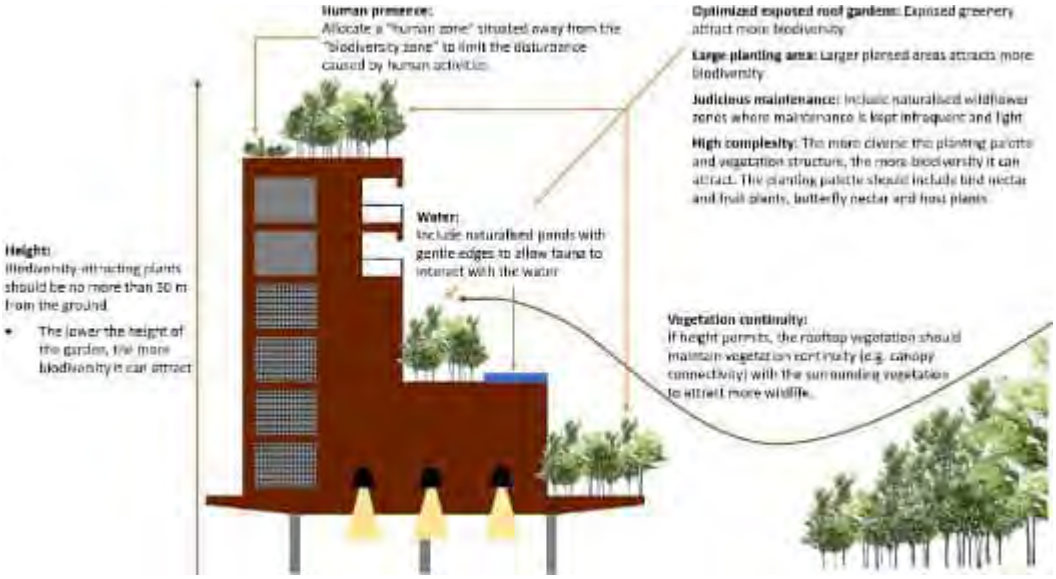



**Figure 7-34 Summary of design principles for biodiversity-attracting skyrise greenery [P-41]**

## 7.8.2 Construction Phase

The location of the conserved area between high intensity development on both sides means that the ecological receptors there may experience major impacts due to the construction works. Key measures to avoid and minimise these impacts are described below and should be implemented as part of the Environmental Management and Monitoring Plan (EMMP) during the construction phase.

### 7.8.2.1 Avoid

Table 7-39 provides a summary of the key recommended measures to avoid biodiversity impacts during the construction phase.

**Table 7-39 Key recommended measures to avoid biodiversity impacts during the construction phase**

| Receptors | Impact Types | Mitigation Measures |
|---|---|---|
| • **Habitats**<br>• **Plant species**<br>• **Faunal species** | • Loss of vegetation<br>• Loss of/ reduction in habitats and food sources<br>• Loss of/ reduction in ecological connectivity for faunal movement | • Ensure no works outside of the worksite or agreed working space, especially into the RAC/ Ecological Corridor. This includes additional clearance of vegetation for material storage, access routes, trampling and vegetation damage. |
| **Habitats** | Habitat degradation | • Ensure no works outside of the worksite or agreed working space, especially into the RAC/ Ecological Corridor. This includes additional clearance of vegetation for material storage, access routes, trampling and vegetation damage;<br>• Ensure any associated slope stabilisation and grading works will not impact topography of areas outside work site and, water quality and hydrology of the waterbodies within the Project site. Care should be taken to prevent siltation into the RAC. Works should not encroach on these areas, not should there be clearance, trampling or vegetation damage to these areas. Overall, these areas should have no or minimal impacts; and |

| Receptors | Impact Types | Mitigation Measures |
|---|---|---|
| | | • Ensure minimum control measures as well as engineering controls are in place to prevent contamination and siltation into the RAC/ Ecological Corridor. |

### 7.8.2.2 Minimise

Table 7-40 provides a summary of the key recommended measures to minimise biodiversity impacts during the construction phase.

**Table 7-40 Key recommended measures to minimise biodiversity impacts during the construction phase**

| Receptors | Impact Types | Mitigation Measures |
|---|---|---|
| **Habitats** | Habitat degradation | • Engage a Qualified Erosion Control Professional (QECP) to formulate and implement an Earth Control Measures (ECM) plan in accordance with PUB requirements;<br>• Ensure silt fences and other silt control measures along the worksite hoarding are installed and maintained properly;<br>• Practise due diligence in proper storage and handling of machinery to prevent leeching of oil or harmful materials such as bentonite slurry; store and handle harmful materials well away from waterbodies;<br>• Implement dust control measures such as dust screens and water suppression systems;<br>• Conduct regular inspections to ensure contractor compliance to the EMMP, with oversight by HDB; and<br>• Retain ground cover for as long as possible before removal. When ground cover is removed, ECM is to be in place. |
| **Plant species** | Mortality | • Transplant or harvest and propagate trees/ saplings of conservation significance if they are to be cleared;<br>• Erect Tree Protection Zones (TPZs) to prevent encroachment of construction activities and excessive vegetation clearance around retained trees or areas (if any);<br>• Conduct regular inspections to ensure contractor compliance to the EMMP; and<br>• Engage with a certified arborist if pruning is needed for any tree specimens that are located close to the construction boundary. |
| **Faunal species** | • Accidental injury or mortality<br>• Human-wildlife conflict | • Carry out directional site clearance from southern to northern ends to prevent fauna entrapment on site (Section 11.10.1.3; Figure 11-7). This should be executed only after the site has been hoarded up based on the measures listed in Section 7.8.1.1;<br>• Conduct pre-felling fauna inspections before felling any trees or removing any vegetation;<br>• Conduct detection, rescue, release, and/ or translocation of bamboo bats (*Tylonycteris* spp.) prior to the felling of bamboo clusters. This should be planned and executed by an Ecologist;<br>• Use only fully biodegradable erosion control blankets (ECB) to avoid trapping fossorial fauna such as snakes;<br>• Adopt road calming measures such as speed bumps and speed limits to minimise roadkill accidents;<br>• Train site personnel on biodiversity awareness and actions to take when encountering wildlife; |

| Receptors | Impact Types | Mitigation Measures |
|---|---|---|
| | | • Establish a Wildlife Response Plan to be executed when trapped/ injured/ dead/ dangerous fauna is found on-site, in consultation with NParks;<br>• Ensure good housekeeping controls such as provision of wildlife-proof bins and eating areas; and<br>• Conduct regular inspections to ensure contractor compliance to the EMMP and identify potential faunal entrapments. |
| **Faunal species** | Light disturbances | Minimise night-time works to prevent disturbances to nocturnal fauna; restrict working hours to 08:00 h–18:00 h. Where night-time works are not avoidable, adopt the following measures:<br>• Review construction method statements and site lighting plan with the EMMP Specialist and Ecologist before the commencement of nights works and where necessary<br>• Reduce light spillage into adjacent areas by adopting the following measures:<br>○ Worksite hoarding to be opaque, and dark-coloured where possible;<br>○ Increase the height of worksite hoarding, especially in areas adjacent to natural areas;<br>○ Ensure that lighting is only used where necessary; remainder of worksite to remain dark as much as possible;<br>○ Lighting to be directed downwards to reduce light spillage upwards, as it may impact migratory birds; and<br>• Avoid using high UV and broad-spectrum lights (except for safety reasons) if possible. |
| **Faunal species** | Human disturbances | Restrict entry of site personnel into the Ecological Corridor |

## 7.8.3 Operational Phase

Mitigation measures stated here should be relevant for the Project site and enforced if applicable. However, most of the strategies for enhancement should have been considered during the design phase. Minimisation, restoration, and compensation measures would be the most applicable at the operational phase.

**Table 7-41 Key recommended measures to minimise/ rehabilitate biodiversity impacts during operational phase**

| Receptors | Impact Types | Mitigation Measures |
|---|---|---|
| **Plant species** | Change in plant species composition | • Unused areas cleared for works during construction should be replanted.<br>• Adopt a native planting palette |
| **Faunal species** | • Human-wildlife conflict<br>• Light disturbances<br>• Human disturbances | • Education sign boards to educate the public on how to identify, interact with, and respond to wildlife;<br>• Conduct regular site inspections in the initial phase of operation to ensure proposed mitigating measures are effective and to monitor usage of propose ecological bridge and fauna underpass (refer to Section 11.10.2.2);<br>• Education sign boards to prevent encroachment into the RAC/ Ecological Corridor; |

| Receptors | Impact Types | Mitigation Measures |
|---|---|---|
| | | • Proper trash management measures such as wildlife-proof bins;<br>• Strategies to reduce light pollution into the Ecological Corridor such as (see measures in Design Phase in Section 7.8.1):<br>  ○ Vegetation Buffer planting along edge to reduce light spillage (refer to Section 7.8.1.3); and<br>  ○ Avoid shining light into the Ecological Corridor. |

# 7.9 Residual Impacts

## 7.9.1 Construction Phase

### 7.9.1.1 Habitats

In the assessment of ecological impacts for the construction phase, the most substantive impact was **Major** arising from site clearance due to the loss of vegetation for both habitat type. These impacts were assessed before mitigation measures were theoretically implemented. Only the most substantive impact for each impact type is presented. A summary of the key biodiversity habitat receptors impacted during construction phase is shown in Table 7-42. The detailed evaluation for each species is provided in Appendix L.

Loss of vegetation

The **Major** impact arising from loss of vegetation cannot be mitigated due to the need for development. However, following the mitigation hierarchy, restoration and compensation measures can be adopted instead to help increase the ecological value of the habitats within the Recommended Area to be Conserved (RAC) (Section 7.8.1.3).

Habitat degradation

Assuming that the mitigation measures mentioned in Section 7.8 were enforced (e.g., conducting regular inspections to ensure contractor compliance on the minimum control measures (Section 7.6) etc, the likelihood of this impact type would reduce to **'Less likely'** and hence, reduces the impact significance from **Moderate** to **Minor**.

Formation of forest edge

For the formation of forest edge, there is no change to the impact significance for both habitats as the impact has been reduced to a level that is as low as reasonably practicable (i.e., **Negligible-Minor)**. Even so, the implementation of other mitigation measures, such as the planting of a dense landscape around the edges of the RAC/ Ecological Corridor proposed in Section 7.8.1.3 should be implemented. This is to provide a vegetation buffer for the habitats within the RAC/ Ecological Corridor from the predicted changes to local abiotic conditions (i.e., temperature, light, wind conditions). In addition, this dense planting would also function as a buffer in the event of tree failure due to the changes in abiotic conditions within the Project site (Section 7.8.1.3).

**Table 7-42 Key biodiversity habitat receptors likely to experience direct and indirect impacts within the Project site during construction phase**

| Habitat receptor | Priority level and other relevant status | Direct impact (% of total habitat type within study area) | Indirect impact (% of total habitat type within study area) | Most Severe Impact Significance and impact type |
|---|---|---|---|---|
| **Managed vegetation- Planted trees** | Priority 1 | 57.1% (5.10 ha) | 36.3% (3.24 ha) | **Major (loss of vegetation is irreversible)** |
| **Managed vegetation- Turf** | Priority 2 | 94.4% (4.85 ha) | 5.1% (0.26 ha) | **Major (loss of vegetation is irreversible)** |

### 7.9.1.2 Flora

Similar to the pre-mitigation impact assessment, all 19 flora species receptors are assessed for two ecological impact types, (1) mortality and (2) decline in plant health. The assessment considered mitigation measures for flora species. It also assumes minimum controls are properly implemented and enforced. A summary of the impact to flora receptors is provided in Table 7-43. The detailed evaluation for each species is provided in Appendix L.

Mortality

For this impact type, there is no change to the impact significance for all flora species receptors as vegetation clearance in inevitable for the development of CCK N1. As mentioned in Section 7.7.1.2, the significance of the impacts was assessed to be Major for four species, Moderate for three species, Minor for seven species, and Negligible for five species.

Decline in plant health

With proposed mitigation measures such as in-fill planting and dense landscaping/ planting along the edges of the RAC Section 7.8.1.3, this will act as a buffer and possibly reduce the likelihood of the impact (i.e., Possible to Less likely) of any forest edges to affect the existing vegetation within the RAC/ Ecological Corridor. As a result, the impact significance of six flora species receptors that were initially assessed as Moderate during the pre-mitigation impact assessment, is reduced to Minor. As for the remaining nine species, their impact significance remains as Minor since this impact cannot be mitigated further.

**Table 7-43 Summary of construction phase residual impacts to flora receptors**

| Impact Type | No. of Species | | | |
|---|---|---|---|---|
| | Major | Moderate | Minor | Negligible |
| **Mortality** | 4 | 3 | 7 | 5 |
| **Decline in plant health** | — | — | 15 | — |

### 7.9.1.3 Fauna

Six impact types were identified and assessed for the 18 faunal receptors: (1) loss of/ reduction in habitats and food sources, (2) accidental injury or mortality, (3) human-wildlife conflict, (4), loss/ reduction of ecological connectivity for faunal movement, (5) light disturbances and (6) human disturbances. The assessment considered mitigation measures for faunal species as well as habitats, which directly influences how fauna will respond to the measures. It also assumes minimum controls are properly implemented and enforced.

With implementation of mitigation measures, the likelihood for accidental injury or mortality was reduced to **Less likely,** therefore, resulting in **Minor** impact significance. A **Moderate** impact significance will still result from reduction of ecological connectivity. While it cannot be mitigated to a Minor level, compensatory measures to improve connectivity of the site could be considered. This includes widening of the Ecological Corridor and/ or additional planting in the northern part of the site towards Villa Verde Bridge. Since habitat loss cannot be mitigated, the loss of/ reduction in habitats and food sources remain as **Major** for all species. A summary of residual impacts to faunal receptors is given in Table 7-44. The detailed evaluation for each species is provided in Appendix L. In addition to this, the residual impacts from airborne noise to fauna during construction phase are assessed in Section 10.

Loss of/ reduction in Habitats and Food Sources

For all taxa, the **Major** impact significance owing to the loss of/ reduction in habitats and food sources will remain **Major** despite implementing the mitigation measures as more than 40% of the habitats will still certainly be cleared. Habitat loss cannot be further mitigated. Nevertheless, the minimum controls such as limiting works to agreed boundaries within the worksite, ensuring the connectivity of the Ecological Corridor throughout the construction phase, and implementing enhancement planting in the Ecological Corridor and Rail Corridor prior to site clearance should be implemented to minimise these impacts to as low as reasonably practicable.

Loss/ reduction of Ecological Connectivity for Faunal Movement

While the reduction in ecological connectivity for faunal movement cannot be further mitigated, compensatory measures stated in Section 7.8.1.3 could be considered. This includes widening of the Ecological Corridor and/or additional planting in the northern part of the site towards Villa Verde Bridge.

Accidental Injury or Mortality

Accidental injury or mortality could be reduced for the smooth otter and Sunda pangolin by adhering to speed limits and conducting regular site inspections for entrapped fauna; and for the two bamboo bats by conducted bamboo bat detection and rescue before site clearance. This reduces the likelihood to **Less likely**, resulting in **Minor** impact significance.

Light Disturbances

Since no night works will be carried out, i.e., works restricted to 08:00 h–18:00 h, impact significance remains as **Minor**.

**Table 7-44 Summary of construction phase residual impacts to faunal receptors**

| Impact Type | No. of Species | | | |
|---|---|---|---|---|
| | Major | Moderate | Minor | Negligible |
| **Loss of/ reduction in habitats and food sources** | 18 | — | — | — |
| **Loss/ reduction of ecological connectivity for faunal movement** | — | 8 | 10 | — |
| **Light disturbances** | — | — | 18 | — |
| **Human disturbances** | — | — | 16 | — |
| **Accidental injury or mortality** | — | — | 5 | 13 |
| **Human-wildlife conflict** | — | — | 2 | — |

## 7.9.2 Operational Phase

### 7.9.2.1 Habitats

Habitat degradation

Based on the mitigation measures proposed in Section 7.8.1.2 (e.g., limiting the public access into the RAC) will reduce the likelihood of habitat degradation as it would reduce the amount of trampling of vegetation. Assuming that these mitigation measures are implemented, the likelihood of this impact to this habitat is expected to be reduced to '**Less likely'** for the managed vegetation with planted trees**.** This reduces the impact significance for this habitat to **Minor.**

**As for the turf area,** there is no change to the impact significance (e.g., **Minor**) as the impact has been reduced to a level that is as low as reasonably practicable.

Changes in species composition

During the operational phase, only **Minor** impact significance are expected for both habitats. Since it cannot be mitigated further, the impact significance remains.

With the proposed enhancement and rehabilitation measures mentioned in Section 7.8.1.3 (e.g., dense landscaping within the RAC/ Ecological Corridor and along the edges, this would also function as an additional buffer for the RAC from the long-term changes in light, temperature, and humidity due to the proposed residential development. Since the existing RAC/ Ecological Corridor is also mainly exotic-dominated, by adopting a native-

planting palette for the enhancement planting, this would have a positive impact to the species composition as it increases the native flora biodiversity of the site.

**Table 7-45 Key biodiversity habitat receptors likely to experience indirect residual impacts within the Project site during operational phase**

| Habitat receptor | Priority level | Indirect impact (% of total habitat type within study area) | Most Severe Impact Significance and impact type |
|---|---|---|---|
| **Managed vegetation-Planted trees** | Priority 1 | 36.3% (3.24 ha) | **Minor** |
| **Managed vegetation-Turf** | Priority 2 | 5.1% (0.26 ha) | **Minor** |

### 7.9.2.2 Flora

For the 15 plant species recorded from Project site and selected for the assessment of ecological impacts during the operational phase, impacts during the operational phase before mitigation measures were theoretically implemented are **Moderate** for one species and **Negligible** for 14 species (Table 7-46; Appendix L). The four plant species that were extirpated from the Project site during the construction phase were not considered. Limiting public access to the RAC can reduce the likelihood of poaching. In doing so, specifically for *Bridelia stipularis*, the residual impact is expected to be lowered from **Moderate** to **Minor**. As the other plant species face **Negligible** impacts, there is no further reduction in overall impact (refer to Section 7.7.2.2).

**Table 7-46 Summary of operational phase residual impacts to flora species receptors**

| Impact Type | No. of Species | | | |
|---|---|---|---|---|
| | Major | Moderate | Minor | Negligible |
| **Poaching** | — | — | 1 | 14 |

### 7.9.2.3 Fauna

Six operational phase impacts were identified and assessed for faunal receptors: (1) accidental injury or mortality, (2) human-wildlife conflict, (3) poaching, (4) loss of/ reduction in ecological connectivity for faunal movement, (5) light disturbances, and (6) human disturbances. The assessment considered mitigation measures for faunal species as well as habitats, which directly influences how fauna will respond to the measures.

The residual impact significance ranged from Negligible to **Moderate**. A summary of the impact to fauna receptors is given in Table 7-47. The detailed evaluation for each species is provided in Appendix L.

With the implementation of lighting strategies to minimise light pollution to the RAC/ Ecological Corridor, the impact significance from light disturbances and accidental injury or mortality due to bird-building collisions could be reduced from **Moderate** to **Minor**. The impact significance of accidental injury or mortality for these birds would hence be reduced to **Minor** from Moderate. By adopting appropriate design and administrative measures, the likelihood of human-wildlife conflict for one species, the long-tailed macaque, may be reduced to **Less Likely**, thus reducing the impact significance to Negligible to **Minor**. In addition to this, the residual impacts from airborne noise to fauna during operational phase area assessed in Section 10.9.2.

Light disturbances

The presence of residential buildings during the operational phase will increase the levels of artificial light around the Study Area. Fauna residing within the RAC/ Ecological Corridor will be the most affected by light disturbances. Light disturbances can be reduced to **Minor** residual impacts with the implementation of the measures to minimise ecological light pollution, such as establishing “dark buffers” at the edges of the RAC/ Ecological Corridor,

minimising light spills, and using wildlife-friendly light properties or features. The likelihood of light disturbances occurring can be reduced from **Likely** to **Less likely.**

Accidental Injury or Mortality

With lighting strategies in place, the impact significance from accidental injury or mortality due to bird-building collisions can be reduced from **Moderate** significant impacts for eight species of birds assessed to **Minor** residual impacts as the likelihood of collisions occurring will be reduced from **Possible** to **Less Likely**.

Human-wildlife Conflict

**Moderate** significant impacts owing to human-wildlife conflict may be reduced to **Minor** residual impacts with the limitation of human activities and access in the RAC/ Ecological Corridor, installation of educational sign boards, wildlife awareness programs, and monkey-proofing features. The likelihood of human-otter and monkey interactions resulting in conflict may be reduced from **Possible** to **Less Likely**.

**Table 7-47 Summary of operational phase residual impacts to faunal receptors**

| Impact Type | No. of Species | | | |
|---|---|---|---|---|
| | Major | Moderate | Minor | Negligible |
| **Loss/ reduction of ecological connectivity for faunal movement** | — | 8 | 10 | — |
| **Light disturbances** | — | — | 18 | — |
| **Human disturbances** | — | — | 18 | — |
| **Accidental injury or mortality** | — | — | 14 | 4 |
| **Human-wildlife conflict** | — | — | 2 | 16 |
| **Poaching** | _ | – | 4 | 14 |

# 7.10 Cumulative Impacts from Other Concurrent Developments

## 7.10.1 Construction Phase

One major concurrent development, a nearby future development by other agency, has been identified in Section 3.2.1 to be in the vicinity of the Project. The cumulative impact on biodiversity during construction phase is elaborated in sections below.

### 7.10.1.1 Nearby Future Development by Other Agency

The nearby future development by another agency will have an overlapping construction timeline with CCK N1 for the Project's construction. The nearby future development by other agency involves which is expected to take place longer than CCK N1. HDB CCK N1 involves the construction of HDB residential buildings which is expected take place over 6 years. The nearby future development by other agency worksite will be situated on the boundary of the CCK N1 Study Area, just outside of the Rail Corridor. It is expected to have a much smaller footprint than CCK N1 at this area. However, minor site clearance is expected in some areas along the Rail Corridor further north of CCK N1.

Impacts to habitats and flora: There is minimal vegetation clearance from the nearby future development by other agency project. Indirect impacts such as habitat degradation may occur on the remaining habitats and flora within the CCK N1 site. Dust impacts to the plant species within site should also be considered (see Section 9.10 for cumulative dust impacts). Due to small area of vegetation that may be affected, cumulative impact to habitats and flora is expected to be minimal.

Impacts to fauna: Similarly, direct impacts from vegetation removal would result in loss/ reduction in habitat for fauna is minor, while indirect impacts such as habitat degradation, increase in noise and dust would also cause some impact to faunal species utilising Study Area. For dust and noise cumulative impacts to the fauna species within Study Area, please refer to Section 9.10 and Section 10.10, respectively. Therefore, cumulative impact was assessed to be some increase to the fauna within Study Area.

### 7.10.1.2 Bukit Panjang North Park Connector

Works are likely to take place from 2023 along the roadside, and large heavy machineries are not expected. Vegetation loss and disturbances generated are not expected to be extensive. Since there are few sensitive ecological receptors nearby, cumulative impacts from habitats, flora and fauna are expected to be minimal.

### 7.10.1.3 Rail Corridor North Enhancement Works

Works will take place along the Rail Corridor. Extensive vegetation loss and large heavy machineries are not expected. It is also assumed that night works will not happen here. Therefore, cumulative impacts from habitats, flora and fauna are expected to be minimal.

## 7.10.2 Operational Phase

### 7.10.2.1 Nearby Future Development by Other Agency

During the operational phase, construction works for the nearby future development by other agencyproject is likely still ongoing. Similar to construction phase, cumulative impact to habitats and flora is expected to be minimal, and that for fauna to have some increase.

### 7.10.2.2 Bukit Panjang North Park Connector

During operational phase, it is unclear if the works will still be ongoing. However, impacts are expected largely from light disturbances from street lights along the road edge. Overall, cumulative impacts from habitats, flora and fauna are expected to be minimal.

### 7.10.2.3 Rail Corridor North Enhancement Works

During operational phase, it is unclear if the works will still be ongoing. However, as the works for Rail Corridor complete, it is expected to bring positive impacts to habitats, flora and fauna.

## 7.11 Summary of Key Findings

The floristic field assessment shows that the Study Area mainly constitutes managed vegetation, comprising clusters of trees planted for landscape purposes (9.62 ha; 45.2%) which occupies about half of the Study Area, and turf area (5.36 ha; 25.2%). Existing canal and infrastructure, such as the heavy vehicle carpark and defunct bus terminal take up 6.32 ha (29.6%) of the Study Area. The floristic assessment identified a total of 119[9] species from 45 families. Of the 119 species recorded, majority are exotic (81 species; 68.1%), only 27 species are native (22.7%) and 11 (9.2%) are cryptogenic (i.e., species that has unknown or uncertain origins). Only one species, *Bridelia stipularis* is considered as species of conservation significance. Ninety-one large plant specimens were recorded in the Study Area, largely dominated by Senegal mahogany (*Khaya senegalensis*) and raintree (*Samanea saman*). Other specimens of value consist of two keystone species with two specimens respectively: Malayan banyan (*Ficus microcarpa*) and weeping fig (*F. benjamina),* with a spread that ranges from 3-8 m. In addition, a bamboo cluster, *Bambusa* cf. *heterostachya* with a spread of 2.5 m, were also identified to be possible roosting habitat for bamboo bats. In total, 397 trees of $\geqslant$ 0.3 m girth were tagged and recorded within the Study Area.

The faunistic field assessment recorded 78 species, dominated by birds (29 species) and butterflies (18 species). Most of the species recorded are widespread and common, typical of such parkland habitats. Most of the species recorded are widespread and common, typical of such parkland habitats. No species of conservation significance was recorded although uncommon or rare species such as the dingy duskhawker (*Gynacantha subinterrupta*) and common evening brown (*Melanitis leda leda*) were recorded. Nine migratory bird species were also recorded, including uncommon migrants, such as the rare yellow-browed warbler (*Phylloscopus inornatus*) and uncommon migrant, yellow-rumped flycatcher (*Ficedula zanthopygia*). These records show the value of the Study Area in supporting uncommon species and migratory birds.

Other species of conservation significance that may utilise the Study Area as a stepping stone to move between habitats include the globally Critically Endangered and nationally Endangered straw-headed bulbul (*Pycnonotus zeylanicus*), the globally Vulnerable and nationally Endangered smooth-coated otter (*Lutrogale perspicillata*), as well as the globally and nationally Critically Endangered Sunda pangolin (*Manis javanica*). These species have been recorded in surrounding green spaces and/ or waterbodies and deemed possible to utilise the Study Area. The presence of species of conservation significance, forest-associated species, and migrants demonstrates the value of the Study Area as a stepping stone to surrounding green spaces, such as the Bukit Mandai forest to the northeast and Bukit Gombak forest to the south, in enhancing ecological connectivity across the landscape (Section 7.4.4). The waterbodies within the Study Area are poor in aquatic life and are more likely to be used by fauna as a corridor to move between habitats.

A recommended area of conservation (RAC) is developed with reference to the proposed Ecological Corridor boundary developed with reference to EBS findings and recommendations, and consultations with agencies and Interest Groups. Generally, the RAC aims to conserve a minimum of 2 ha of the total Study Area. The ecological receptors that will be retained within this RAC includes 42.9% (3.83 ha) of the Priority 1 and 2 habitats (i.e., managed vegetation with planted trees and turf area), clusters of large specimens and Priority 1 flora receptors such as three fig (*Ficus* sp.) stranglers and the nationally Vulnerable climber, *Bridelia stipularis*.

The RAC will primarily function as an ecological corridor during the development and upon the establishment of residential area in CCK N1. Currently, the proposed width of this Ecological Corridor will range from approximately 20 m and up to 85 m. By retaining this strip of linear greenery, this will provide vegetated corridor for ground-dwelling fauna species to travel to other habitat patches located up north of the Study Area and/ or south towards Hillview and Bukit Timah Nature Reserve (BTNR) during the construction and operational phase of CCK N1. It is to note that the width of the Ecological Corridor is not taken to be final but subject to further changes based on detailed studies such as design, on-site conditions, arborist's assessment, etc.

The ecological value of two terrestrial habitats within the Project site were assessed, of which, managed vegetation comprising the planted trees is assessed with high ecological value (Priority 1) while the managed turf area is assessed with a medium ecological value (Priority 2). A total of 19 flora receptors (i.e., species of conservation

[9] During the Environmental Impact Assessment it was noticed that some of the species count data was incorrectly displayed. As such, the data has been updated within this EIA to accurately reflect the correct data.

significance, large specimens and species affected by the development) as well as 18 faunal receptors of Priority 1 were identified for impact assessment.

Three types of impact for the identified sensitive habitat receptors during the construction phase— (1) loss of vegetation, (2) habitat degradation, and (3) formation of forest edge—the impact significance ranged from **Negligible** to **Major**. Both habitat receptors will be majorly affected by vegetation clearance. For habitat degradation, both habitats are expected to face with **Moderate** impacts and for the impact of formation of forest edges, only Negligible and **Minor** impact are expected. As for the residual impact significance, the impact for loss of vegetation remains the same as land clearance is inevitable for the development of CCK N1. With mitigation measure such as conducting regular inspections to ensure contractor compliance mentioned in Section 7.8.2 on the minimum control measures listed in Section 1.1, this would reduce the impact significance of habitat degradation from **Moderate** to **Minor**. Lastly, the impact significance for formation of forest edge for both habitats remain the same (i.e., **Negligible** - **Minor**) as the impact has been reduced to a level that is as low as reasonably practicable.

For operational phase, two types of impacts for habitat receptors were assessed during the operational phase– (1) habitat degradation and (2) change in species composition–the impact significance was **Moderate** mainly for the area with planted trees, and **Minor** respectively. Assuming that the recommended mitigation measures are imposed (e.g., limiting the public access into the RAC/ Ecological Corridor etc) (Section 7.8.1.3), the impact for habitat degradation will be reduced to **Minor.** As for the impact of change in species composition**,** only **Minor** impact significance are expected for both habitats.

In the assessment of the two types of impact for individual flora species receptors during the construction phase – (1) mortality, (2) decline in plant health and survival. Four species are likely to experience **Major** impacts owing to mortality, three species will experience **Moderate** impacts and seven species that will experience **Minor** impacts. The remaining five species will face **Negligible** impact as it will not be directly affected by vegetation clearance. As for decline in plant health, only 15 flora receptors were assessed as it is assumed that all specimens of the remaining 4 flora receptors have been already cleared. Six species are likely to experience **Moderate** impacts owing to decline in plant health, while for the remaining nine species, they are assessed with **Minor** impact significance.

The residual impact significance of mortality remains the same for all flora receptors since land clearance is inevitable for the development of CCK N1. As for the impact resulted from decline in plant health, the impact significance of six flora species receptors that were initially assessed as **Moderate** during the pre-mitigation impact assessment, is reduced to **Minor**. As for the remaining nine species, proposed mitigation measures such as in-fill planting and dense landscaping/ planting along the edges of the RAC/ Ecological Corridor (Section 7.8.1.2 and 7.8.1.3), the impact significance for six flora species receptors, is reduced to from **Moderate** to **Minor**. As for the remaining nine species, their impact significance remains as **Minor** since this impact cannot be mitigated further.

For the operational phase, only one impact type was assessed (i.e., poaching), of which, all flora receptors were assessed with **Negligible** impact significance, except for one species, *Bridelia stipularis*, which was assessed with **Moderate** impact. Assuming the proposed mitigation measures are implemented (i.e., limiting public access in the RAC), this reduces the residual impact is expected to be lowered from **Moderate** to **Minor** for *B. stipularis.*

Six construction phase impacts were identified and assessed for faunal receptors: (1) loss of/ reduction in habitats and food sources, (2) accidental injury or mortality, (3) human-wildlife conflict, (4) loss of/ reduction in ecological connectivity for faunal movement, (5) light disturbances, and (6) human disturbances. The impact significance ranged from **Negligible** to **Major**. **Major** impact was expected from loss of habitats from site clearance for all species but cannot be mitigated. **Minor** impacts were expected from light disturbances since no night works will be carried out. **Moderate** impacts were also expected from reduction in ecological connectivity for faunal movement, and accidental injury/ mortality. The remaining impacts are considered **Minor**.

With the implementation of i) lighting strategies to minimise light pollution to the Ecological Corridor, and ii) imposing speed limits, impacts from accidental injury or mortality can be reduced to **Minor**. A **Moderate** impact significance will still result from reduction of ecological connectivity. While it cannot be mitigated to a **Minor** level, compensatory measures to improve connectivity of the site could be considered. This includes widening of the RAC/ Ecological Corridor and/ or additional planting in the northern part of the site towards Villa Verde Bridge (Section 7.8.1.3). All minimum controls are assumed to be properly implemented and enforced.

Six operational phase impacts were identified and assessed for faunal receptors: (1) accidental injury or mortality, (2) human-wildlife conflict, (3) poaching, (4) loss of/ reduction in ecological connectivity for faunal movement, (5) light disturbances, and (6) human disturbances. The impact significance ranged from **Negligible** to **Moderate.**

Moderate impacts were expected from reduction in ecological connectivity for faunal movement, light disturbances, accidental injury or mortality and human-wildlife conflict.

With the implementation of i) lighting strategies to reduce light pollution to RAC/ Ecological Corridor, and ii) installation of education signages to educate residents on proper behaviors around wildlife, and iii) use of wildlife-proof bins and proper waste management, impacts from light disturbances, accidental injury or mortality (from bird-building collision) and human-wildlife conflict can be reduced to **Minor.** All minimum controls are assumed to be properly implemented and enforced.

**Table 7-48 Summary of biodiversity impact assessment**

| Potential Source of Impact | Impact Significance with Minimum Control | Residual Impact Significance with Mitigation Measures (if required) |
|---|---|---|
| **Construction Phase** | | |
| **Habitats** | Minor – Major | Minor – Major |
| **Flora** | Negligible – Major | Negligible – Major |
| **Fauna** | Negligible – Major | Negligible – Major |
| **Operational Phase** | | |
| **Habitats** | Minor – Moderate | Minor |
| **Flora** | Negligible – Moderate | Negligible – Minor |
| **Fauna** | Negligible – Moderate | Negligible – Moderate |

# 8 Water Resources

## 8.1 Introduction

This section includes the assessment of baseline conditions of hydrology, surface water quality and groundwater within the Study Area (as defined in Section 4.1), as well as the evaluation of the potential impacts on these parameters, arising from activities during Project's construction and operational phases. Baseline conditions were established by AECOM during previously carried out EBS [P-1] based on the analysis of primary (e.g. visual observations during site reconnaissance and surveys, hydrological surveys [i.e., during both dry and wet weather conditions], surface water quality sampling, etc.) and secondary data (e.g. publicly-available secondary data and data provided by the Client). The EBS findings were subsequently used to analyse the changes that might occur due to the impacts associated with assumed activities during construction and operational phases of the Project (as detailed in Section 3 of this Report). Ecological, human and socio-economic sensitive receptors were identified and classified according to the sensitivity categorization as defined in Section 6.2.2 of this Report. The prediction of impacts was conducted by considering various potential sources of impact from the Project which could affect identified sensitive receptors. Minimum control measures, which are standard practices that should be implemented on-site during the construction and operational phases, were also described. In consideration of the baseline survey findings and with the assumption that minimum controls are implemented, the evaluation of these potential impacts was carried out (refer to Section 1.1). Mitigation measures and EMMP was developed (refer to Section 8.8 and Section 11, respectively) to reduce/ minimise any impacts identified to be moderate or major.

The scope of work of the water resources (i.e., hydrology, surface water quality and groundwater) baseline study (carried out as part of EBS [P-1]) consisted of:

- Review of data provided by the Client and desktop research of publicly available data;
- Analysis of topographic and hydrographic characteristics of the Study Area, based on topographic survey and reviewing data provided by the Client;
- Desktop research of publicly available data to determine the characteristics of groundwater below the Study Area;
- Site reconnaissance survey for better understanding of the Study Area's topography, hydrology, land cover and properties of existing watercourses (i.e., locations, water flow conditions and bank characteristics);
- Identification and mapping the location and alignment of all watercourses within the Study Area;
- Identification of sampling locations for in-situ and ex-situ water quality analysis of existing watercourses within the Study Area;
- Establishment of hydrological baseline conditions and determining water sources feeding major watercourses, based on the collected data; and
- Establishment of baseline quality of watercourses present within the Study Area.

The scope of work of the water resources (hydrology, surface water quality and groundwater) impact assessment study consisted of:

- Site reconnaissance survey to identify any changes in hydrological and water quality conditions, compared to the EBS findings;
- Review of data provided by the Client regarding the Project's proposed activities to identify potential sources of impacts during construction and operational phases of the Project;
- Assessment of hydrological, surface water quality and groundwater impacts associated with the proposed Project activities;
- Proposal of mitigation measures to mitigate the potential moderate to major impacts; and
- Development of EMMP to manage and monitor potential impacts of the Project during construction and operational phases.

# 8.2 Methodology and Assumptions

This section details the methodology adopted for water resources (hydrology, surface water quality and groundwater) baseline study as well as approach and methodology for impact assessment during both construction and operational phases of the Project.

## 8.2.1 Water Resources Baseline Study

Water resources baseline study was carried out as part of EBS [P-1] by a combination of desktop research (i.e., review of publicly available secondary data, data provided by the Client, previous studies, etc.) and field surveys (including the collection and analysis of primary data such as surface water samples and quality analysis and visual observations during site visits). Subsequently, this data was collated, analysed and compared to the selected criteria, where applicable. The water resources baseline study included establishment of hydrological, surface water quality and groundwater baseline conditions within the Study Area.

### 8.2.1.1 Data Collection

#### 8.2.1.1.1 Desktop Research

Desktop research consisted of a review of secondary data (including existing topographic data, vegetation cover, existing land use and development activities, satellite images, groundwater levels, etc.) which aided in determining the location of existing watercourses within the Study Area. The topographic survey was carried out by Client-appointed surveyor and was provided to AECOM by the Client. Regional catchment map (i.e., the source of water flow into existing reservoirs) was sourced from PUB website [W-3] and was coupled with topographic survey data to support the findings of the hydrological survey. As part of desktop research, AECOM also reviewed other publicly available data from government and technical agencies, existing available data (e.g., online satellite images), as well as published books, relevant articles, and other online sources.

#### 8.2.1.1.2 Field Survey and Sampling Events

The activities performed as part of the field investigations included the following:

- Evaluation of the accessibility of the watercourses through existing tracks;
- Verification of the information collected from the available topographic surveys and satellite images;
- Identification and mapping of the existing watercourses within the Project site;
- Assessment of the flow conditions and bank characteristics of the identified watercourses during dry and wet weather conditions;
- Observation of water quality indicators in existing watercourses within the Project site (e.g., physical parameters such as colour, turbidity, odour, etc); and
- Sampling of representative surface water samples for the purposes of in-situ and ex-situ water quality analysis.

##### *8.2.1.1.2.1 Hydrological Survey*

Hydrological survey was conducted as a part of the EBS [P-1] with aim to identify the watercourses currently present at the Project site and to understand the watercourses conditions such as stream bank characteristics and flow conditions. Data collected as part of hydrological survey was subsequently used to establish the hydrological baseline conditions and to carry out impact assessment due to the proposed activities during construction and operational phases of the Project.

Prior to site visit, available topographic survey data and Google satellite images were analysed and used to preliminary locate the watercourses currently present within the site. Following this, hydrological site survey was conducted by casual exploration methods to confirm/ identify the exact locations of the watercourses. A Global Positioning System (GPS) device was used to track the hydrological survey route. During the survey, characteristics of stream banks (e.g. natural bank or artificial bank) and their flow conditions (e.g. flow direction, velocity) were estimated based on visual observations and recorded in the form of photographs and field notes. This qualitative data was coupled and synchronised with the GPS data and used for establishment of hydrological baseline conditions. Hydrological survey also included assessment of current topography and land uses of the site in order to predict the likely overland flow routes of surface water runoff and identify main water sources feeding the watercourses.

#### *8.2.1.1.2.2 Surface Water Quality Sampling*

The potential water quality sampling locations were identified based on preliminary findings during site reconnaissance and hydrological survey. The final locations were selected taking into consideration the following aspects:

- Location of watercourses within the Project site relative to each other and watercourses in the surrounding area;
- Junctions with other watercourses, if any;
- Catchment delineation and potential water sources feeding the watercourses;
- Surrounding land use and biodiversity habitats;
- Shape and size of watercourses; and
- Estimated flow characteristics and direction.

In order to obtain comprehensive surface water quality baseline data that will capture the possible changes in physico-chemical composition of surface water over time and different events, identified watercourses were sampled during both dry weather and wet weather conditions. Dry weather conditions are defined as flow conditions and water quality in watercourses after a continuous 48-hour period of no-rain, while wet weather conditions are defined as flow conditions and water quality within watercourses after rainfall event having more than 10 mm of rainfall, with samples to be collected within three (3) hours after the rain stops. Generally, two (2) dry weather and one (1) wet weather samples were collected from each water quality station. Collected surface water samples were collected and tested in-situ and ex-situ for a range of physical and chemical parameters.

For this study, in-situ water quality parameters were measured using a calibrated multi-parameter digital sensor (YSI ProDSS) with United States Environmental Protection Agency (USEPA) approved testing methods for water quality parameters and included:

- Temperature
- pH;
- Salinity/ Conductivity;
- Total Dissolved Solids (TDS);
- Turbidity; and
- Dissolved Oxygen (DO).

The ex-situ parameters that were analysed by Marchwood Laboratory Services Pte. Ltd. (MLS) are listed below:

- Total Nitrogen (TN);
- Total Phosphorus (TP);
- Ammonium Nitrogen (NH4-N);
- Nitrates (NO3-N);
- Orthophosphates (PO4-P);
- Total Suspended Solids (TSS);
- Total Organic Carbon (TOC);
- Enterococcus; and
- Lead (Pb).

## 8.2.2 Water Resources Baseline Data Assessment

The activities performed as part of the analysis and assessment of baseline data included the following:

- Analysis of collected data using various specialized software programmes (e.g. ArcGIS);
- Evaluation of the accuracy of collected primary data and comparison and coupling with relevant available secondary data;

- Development of maps and figures for better visualisation and comparison of data; and
- Comparison of data to selected criteria.

#### 8.2.2.1 Hydrology and Groundwater Baseline Assessment

Hydrological baseline study aims to establish current hydrological conditions of the site and present watercourses based on the collected primary and secondary data. This includes the overview of site's topography, land use/ cover, understanding the hydrological features present on the site (e.g. slopes), existing drainage network and flow conditions. Groundwater conditions were determined by review and analysis of available secondary data [P-69, M-3].

The elevation and slope maps of the Project site were developed based on surveyed topographic survey data using GIS technique. In order to determine the exact locations of each of the identified watercourses, GPS data from surveys was synchronised with the photos taken on site. Catchment analysis was conducted based on surveyed topographic data and publicly available catchment map of Singapore developed by PUB [W-3]. Catchment delineation is a key step in the identification of the main sources of water that feed each of the watercourses within the Study Area and also aids in the understanding of how stormwater runoff flows within the site.

#### 8.2.2.2 Surface Water Quality Baseline Assessment and Adopted Criteria

The baseline water quality of the watercourses located within the Project site was determined by comparing the selected parameters against the NEA Trade Effluent Discharge limits for controlled watercourses [R-12]. This comparison could be used to determine whether the existing baseline water quality of the watercourses within the site complies with NEA limits or already exceeds these limits. However, the NEA Trade Effluent Discharge limits do not provide criteria for the preservation and growth of aquatic life locally. To assess whether the surface water quality within the Project site is suitable for aquatic life, the baseline water quality was compared to the water quality criteria for aquatic life from other countries (i.e., USEPA [R-22], Australian & New Zealand [R-23], Canada [R-24], Philippines [R-25], and Malaysia [R-26]), as well as criteria set up by international organisations (i.e., United Nations Economic Commission for Europe [R-19], World Health Organization [R-21],) which provide guidelines for the protection of aquatic life. The relevant limits and guidelines for water quality parameters were summarised in Table 8-1; however, where no guidelines exist, the monitored results would be considered as the baseline.

**Table 8-1 Water quality guidelines and criteria**

| Parameter | NEA Trade Effluent Discharge Limits[1] | International Water Quality Criteria for Aquatic Life[2] |
|---|---|---|
| **pH** | 6 – 9 | 6.5 – 9 |
| **Temperature (°C)** | 45 | - |
| **Salinity (ppt)/ Conductivity (µS/cm)** | - | - |
| **Dissolved Oxygen, DO (mg/L)** | - | > 4.0 |
| **Turbidity (NTU)** | - | 50 |
| **Total Dissolved Solids, TDS (mg/L)** | 1000 | 1000 |
| **Total Suspended Solids, TSS (mg/L)** | 30 | 50 |
| **Total Organic Carbon, TOC (mg/L)** | - | - |
| **Total Phosphorous, TP (mg/L)** | - | Eutrophic limit: 0.075 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 |
| **Ammonium Nitrogen, $NH_4$-N (mg/L)** | - | 0.5 |
| **Nitrate, $NO_3$-N (mg/L)** | 4.52 (equivalent to 20 as $NO_3$) | 10 (equivalent to 44 as $NO_3$) |
| **Enterococcus[3]** | - | - |
| **Lead, Pb (µg/L)** | 100 | Acute LOEL[4]: 82<br>Chronic LOEL[4]: 3.2 |

**Note:**

1. NEA Trade Effluent Discharge Limits for discharge into a controlled watercourse.
2. The sources of international water quality criteria for aquatic life includes Australian and New Zealand Environment and Conservation Council (ANZECC, 2000) [R-23], Canadian Council of Ministers of the Environment (CCME, 2007) [R-24], Department of Environment of Malaysia (DOE, n.d.) [R-26], United Nations Economic Commission for Europe (UNECE, 1994) [R-19], World Health Organization (WHO, n.d.) [R-21], United States Environmental

| Parameter | NEA Trade Effluent Discharge Limits[1] | International Water Quality Criteria for Aquatic Life[2] |
|---|---|---|

Protection Agency (USEPA, 2017) [R-22], and Mitigating Impact from Aquaculture in the Philippines (PHILMINAQ, n.d.) [R-25].

3. Singapore's Water Quality Guidelines for Recreational Beaches and Fresh Water Bodies requires that the Enterococcus count should be less than or equal to 200 counts per 100 millilitres of water at 95% of the time [W-18]
4. LOEL – Lowest Observed Effect Level

## 8.2.3 Impact Assessment

The detailed methodology for the prediction and evaluation of potential hydrology, surface water quality and groundwater impacts during construction and operational phases have been described in following sub-sections.

### 8.2.3.1 Hydrology Impact Assessment

The direct impacts on hydrological characteristics of the Study Area (e.g., quantities of surface water runoff, peak flow of surface water runoff, flow conditions within the watercourses, etc.) were assessed by using qualitative methods, based on the understanding of proposed development, activities during construction and operational phases and hydrological baseline findings.

Subsequently, the impact on identified ecological, human and socio-economic receptors (i.e., indirect impacts) due to hydrological changes was assessed qualitatively, based on the extent of direct impacts, sensitivity of receptors and estimated frequency of the impacts.

### 8.2.3.2 Surface Water Quality Impact Assessment

Qualitative and analytical methods were applied to assess the potential impact(s) of pre-construction, construction and operational activities on the surface water quality of the identified present and future watercourses within the Study Area. This approach was based on the analysis of primary and secondary data, technical experiences from previous projects and from an understanding of the Project's activities during construction and operational phases (as described in Section 3.2.1 and Section 3.3, respectively).

Subsequently, qualitative impact assessment on identified ecological, human and socio-economic receptors (i.e., indirect impacts) as a consequence of water quality changes was carried out based on the severity and extent of potential deterioration of water quality due to proposed Project activities.

### 8.2.3.3 Groundwater Impact Assessment

Qualitative assessment methods were applied to assess the potential impact that activities planned for construction and operational phases of the Project might have on groundwater. Subsequently, impacts on identified ecological and human receptors due to changes in groundwater quality and/ or levels were assessed qualitatively, based on the impact intensity, sensitivity of the receptors and estimated likelihood of impacts.

# 8.3 Potential Sources of Water Resources Impact

This section discusses the potential environmental impacts due to hydrological and/ or surface water quality changes arising from the construction and operational phases of the Project.

## 8.3.1 Construction Phase

Identified watercourses within Project site and its vicinity could be potentially exposed to hydrological flow changes and contamination due to the activities planned to take place during construction phase of the Project. The activities and their associated impacts include, but are not limited to, those listed in Table 8-2.

**Table 8-2 Potential water resources impacts during the construction phase**

| Activity | Potential Sources of Impact | Potentially Affected Environmental Parameter | Potential Associated Impacts |
|---|---|---|---|
| • Clearance of trees and other vegetation (outside of proposed Ecological Corridor)<br>• Removal of existing structures currently present on the site such as drains and Rail Corridor<br>• Site levelling<br>• Soil dewatering during foundation works<br>• Superstructure works (i.e., construction of residential buildings and accompanying roads and other infrastructure) | • Temporary and/ or permanent land use change (e.g. earthwork areas, built-up areas, soil stockpiles) causing increase in stormwater runoff peak flow;<br>• Pre-construction and construction activities which increase quantities of water flowing into the watercourses (e.g. stormwater and/ or groundwater pumped out from excavated areas, runoff from dust suppression sprays, etc.);<br>• Groundwater extraction/ soil dewatering during pre-construction and construction activities that require dry soil conditions;<br>• Reduced groundwater baseflow feeding into the watercourses due to temporary and/ or permanent increase in impervious surfaces;<br>• Different water inflow distribution along the watercourses due to proposed changes in drainage system; and<br>• Heavy rainfall events. | • Hydrology<br>• Groundwater Level | • Altered dry and wet weather flow conditions within watercourses;<br>• Increased water levels within watercourses and consequent flooding of adjacent areas/ parcels;<br>• Increased water flow velocity, leading to erosion along the watercourses;<br>• Stormwater runoff from exposed and unstable slopes may cause soil erosion and accretion;<br>• Altered dry weather flow conditions may cause adverse impacts to downstream aquatic habitats and communities;<br>• Disturbances in habitats due to reduction of groundwater levels;<br>• Flooding may have adverse impacts on surrounding habitats and biocenosis; and<br>• Localised flooding within the Project site may cause abruption of the regular on-site activities.<br>• It is understood that currently in Singapore groundwater is not used for any beneficial purposes (i.e. drinking or industrial purposes, irrigation). |
| • Site clearance<br>• Civil engineering earthworks (e.g. construction of temporary and permanent roads, accompanying infrastructure, etc.) | • Discharge of contaminated surface water runoff originating from exposed soil surface during earthworks;<br>• Discharge of contaminated stormwater and/ or groundwater | • Surface water quality<br>• Groundwater Quality | • Elevated levels of suspended solids (e.g. silt) in surface water runoff leading to quality changes in receiving and downstream watercourses;<br>• Increased quantity of solid waste and contaminated material in receiving watercourses; |

| Activity | Potential Sources of Impact | Potentially Affected Environmental Parameter | Potential Associated Impacts |
|---|---|---|---|
| • Site levelling<br>• Soil dewatering<br>• Foundation works<br>• Superstructure works | pumped out from excavated areas;<br>• Release of grouting and cement materials;<br>• Contaminated runoff from dust suppression sprays;<br>• Discharge of construction wastewater; and<br>• Seepage of contaminants from excavated contaminated soil (if encountered) and/ or extracted groundwater into the underlying soil and groundwater | | • Increase in the levels of oil, grease, and other chemical substances in receiving watercourses;<br>• Changes in surface water quality could have adverse impact on surrounding habitats and/ or species;<br>• Some contaminants such as metals can accumulate in the root zone, affecting vegetation growth and long-term viability;<br>• Contaminated soil and groundwater can directly or indirectly affect fauna, possibly leading to reduction in size of species' population and long-term viability<br>• Adverse impact on human health due to direct or indirect exposure to contaminated soil and groundwater; and<br>• Contamination may spread to downstream watercourses, eventually reaching reservoirs from which the water is captured for drinking water purposes. |
| • Storage and disposal of liquid and solid wastes<br>• Handling, transfer and storage of chemical substances<br>• Maintenance and refuelling of vehicles, machinery and equipment | • Discharge of contaminants due to improper handling, transfer, storage and disposal of solid waste (e.g. construction debris);<br>• Discharge of contaminants due to improper handling, transfer, and storage of chemical substances;<br>• Seepage of contaminants due to inappropriate discharge of domestic sewage and poor maintenance of the portable chemical toilets, storage tanks and septic tanks (e.g. overflow, overload);<br>• Fuel and lubricants spillage from maintenance of construction vehicles and mechanical equipment; and<br>• Accidental spills and leaks of chemical substances used for construction activities. | • Surface water quality<br>• Groundwater Quality | • Contamination of watercourses within the Project site may spread beyond the boundaries and contaminate downstream watercourses;<br>• Contaminated surface water could directly or indirectly affect surrounding habitats and water-dependent species;<br>• Some contaminants such as metals can accumulate in the root zone, affecting vegetation growth and long-term viability; and<br>• Adverse impacts on human health due to direct or indirect exposure to contaminated water. |

## 8.3.2 Operational Phase

Watercourses can potentially be exposed to hydrological flow change and surface water contamination due to the activities taking place during the Project's operational phase. The activities that could potentially have an impact on watercourses' quality and quantity and groundwater include but are not limited to those listed in Table 8-3.

**Table 8-3 Potential water resources impacts during the operational phase**

| Activity | Potential Sources of Impact | Potentially Affected Environmental Parameter | Potential Associated Impacts |
|---|---|---|---|
| Permanent land use change | • Increased surface water runoff peak due to more areas with impervious surfaces within new development (e.g. roads, buildings, etc.);<br>• Increased quantities of surface water runoff due to reduced percolation into the soil; and<br>• Decreased infiltration into the ground due to more areas with impervious surfaces in the new development. | • Hydrology<br>• Groundwater Level | • Increased water levels within existing and proposed future watercourses and consequent flooding of adjacent areas/ parcels;<br>• Increased flow velocity within existing natural stream which could cause soil erosion and accretion, changing flow characteristics of the natural stream long-term;<br>• Localised flooding which may interrupt everyday activities of future residents and/ or visitors; and<br>• Altered dry and wet weather flow conditions compared to baseline conditions may cause disturbances in surrounding habitats and species. |
| | Heavy rain and stormwater wash-off pollutants built-up in the new development area and discharge to the surrounding watercourses. | • Surface water quality<br>• Groundwater Quality | • Elevated suspended solids (e.g. silt and sediment) and pollutants (e.g. heavy metals and nutrients from human activities) in site runoff; and<br>• Contamination of surface water may cause disturbances in surrounding habitats and species |
| Improper management of liquid and solid wastes | • Accidental spills and leaks (e.g. during storm event); and<br>• Improper handling, transfer, and storage of solid and liquid wastes (e.g. rubbish collection and sewage disposal); | • Surface water quality<br>• Groundwater Quality | • Solid wastes generated from human activities can lead to elevated levels of suspended solids entering watercourses. The wastes can also block the watercourse and leading to contamination of receiving watercourses;<br>• Contaminated soil and groundwater can directly or indirectly affect fauna, possibly leading to reduction in size of species' population and long-term viability;<br>• Adverse impact on human health due to direct or indirect exposure to contaminated soil and groundwater;<br>• Inappropriate discharge of liquid wastes to the watercourse results in contamination of nearby or downstream watercourses; and |

| Activity | Potential Sources of Impact | Potentially Affected Environmental Parameter | Potential Associated Impacts |
|---|---|---|---|
| | | | • Contamination of surface water may cause disturbances in surrounding habitats and species |

# 8.4 Baseline Water Resources Conditions

As summarized in Table 6-2, this Report presents the hydrology and surface water quality baseline findings from field surveys and surface water sampling collected until April 2021 as part of EBS [P-1]. Groundwater baseline conditions were determined based on available secondary data. Additional field survey was conducted in June 2022 to verify the existing site conditions.

## 8.4.1 Baseline Monitoring Personnel

The field assessment and site surveys were conducted by the following AECOM personnel:

- Dr. Thanh Nguyen (Water Resources Technical Reviewer);
- Dr. Liang Liang (Water Resources Technical Lead);
- Mr. Grujica Sarenac (Water Resources Specialist);
- Ms. Jacquelynn Chia (Water Resources Specialist); and
- Ms. Celine Cho (Water Resources Specialist).

## 8.4.2 Baseline Findings

The following sections describe the hydrological, surface water quality and groundwater baseline conditions within the Study Area. As mentioned earlier in the Report, baseline conditions of the Study Area (i.e. Project site and Pang Sua Canal) were assessed as part of the previous EBS carried out by AECOM [P-1]. The findings of EBS are presented in the following sections. For the consistency, the same naming convention of the watercourses as used in EBS was adopted in this EIA Report.

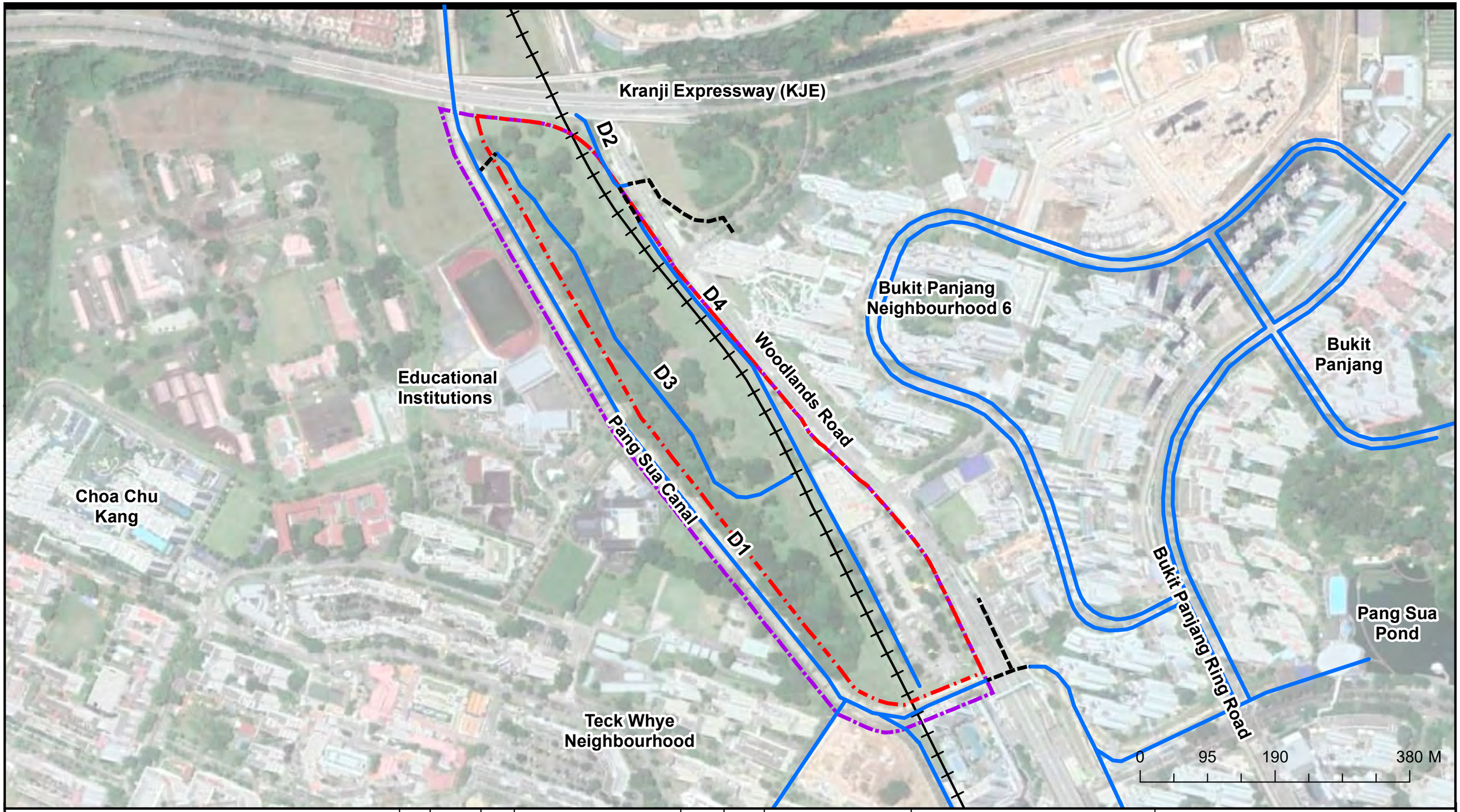
### 8.4.2.1 Hydrological and Groundwater Level Baseline Conditions

Pang Sua Canal (D1) and three (3) concrete drains (D2, D3 and D4) were observed within the Study Area, as shown in Figure 8-1 with bank features and water flow conditions of the watercourses during dry and wet weather conditions provided in Table 8-4. The Pang Sua Canal D1 has perennial flow with water flow ranging from 0.2 m/s to 1.56 m/s observed during dry and wet weather conditions throughout the canal. The concrete drain D2 located near the northeast border of the Project site has a perennial flow approximately 0.08 m/s to 0.6 m/s observed during dry and wet weather conditions. Concrete drain D3 goes through central and north portion of the site and eventually drains into Pang Sua Canal at the northwest border of the site via underground culvert. It has ephemeral flow with flow velocity of approximately 0.29 m/s during wet weather conditions (dry during dry weather conditions). Concrete drain D4 begins at southern portion of the site and runs approximately parallel to the existing Rail Corridor alignment until it eventually drains into D2 at the northeast border of the site via underground culvert. It has ephemeral flow only during the wet weather conditions approximately with a flow of 0.43 m/s. Generally, water in all the watercourses flows from southeast to northwest. All the drains within the Study Area did not have obvious smell based on site observations.

Catchment delineation and estimation of probable overland flow directions were carried out based on the surveyed topographic data and site observations. The topographic data was used to generate elevation and slope maps and subsequently overlaid with surface watercourses using ArcGIS software, as shown in Figure 8-2 and Figure 8-3. As shown in Figure 8-2, the elevation of the Study Area ranges from +0.55 mRL to +27.33 mRL, with decreasing elevations from southeast toward northwest of the Study Area. The terrain is generally flat with mild slopes. The steep slopes are located only along banks of the watercourses (refer to Figure 8-3).

As shown in Figure 8-4, the Study Area is divided into four (4) sub-catchment areas (i.e. western, central, southeastern and northeastern catchment areas). Pang Sua Canal (D1) receives surface runoff from the western catchment area within the Study Area. Besides, it also receives inflow from upstream drainage networks which collect surface runoff from surrounding residential area (i.e. Teck Whye Neighbourhood and Bukit Panjang Neighbourhood) in the west and south. The concrete drain D2 collects the surface water runoff from the concrete drain D4 and vegetated area in northeastern catchment area. D2 also receives inflow from an underground culvert in the east, which collects urban runoff from surrounding residential area. The concrete drain D3 and the concrete drain D4 collect surface water runoff from the central and southeastern catchments, respectively.

In terms of groundwater level, site-specific groundwater table depth was not known at the time of reporting writing, as groundwater level baseline survey was not the scope of this Study. Based on AECOM's review of environmental studies carried out in the vicinity of the Study Area, groundwater depth within the Study Area was expected to be at about 2 m below ground surface (bgs) [P-69]. It is expected that the groundwater flow direction will follow the general topography of the site (i.e., flow direction towards northwest) and towards larger watercourses.




**Legend**

- CCK N1 Study Area
- CCK N1 Project Site

**Waterbodies**

- Above-ground
- Underground

N

| Rev. | Date | By | Description | Chk'd | App'd |
|---|---|---|---|---|---|
| - | JAN 2023 | SAG | Final Report | NHT | JAG |

Qualified Person Endorsement : NA

HDB Endorsement : NA

Consultant : AECOM

Client: HOUSING & DEVELOPMENT BOARD

Project Title :

**ENVIRONMENTAL IMPACT ASSESSMENT (EIA) ON CHOA CHU KANG N1**

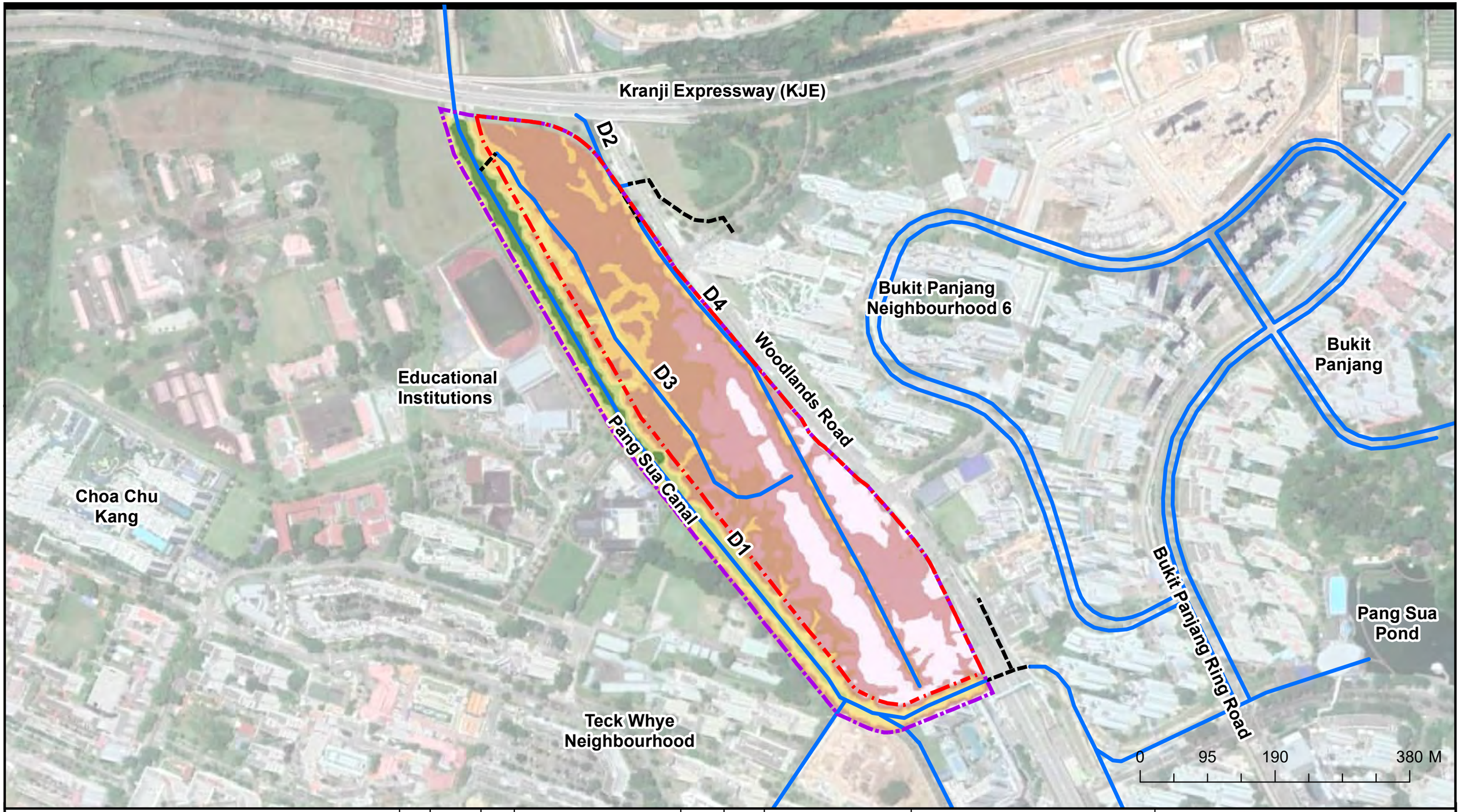
Figure Title :

**Watercourses of the Study Area and its surroundings**

| Designed | Checked | Approved | Figure No. : | Rev. | Sheet |
|---|---|---|---|---|---|
| SAG | NHT | JAG | 8 - 1 | - | 1 of 1 |
| | Drawn SAG | Date JAN 2023 | CAD File Name : NA | | A3 |

Note: Source of basemap - Google Earth Map

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**Legend**

- CCK N1 Study Area
- CCK N1 Project Site

**Waterbodies**

- Above-ground
- Underground

**Elevation (mRL)**

- <5
- 5-6
- 6-7
- 7-8
- 8-9
- 9-10
- >10

N

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

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Project Title :

**ENVIRONMENTAL IMPACT ASSESSMENT (EIA) ON CHOA CHU KANG N1**

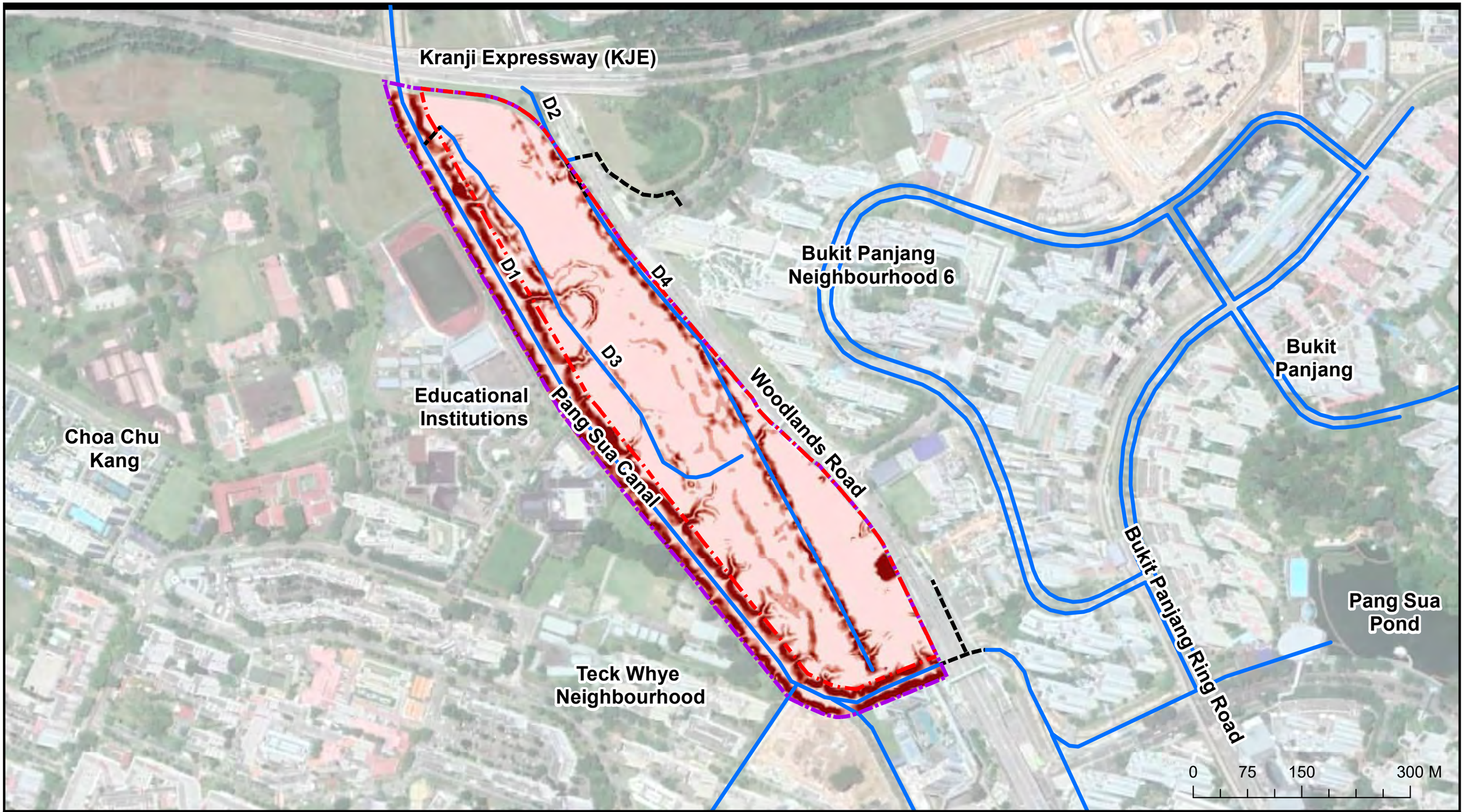
Figure Title :

**Elevation map with watercourses of the Study Area**

| Designed | Checked | Approved | Figure No. : | Rev. | Sheet |
|---|---|---|---|---|---|
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| | Drawn SAG | Date JAN 2023 | CAD File Name : NA | | A3 |

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## Legend

- CCK N1 Study Area
- CCK N1 Project Site

**Watercourses**

- Drain/ Canal
- Culvert

**Slope (%)**

- <10
- 10-15
- 15-20
- 20-25
- >25

N

| Rev. | Date | By | Description | Chk'd | App'd |
|---|---|---|---|---|---|
| - | JAN 2023 | SAG | Final Report | NHT | JAG |

Qualified Person Endorsement : NA

HDB Endorsement : NA

Consultant : AECOM

Client: HOUSING & DEVELOPMENT BOARD

Project Title :

**ENVIRONMENTAL IMPACT ASSESSMENT (EIA) ON CHOA CHU KANG N1**

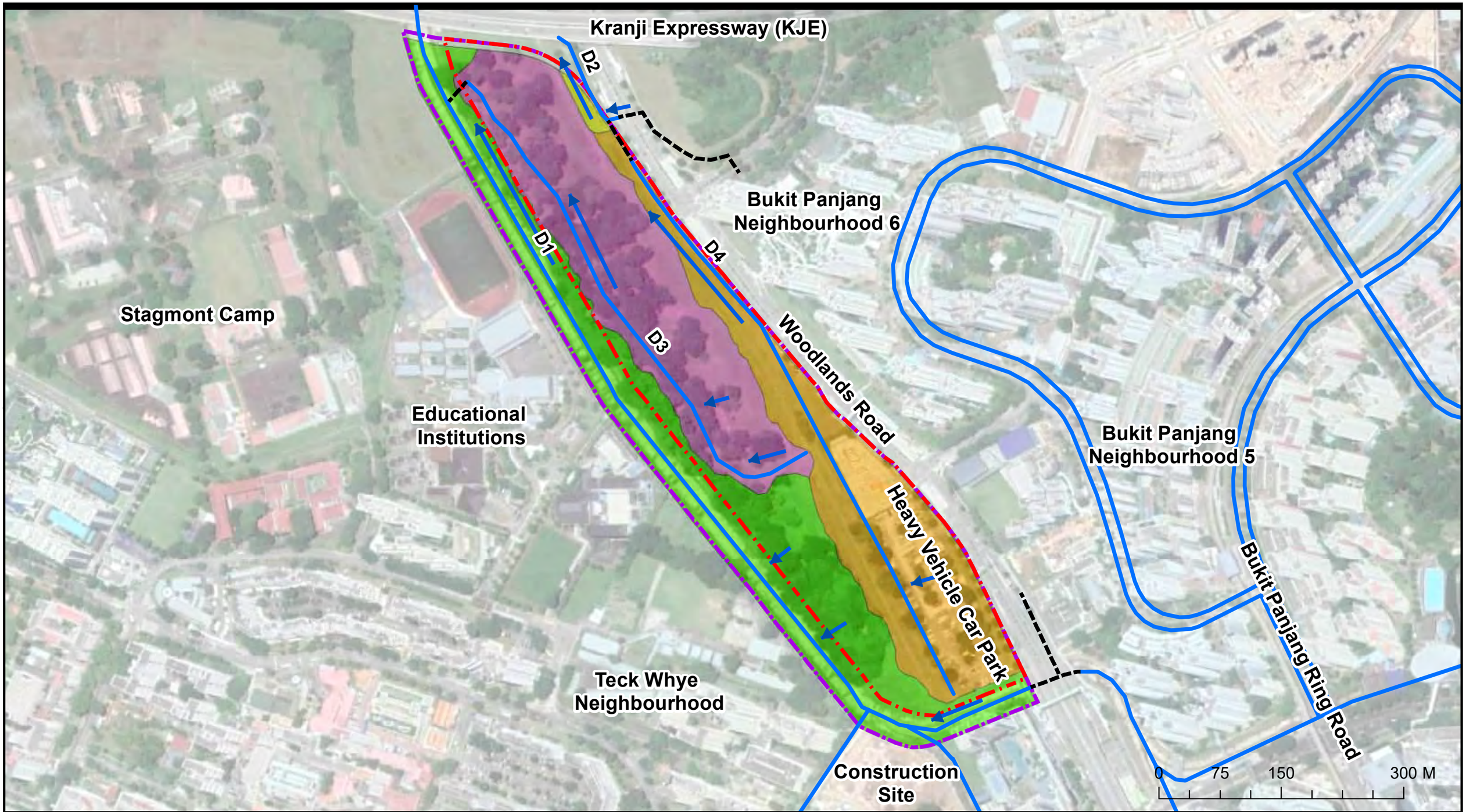
Figure Title :

**Slope map of the Study Area**

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|---|---|---|---|---|---|
| SAG | NHT | JAG | 8 - 3 | - | 1 of 1 |
| | Drawn SAG | Date JAN 2023 | CAD File Name : NA | | A3 |

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## Legend

- CCK N1 Study Area
- CCK N1 Project Site
- Water Flow Direction

**Watercourses**

- Drain/ Canal
- Culvert

**Catchment**

- 1 - Western
- 2 - Northeastern
- 3 - Central
- 4 - Southeastern

N

| Rev. | Date | By | Description | Chk'd | App'd |
|---|---|---|---|---|---|
| - | JAN 2023 | SAG | Final Report | NHT | JAG |

Qualified Person Endorsement : NA

HDB Endorsement : NA

Consultant : AECOM

Client: HOUSING & DEVELOPMENT BOARD

Project Title :

**ENVIRONMENTAL IMPACT ASSESSMENT (EIA) ON CHOA CHU KANG N1**

Figure Title :

**Catchment Map of the Study Area**

| Designed | Checked | Approved | Figure No. : | Rev. | Sheet |
|---|---|---|---|---|---|
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| | Drawn SAG | Date JAN 2023 | CAD File Name : NA | | A3 |

Note: Source of basemap - Google Earth Map

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**Table 8-4 Description of watercourses within the Study Area**

| Watercourses | Bank Characteristics | Water Flow Conditions | Photos |
|---|---|---|---|
| **Pang Sua Canal D1** | Wide concrete canal.<br><br>Estimated canal length within the Study Area is 860m. | • Originates from confluence of upstream drainage networks collecting surface runoff from surrounding residential area (refer to Figure 8-4) before reaching the Study Area, and it drains into the Kranji Reservoir eventually<br>• Perennial flow<br><br>**During dry weather condition:**<br>• Upstream: slow water flow velocity approximately 0.2 m/s - 0.4 m/s<br>• Approximately 16 cm – 18.5 cm depth and an approximate width of 500 cm, at the time of survey<br>• Midstream: slow water flow velocity approximately 0.2 m/s - 0.6 m/s<br>• Approximately 16 cm - 23 cm depth and width of 500 cm at the time of survey<br>• Downstream: slow dry weather flow velocity approximately 0.25 m/s - 0.6 m/s<br>• Approximately 18 cm - 20 cm depth and an approximate width of 500 cm, at the time of survey<br>• Water was clear and no smell | **Upstream**<br>During Dry Weather Conditions<br>  <br>During Wet Weather Conditions<br>  <br>**Midstream**<br>During Dry Weather<br>  <br>During Wet Weather<br>  |

| Watercourses | Bank Characteristics | Water Flow Conditions | Photos |
|---|---|---|---|
| | | **During wet weather condition (at surveyed time):**<br>• Upstream: slow water flow velocity observed of approximately 0.79 m/s<br>• Midstream: Water flow velocity of approximately 1.56 m/s<br>• Approximately 25 m width and cover the entire depth of the canal at time of survey<br>• Downstream: Water flow velocity of approximately 1 m/s<br>• Approximately 10.5 m width at the time of survey<br>• Water was clear and no smell | **Downstream**<br>During Dry Weather<br>  <br>During Wet Weather<br>  |
| **Concrete Drain D2** | Concrete drain with artificial banks | • Originates from vegetated area inside the Project site and surrounding residential area in the east, outside of the Project site, flowing next to Woodlands Road, along the northeast boundary of the site.<br>• Perennial flow<br><br>**During dry weather condition:**<br>• Slow water flow velocities of approximately 0.08 m/s - 0.4 m/s<br>• Approximately 5 cm - 7 cm water depth and width of 100 cm at the time of survey<br>• Water was clear and has no smell<br><br>**During wet weather condition:** | During Dry Weather<br>  <br>During Wet Weather<br>  |

| Watercourses | Bank Characteristics | Water Flow Conditions | Photos | |
|---|---|---|---|---|
| | | • Slow water flow observed of approximately 0.6 m/s<br>• Approximately 14 cm water depth and width of 120 cm at time of survey<br>• Water was clear and odourless | | |
| **Concrete Drain D3** | Concrete drain within Project Site | • Originates from vegetated area within the Project site<br>• Ephemeral flow<br><br>**During dry weather condition**:<br>• No flow observed<br><br>**During wet weather condition (at surveyed time):**<br>• Slow water flow of approximately 0.29 m/s<br>• Approximately 1 cm water depth and width of 20 cm at time of survey | During Dry Weather<br>  | During Wet Weather<br>  |
| **Concrete Drain D4** | Concrete drain with artificial banks | • Originates from the heavy vehicle car park within Study Area, flowing towards the north along the eastern part of the site and discharging water to D2<br>• Ephemeral flow<br><br>**During dry weather condition:**<br>• Almost no flow<br><br>**During wet weather condition (at surveyed time):**<br>• Slow water flow observed of approximately 0.43 m/s<br>• Approximately 15 cm water depth and width of 1.5 m at time of survey<br>• Water was clear and odourless | During Dry Weather<br>  | During Wet Weather<br>  |

## 8.4.2.2 Water Quality Baseline Conditions

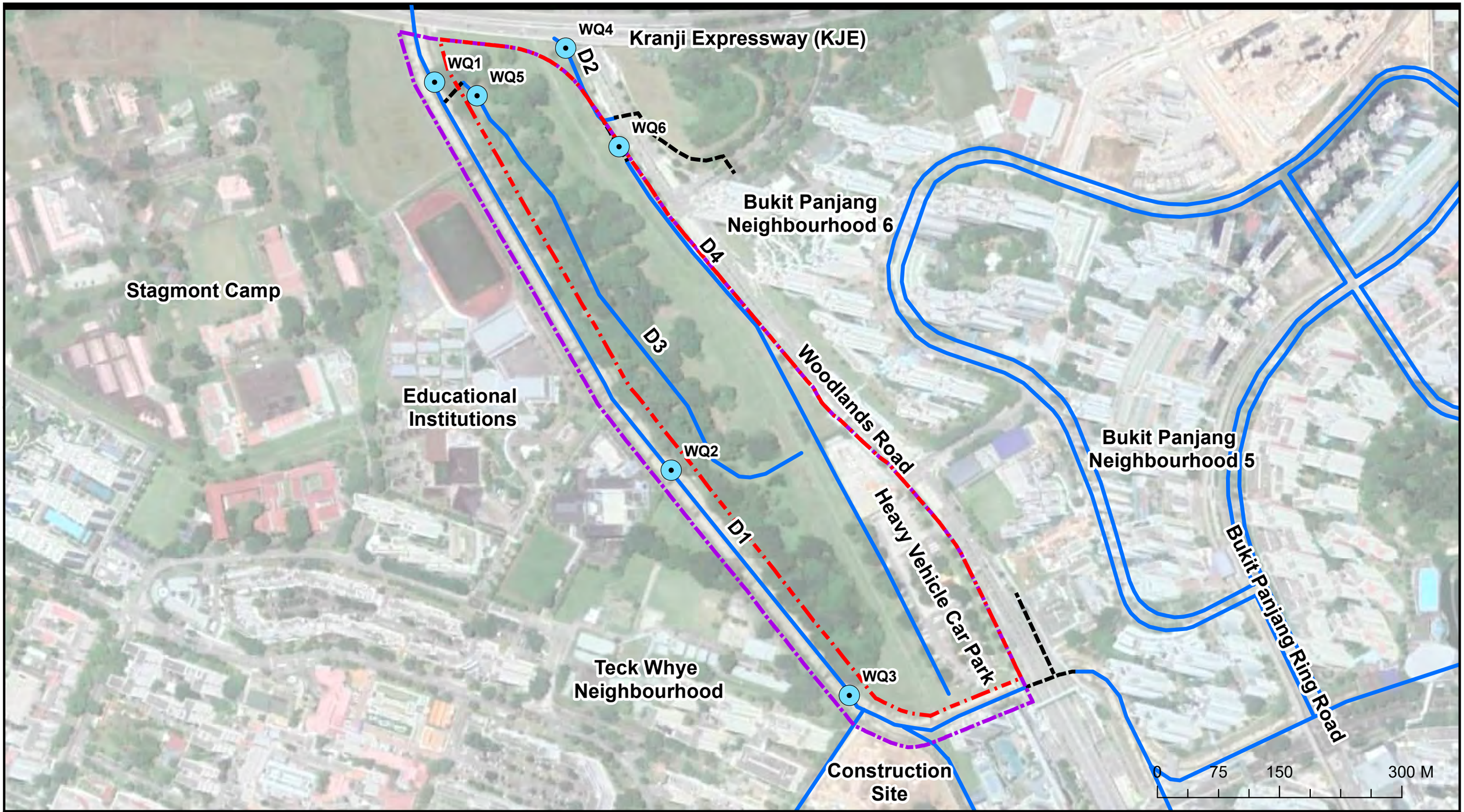
### 8.4.2.2.1 Surface Water Quality Sampling Locations

The surface water quality sampling locations were selected strategically along the identified watercourses within the Study Area based on preliminary hydrological findings during site reconnaissance. The baseline conditions of the surface water quality at the Study Area were then established at these selected water quality sampling stations by comparing the water quality results with national/ international water quality standards/ criteria relevant to ecological uses.

In the end, six (6) water quality stations were decided along the canal or drains as detailed in Figure 8-5 and Table 8-5. Station WQ1 was selected to capture the water quality of downstream of Pang Sua Canal (D1) before it flows out from Study Area. Station WQ2 was selected to capture the water quality of middle section of D1. Station WQ3 was selected to determine the upstream water quality of Pang Sua Canal (D1). Station WQ4 was selected to study the water quality in the concrete drain (D2) next to Woodlands Road. WQ5 was selected to capture the water quality in the concrete drain (D3) within Study Area. Station WQ6 was selected to determine the water quality in the concrete drain (D4) in the eastern part of Study Area.

**Table 8-5 Rationale for the selection of proposed water quality sampling locations**

| S/N | Monitoring Location | Rationale |
|---|---|---|
| **WQ1** | Pang Sua canal (D1) | To capture the water quality of at downstream of Pang Sua Canal before the runoff leaving the Study Area |
| **WQ2** | Pang Sua canal (D1) | To capture the water quality of water in the middle of Pang Sua Canal where it flows crossing the site |
| **WQ3** | Pang Sua canal (D1) | To capture the water quality of water flowing into Pang Sua Canal from surrounding urbanized area outside of the Study Area |
| **WQ4** | Concrete drain (D2) | To capture the water quality in D2 which is part of the study area |
| **WQ5** | Concrete drain (D3) | To capture the water quality in D3 in which stormwater in the centre area of the Project site will be collected to this drain before discharging to Pang Sua canal. During the site reconnaissance (dry weather conditions) D3 was found to be dry. Hence the water quality samples from this location were only be taken during wet weather conditions. |
| **WQ6** | Concrete drain (D4) | To capture the water quality in D4 in which stormwater in the eastern part of the Project site will be collected to. During the site reconnaissance (dry weather conditions) D4 was found to be dry. Hence the water quality samples from this location were only be taken during wet weather conditions. |




## Legend

- CCK N1 Study Area
- CCK N1 Project Site
- Water Quality Sampling Points

**Watercourses**

- Drain/ Canal
- Culvert

N

| Rev. | Date | By | Description | Chk'd | App'd |
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| | | | | | |
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| - | JAN 2023 | SAG | Final Report | NHT | JAG |

Qualified Person Endorsement : NA

HDB Endorsement : NA

Consultant : AECOM

Client: HOUSING & DEVELOPMENT BOARD

Project Title :

**ENVIRONMENTAL IMPACT ASSESSMENT (EIA) ON CHOA CHU KANG N1**

Figure Title :

**Water quality sampling locations within/surrounding the Study Area**

| Designed | Checked | Approved | Figure No. : | Rev. | Sheet |
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| SAG | NHT | JAG | 8 - 5 | - | 1 of 1 |
| | Drawn SAG | Date JAN 2023 | CAD File Name : NA | | A3 |

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#### 8.4.2.2.2 Water Quality Baseline Results

All water quality stations have been sampled for both in-situ and ex-situ analysis. The in-situ and ex-situ water quality sampling were conducted on 8 March and 21 April 2021 for two (2) dry weather events and 13 April 2021 for one (1) wet weather event in the Study Area as shown in Table 8-6.

The water quality stations (i.e. WQ1 to WQ4) at Pang Sua Canal (D1) and the concrete drain (D2) were sampled during both dry and wet weather conditions due to their perennial conditions. Meanwhile, the ephemeral drains D3 and D4 were sampled during storm event only. Hence, only wet weather samples were collected at WQ5 and WQ6.

In terms of groundwater quality, site-specific data was not known at the time of report writing and groundwater quality baseline sampling was not the scope of this Study. Based on review of historical land use data (refer to Section 4.2 of this Report), this site has been used for rubber plantations, sundry cultivation and residential and infrastructural developments. Eventually, these were all removed, with the exception of Rail Corridor track and the area has been re-vegetated. No records of historical environmental accidents were within the Study Area. Based on AECOM's review of beforementioned data, the potential contamination severity of soil and groundwater from past uses of area is likely to be low.

**Table 8-6 Water quality monitoring schedule**

| Sampling Event / Sampling Location | Dry Weather | | Wet weather |
|---|---|---|---|
| | 08 March 2021 | 21 April 2021 | 13 April 2021 |
| WQ1 | √ | √ | √ |
| WQ2 | √ | √ | √ |
| WQ3 | √ | √ | √ |
| WQ4 | √ | √ | √ |
| WQ5 | - | - | √ |
| WQ6 | - | - | √ |

Note:
√ indicates that the station has been sampled
- indicates that sampling not required

## Table 8-7 Water quality results

| Parameter | | WQ1 (D1) | WQ2 (D1) | WQ3 (D1) | WQ4 (D2) | WQ5 (D3) | WQ6 (D4) | Average | NEA Allowable Limits [1] | Water Quality Criteria for Aquatic Life from other countries[2] |
|---|---|---|---|---|---|---|---|---|---|---|
| Temperature (˚C) | Dry Average | 31.4 | 31.3 | 30.9 | 29.3 | - | - | 30.7 | 45 | - |
| | Wet Average | 29.1 | 29.7 | 30.0 | 29.5 | 28.3 | 30.7 | 29.6 | | |
| pH | Dry Average | 8.54 | 8.72 | 8.63 | **9.54** | - | - | 8.86 | 6 – 9 | 6.5 - 9 |
| | Wet Average | 8.05 | 8.25 | **9.07** | 8.60 | 6.98 | 8.46 | 8.24 | | |
| DO (mg/L) | Dry Average | 9.23 | 9.18 | 8.98 | 7.97 | - | - | 8.84 | - | > 4.0 |
| | Wet Average | 8.27 | 7.76 | 7.93 | 7.80 | 4.59 | 7.40 | 7.29 | | |
| Salinity (PSU) | Dry Average | 0.17 | 0.17 | 0.16 | 0.31 | - | - | 0.20 | - | - |
| | Wet Average | 0.05 | 0.04 | 0.06 | 0.07 | 0.23 | 0.05 | 0.08 | | |
| Total Dissolved Solids (mg/L) | Dry Average | 231.3 | 224.8 | 224.3 | 415.0 | - | - | 273.9 | 1000 | 1000 |
| | Wet Average | 66.0 | 52.0 | 89.8 | 105.0 | 307.0 | 66.0 | 114.3 | | |
| Conductivity (µS/cm) | Dry Average | 403.9 | 391.4 | 387.6 | 694.6 | - | - | 469.4 | - | - |
| | Wet Average | 109.7 | 87.5 | 151.4 | 175.3 | 503.0 | 111.9 | 189.8 | | |
| Turbidity (NTU) | Dry Average | 27.8 | 33.0 | 33.4 | 23.4 | - | - | 29.4 | - | 50 |
| | Wet Average | 43.4 | **73.9** | 47.4 | 47.5 | 9.3 | 17.1 | 39.8 | | |
| Total Suspended Solids, TSS (mg/L) | Dry Average | 25.1 | **30.1** | **36.0** | 24.8 | - | - | 29.0 | 30 | 50 |
| | Wet Average | **40.0** | **70.0** | **45.7** | **37.0** | <10 | <10 | **32.1** | | |
| Total Nitrogen, TN (mg/L) | Dry Average | 1.15 | 1.05 | 1.18 | 1.20 | - | - | 1.15 | - | Eutrophic limit: 1.5mg/L |
| | Wet Average | **1.50** | **2.17** | **3.50** | **2.20** | 0.67 | **2.29** | **2.06** | | |
| Nitrate as $NO_3$-N (mg/L) | Dry Average | 0.55 | 0.57 | 0.57 | 0.54 | - | - | 0.56 | 4.52 (equivalent to 20 as $NO_3$) | 10 (equivalent to 44 as $NO_3$) |
| | Wet Average | 1.27 | 2.14 | 2.04 | 1.96 | 0.35 | 1.92 | 1.61 | | |
| Ammonium Nitrogen as $NH_4$-N (mg/L) | Dry Average | 0.099 | 0.105 | 0.103 | 0.210 | - | - | 0.129 | - | 0.5 |
| | Wet Average | 0.098 | 0.150 | 0.300 | 0.099 | 0.053 | 0.170 | 0.145 | | |
| Total Phosphorous, TP (mg/L) | Dry Average | **0.222** | **0.250** | **0.317** | **0.078** | - | - | **0.217** | - | Eutrophic limit: 0.075 mg/L |
| | Wet Average | 0.037 | 0.047 | 0.045 | 0.043 | 0.071 | 0.025 | 0.045 | | |
| Orthophosphate as $PO_4$-P (mg/L) | Dry Average | **0.144** | **0.179** | **0.200** | **0.060** | - | - | **0.146** | 0.65 (equivalent to 2 as $PO_4$) | <0.033 (equivalent to <0.1 as $PO_4$) |
| | Wet Average | 0.020 | 0.014 | 0.028 | **0.034** | **0.057** | 0.018 | 0.029 | | |
| Total Organic Carbon, TOC (mg/L) | Dry Average | 2.52 | 2.27 | 2.38 | 3.25 | - | - | 2.61 | - | - |
| | Wet Average | 2.85 | 4.15 | 6.63 | 6.46 | 4.23 | 7.15 | 5.25 | | |
| Enterococcus (cfu/100ml) | Dry Average | 2,125 | 2,015 | 1,990 | 225 | - | - | 1,589 | - | - |
| | Wet Average | 7,000 | 14,000 | 16,000 | 14,000 | 6,800 | 8,100 | 10,983 | | |
| Lead, Pb (µg/L) | Dry Average | 0.27 | 0.28 | 0.32 | <0.5 | - | - | 0.22 | 100 | Acute LOEL[4]: 82<br>Chronic LOEL[4]: 3.2 |
| | Wet Average | <0.5 | <0.5 | <0.5 | 0.69 | <0.5 | <0.5 | 0.12 | | |

Note:

1. NEA Trade Effluent Discharge Limits are for controlled watercourses.
2. The sources of water quality criteria for aquatic life include United Nations Economic Commission for Europe [R-21], World Health Organization [R-22], United States Environmental Protection Agency [R-23], Australian & New Zealand [R-24], Canada [R-25], Philippines [R-26], and Malaysia [R-26].
3. Red values mean data exceeding the NEA limits; Blue values mean data exceeding aquatic life criteria; Purple values mean data exceeding both NEA limits and aquatic life criteria.
4. <0.5 means lower than 0.5 µg/L of level of detection limit.
5. LOEL – Lowest Observed Effect Level

As described in Section 8.4.2.1, watercourses in the Study Area had either perennial or ephemeral flow. It is unlikely that ephemeral watercourses will have any aquatic life. Hence, water quality of all stations was compared with NEA guidelines, while that of stations located along perennial watercourses (i.e. WQ1, WQ2, WQ3 and WQ4) was compared against criteria for aquatic life. In should be noted that according to biodiversity findings in Section 7, only Pang Sua Canal (D1) supported poor aquatic life at the time of survey.

As shown in Figure 8-6, water temperature across all water quality stations during dry and wet condition do not vary significantly ranged from 28.3 ˚C – 31.4 ˚C, which is below the NEA trade effluent limit of 45˚C.

The pH of the watercourses within the Study Area during dry and wet weathers (i.e. average at 8.86 and 8.24, respectively) were close to the upper limit for both NEA trade effluent (i.e. 6 – 9) and water quality criteria for aquatic life (i.e. 6.5 – 9). Sometimes (either dry or wet days), the pH at two perennial watercourses (i.e. Pang Sua Canal – D1 and drain D2) had slightly elevated pH above 9 (i.e. both NEA guideline and criteria for aquatic life), possibly due to the wash-off of the concrete surface from surrounding urbanized area (especially the construction site nearby), where chemicals washed away from concrete could lead to the increased pH. The residential area might have also contributed to the elevated pH value by discharging wash waters containing high alkali compounds such as detergent chemicals during normal dry days. During wet weather, the pH of WQ5 (i.e. pH 6.98) was slightly acidic might be due to the presence of humic acid from decomposing organic debris from the surrounding vegetation since the drain only receives runoff from vegetated area.

The measures dissolved oxygen (DO) for all sampling sites ranged from 7.97 to 9.23 mg/L (average at 8.84 mg/L) during dry weather, while from 4.59 to 8.27 (average at 7.29 mg/L) during wet weather. All water quality stations met water quality criteria for aquatic life (i.e. > 4.0 mg/L).

The conductivity of water and Total Dissolve Solid (TDS) are strongly dependent on the number of ions available to participate in the conduction process. These parameters positively correlated to salinity which measures the amount of salts dissolved in water. The average salinity, TDS and conductivity of the water found within the study were low during dry weathers (i.e. 0.20 PSU, 273.9 mg/L and 469.4 µS/cm, respectively) and wet weather (i.e. 0.08 PSU, 114.3 mg/L and 189.8 µS/cm, respectively) which confirmed prevalence of freshwater, given that the seawater generally has salinity of around 35 PSU [P-48], conductivity of around $3.31 \times 10^6$ µS/m [P-49] and TDS of around 35,000 mg/L [P-42].

The turbidity of water at the sampling locations ranged from 23.4 to 33.4 Nephelometric Turbidity Units (NTU) (average at 29.4 NTU) during dry weather, while from 9.3 to 73.9 NTU (average at 39.8 NTU) during wet weather. Turbidity increased along Pang Sua Canal (D1) and drain D2 during storm events compared to dry days, especially with turbidity level at WQ2 along Pang Sua Canal (i.e. 73.9 NTU) exceeding criteria for aquatic life (i.e. 50 NTU). This might be due to flushing from surrounding urban surface (including the construction site nearby) which carried high concentration of TSS during storm event.

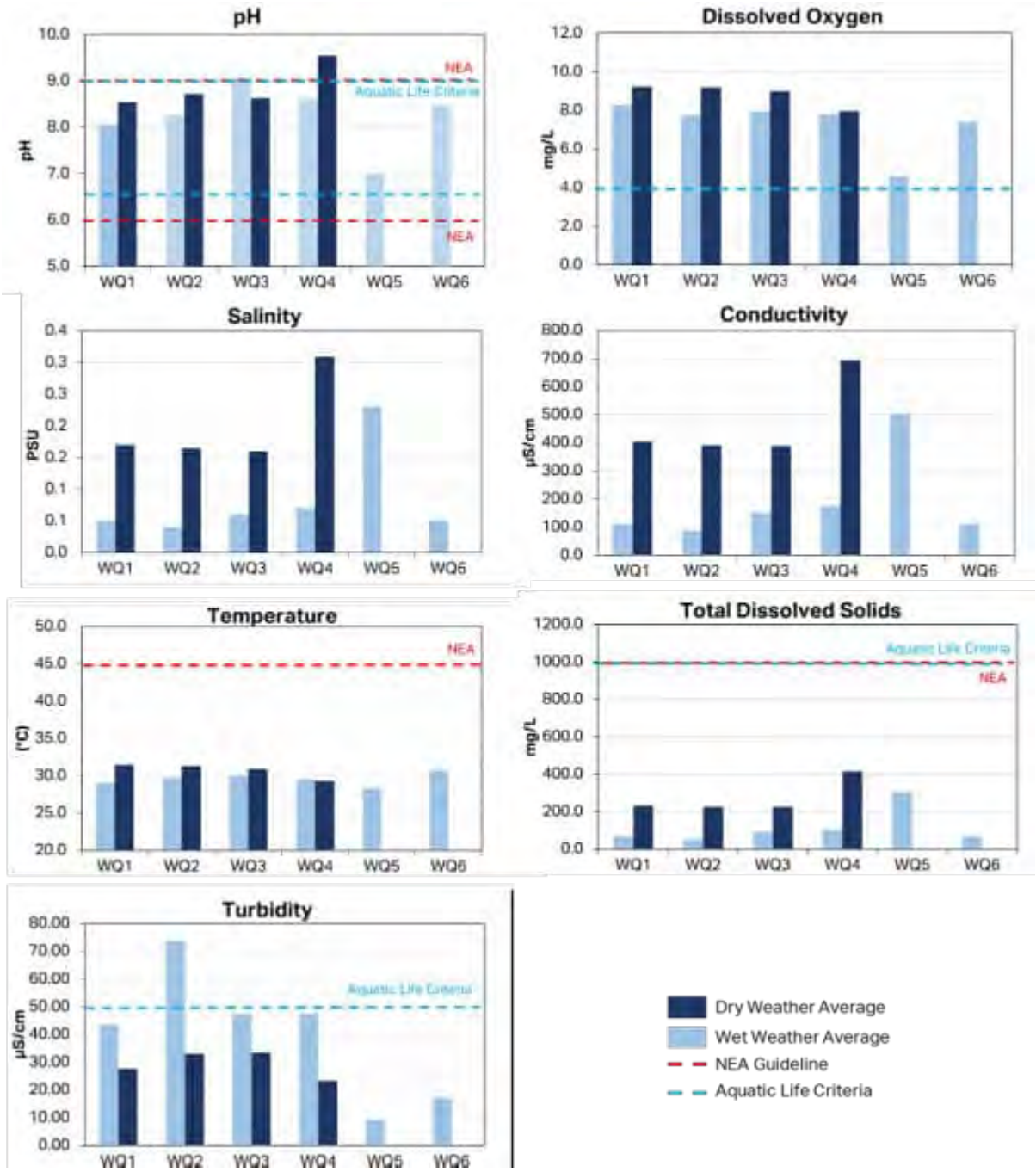



**Figure 8-6 Average monitoring results of in-situ parameters for dry and wet weather conditions**

As shown in Figure 8-7 and Table 8-7, Total Suspended Solids (TSS) had an average concentration of 29.0 mg/L (ranging from 24.8 – 30.1 mg/L) during dry weather and 32.1 mg/L (ranging from less than 10 to 70 mg/L) during wet weather. Similar with turbidity, TSS increased along Pang Sua Canal (D1) and drain D2 during storm events compared to dry days. The TSS concentration for Pang Sua Canal D1 ranged from 25.1 to 70.0 mg/L during both dry and wet weather, either exceeding NEA trade effluent limit (i.e. 30 mg/L) or aquatic life criteria (i.e. 50 mg/L), while D2 only exceeding NEA trade effluent limit (i.e. 30 mg/L) with TSS of 37.0 mg/L during wet day. This might be due to the runoff from the surrounding residential areas or construction site nearby, where the paved surface of surrounding urbanized area has less tendency to trap any TSS from surface runoff before it reaches to the waterbodies. The TSS concentration for WQ5 (i.e. D3) and WQ6 (i.e. D4) were below the 10 mg/L of detection limit during wet weather, which might be due to the surrounding vegetated surface trapping sediment before stormwater discharging into canal/drains.

Total Nitrogen (TN) had an average concentration of 1.15 mg/L and 2.06 mg/L during dry and wet weather, respectively. Comparing with the water quality criteria for aquatic life, the detected TN at Pang Sua Canal (D1),

drains D2 and D4 during wet weather were above the eutrophic limit of TN in waterbodies (i.e. 1.5 mg/L), suggesting nitrogen was potential cause of eutrophication in the watercourses. The TN levels might due to the stormwater run-off from residential and construction areas outside of the Study Area (e.g. fertilizer from vegetation, food waste, etc.) as well as the vegetated area within the Study Area (e.g. decomposed organic nitrogen). $NO_3$-N had an average concentration of 0.56 mg/L and 1.61 mg/L during respective dry and wet weathers, with values of all stations below the NEA guidelines limit (i.e. 4.52 mg/L) and aquatic life criteria (i.e. 10 mg/L). $NH_4$-N had an average concentration of 0.129 mg/L and 0.145 mg/L during respective dry and wet weathers, with values of all stations below the aquatic life criteria (i.e. 0.5 mg/L).

Total phosphorus (TP) vary significantly between dry and wet weathers, TP ranged from 0.078 mg/L to 0.317 mg/L (average at 0.217 mg/L) during dry weathers and ranged from 0.025 mg/L to 0.071 mg/L (average at 0.045 mg/L) during wet weather. Compared with water quality criteria for aquatic life, Pang Sua Canal (D1) and drain D2 exceeded the eutrophication limit (i.e. 0.075 mg/L) during dry weathers, indicating eutrophication potential. During storm event, TP concentration within all watercourses fell below the eutrophication limit. The concentration of $PO_4$-P (Orthophosphate) at Pang Sua Canal (D1) and drain D2 (ranging from 0.060 mg/L to 0.200 mg/L) during dry weathers as well as drains D2 and D3 (i.e. 0.034 mg/L and 0.057 mg/L, respectively) during wet weather slightly exceeded the aquatic life criteria (i.e. 0.033 mg/L), but within the NEA trade effluent limits (i.e. 0.65 mg/L). Phosphorus data showed eutrophication potential in Pang Sua Canal (D1) and drain D2, which was consistent with the site observation of greenish waterbodies with algae (refer to photos in Table 8-4). The source of phosphorus might come from urbanized area (e.g. fertilizer from tree plantation, food wastes, etc.) outside of the Study Area and from the decomposed vegetation within the Study Area.

Total organic carbon (TOC) had an average concentration of 2.61 mg/L during dry weathers and 5.25 mg/L during wet weather. Although there are no available TOC guidelines for aquatic life, but comparable to criteria for drinking source water from Canada (i.e. 4 mg/L, [R-40]), indicating relatively low TOC in the tested watercourses within the Study Area.

Enterococcus counts ranged from 225 cfu/100ml to 2,125 cfu/100ml with an average value of 1,589 cfu/100ml during dry weathers and ranged from 6,800 cfu/100ml to 16,000 cfu/100ml with an average value of 10,983 cfu/100ml. There are no available enterococcus guidelines for freshwater aquatic life, but comparing with the NEA Recreational Water Quality Guidelines [W-9] on enterococcus (200 cfu/100ml), the enterococcus concentrations were slightly high in our Study Area. This indicated possible human or animal faecal pollution in the watercourses within the Study Area. However, it should be noted that the criteria is for marine water and none of the watercourses is expected to hold any recreational activities involving direct human contact. During wet weather, the Pang Sua Canal (D1) and drain D2 had elevated enterococcus counts (i.e. 14,000 cfu/100mL, 16,000 cfu/100mL and 14,000 cfu/100mL, respectively) compared to that in dry weather, indicating that the enterococcus might come from storm carrying faecal contaminants from surrounding residential or vegetated area.

Lead (Pb) had an average value of 0.22 µg/L during dry weathers and 0.12 µg/L during wet weather, which were all below the NEA limits (100 µg/L) and aquatic life criteria (Acute LOEL: 82 µg/L, Chronic LOEL: 3.2 µg/L). This indicates low Pb pollution within this Study Area.

Both in-situ and ex-situ water quality parameters showed relatively high pH, TSS and nutrient (i.e. nitrogen and phosphorus) concentrations in the watercourses, indicating poor water quality for survival of aquatic life. This aligns with biodiversity findings in Section 7, which shows only Pang Sua Canal (D1) supported poor aquatic life at the time of survey.

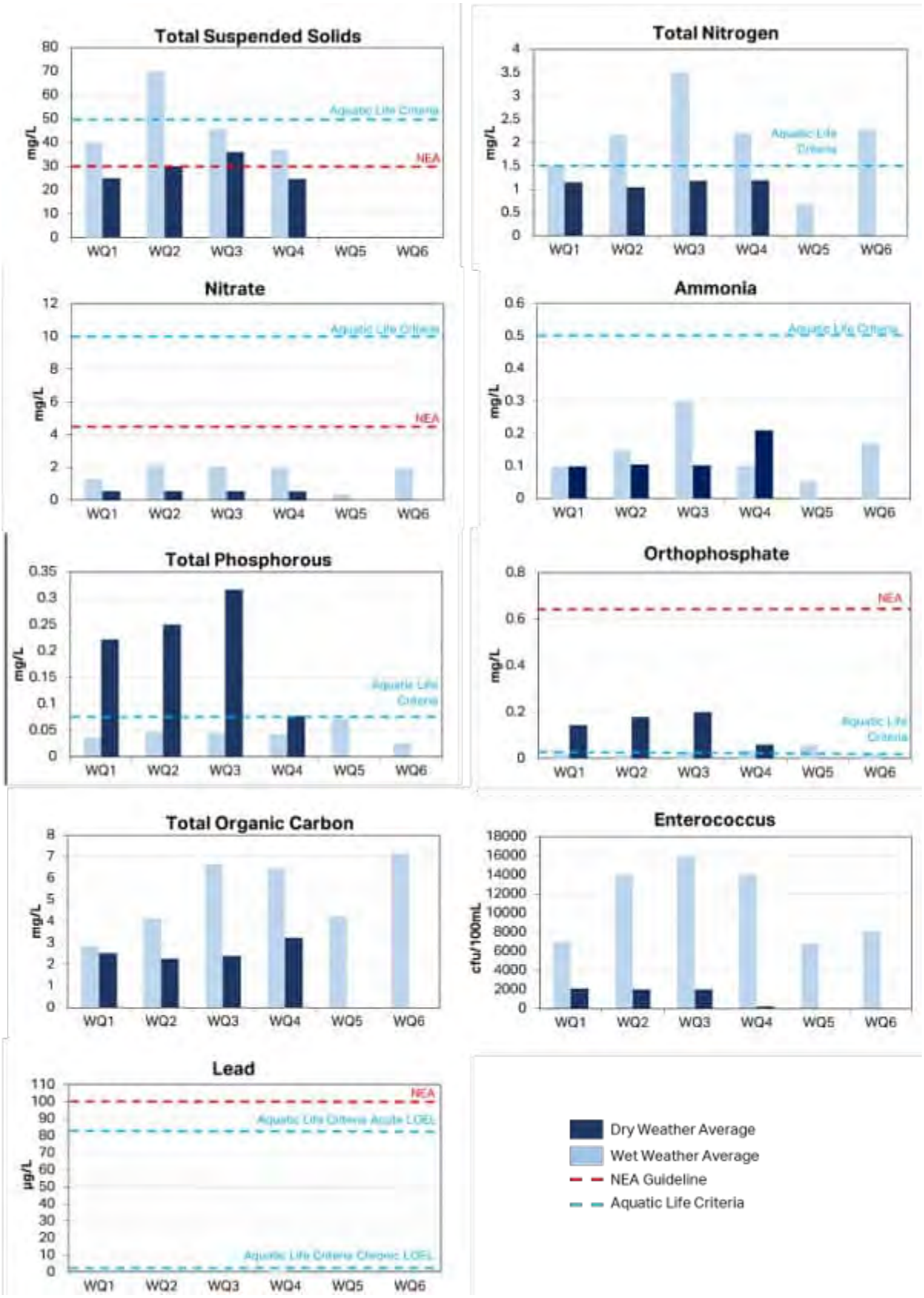



**Figure 8-7 Average monitoring results of ex-situ parameters for dry and wet weather conditions**

# 8.5 Identification of Water Resources Sensitive Receptors

Receptor screening for water sensitive receptors was conducted for the Study Area for both construction and operational phases. The criteria detailed in Table 6-1 was used to determine the sensitivity of the ecological, human and socio-economic receptors presented in Table 8-8 and Table 8-9.

## 8.5.1 Construction Phase

As shown in Table 8-8, the potential ecological, human and socio-economic receptors impacted during construction phase were identified and classified based on the sensitivity classification previously presented in Table 6-1. It is understood that currently in Singapore groundwater is not extracted for any beneficial purposes. Therefore, socio-economic receptors were identified only with regards to hydrology and surface water quality.

Screening of ecological receptors was carried out based on the current site conditions, biodiversity baseline findings as well as proposed future land use plans (refer to Figure 3-3). As described in Section 7 of this Report, there are two (2) ecological habitats found within the site – Planted Trees (managed vegetation) and Turf. Based on the proposed future land use, the majority of the site will be redeveloped into residential area with accompanying infrastructure and amenities/ facilities. This will result in clearance of most of the habitats currently found on the site. As western portion of the site is planned to be retained (to form a part of proposed Ecological Corridor along Pang Sua Canal), it is assumed that majority of Planted Trees habitat and small portion of Turf will be preserved after the construction phase of the Project. The watercourses within the site were found to be poor in aquatic life and are more likely to be used by fauna to move between the habitats.

Human and socio-economic receptors were screened based on current and future land uses, catchment areas and potential areas of impact due to hydrological and surface water quality changes. With regards to human receptors, their sensitivity was assessed based on several criteria (i.e., health and safety, disruption of regular activities), while the sensitivity of socio-economic receptors was defined based on the development type and its dependency of surface water resources required for its activities and processes.

**Table 8-8 Classification of water resources sensitive receptors identified within the Study Area for construction phase**

| Sensitive Receptor | Environmental Parameter | Receptor Description | Receptor Classification |
|---|---|---|---|
| **Ecological Receptors** | | | |
| **Managed Vegetation**<br><br>**(Planted Trees)** | Hydrology | • Terrestrial habitat of high ecological value (as defined in Table 7-15) that are resilient of changes in water quantities and water flow conditions<br>• Significance of this habitat is mostly due to it's important role as a stepping stone for migratory species that move between the surrounding green spaces<br>• The habitat receives water from the surrounding catchment area<br>• Majority of this habitat is planned to be retained (proposed Ecological Corridor) | Priority 2 |
| | Surface water quality | • Terrestrial habitat | Priority 3 |
| | Groundwater quality and level | • Terrestrial habitat of high ecological value that receives water from various sources | Priority 2 |
| **Managed Vegetation (Turf)** | Hydrology | • Terrestrial habitat of medium ecological value (as defined in Table 7-15)<br>• Significance of this habitat is mostly due to it's important role as a stepping stone for migratory species that move between the surrounding green spaces<br>• The habitat receives water from the surrounding catchment area | Priority 3 |

| Sensitive Receptor | Environmental Parameter | Receptor Description | Receptor Classification |
|---|---|---|---|
| | | • Small part of this habitat is proposed to be retained as part of proposed Ecological Corridor | |
| | Surface water quality | • Terrestrial habitat | Priority 3 |
| | Groundwater quality and level | • Terrestrial habitat that is not of high ecological value | Priority 3 |
| **Human Receptors** | | | |
| **On-site construction workers** | Hydrology | • Regular activities of on-site workers may be temporarily disrupted due to localised flooding within the construction sites especially during heavy rainfall events<br>• Safety of this receptor is not expected to be compromised | Priority 2 |
| | Surface water quality | • Construction workers may come into direct contact with surface water within the Project site, likely originating from various construction activities (e.g. soil dewatering, detention tanks, etc.) | Priority 1 |
| | Groundwater quality and level | • On-site construction workers may come in direct contact with groundwater during activities which require soil excavation, management and dewatering<br>• It is assumed that currently in Singapore groundwater is not extracted for any beneficial purposes (i.e. drinking and industrial purposes, irrigation) | Priority 2 |
| **Off-site permanent residents and visitors in the vicinity of the Project Site** | Hydrology | • Activities (e.g. commuting, leisure walks) could be temporarily disrupted due to localised flooding in the vicinity of the Project site, especially during heavy rainfall events (i.e. flash floods)<br>• Safety of this receptor is not expected to be compromised | Priority 2 |
| | Surface water quality | • Off-site permanent residents and visitors are not going to directly use the surface water for any beneficial purpose<br>• The receptor will not experience nuisance nor develop health issues due to the change in surface water quality | Priority 3 |
| | Groundwater quality and level | • Off-site permanent residents and visitors are unlikely to come in direct contact with groundwater during construction phase<br>• It is assumed that currently in Singapore groundwater is not extracted for any beneficial purposes (i.e. drinking and industrial purposes, irrigation) | Priority 3 |
| **Socio-Economic Receptors** | | | |
| **Pang Sua Canal** | Hydrology | • Development used for essential services (i.e., water supply) located adjacent to Project site<br>• Changes in surrounding land use during construction phase may cause the changes in current flow characteristics of Pang Sua Canal, such as change in water depths and quantities of water | Priority 1 |
| | Surface water quality | • The water from Pang Sua Canal eventually gets discharged into Kranji Reservoir and from there it gets used for water supply (after treatment)<br>• Improper management of waste, surface water runoff as well as accidental | Priority 1 |

| Sensitive Receptor | Environmental Parameter | Receptor Description | Receptor Classification |
|---|---|---|---|
| | | leakage and spillage of contaminants may alter Pang Sua's Canal water quality | |
| **Drain D2** | Hydrology | • Concrete Drain D4 collects surface runoff from Project site and discharges into Drain D2 via underground culvert [P-1]<br>• Eventually, this water gets discharged into Sungei Pang Sua and into the sea<br>• Therefore, it is assumed that the water from these drains will not be used for any beneficial purposes | Priority 3 |
| | Surface water quality | • Water collected in Drains D2 and D4 eventually gets discharged into the sea (i.e., outside of catchment areas)<br>• Water is not used for any beneficial purposes | Priority 3 |
| **Drain D3** | Hydrology | • Drain collects the surface water runoff from part of the Project site and discharges the water into Pang Sua Canal via culvert<br>• Eventually, this water gets discharged into Kranji Reservoir from where it is expected that the water will be used for beneficial purposes | Priority 1 |
| | Surface water quality | • This drain collects the surface water runoff from part of the Project site and discharges the water into Pang Sua Canal via culvert<br>• The water from Pang Sua Canal eventually gets discharged into Kranji Reservoir and from there it gets used for water supply (after treatment) | Priority 1 |
| **Woodlands Road** | Hydrology | • Development used for non-essential services (i.e., transport infrastructure) located in the vicinity of Project site<br>• Dual carriageway with physical median between the opposite lanes (three lanes in each direction)<br>• Localised flooding may cause changes in regular activities | Priority 2 |
| | Surface water quality | • Infrastructural development that does not directly use surface water from Project Stie for any beneficial purposes | Priority 3 |
| **Bukit Panjang Neighbourhoods 5 and 6** | Hydrology | • Permanently inhabited developments (i.e., residential developments) located in the vicinity of Project site<br>• Flooding may greatly disrupt peoples lives and activities, damage property and without potential work-around, since these residents may not have an alternative residence to relocate to | Priority 1 |
| | Surface water quality | • Mostly residential developments which do not directly use surface water originating from Project site for any beneficial purposes | Priority 3 |

## 8.5.2 Operational Phase

The ecological, human and socio-economic receptors of the operational phase were identified based on the proposed development plans known at this stage of the Project and classified based on sensitivity classification shown in Table 6-1.

**Table 8-9 Classification of water resources sensitive receptors identified within the Study Area for operational phase**

| Sensitive Receptor | Environmental Parameter | Receptor Description | Receptor Classification |
|---|---|---|---|
| **Ecological Receptors** | | | |
| **Proposed Ecological Corridor** | Hydrology | • Terrestrial habitat comprising of green buffer and cluster of trees in the western portion of the Project site<br>• Significance of this habitat (i.e. high) is mostly due to it's important role as a stepping stone for migratory species that move between the surrounding green spaces<br>• The habitat possibly receives water from the surrounding catchment area<br>• This receptor is tolerant of fluctuations in water levels, and such change in hydrology may only cause short-term and moderate disturbances in their functioning. | Priority 2 |
| | Surface water quality | • Terrestrial habitat | Priority 3 |
| | Groundwater quality and level | • Terrestrial habitat of high ecological value that receives water from various sources | Priority 2 |
| **Managed vegetation within the future residential development** | Hydrology | • Future landscape features within the proposed residential development and retained Rail Corridor alignment<br>• As these will be managed habitats, they will not be disturbed due to changes in existing hydrology | Priority 3 |
| | Surface water quality | • Terrestrial habitats | Priority 3 |
| | Groundwater quality and level | • Managed terrestrial habitat that is not of high ecological value | Priority 3 |
| **Human Receptors** | | | |
| **Future residents, visitors and maintenance workers of the proposed development** | Hydrology | • Regular activities of future residents, visitors and maintenance workers of the proposed development may be disrupted due to localised flooding within the site, especially during heavy rainfall events<br>• Safety of this receptor is not expected to be compromised | Priority 2 |
| | Surface water quality | • Receptor is unlikely to have direct contact with the surface water within the site<br>• Health of this receptor will unlikely be harmed by the changes in surface water quality<br>• The receptors might experience nuisance by changes in water quality (e.g. odour, increased turbidity, changes in colour) | Priority 2 |
| | Groundwater quality and level | • Receptor is unlikely to have direct contact with the groundwater within the site | Priority 3 |
| **Off-site permanent residents and visitors in the vicinity of the proposed development** | Hydrology | • Activities (e.g. commuting, leisure walks) could be temporarily disrupted due to localised flooding<br>• Safety of this receptor is not expected to be compromised | Priority 2 |
| | Surface water quality | • Receptor is unlikely to have direct contact with the surface water within the site<br>• Health of this receptor will unlikely be harmed by the changes in surface water quality | Priority 3 |
| | Groundwater quality and level | • Receptor is unlikely to have direct contact with the groundwater within the site | Priority 3 |
| **Socio-Economic Receptors** | | | |

| Sensitive Receptor | Environmental Parameter | Receptor Description | Receptor Classification |
|---|---|---|---|
| **Proposed residential developments within Project Site** | Hydrology | • Permanently inhabited developments (i.e., residential developments) located within the Project site | Priority 1 |
| | Surface water quality | • Residential developments which do not directly use surface water for beneficial purposes | Priority 3 |
| **Pang Sua Canal** | Hydrology | • The water from Pang Sua Canal eventually gets discharged into the Kranji Reservoir from where it will be used for beneficial purposes (after treatment)<br>• Being one of the water sources for Kranji Reservoir any significant changes in water inflow may have impacts on quantities of water in Kranji Reservoir | Priority 1 |
| | Surface water quality | • The water from Pang Sua Canal eventually gets discharged into the Kranji Reservoir from where it will be used for beneficial purposes (after treatment)<br>• Deterioration of water quality of Pang Sua Canal may impact the quality of Kranji Reservoir from which the water is used for beneficial purposes | Priority 1 |
| **Drain D2** | Hydrology | • Based on the proposed drainage plans, drain D2 will remain and be upgraded as part of the future developments<br>• Eventually, this water gets discharged into Sungei Pang Sua and into the sea<br>• Therefore, it is assumed that the water from these drains will not be used for any beneficial purposes | Priority 3 |
| | Surface water quality | • Water collected in Drain D2 eventually gets discharged into the sea (i.e., outside of catchment areas)<br>• Therefore, it is assumed that the water from these drains will not be used for any beneficial purposes | Priority 3 |
| **Drain D3** | Hydrology | • The part of the drain D3 that is located within the proposed RAC will not be altered and it will collect surface water runoff from the RAC<br>• The water collected by this drain will get discharged into Pang Sua Canal<br>• Eventually, this water gets discharged into Kranji Reservoir from where it is expected that the water will be used for beneficial purposes | Priority 1 |
| | Surface water quality | • The part of the drain D3 that is located within the proposed RAC will not be altered and it will collect surface water runoff from the RAC<br>• This drain collects the surface water runoff from part of the Project site and discharges the water into Pang Sua Canal via culvert<br>• The water from Pang Sua Canal eventually gets discharged into Kranji Reservoir and from there it gets used for water supply (after treatment) | Priority 1 |
| **Woodlands Road** | Hydrology | • Development used for non-essential services (i.e., transport infrastructure) located in the vicinity of Project site<br>• Dual carriageway with physical median between the opposite lanes (three lanes in each direction) | Priority 2 |

| Sensitive Receptor | Environmental Parameter | Receptor Description | Receptor Classification |
|---|---|---|---|
| | | • Localised flooding may cause changes in regular activities | |
| | Surface water quality | • Infrastructural development that does not directly use surface water from Project Stie for any beneficial purposes | Priority 3 |
| **Bukit Panjang Neighbourhoods 5 and 6** | Hydrology | • Permanently inhabited developments (i.e., residential developments) located in the vicinity of Project site<br>• Flooding may greatly disrupt peoples lives and activities, damage property and without potential work-around, since these residents may not have an alternative residence to relocate to | Priority 1 |
| | Surface water quality | • Mostly residential developments which do not directly use surface water originating from Project site for any beneficial purposes | Priority 3 |

# 8.6 Minimum Control Measures

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

## 8.6.1 Construction Phase

Table 8-10 has a non-exhaustive list of minimum controls for each potential impact identified in Section 8.3.1 for construction phase.

**Table 8-10 Minimum control measures during construction phase applicable for water resources**

| Potentially Affected Environmental Parameter | Potential Source(s) of Impact | Minimum Control Measures |
|---|---|---|
| **Hydrology** | Temporary and/ or permanent land use change causing increased surface runoff peak flow (e.g. earthwork areas, soil stockpiles, removal of vegetation, construction of impermeable structures, etc.) and/ or occupation of existing drains | • Drain diversion for the watercourses impacted by this development (i.e., drains D2 and D4) should be provided before the commencement of construction works.<br>• Develop stormwater drainage system designed with reference to PUB COP (e.g. perimeter drains) that will effectively drain away runoff originating within, upstream of and adjacent to the work site. Proposed system should not cause flooding in its vicinity.<br>• Development of temporary routes to be used by heavy vehicles/ machinery aiming to reduce the compaction of soil (and therefore soil permeability) as much as possible.<br>• Geotechnical aspect of site's slope stability (such as Earth Retaining and Stabilising Structures [ERSS] to be included in detailed design engineering for the construction phase.<br>• The design engineers responsible for detailed design may need to ensure that ERSS are proposed when the site is cleared and excavated. Concurrently, the Environmental Control Officer (ECO) must ensure that these measures are successfully implemented in the construction phase, as cutting of slopes may result in slope instability |
| | • Increased quantities of surface water flowing into the watercourses due to proposed construction activities (e.g. soil dewatering, collection of stormwater)<br>• Different water inflow distribution along the watercourses due to proposed changes in drainage systems<br>• Heavy rainfall events | • Plan soil dewatering in phases to avoid generating large quantities of water to be discharged into receiving watercourses. Furthermore, soil dewatering in phases will reduce the groundwater drawdown and minimise the reduction of baseflow feeding the stream.<br>• Provide detention basins (e.g. detention tanks, detention ponds) within the Project site with controlled outlet. By controlling the outflow from the basins, it is possible to reduce the stress on the receiving watercourses by distributing the discharge more evenly.<br>• Regular maintenance of stormwater and drainage systems to prevent obstruction of channels and consequent flooding of adjacent areas<br>• Develop detailed emergency evacuation plan in the event of flash floods within the site. To develop early warning system, where applicable. |

| Potentially Affected Environmental Parameter | Potential Source(s) of Impact | Minimum Control Measures |
|---|---|---|
| | | • Provide pumping stations to extract the excess water ponded within the site after heavy rainfall events. |
| **Surface Water Quality** | • Discharge of contaminated surface water runoff originating from exposed soil surfaces<br>• Discharge of contaminated stormwater and/ or groundwater pumped out from excavated areas<br>• Discharge of construction wastewater<br>• Contaminated runoff from dust suppression sprays | • A full inventory of all anticipated wastewater streams and volumes should be finalised before the onset of the construction works.<br>• No unmanaged discharge of wastewater stream permitted.<br>• Reduce, reuse, and recycle hierarchy principle to be applied to wastewater on-site.<br>• Regular audits on environmental management procedures will be carried out onsite.<br>• No hazardous liquids to be sent to the detention pond.<br>• Hazardous wastewater, such as oily water, thinners, solvents, or paints, are to be stored and removed for treatment and disposal off-site by an approved Waste Management Contractor. Hazardous liquids to be handled as Hazardous Waste.<br>• Settling ponds will be of impervious material and be designed with sufficient capacity to hold volumes of wastewater produced on-site, as well as allowance for stormwater run-off and potential fire-fighting wastewater.<br>• 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;<br>• A responsible person (e.g. ECO) to be assigned to oversee the efficient operation of the detention ponds where 'Good Housekeeping' practices would be adhered to. Also, the area would be carefully managed to avoid spills, leaks, and odour issues, with the settling ponds checked at least daily to ensure proper functionality.<br>• Daily record volume of wastewater, as well as volumes of sludge and other produced wastes.<br>• The settling ponds, as well as wastewater generating areas on-site, to be equipped with spill clean-up kits.<br>• 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.<br>• Implement a construction EMMP and ensure full preparation of associated plans and procedures including the following:<br>• EMMP to include Standard Operation Procedures (SOPs), an Emergency Response Plan |

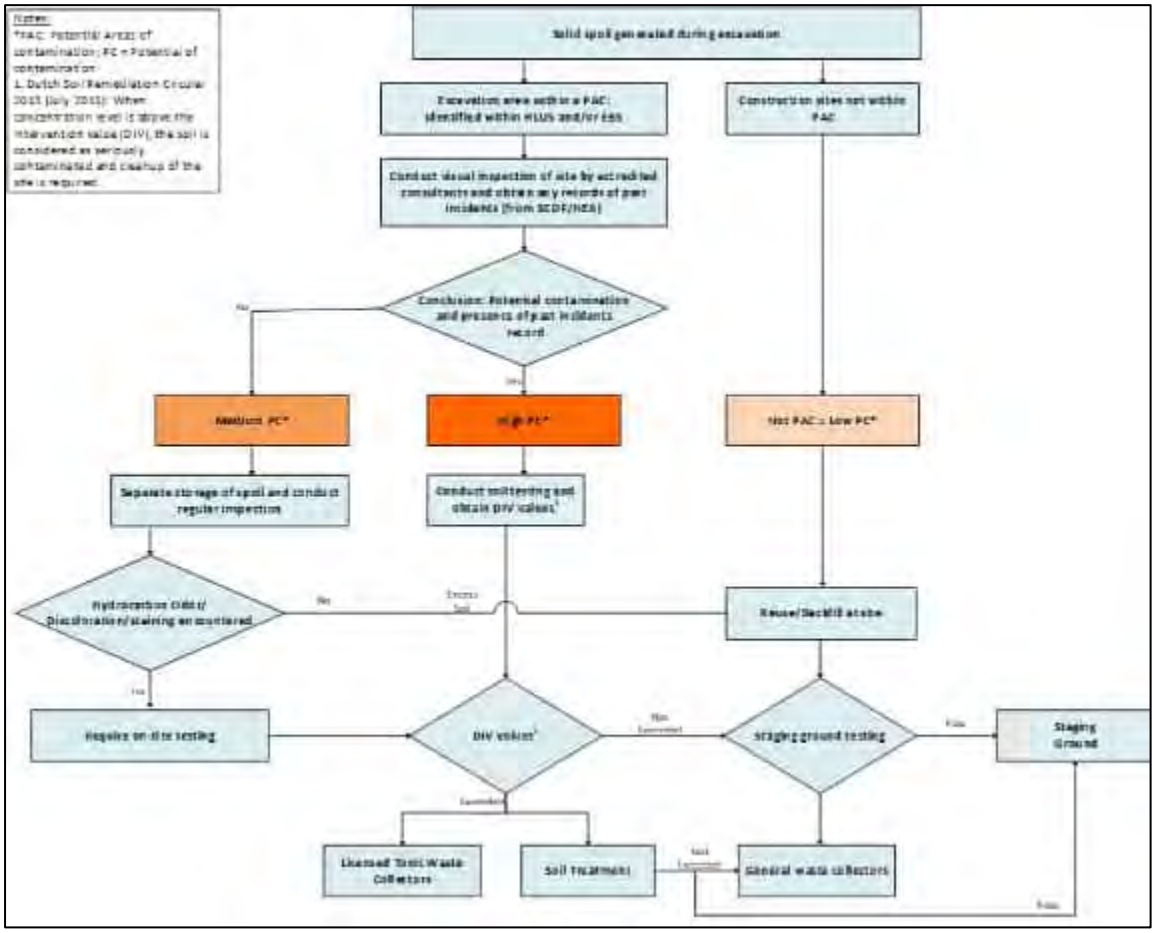
| Potentially Affected Environmental Parameter | Potential Source(s) of Impact | Minimum Control Measures |
|---|---|---|
| | | (ERP), an inventory of wastewater streams, training of staff as well as an inspection, maintenance and audit schedule; and<br>• Full development of EMMP Wastewater Management Procedures to include dedicated management and monitoring procedures that covers all eventualities related to the proper operation of the settling ponds, or any other wastewater discharge location/ equipment.<br>• Regular and dedicated procedures for the inspection and maintenance of wastewater collection, storage, and treatment infrastructure, such as pipes, oil water separators, silt screens, etc.;<br>• 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 (e.g. silt curtains) to prevent high sediment concentration stormwater drainage to watercourses; and<br>• A training programme for all on-site workers, including sub-contractors, in relation to their obligations for ensuring proper water quality management.<br>• ECM measures include but are not limited to minimisation of formation of bare soil, coverage of all bare/ erodible surfaces with wildlife-friendly, biodegradable erosion blankets, concrete cut-off drains, silt fences/ traps along the perimeter cut-off drain, turbidity curtains for works adjacent to watercourses (canals, drains, streams), etc.;<br>• Adequate drainage and piping for channelling of stormwater run-off to be assured through detailed design for capture and treatment before discharge into surface watercourses;<br>• Sizing of sediment/ detention pond and its associate structures will strictly comply with the criteria required in ECM, i.e., design to cater for at least 5-year return period storm event;<br>• 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.; and<br>• 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 water. |
| **Surface Water Quality** | Discharge of contaminants due to improper handling, transfer, storage and disposal of solid and toxic waste | • Development of a SOP for safe handling, transfer, storage and disposal of solid and toxic wastes.<br>• Effective ECM and monitoring implemented as required 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 |

| Potentially Affected Environmental Parameter | Potential Source(s) of Impact | Minimum Control Measures |
|---|---|---|
| | | under the Sewerage and Drainage (Surface Water Drainage) Regulations.<br>• 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.;<br>• 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).<br>• 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.<br>• 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.).<br>• Appropriate disposal of any waste listed in the Environmental Public Health (General Waste Collection) Regulations by licensed waste operator/ collector.<br>• All vehicles and plant 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. |
| **Surface Water Quality** | • Discharge of contaminants due to improper handling, transfer and storage of chemical substances<br>• Fuel and lubricants spillage from maintenance of construction vehicles and mechanical equipment<br>• Accidental spills and leaks of chemical substances used for construction activities | • Development of SOP for safe handling, transfer and storage of toxic waste; housekeeping checks once a day to ensure all toxic wastes cleared from site.<br>• Appropriate tests to ascertain the presence/ absence of contamination of the excavated soil.<br>• Store generated toxic chemical waste under shelter within concrete bund walls or in storage containers with good ventilation. Spill trays shall be provided for all waste containers Spill trays shall be regularly maintained to prevent rain from washing out the pollutive substances.<br>• Appropriate construction material for toxic waste storage containers with leak detection tests conducted periodically.<br>• Provision of secondary containment for all toxic waste stored in bulk as per the requirements in the COPPC/SS593.<br>• Ensure all hazardous substance and chemical containers are labelled its movement is recorded and returned to the designated storage areas when not in use.<br>• Remove any hazardous substance or chemical if there are safer alternatives. |

| Potentially Affected Environmental Parameter | Potential Source(s) of Impact | Minimum Control Measures |
|---|---|---|
| | | • Ensure all activities involving repair, servicing, engine overhaul works, etc. shall be carried out on an area which is appropriately contained (e.g. concreted area and with proper containment/sumps) and all wastes are channelled for appropriate treatment or disposal to meet the regulations.<br>• 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 spillage.<br>• Consignment notification/ tracking system and transport emergency response plan for transport of toxic waste.<br>• Appropriate disposal of toxic waste as per required in the Environmental Public Health (Toxic Industrial Waste) Regulations by licensed waste operator/ collector. |
| **Surface Water Quality** | • Seepage of contaminated sewage effluents originating on-site<br>• Seepage of contaminants due to inappropriate discharge of domestic swage and poor maintenance of the portable chemical toilets, storage tanks and septic tanks | • Provision of portable toilets and on-site septic tanks.<br>• Regular cleaning of the portable toilets and clearing of sewage waste.<br>• Appropriate location of toilet facilities away from any nearby watercourses.<br>• Inspections and audits to ascertain the hygienic conditions onsite.<br>• Training of workers on the best practices to contribute in environmental protection.<br>• Appropriate disposal of any waste listed in the Environmental Public Health (General Waste Collection) Regulations by licensed waste operator/ collector.<br>• Surface Water Drainage, to be endorsed by a QECP and submitted to PUB.<br>• Implementation of the ECM plan before the start of any construction work.<br>• Effective ECM and monitoring implemented as recommended in the Code of Practice on Surface Water Drainage to ensure that discharge into stormwater drainage system does not contain TSS in concentrations greater than the prescribed limits under the Sewerage and Drainage (Surface Water Drainage) Regulations.<br>• 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 water bodies (canals, drains, streams), etc.<br>• Implementation of CCTV including a SIDS at the public drain to monitor the surface run-off discharges from the sites as per the PUB circular on Preventing Muddy Waters from the Construction Sites (October 2015).<br>• Runoff within, upstream of, and adjacent to the work site will be effectively drained away without causing flooding in the vicinity.<br>• Manholes should always be adequately covered and temporarily sealed. |

| Potentially Affected Environmental Parameter | Potential Source(s) of Impact | Minimum Control Measures |
|---|---|---|
| | | • Protection of stockpiles with erosion blanket coverage and proper scheduling of the demolition and earthworks to reduce the quantity of stockpiles to be stored onsite.<br>• Coverage of temporary/ open storage of excavated materials.<br>• Appropriate permits for discharge to be obtained from relevant authority prior to discharge. No trade effluent other than that of a nature or type approved by NEA Director-General will be discharged into any watercourse or land. |
| **Groundwater Level** | • Decreased infiltration into the ground due to increased runoff from hard standing surfaces<br>• Groundwater extraction during construction activities that require soil dewatering | • Install piezometers to monitor the changes in groundwater level in compliance with Building Control Regulations 2003 as part of its instrumentation and monitoring plan to be endorsed by the Qualified Professional (QP)<br>• Proper Earth Retaining Stabilising Structures (ERSS) should be selected and designed to limit groundwater settlement<br>• Plan soil dewatering in phases to avoid as much as practicably possible groundwater drawdown |
| **Groundwater Quality** | • Seepage of contaminants from excavated contaminated soil (if encountered) into the underlying soil and groundwater<br>• Seepage of contaminants from extracted contaminated groundwater (if encountered) into the underlying soil and groundwater | • Identify all types of solid waste and implement comprehensive waste management system at the site in order to ensure proper disposal and prevent pollution to the environment. This contractor should conduct a construction risk assessment and prepare a comprehensive construction health, safety and environment plan. If health impacts to workers are foreseen due to the handling of such waste, necessary precautionary measures as per the safety data sheets (SDS) including personal protective equipment should be implemented on site.<br>• Use approved materials, of the same or better quality as the surrounding area, for backfilling works. All backfilled material shall be free of debris, and of good material soil.<br>• Handle and dispose excavated soil following the procedure shown in Figure 8-8. This flow chart explains how to handle excavated soils and identify potential areas of contamination as well as potential of contamination (POC) in excavated soils. If the POC soils are tested for exceedance in DIVs, the soils can be disposed of to toxic waste collectors or undergo soil treatment. If contaminated soils were sent for treatment to an acceptable standard such as the DIV, the treated soil can be disposed in the staging ground or through a general waste collector, depending on the level of the contaminants during the staging ground testing.<br>• Upon receipt of results on the tested parameters (chemicals, heavy metals) exceeding the regulatory limits, the construction contractor should further assess the potential inhalation and dermal contact impacts of the exceeded parameters to the site workers exposed to areas where soil and/or groundwater contamination is identified. The risk assessment should be conducted before the commencement of construction activities and the findings incorporated |

| Potentially Affected Environmental Parameter | Potential Source(s) of Impact | Minimum Control Measures |
|---|---|---|
| | | into the contractors' construction risk assessment and health, safety and environment plan. If health impacts to workers are foreseen, necessary precautionary measures, as per the respective chemical SDS, should be implemented on site.<br>• A site management plan should include plans of safe handling, transfer and storage of excavated soils following the procedure in Figure 8-8<br>• Discharge of extracted groundwater shall be to an area approved for such disposal by the NEA and the proposed location as identified in Figure 8-8 and following the process set out in Figure 8-9. It is recommended that the construction contractor to be vigilant of site conditions and extracted groundwater to be tested at regular intervals, especially for extracted groundwater with oily sheens or noticeable odour. If a contaminant concentration in excess of the DIV is detected, the contractor shall assess the potential inhalation and dermal impacts of the chemical identified and assess potential health and safety considerations for exposure to groundwater before commencement of construction activities. Such contaminated wastewater may need to be disposed of to a licenced toxic waste collector.<br>• Contractor will need to seek approval from relevant authorities (e.g., PUB & NEA) as per NEA's Trade Effluent Discharge Limits if the treated groundwater will be disposed to controlled watercourse If such discharges are not approved, the trade effluent will be stored, treated, or recycled on site and finally disposed of. The extracted groundwater to be discharged should be tested in regular intervals, especially if oily sheens or odour are observed |



Note: DIV standards were developed to assess the acceptability of impacted sites in the Netherlands in support of the Dutch Soil Protection Act. Therefore, it is based on local Dutch ecotoxicology, soil (consisting of 10% organic clay or 25% clay) and climate conditions for residential usage which may not be applicable to conditions in Singapore.

**Figure 8-8 Screening and disposal of excavated soils**

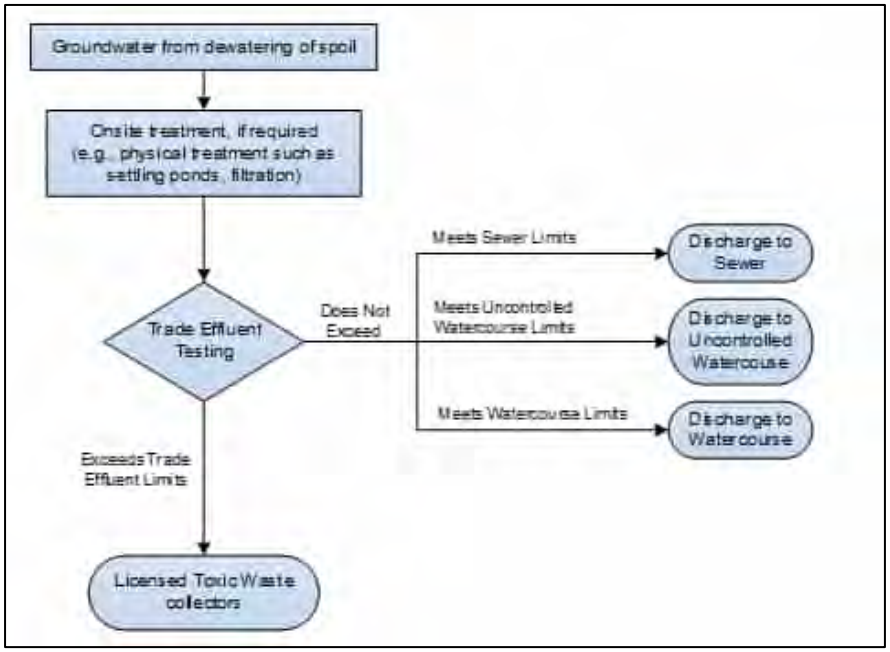



**Figure 8-9 Disposal of the groundwater generated through dewatering or inflow into excavations**

## 8.6.2 Operational Phase

Table 8-11 has a non-exhaustive list of minimum controls for each potential impact identified in Section 8.3.2 for operational phase.

**Table 8-11 Minimum control measures during the operational phase applicable for water resources**

| Potentially Affected Environmental Parameter | Potential Source(s) of Impact | Minimum Control Measures |
|---|---|---|
| **Hydrology** | Increased surface water runoff peak flow due to more areas with impervious surfaces within new development (e.g. roads, buildings, etc.) | • Potential increase of peak flow due to the change in the land use at the new developments can be mitigated by providing detention tanks within the site. Detention tanks 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.<br>• Geotechnical aspect of site's slope stability (such as ERSS) to be included in detailed design engineering for the operational phase.<br>• 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. Active, Beautiful, Clean (ABC) Water design approach can be considered to reduce the peak flow.<br>• Provide more pervious areas to increase the seepage of surface water into the soil. |
| **Surface Water Quality** | Heavy rain and stormwater wash-off pollutants built-up in the new development area and discharge to the surrounding watercourses | • 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.<br>• 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.<br>• 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. |
| | • Accidental spill and leaks (e.g. during storm event)<br>• Improper handling, transfer, and storage of solid and liquid wastes (e.g. rubbish collection and sewage disposal); | • To prepare sufficient disposal bins surrounding of the Project to avoid improper disposal of waste.<br>• To conduct regular inspection on wastes' storage system of the Project.<br>• To monitor the proposed watercourses and its surroundings with CCTV surveillance regularly to ensure no contamination occurred.<br>• To develop an emergency response plan and conduct adequate training to maintenance workers to cope the accidental water contamination.<br>• Raising awareness of various stakeholders with community/ stakeholder engagement (e.g. signage boards, warning signs, etc.). |
| **Groundwater Level** | More areas with impervious surfaces in the new development | • Incorporate more pervious surfaces in the development plan<br>• Installation of recharge wells, if necessary |

| Potentially Affected Environmental Parameter | Potential Source(s) of Impact | Minimum Control Measures |
|---|---|---|
| **Groundwater Quality** | Stormwater wash-off pollutants built-up in the new development area and discharge to surrounding soil and groundwater | • Ensure no trade effluent other than that of a nature or type approved by NEA Director-General shall be discharged into any watercourse or land. |
| | Discharge or leakage of waste and chemicals into the soil | • Conduct regular inspections on waste storage system within the Project to prevent system's clogging and leachate entering the underlying soil<br>• Store all toxic waste and hazardous substances/chemicals (if any) at designated sheltered area provided with access-controlled entrance and concrete bund walls or in storage of containers with good ventilation. Spill trays shall be provided for all chemical drums and potentially pollutive substances. Spill trays shall be regularly maintained to prevent the rain from washing out the pollutive substances<br>• Dispose all toxic waste chemicals to licensed Toxic Industrial Waste (TIW) collectors for treatment<br>• Ensure all hazardous chemicals/substances (if stored on site) are labelled, its movement is recorded and returned to the designated storage areas when not in use<br>• Ensure all activities involving the use of hazardous chemicals/substances are carried out on an area which is appropriately contained (e.g. concreted area and with proper containment/sumps).<br>• Provide emergency spill kits on site in the event of any chemical spillages. The emergency response team shall also be competent in the use of these spill kits |

# 8.7 Prediction and Evaluation of Water Resources Impacts

This section details prediction and evaluation of water resources (hydrology, water quality and groundwater) impacts identified to arise from construction and operational phases of the Project.

## 8.7.1 Construction Phase

Construction phase of the Project is expected to last approximately 6 years during which the Project site will go through a number of changes. In the early stage of the construction phase, as part of site preparations, site clearance, road and utilities diversion and construction of temporary worksites will be carried out. Furthermore, existing Rail Corridor alignment will have to be removed prior to earthworks for obtaining required platform levels. The main construction works will include foundation works and superstructure construction. Landscaping and finishing works will be undertaken during the final stages of construction phase to reinstate the designated work areas to their original condition.

Beforementioned activities could have potential impacts on current hydrological conditions at the Project site and watercourses, groundwater levels, as well as cause changes in surface water and groundwater quality. Consequently, these changes might have adverse impacts on identified sensitive receptors. The following sub-sections provide qualitative assessment and evaluation of water resources (hydrology, surface water quality, groundwater quality and level) impacts expected to occur during the construction phase of the Project.

### 8.7.1.1 Impacts due to Hydrological Changes

Pre-construction activities will include clearance of trees and vegetation not intended to be preserved (i.e. outside of proposed Ecological Corridor along Sungei Pang Sua), removal of existing structures (e.g. drains and Rail Corridor tracks) and earthworks to obtain required platform levels. Due to these activities, current land use of the site will significantly change as most of the site, which is currently vegetated, will eventually be covered with impervious surfaces such as roads, pavements, residential buildings, etc. Consequently, this may cause disturbances in current hydrological conditions on the site such as reduction of water seepage into the soil, increase of surface water peak runoff and change in water inflow distribution along the watercourses. Furthermore, some activities during the construction phase such as soil dewatering (upon PUB or NEA's approval if required) for foundation works may increase the overall quantities of water getting discharged into receiving watercourses. As per the latest development plans, during the construction phase water from construction site will be eventually be discharged into the Pang Sua Canal. It is assumed that prior to any construction works appropriate drain diversion will be carried out for the impacted drains. In addition, other minimum control measures including, but not restricted to PUB's COP regarding the water management (e.g. perimeter drains, dimensioning of temporary and permanent infrastructure, etc.) are also assumed to be successfully implemented at the site. Due to beforementioned reasons, the impact intensity was assessed to be **Medium** (i.e. medium scale changes to existing hydrology or flow, as per Table 6-5). 7

#### 8.7.1.1.1 Assessment of Impacts on Ecological Receptors

As detailed in Section 8.5.1, ecological receptors taken into consideration for the purposes of this EIA are the habitats which will form a part of the proposed Ecological Corridor along Pang Sua Canal (i.e., Managed Vegetation [Planted Trees] and Managed Vegetation [Turf Area]).

The habitat of Managed Vegetation (Planted Trees) is mostly located in the western portion of the Project site and it is also the largest habitat type present on the site (refer to Section 7.4.2). It is dominated by exotic species and it has the highest abundance of large plant specimens and other specimens of value. Although only one species of conservation significance was found within this habitat (i.e., *Bridelia stipularis;* refer to Section 7.4.2), the large plant specimens are assessed to have numerous beneficial ecological functions (e.g. provide shade and refuge area to migratory faunal species, create a biome of microhabitats, etc.). Furthermore, this habitat is a part of Sungei Pang Sua Woodland and therefore has an important role as an ecological link and a stepping stone for migratory species moving between surrounding green areas such as Bukit Gombak Forest and Bukit Mandai. Therefore, habitat of Planted Trees has been assessed to have high ecological value (as detailed in Section 7.4.5). This terrestrial habitat is expected to receive water from multiple sources (e.g. groundwater, surface water) and hence was categorised as **Priority 2** ecological sensitive receptor, with regards to hydrology (refer to Table 6-1). With Medium impact intensity, impact consequence was assessed to be **Low** (as per Impact Consequence Matrix [Table 6-6]). As explained earlier, the proposed pre-construction and construction activities have a potential to change

the hydrological conditions of the site. The degree of these hydrological changes (e.g., change in surface water flow directions, reduction of surface water quantities) was assessed by comparing the current catchment map of the site (Figure 8-4) with proposed developments and work sites (Figure 3-3). It can be observed that the current catchment of this habitat (i.e., western catchment) will generally stay intact, with limited reductions in size mostly in the southern parts of the catchment. Although this habitat possibly receives some amount of water from central catchment, re-routing of this water from central catchment during construction phase is not expected to have any significant impact given the overall quantities that it receives from its catchment (i.e., western catchment). Furthermore, as this habitat will mostly be retained as part of Ecological Corridor, it will be hoarded and fenced from future construction site and no activities will be allowed. As the future construction site must comply with local guidelines and regulations (e.g. PUB COP) with regards to water management, it is assumed that the minimum control measures such as perimeter drains and diversion of drains will be successfully implemented on the site . Therefore, it is **Unlikely** that the pre-construction and construction activities would cause hydrological impacts (e.g. flooding) to this habitat. Therefore, the overall impact significance on this ecological receptor was assessed to be **Negligible**.

The habitat of manged Turf is the second largest habitat, mostly concentrated in the eastern half of the site. It comprises mostly turf and exotic weeds that are maintained, with no species of conservation significance recorded during the biodiversity baseline surveys. However, as this habitat acts as an ecological linkage (together with the habitat of planted trees) it is considered to have medium ecological value (as detailed in Section 7.4.5). Because this terrestrial habitat is not of high ecological value, it was categorised as **Priority 3** ecological receptor with regards to hydrology (refer to Table 6-1). With impact intensity of hydrological changes assessed to be **Medium**, the impact consequence was assessed to be **Very Low**, as per Impact Consequence Matrix (Table 6-6). It should be noted that the small parts of Turf Area, that are planned to be retained, will form a part of the future Ecological Corridor, along Sungei Pang Sua, at the west portion of the Project site. The Ecological Corridor will be hoarded and fenced from the construction site and pre-construction and construction activities will be forbidden to be carried out in this area. Similarly to the habitat of Manged Vegetation (Planted Trees), it is **Unlikely** that the hydrological changes due to activities during construction phase will impact this receptor. Therefore, the overall impact significance was assessed to be **Negligible**.

The habitats and/ or parts of habitats that are outside of the future Ecological Corridor will be permanently removed for the construction of the proposed developments and therefore the impacts on those areas were not assessed. It should also be noted that the biodiversity baseline study has found that the watercourses within the Project site and its vicinity (i.e. Pang Sua Canal) support poor aquatic life and hence were not regarded as ecological receptors for the purposes of this EIA.

#### 8.7.1.1.2 Assessment of Impacts on Human Receptors

Identified human receptors during construction phase include on-site construction workers, off-site permanent residents as well as visitors in the vicinity of the site.

Regular activities of on-site workers such as driving of heavy vehicles and machinery, construction works, etc. may be temporarily disturbed due to hydrological changes which could potentially lead to localised flooding during heavy storm events. However, given the size of the site and under assumption that appropriate health and safety measures will be adhered to at all times at site, such flooding is not expected to compromise safety of this receptor. Therefore, on-site construction workers have been categorised as **Priority 2** sensitive receptors. With impact intensity assessed to be Medium, impact consequence was assessed to be **Low** (as per Impact Consequence Matrix shown in Table 6-6). Because disturbances, if any, of this receptor are expected to occur only during heavy rainfall events, likelihood was assessed to be **Rare** and therefore the overall impact significance was assessed to be **Minor**.

Similarly to on-site workers, off-site residents and visitors may experience obstruction of activities (e.g. leisure walks along Woodlands Road). Therefore, they have been categorised as **Priority 2** receptors and the impact consequence was assessed to be **Low** (medium impact intensity). Likelihood of occurrence was assessed to be **Rare**, as this receptor might experience impacts only during heavy rainfall events strong enough to cause flooding of existing drains which would consequently flood the surrounding areas. Hence the overall impact significance was assessed to be **Minor.**

#### 8.7.1.1.3 Assessment of Impacts on Socio-Economic Receptors

Socio-economic receptors are developments within the Study Area whose regular processes and/ or activities may be impacted by foreseen hydrological changes. As detailed in Section 8.5.1, these receptors include Pang Sua Canal, Drain D2, Drain D3, Woodlands Road and Bukit Panjang Neighbourhoods 5 and 6.

As detailed in Section 4.5, the water from Pang Sua Canal eventually gets discharged into the Kranji Reservoir (refer to Section 4.5) and from there (after adequate treatment) is used for beneficial purposes (e.g. drinking, industrial, etc.). This implies that hydrological changes of the site which could lead to increase or decrease of water quantities within the Pang Sua Canal could consequently have an impact on Kranji Reservoir and water supply. Therefore, Pang Sua Canal was categorised as **Priority 1** sensitive receptor. As the impact intensity was assessed to be Medium, impact consequence was assessed to be **Medium**. With reference to hydrological baseline findings (as detailed in Section 8.4.2.1) it can be observed that currently Pang Sua Canal receives water from the site from two catchments: 1) western catchment (by direct discharge of water along the canal); and 2) central catchment (via underground culvert at the northwest part of the site). With regards to water quantities originating from western catchment, they are most likely not going to change significantly as no major changes are expected to occur in this area. During the construction phase, surface water originating from central catchment will most likely be re-routed and discharged into a different watercourse. However, considering the overall catchment area of Pang Sua Canal and the quantities of water it receives from other areas (i.e., upstream urbanised area, downstream areas), it is not expected that such change of hydrology will have significant impact on the overall quantities of water at Pang Sua Canal and Kranji Reservoir. Therefore, the likelihood of this impact was assessed to be **Less Likely**, and the overall impact significance was assessed to be **Minor**.

As the water from Drain D3 will get discharged into Pang Sua Canal, eventually the surface water runoff collected by drain D3 will get discharged to Kranji Reservoir and from there it will be used for beneficial purposes after the adequate treatment. Therefore, this drain has been categorised as **Priority 1** sensitive receptor. With the impact intensity assessed to be Medium, impact consequence was assessed to be **Medium** (as per Table 6-6). Based on the proposed development plans, drain D3 will remain within the preserved RAC and will aim to capture the stormwater originating from this area. It is to be noted that no activities will be allowed within RAC during the construction phase of the Project. In addition, it is assumed that minimum control measures will be successfully implemented within the site. Because of the beforementioned reasons, the likelihood of this impact was assessed to be **Unlikely** and the overall impact significance was assessed to be **Negligible**.

Bukit Panjang residential areas were categorised as **Priority 1** receptors as they are permanently inhabited and potential flooding may disrupt regular activities of the people living there. With Medium impact intensity, impact consequence was assessed to be **Medium**. However, given the location and distance of these areas (i.e. across Woodlands Road) from the site and the fact that localised flooding, if any, will most likely occur in the vicinity of D2, likelihood was assessed to be **Unlikely**. Therefore, the overall impact significance was assessed to be **Negligible**.

The water collected in existing Drain D2 will eventually get discharged into the sea (refer to Section 4.5) and is not expected to be used for beneficial purposes. Therefore, this receptor was categorised as **Priority 3**. With impact intensity assessed to be Medium, impact consequence on this receptor was assessed to be **Very Low**. During the construction phase it is noted that the water will not be discharged into Drain D2, but in Pang Sua Canal. Under the assumption that appropriate water management minimum controls such as detention ponds and retention tanks will be implemented during the construction phase, it is expected that additional quantities of water would not be significant. However, the land use change may also lead to increase in surface water peak runoff, consequently potentially impacting water levels in drain. This impact will be the most prominent only during the heavy storm events. Therefore, the likelihood of this impact was assessed to be **Rare** and the overall impact significance was assessed to be **Negligible**.

Woodlands Road is an infrastructure development running along the eastern border of the Project site. However, as this development is used for non-essential services, it is categorised as **Priority 2** sensitive receptor. As the impact intensity was assessed to be Medium, the impact consequence (as per Table 6-6), was assessed to be **Low**. Although the receptor is close to site, given the successful implementation of minimum controls, it was assessed that the short-term flooding will be **Rare** during construction phase. Therefore, based on the Impact Significance Matrix (Table 6-8), the overall impact significance was assessed to be **Minor**.

#### 8.7.1.2 Impacts due to Surface Water Quality Changes

Construction phase of the Project will entail various on-site activities which directly, or indirectly can cause the pollution of the watercourses within and in the vicinity of the Project site. Consequently, this pollution could have adverse impacts on the surrounding flora, fauna, habitats, humans as well as developments whose productivity and processes are dependent on the water quality.

Pre-construction and construction activities (as described in Section 3.2.1) are expected to generate significant quantities of waste material. During the site clearance, vegetation not intended to be preserved (i.e. outside of proposed Ecological Corridor) and existing structures and built-up areas (e.g. existing drains, heavy vehicle carpark

and defunct bus terminal) will be removed from the site resulting in mixed solid waste comprising biodegradable components, soil and construction waste. Earthworks will entail activities during which the soil will be excavated, transported, placed at the new location and compacted. If not managed properly, these activities may result in the increased concentration of suspended solids, sediments, chemical pollutants and nutrients in surface runoff (especially during heavy storm events) which can have negative effects on the receiving watercourses. Furthermore, handling and storing of soil during the earthworks may expose workers to historically contaminated soil.

Activities during the construction phase are also expected to generate liquid effluents. These commonly include extracted groundwater (from soil dewatering required for foundation works), construction wastewater (e.g. from wheel washing and dust suppression sprays) as well as stormwater runoff from exposed soil slopes. Such effluents often contain elevated levels of sediments and pollutants and therefore need to be managed adequately to prevent it from entering into watercourses without treatment. Additionally, since domestic sewage will be generated onsite, inappropriate discharge of domestic sewage and poor maintenance of the portable chemical toilet, storage tanks and septic tanks (e.g. overflow or overload) can potentially lead to an increase in nutrients, which can lead to algal overgrowth, which depletes dissolved oxygen leading to anoxic conditions and can produce toxins that can pose a threat to the health of the aquatic ecosystems.

It should be noted that it is expected that chemicals substances such as fuel and lubricants will be stored and handled on site. Uncontrolled releases of such chemicals (e.g. accidental spillage, improper management practices) have a potential to be flushed by surface runoff or transported via seepage through the soil into downstream watercourses. This can lead to increase in concentration of heavy metals, oil, grease, pH levels, etc. in receiving watercourses.

As explained in previous paragraphs, construction phase activities are expected to generate significant amount of waste material potentially containing a wide range of pollutants (e.g. chemicals, nutrients, solids, etc.) which could deteriorate quality of receiving watercourses. Assuming that the proposed minimum controls are successfully implemented (and approved by relevant Agencies, where applicable), the impact intensity on the change in water quality was assessed to be **Medium**.

#### 8.7.1.2.1 Assessment of Impacts on Ecological Receptors

As both ecological receptors (i.e. Planted Trees and Turf) are terrestrial habitats, they were categorised as **Priority 3** receptors. Therefore, with Impact Intensity assessed to be Medium, and as per Table 6-5, the impact consequence on these receptors was assessed to be **Very Low**. Furthermore, as both of the habitats will form a part of proposed Ecological Corridor which will be outside of the construction sites and no activities will be allowed within it, it is **Unlikely** that any of the wastes and/ or pollutants/ chemicals produced on the site will propagate towards these habitats. Therefore, the overall impact significance was assessed to be **Negligible**.

#### 8.7.1.2.2 Assessment of Impacts on Human Receptors

As detailed in section 8.5.1, identified human receptors during construction phase will include on-site workers and off-site permanent residents and visitors. Certain construction phase activities, such as groundwater extraction during earthworks and foundation works will require handling and management of potentially contaminated water extracted from the soil. Furthermore, on-site construction workers may also come into direct contact with contaminated water generated on the site (e.g. effluents, construction wastewater, etc.). As such water may contain contaminants which could have adverse impacts on their health, on-site workers were categorised as **Priority 1** human receptors. Because off-site permanent residents and visitors are unlikely to come in direct contact with contaminated water or experience nuisance (e.g. odour) they were categorised as **Priority 3** human receptors. With impact intensity on water quality assessed to be Medium, the impact consequence on human receptors was assessed to be **Medium** and **Very Low** (for on-site workers and off-site permanent residents and visitors, respectively). Under the assumption that minimum control measures will be successfully implemented on the site, the likelihood of direct contact of on-site workers with contaminated water was assessed to be **Rare**, and the overall impact significance was assessed to be **Minor**. As it is **Unlikely** that off-site residents and visitors will come into contact with contaminated water, the overall impact significance was assessed to be **Negligible**.

#### 8.7.1.2.3 Assessment of Impacts on Socio-Economic Receptors

With regards to water quality, Pang Sua Canal and Drain D3 were categorised as **Priority 1** sensitive receptor, as the water from these two watercourses eventually gets discharged into the Kranji Reservoir from where it will be used for beneficial purposes. Based on the assessed impact intensity (i.e., Medium), the impact consequence on Pang Sua Canal and Drain D3 was assessed to be **Medium.** Due to the fact that Ecological Corridor is proposed to be retained east of the Pang Sua Canal (between the canal and construction sites) and that no activities will be

allowed in this area, it is not **Unlikely** that potentially contaminated water originating from site will get discharged into Pang Sua Canal nor Drain D3. Therefore, the overall impact significance on this receptor was assessed to be **Negligible**.

Drain D2 was categorised as **Priority 3** because the water from it will eventually get discharged into the sea and therefore will not be used for any beneficial purposes. As Woodlands Road and Bukit Panjang Neighbourhoods 5 and 6 are type of developments that will not directly use the water from the site for beneficial purposes (e.g. drinking water in apartments, water for washing the pavements, etc.), they were also categorised as **Priority 3** receptors. With impact intensity assessed to be Medium, the impact consequence on these receptors was assessed to be **Very Low**. Although construction phase activities may lead to deterioration of water quality, such contamination (if any) is **Unlikely** to impact or obstruct the regular activities of these sensitive receptors. Therefore, the overall impact consequence was assessed to be **Negligible**.

### 8.7.1.3 Impacts due to Groundwater Level Decrease

Certain pre-construction activities (e.g. earthworks) and construction activities (e.g. foundation works) that are planned to be carried out within CCK N1 will require extraction of groundwater from the soil. This will enable dry ground conditions of the excavation areas which is a pre-requisite for safe and successful earthworks. Consequently, soil dewatering might have an impact on current groundwater levels by lowering the water table to required depths. Furthermore, as the pre-construction and construction works progress, more areas at Project site, which are currently vegetated (and hence pervious), will be replaced with various structures (e.g. buildings, platforms, roads) which are impervious. This might reduce the infiltration of surface water and rainfall into the soil, potentially reducing the current groundwater level. However, as the groundwater will be replenished from upgradient sources, it is expected that groundwater level decrease during the construction phase will only be localised. Because of that, and under the assumption that appropriate minimum controls have been successfully implemented, impact intensity due to pre-construction and construction activities was assessed to be **Low**.

#### 8.7.1.3.1 Assessment of Impacts on Ecological Receptors

The potential importance of groundwater level to ecological receptors is twofold – it may feed the surface watercourses and hence support natural habitats and it also may be the main source of water for various plant species that are dependent of groundwater due to the lack of surface water sources. Identified ecological receptors include the habitats which will be retained as part of the Proposed Ecological Corridor at the western portion of the site (i.e., Managed Vegetation [Planted Trees and Turf]).

Planted Trees form the largest habitat of the Project site, mostly comprising of exotic species. It is located in the western portion of the site with assessed high ecological value (refer to Section 7.4.5) as it likely acts as a stepping stone for migratory species. Such habitat is expected to obtain water from multiple sources and was therefore categorised as **Priority 2** sensitive receptor. As the impact intensity was assessed to be Low, impact consequence was assessed to be **Very Low**. As the soil dewatering is **Likely** to occur during the construction phase, the overall impact significance was assessed to be **Minor**, as per Impact Significance Matrix (Table 6-8).

Besides abovementioned habitat, part of the Turf area is also intended to be preserved as part of the proposed Ecological Corridor. As this habitat is not of a high ecological value, it was categorised as **Priority 3** receptor. Impact consequence was assessed to be **Very Low** (as per Table 6-6 and with Low impact intensity). With **Likely** groundwater extraction activities during the construction phase of the Project (e.g. during earthworks, foundation works), impact significance on this receptor was assessed to be **Minor**.

#### 8.7.1.3.2 Assessment of Impacts on Human Receptors

It is understood that currently groundwater in Singapore is not extracted for any beneficial purposes (i.e. drinking and industrial purposes, irrigation). Hence, it is **Unlikely** that the potential groundwater level decrease will have any impact on the human receptors and the overall impact significance is assessed to be **Negligible**.

### 8.7.1.4 Impacts due to Groundwater Contamination

The activities planned for the construction phase of the Project are expected to generate large amounts of spoil material. The quantity of solid waste stored on site (e.g. excavated soil, debris resulting from demolition activities, construction debris, etc.) is expected to be limited, given the periodical disposal by licenced general and toxic waste contractors as part of minimal controls. Handling and storing of soil may expose workers to historically contaminated soil, if any. Furthermore, if not managed properly, contaminants from the waste may seep into the underlying soil and groundwater and from get transported into downgradient watercourses, potentially impacting surrounding habitats. In the event that contaminated soil or groundwater are encountered during excavations,

implementation of the measures detailed in Figure 8-8 and Figure 8-9 will ensure that the contaminated soil and/ or groundwater are properly managed and disposed.

Besides historical contamination, another potential mechanism to soil and groundwater contamination is through leakage and seepage of contaminants originating from toxic waste that is stored on site as well as from chemicals used and stored on site. The quantity of toxic waste stored on-site is expected to be limited, with the assumption that generated waste will be periodically removed and disposed off-site by licensed Toxic Industrial Waste (TIW) contractors during the construction phase. Chemicals used during the construction phase will be stored at designated sheltered area with access-controlled entrance and concrete bund walls or in storage containers with good ventilation or on spill pallets. In the event of chemical spillage, spill kits will be available on site to be operated by an emergency response team competent in their use.

Given the historical land use and assuming that proposed minimum controls are successfully implemented (and approved by the relevant Agencies, where applicable) it is unlikely that discharge, spillage and/or leakage from spoil, toxic waste and chemicals will be in quantity that may adversely impact the environment (i.e. groundwater). Furthermore, if the potential contamination occurs, it will most likely cause localised impacts to soil and groundwater quality which are unlikely to extend beyond the Project site and which will be possible to remediate. Therefore, the impact intensity was assessed to be **Low**

#### 8.7.1.4.1 Assessment of Impacts on Ecological Receptors

Based on the assessed impact intensity (i.e. Low), impact consequence on ecological receptors (i.e., Planted Trees [**Priority 2** receptor] and Turf [**Priority 3** receptor]) was assessed to be **Very Low**, as per Impact Consequence Matrix (Table 6-6). With the assumption that the proposed minimum control measures have been implemented, proper mandatory training for workers regarding environmental management and spill management has been conducted and regular site inspections are carried out, the likelihood of occurrence during the construction phase is expected to be **Occasional**. Overall, based upon the assessment of the likelihood and consequences, and considering the routine, standard industry practices implemented during the construction phase of the Project, the potential impacts on ecological sensitive receptors due to groundwater contamination are assessed to be **Minor.**

#### 8.7.1.4.2 Assessment of Impacts on Human Receptors

During the construction phase, it is expected that future on-site construction workers will come in contact with groundwater during the pre-construction and construction activities such as earthworks, soil dewatering, foundation works which require extraction of groundwater from soil to ensure dry working conditions. Possible pathways for exposure of these receptors might be dermal contact and incidental ingestion of groundwater. Therefore, these receptors were categorised as **Priority 2**, as detailed in Table 6-1, with impact consequence assessed to be **Very Low.** With the assumption that the proposed minimum control measures have been implemented, proper mandatory training for workers regarding environmental management and spill management has been conducted and regular site inspections are carried out, the likelihood of occurrence during the construction phase is expected to be **Occasional.** Therefore, the overall impact significance was assessed to be **Minor.**

It is assumed that during the construction phase the site will be closed for public and only authorised personnel will be allowed to enter the worksite. Therefore, it is **Unlikely** that off-site residents and visitors will come in contact to potentially contaminated groundwater and the overall impact significance was assessed to be **Negligible**.

**Table 8-12 Summary of impact evaluation during construction phase**

| Impact | Source of Impact | Environmental Parameter Affected | Sensitive Receptor Affected | Receptor Sensitivity | Impact Intensity | Impact Consequence | Impact Likelihood | Impact Significance |
|---|---|---|---|---|---|---|---|---|
| **Ecological Receptors** | | | | | | | | |
| Disturbances in habitat and/ or reduction in size of species' population | • Temporary and/ or permanent land use change causing increase in stormwater runoff peak flow<br>• Activities which increase quantities of water flowing into the watercourses<br>• Reduced groundwater baseflow<br>• Different water inflow distribution along the watercourses | Hydrology | Managed Vegetation (Planted Trees) | Priority 2 | Medium | Low | Unlikely/ Remote | Negligible |
| | | | Managed Vegetation (Turf) | Priority 3 | Medium | Very Low | Unlikely/ Remote | Negligible |
| | • Discharge of contaminated surface water from construction site<br>• Discharge of contaminants due to improper handling, transfer, and storage of chemical substances;<br>• Discharge of contaminants due to improper handling, transfer, storage and disposal of solid waste (e.g. construction debris);<br>• Fuel and lubricants spillage from maintenance of construction vehicles and mechanical equipment | Surface Water Quality | Managed Vegetation (Planted Trees) | Priority 3 | Medium | Very Low | Less Likely/ Rare | Negligible |
| | | | Managed Vegetation (Turf) | Priority 3 | Medium | Very Low | Less Likely/ Rare | Negligible |
| | • Decreased infiltration into the ground due to increased runoff from hard standing surfaces<br>• Groundwater extraction during pre-construction and construction activities that require soil dewatering | Groundwater Level | Managed Vegetation (Planted Trees) | Priority 2 | Low | Very Low | Likely/ Regular | Minor |
| | | | Managed Vegetation (Turf) | Priority 3 | Low | Very Low | Likely/ Regular | Minor |

| Impact | Source of Impact | Environmental Parameter Affected | Sensitive Receptor Affected | Receptor Sensitivity | Impact Intensity | Impact Consequence | Impact Likelihood | Impact Significance |
|---|---|---|---|---|---|---|---|---|
| | • Seepage of contaminants (if encountered) from excavated soil and extracted groundwater, soil erosion of exposed soil<br>• Discharge of toxic chemical waste and/or leakage of chemicals used for refuelling and maintenance of vehicles, machinery and equipment | Groundwater Quality | Managed Vegetation (Planted Trees) | Priority 2 | Low | Very Low | Possible/ Occasional | Minor |
| | | | Managed Vegetation (Turf) | Priority 3 | Low | Very Low | Possible/ Occasional | Minor |
| **Human Receptors** | | | | | | | | |
| Obstruction or prevention of regular human activities and safety concerns | • Increased stormwater runoff peak and quantity due to temporary and/ or permanent land use change, causing localised flooding<br>• Flooding in areas adjacent to watercourses due to increased water quantities and water levels<br>• Different water inflow distribution along watercourses<br>• Heavy rainfall events | Hydrology | On-site construction workers | Priority 2 | Medium | Low | Less Likely/ Rare | Minor |
| | | | Off-site permanent residents and visitors in the vicinity of the site | Priority 2 | Medium | Low | Less Likely/ Rare | Minor |
| Adverse impact to human health due to exposure to contaminated water or groundwater | • Dermal exposure to contaminated water and/ or groundwater<br>• Incidental ingestion of contaminated water and/ or groundwater<br>• Nuisance due to changes in physico-chemical characteristics of water such as odour | Surface Water Quality | On-site construction workers | Priority 1 | Medium | Medium | Less Likely/ Rare | Minor |
| | | | Off-site permanent residents and visitors in the vicinity of the site | Priority 3 | Medium | Very Low | Unlikely/ Remote | Negligible |

| Impact | Source of Impact | Environmental Parameter Affected | Sensitive Receptor Affected | Receptor Sensitivity | Impact Intensity | Impact Consequence | Impact Likelihood | Impact Significance |
|---|---|---|---|---|---|---|---|---|
| | | Groundwater Quality | On-site construction workers | Priority 2 | Low | Very Low | Possible/ Occasional | Minor |
| | | | Off-site permanent residents and visitors in the vicinity of the site | Priority 3 | Low | Very Low | Unlikely/ Remote | Negligible |
| Groundwater Level Decrease | • Decreased infiltration into the ground due to increased runoff from hard standing surfaces<br>• Groundwater extraction during pre-construction and construction activities that require soil dewatering | Groundwater Level | On-site construction workers | Priority 3 | Low | Very Low | Unlikely/ Remote | Negligible |
| | | | Off-site permanent residents and visitors in the vicinity of the site | Priority 3 | Low | Very Low | Unlikely/ Remote | Negligible |
| **Socio-Economic Receptors** | | | | | | | | |
| Obstruction of regular processes and/ or activities of within the developments | • Changes in water levels and flow conditions within watercourses<br>• Changes in quantities of water within watercourses<br>• Different water inflow distribution along the watercourses | Hydrology | Pang Sua Canal | Priority 1 | Medium | Medium | Less Likely/ Rare | Minor |
| | | | Drain D2 | Priority 3 | Medium | Very Low | Less Likely/ Rare | Negligible |
| | | | Drain D3 | Priority 1 | Medium | Medium | Unlikely/ Remote | Negligible |

| Impact | Source of Impact | Environmental Parameter Affected | Sensitive Receptor Affected | Receptor Sensitivity | Impact Intensity | Impact Consequence | Impact Likelihood | Impact Significance |
|---|---|---|---|---|---|---|---|---|
| | | | Woodlands Road | Priority 2 | Medium | Low | Less Likely/ Rare | Minor |
| | | | Bukit Panjang Neighbourhoods 5 and 6 | Priority 1 | Medium | Medium | Unlikely/ Remote | Negligible |
| | • Change of physico-chemical characteristics of water due to pre-construction and construction activities | Surface Water Quality | Pang Sua Canal | Priority 1 | Medium | Medium | Unlikely/ Remote | Negligible |
| | | | Drain D2 | Priority 3 | Medium | Very Low | Unlikely/ Remote | Negligible |
| | | | Drain D3 | Priority 1 | Medium | Medium | Unlikely/ Remote | Negligible |
| | | | Woodlands Road | Priority 3 | Medium | Very Low | Unlikely/ Remote | Negligible |
| | | | Bukit Panjang Neighbourhoods 5 and 6 | Priority 3 | Medium | Very Low | Unlikely/ Remote | Negligible |

## 8.7.2 Operational Phase

As described in Section 8.3.2, during operational phase, the permanent change in land use and potential improper management of liquid and solid waste may potentially impact the hydrology, and water quality of the watercourses in the Study Area. Furthermore, increase of impervious surfaces may cause decreased infiltration of surface water and rainfall into the ground while chemicals used during the maintenance and landscaping activities might accidentally leak into the ground, affecting underlying groundwater's quality. Impact evaluation was conducted with the assumption that minimum control measures have been implemented.

Following sub-sections present the impact prediction and evaluation of the potential changes in hydrology and surface water quality on ecological, human and socio-economic sensitive receptors during the operational phase. These sensitive receptors have been defined in Section 8.5.2.

### 8.7.2.1 Impacts due to Hydrological Changes

During the operational phase, a major source of impact would be the permanent change in land use/ increased urbanised areas. Such changes have a potential to alter the current water cycle within the site long-term. Reduced infiltration, higher peak of runoff and other hydrological changes due to increase in impervious surfaces, if not managed properly, may result in more frequent and harmful (for humans, biodiversity and immovable assets) events such as flash floods. This issue becomes even more complex due to the additional climate change impacts and changes in rainfall patterns. Taking beforementioned reasons into consideration, the impact intensity was assessed to be **Medium**.

#### 8.7.2.1.1 Assessment of Impacts on Ecological Receptors

Identified ecological receptors during the operational phase of the Project include proposed Ecological Corridor and managed vegetation within the future residential developments and Rail Corridor.

Ecological Corridor was proposed to be retained in order to maintain the current role of the site as an important stepping stone for migratory species (refer to Section 7.4.6). This Corridor will comprise green buffer along Pang Sua Canal and cluster of trees and turf currently present in the western portion of the site. As this receptor will have a high ecological value and it will receive the water from surrounding area as well as from groundwater, it was categorised as **Priority 2** sensitive receptor. With Medium impact intensity, the impact consequence was assessed to be **Low**. As explained in Section 8.7.1.1.1, the catchment area of this habitat will not change significantly due to the proposed developments. This implies that hydrological changes due to the proposed residential development are **Less Likely** going to have an impact on this receptor. Therefore, the overall impact significance on Ecological Corridor due to hydrological changes was assessed to be **Minor**, as per impact significance matrix (Table 6-8).

It is expected that new vegetation will be established within the proposed residential developments and retained Rail Corridor as part of landscape enhancements. Being a habitat that will be maintained by humans, it is expected that it will not be disturbed by potential hydrological changes due to the proposed residential developments and was categorised as **Priority 3** sensitive receptor. As the impact intensity was assessed to be Medium, the impact consequence was assessed to be **Very Low**. Hydrological occurrences such as flash floods and ponding due to increase in impervious surfaces may cause short-term disturbances of this habitat. However, this is expected to occur only during the heavy storm events and hence the likelihood was assessed to be **Rare**. The overall impact significance was assessed to be **Negligible**, as per impact significance matrix (Table 6-8).

#### 8.7.2.1.2 Assessment of Impacts on Human Receptors

During the operational phase, the site is expected to see the increase of not just permanent residents but also visitors to proposed enhancement works at the Rail Corridor. Furthermore, maintenance workers are expected to conduct the maintenance of the landscaping features of the site. All individuals expected within the site (i.e. future residents, visitors and maintenance workers) have been categorised as **Priority 2** sensitive receptors as their activities may be disrupted due to localised flooding. Furthermore, under the assumption that adequate health and safety measures are implemented, it is not expected that their safety would be compromised during such events. Because impact intensity was assessed to be Medium, the impact consequence on these receptors was assessed to be **Low**. With minimum controls being implemented, localised flooding and ponding is expected to occur only during the heavy storm events and therefore the likelihood was assessed to be **Rare**. The overall impact significance was assessed to be **Minor**.

Off-site permanent residents and visitors in the vicinity of the site were also categorised as **Priority 2** receptors as their activities may be disrupted short-term, but their safety is not expected to be compromised. With assessed **Low** impact consequence (Medium impact intensity for Priority 2 receptor, as per Table 6-6) and **Rare** likelihood (due to the distance of the receptors from the site), the overall impact significance was assessed to be **Minor**.

#### 8.7.2.1.3 Assessment of Impacts on Socio-Economic Receptors

As Pang Sua Canal and Drain D3 will continue to discharge water into Kranji Reservoir during the operational phase of the Project, they were categorised as Priority 1 sensitive receptors. With Medium impact intensity, the impact consequence was assessed to be **Medium**. The overall quantities of water that Pang Sua Canal receives (e.g., from upstream urban area, downstream of the Project site) are significantly larger than the water originating from the site. Therefore, it is **Less Likely** that hydrological changes due to operational phase of the Project will have significant or long-term impacts on the quantities of water getting discharged into the Kranji Reservoir from Pang Sua Canal. Furthermore, as the catchment area of Drain D3 is not going to be changed significantly during the operational phase, it is also Less Likely that these changes will have an impact the baseline hydrological conditions. Based on the likelihood and impact consequence, and as per impact significance matrix Table 6-8, the overall impact significance was assessed to be **Minor** for both Pang Sua Canal and Drain D3.

Proposed future residential developments within the site and areas surrounding the site (i.e., Bukit Panjang Neighbourhood 5 and 6) were categorised as **Priority 1** receptors as hydrological impacts such as floods and ponding may obstruct the regular activities of their future/ existing residents. With impact intensity assessed to be Medium, the impact consequence on these receptors was assessed to be **Medium**. The proposed future residential developments and accompanying infrastructure (e.g. roads, drainage systems, etc.) within the site are expected to be constructed and dimensioned taking into consideration new land use (i.e., with low permeability). Furthermore, this type of developments commonly have a system of inner roads and walkways which would provide the alternative routes for individuals to carry out their regular activities undisturbed during the potential floods and ponding. Hence, the likelihood was assessed to be **Less Likely** and the overall impact significance was assessed to be **Minor**. Given the location and distance of residential developments across the Woodlands Road and the fact that localised flooding, if any, will most likely occur within the site, likelihood was assessed to be **Unlikely**. Therefore, the overall impact significance was assessed to be **Negligible**.

Woodlands Road is a type of development used for non-essential services (as defined in Table 6-1) and hence was categorised as **Priority 2** sensitive receptor. As the impact intensity was assessed to be Medium, the impact consequence on this receptor was assessed to be **Very Low**. Due to the fact that flooding of the road, if any, is likely to occur only during heavy rainfall events, the likelihood of this impact was assessed as **Rare**. Therefore, the overall impact significance was assessed to be **Minor**.

As the water from D2 eventually gets discharged into the sea, this receptor was categorised as **Priority 3** (i.e., no beneficial uses of water). With Medium impact intensity, the impact consequence was assessed to be **Very Low**. Although the land use is expected to change after the development, given the implemented minimum control measures it is **Unlikely** that these changes due to construction activities will impact the Drain D2, the overall impact significance was assessed to be **Minor**, as per Impact Significance Matrix (Table 6-8).

### 8.7.2.2 Impacts due to Surface Water Quality Changes

As described in Section 8.3.2, the major sources of impact on surface water quality during the operational phase includes stormwater runoff contamination and improper management of liquid and solid wastes.

During operational phase, solid and liquid waste will be frequently generated by the residents in the proposed development (e.g. domestic waste, car wash wastewater, etc). If poorly managed, the waste and/ or wastewater may potentially enter and pollute the receiving watercourses.

Furthermore, as the Project site will mostly consists of urbanised areas, it is likely that there will be more sources of contamination (e.g., accidental spillage and leakages). During storm events, the stormwater runoff from carparks, gardens and concrete surfaces may become contaminated with suspended solids, heavy metals and nutrients, which will then be conveyed to the surrounding watercourses. The overall impact intensity due to surface water quality changes during operational phase of the Project has been assessed as **Medium**.

#### 8.7.2.2.1 Assessment of Impact on Ecological Receptors

Both proposed Ecological Corridor and Managed Vegetation within the future residential development will be terrestrial habitats and therefore were categorised as **Priority 3** sensitive receptors. With Medium impact intensity,

the impact consequence on these receptors was assessed to be **Very Low**, as per impact consequence matrix (Table 6-6). Under the assumption that minimum control measures regarding liquid and solid waste will be successfully implemented, the potential pollution may occur due to accidental spills and leaks (e.g. from cars) which could be further transmitted by surface water runoff during rainfall events. As the Ecological Corridor is **Unlikely** to receive water from the future residential area, the overall impact significance was assessed to be **Negligible**. The likelihood of pollution of Managed Vegetation was assessed to be **Occasional** (i.e., during rainfall events and unplanned events such as accidental spills), and the overall impact significance was assessed to be **Minor**.

#### 8.7.2.2.2 Assessment of Impacts on Human Receptors

Although the future residents, visitors and maintenance workers of the proposed development are unlikely to come in direct contact with potentially contaminated water (if any), they could experience nuisance caused by the changes in the physico-chemical characteristics of water (e.g. odour). Hence, they were categorised as **Priority 2** sensitive receptors. As the impact intensity was assessed to be Medium, the impact consequence was **Low**. As the nuisance that these receptors might experience is expected to be short-term, the likelihood of this impact was assessed to be **Occasional**. The overall impact significance was assessed to be **Minor**, as per impact significance matrix shown in Table 6-8 .

The potential changes of water quality within Project site (if any) are not expected to cause nuisance to off-site residents and visitors and hence were categorised as **Priority 3** sensitive receptors. Impact consequence on this receptor was assessed to be **Very Low** (Medium impact intensity and Priority 3 receptor, as per Table 6-6). As it is **Unlikely** that potential water quality changes within the site will cause any significant impacts on these receptors, the overall impact significance on off-site residents and visitors was assessed to be **Negligible**.

#### 8.7.2.2.3 Assessment of Impacts on Socio-Economic Receptors

As the water from Pang Sua Canal and Drain D3 eventually gets discharged into the Kranji Reservoir, potential changes in water quality could consequently have impacts on the quality of water in the Reservoir. Hence, Pang Sua Canal and Drain D3 were categorised as Priority 1 sensitive receptors and impact consequence was assessed to be **Medium** (for Medium impact intensity and as per Table 6-6). However, as no water originating from the site is expected to be discharged directly into Pang Sua Canal, and drainage system of the future development is expected to be sized enough to adequately conduct stormwater, the likelihood for contamination was assessed to be **Less Likely**. Similarly, the Drain D3 will be receiving water from the surrounding RAC which is not expected to undergo changes compared to the current status. Therefore, the overall impact significance to Pang Sua Canal and Drain D3 was assessed to be **Minor**.

The other socio-economic receptors (i.e. proposed residential developments within the site, drain D2, Woodlands Road and Bukit Panjang Neighbourhoods 5 and 6) are categorised as **Priority 3** sensitive receptors. With impact intensity assessed to be Medium, the impact consequence on these receptors was assessed to be **Very Low**. The receptors within the site (i.e. Drain D2 and proposed residential developments) could **Occasionally** experience impacts due to water quality change and hence the overall impact significance on them was assessed to be **Minor**. The activities of remaining socio-economic receptors (i.e., Woodlands Road and Bukit Panjang Neighbourhood 5 and 6) are **Unlikely** to be obstructed or impacted due to potential water quality changes and the overall impact significance was assessed to be **Negligible**.

### 8.7.2.3 Impacts due to Groundwater Level Decrease

Based on the footprint of the future development, majority of the site will be converted into high-rise building developments and accompanying infrastructure such as internal roads. This will increase the percentage of impervious surfaces, consequently reducing the infiltration of surface water and rainfall into the ground which could possibly impact the groundwater levels on site. Furthermore, high-rise developments might require deep foundations which could also impact the groundwater levels. However, it is anticipated that after the construction phase, the water table in the long-term will equilibrate to its new groundwater level. Furthermore, parks and open spaces that will surround the future residential development and landscape enhancements along the Rail Corridor are expected to have positive impact on the stabilisation of the future groundwater level. Therefore, the impact intensity on the groundwater levels during the operational phase was assessed to be **Low**.

#### 8.7.2.3.1 Assessment of Impacts on Ecological Receptors

Ecological receptors identified in the surrounding area for the operational phase of the Project might potentially be affected by the groundwater level decrease due to the permanent land use change. Proposed Ecological Corridor was categorised as **Priority 2** sensitive receptor as it is a terrestrial habitat, most likely with diversified water

sources. Future managed vegetation includes the green areas (e.g. parks) within the proposed future residential development as well as landscape features along the Rail Corridor. As these will be managed habitat, it will not be disturbed by the changes in groundwater level and hence was categorised as **Priority 3**. As the impact intensity was assessed to be Low, impact consequence on ecological receptors was assessed to be **Very Low**. Given that the decreased groundwater level is expected only in the early stages of the operational phase (until the groundwater level equilibrates long-term) and during dry weather conditions, likelihood was assessed to be **Occasional**. Therefore, the overall impact (i.e. impact significance) of the groundwater level decrease on the ecological sensitive receptors was assessed to be **Minor**.

#### 8.7.2.3.2 Assessment of Impacts on Human Receptors

As groundwater is currently not used for any beneficial purposes (i.e. drinking and industrial, irrigation) in Singapore, it is **Unlikely** that the potential groundwater level decrease will affect human receptors. Hence, the overall impact on human receptors due to the groundwater level decrease is assessed to be **Negligible**.

### 8.7.2.4 Impacts due to Groundwater Contamination

As the area becomes operational, increased human activity (both from permanent future residents and visitors) will possibly lead to higher generation of solid and liquid waste. Furthermore, the maintenance of proposed green areas, open spaces and parks might require the usage of certain chemicals (e.g. pesticides) which may or may not be stored on the site. If not managed properly, leachate from waste generated and collected on the site and accidental leakage of chemicals stored and used on site may infiltrate the ground, potentially affecting groundwater quality. However, it is expected that during the operational phase, the Study Area will have little use of hazardous substances and chemicals. Furthermore, small, localised contamination that may happen in certain areas as a result of accidental spillages and leakages will most likely cause limited impacts to groundwater quality and are unlikely to extend beyond the Study Area. Therefore, the impact intensity was considered to be **Low.**

#### 8.7.2.4.1 Assessment of Impacts on Ecological Receptors

Ecological receptors were categorised as **Priority 2** (proposed Ecological Corridor) and **Priority 3** (managed vegetation within the future residential development) sensitive receptors based on their ecological significance and dependence of groundwater. As the impact intensity is assessed to be Low, the impact consequence will be **Very Low** for both ecological sensitive receptors (based on impact consequence matrix [refer to Table 6-6]). Given that the minimum control measures have been successfully implemented, potential accidental spills and leaks of chemicals are expected to occur **Rarely** on the site. Based on the assessed impact consequences and their likelihood, the overall impact significance of potential groundwater contamination during the operational phase of the project on ecological sensitive receptors is assessed to be **Negligible**.

#### 8.7.2.4.2 Assessment of Impacts on Human Receptors

Considering that the current groundwater depth within the Study Area is estimated to be at about 2 m bgs (refer to Section 8.4.2.1) it is **Unlikely** that identified human receptors (i.e., future residents, visitors and maintenance workers of the proposed development, off-site permanent residents and visitors in the vicinity) will come in contact with potentially contaminated groundwater. Therefore, the overall impact significance was assessed to be **Negligible**.

**Table 8-13 Summary of impact evaluation during operational phase**

| Impact | Source of Impact | Environmental Parameter Affected | Sensitive Receptor Affected | Receptor Sensitivity | Impact Intensity | Impact Consequence | Impact Likelihood | Impact Significance |
|---|---|---|---|---|---|---|---|---|
| **Ecological Receptors** | | | | | | | | |
| Disturbances in habitat and/ or reduction in size of species' population | • Permanent land use change causing increase in stormwater runoff peak flow<br>• Reduced groundwater baseflow<br>• Different water inflow distribution along the watercourses | Hydrology | Ecological Corridor | Priority 2 | Medium | Low | Less Likely/ Rare | Minor |
| | | | Managed vegetation within the future residential developments | Priority 3 | Medium | Very Low | Less Likely/ Rare | Negligible |
| | • Discharge of contaminated stormwater runoff from potentially contaminated surfaces<br>• Discharge of contaminants due to improper handling, transfer, and storage of chemical substances;<br>• Discharge of contaminants due to improper handling, transfer, storage and disposal of solid and liquid waste (e.g. construction debris); | Surface Water Quality | Ecological Corridor | Priority 3 | Medium | Very Low | Unlikely/ Remote | Negligible |
| | | | Managed vegetation within the future residential developments | Priority 3 | Medium | Very Low | Possible/ Occasional | Minor |
| | • Decreased infiltration into the ground due to more areas with impervious surfaces in the new development | Groundwater Level | Ecological Corridor | Priority 2 | Low | Very Low | Possible/ Occasional | Minor |
| | | | Managed vegetation within the future | Priority 3 | Low | Very Low | Possible/ Occasional | Minor |

| Impact | Source of Impact | Environmental Parameter Affected | Sensitive Receptor Affected | Receptor Sensitivity | Impact Intensity | Impact Consequence | Impact Likelihood | Impact Significance |
|---|---|---|---|---|---|---|---|---|
| | | | residential developments | | | | | |
| | • Heavy rain and stormwater wash-off pollutants built-up in the new development area and discharge to surrounding soil and groundwater<br>• Leakage of solid waste leachate into the underlying soil and/or groundwater<br>• Discharge of toxic chemical waste and/or leakage of chemicals used for refuelling and maintenance of vehicles, machinery and equipment | Groundwater Quality | Ecological Corridor | Priority 2 | Low | Very Low | Less Likely/ Rare | Negligible |
| | | | Managed vegetation within the future residential developments | Priority 3 | Low | Very Low | Less Likely/ Rare | Negligible |
| **Human Receptors** | | | | | | | | |
| Obstruction or prevention of regular human activities and safety concerns | • Increased stormwater runoff peak and quantity due to permanent land use change, causing localised flooding<br>• Flooding in areas adjacent to watercourses due to increased water quantities and water levels<br>• Different water inflow distribution along watercourses<br>• Heavy rainfall events | Hydrology | Future on-site residents, visitors and maintenance workers | Priority 2 | Medium | Low | Less Likely/ Rare | Minor |
| | | | Off-site permanent residents and visitors in the vicinity of the site | Priority 2 | Medium | Low | Less Likely/ Rare | Minor |
| Adverse impact to human health due to exposure to | • Dermal exposure to contaminated water<br>• Incidental ingestion of contaminated water<br>• Nuisance due to changes in physico-chemical characteristics of water such as odour | Surface Water Quality | Future on-site residents, visitors and maintenance workers | Priority 2 | Medium | Low | Possible/ Occasional | Minor |

| Impact | Source of Impact | Environmental Parameter Affected | Sensitive Receptor Affected | Receptor Sensitivity | Impact Intensity | Impact Consequence | Impact Likelihood | Impact Significance |
|---|---|---|---|---|---|---|---|---|
| contaminated water or groundwater | | | Off-site permanent residents and visitors in the vicinity of the site | Priority 3 | Medium | Very Low | Unlikely/ Remote | Negligible |
| | | Groundwater Quality | Future on-site residents, visitors and maintenance workers | Priority 3 | Low | Very Low | Unlikely/ Remote | Negligible |
| | | | Off-site permanent residents and visitors in the vicinity of the site | Priority 3 | Low | Very Low | Unlikely/ Remote | Negligible |
| Groundwater Level Decrease | • Decreased infiltration into the ground due to more areas with impervious surfaces in the new development | Groundwater Level | Future on-site residents, visitors and maintenance workers | Priority 3 | Low | Very Low | Unlikely/ Remote | Negligible |
| | | | Off-site permanent residents and visitors in the vicinity of the site | Priority 3 | Low | Very Low | Unlikely/ Remote | Negligible |
| **Socio-Economic Receptors** | | | | | | | | |

| Impact | Source of Impact | Environmental Parameter Affected | Sensitive Receptor Affected | Receptor Sensitivity | Impact Intensity | Impact Consequence | Impact Likelihood | Impact Significance |
|---|---|---|---|---|---|---|---|---|
| Obstruction of regular processes and/ or activities of within the developments | • Changes in water levels and flow conditions within watercourses<br>• Changes in quantities of water within watercourses<br>• Different water inflow distribution along the watercourses | Hydrology | Pang Sua Canal | Priority 1 | Medium | Medium | Less Likely/ Rare | Minor |
| | | | Drain D3 | Priority 1 | Medium | Medium | Less Likely/ Rare | Minor |
| | | | Proposed future residential development within the site | Priority 1 | Medium | Medium | Less Likely/ Rare | Minor |
| | | | Drain D2 | Priority 3 | Medium | Very Low | Unlikely/ Remote | Minor |
| | | | Woodlands Road | Priority 2 | Medium | Low | Less Likely/ Rare | Minor |
| | | | Bukit Panjang Neighbourhoods 5 and 6 | Priority 1 | Medium | Medium | Unlikely/ Remote | Negligible |
| | • Change of physico-chemical characteristics of water due to operational activities | Surface Water Quality | Pang Sua Canal | Priority 1 | Medium | Medium | Less Likely/ Rare | Minor |
| | | | Drain D3 | Priority 1 | Medium | Medium | Less Likely/ Rare | Minor |
| | | | Proposed future residential | Priority 3 | Medium | Very Low | Possible/ Occasional | Minor |

| Impact | Source of Impact | Environmental Parameter Affected | Sensitive Receptor Affected | Receptor Sensitivity | Impact Intensity | Impact Consequence | Impact Likelihood | Impact Significance |
|---|---|---|---|---|---|---|---|---|
| | | | development within the site | | | | | |
| | | | Drain D2 | Priority 3 | Medium | Very Low | Possible/ Occasional | Minor |
| | | | Woodlands Road | Priority 3 | Medium | Very Low | Unlikely/ Remote | Negligible |
| | | | Bukit Panjang Neighbourhoods 5 and 6 | Priority 3 | Medium | Very Low | Unlikely/ Remote | Negligible |

## 8.8 Recommended Mitigation Measures

No additional mitigation measures aside from the proposed minimum controls were proposed to further minimise the adverse impacts on the environment as none of the impacts on the sensitive receptors have been assessed to be Moderate or Major.

## 8.9 Residual Impacts

No residual impact assessment has been undertaken as no Moderate or Major impact significance on sensitive receptors were assessed.

## 8.10 Cumulative Impacts from Other Concurrent Developments

This section focuses on assessing the cumulative impacts of the construction and operational activities from identified concurrent developments. It should be noted that the details of the scope of work as well as the timeline of the identified concurrent projects is not available at writing of this Report, so only high-level qualitative cumulative impact assessment was carried out based on standard practices utilized in similar projects.

### 8.10.1 Construction Phase

It was assumed that all the concurrent developments would comply with the construction standards. Therefore, they may not increase the impact on water resources.

### 8.10.2 Operational Phase

It was assumed that all the concurrent developments would comply with the operation standards. Therefore, they may not increase the impact on water resources.

## 8.11 Summary of Key Findings

While the hydrological baseline study aimed to identify watercourses present in the Study Area including their location, water flow conditions and bank characteristics, the water quality surveys determined the quality of water in these surface watercourses.

Based on surveyed topographic data (including previous topographic data provided by Client and current site observation), water catchment analysis indicated that the Study Area mainly contributes water to the identified watercourses including one (1) perennial Pang Sua Canal (D1), three (3) concrete drains (D2, D3 and D4).

- Pang Sua Canal D1 is located along the western part of the Study Area, with perennial flow from the southeast to the northwest. It receives surface runoff from the western catchment area within the Study Area, as well as surrounding residential and construction areas;
- Concrete drain D2 is located at the northeast study boundary, with perennial flow from southeast to northwest. It collects surface runoff from the concrete drain D4 and vegetated area within the Study area, as well as surrounding residential area through culvert structure;
- Concrete drain D3 with ephemeral flow is located within the Study Area; and
- Concrete drain D4 with ephemeral flow is located at the eastern part of the Study Area.

Regarding the groundwater level in the Study Area, based on AECOM's desktop review and experience working in the area, groundwater depth within the Study Area was expected to be at about 2 m bgs. Based on the historical land use of the area, the potential underlying contamination severity of soil and groundwater was estimated to be low.

Six (6) water quality sampling locations have been identified based on hydrological findings, including three (3) at the upstream, mid-stream and downstream of Pang Sua Canal (D1), and one (1) at each drain (i.e. D2, D3 and D4).

Water samples were tested for parameters including temperature, pH, salinity, total dissolved solids (TDS), conductivity, turbidity, dissolved oxygen (DO), total suspended solids (TSS), total organic carbon (TOC), total nitrogen (TN), nitrates ($NO_3$-N), ammonium nitrogen ($NH_4$-N), total phosphorus (TP), orthophosphates ($PO_4$-P), enterococcus and lead. `

Results were compared with both NEA discharge guidelines in Singapore and international criteria for aquatic life. According to NEA discharge guidelines, the temperature, TDS, $NO_3$-N, $PO_4$-P and Pb at all sampling locations met the discharge limits. Temperature did not vary much across all the sampling stations for wet and dry weathers. pH of perennial watercourses (i.e. Pang Sua Canal D1 and concrete drain D2) slightly exceeded the NEA limit and aquatic life criteria sometimes, possibly due to the wash-off of the concrete surface of surrounding urbanized area (especially the construction site nearby), where chemicals washed away from concrete could lead to the increased pH. Given that the Study Area is inland area and far from the sea, the salinity, conductivity and TDS of the water confirmed the prevalence of freshwater. Low Pb indicated low contamination from modern anthropogenic activities. However, relatively high TSS and turbidity in Pang Sua Canal D1 and concrete drain D2 could due to flushing from surrounding urban surface (including the construction site nearby) which carried high concentration of TSS during storm event. $NO_3$-N and $NH_4$-N was generally low below NEA and aquatic criteria. However, TN concentrations during wet weather and Phosphorus concentrations (i.e. TP and $PO_4$-P) during dry weather were relatively high in Pang Sua Canal D1 and concrete drain D2, indicating a higher eutrophication potential which was consistent with greenish water with algae observed during site survey. Elevated enterococcus counts were observed along the Pang Sua Canal D1 and concrete drain D2 due to storm carrying faecal contaminants from surrounding residential or vegetated area. TOC showed minor organic contents in all water samples during dry and wet weather conditions.

From the results of the hydrological and water quality assessment, it could be inferred that the Pang Sua Canal D1 and concrete drain D2 which were generally perennial (fed from stormwater). Both Pang Sua Canal D1 and concrete drain D2 have relatively high pH, TSS and nutrient (i.e. nitrogen and phosphorus) concentrations, indicating poor water quality for survival of aquatic life. This aligns with biodiversity findings in Section 7, which shows only Pang Sua Canal (D1) supported poor aquatic life at the time of survey.

The potential hydrological and surface water quality related impacts on the ecological, human and socio-economic receptors, arising during construction and operational phases of the Project, were assessed using qualitative and analytical methods. The findings for the construction and operational phase were summarized in Table 8-12 and Table 8-13, respectively.

For the construction phase, it was assessed that the impacts due to hydrological changes (e.g., increase in surface water peak runoff, decreased seepage into soil, etc.) would be **Negligible** (to Turf and Planted Trees [ecological receptors] and Bukit Panjang Neighbourhoods 5 and 6, Drains D2 and D3 [socio-economic receptors]) to **Minor** (on-site construction workers and off-site residents and visitors [human receptors], Pang Sua Canal and Woodlands Road [socio-economic receptors]). This assessment was carried out under the assumption that minimum control measures such as adequately sized detention tanks and ponds, planned soil dewatering and regular maintenance of drainage system have been successfully implemented. Impacts due to changes in quality of surface water resources (e.g., improper management of solid and liquid waste, accidental spills and leaks, etc.) were assessed to be **Negligible** to ecological receptors (i.e., Planted Trees and Turf to be retained), **Negligible** to **Minor** to human receptors (i.e., on-site construction workers and off-site permanent residents and visitors in the vicinity of the site) and **Negligible** to socio-economic receptors (i.e., Pang Sua Canal, Drain D2, Drain D3, Woodlands Road and Bukit Panjang Neighbourhoods 5 & 6). Minimum controls assumed to be implemented with regards to this aspect include settling ponds, regular inspection and maintenance of wastewater and stormwater collection infrastructure, ECM measures, implementation of CCTV, etc. Upon implementation of minimum controls such as piezometers for groundwater level monitoring and proper ERSS, it was assessed that the impact due to groundwater level decrease would be **Minor** to ecological receptors and **Negligible** to human receptors. Under the assumption that appropriate management and storage of soil, extracted groundwater, waste, chemicals and other toxic material as well as other minimum controls will be implemented on the site, impacts on sensitive receptors due to groundwater quality changes were assessed to be **Negligible** to **Minor**. Therefore, no additional mitigation measures have been proposed.

During the operational phase permanent land use was identified to be the main potential source of hydrological impacts, while contaminated surface runoff and improper management of liquid and solid waste were identified as a main source of surface water quality impacts. Hydrological impacts on ecological, human and socio-economic receptors were assessed to be **Minor** (with the exception of impact on Bukit Panjang Neighbourhoods 5 and 6 and future managed vegetation which were assessed to be **Negligible**). Under the assumption that minimum controls such as regular inspections and maintenance of stormwater collection infrastructure impacts from changes in quality of surface water resources were assessed to be **Negligible** to Ecological Corridor and **Minor** to managed

vegetation within the future residential development. Furthermore, potential impact on future on-site residents, visitors and maintenance workers was assessed to be **Minor**, while on off-site permanent residents and visitors was assessed to be **Negligible**. With regards to socio-economic receptors, impacts were assessed to be **Negligible** to Woodlands Road and Bukit Panjang Neighbourhoods 5 & 6 and **Minor** to Pang Sua Canal, Proposed future residential development within the site and Drains D2 and D3. Groundwater quality and level impacts on ecological and human receptors were also assessed to be **Negligible** to **Minor**. As none of the impacts were assessed to be Moderate or Major, no additional mitigation measures have been proposed.

It was assumed that all the concurrent developments would comply with the construction standards and hence their impact on hydrology and surface water quality for the watercourses was not expected to be significant.

**Table 8-14 Summary of water resources impact assessment**

| Potential Source of Impact | Impact Significance with Minimum Control | Key Mitigation Measures (if any) | Residual Impact Significance with Mitigation Measures (if required) |
|---|---|---|---|
| **Construction Phase** | | | |
| Altered dry and wet weather flow conditions within watercourses, surface water peak runoff and potential flooding due to pre-construction and construction activities and land use change | Negligible – Minor | - | N.A. |
| Contamination of watercourses due to improper management of solid and liquid wastes and accidental spills and leaks | Negligible – Minor | | N.A. |
| Decrease of groundwater level due to pre-construction and construction activities and land use change | Negligible – Minor | | N.A. |
| Soil and groundwater contamination due to seepage of contaminants originating from excavated soil, chemicals and waste stored on the site | Negligible – Minor | | N.A. |
| **Operational Phase** | | | |
| Hydrological occurrences such as flooding and ponding due to permanent land use change | Negligible – Minor | - | N.A. |
| Contamination of watercourses due to improper management of solid and liquid waste and from contaminated stormwater | Negligible – Minor | | N.A. |
| Decrease of groundwater level due to permanent land use change | Negligible – Minor | | N.A. |
| Soil and groundwater contamination due to seepage and leakage of contaminants originating from generated waste and chemicals stored and/or used on the site | Negligible – Minor | | N.A. |
| **Note:**<br>N.A. – Not Applicable; no Moderate or Major impacts have been identified. | | | |

# 9 Air Quality

## 9.1 Introduction

This section presents the air quality impact assessment for the construction and operational phases of the Project following the general EIA methodology described in Section 6. Air quality impact tends to impact sensitive receptors such as schools, medical institutions and residential areas located in the vicinity of the Project site. Therefore, the Study Area for air quality is well beyond the Project site and is focused largely on the sensitive receptors (see Section 6.2.1). In line with the applicable legislation detailed in Section 5, the key steps for conducting the air quality impact assessment are as follows:

- Review existing baseline monitoring data and conduct baseline air monitoring at representative locations to evaluate the current air quality in the Study Area;
- Identify and classify sensitivity of the area around the construction or operational footprint;
- Understand the proposed activities during construction and operational phases;
- Conduct an impact assessment to qualitatively assess air quality impacts during construction and operation of the Project;
- Evaluate qualitative air quality impacts against nominated assessment criteria;
- Specify mitigation measures to be implemented;
- Determine the overall significance of the residual air quality impacts after implementation of mitigation measures; and
- Recommend a suitable monitoring and management plan.

## 9.2 Methodology and Assumptions

The sub-sections below outline the methodology used in the air quality impact assessment for both construction and operational phases, including the determination of Study Area and baseline collection methodology.

### 9.2.1 Study Area and Screening of Air Sensitive Receptors

The Study Area for air quality impact assessment during construction phase is recommended as 350 m and 50 m from the construction footprint (i.e., earthworks, construction works, trackout) of the proposed development for human and ecological receptors, respectively (in accordance with UK IAQM guidance [R-31]). For operational phase the Study Area is recommended as 250 m around the project/ operational footprint (e.g., building locations, building functions with any rooftop air pollutants-emitting equipment, etc.). The 250 m Study Area for operational phase covers the future operational roads within the Project site as well as the existing major operational roads outside or nearby the Project site.

During the scoping phase for this EIA, an initial screening of receptors in the Study Area was conducted as per Section 6.2.2 and detailed in Section 9.4, in order to determine the areas which are sensitive to potential construction and operational impacts detailed in Section 1.1.

### 9.2.2 Air Quality Baseline Study

Baseline air quality monitoring includes primary data collection in the form of baseline ambient air quality monitoring in the Study Area. Out of the criteria pollutants generally measured as part of ambient air monitoring (such as CO, $NO_2$, $SO_2$, $PM_{10}$ and $PM_{2.5}$), this baseline monitoring only focuses on dust levels i.e., $PM_{10}$ and $PM_{2.5}$, since these are the major pollutants that are likely to have the biggest impact on the ambient air quality as a result of the proposed developments. The purpose of the baseline monitoring is to understand what the natural conditions of these air quality parameters are, so that in the event that a repeat monitoring event is to be conducted during the construction and/ or operational phases of the Project, this monitoring data can be used as a reference of the existing baseline prior to any disturbance in the Study Area.

Air quality has both short-term and long-term targets which vary from a 1-hr target to an annual target. Owing to the timeframe of the Project, annual monitoring cannot be accommodated in this study; however, a short-term

monitoring baseline will be established. With varying seasonal fluctuations, it is understandable that wind flow and direction will vary throughout the year, and hence short-term baselines will also fluctuate. However, a correlation, be it direct or indicative between the site baseline and NEA's central area monitoring data, will be useful for future monitoring as it provides a reliable context for any future comparisons based on the relation between the two datasets. Hence, secondary data, such as NEA's long-term air quality data, 24-hr $PM_{2.5}$ and $PM_{10}$ concentrations, and meteorological data observed in the vicinity of the Project site have been collected from publicly available sources.

### 9.2.2.1 Secondary Data Collection (Review of Background Data)

Desktop research consists of a review of secondary data (including existing land use and development activities, satellite images, etc.) which aids in determining the baseline air monitoring location. The information retrieved during the desktop research comprised of publicly available data from government and technical agencies, existing available data, relevant articles, and other online sources.

#### 9.2.2.1.1 NEA Long Term Ambient Air Quality

NEA carries out routine monitoring of ambient air quality through the Telemetric Air Quality Monitoring and Management System (TAQMMS). This system comprises 22 monitoring stations (refer to Figure 9-1) which are located around Singapore and linked into a Central Control System (CCS). General NEA ambient air monitoring results for Singapore over the period 2016 – 2021 have been presented and compared with Singapore Ambient Air Quality Targets (Long Term Target and 2020 Target) in Section 9.5.2.1.1. Air pollution control in Singapore is governed by legislation listed in Section 5.




**Figure 9-1 NEA ambient air quality monitoring stations in Singapore [R-41]**

#### 9.2.2.1.2 24-hour $PM_{10}$ and $PM_{2.5}$ Concentrations

The 24-hr $PM_{2.5}$ and $PM_{10}$ readings were available on data.gov.sg for the North Region of Singapore. These data were collected during the same period of primary data collection period and discussed in Section 9.5.2.1.2.

#### 9.2.2.1.3 Other Parameters (Rainfall, Temperature, Wind Speed)

Rainfall, temperature, and wind speed can significantly affect the distribution of pollutants. Bukit Panjang is the nearest monitoring station to the Study Area, located approximately 800 m from the Study Area. However, this monitoring location only recorded rainfall data. Hence, only rainfall data was presented for Bukit Panjang. Collection

of temperature and wind speed was conducted for the next nearest weather monitoring locations which have these data available, i.e., Tengah and Admiralty located approximately 5 km and 7 km from the Study Area respectively. It should be noted that Tengah has stopped recording temperature and wind speed since August 2017 and May 2020 respectively. These baseline findings are discussed in Section 9.5.2.1.3.




**Figure 9-2 NEA weather monitoring stations in Singapore [W-19]**

### 9.2.2.2 Secondary Air Quality Monitoring Data from Concurrent Study

Air quality monitoring services were conducted by AECOM Singapore Pte Ltd with the assistance from ALS Technichem (S) Pte Ltd as part of the concurrent study in the vicinity of the Study Area [R-49]. A total of one (1) air monitoring location was conducted as part of concurrent study for one (1) week to collect air quality samples for the following air quality parameters:

- Particulate matter smaller than 2.5 µm, $PM_{2.5}$; and
- Particulate matter smaller than 10 µm, $PM_{10}$.

Air quality monitoring was conducted from 07 – 14 March 2022. The air monitoring location for the concurrent study is presented in Table 9-1 and Figure 9-3. The results for concurrent study air quality monitoring are presented in Section 9.5.2.2.

TSI Environmental DustTrak Monitoring System was used for the purpose of $PM_{10}$ and $PM_{2.5}$ monitoring. Concentrations of $PM_{10}$ and $PM_{2.5}$ were measured by the light scattering laser photometer principle using an Environmental DustTrak Monitoring System coupled with a heated inlet for 5-minute interval data logging over a 7-day continuous sampling period. The photometer uses an ellipsoidal reflector and simple optical components to collect the laser-scattered light and to focus it onto a photodiode array. The mass and particle size were determined by detecting how the particles scatter light.

**Table 9-1 Air quality monitoring location in concurrent study**

| Monitoring ID in the Concurrent Study | Monitoring Location | Photo of Monitoring Location |
|---|---|---|
| **A03** | Choa Chu Kang Rail Corridor |  |

### 9.2.2.3 Primary Data Collection (Survey & Sampling)

Air quality monitoring services were provided by ALS Technichem (S) Pte. Ltd. (ALS). A total of five (5) air monitoring locations were proposed (since the Inception stage), based on the following considerations:

- Identification of Air Sensitive Receptors (ASRs) (hospitals, schools, childcare facilities, old age homes, residences, flora and habitats of high ecological value) nearest to the construction worksite areas/ operational footprint boundary;
- Other ASRs away from the construction worksite areas/ operational footprint were eliminated as these receptors are assumed to be barricaded by the first row of buildings;
- ASRs with areas having ongoing construction were avoided; and
- The closest ASR to the Study Area was selected.

Air quality monitoring was conducted at the monitoring locations for one week on 2 – 9 September 2022 and 9 – 16 September 2022, 19 – 26 September 2022, and 26 September – 3 October 2022 to collect air quality samples for the following air quality parameters:

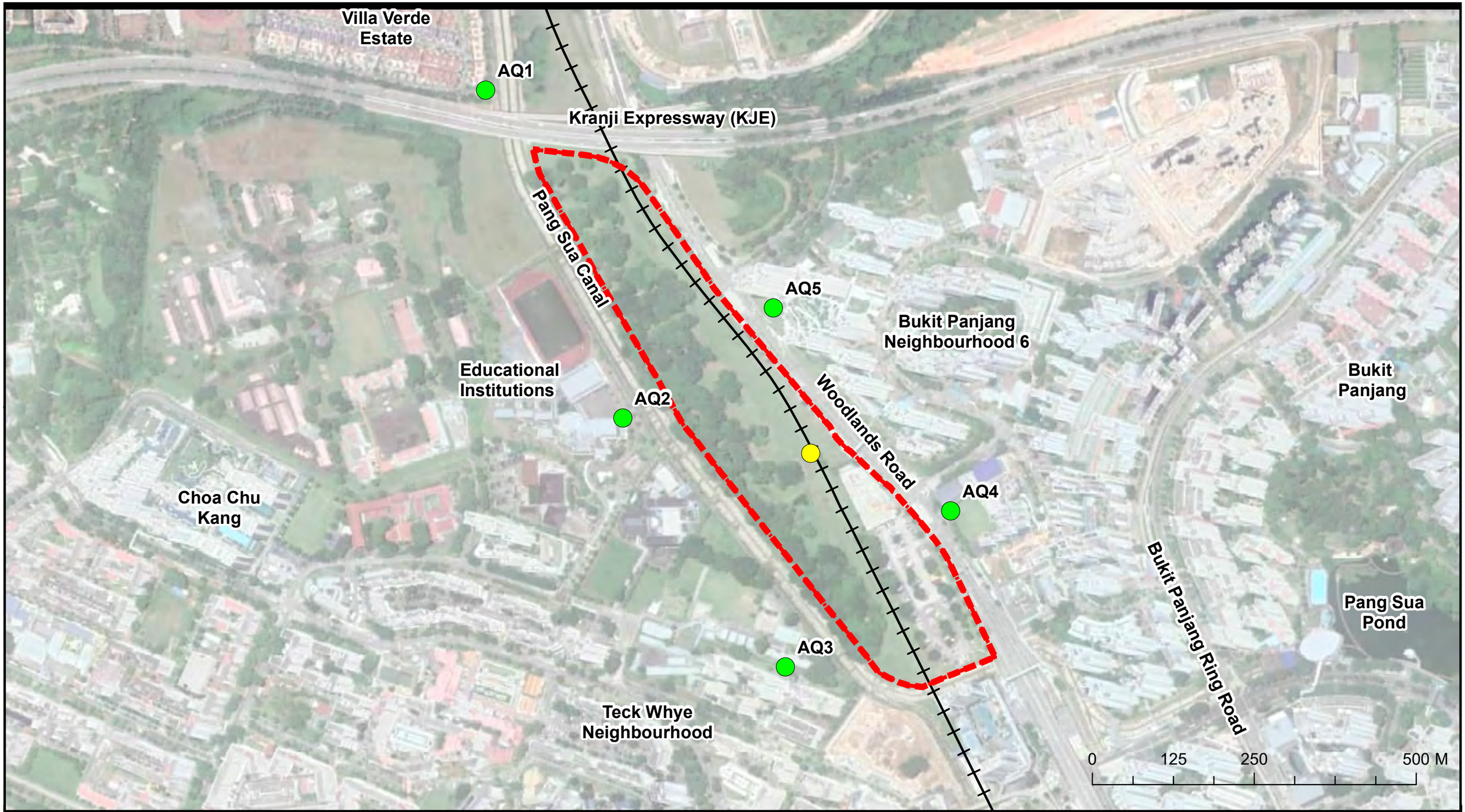
- Particulate matter smaller than 2.5µm, $PM_{2.5}$; and
- Particulate matter smaller than 10 µm, $PM_{10}$.

Air quality monitoring was conducted for 1 week within the Study Area in order to establish a baseline for existing air quality levels. Following the site reconnaissance survey conducted at Inception stage on 6 June 2022, five (5) monitoring locations were identified to represent the site as documented in the approved Inception Report [R-1]. Such detailed justifications are provided in Table 9-2, whereas the selected baseline air monitoring locations are shown in Figure 9-3.

The monitoring location was chosen so that the equipment was more than 1 metre from any buildings or structures, and not shaded by structures or trees. This is necessary to ensure adequate airflow. The indicative air quality monitor was installed at 1.8 m from ground level in the breathing zone. TSI Environmental DustTrak Monitoring System was used for the purpose of $PM_{10}$ and $PM_{2.5}$ monitoring. Concentrations of $PM_{10}$ and $PM_{2.5}$ are measured by the light scattering laser photometer principle using an Environmental DustTrak Monitoring System coupled with a heated inlet for 5-minute interval data logging over a 7-day continuous sampling period. The photometer uses an ellipsoidal reflector and simple optical components to collect the laser-scattered light and to focus it onto a photodiode array. The mass and particle size are determined by detecting how the particles scatter light. For further details of air quality monitoring, please refer to Appendix T.

**Table 9-2 Rationale for the selection of proposed air quality monitoring locations with photos**

| S/N | Monitoring Location | Justification | Photo of Monitoring Location |
|---|---|---|---|
| **AQ1** | Villa Verde Estate | AQ1 was located in the vicinity of Villa Verde Estate. The ambient air quality in the vicinity of AQ1 was affected by vehicle traffic along Kranji Expressway (KJE) on the south. AQ1 was chosen to represent the site in terms of existing ambient air quality in the vicinity of Villa Verde Estate. |  |
| **AQ2** | Jurong Pioneer Junior College | AQ2 was located in the vicinity of Jurong Pioneer Junior College. The ambient air quality in the vicinity of AQ2 was affected by localised sources within the school or along park connector on the east. AQ2 was chosen to represent the site in terms of existing ambient air quality in the vicinity of educational institutions in the area, along the park connector and Pang Sua Canal. |  |
| **AQ3** | HDB Blk 162 Teck Whye Neighbourhood | AQ3 was located in the vicinity of HDB Blk 162 Teck Whye Neighbourhood. The ambient air quality in the vicinity of AQ3 was affected by localised sources within the HDB estate. AQ3 was chosen to represent the site in terms of existing ambient air quality in the vicinity of residential properties along Teck Whye Neighbourhood. |  |
| **AQ4** | West View Primary School | AQ4 was located in the vicinity of West View Primary School. The ambient air quality in the vicinity of AQ4 was affected by vehicle traffic along Woodlands Road on the west. AQ4 was chosen to represent the site in terms of existing ambient air quality in the vicinity of West View Primary School and neighbouring sensitive and residential receptors. |  |
| **AQ5** | HDB Blk 634 Senja Road | AQ5 was located in the vicinity of HDB Blk 634 Senja Road. The ambient air quality in the vicinity of AQ5 was affected by vehicle traffic along Woodlands Road on the west and slip road to/from KJE to the north. AQ5 was chosen to represent the site in terms of existing ambient air quality in the vicinity of HDB estate Senja Gateway. |  |




**Legend**

- Baseline Air Monitoring Locations
- Secondary Air Monitoring Data
- CCK N1 Project Site
- Original Track Alignment

N

| Rev. | Date | By | Description | Chk'd | App'd |
|---|---|---|---|---|---|
| 01 | MAR 2023 | HHL | Final Report | NHT | JAG |
| - | JAN 2023 | HHL | Final Report | NHT | JAG |

Qualified Person Endorsement : NA

HDB Endorsement : NA

Consultant : AECOM

Client: HOUSING & DEVELOPMENT BOARD

Project Title :

**ENVIRONMENTAL IMPACT ASSESSMENT (EIA) ON CHOA CHU KANG N1**

Figure Title :

**Baseline air quality monitoring locations**

| Designed | Checked | Approved |
|---|---|---|
| HHL | NHT | JAG |
| | Drawn HHL | Date MAR 2023 |

Figure No. : 9 - 3 | Rev. 01 | Sheet 1 of 1

CAD File Name : NA | A3

Note: Source of basemap - Google Earth Map

THIS DRAWING IS COPYRIGHT

## 9.2.3 Prediction and Evaluation of Impact Assessment

The air quality impact assessment includes evaluation of air quality impacts from construction and operational activities.

### 9.2.3.1 Construction Phase

Air quality impacts were assessed using the methodology outlined in the document entitled “Guidance on the Assessment of Dust from Demolition and Construction” which was published by the UK IAQM in 2014 for impacts during construction phase. This methodology was adapted to the general methodology outlined in this EIA.

#### 9.2.3.1.1 Identification of Potential Sources of Air Quality Impacts

It is important to identify potential sources of air quality impact within the Study Area. While conducting the assessment, a typical construction machinery was assumed to be used during the construction equipment and activities. These have been detailed in Section 9.3.1.

#### 9.2.3.1.2 Identification of Sensitive Receptors

Identification of Air Sensitive Receptors (ASRs) in the Study Area was subsequently undertaken. IAQM identifies an entire area around one continuous stretch of construction footprint as a category or sensitive receptor. It does not distinguish between each unit, household or block present in the area as a separate ASR but designates the whole area as same category of sensitivity based on an overall location, number, proximity and scale to the construction activity. This approach thereby adopts a conservative principle to air quality. A further discussion on receptor sensitivity is presented in Section 9.4.1.

Sensitive areas identified as Priority 1, Priority 2, and Priority 3 for air quality during the screening process were examined in the impact assessment in this EIA in order to provide a more refined classification for receptor sensitivity. Sensitivity of the area was determined based on the usage, number of receptors, distance from the construction footprint, and the current context of sensitive buildings in Singapore.

#### 9.2.3.1.3 Understanding of Baseline Air Quality

Primary and secondary data were collected to understand the baseline air quality of the Study Area. NEA’s 24-hr $PM_{2.5}$ and $PM_{10}$ data from the North region was also reviewed for the Study Area. In addition, baseline air quality data was collected at representative locations near the construction footprint. The baseline air quality review and data measured is discussed in Section 9.5.

#### 9.2.3.1.4 Impact Intensity Definition

The impact intensity was determined by reviewing the scale of construction activities and classifying them as Low, Medium or High. The IAQM Guidance document provides example definitions for determining impact intensity for earthworks (based on construction footprint, heavy duty vehicles movement, formation of bunds, and material moved), for construction (based on total building volume, on-site concrete batching), for trackout (based on heavy duty vehicle outward movement, surface material, and unpaved road lengths), and for demolition (based on total demolition volume, construction material, on-site crushing of material, and height of demolition activity), if any. The definition of parameters is defined in Table 6-5 in Section 6.4.3. It should be noted that in each case, not all criteria need to be met and that determination of magnitude is also based on the professional judgment of the air quality consultant. If the areas around the construction footprint are rated as High for one activity and Medium or Low for the other activities, the overall impact intensity result is classified as High for that site as those multiple activities may be occurring concurrently.

#### 9.2.3.1.5 Classification of Overall Consequence

The dust impact assessment therefore evaluates the overall consequence prior to the implementation of mitigation. The work site was 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 is explained in matrices shown in Table 9-3 to Table 9-6. Each activity for the work site was rated as being High, Medium, Low, or Imperceptible in terms of overall consequence based upon pre-mitigation measures.

**Table 9-3 Overall consequence of the 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 9-4 Overall consequence of the 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 9-5 Overall consequence of the air impact analysis (Trackout)**

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

**Table 9-6 Overall consequence of the air impact analysis (Demolition)**

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

#### 9.2.3.1.6 Establishing Impact Significance

Impact Significance was evaluated by considering both the overall consequence and the likelihood of occurrence of significant adverse impacts. The likelihood of occurrence may be defined as remote, rare, occasional, regular, and continuous as per criteria listed in Table 6-7. Impact significance was evaluated in accordance with the matrix presented below in Table 9-7. The IAQM methodology does not differentiate between imperceptible and very low Consequences, due to the nature of air impacts as perceived by humans. In order to align the IAQM methodology with the methodology of this Report, imperceptible and very low Consequences were consolidated.

**Table 9-7 Impact significance matrix for air quality**

| Consequence / Likelihood | Imperceptible / Very Low | Low | Medium | High |
|---|---|---|---|---|
| **Remote** | Negligible | Negligible | Negligible | Negligible |
| **Rare** | Negligible | Minor | Minor | Minor |
| **Occasional** | Minor | Minor | Moderate | Moderate |
| **Regular** | Minor | Moderate | Moderate | Major |
| **Continuous** | Minor | Moderate | Major | Major |

#### 9.2.3.1.7 Mitigation Measures Recommendations

Mitigation measures were proposed for implementation when the Impact Significance was predicted to be Moderate or Major. Where mitigation measures are required, specific mitigation measures were proposed based on the level of overall Consequence (High, Medium, and Low) as per the IAQM guidance. This is the most efficient way of prescribing dust mitigation measures so that high Consequence areas have the most comprehensive mitigation measures implemented whilst avoiding unnecessary implementation of complex mitigation measures in low Consequence areas.

#### 9.2.3.1.8 Establishing Residual Impact Significance

Following implementation of mitigation measures prescribed in the EIA at the proposed construction footprint, the residual Impact Significance was evaluated using the matrix outlined in Table 9-7. Ideally, the mitigation measures required should be specified within the conditions given for planning permission and should be stipulated in construction contracts.

### 9.2.3.2 Operational Phase

This methodology below was used to assess the air quality impact during operational phase of the Project.

#### 9.2.3.2.1 Identification of Potential Sources of Air Quality Impacts

It is important to identify potential sources of air quality impact within the Study Area. While conducting the assessment, an increase in traffic volume in the vicinity of the Project site during operational phase was assumed. These have been detailed in Section 9.3.2.

#### 9.2.3.2.2 Identification of Sensitive Receptors

Identification of ASRs in the Study Area within 250 m around the operational footprint was subsequently undertaken. A further discussion on Receptor Sensitivity is presented in Section 9.4.

Sensitive areas identified as Priority 1, Priority 2, and Priority 3 for air quality during the screening process were examined in the Impact Assessment in this EIA in order to provide a more refined classification for Receptor Sensitivity. Sensitivity of the area was determined based on the usage and the current context of sensitive buildings in Singapore.

#### 9.2.3.2.3 Understanding of Baseline Air Quality

Primary and secondary data were collected to understand the baseline air quality of the Study Area. NEA's PSI data from the North region was also reviewed for the Study Area. In addition, baseline air quality data was collected for representative location near the operational footprint. The baseline air quality review and data measured is discussed in Section 9.5.

#### 9.2.3.2.4 Impact Intensity Definition

The impact intensity was determined by reviewing the scale of increase in air quality levels due to traffic volume increase in the vicinity of the operational footprint by comparing the baseline and predicted traffic volume. The impact intensity was then classified as Low, Medium or High.

#### 9.2.3.2.5 Classification of Overall Consequence

The air quality impact assessment therefore evaluates the overall consequence prior to the implementation of mitigation. The operational footprint was assessed by considering both the impact intensity and the Receptor Sensitivity to obtain an overall consequence rating. The overall consequence was rated as being High, Medium, Low, or Imperceptible in terms of overall consequence based upon pre-mitigation measures.

#### 9.2.3.2.6 Establishing Impact Significance

Impact Significance was evaluated by considering both the overall Consequence and the Likelihood of occurrence of significant adverse impacts. The Likelihood of occurrence may be defined as unlikely, rare, occasional, regular, and continuous as per criteria listed in Table 6-7. Impact Significance was evaluated in accordance with the matrix presented in Table 9-7.

#### 9.2.3.2.7 Mitigation Measures Recommendations

Mitigation measures were proposed for implementation when the Impact Significance was predicted to be Moderate or Major.

#### 9.2.3.2.8 Establishing Residual Impact Significance

Following implementation of mitigation measures prescribed in the EIA at the proposed operational footprint, the residual Impact Significance was evaluated using the matrix outlined in Table 9-7. Ideally, the mitigation measures required should be specified within the conditions given for planning permission and should be stipulated in construction contracts.

# 9.3 Potential Sources of Air Quality Impact

Fugitive particulate emissions from construction and operational activities have the potential to result in adverse impacts on air quality and therefore, public and ecosystem health. Particulate emissions may also generate significant nuisance to receptors near the heavy use construction footprint.

## 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. For ecological receptors, dust generated during construction works can have adverse effects upon vegetation 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 9-8 listed potential sources of air quality impact during construction phase of the project.

**Table 9-8 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 network, where it may be deposited and resuspended by vehicles using the network. | 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. |
| 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. |

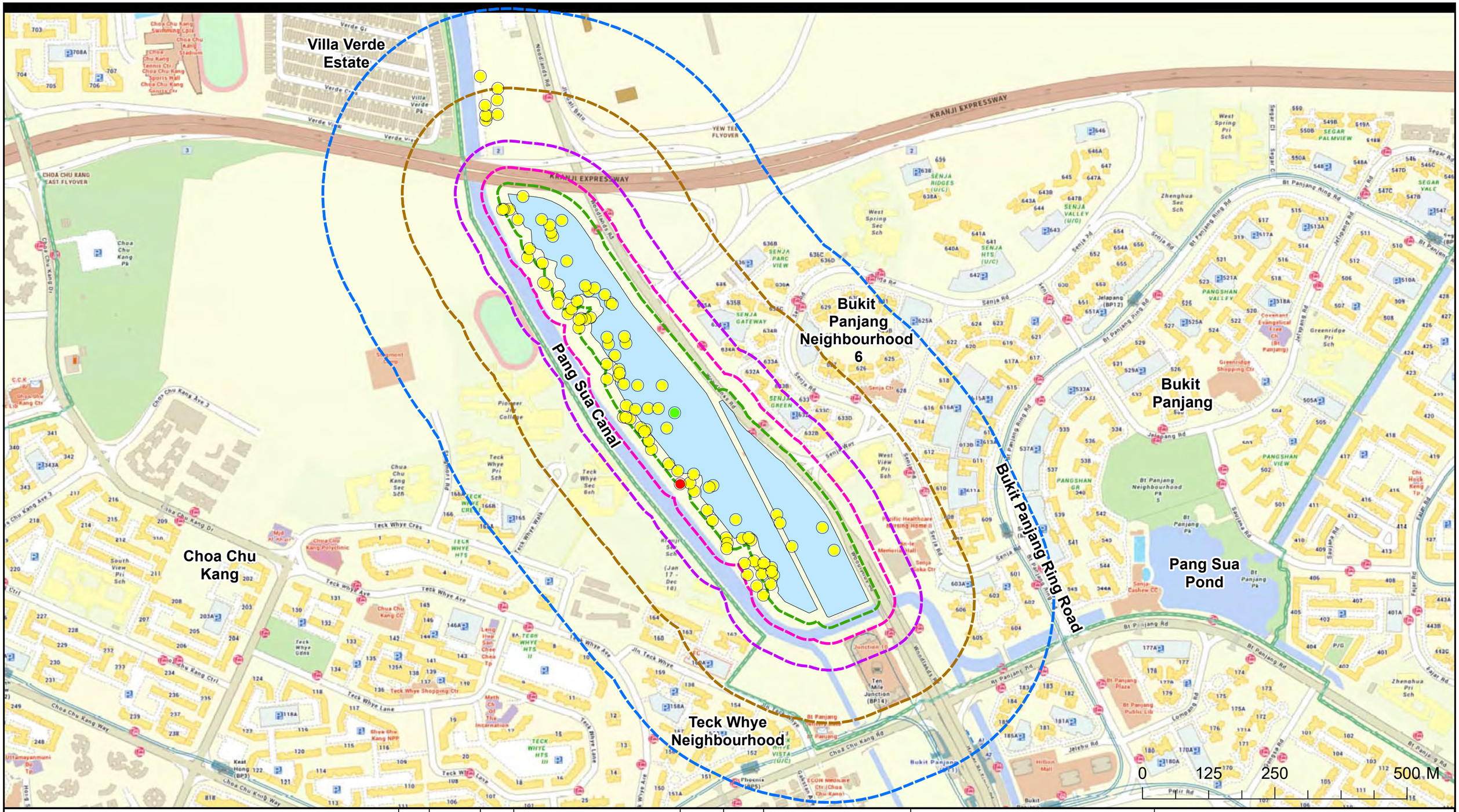
In the general context of air quality impact assessment, earthworks include some extent of soil-cutting, excavation, piling and excavation works, while the construction activity includes the construction of the proposed buildings. Based on the conceptual view of the from the proposed land use plan in Figure 3-2, the worst-case emission sources for earthworks and construction activities may comprise most of the areas planned for development within the Project site, including residential buildings and proposed roads within the Project site, but excluding the proposed Ecological Corridor and Retained Rail Corridor Alignment (see Figure 3-2) within the Project site as they will be retained. According to the preliminary planning, the Project is expected to be generating about 20,000 to 100,000 tonnes of spoil amount (comprising mainly excavated soils) across the earthworks footprint.

It is estimated to be requiring approximately 25,000 to 100,000 $m^3$ of concrete for the overall construction of this Project. At current stage, it is not yet determined if the worksites will have/ not have concrete batching plants, hence

assuming no concrete batching plant to be located within the Project site. Since this Project is situated on a piece of less-developed area with mainly dense forest or empty green field, it is also assumed that no demolition of permanent structure/ building will be required. In view of the scale of this Project, about 5 to 10 heavy vehicles/ machineries are expected to be operating on site at any of the time throughout the construction phase.

The trucks carrying construction materials and/ or spoil to and from the construction footprint on access roads are also considered as a potential source of emission (referred to as trackout activity) as shown in Figure 9-6. The number of outward trucks movement is expected to be around 10 - 50 HDVs per day. The HDVs are expected to travel along the existing paved roads along Woodlands Road for access to the Project site, it is assumed that no unpaved roads are involved. Impact prediction and evaluation were detailed in Section 9.7.1.

Note that the proposed boundaries of the proposed Ecological Corridor and Residential Area are subject to further changes based on detailed studies such as design, on-site conditions, arborist's assessment etc.




## Legend

- Species of Conservation Significance
- Large Plant Specimens
- Other Specimens of Value
- Earthworks Footprint
- 20m from Source
- 50m from Source
- 100m from Source
- 200m from Source
- 350m from Source

N

| Rev. | Date | By | Description | Chk'd | App'd |
|---|---|---|---|---|---|
| - | SEP 2022 | TTR | Draft Final Report | NHT | JAG |

Qualified Person Endorsement : NA

HDB Endorsement : NA

Consultant : AECOM

Client: HOUSING & DEVELOPMENT BOARD

Project Title :

**ENVIRONMENTAL IMPACT ASSESSMENT (EIA) ON CHOA CHU KANG N1**

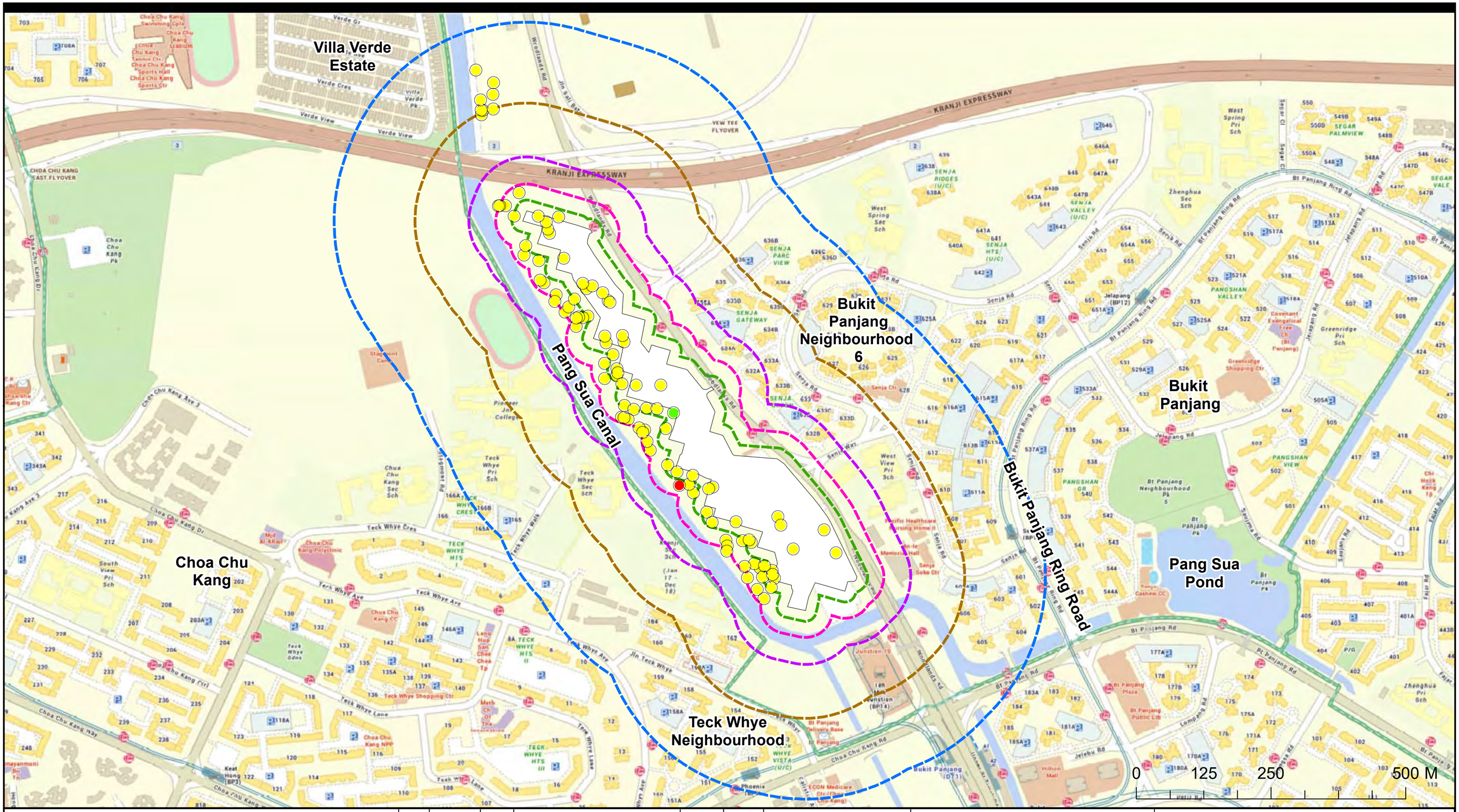
Figure Title :

**Emission sources and sensitive receptors – earthworks**

| Designed | Checked | Approved | Figure No. : | Rev. | Sheet |
|---|---|---|---|---|---|
| TTR | NHT | JAG | 9 - 4 | - | 1 of 1 |
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## Legend

- Species of Conservation Significance
- Large Plant Specimens
- Other Specimens of Value
- Construction Footprint
- 20m from Source
- 50m from Source
- 100m from Source
- 200m from Source
- 350m from Source

N

| Rev. | Date | By | Description | Chk'd | App'd |
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| 01 | MAR 2023 | TTR | Final Report | NHT | JAG |
| - | JAN 2023 | TTR | Final Report | NHT | JAG |

Qualified Person Endorsement : NA

HDB Endorsement : NA

Consultant : AECOM

Client: HOUSING & DEVELOPMENT BOARD

Project Title :

**ENVIRONMENTAL IMPACT ASSESSMENT (EIA) ON CHOA CHU KANG N1**

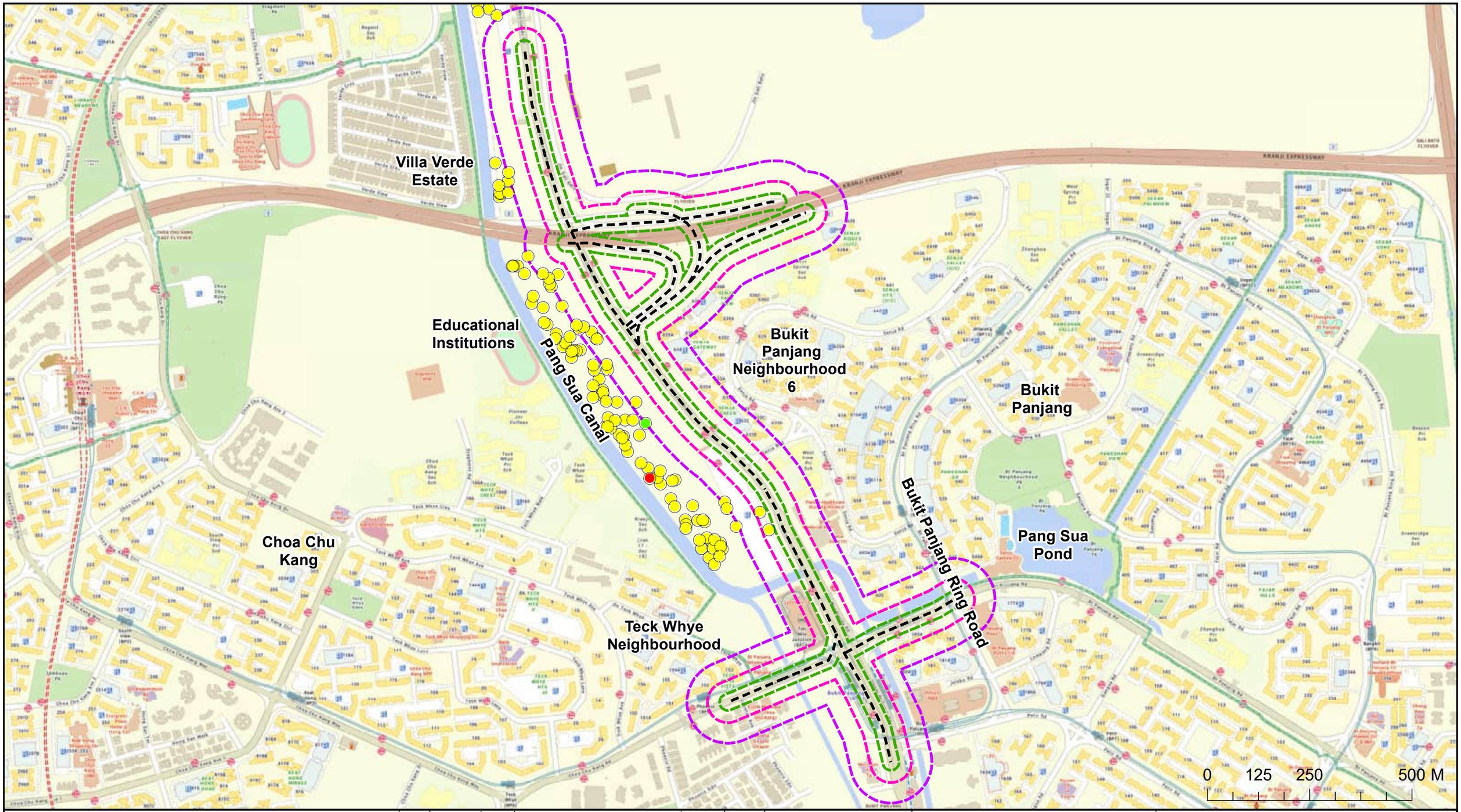
Figure Title :

**Emission sources and sensitive receptors – construction**

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| | Drawn TTR | Date MAR 2022 | CAD File Name : NA | | A3 |

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**Legend**

- Species of Conservation Significance
- Large Plant Specimens
- Other Specimens of Value
- Access Road
- 20m from Source
- 50m from Source
- 100m from Source

N

| Rev. | Date | By | Description | Chk'd | App'd |
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HDB Endorsement : NA

Consultant : AECOM

Client: HOUSING & DEVELOPMENT BOARD

Project Title :

**ENVIRONMENTAL IMPACT ASSESSMENT (EIA) ON CHOA CHU KANG N1**

Figure Title :

**Emission sources and sensitive receptors – trackout**

| Designed | Checked | Approved | Figure No. : | Rev. | Sheet |
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### 9.3.2 Operational Phase

As presented in Table 9-9, 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., Woodlands Road and Kranji Expressway) connected to the nearest junctions from the Project site, and the future proposed road within the Project site based on the review of the proposed land use plan in Figure 3-2. An overview of the potential emission sources and sensitive receptors within the 250 m air quality Study Area (as defined in Section 9.2.1) for operational phase is provided in Figure 9-7.

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 (NOx), sulphur dioxide ($SO_2$) and ammonia ($NH_3$) [R-42]. In the context of this Project, the air pollutant of concern will be NOx 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 activities and therefore, not relevant for the purpose of this Project. There is no published evidence for any direct toxic effect of NOx on animals and therefore effects on animals are not included in ecological impact assessment [R-42].

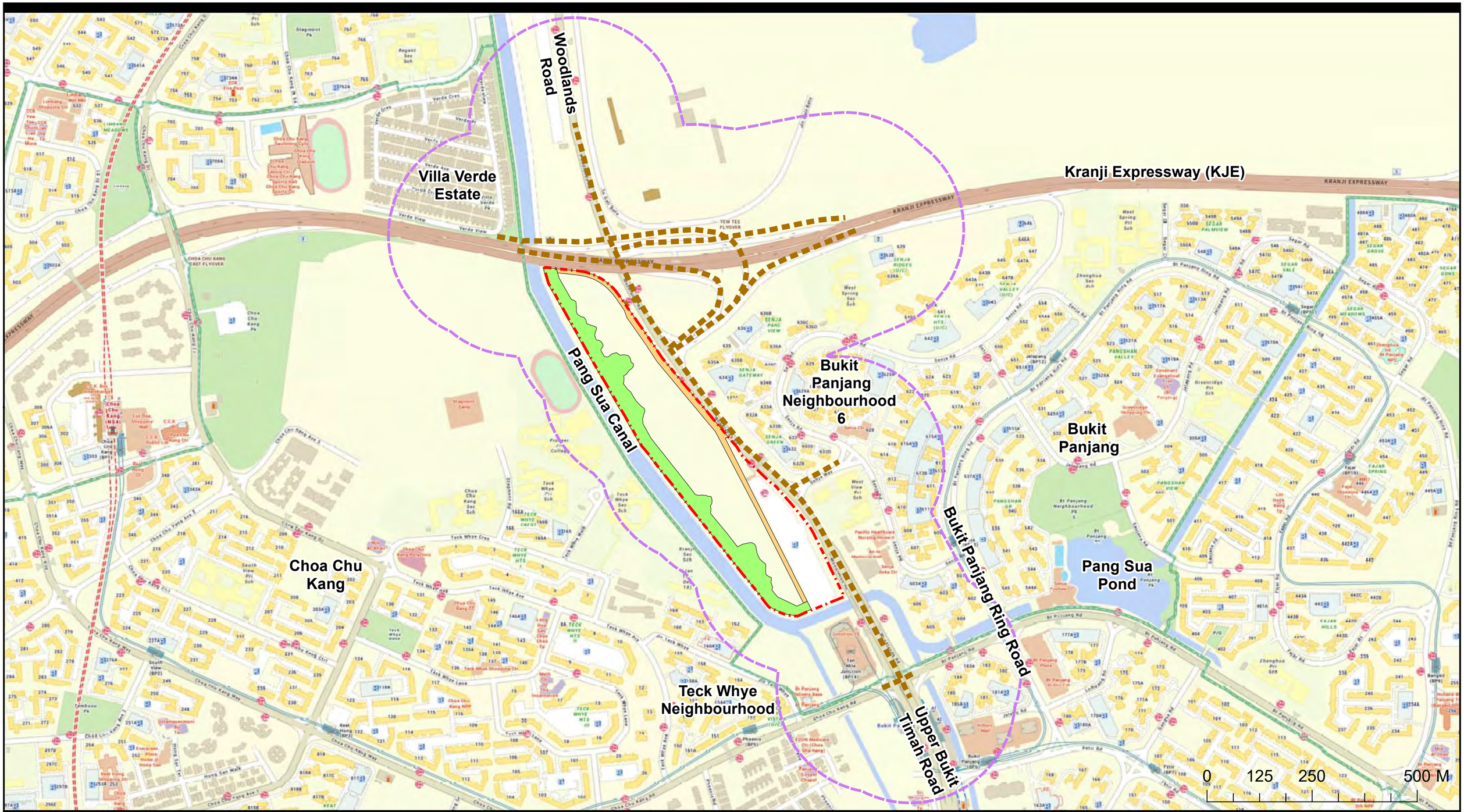
As per the NEA website, since 1 September 2017, all new petrol vehicles have had to meet the Euro 4 emission standard, and since 1 January 2018, all new diesel vehicles have had to meet the Euro 6 emission standard. The new standards will tighten fine particulate emissions from direct-injection petrol 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 9-10.

**Table 9-9 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 9-10 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**

- 250m from Source
- Proposed Ecological Corridor*
- Retained Rail Corridor Alignment
- CCK N1 Project Site

**Potential Emission Sources**

- Existing Road

Note: *Exact boundaries/ alignment subject to further changes

N

| Rev. | Date | By | Description | Chk'd | App'd |
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| 01 | MAR 2023 | TTR | Final Report | NHT | JAG |
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Qualified Person Endorsement : NA

HDB Endorsement : NA

Consultant : AECOM

Client: HOUSING & DEVELOPMENT BOARD

Project Title :

**ENVIRONMENTAL IMPACT ASSESSMENT (EIA) ON CHOA CHU KANG N1**

Figure Title :

**Emission sources and sensitive receptors – operational footprint**

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# 9.4 Identification of Air Quality Sensitive Receptors

## 9.4.1 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 6-1, 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 9-4 to Figure 9-6, 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 6-1, according to UK IAQM [R-31], 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 9-11. 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. Table 9-12 summarizes the sensitivity of each construction phase for earthworks and construction, as well as trackout.

**Table 9-11 Focal list of flora species of high ecological value identified within the air quality Study Area**

| Distance from Worksites | Identified Species | Status | Number of Species Identified |
|---|---|---|---|
| **Species of Conservation Significance** | | | |
| **Within 20 m** | - | - | - |
| **Between 20 m to 50 m** | *Bridelia stipularis* | Vulnerable | 1 |
| **Large Specimens** | | | |
| **Within 20 m** | *Ficus benjamina*<br>*Ficus macrocarpa*<br>*Khaya senegalensis*<br>*Pterocarpus indicus*<br>*Samanea saman*<br>*Tabebuia rosea* | -<br>Common<br>Cultivated Only<br>Casual<br>Casual<br>Casual | 2<br>1<br>25<br>3<br>19<br>1 |
| **Between 20 m to 50 m** | *Artocarpus altilis*<br>*Ficus macrocarpa*<br>*Khaya senegalensis*<br>*Samanea saman*<br>*Tabebuia rosea* | Casual<br>Common<br>Cultivated Only<br>Casual<br>Casual | 1<br>1<br>11<br>19<br>5 |
| **Other Specimens of Value** | | | |
| **Within 20 m** | *Bambusa cf heterostachya* | Cultivated Only | 1 |
| **Between 20 m to 50 m** | - | - | - |

**Table 9-12 Receptor sensitivity for air quality impact assessment – construction phase (ecological receptors)**

| Distance | Identified Receptors | Sensitivity of the Area |
|---|---|---|
| **For Earthworks** | | |
| **Within 20 m** | Vegetated area within Project site | Priority 1 |
| **Between 20 m to 50 m** | Vegetated area within Project site | |
| **For Construction** | | |
| **Within 20 m** | Vegetated area within Project site | Priority 1 |
| **Between 20 m to 50 m** | Vegetated area within Project site | |
| **For Trackout** | | |
| **Within 20 m** | Vegetated area within Project site | - |
| **Between 20 m to 50 m** | Vegetated area within Project site | Priority 2 |

**Human Receptors**

Study Area of 350 m was considered for human health impacts during construction phase. Based on Table 6-1, 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 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 350 m Study Area will be considered as Priority 3.

Therefore, based on the distances of emission sources to the identified receptors presented in Figure 9-4 to Figure 9-6, the Sensitivity of the Area for each construction worksite was determined to be ranging from Priority 1 to Priority 3 as summarized in Table 9-13 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 U.

**Table 9-13 Receptor sensitivity for air quality impact assessment – construction phase (human receptors)**

| Activities | Sensitivity of the Area |
|---|---|
| **Earthworks** | Priority 2 |
| **Construction** | Priority 2 |
| **Trackout** | Priority 1 |

## 9.4.2 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 Woodlands Road, Kranji Expressway and future proposed road within Project site) as discussed in Section 9.3.2. Potential human and ecological sensitive receptors which might be impacted by the increased traffic within 250 m air quality Study Area (see Figure 9-7) are presented in Table 9-14 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.

**Table 9-14 Receptor sensitivity for air quality impact assessment – operational phase**

| No. | Receptor Name | Land Use | Receptor Type | Sensitivity Classification |
|---|---|---|---|---|
| **Existing Receptors** | | | | |
| 1 | HDB Block 638A, 630, 640, 640A, 641A at Senja Close | Residential | Human | Priority 1 |
| 2 | HDB Block 601, 602, 603, 604, 605, 606, 607, 608, 609, 610, 612, 614, 616, 618, 622, 625, 625B, 626, 627, 629, 629B, 630, 631, 632A, 632B, 633, 633A, 633B, 633C, 633D, 634A, 634B, 634C, 635, 635A, 635B, 635C, 635D, 636A, 636B, 636C, 636D at Senja Road | Residential | Human | Priority 1 |
| 3 | HDB Block 611, 613, 613B, 620 at Bukit Panjang Ring Road | Residential | Human | Priority 1 |
| 4 | HDB Block 181, 182, 183, 183A, 184, 185 at Jelebu Road | Residential | Human | Priority 1 |
| 5 | Hillion Residences | Residential | Human | Priority 1 |
| 6 | 3, 5, 7, 7A, 9, 9A, 13, 14, 14A, 15, 17, 55 Galistan Avenue | Residential | Human | Priority 1 |
| 7 | HDB 153, 161A, 161B, 161C, 162, 163 at Jalan Teck Whye | Residential | Human | Priority 1 |
| 8 | 9, 11, 13-37, 39-129 (odd number), 130-206 (even number) Verde View, Villa Verde | Residential | Human | Priority 1 |
| 9 | 1, 3, 5, 7, 9, 10, 11, 13 Verde Place, Villa Verde | Residential | Human | Priority 1 |
| 10 | 1-16, 17-37 (odd number) Verde Grove, Villa Verde | Residential | Human | Priority 1 |
| 11 | 1-49, 51, 53, 55, 57, 59 Verde Avenue, Villa Verde | Residential | Human | Priority 1 |
| 12 | 1-67, 69, 71, 73, 75 Verde Crescent, Villa Verde | Residential | Human | Priority 1 |
| 13 | West Spring Secondary School | Educational Institution | Human | Priority 1 |
| 14 | West View Primary School | Educational Institution | Human | Priority 1 |
| 15 | Teck Whye Secondary School | Educational Institution | Human | Priority 1 |
| 16 | Jurong Pioneer Junior College | Educational Institution | Human | Priority 1 |
| 17 | Bukit Panjang Polyclinic | Healthcare | Human | Priority 1 |
| 18 | Pacific Healthcare Nursing Home II @ Bukit Panjang | Healthcare | Human | Priority 1 |
| 19 | Econ Medicare Centre | Healthcare | Human | Priority 1 |
| 20 | Sri Murugan Hill Temple | Place of Worship | Human | Priority 3 |

| No. | Receptor Name | Land Use | Receptor Type | Sensitivity Classification |
|---|---|---|---|---|
| 21 | Bukit Panjang Gospel Chapel | Place of Worship | Human | Priority 3 |
| 22 | 205A, 301A Woodlands Road, Temporary Site Office | Commercial | Human | Priority 3 |
| 23 | Gali Batu Bus Terminal | Commercial | Human | Priority 3 |
| 24 | 180 Woodlands Road | Commercial | Human | Priority 3 |
| 25 | HDB Multi-storey Carpark Block 638 Senja Close | Commercial | Human | Priority 3 |
| 26 | Senja Centre | Commercial | Human | Priority 3 |
| 27 | HDB Multi-storey Carpark Block 603A, 616A, 625A, 629A, 632, 634, 636 at Senja Road | Commercial | Human | Priority 3 |
| 28 | Bukit Panjang Telephone Exchange | Commercial | Human | Priority 3 |
| 29 | Senja Soka Centre | Commercial | Human | Priority 3 |
| 30 | HDB Multi-storey Carpark Block 611A, 613, 615A at Bukit Panjang Ring Road | Commercial | Human | Priority 3 |
| 31 | HDB Multi-storey Carpark Block 181A, 185A at Jelebu Road | Commercial | Human | Priority 3 |
| 32 | Bukit Panjang Integrated Transport Hub | Commercial | Human | Priority 3 |
| 33 | Bukit Panjang MRT Station | Commercial | Human | Priority 3 |
| 34 | Bukit Panjang Delivery Base | Commercial | Human | Priority 3 |
| 35 | HDB Multi-storey Carpark Block 160A, 161 at Jalan Teck Whye, MSCP | Commercial | Human | Priority 3 |
| 36 | 38 Jalan Teck Whye | Commercial | Human | Priority 3 |
| **Future Receptors as per Proposed Land Use Plan** (see Figure 3-2) | | | | |
| 37 | Proposed Ecological Corridor within Project site | Park/ Natural Area | Ecological | Priority 1 |
| 38 | Proposed Rail Corridor | Natural Area | Ecological | Priority 1 |
| 39 | Proposed Residential Development | Residential | Human | Priority 1 |
| 40 | Proposed Multi-storey Carpark | Place of Worship | Human | Priority 3 |
| 41 | Proposed Environmental Deck | Park | Human | Priority 3 |

# 9.5 Baseline Air Quality

## 9.5.1 Baseline Monitoring Personnel

The assessment and site surveys were conducted by the following personnel:

- Ms. Jagriti Dawra, AECOM (EIA Specialist);
- Mr. Hanzel Lalitan, AECOM (Air Quality Consultant);
- Ms. Tiffany Tan, AECOM (Air Quality Consultant); and
- Mr. Yong Li Sheng, ALS Technichem (S) Pte Ltd.

Site reconnaissance surveys were carried out on 6 June 2022 and 1 September 2022. Subsequently, the primary baseline air quality data collection was conducted on 2 – 9 September 2022 at AQ3 monitoring location, 9 – 16 September 2022 at AQ1 monitoring location, 19 – 26 September 2022 at AQ5 monitoring location, 26 September – 3 October at AQ2 and AQ4 monitoring locations. The baseline monitoring locations are presented in Table 9-2 and Figure 9-3.

## 9.5.2 Baseline Findings

### 9.5.2.1 Secondary Data Collection (Review of Background Data)

#### 9.5.2.1.1 NEA Singapore Ambient Air Quality Targets and Monitoring

Table 9-15 provides the general NEA ambient air monitoring results for Singapore over the period 2017 – 2021 and compares them with the Long Term Singapore Ambient Air Quality Targets (SAAQT). The SAAQT have been adopted in this Report and is generally more stringent than the USEPA National Ambient Air Quality Standards (NAAQS).

It can be observed from Table 9-15 that the NEA monitoring results for background carbon monoxide (CO) and nitrogen dioxide ($NO_2$) were below the SAAQT between 2017 and 2021. Whereas the background particulate matter less than 10 µm ($PM_{10}$) annual mean, particulate matter less than 2.5 µm ($PM_{2.5}$) annual mean, sulphur dioxide ($SO_2$) 24-hour average and ozone ($O_3$) 8-hour average, have consistently exceeded the SAAQT over the period 2017 – 2021. The elevated $PM_{10}$ and $PM_{2.5}$ concentrations in Singapore are partly attributable to the intermittent haze periods resulting from forest fires in neighbouring countries, although other significant contributors to the background levels may also be domestic emissions from industries, shipping and motor vehicles.

Nonetheless, the NEA monitored results have also demonstrated a considerably great reduction in most of the air pollutant levels (except for $O_3$) in Year 2020. This may be due to the COVID-19 restrictions at regional and global levels where human activities such as commercial events and transportation activities have drastically decreased.

**Table 9-15 NEA ambient air quality monitoring [R-29, R-43]**

| Pollu-tants | Averaging Period | 2017 results (µg/m³) | 2018 results (µg/m³) | 2019 results (µg/m³) | 2020 results (µg/m³) | 2021 results (µg/m³) | Average results 2016 – 2021 (µg/m³) | Singapore Ambient Air Quality Targets (µg/m³) Long Term Target (SAAQT) |
|---|---|---|---|---|---|---|---|---|
| **$PM_{10}$** | 99th %ile of 24-Hour Averages | **57** | **59** | **90** | 43 | **51** | **60** | *50* |
| | Annual Mean | **25** | **29** | **30** | **25** | **28** | **27** | *20* |
| **$PM_{2.5}$** | 99th %ile of 24-Hour Averages | **34** | **32** | **62** | 24 | **28** | **36** | *25* |
| | Annual Mean | **14** | **15** | **16** | **11** | **12** | **14** | *10* |

| Pollu-tants | Averaging Period | 2017 results (µg/m³) | 2018 results (µg/m³) | 2019 results (µg/m³) | 2020 results (µg/m³) | 2021 results (µg/m³) | Average results 2016 – 2021 (µg/m³) | Singapore Ambient Air Quality Targets (µg/m³) Long Term Target (SAAQT) |
|---|---|---|---|---|---|---|---|---|
| **CO** | Maximum 1-Hour Average | 2,300 | 2,500 | 2,300 | 1,600 | 1,300 | 2,000 | *30,000* |
| | Maximum 8-Hour Average | 1,700 | 2,000 | 1,700 | 1,200 | 1,200 | 1,560 | *10,000* |
| **$NO_2$** | Maximum 1-Hour Average | 158 | 147 | 156 | 118 | 123 | 140 | *200* |
| | Annual Mean | 25 | 26 | 23 | 20 | 25 | 24 | *40* |
| **$SO_2$** | 24-Hour Average | **59** | **65** | **57** | **30** | **89** | **68** | *20* |
| **$O_3$** | 8-Hour Average | **191** | **150** | **125** | **145** | **176** | **157** | *100* |

Notes:

1. Values in Bold exceed the Long Term Singapore Ambient Air Quality Targets
2. Singapore was affected by haze in 2019, thus, the 2019 data is not representative of the baseline air quality

#### 9.5.2.1.2 24-hour $PM_{10}$ and $PM_{2.5}$ Concentrations Readings

Historical 24-hr $PM_{10}$ and $PM_{2.5}$ readings for North Region of Singapore available on data.gov.sg were collected during the air quality baseline monitoring period for comparison between the primary and secondary data findings.

A review was conducted for 24-hr $PM_{2.5}$ and $PM_{10}$ readings available on data.gov.sg for the North of Singapore during the monitoring period (i.e., 2 – 9 September 2022 for AQ3 monitoring location, 9 – 16 September 2022 for AQ1 monitoring location, 19 – 26 September 2022 for AQ5 monitoring location, 26 September – 3 October for AQ2 and AQ4 monitoring locations) [W-23]. Figure 9-8 and Figure 9-9 show the variation of $PM_{10}$ and $PM_{2.5}$ concentrations recorded by the NEA during the primary baseline data collection period of 2 – 9 September 2022. Figure 9-10 and Figure 9-11 show the variation of $PM_{10}$ and $PM_{2.5}$ concentrations recorded by the NEA during the primary baseline data collection period of 9 – 16 September 2022. Figure 9-12 and Figure 9-13 show the variation of $PM_{10}$ and $PM_{2.5}$ concentrations recorded by the NEA during the primary baseline data collection period of 19 – 26 September 2022. Figure 9-14 and Figure 9-15 show the variation of $PM_{10}$ and $PM_{2.5}$ concentrations recorded by the NEA during the primary baseline data collection period of 26 September – 3 October 2022. All the 24-hr $PM_{2.5}$ and $PM_{10}$ readings recorded were well below Long Term Singapore Ambient Air Quality Targets.

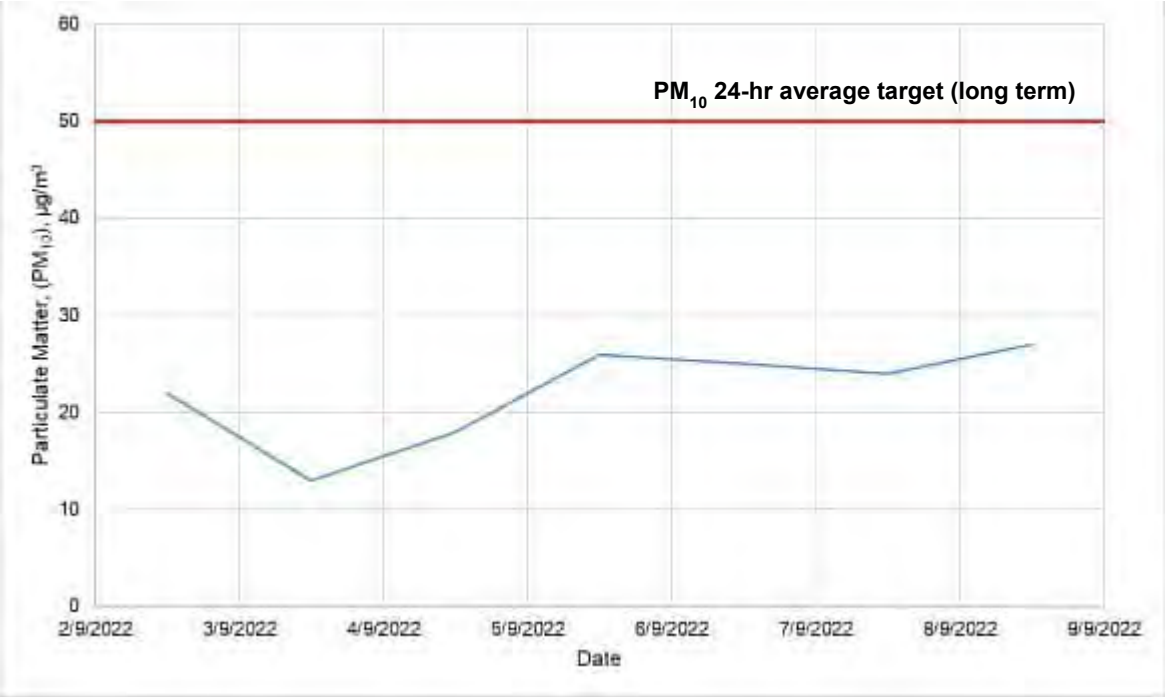



**Figure 9-8 24-24-hr $PM_{10}$ concentrations reading of North Singapore from 2 – 9 September 2022 (AQ3) [W-23]**

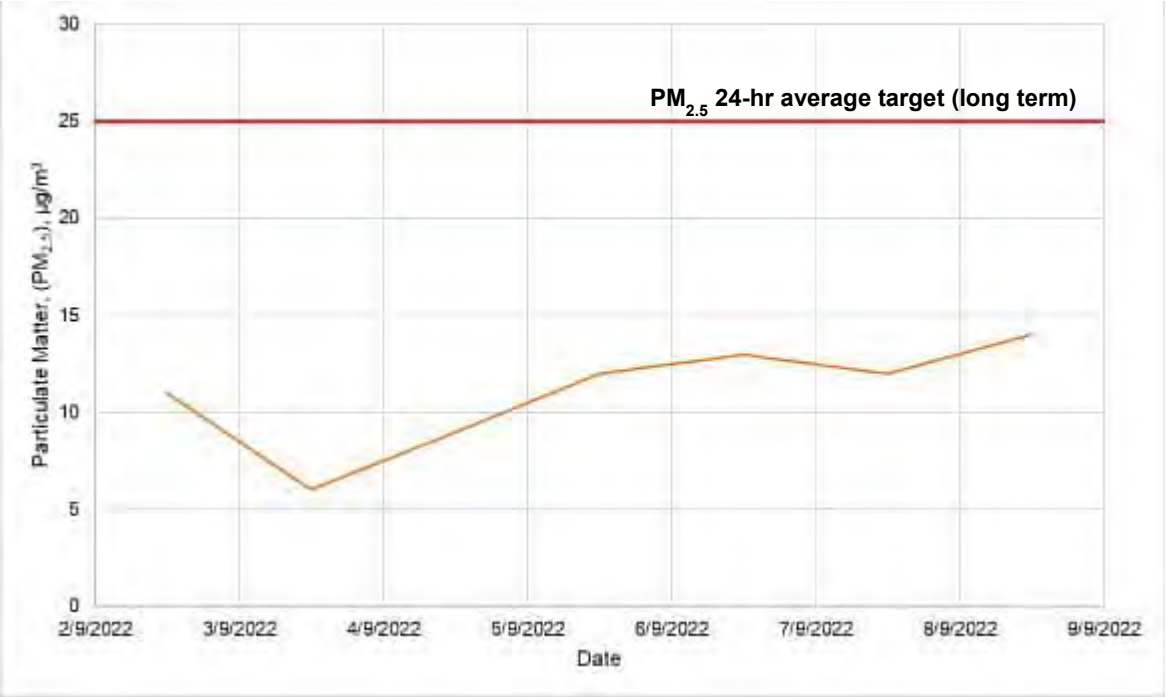



**Figure 9-9 24-hr $PM_{2.5}$ concentrations reading of North Singapore from 2 – 9 September 2022 (AQ3) [W-23]**

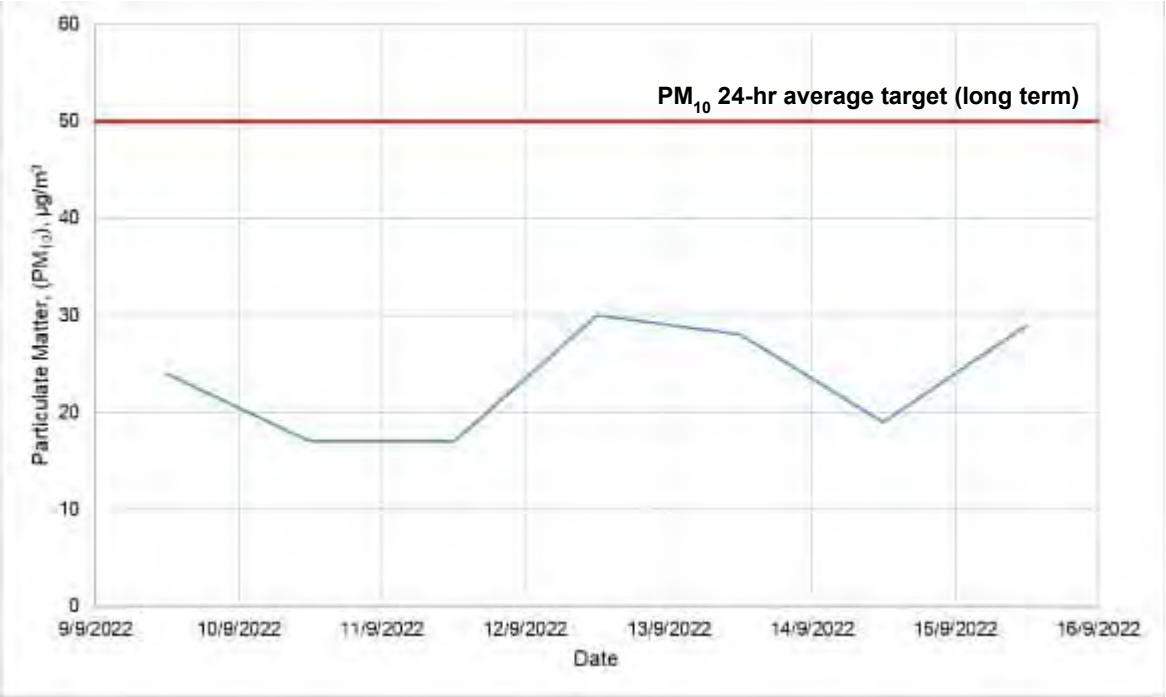



**Figure 9-10 24-hr PM10 concentrations reading of North Singapore from 9 - 16 September 2022 (AQ1) [W-23]**

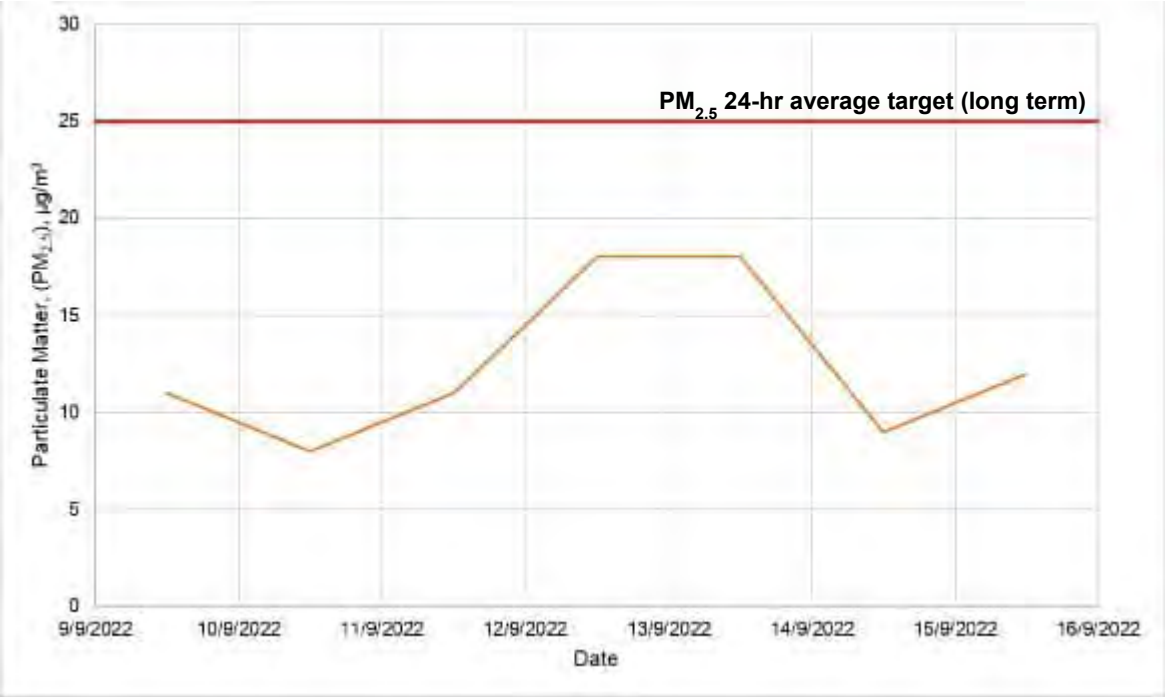



**Figure 9-11 24-hr $PM_{2.5}$ Concentrations Reading of North Singapore from 12 - 19 September 2022 (AQ1) [W-23]**

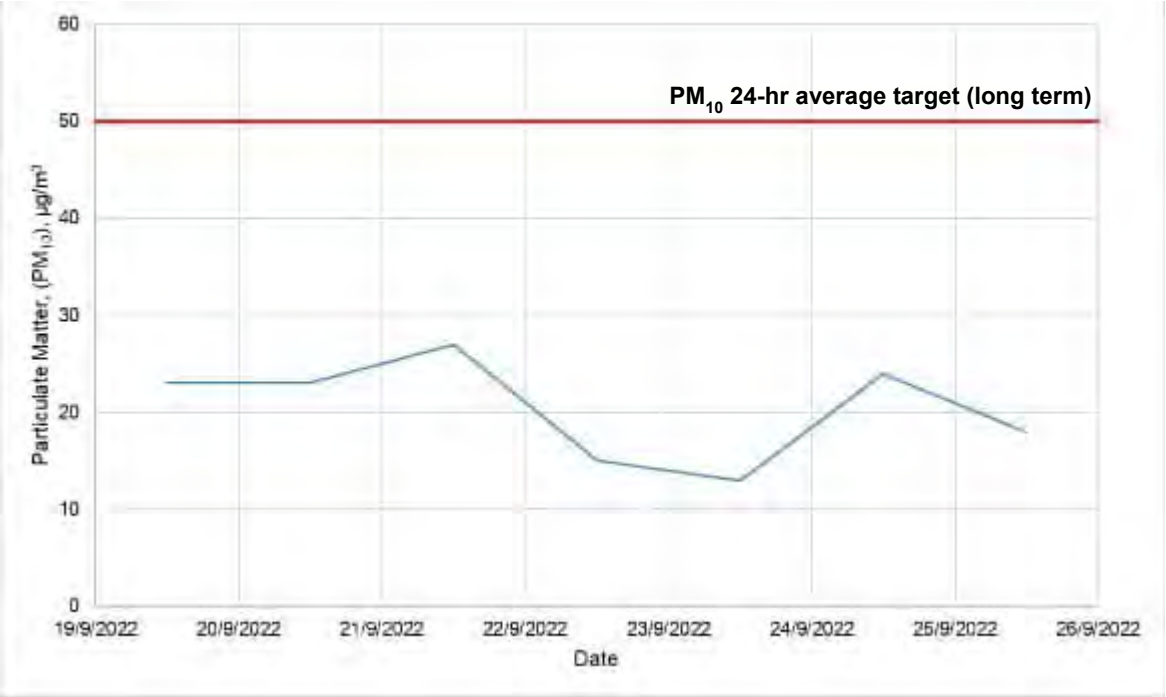



**Figure 9-12 24-hr PM10 concentrations reading of North Singapore from 19 - 26 September 2022 (AQ5) [W-23]**

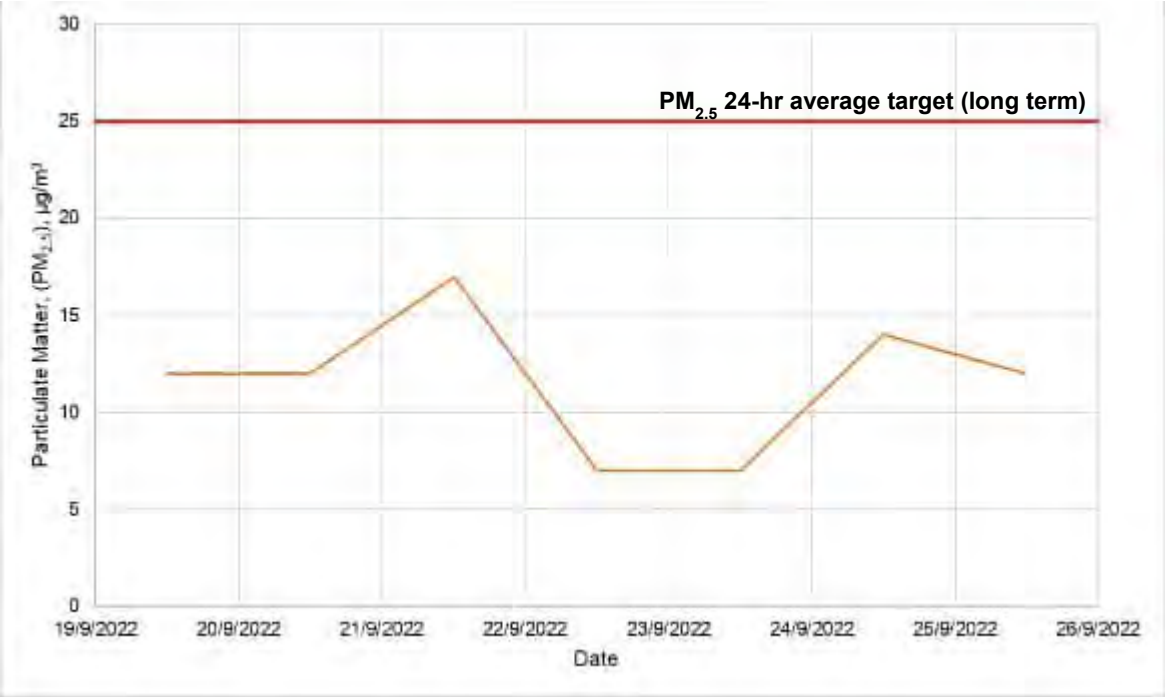



**Figure 9-13 24-hr $PM_{2.5}$ concentrations reading of North Singapore from 19 - 26 September 2022 (AQ5) [W-23]**




**Figure 9-14 24-hr PM10 concentrations reading of North Singapore from 26 September – 3 October 2022 (AQ2 and AQ4) [W-23]**

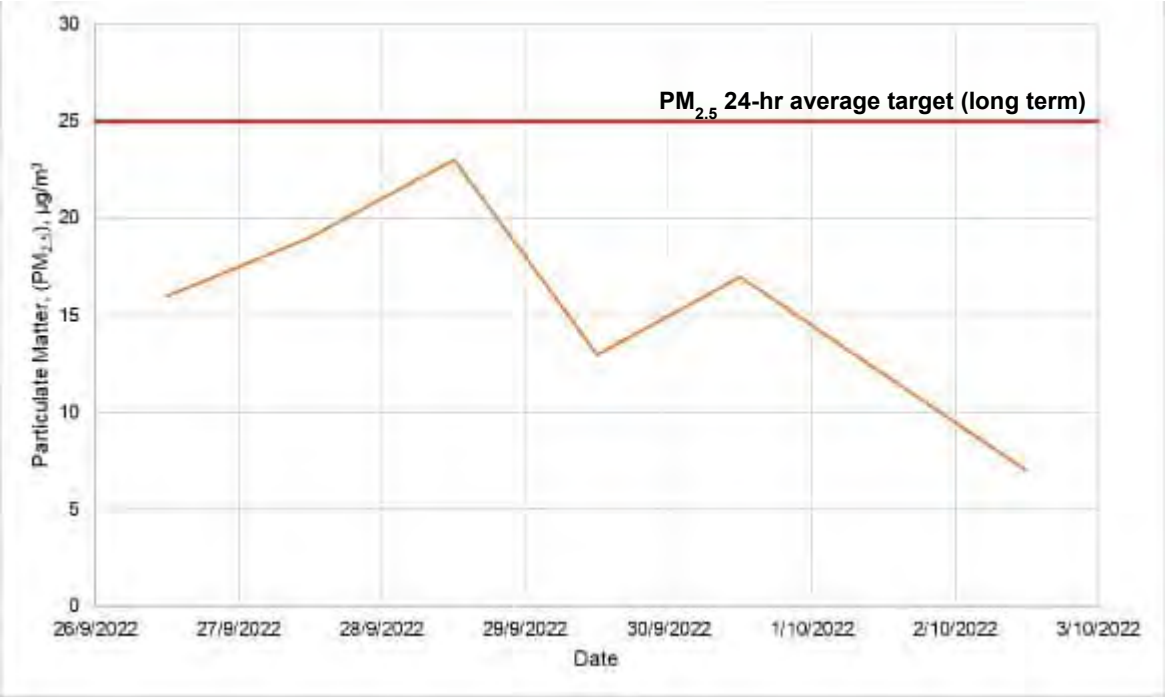



**Figure 9-15 24-hr $PM_{2.5}$ Concentrations Reading of North Singapore from 26 September – 3 October 2022 (AQ2 and AQ4) [W-23]**

#### 9.5.2.1.3 Other Parameters (Rainfall, Temperature, Wind Speed)

Figure 9-16, Figure 9-17, and Figure 9-18 below present the trend of daily total rainfall, mean temperature and mean wind speed observed at Bukit Panjang, Admiralty and Tengah weather monitoring stations (nearest to the Project site as identified in Section 9.2.2.1.3), from March 2017 to March 2022.

From Figure 9-16, an average of approximately 7.6 mm, 6.3 mm and 7.4 mm of daily rain was observed from Bukit Panjang, Admiralty and Tengah monitoring stations, respectively. This calculates to approximately 2770 mm, 2290 mm and 2683 mm of rain annually for Bukit Panjang, Admiralty and Tengah monitoring stations respectively. With regards to mean temperature and mean wind speed, the temperature and wind speed within Study Area is expected to be relatively constant with average 27.7°C and 27.7°C mean temperature as observed in Figure 9-17 from Admiralty and Tengah monitoring stations respectively, and 11.2 km/h and 10.2 km/h mean wind speed as observed in Figure 9-18 from Admiralty and Tengah monitoring stations respectively.

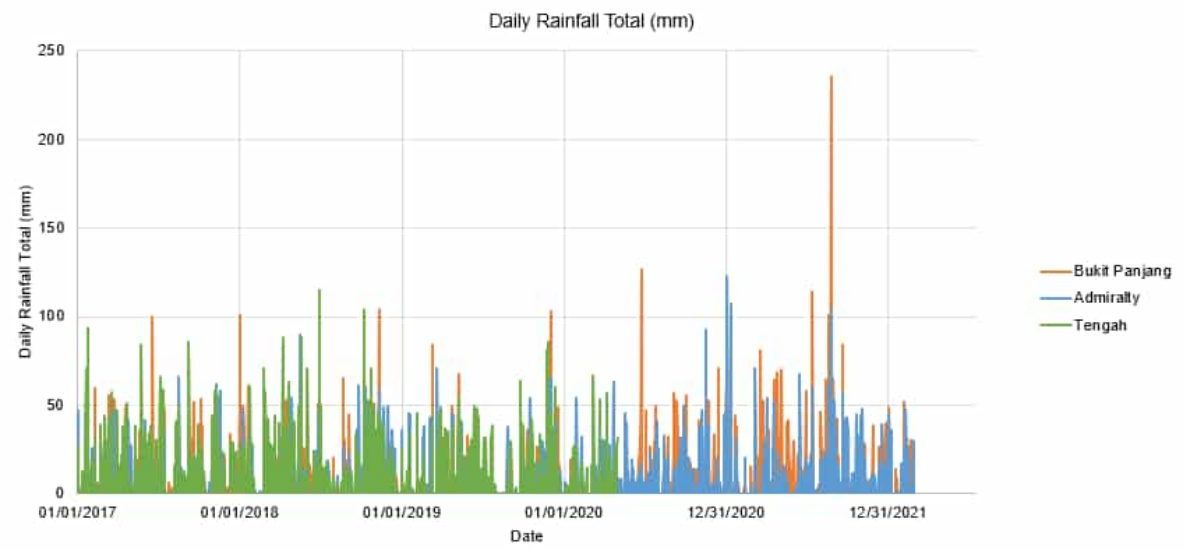



**Figure 9-16 Daily rainfall monitored at Bukit Panjang, Admiralty and Tengah monitoring stations [W-24]**

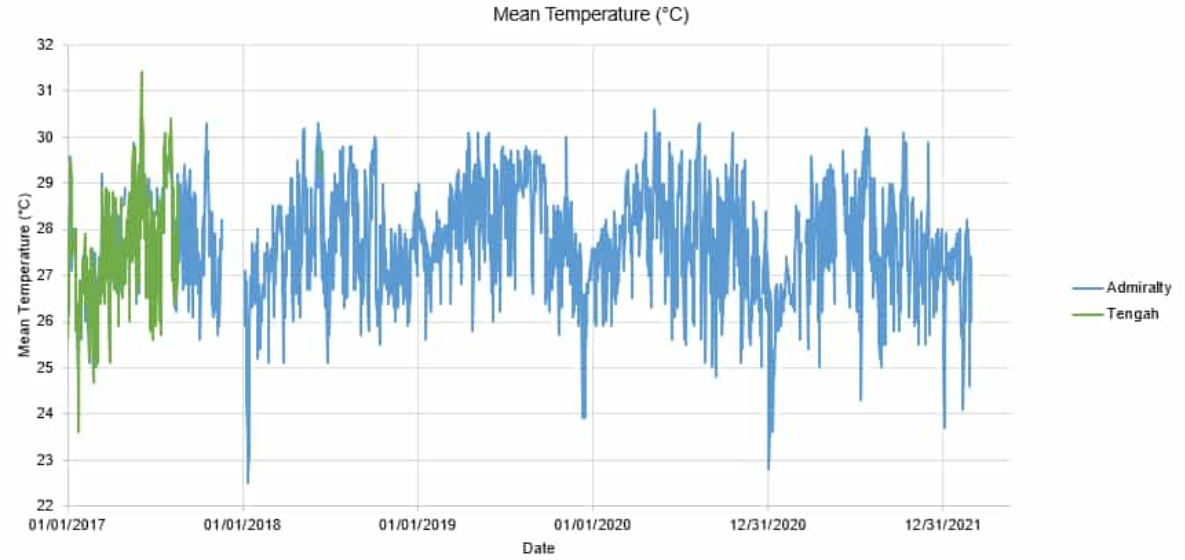



**Figure 9-17 Mean temperature monitored at Admiralty and Tengah monitoring stations [W-24]**

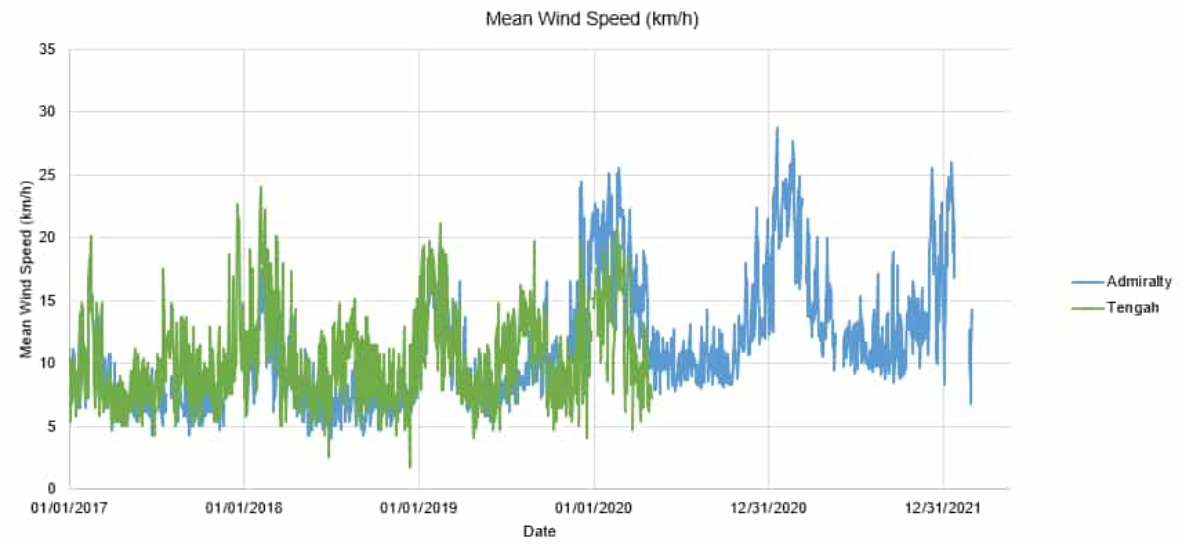



**Figure 9-18 Mean wind speed monitored at Tengah and Admiralty monitoring stations [W-24]**

### 9.5.2.2 Secondary Air Quality Monitoring Data from Concurrent Study

Seven (7) days of continuous ambient air quality monitoring was conducted to determine the pollutant concentrations from existing background pollutant sources. The monitoring results for each pollutant at all monitoring locations are summarised in Table 9-16 below and compared with the Singapore Ambient Air Quality Long Term Targets.

**Table 9-16 Concurrent study air quality monitoring results**

| Monitoring Location | Monitoring Date | Daily $PM_{10}$ Concentration, $\mu g/m^3$ | | | Daily $PM_{2.5}$ Concentration, $\mu g/m^3$ | | |
|---|---|---|---|---|---|---|---|
| | | Min | Max | Average | Min | Max | Average |
| A03: Choa Chu Kang Rail Corridor | 7 – 14 March 2022 | 8.5 | 25.1 | 16.1 | 5.8 | 20.6 | 12.5 |
| *Singapore Ambient Air Quality Long Term Targets* | | *50* | | | *25* | | |

It can be observed from Table 9-16 that all pollutant concentrations are within the Singapore Ambient Air Quality Long Term Targets at the monitoring location. It should be noted that air quality monitoring was conducted during COVID-19 pandemic. Ambient air quality in this area might be higher during normal condition.

### 9.5.2.3 Primary Data Collection (Survey & Sampling)

As mentioned in Table 9-2, seven (7) days of continuous ambient air quality monitoring was conducted at AQ1 (Villa Verde Estate), AQ2 (Jurong Pioneer Junior College), AQ3 (HDB Blk 162 Teck Whye Neighbourhood), AQ4 (West View Primary School), and AQ5 (HDB Blk 634 Senja Road) respectively, to determine the pollutant concentrations from existing background pollutant sources. The monitoring results are summarized in Table 9-17 below and compared against the SAAQT. Baseline monitoring results are presented graphically in Figure 9-19 to Figure 9-20.

It can be observed from Table 9-17, Figure 9-19 and Figure 9-20 that the results of 24-hours average $PM_{10}$ at all locations were well below the Long Term SAAQT. However, the maximum concentration of 24-hours average $PM_{2.5}$ at both AQ1, AQ2 and AQ3 exceeded the Long Term SAAQT. The monitoring results trend is similar with the trend of secondary data presented in Section 9.5.2.1.2.

**Table 9-17 Baseline air quality monitoring results**

| Monitoring Location | Monitoring Date | 24-hour Average $PM_{10}$ Concentration (7-Days Period), µg/m³ | | | 24-hour Average $PM_{2.5}$ Concentration (7-Days Period), µg/m³ | | |
|---|---|---|---|---|---|---|---|
| | | Min | Max | Average | Min | Max | Average |
| **AQ1:** Villa Verde Estate | 9 – 16 September 2022 | 9.4 | **31.0** | 15.6 | 8.6 | **29.8** | 14.6 |
| **AQ2:** Jurong Pioneer Junior College | 26 September – 3 October 2022 | 10.0 | **26.5** | 18.6 | 8.3 | **25.3** | 17.4 |
| **AQ3:** HDB Blk 162 Teck Whye Neighbourhood | 2 – 9 September 2022 | 11.1 | 36.9 | 22.7 | 8.6 | **27.7** | 17.8 |
| **AQ4:** West View Primary School | 26 September – 3 October 2022 | 12.7 | 27.6 | 20.9 | 10.3 | 24.1 | 16.9 |
| **AQ5:** HDB Blk 634 Senja Road | 19 – 26 September 2022 | 6.6 | 24.8 | 13.28 | 5.92 | 23.4 | 12.47 |
| *Singapore Ambient Air Quality Target (Long Term)* | | *50* | | | *25* | | |

Notes:

1. Values in Bold exceed the Long Term Singapore Ambient Air Quality Targets.

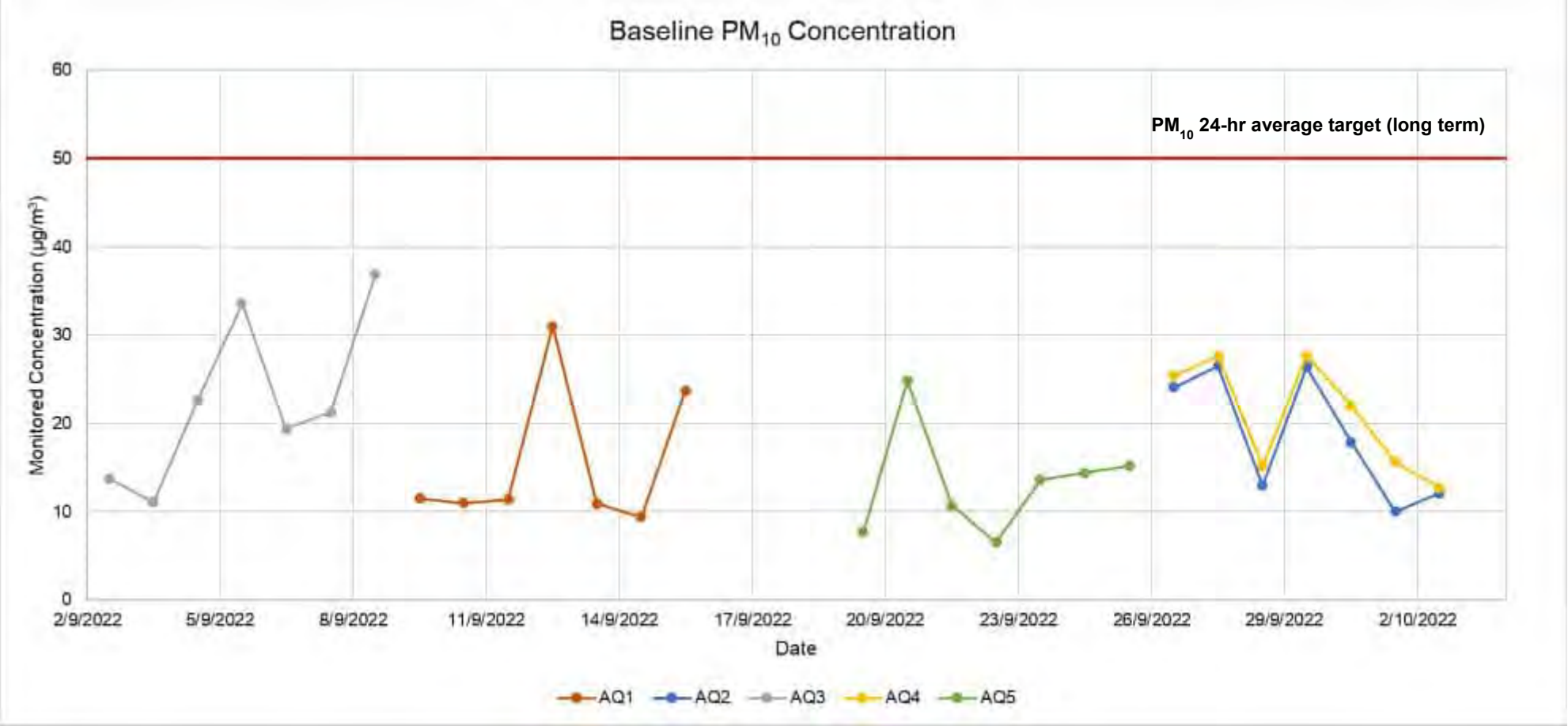



**Figure 9-19 Baseline $PM_{10}$ air quality monitoring results [R-45]**

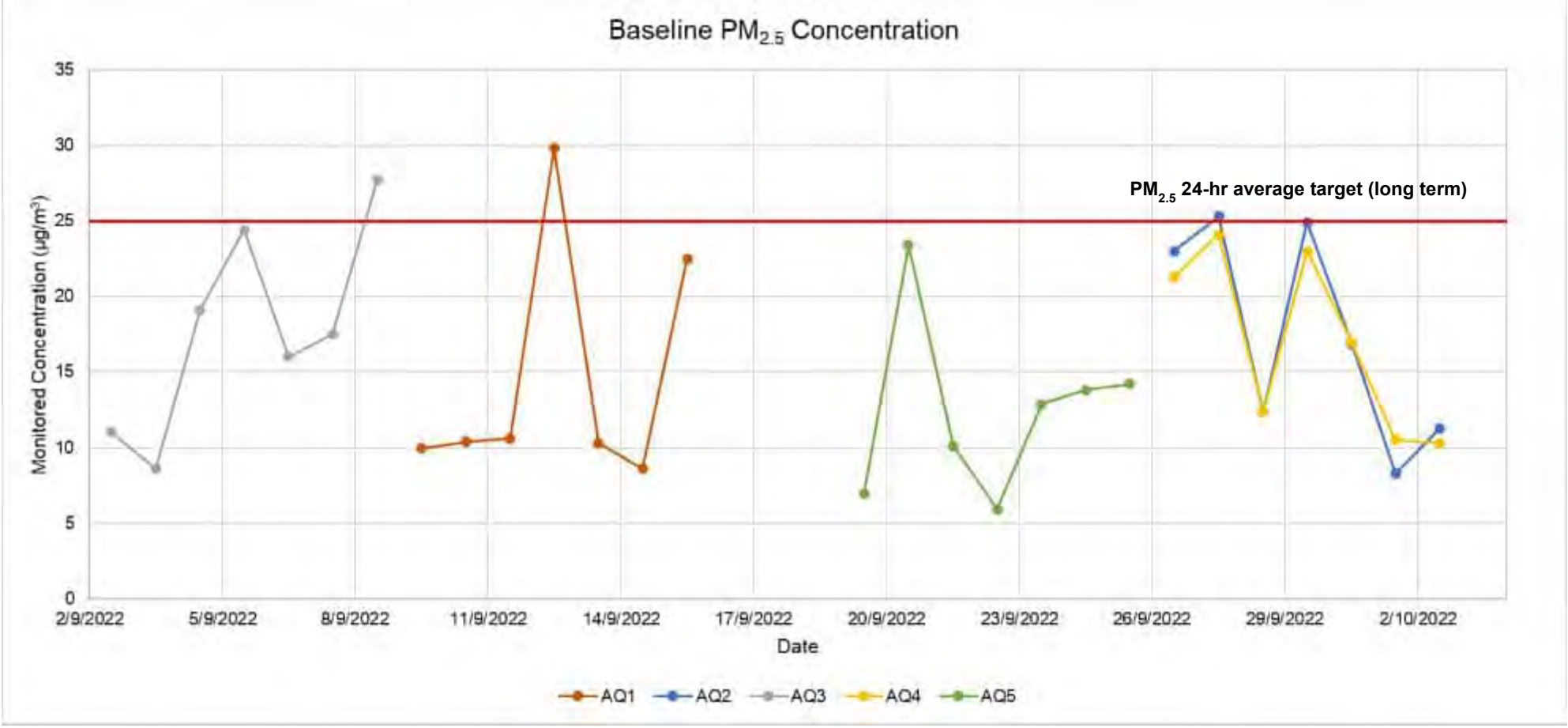



**Figure 9-20 Baseline air quality monitoring results [R-45]**

# 9.6 Minimum Control Measures

This section proposes minimum controls or standard practices commonly implemented that have been assumed to be implemented for the purposes of impact assessment.

## 9.6.1 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; and
- Access road construction or expansion is recommended to be completed first and paved before the construction of other development commences.

## 9.6.2 Operational Phase

No minimum control has been assumed for the purpose of air quality impact assessment during operational phase.

# 9.7 Prediction and Evaluation of Air Quality Impacts

## 9.7.1 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.

### 9.7.1.1 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 9.2.3.1.

**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-5]. Dust may affect photosynthesis, respiration, transpiration and allow the penetration of phytotoxic gaseous pollutants [P-32].

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 9.5.2.1.3, 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 9-18.

Based on the assessment, the Impact Significance was predicted to be ranging from **Moderate** to **Major** for ecological impact. Hence, based on the assessment methodology in Section 9.2.3.1.7, 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.

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 9-18.

Based on the assessment, the Impact Significance was predicted to be **Moderate** for human health impact. Hence, based on the assessment methodology in Section 9.2.3.1.7, Impact Significance evaluated as Major and Moderate requires the adoption of management or mitigation measures.

**Table 9-18 Impacts of dust risk assessment (before mitigation)**

| Key Parameter - Earthworks | | | Impact Assessment | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Total Site Area ($m^2$) | No. of Vehicles Moving Within the Site | Total Material Moved (tonnes) | 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 |
| >10,000 | 5-10 | 20,000-100,000 | High | Priority 1 | Priority 2 | High | Medium | Regular | **Major** | **Moderate** |
| **Key Parameter - Construction** | | | **Impact Assessment** | | | | | | | |
| Total Building Volume ($m^3$) | 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 |
| 25,000-100,000 | Potentially dusty (e.g., concrete) | 0 | Medium | Priority 1 | Priority 2 | Medium | Medium | Regular | **Moderate** | **Moderate** |
| **Key Parameter - Trackout** | | | **Impact Assessment** | | | | | | | |
| No. of Outward Trucks Movement Per Day | 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 |
| 10-50 | Less to moderately dusty | 0 | Medium | Priority 2 | Priority 1 | Low | Medium | Regular | **Moderate** | **Moderate** |

Note:

1. The HDVs are expected to travel along the existing paved road along Woodlands Road for access to the Project site, hence an unpaved road length of 0 m (< 50 m) is considered in this air quality impact assessment.

#### 9.7.1.2 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 utilized 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. 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 6-6. 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 based on the assessment methodology in Section 9.2.3.1.7. The Impact Intensity, Impact Consequence and Impact Significance are outlined in Table 9-19.

**Table 9-19 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** |

## 9.7.2 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 9-20, $NO_x$ 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 9-21, $NO_x$ 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.

**Table 9-20 Euro emission standard for passenger cars [W-25]**

| 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 9-21 Euro emission standard for commercial good vehicles [W-25]**

| 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 |

| Category | Tier | Approval Date | Emission standard for commercial good vehicles, g/km | | | | |
|---|---|---|---|---|---|---|---|
| | | | CO | HC | $NO_X$ | HC+$NO_X$ | PM |
| **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.

Within the 250 m Study Area, the existing residential properties are mostly located at the east and northwest of the Project site, including the HDB blocks along Senja Road and the private residences (Villa Verde Estate). There are also educational institutes located at the east and west of the Project site, (i.e., West Spring Secondary School, West View Primary School, Teck Whye Secondary School, and Jurong Pioneer Junior College). Note that the western part of the Study Area does not contain existing paved roads for motor vehicles, it is occupied as a cycling path beside Pang Sua Canal, which is directly connected to the Study Area. Typically, the pollutants of concern in a 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-26]. 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 9.4.1).

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-33]. 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-42].

Lichens/ mosses are indicator 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 vegetated/ ecological receptors in the proposed development are immediately adjacent to the Woodlands Road 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-35].

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-48]. 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 100m. 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 high traffic volume along the existing Woodlands Road at the East of the Project site and Kranji Expressway at the North of the Project Site. In addition, there will be future internal arterial roads that will be constructed within the Project site as per the proposed land use plan (see Figure 3-2). Hence, locally the traffic within and in the vicinity of the Project site is likely to increase. It should also be noted that currently there is a significant traffic volume along the Woodlands Road and Kranji Expressway. The exact numbers in terms of increase /change in volume of traffic to and from the worksites were not available. AECOM has monitored traffic along highways and smaller roads in several Singapore projects in the past. From our previous experience, the traffic volume at KJE can reach up to 12500 veh/hr and 3000 veh/hr for Woodlands Road, while traffic volume within internal roads in HDB estate vary between 1000-2000 veh/hr. The incremental traffic volume within HDB estate is therefore, expected to be only 6-13% of the KJE traffic. While there is no denying that the internal roads will also contribute to the impact on the residential area located away from Woodlands Road and KJE, their contribution as compared to the existing Woodlands Road and KJE will be proportionately significantly less. 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, current large base traffic volume along existing roads, the 60% to 80% decrease over distance (by Zhu et al. (2002)) from the existing road (about 15 m – 400 m either horizontally or vertically from Woodlands 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 6-5.

With the Priority 1 and 3 sensitive receptors identified for operational phase of this Project (see Section 9.4), according to the assessment matrix in Table 6-7, 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 9-7, the Impact Significance is predicted to be **Minor** (refer to Table 9-22). No mitigation measures are required during operational phase.

Nonetheless, it should be noted that this transport impact assessment study of this Project is still ongoing and the traffic volume estimation discussed in this section is meant for reference only, hence no detailed assessment of operational air quality impact assessment could be carried out. However, a high-level qualitative assessment has been conducted.

**Table 9-22 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** |
| Negligible | Priority 3 | Imperceptible | Regular | **Minor** |

# 9.8 Recommended Mitigation Measures

## 9.8.1 Construction Phase

Based on the assessment in Section 9.7.1, the Impact Significance was determined to be ranging from **Moderate** to **Major**. The range of dust mitigation measures to be implemented at the construction sites are outlined in Table 9-23. Upon the implementation of mitigation measures, the residual Impact Significance was determined to be **Minor**. This will be detailed in Section 9.9.1.

**Table 9-23 Air quality mitigation measures (construction phase)**

| Mitigation Measures | |
|---|---|
| **GENERAL MITIGATION MEASURES TO BE IMPLEMENTED THROUGH OUT CONSTRUCTION PERIOD** | |
| **Communications** | |
| Develop and implement a stakeholder communications plan that includes community engagement before work commences on site. | Mandatory |
| 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. | Mandatory |
| Develop and implement an Air Pollution Control Plan (APCP) (see paragraph below for APCP details). | Mandatory |
| **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. | Mandatory |
| Make the complaints log available to the local authority when asked. | Mandatory |
| 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 log book. | Mandatory |
| 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. | Mandatory |
| **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 window sills within 100 m of site boundary. Cleaning should be provided if necessary. | Mandatory |
| Carry out regular site inspections to monitor and record compliance with the Air Pollution Control Plan. | Mandatory |
| Increase the frequency of site inspections during prolonged dry or windy conditions. | Mandatory |
| Conduct monitoring for $PM_{10}$ and $PM_{2.5}$ at suitable locations (refer to Section 11.12.1) | Mandatory |
| **Preparing and maintaining the site** | |
| Plan site layout so that machinery and dust causing activities are located away from receptors, where possible. | Mandatory |
| 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. | Mandatory |
| Fully enclose specific activities where there is a known high potential for dust production and the site will be active for an extensive period of time. | Mandatory |
| Keep site fencing, barriers, and scaffolding clean by cleaning regularly using wet methods (dry methods may give rise to fugitive dust). | Mandatory |

| Mitigation Measures | |
|---|---|
| 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. | Mandatory |
| **Operating vehicle/ machinery and sustainable travel** | |
| Ensure all vehicles and engine powered equipment comply with the legislative requirements of Singapore. | Mandatory |
| 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. | Mandatory |
| Where practicable, avoid the use of diesel- or petrol-powered generators and use mains electricity or battery powered equipment. | Mandatory |
| 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. | Mandatory |
| Produce a Construction Logistics Plan to manage the sustainable delivery of goods and materials. | Mandatory |
| **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. | Mandatory |
| Ensure an adequate water supply on the site for effective dust/ particulate matter suppression/ mitigation, using non-potable water where possible and appropriate. | Mandatory |
| Use enclosed chutes and conveyors and covered skips wherever possible. | Mandatory |
| Minimise drop heights from conveyors, loading shovels, hoppers, and other loading or handling equipment and use fine water sprays on such equipment wherever appropriate. | Mandatory |
| 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. | Mandatory |
| **Waste Management** | |
| Avoid burning of waste or other materials. | Mandatory |
| Where possible, horticultural waste should be upcycled as wood material for products.<br>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). | Mandatory |
| **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. This will reduce dust emission. In the air assessment it refers to reinstatement as a regrown area, it does not mean replanting same trees. It only refers to vegetation plantation which prevents erosion of soil to form dust. | Mandatory |
| 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. | Mandatory |
| Only remove the cover in intended working areas and not all at once. | Mandatory |
| **MITIGATION MEASURES FOR CONSTRUCTION** | |
| Avoid scabbling (roughening of concrete surfaces) if possible. | Recommended |

| Mitigation Measures | |
|---|---|
| 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. | Mandatory |
| 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. | Recommended |
| For smaller supplies of fine power materials ensure bags are sealed after use and stored appropriately to prevent dust. | Recommended |
| **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. | Mandatory |
| Avoid dry sweeping of large areas. | Mandatory |
| Ensure vehicles entering and leaving sites are covered to prevent escape of materials during transport. | Mandatory |
| Inspect on-site haul routes for integrity and instigate necessary repairs to the surface as soon as reasonably practicable. | Mandatory |
| Record all inspections of haul routes and any subsequent action in a site log book. | Mandatory |
| Install hard surfaced haul routes, which are regularly damped down with fixed or mobile sprinkler systems, or mobile water bowsers and regularly cleaned. | Mandatory |
| Implement a wheel washing system (with rumble grids to dislodge accumulated dust and mud prior to leaving the site where reasonably practicable). | Mandatory |
| 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. | Mandatory |
| Site access gates to be located at least 10 m from receptors where possible. | Mandatory |

The APCP shall 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 shall 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 shall 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 shall 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. The responsibilities of the SO are listed in Section 11.4.4; and

- The air pollution control plan shall 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.

### 9.8.2 Operational Phase

As discussed in Section 9.7.2, the potential impact significance due to increased traffic is considered to be **Minor**. No mitigation measures are required during operational phase.

## 9.9 Residual Impacts

### 9.9.1 Construction Phase

Residual Impact Assessment assumes that the mitigation measures within Section 9.8.1 are implemented within the construction footprint.

#### 9.9.1.1 Impact Assessment on Dust Emissions from Earthworks, Construction and Trackout

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 9-24 below.

**Table 9-24 Impacts of dust risk assessment (after mitigation)**

| Key Parameter - Earthworks | | | Impact Assessment | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Total Site Area ($m^2$) | No. of Vehicles Moving Within the Site | Total Material Moved (tonnes) | 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 |
| >10,000 | 5-10 | 20,000-100,000 | High | Priority 1 | Priority 2 | High | Medium | Rare | **Minor** | **Minor** |
| **Key Parameter - Construction** | | | **Impact Assessment** | | | | | | | |
| Total Building Volume ($m^3$) | 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 |
| 25,000-100,000 | Potentially dusty (e.g., concrete) | 0 | Medium | Priority 1 | Priority 2 | Medium | Medium | Rare | **Minor** | **Minor** |
| **Key Parameter - Trackout** | | | **Impact Assessment** | | | | | | | |
| No. of Outward Trucks Movement Per Day | 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 |
| 10-50 | Less to moderately dusty | 0 | Medium | Priority 2 | Priority 1 | Low | Medium | Rare | **Minor** | **Minor** |

Note:

1. The HDVs are expected to travel along the existing paved road along Woodlands Road for access to the Project site, hence an unpaved road length of 0 m (< 50 m) is considered in this air quality impact assessment.

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

With the implementation of mitigation measures outlined in Table 9-23, 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 12/5/2023Likelihood 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 9.7.1.2. The Impact Intensity, Impact Consequence and Impact Significance are outlined in Table 9-19.

**Table 9-25 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** |

### 9.9.2 Operational Phase

As discussed in Section 9.7.2, 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.

## 9.10 Cumulative Impacts from Other Concurrent Developments

It is known that construction activities are planned to occur in the vicinity of the Project as highlighted in Section 3.2.1. Hence, cumulative impacts from other relevant major concurrent development in the vicinity of the Project will be assessed and considered.

### 9.10.1 Construction Phase

There are three (3) nearby concurrent Projects:

- Nearby Future Development by Other Agency;
- NParks upcoming Bukit Panjang North PC; and
- NParks Rail Corridor North Enhancement Works.

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 HDB CCK N1.

### 9.10.2 Operational Phase

No cumulative impacts were considered during operational phase.

# 9.11 Summary of Key Findings

Air quality impacts from the construction and operation of the Project were assessed on air sensitive receptors (ASRs) within the Study Area. Primary baseline air quality monitoring was conducted for 1 week at each representative monitoring locations, i.e., AQ1 (9 – 16 September 2022), AQ2 (26 September – 3 October 2022), AQ3 (2 – 9 September 2022), AQ4 (26 September – 3 October 2022), and AQ5 (19 – 26 September 2022).The measured 24-hours average $PM_{10}$ concentration at all monitoring locations were well below the Long Term Singapore Ambient Air Quality Targets, however, the results of 24-hours average $PM_{2.5}$ at AQ1, AQ2 and AQ3 exceeded the Long Term SAAQT. The monitoring results trend is in line with the trend of secondary data, with a spike of 24-hours average $PM_{2.5}$ between 13 – 14 and 28 – 29 September 2022. Analysis of baseline results are detailed in Section 9.5.2.2.

Potential impacts to the neighbouring sensitive receptors during construction phase mainly include emissions from the heavy vehicular exhaust and dust emitted from the earthworks, construction and trackout activities. During the operational phase, emissions from vehicle exhaust due to increased traffic in the vicinity of the proposed development is identified as the predominant air emission source.

Air quality impact assessment for construction phase were undertaken in accordance with the *UK IAQM Guidance on the Assessment of Dust from Demolition and Construction*. Pursuant to which, 50 m and 350 m Study Area for ecological and human receptors respectively were considered for earthworks, construction and trackout activities. Dust generated during construction works can have adverse effects upon vegetation 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. For human receptors, the dust and gaseous emissions might cause respiratory problems and diseases in human health.

The results of the assessment show that unmitigated impacts are classified as **Moderate** to **Major** (for both ecological and human receptors) and have the potential to affect the receptors near the construction footprint unless mitigation measures are put in place (see Section 9.7 for assessment details). This is largely because of the large extent of the construction worksite located very close to the neighbouring sensitive receptors. This Report pulls together mitigation measures that can be implemented by the contractor as administrative or management measures, sourcing from best practice measures internationally, which are detailed Section 9.8, which when applied successfully, the significance of impacts is anticipated to be reduced to **Minor**, for both ecological and human receptors (see Section 9.9 for details). The key control and mitigation measures include but not limited to development and stringent implementation of air pollution control plan, dust control measures on site, site hoarding, planning of dust causing activities-location and timing, reinstating land upon completion of works amongst several others.

The construction contractor is recommended to prepare an air quality management plan incorporating a range of monitoring and mitigation measures in line with Section 9.8, Section 11.12 and Section 11.14.

**Table 9-26 Summary of air quality impact assessment**

| Potential Source of Impact | Impact Significance with Minimum Control | Key Mitigation Measures (if any) | Residual Impact Significance with Mitigation Measures (if required) |
|---|---|---|---|
| **Construction Phase** | | | |
| **Dust emissions generated by earthworks processes and construction of new structures, as well as from the transport of dust and dirt by dumper trucks (trackout)** | Moderate to Major | • Implement dust control measures e.g., dust screens, etc.<br>• Install hard surfaced haul routes.<br>• Only use cutting, grinding and sawing equipment with dust suppression water spray mechanisms.<br>• Erect hoarding around dusty activities and site boundary min. 1.8m height in line with BCA guideline.<br>• Impose and signpost maximum speed-limit of 25km/hr on paved roads and 15 km/hr on unpaved roads and work areas.<br>• No burning of waste allowed on site.<br>• Revegetate earthworks and exposed areas/ soil stockpiles. | Minor |
| **Gaseous emissions generated from equipment and vehicle exhausts, including the use of off-road diesel generators on-site** | Moderate | | Minor |
| **Operational Phase** | | | |
| **Gaseous and particulate emissions from vehicle exhaust due to the increased traffic** | Minor | - | Minor |

# 10 Airborne Noise

## 10.1 Introduction

This section details the assessment of airborne noise impacts arising from noise emissions of the construction and operational phases of the proposed development within the Choa Chu Kang N1 Project site to the identified ecological and human noise sensitive receptors (NSRs).

The Project site has been proposed for the siting of residential development located northwest of mainland Singapore. Noise arising from construction and operational activities associated with the proposed developments may be perceivable, especially to receptors in proximity and those having a direct line-of-sight to the noise sources.

## 10.2 Methodology and Assumptions

This section outlines the methodology and assumptions applied to noise impact assessment conducted for the construction and operational phases of the Project as defined in the Inception Stage [R-1].

### 10.2.1 Assessment Approach

As defined in the Inception Stage [R-1], impact assessment for noise emissions arising from the construction phase adopted both quantitative and qualitative approach, while a qualitative means of assessment were applied to determine the potential operational noise impacts.

The Study mapped out the impacts from noise generated during the construction and operational phases on the NSRs. Baseline airborne noise monitoring was carried out to establish the baseline airborne noise levels to develop the specific construction noise criteria for the Project to analyse the impacts on the NSRs.

#### 10.2.1.1 Construction Phase

A quantitative means of assessment were applied to determine the impacts of the predicted noise emissions experienced by identified NSRs in accordance with noise legislations outlined in *Environmental Protection and Management (Control of Noise at Construction Sites) Regulations, 2008* [R-33] (EPM, 2008). A semi-quantitative means of assessment were applied to determine the cumulative noise impacts accounting for potential noise emissions from other concurrent developments in proximity to the Project site where the supplement of information was available. Where quantifiable information are unavailable, a qualitative means of assessment for the other concurrent developments were applied.

Construction noise impacts were assessed and studied in detail in this Report following these key steps:

- Review baseline noise monitoring data, conduct and assess current baseline noise levels in the Airborne Noise Study Area (see Section 10.2.2);
- Identify and classify sensitivity of receptors surrounding the Project site within the Airborne Noise Study Area;
- Conduct noise impact assessment to quantitatively assess potential noise impacts arising from construction phase activities;
- Recommend minimum control and mitigation measures to be implemented; and
- Determine overall significance of residual noise impacts after implementation of mitigation measures.

#### 10.2.1.2 Operational Phase

A qualitative means of assessment were applied to determine the impacts of noise arising from the operational phase due to the lack of detailed information relating to air conditioning and mechanical ventilation (ACMV) systems and land traffic noise at the current design stage (see Section 10.2.2).

Referring to Section 10.2.5, it is mandatory that the proposed developments within the Project site comply with the *NEA Technical Guideline on Boundary Noise Limits for Air Conditioning and Mechanical Ventilation Systems in*

*Non-Industrial Buildings, 2018* [R-38] (ACMV Guidelines, 2018) and *NEA Technical Guideline for Land Traffic Noise Impact Assessment, 2016* [R-37] (TNIA Guidelines, 2016).

Usually conducted by appointed Noise Consultant(s) during the development stage, AECOM recommends for ACMV boundary and land traffic noise impact assessment to be conducted at the later stages of development in accordance with the respective NEA guidelines.

## 10.2.2 Study Area

### 10.2.2.1 Construction Phase

The Airborne Noise Study Area, was recommended as 150 m from the proposed construction worksites, was established in accordance with EPM, 2008 [R-33] to identify the human NSRs potentially impacted by the construction noise emissions.

The assessment of the airborne noise impacts on ecological NSRs considered the Biodiversity Study Area, which is a subset of the noise study area for humans, demarcated by the Rail Corridor and Pang Sua Canal, suitable in supporting the presence of fauna. Other areas such as the construction worksites, urbanized residential/ commercial/ industrial sites abutting the Rail Corridor, not suitable in supporting the present of fauna have been deemed as “Not Assessable Areas” pertaining to the assessment of construction noise impacts in ecological NSRs.

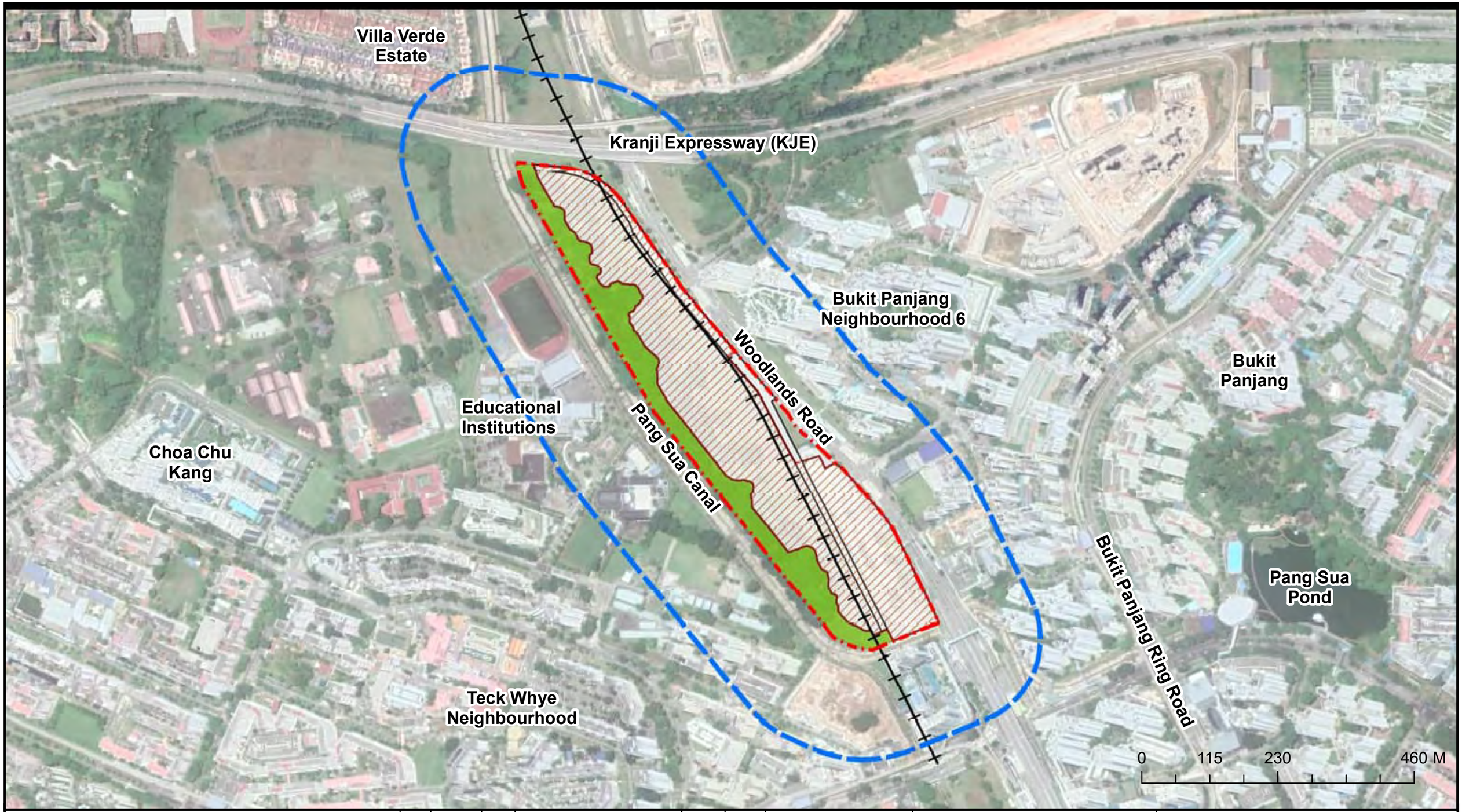
It should be noted the proposed construction worksites are subjected to changes in accordance with the associated construction stage and required footprint (e.g., demolition, site clearance, etc.). As such, the Airborne Noise Study Area will also change in congruence with the relevant worksite footprint being assessed. Figure 10-1 presents the Airborne Noise Study Area. Refer to Section 10.2.6.1 for details on the construction stages selected for assessment in this study.

### 10.2.2.2 Operational Phase

The Study Area for the assessment of impacts arising from activities associated with the operational phase is contributed by two (2) elements – noise from air conditioning and mechanical (ACMV) systems for non-industrial buildings within the Project site, and vehicular noise from traffic networks within the Project site (i.e., Proposed Road)/ increased traffic volumes of existing traffic networks near the Project site (e.g., Woodlands Road, KJE).

Specifically for operational noise arising from ACMV systems, the Study Area looks into impacts on human receptors at the immediate boundary of the operational footprint as defined by the ACMV Guidelines, 2018 [R-38]. While for operational noise arising from vehicular noise on new/ existing traffic networks, the Study Area was recommended by the TNIA Guidelines, 2016 [R-37] as 70 m from the land traffic noise sources to the ecological and human receptors.

It should be noted that at the current design stage, the proposed developments within the Project site shall comprise only of residential developments as established in Section 3.3. Consequential to the proposed residential developments, the Project site will observe an associated increase with human activity for vehicular traffic movement to the area upon commencement of operations. This may result in traffic noise impacts on existing residential and noise sensitive premises within proximity to the Project site. However, due to the lack of detailed design information required for the assessment of operational noise impacts relating to land traffic noise and possible ACMV systems (refer to the respective guidelines for the requirements), the Study Area for operational noise impact assessment has hence been omitted in this Report and shall be defined at the detailed design stage by Noise Consultant(s) appointed by HDB/ the contractor contracted by HDB to procure an accurate understanding of the Study Area for operational noise impact assessment.




**Legend**

- CCK N1 Project Site
- Airborne Noise Study Area (150m)
- Rail Corridor
- Proposed Construction Footprint
- Proposed Development Boundary
- Linear Green (to be preserved)

N

| Rev. | Date | By | Description | Chk'd | App'd |
|---|---|---|---|---|---|
| - | SEP 2022 | SYT | Draft Final Report | NHT | JAG |

Qualified Person Endorsement : NA

HDB Endorsement : NA

Consultant : AECOM

Client: HOUSING & DEVELOPMENT BOARD

Project Title :

**ENVIRONMENTAL IMPACT ASSESSMENT (EIA) ON CHOA CHU KANG N1**

Figure Title :

**Airborne Noise Study Area**

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Note: Source of basemap - Google Earth Map

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## 10.2.3 Baseline Airborne Noise Study

Baseline airborne noise study was conducted to establish the existing noise levels in the Airborne Noise Study Area (detailed in 10.2.2).

### 10.2.3.1 Desktop Research

Desktop research consists of a review of secondary data (including existing land use and development activities, satellite images, etc.) which aids in determining the baseline noise monitoring location. The information retrieved during the desktop research comprised of publicly available data from government and technical agencies, existing available data, relevant articles, and other online sources.

### 10.2.3.2 Field Survey and Assessment

As part of field survey and assessment, site reconnaissance was conducted on 20 December 2021 within the established 150 m Airborne Noise Study Area following the acceptance of the proposed baseline airborne noise monitoring locations at the Inception Stage by HDB [R-1]. Subsequently, baseline airborne noise monitoring was conducted at a total of six (6) locations to establish the existing noise levels within the Airborne Noise Study Area based on the following considerations:

- Identification of ecological and human NSRs (e.g., hospitals, schools, old age homes, residences, fauna, and habitats of high ecological value) within the Airborne Noise Study Area;
- Other NSRs beyond the Airborne Noise Study Area were excluded;
- NSRs near areas with on-going construction were avoided; and
- For high-rise residential human NSRs, monitoring was conducted at different floor heights (i.e., ground level, mid-level, top-level) to capture the terrain variation and its impact on noise levels where accessible.

Noise monitoring was conducted for one (1) week (inclusive of weekdays and weekends) to capture baseline noise levels over time periods of 12 hours (long term), 1 hour, 15 minutes, and 5 minutes (short term) at each of these locations. The NEA-approved Norsonic 131 Type 1 Sound Level Meter (SLM) was used to record the noise levels during the time periods. The baseline airborne noise monitoring locations are detailed in Table 10-1 and presented in Figure 10-2 with the methods and results detailed in a separate Baseline Noise Monitoring Report (Appendix V).

As observed in Table 10-1, baseline noise monitoring was conducted at each of the locations to capture the ambient noise conditions experienced by ecological and human receptors in its vicinity. This information will be used in the later sections to deduce the respective noise criteria applicable as part of noise impact assessment for this EIA.

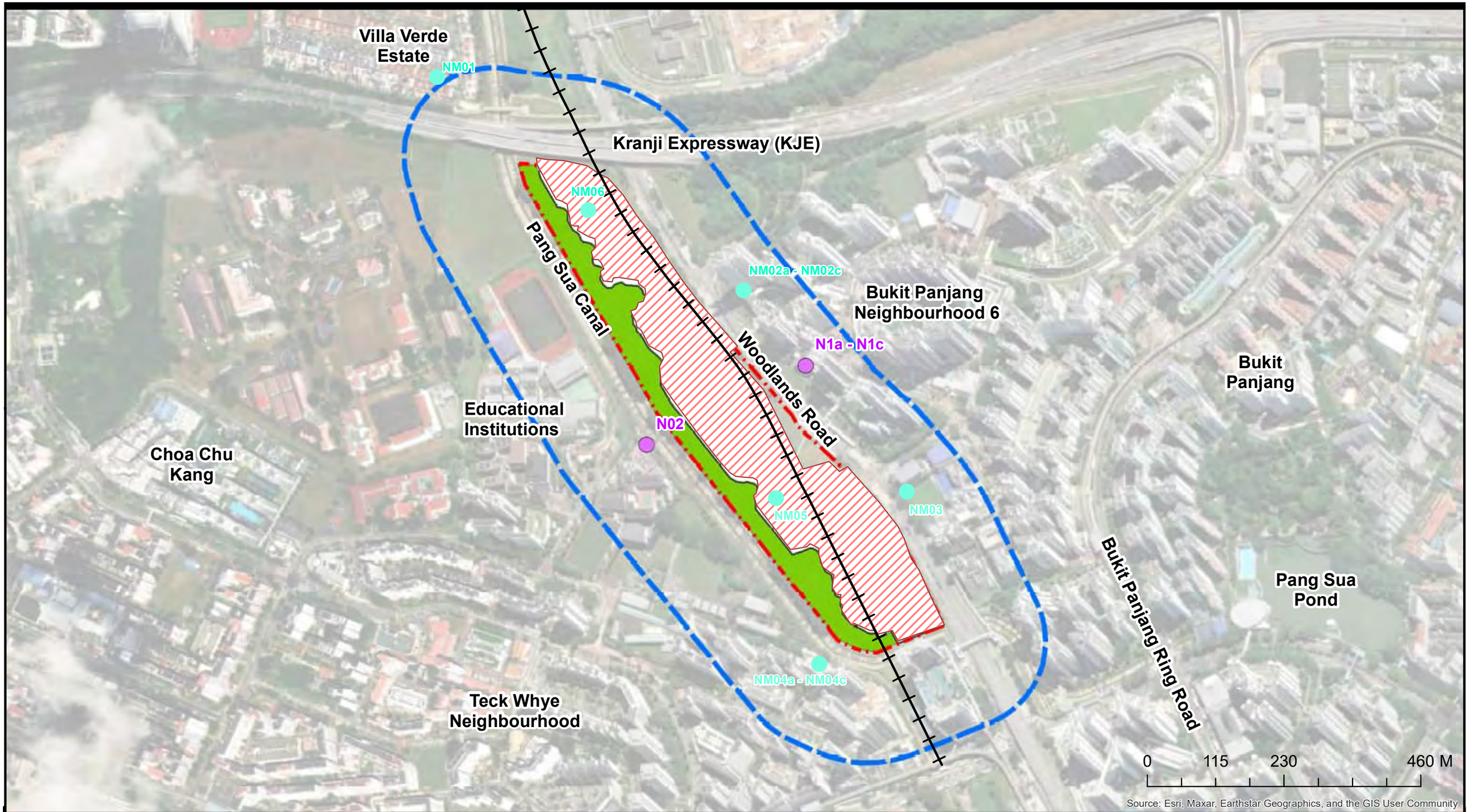
**Table 10-1 Airborne noise baseline monitoring locations**

| S/N | Monitoring Location | Justification | Photo of Monitoring Location |
|---|---|---|---|
| **NM01** | Villa Verde Estate | Representative baseline noise monitoring location for low-rise private residences north of the Study Area.<br><br>The baseline noise level is dominated by traffic noise from Yew Tee Flyover and Kranji Expressway (KJE). |  |

| S/N | Monitoring Location | Justification | Photo of Monitoring Location |
|---|---|---|---|
| **NM02a** | HDB Block 635A Senja Road:<br>• NM02a – Ground Level | Representative baseline noise monitoring location for high-rise residences north-west of the Study Area.<br><br>The baseline noise level is dominated by traffic noise from Woodlands Road and Kranji Expressway (KJE). |  |
| **NM02b** | HDB Block 635A Senja Road:<br>• NM02b – Level 15 | Representative baseline noise monitoring location for high-rise residences north-west of the Study Area.<br><br>The baseline noise level is dominated by traffic noise from Woodlands Road and Kranji Expressway (KJE). |  |
| **NM02c** | HDB Block 635A Senja Road:<br>• NM02c – Level 34 | Representative baseline noise monitoring location for high-rise residences north-west of the Study Area.<br><br>The baseline noise level is dominated by traffic noise from Woodlands Road and Kranji Expressway (KJE). |  |

| S/N | Monitoring Location | Justification | Photo of Monitoring Location |
|---|---|---|---|
| **NM03** | West View Primary School | Representative baseline noise monitoring location for establishments such as West View Primary School, Senja Care Home, south-east of the Study Area.<br><br>The baseline noise level is dominated by traffic noise from Woodlands Road, Bukit Panjang Flyover, and Senja Way. |  |
| **NM04a** | HDB Block 162 Jalan Teck Whye:<br>• NM04a – Ground Level | Representative baseline noise monitoring location for high-rise residences, south-west of the Study Area.<br><br>The baseline noise level is dominated by traffic noise from Woodlands Road. |  |
| **NM04b** | HDB Block 162 Jalan Teck Whye:<br>• NM04b – Level 7 | Representative baseline noise monitoring location for high-rise residences, south-west of the Study Area.<br><br>The baseline noise level is dominated by traffic noise from Woodlands Road. |  |

| S/N | Monitoring Location | Justification | Photo of Monitoring Location |
|---|---|---|---|
| **NM04c** | HDB Block 162 Jalan Teck Whye:<br>• NM04c – Level 13 | Representative baseline noise monitoring location for high-rise residences, south-west of the Study Area.<br><br>The baseline noise level is dominated by traffic noise from Woodlands Road. |  |
| **NM05** | Green Area within Study Area (Northern) | Representative baseline noise monitoring location for Green Area within the Study Area (Northern).<br><br>The selected location represents the internal environment within the Study Area (Northern).<br><br>The baseline noise level is dominated by traffic noise from Yew Tee Flyover and Kranji Expressway (KJE). |  |
| **NM06** | Green Area within Study Area (Southern) | Representative baseline noise monitoring location for Green Area within the Study Area (Southern).<br><br>The selected location represents the internal environment within the Study Area (Southern). |  |




**Legend**

- CCK N1 Project Site
- Airborne Noise Study Area (150m)
- Original Track Alignment
- Proposed Construction Footprint*
- Proposed Development Boundary*
- Proposed Ecological Corridor*

**Primary Data**

- HDB's Noise Monitoring Locations

**Secondary Data**

- LTA's Noise Monitoring Locations

* exact boundaries/ alignment subject to further changes

N

| Rev. | Date | By | Description | Chk'd | App'd |
|---|---|---|---|---|---|
| - | SEP 2022 | SYT | Draft Final Report | NHT | JAG |

Qualified Person Endorsement : NA

HDB Endorsement : NA

Consultant : AECOM

Client: HOUSING & DEVELOPMENT BOARD

Project Title :

**ENVIRONMENTAL IMPACT ASSESSMENT (EIA) ON CHOA CHU KANG N1**

Figure Title :

**Baseline Airborne Noise Monitoring Locations**

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## 10.2.4 Classification of Noise Sensitive Receptors

The classification of both ecological and human receptors described as follows and visualized respectively in Figure 10-3 and Figure 10-4 of Section 10.4. Further discussion on the identification of the NSRs are detailed in Section 10.4.

### 10.2.4.1 Ecological Receptors

Based on the assessment methodology presented in Table 6-1, the classification of ecological receptors is deduced based on the auditory sensitivities of the respective fauna species as reflected below:

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

The classification of auditory sensitivities of the ecological receptors are applicable for both the construction and operational phases and shall be further discussed in Section 10.4.1.1.

### 10.2.4.2 Human Receptors

#### 10.2.4.2.1 Construction Phase

Based on the assessment methodology detailed in Table 6-1, there are three (3) classifications of human NSRs (i.e., Priority 1, Priority 2, Priority 3) which relates to the nature of the establishment as reflected in the following:

- Priority 1 – Schools and Education Buildings, Hospitals and Medical Centres, Nursing Homes, Religious Buildings;
- Priority 2 – Residential Buildings; and
- Priority 3 – Other Buildings (Industrial, Commercial, Infrastructure, Sport & Recreation Areas, etc.)

The classification of auditory sensitivities of the human receptors shall be further discussed in Section 10.4.1.2.

#### 10.2.4.2.2 Operational Phase

Human receptors subjected to potential impacts from noise associated with the operational phase are classified respective to the type of noise emissions.

Human receptors subjected to operational noise from ACMV systems of non-industrial buildings are defined as establishments at the immediate boundary of the non-industrial building with the classifications relating to the type of establishment, similar to that of the construction phase (refer to Section 10.2.4.2.1).

The human receptors subjected to vehicular noise on new/ existing traffic networks are defined as residential and noise sensitive receptors within 70 m from the traffic source.

The classification of auditory sensitivities of the human receptors shall be further discussed in Section 10.4.2.2.

# 10.2.5 Assessment Criteria

## 10.2.5.1 Airborne Noise Impact Assessment Criteria

This section details the quantitative noise assessment criteria extracted from the respective noise legislations/ guidelines relevant to the assessment of noise impacts associated with the construction and operational phases.

As defined in Section 10.2.1, noise arising from the construction phase will partly be assessed quantitively, while operational noise emissions will only be assessed qualitatively due to the lack of detailed design information. As such, information presented in this EIA pertaining to quantifications of findings/ noise impacts for the operational phase shall only serve as reference to gauge the potential operational noise impacts experienced by the identified NSRs within the Project site, with the assessment addressed qualitatively.

It should be noted that as mandated by law, Noise Consultant(s) appointed by HDB/ the contractor engaged by HDB shall conduct operational noise impact assessment in accordance with the respective NEA guidelines (refer to Section 10.2.1.2) at the later stages of development.

### 10.2.5.1.1 Construction Phase

#### *10.2.5.1.1.1 Ecological Receptors*

The airborne noise impacts on the ecological receptors are species-dependent. Species which are noise sensitive are those that use noise, for example for their communication or navigation, at certain times of the day. Construction and noisy activities during periods where fauna are active can result in interference to their day-to-day activities. As such, the assessment would be based on the species identified during faunal surveys conducted within the Airborne Noise Study Area, aligned with the Biodiversity study in Section 7.

Due to the absence of adequate research data on criterions applicable for the assessment of construction noise impacts on ecological receptors, with no current existing established guidelines or standards, a more-stringent criterion of no-worse-off than the average of baseline was adopted for the purpose of assessment in this EIA.

It should be noted that while there exist assessment criterions for construction noise impacts on human receptors, the more-stringent baseline noise monitoring results were chosen as a basis of comparison for ecological receptors as fauna species face a direct form of impact, given that the previously undisturbed habitat they reside in are directly impacted by the human disturbances in the form of construction activities and noise emissions. Therefore, it is not advisable to adopt a similar assessment criterion to human receptors as they operate in a different nature.

Furthermore, akin to the correction factor used to deduce the corrected noise criteria for human receptors discussed in the section below adjustments will be made to the predicted noise levels for ecological receptors to account for existing average baseline noise levels.

#### *10.2.5.1.1.2 Human Receptors*

Specific construction noise criteria for the construction phase were developed with the baseline noise levels detailed in Section 10.5.2 included in the calculation to derive a background noise correction factor to establish the adjusted maximum permissible construction noise levels in accordance with the EPM, 2008 [R-33].

It should be noted that airborne noise impacts will only occur from above-ground construction worksites. The legislative requirements for environmental noise arising from construction activities in Singapore contains three (3) parts which specifies the applicable noise criteria for construction sites over different time periods. The corresponding permissible noise criteria have been extracted from EPM, 2008 [R-33] and presented in Table 10-2 to Table 10-4 for different time periods.

They are reflected in the order as follows:

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

**Table 10-2 Maximum permissible noise levels for construction works over a period of 12 hours**

| Types of Affected Buildings | Days of the Week | Maximum Permissible $L_{Aeq(12\ hrs)}$, 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 150m from the construction site where noise is being emitted | All days | 75 | – |
| (c) Buildings (Other than those in (a) and (b)) | All days | 75 | 65 |

**Table 10-3 Maximum permissible noise levels for construction works over a period of 1 hour**

| Types of Affected Buildings | Days of the Week | Maximum Permissible $L_{Aeq(1\ hr)}$, dB | |
|---|---|---|---|
| | | 7pm – 10pm | 10pm – 7am |
| Residential buildings located less than 150m from the construction site where noise is being emitted | Monday – Saturday | 65 | 55 |

**Table 10-4 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 150m from the construction site where noise is being emitted | Monday – Saturday | 90 | 70 | 55 |
| | Sundays and Public Holidays | 75 | 55 | 55 |
| (c) Buildings (Other than those in (a) and (b)) | All days | 90 | 70 | 70 |

As per the legislation, if there exist 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 adjustment 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 noise levels and the background noise levels as presented in Table 10-5. The difference in noise levels is then added to the higher of the two (2) noise levels (i.e., maximum permissible noise criteria/ background noise level) to deduce the applicable noise criteria for the specified construction area.

**Table 10-5 Construction noise correction factor**

| Difference between Permissible and Background Noise Levels, dB(A) | Correction Factor to be added to the Higher of the Two (2) Noise Levels, dB(A) |
|---|---|
| Below 2 | 3 |
| 2 to 4 | 2 |
| 4 to 10 | 1 |
| 10 and above | NIL |

The corrected construction noise criteria will be presented and further elaborated in Section 10.5.2.3.

#### 10.2.5.1.2 Operational Phase

##### *10.2.5.1.2.1 Ecological Receptors*

As discussed in Section 10.2.5.1.1.1, airborne noise impacts on ecological receptors are species-dependent. Given that the habitat fauna receptors reside in are directly impacted by noise from operational activities in the vicinity, it is therefore not advisable to adopt a similar assessment criterion to human receptors as they operate in a different nature. Therefore, ecological receptors considered for operational noise impact assessment shall adopt a similar approach to that detailed for the construction phase (refer to Section 10.2.5.1.1.1) and be assessed against the more-stringent criterion of no-worse-off than the average of baseline.

It should be noted that information presented relating to quantifications of findings/ noise impacts for the operational phase shall only serve as reference to gauge the potential operational noise impacts experienced by the identified NSRs within the Project site (refer to Section 10.2.5.1). The relevant operational baseline noise criterion shall be defined by Noise Consultant(s) appointed by HDB/ the contractor contracted by HDB as part of operational noise impact assessment at the detailed design stage in accordance with the respective NEA guidelines.

##### *10.2.5.1.2.2 Human Receptors*

For airborne noise arising from the operational phase, there exists two (2) aspects of impact for consideration (refer to Section 10.2.1.2):

1. Operation of ACMV systems for non-industrial buildings within the Project site; and
2. Vehicular noise on new/ existing traffic networks within/ near the Project site.

###### *10.2.5.1.2.2.1 Air Conditioning and Mechanical Ventilation Boundary Noise Limits*

According to the ACMV Guideline, 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.

The boundary noise limits for ACMV systems have been extracted from the ACMV Guideline, 2018 [R-38] and outlined in Table 10-6 below.

**Table 10-6 NEA boundary noise limits**

| Type of Affected Premises | Boundary Noise Limits (reckoned as the equivalent continuous level over 15 minutes), dB(A) | | |
|---|---|---|---|
| | Day 7am-7pm | Evening 7pm-11pm | Night 11pm-7am |
| Noise Sensitive Premises (e.g., hospital, home for the aged sick, library) | 60 | 55 | 50 |
| Residential Premises | 65 | 60 | 55 |
| Others | 70 | 65 | 60 |

As part of the requirements of operational noise impact assessment mandated by NEA, baseline noise results captured during noise monitoring shall be used to derive the operational noise criteria for noise impacts over a continuous period of 15 minutes. However, it should be noted that at the current design stage, the proposed developments within the Project site shall comprise only of residential developments. Due to the lack of detailed design information required for the assessment of operational noise impacts relating to possible ACMV systems, the Study Area for operational noise impact assessment has hence been omitted in this Report and shall be defined at the detailed design stage by Noise Consultant(s) appointed by HDB/ the contractor contracted by HDB to procure an accurate understanding of the Study Area for operational noise impact assessment.

Hence, the baseline noise results recorded for $L_{Aeq(15\ mins)}$ reflected in Section 10.5.2.3.2 shall only serve to reflect the indicative operational baseline noise conditions experienced by the identified NSRs within the Project site. As such, to deduce the adjusted permissible boundary noise criteria, Noise Consultant(s) appointed by HDB/ the contractor contracted by HDB shall conduct operational noise impact assessment in accordance with the respective NEA guidelines (refer to Section 10.2.1.2) once the non-industrial buildings and associated ACMV systems are laid at the detailed design stage. Hence, the operational noise criteria have been omitted from in this EIA.

According to the guideline:

> *"Where a noise source contains certain characteristics such as tonality, impulsiveness, intermittency, irregularity or dominant low frequency content, there is evidence to suggest that it can cause greater annoyance than other noise at the same level and a penalty of 5 dB (A) shall be added for each of the following characteristics, up to a maximum to 10 dB (A)."*

Hence, noise correction factors shall be applied to the baseline noise results to determine the operational noise criteria for the Project. The maximum permissible noise levels for the Project shall be deduced and adjusted by the correction factor reflected in Table 10-7 below to account for the existing noise levels measured at defined boundaries of the non-industrial buildings at the detailed design stage, by the appointed Noise Consultant(s).

The correction factor corresponds to the difference between maximum permitted noise levels (see Table 10-7)and the baseline noise levels (see Section 10.5.2), to the higher of the two (2) noise levels. The adjusted value for the maximum permissible noise limit (i.e., the operational noise criteria), shall be determined through the addition of the correction factor to the baseline noise results. This shall too be conducted by the appointed Noise Consultant(s) at a later stage as mandated by law.

**Table 10-7 ACMV noise correction factor**

| Difference between Permissible and Background Noise Levels, dB(A) | Correction Factor to be added to the Higher of the Two (2) Noise Levels, dB(A) |
|---|---|
| Below 2 | 3 |
| 2 to 4 | 2 |
| 4 to 10 | 1 |
| 10 and above | NIL |

*10.2.5.1.2.2.2 Land Traffic Noise*

The TNIA Guideline, 2016 [R-37] provides guidance to conduct 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 shall be assessed against the TNIA Guideline, 2016 [R-37] for operational noise arising from vehicular noise on new/ existing traffic networks within/ near the Project site. The noise levels of the new residential and noise sensitive development shall comply with the following NEA noise requirements from the TNIA Guideline, 2016 [R-37] presented as follows:

- The noise levels at 1m 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.

This Traffic Noise Impact Assessment (TNIA) is typically conducted by Noise Consultant(s) appointed by HDB/ the contractor contracted by HDB for the proposed residential and noise sensitive buildings of the Project at the detailed design stage and have hence been omitted in this Report.

## 10.2.6 Prediction and Evaluation of Impact Assessment

This section details the impact assessment methodologies applied as part of airborne noise impact assessment which includes the prediction and evaluation of construction and operational noise impacts on the respective noise sensitive ecological and human receptors.

### 10.2.6.1 Construction Phase

#### 10.2.6.1.1 Determination of Assessment Scenario

As reflected in Section 10.3.1, a total of six (6) construction stages: Stage 1 – Site Preparation for Earthworks; Stage 2 – Foundation Work; Stage 3 – Superstructure; Stage 4 – Landscape Works; and Stage 5 – Removal of temporary works and re-instatement, were proposed for the development within the Project site.

The effective sound power level (SWLs) of each of the construction stages (see Table 10-9) were calculated based on the list of powered mechanical equipment (PMEs) provided by HDB (see Appendix W). The study of noise impacts on the NSRs due to noise emissions arising from the construction phase will focus on the following two (2) worst case scenarios:

- Scenario 1: Site Preparation for Earthworks; and
- Scenario 2: Foundation Works.

Scenario 1: Site Preparation for Earthworks was established to determine the noise impacts arising from the construction phase during the clearance of site for the proposed construction worksites involving the levelling of the topography to a working platform level. Thereafter, the worst-case noisiest scenario (i.e., Scenario 2: Foundation Works) was devised as a conservative means of assessment wherein the entire Project site was assumed to undergo a single phase at the same time (see Figure 10-1)) which may represent the worst potential peak time of construction phase instead of the entire duration as assessed in this Report.

As observed in Table 10-9, Scenario 2: Foundation Works was established as the worst-case noisiest scenario. The intent of establishing the worst-case scenario for assessment was to ensure that noise can be controlled by permanent features during the entire construction period (if deemed necessary).

It should be noted that in accordance with information provided by HDB on the construction work schedules, construction works are only proposed to occur within the time period of 8am – 6pm on Weekdays (i.e., no night-works, no works Weekends). As such, in accordance with the noise legislations detailed in EPM, 2008 [R-33], construction noise impact assessment will only be assessed for $L_{Aeq(12\ hrs)}$ and $L_{Aeq(5\ mins)}$ for the construction period of 7am – 7pm for Weekdays.

#### 10.2.6.1.2 Noise Prediction Methodology

The noise levels generated from the assessment scenarios for the construction phase shall be predicted through noise modelling using SoundPLAN ver. 8.2. Information on the effective SWL of the assessment scenarios, proposed development areas constituting as area sources, noise sensitive ecological and human receptors as receivers, and topography before and after site clearance were input into the noise model to determine the predicted noise levels experienced by the NSRs.

Where topography is not available, a flat terrain based non the nearest spot height from topographic survey will be taken within the Project site and Airborne Noise Study Area. The NSRs will then be assessed in accordance to the impact evaluation matrix in Section 6.4.3. Noise contours will be provided to the extent where topography is available. Based on the impact evaluation, mitigation to reduce airborne noise impacts will be recommended for the affected NSRs where necessary.

#### 10.2.6.1.3 Noise Impact Evaluation Methodology

As detailed in the assessment methodology (see Section 6.4.3), NSRs are first identified and classified by the nature of the receptors as reflected in Table 6-1. Then, Impact Intensity is determined by the magnitude of noise exceedances predicted as shown in Table 6-5. The magnitude of noise exceedances was predicted through noise modelling with SoundPLAN ver. 8.2.

For the assessment of construction noise impacts on ecological receptors, the recorded average baseline noise levels are added to predicted noise levels to account for pre-existing baseline conditions. Thereafter, the adjusted predicted noise levels were compared against the average baseline noise levels established as the no-worse-off than the average of baseline criterion for ecological receptors adopted in this EIA (refer to Section 10.2.5.1.1.1). Noise exceedances derived from this comparison will then be used to deduce Impact Intensity.

While for human receptors, noise impacts experienced by the receptors from the worst-case scenario were similarly predicted using SoundPLAN ver. 8.2. However, as the current baseline noise levels are already accounted for as part of corrected noise criterion where the maximum permissible noise levels are adjusted according to baseline noise levels, no further addition of baseline noise levels to predicted noise levels was conducted. The predicted noise levels experienced by human receptors were then compared to the corrected noise criteria adjusted using average baseline noise levels recorded near the human receptors where exceedance found would contribute to the deduction of Impact Intensity.

By considering both Impact Intensity and Receptor Sensitivity, Impact Consequence can be obtained as per the matrix in Table 6-6. Thereafter, Likelihood of the impact from the construction activities of this Project were calculated based on the percentage of the duration of the activity over the construction timeline at the worksite (e.g., an activity happening < 5% of the construction timeline at the worksite results in an Unlikely/ Remote Likelihood) as shown in Table 6-7. By relating both Impact Consequence and Likelihood of Occurrence, the Impact Significance of airborne noise impacts were predicted with the consideration of minimum control measures (see Section 10.6 below).

Further analysis and evaluation were then conducted to recommend additional mitigation measures (e.g., noise barriers, etc.) where necessary. At the end a monitoring plan was established and triggers for action determined so that the impacts can be controlled within acceptable limits or as low as reasonably practicable.

### 10.2.6.2 Operational Phase

Referring to Section 10.2.5.1.2, it is mandatory for the proposed developments to comply with NEA's guidelines for boundary noise impact assessment ACMV systems of non-industrial buildings and land traffic noise impact assessment from vehicular noise on new/ existing traffic networks proposed within the Project site.

Usually conducted by an appointed Noise Consultant during the development stage, AECOM recommends the works for ACMV boundary noise impact assessment and land traffic noise impact assessment to be conducted by the Noise Consultant(s) appointed by HDB/ the contractor contracted by HDB in the later stages of the development in accordance with NEA's ACMV Guidelines, 2018 [R-38] and TNIA Guidelines, 2016 [R-37].

## 10.3 Potential Sources of Airborne Noise Impact and Likelihood of Occurrence

### 10.3.1 Construction Phase

This section discusses on the equipment and activities which could potentially contribute to noise impacts during the construction phase of the Project. The main sources of noise will originate from the PMEs used for the construction stages. The PMEs and their respective SWLs used in this study are listed in the equipment inventory list provided in Appendix W.

Based on the construction programme proposed by HDB, there will be a total of five (5) construction stages starting with Stage 1: Site Preparation for Earthworks, followed by Stage 2: Foundation Works, Stage 3: Superstructure; Stage 4: Landscape Works; and Stage 5: Removal of temporary works and re-instatement. The summary of the proposed construction stages and their associated effective SWLs are reflected in Table 10-9 below with the detailed list of equipment inventory with corresponding SWLs found in Appendix W.

As discussed in Section 10.2.1.1, the construction phase is modelled as a result of construction activities proposed to occur within the Project site as per information provided by HDB. Scenario 1: Site Preparation for Earthworks and worst-case Scenario 2: Foundation Works were chosen respectively for assessment to determine the noise impacts arising from the construction phase during the clearance of site and based on the worst-case construction stage with the highest effective SWL as reflected in Table 10-10. The rationale behind deducing the worst-case scenario is under the assumption that if the construction stage with the highest SWL can be mitigated for instance with permanent fixtures such as noise barriers or other means proposed in Section 10.8, noise impacts from other construction stages/ activities with lower SWLs will also be addressed.

As observed in Table 10-10, Scenario 1: Site Preparation for Earthworks was established based on the associated construction stage – Stage 1: Site Preparation for Earthworks. Scenario 2: Foundation Works were established as the worst-case scenarios.

Hence, based on the effective SWLs generated from the proposed construction works in the Project site summarized in Table 10-9, the SWLs of the assessment scenarios applied for construction phase noise modelling are reflected in Table 10-10.

### 10.3.1.1 Likelihood of Occurrence of Impacts

The Likelihood of Occurrence of airborne noise impacts were determined based on the active duration of the proposed equipment provided by HDB in Appendix W over the daily working period (e.g., 7am – 7pm, 7pm – 10pm, 10pm – 7am), detailed as frequency of exposure in Table 10-8.

It should be noted that in accordance with information provided by HDB 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). This equates to a daily working period of 0.5 days (i.e., 12/ 24 hrs or 0.5/ 1 days).

The active duration of equipment over a continuous time period of 12 hours (for $L_{Aeq(12\ hrs)}$, dB(A)) was defined as 0.5 (i.e., active for 50% of the time over a continuous time period of 12 hours) based on information provided by HDB in Appendix W. While the active duration of equipment over a continuous time period of 5 minutes (for $L_{Aeq(5\ mins)}$, dB(A)) was defined as 1.0 (i.e., active for 100% of the time over a continuous time period of 5 minutes).

With reference to the active duration of equipment and a daily working period of 0.5 days, the frequency of exposure to construction noise impacts over a continuous time period of 12 hours for both Scenario 1: Site Preparation for Earthworks and Scenario 2: Foundation Works were determined as 0.25 (i.e., 25%). Similarly, when relating the active duration of equipment to the daily working period of 0.5 days, the frequency of exposure to construction noise impacts over a continuous time period of 5 minutes for both assessment scenarios were determined as 0.5 (i.e., 50%).

The frequency of exposure of 0.25 (for $L_{Aeq(12\ hrs)}$, dB(A)) and 0.5 (for $L_{Aeq(5\ mins)}$, dB(A)) corresponds to a Likelihood of Occurrence of 'Possible/ Occasional' and 'Likely/ Regular' respectively (see Table 6-7). In order to streamline the report, reference to the Likelihood of Occurrence of airborne noise impacts on both assessment scenarios will apply the terms 'Occasional' to refer to 'Possible/ Occasional', and 'Likely' when referring to 'Likely/ Regular'.

**Table 10-8 Likelihood evaluation for airborne noise impact assessment (construction phase)**

| Assessment Scenario(s) | $L_{Aeq}$, dB(A) | Frequency of Exposure | Likelihood of Occurrence |
|---|---|---|---|
| Scenario 1: Site Preparation for Earthworks | $L_{Aeq(12\ hrs)}$, dB(A) | • Daily working period over 24 hrs = 0.5<br>• Active duration of equipment = 0.5<br>• Frequency of exposure = 0.5 x 0.5 = 0.25 | Possible/ Occasional |
| | $L_{Aeq(5\ mins)}$, dB(A) | • Daily working period over 24 hrs = 1.0<br>• Active duration of equipment = 0.5<br>• Frequency of exposure = 1.0 x 0.5 = 0.5 | Likely/ Regular |
| | $L_{Aeq(12\ hrs)}$, dB(A) | • Daily working period over 24 hrs = 0.5<br>• Active duration of equipment = 0.5 | Possible/ Occasional |

| Assessment Scenario(s) | $L_{Aeq}$, dB(A) | Frequency of Exposure | Likelihood of Occurrence |
|---|---|---|---|
| Scenario 2: Foundation Works | | • Frequency of exposure = 0.5 x 0.5 = 0.25 | |
| | $L_{Aeq(5\ mins)}$, dB(A) | • Daily working period over 24 hrs = 1.0<br>• Active duration of equipment = 0.5<br>• Frequency of exposure = 1.0 x 0.5 = 0.5 | Likely/ Regular |
| *Note: The colours of the cells corresponds to that of the assessment matrices in Section 6.4.3.* | | | |

**Table 10-9 Effective sound power level**

| Construction Stages | Effective Sound Power Level (SWL), dB(A) from overall equipment inventory | |
|---|---|---|
| | $L_{Aeq(12\ hrs)}$ 7am-7pm | $L_{Aeq(5\ mins)}$ 7am-7pm |
| Site Preparation for Earthworks | 116 | 119 |
| Foundation Works | **123** | **126** |
| Superstructure | 115 | 118 |
| Landscape Works | 117 | 120 |
| Removal of temporary re-instatement | 117 | 120 |
| *Note: Applicable to both Northern and Southern parcels. In accordance with information provided by HDB on the construction work schedule proposed for this Project, construction works are only proposed to occur within the time period of 7am – 7pm for $L_{Aeq(12\ hrs)}$ and $L_{Aeq\ (5\ mins)}$ and only on Weekdays (i.e., no night-works, no works on Weekends).* | | |

**Table 10-10 Effective sound power level – noise model input**

| Scenario(s) | Effective Sound Power Level (SWL), dB(A) from overall equipment inventory | |
|---|---|---|
| | $L_{Aeq(12\ hrs)}$ 7am-7pm | $L_{Aeq(5\ mins)}$ 7am-7pm |
| **Scenario 1: Site Preparation for Earthworks** | | |
| Site Preparation for Earthworks | 116 | 119 |
| **Scenario 2: Foundation Works** | | |
| Foundation Works | 123 | 126 |

## 10.3.2 Operational Phase

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

- ACMV noise from services emitted from non-industrial buildings as part of the Project development; and
- Traffic noise due to increase in vehicular volume and road networks due to the development of the Project and in the vicinity of the Airborne Noise Study Area.

Operational noise arising from ACMV systems, if any, are expected to persist throughout the day, emitting from proposed non-industrial buildings depending on the nature of the eventual establishment. While land traffic noise emissions are expected to follow traffic trends, peaking during traffic peak hours. 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/ near the Project site such as potential impacts to affecting ecological foraging behaviour, and intra-species and inter-species communication.

It should be noted that at the current design stage, only preliminary parcellation to reflect the proposed developments within the Project site have been established. Due to the lack of detailed design information required for the assessment of operational noise impacts relating to ACMV systems and land traffic noise, the potential operational noise sources cannot be accurately defined in this EIA. As such, AECOM recommends that the potential sources of operational noise impacts be defined at the later detailed design stage by Noise Consultant(s) appointed by HDB/ the contractor contracted by HDB to procure an accurate understanding of the Study Area for operational noise impacts.

# 10.4 Identification of Airborne Noise Sensitive Receptors

The study focused on airborne noise impacts to the ecological and human NSRs within the Airborne Noise Study Area during the construction and operational phases of the Project. The classification of ecological NSRs was based on the area delimited by the presence of fauna species of Conservation Significance (CS)/ non-CS, their susceptibility to airborne noise impacts, and ability to move away from the area. While human NSRs were classified based on the type of establishments/ buildings.

The identified ecological receptors and human receptors are further discussed in Section 10.4.1.1 and Section 10.4.1.2 respectively.

## 10.4.1 Construction Phase

### 10.4.1.1 Ecological Receptors

As discussed in Section 10.2.2, the assessment of the airborne noise impacts on ecological NSRs shall consider the Biodiversity Study Area, demarcation the Rail Corridor and Pang Sua Canal, suitable in supporting the presence of fauna. Other areas such as the construction worksites, urbanized residential/commercial/industrial sites abutting the Rail Corridor, not suitable in supporting the present of fauna have been deemed as “Not Assessable Areas” pertaining to the assessment of construction noise impacts in ecological NSRs (refer to Figure 10-3).

Based on faunistic field assessment conducted within these areas, fauna species of CS/non-CS sauna species that use sound for communication, foraging and breeding, and are known to have their behaviours disrupted by the increase in airborne noise levels with the ability to move away temporarily to neighbouring areas not impacted by construction noise were recorded within the Project site.

The prioritization of the ecological receptors within and surrounding the Airborne Noise 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 the Airborne Noise Study Area of the Project, a summary of the identified ecological receptors of concern in line with the biodiversity section are discussed below (refer to Section 10.4.1.1.1). Priority 2, and Priority 3 fauna species have been identified within the 150m Airborne Noise Study Area. Species of Conservation Significance (CS) were also recorded and identified within the Airborne Noise Study Area and listed in Table 10-5. A full detailed list of ecological receptors found within the Airborne Noise Study Area is provided in Appendix Y.

#### 10.4.1.1.1 Receptor Sensitivity to Airborne Noise

This section provides an insight to the fauna species identified within the Airborne Noise Study Area as part of faunistic field assessment. The list of receptor taxon and their associated literature review findings detailing response behaviour of identified fauna species to airborne noise are presented in Table 10-11 and Table 10-12 below respectively.

**Table 10-11 Receptor taxon of list of identified airborne noise sensitive fauna species**

| Terrestrial Fauna | Freshwater Fauna |
|---|---|
| • Aculeata<br>• Amphibian<br>• Bird<br>• Butterfly<br>• Non-volant Mammal<br>• Volant Mammal<br>• Odonate<br>• Reptile | • Fish |

| Terrestrial Fauna | Freshwater Fauna |
|---|---|
| *Note: A full detailed list of ecological receptors found within the Airborne Noise Study Area is provided in Appendix Y.* | |

**Table 10-12 Literature review of taxon of identified airborne noise sensitive fauna species**

| Receptor Taxon | Literature findings |
|---|---|
| **Aculeata** | Aculeata such as ants and bees have been studied considered highly sensitive to airborne noise as studies have demonstrated that anthropogenic noise |
| **Amphibian** | Amphibians such as frogs are considered to be highly sensitive to airborne noise as studies have demonstrated that anthropogenic noise is likely to substantially decrease the reproductive success in frogs [P-16]. |
| **Bird** | Birds are considered to be highly noise sensitive as most make use of sound for communication and breeding. Studies have also shown that birds are impacted negatively by anthropogenic noise [P-20]. |
| **Butterfly** | Lepidoptera such as the butterflies are known to behaviourally respond to low-frequency vibrations and sounds to avoid insect predators and parasites [P-21]. Adult butterflies are known to make use of existing airborne noise in order to avoid predators [P-22]. Hearing dependent night-flying butterflies and moths are sensitive to sounds in order to avoid predation from bats [P-48].<br>Hence, lepidopterans are considered highly sensitive to airborne noise. |
| **Non-volant Mammal** | 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-28]. Hence, non-volant mammals are deemed to be highly noise sensitive. |
| **Volant Mammal** | While for volant mammals such as bats, anthropogenic noise is known to impacts bats negatively by disrupting foraging patterns [P-27] and are hence classified as highly sensitive to airborne noise. |
| **Odonate** | It is documented that adult odonates appear to be able to hear however sound does not appear to cause significant behavioural change [P-23]. Hence, odonates are consequently regarded as being less sensitive to airborne noise. |
| **Reptile** | Reptiles such as lizards are considered to be highly noise sensitive due to studies showing these species exhibiting stress responses when exposed to anthropogenic noise [P-24]. 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-25]. Turtles on the other hand, follows the classification of aquatic species due to their ability to traverse land and water [P-26]. |

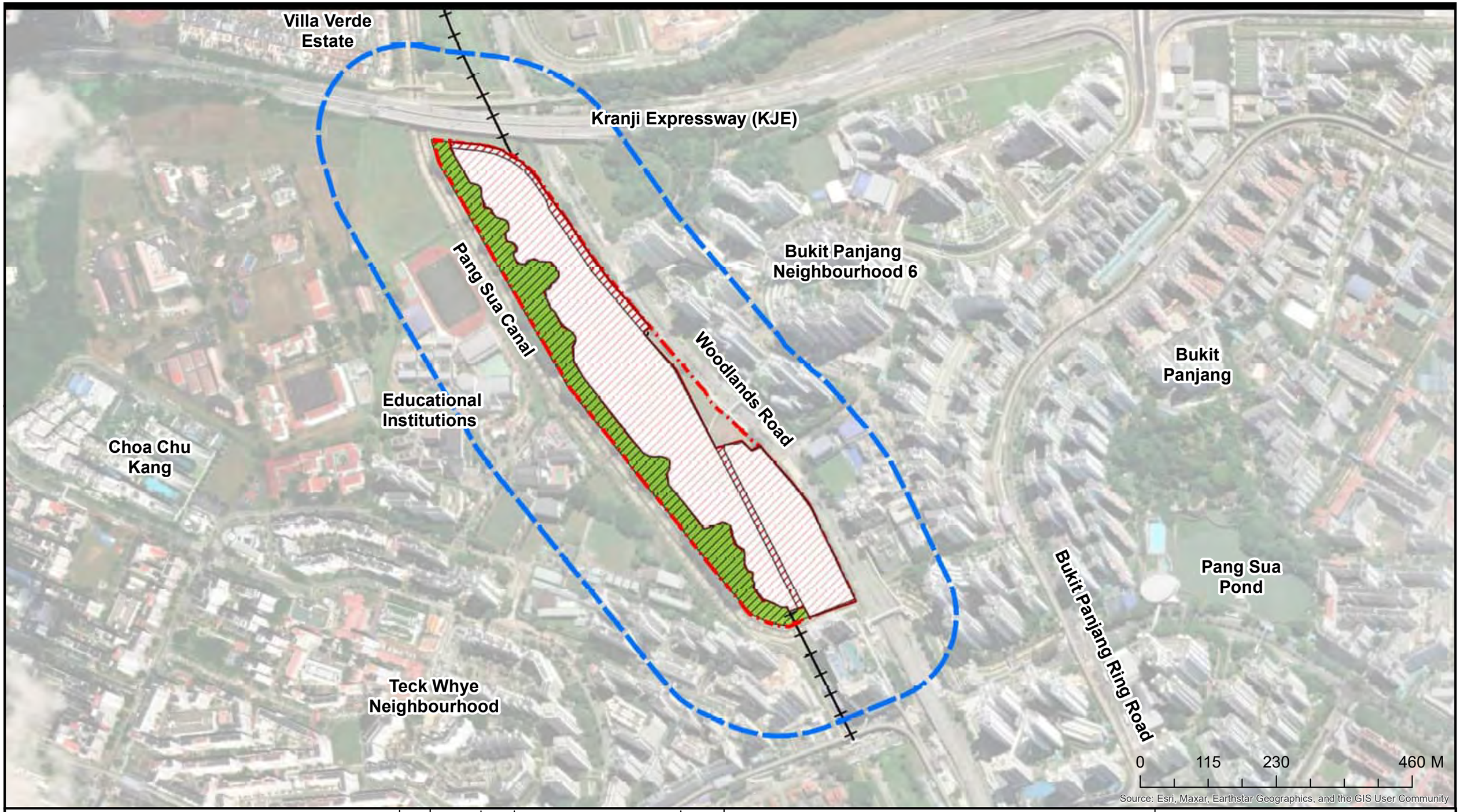
As noted, fauna species of Conservation Significance (CS) were recorded and identified within the Airborne Noise Study Area. A total of eleven (18) CS fauna species inclusive of eleven (11) species of birds, one (1) species of butterfly, three (3) species of non-volant mammal, and three (3) bat species were recorded as presented below in Table 10-13. A list of other probable but not recorded CS fauna species and recorded non-CS fauna species are provided in Appendix Y.

**Table 10-13 List of recorded Ecological Receptors of Conservation Significance (CS)**

| No. | Receptor Taxon | Species | Common Name | Global Status | Local Status |
|---|---|---|---|---|---|
| 1 | Bat | *Eonycteris spelaea* | Cave nectar bat | Least Concern | Vulnerable |
| 2 | Bat | *Tylonycteris fulvida* | Lesser bamboo bat | Least Concern | Vulnerable |
| 3 | Bat | *Tylonycteris malayana* | Greater bamboo bat | Least Concern | Vulnerable |
| 4 | Bird | *Ardea cinerea* | Asian glossy starling | Least Concern | Vulnerable |
| 5 | Bird | *Ardea purpurea* | Purple heron | Least Concern | Endangered |
| 6 | Bird | *Chrysococcyx xanthorhynchus* | Violet cuckoo | Least Concern | Endangered |
| 7 | Bird | *Copsychus saularis* | Oriental magpie-robin | Least Concern | Endangered |
| 8 | Bird | *Haliaeetus ichthyaetus* | Grey-headed fish eagle | Near Threatened | Critically Endangered |

| No. | Receptor Taxon | Species | Common Name | Global Status | Local Status |
|---|---|---|---|---|---|
| 9 | Bird | *Ketupa ketupu* | Buffy fish owl | Least Concern | Critically Endangered |
| 10 | Bird | *Nisaetus cirrhatus* | Changeable hawk-eagle | Least Concern | Endangered |
| 11 | Bird | *Nycticorax nycticorax* | Black-crowned night heron | Least Concern | Critically Endangered |
| 12 | Bird | *Psittacula longicauda* | Long-tailed parakeet | Vulnerable | Near Threatened |
| 13 | Bird | *Pycnonotus zeylanicus* | Straw-headed bulbul | Critically Endangered | Endangered |
| 14 | Bird | *Strix seloputo* | Spotted wood owl | Least Concern | Critically Endangered |
| 15 | Butterfly | *Pelopidas agna agna* | Bengal swift | Not Assessed | Endangered |
| 16 | Non-volant mammal | *Lutrogale perspicillata* | Smooth-coated otter | Vulnerable | Endangered |
| 17 | Non-volant mammal | *Macaca fascicularis* | Long-tailed macaque | Vulnerable | Least Concern |
| 18 | Non-volant mammal | *Manis javanica* | Sunda pangolin | Critically Endangered | Critically Endangered |

*Note: This table presents the list of recorded fauna species of Conservation Significance (CS)*
*A list of other probable but not recorded CS fauna species and recorded non-CS fauna species are provided in Appendix Y.*




**Legend**

- Proposed Development Boundary*
- Proposed Construction Footprint*
- CCK N1 Project Site
- Airborne Noise Study Area (150m)
- Original Track Alignment
- Proposed Ecological Corridor*

**Ecological Receptors**

- Priority 1

* exact boundaries/ alignment subject to further changes

N

| Rev. | Date | By | Description | Chk'd | App'd |
|---|---|---|---|---|---|
| - | SEP 2022 | SYT | Draft Final Report | NHT | JAG |

Qualified Person Endorsement : NA

HDB Endorsement : NA

Consultant : AECOM

Client: HOUSING & DEVELOPMENT BOARD

Project Title :

**ENVIRONMENTAL IMPACT ASSESSMENT (EIA) ON CHOA CHU KANG N1**

Figure Title :

**Airborne Noise - Ecological Noise Sensitive Receptors**

| Designed | Checked | Approved | Figure No. : | Rev. | Sheet |
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| SAG | NHT | JAG | 5 - 3 | - | 1 of 1 |
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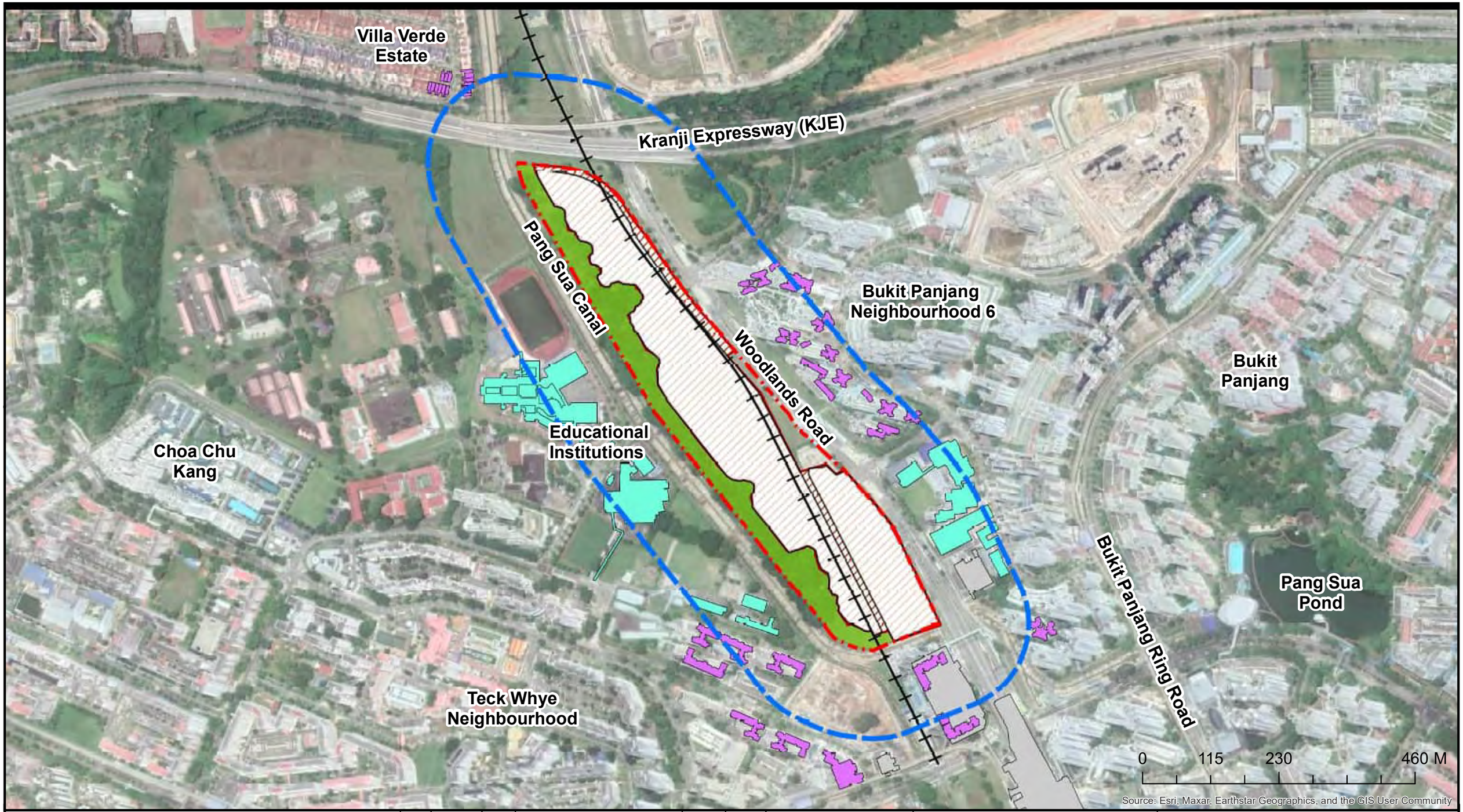
### 10.4.1.2 Human Receptors

According to EPM, 2008 [R-33], human receptors potentially impacted by noise associated with the construction phase were identified as establishments/ buildings within 150m from the proposed developments within the Project site, defined as the Airborne Noise Study Area (see Section 10.2.4.2) and analysed. The human NSRs identified for the construction phase are presented in Table 10-14 and Figure 10-4.

Information on the nearest SLM to the human receptors where records of baseline noise levels are deemed representative of the current environmental noise conditions experienced by the human receptors are also provided in Table 10-14. This association plays an important role in noise impact assessment as the baseline noise levels recorded at the different SLMs will result in differing noise criterions that human receptors will be assessed against as part of quantitative noise impact assessment.

**Table 10-14 Noise sensitive Human Receptors**

| No. | Noise Sensitive Receptors | Receptor Type | Receptor Sensitivity | Nearest SLM |
|---|---|---|---|---|
| 1 | Bukit Panjang Exchange | Commercial | Priority 3 | NM03 |
| 2 | DE142 Gali Batu Bus Depot Site Office | Commercial | Priority 3 | NM02a |
| 3 | HDB Block 162, 163, 164, Jalan Teck Whye | Residential | Priority 2 | NM04a – NM04c |
| 4 | HDB Block 606, 632A, 632B, 633, 633A, 633B, 633C, 633D, 634A, 634B, 634C, Senja Road | Residential | Priority 2 | N1a – N1c |
| 5 | HDB Block 635, 635A, 635B, Senja Road | Residential | Priority 2 | NM02a – NM02c |
| 6 | Junction 10 | Commercial | Priority 3 | NM03 |
| 7 | 38 Teck Whye Crescent | Commercial | Priority 3 | NM04a |
| 8 | 125, 127, 129, Verde View | Residential | Priority 2 | NM01 |
| 9 | Pacific Healthcare Nursing Home | Nursing Home | Priority 1 | NM03 |
| 10 | Pioneer Junior College | Educational Institution | Priority 1 | N02 |
| 11 | Senja Home, Vanguard Senior Care Senja Centre | Nursing Home | Priority 1 | NM03 |
| 12 | Senja Soka Centre | Place of Worship | Priority 1 | NM03 |
| 13 | Teck Whye Secondary School | Educational Institution | Priority 1 | N02 |
| 14 | The Tennery | Residential | Priority 2 | NM03 |
| 15 | West View Primary School | Educational Institution | Priority 1 | NM03 |




**Legend**

- CCK N1 Project Site
- Airborne Noise Study Area (150m)
- Original Track Alignment
- Proposed Construction Footprint*
- Proposed Development Boundary*
- Proposed Ecological Corridor*

**Human Receptors**

- Priority 1
- Priority 2
- Priority 3

N

| Rev. | Date | By | Description | Chk'd | App'd |
|---|---|---|---|---|---|
| - | SEP 2022 | SYT | Draft Final Report | NHT | JAG |

Qualified Person Endorsement : NA

HDB Endorsement : NA

Consultant : AECOM

Client: HOUSING & DEVELOPMENT BOARD

Project Title :

**ENVIRONMENTAL IMPACT ASSESSMENT (EIA) ON CHOA CHU KANG N1**

Figure Title :

**Airborne Noise - Human Noise Sensitive Receptors**

| Designed | Checked | Approved | Figure No. : | Rev. | Sheet |
|---|---|---|---|---|---|
| SAG | NHT | JAG | 10 - 4 | - | 1 of 1 |
| | Drawn SYT | Date SEP 2022 | CAD File Name : NA | | A3 |

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## 10.4.2 Operational Phase

### 10.4.2.1 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 10.4.1.1 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 site 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.

### 10.4.2.2 Human Receptors

Human receptors for the operational phase should be identified and assessed as part of operational noise impacts arising from noise associated with the ACMV systems of non-industrial buildings, and as part of TNIA for land traffic noise. Both elements should be conducted by Noise Consultant(s) engaged by HDB/ contractor engaged by HDB to conduct ACMV boundary noise impact assessment for the human receptors at the boundaries of the non-industrial buildings, as well as TNIA on nearby residential and noise sensitive receptors affected by vehicular noise on new/ existing traffic networks as per the guidelines discussed in Section 10.2.5.1.2.2.

Additionally, the contractors of the proposed developments should assess the noise impacts arising from Woodlands road and KJE if within audible range following the same guidelines to determine the potential noise impacts arising from the existing road networks on future residential and noise sensitive receptors to facilitate the planning of the developments within the Project site.

# 10.5 Baseline Airborne Noise

## 10.5.1 Baseline Monitoring Personnel

The assessment and site surveys were conducted by the following personnel:

- Ms. Jagriti Dawra, AECOM (EIA Technical Lead);
- Mr. Zay Phyo, AECOM (Noise Consultant); and
- Ms. Sim Yi Ting, AECOM (Noise Consultant).

To understand the ambient noise environment within the 150m Airborne Noise Study Area, baseline noise monitoring was conducted between the dates listed below with baseline noise levels captured for the purpose of developing the specific noise criteria applicable for the assessment of noise impacts arising from the construction and operational phases.

The baseline noise monitoring dates are as follow – 11 August – 17 August 2022; 29 August – 04 September 2022; and 09 September – 15 September 2022.

## 10.5.2 Baseline Monitoring Results

Baseline monitoring was conducted to understand the ambient noise levels at locations in proximity of the Airborne Noise Study Area for the purposes of developing the applicable corrected noise criterions.

### 10.5.2.1 Construction Phase

The overall baseline airborne noise monitoring results captured through Monday – Sunday/ Public Holidays at locations N1 – N6 for $L_{Aeq(12\ hrs)}$, $L_{Aeq(1\ hr)}$, and $L_{Aeq(5\ mins)}$ and on Weekdays (Monday – Saturday) and Weekends (Sunday/ Public Holidays) are summarized in Table 10-15 in accordance with local noise legislations for the construction phase.

Following describes the receptors corresponding to noise levels captured at the respective monitoring locations:

- NM01: Noise levels recorded at NM01 is primarily representative of noise levels experienced by human receptors residing at Villa Verde Estate;
- NM02a – NM02c: Noise levels recorded at NM02a – NM02c are representative of noise levels experienced by human receptors residing near Senja Gateway;
- NM03: Noise levels West View Primary School, nursing homes etc along Woodlands Road
- NM04a – NM04c: Noise levels captured at NM04a – NM04c are representative of human receptors residing near Teck Whye View;
- NM05 Noise levels recorded at NM05 is primarily representative of noise levels experienced by ecological receptors found traversing on CCK N1 (Northern); and
- NM06: Noise levels recorded at NM06 is primarily representative of noise levels experienced by ecological receptors found traversing on CCK N1 (Southern).

**Table 10-15 Summary of baseline noise monitoring results for construction noise impact assessment**

| Location | Monitoring Date | $L_{Aeq(12\ hrs)}$, dB(A) | | $L_{Aeq(1\ hr)}$, dB(A) | | | | | | $L_{Aeq(5\ mins)}$, dB(A) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 7am - 7pm | 7pm - 7am | 7pm-10pm | | | 10pm-7am | | | 7am-7pm | | | 7pm-10pm | | | 10pm-7am | | |
| | | | | Min | Max | Ave | Min | Max | Ave | Min | Max | Ave | Min | Max | Ave | Min | Max | Ave |
| **Overall (Monday – Sunday/ Public Holiday) – applicable to Ecological Receptors** | | | | | | | | | | | | | | | | | | |
| NM05: Green Area within Study Area (Northern) | 11 August – 17 August 2022 | 54 | 54 | 50 | 60 | 55 | 49 | 60 | 53 | 46 | 69 | 52 | 49 | 62 | 54 | 48 | 62 | 53 |
| NM06: Green Area within Study Area (Southern) | 09 September - 16 September 2022 | 60 | 60 | 59 | 62 | 61 | 53 | 69 | 58 | 57 | 70 | 60 | 59 | 68 | 60 | 52 | 71 | 58 |
| **Weekdays (Monday – Saturday) – applicable to Human Receptors** | | | | | | | | | | | | | | | | | | |
| NM01: Villa Verde Estate | 11 August – 17 August 2022 | 76 | 77 | 75 | 80 | 77 | 74 | 82 | 77 | 60 | 86 | 76 | 68 | 82 | 77 | 71 | 83 | 77 |
| NM02a: HDB Block 635A Sebja Road (Ground Level) | 29 August – 04 September 2022 | 76 | 77 | 75 | 80 | 77 | 74 | 82 | 77 | 60 | 86 | 76 | 68 | 82 | 77 | 71 | 83 | 77 |
| NM02b: HDB Block 635A Sebja Road (Level 15) | 29 August – 04 September 2022 | 68 | 65 | 66 | 68 | 67 | 59 | 67 | 63 | 65 | 72 | 67 | 65 | 68 | 67 | 57 | 71 | 63 |
| NM02c: HDB Block 635A Sebja Road (Level 34) | 29 August – 04 September 2022 | 68 | 65 | 66 | 68 | 67 | 59 | 68 | 63 | 59 | 72 | 68 | 66 | 69 | 67 | 58 | 71 | 63 |
| NM03: West View Primary School | 09 September - 16 September 2022 | 71 | 68 | 69 | 71 | 70 | 63 | 70 | 66 | 68 | 88 | 71 | 59 | 74 | 70 | 60 | 74 | 66 |
| NM04a: HDB Block 162 Jalan Teck Whye (Ground Level) | 09 September - 16 September 2022 | 59 | 56 | 51 | 59 | 55 | 49 | 62 | 55 | 48 | 74 | 55 | 49 | 61 | 54 | 47 | 67 | 54 |
| NM04b: HDB Block 162 Jalan Teck Whye (Level 7) | 09 September - 16 September 2022 | 57 | 54 | 54 | 61 | 55 | 50 | 58 | 52 | 53 | 76 | 57 | 53 | 71 | 55 | 49 | 68 | 52 |
| NM04c: HDB Block 162 Jalan Teck Whye (Level 13) | 09 September - 16 September 2022 | 58 | 55 | 56 | 59 | 57 | 51 | 56 | 53 | 55 | 68 | 58 | 55 | 67 | 56 | 50 | 58 | 53 |
| N01a: HDB Block 632A Senja Road – Ground Level | 8 November – 14 November 2021 | 66 | 62 | 63 | 67 | 64 | 55 | 64 | 60 | 60 | 73 | 65 | 62 | 67 | 64 | 51 | 66 | 60 |
| N01b: HDB Block 632A Senja Road – Mid-level | 8 November – 14 November 2021 | 67 | 64 | 65 | 68 | 66 | 58 | 66 | 62 | 63 | 76 | 68 | 64 | 69 | 66 | 54 | 68 | 62 |
| N01c: HDB Block 632A Senja Road – Top-level | 8 November – 14 November 2021 | 67 | 63 | 64 | 67 | 65 | 57 | 65 | 61 | 63 | 73 | 67 | 63 | 68 | 65 | 53 | 67 | 61 |

| Location | Monitoring Date | $L_{Aeq(12\ hrs)}$, dB(A) | | $L_{Aeq(1\ hr)}$, dB(A) | | | | | | $L_{Aeq(5\ mins)}$, dB(A) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 7am - 7pm | 7pm - 7am | 7pm-10pm | | | 10pm-7am | | | 7am-7pm | | | 7pm-10pm | | | 10pm-7am | | |
| | | | | Min | Max | Ave | Min | Max | Ave | Min | Max | Ave | Min | Max | Ave | Min | Max | Ave |
| N02: Near Teck Whye Secondary School, facing the Pang Sua Canal | 14 November –20 November 2021 | 52 | 49 | 49 | 52 | 51 | 46 | 51 | 48 | 47 | 64 | 51 | 48 | 58 | 51 | 45 | 53 | 48 |
| **Weekends (Sundays/ Public Holidays) – applicable to Human Receptors** | | | | | | | | | | | | | | | | | | |
| NM01: Villa Verde Estate | 11 August – 17 August 2022 | 76 | 74 | NIL | | | | | | 73 | 82 | 76 | 74 | 75 | 74 | 73 | 76 | 74 |
| NM02a: HDB Block 635A Sebja Road (Ground Level) | 29 August – 04 September 2022 | 76 | 74 | | | | | | | 73 | 82 | 76 | 74 | 75 | 74 | 73 | 76 | 74 |
| NM02b: HDB Block 635A Sebja Road (Level 15) | 29 August – 04 September 2022 | 67 | 64 | | | | | | | 63 | 71 | 66 | 65 | 67 | 66 | 58 | 67 | 62 |
| NM02c: HDB Block 635A Sebja Road (Level 34) | 29 August – 04 September 2022 | 67 | 64 | | | | | | | 65 | 72 | 67 | 66 | 67 | 66 | 58 | 67 | 63 |
| NM03: West View Primary School | 09 September - 16 September 2022 | 69 | 67 | | | | | | | 66 | 71 | 69 | 67 | 74 | 69 | 59 | 71 | 66 |
| NM04a: HDB Block 162 Jalan Teck Whye (Ground Level) | 09 September - 16 September 2022 | 52 | 53 | | | | | | | 48 | 58 | 51 | 49 | 55 | 53 | 49 | 56 | 53 |
| NM04b: HDB Block 162 Jalan Teck Whye (Level 7) | 09 September - 16 September 2022 | 54 | 53 | | | | | | | 51 | 60 | 54 | 53 | 57 | 54 | 49 | 58 | 53 |
| NM04c: HDB Block 162 Jalan Teck Whye (Level 13) | 09 September - 16 September 2022 | 55 | 54 | | | | | | | 53 | 57 | 55 | 54 | 58 | 55 | 49 | 59 | 53 |
| N01a: HDB Block 632A Senja Road – Ground Level | 8 November – 14 November 2021 | 63 | 60 | | | | | | | 61 | 65 | 63 | 60 | 64 | 63 | 52 | 64 | 58 |
| N01b: HDB Block 632A Senja Road – Mid-level | 8 November – 14 November 2021 | 65 | 63 | | | | | | | 63 | 68 | 65 | 63 | 66 | 65 | 53 | 66 | 61 |
| N01c: HDB Block 632A Senja Road – Top-level | 8 November – 14 November 2021 | 65 | 62 | | | | | | | 61 | 68 | 65 | 63 | 67 | 65 | 54 | 66 | 60 |
| N02: Near Teck Whye Secondary School, facing the Pang Sua Canal | 14 November –20 November 2021 | 52 | 48 | | | | | | | 48 | 64 | 51 | 48 | 51 | 50 | 45 | 52 | 49 |

*Note: In accordance with EPM, 2008 [R-33] is not assessed for Weekends and is hence indicated as NIL.*

*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 HDB in Appendix W.*

| Location | Monitoring Date | $L_{Aeq(12\ hrs)}$, dB(A) | | $L_{Aeq(1\ hr)}$, dB(A) | | | | | | | | | $L_{Aeq(5\ mins)}$, dB(A) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 7am - 7pm | 7pm - 7am | 7pm-10pm | | | 10pm-7am | | | 7am-7pm | | | 7pm-10pm | | | 10pm-7am | | |
| | | | | Min | Max | Ave | Min | Max | Ave | Min | Max | Ave | Min | Max | Ave | Min | Max | Ave |
| *Information of baseline noise levels measured at other timings (i.e., 7pm – 7am, 7pm – 10pm, 10pm – 7am) are for purposes of reference.*<br>*Night-works or works on Weekends will only be allowed if permission from relevant local agencies is sought and approved.* | | | | | | | | | | | | | | | | | | |

### 10.5.2.2 Operational Phase

The overall baseline airborne noise monitoring results recorded at locations NM01 – NM06 for $L_{Aeq(15\ mins)}$ are summarized in Table 10-16 below in accordance with the local noise guidelines for the operational phase. Please refer to Appendix V for the Baseline Airborne Noise Monitoring Report detailing the daily recorded noise levels.

It should be noted that the recorded $L_{Aeq(15\ mins)}$ noise levels for the operational phase are only indicative at this stage as baseline noise levels captured are not aligned with the requirements for operational noise impact assessment outline in the ACMV Guidelines, 2018 [R-38] and TNIA Guidelines, 2016 [R-37], due to the lack of information on building boundaries, building type, detailed information traffic volume of new/ existing traffic networks associated with the proposed developments of this Project.

Hence, to meet requirements mandated by law, AECOM recommends that HDB/ the contractor contracted by HDB appoint a Noise Consultant(s) upon finalising of design plans at the detailed design stage to determine the appropriate baseline noise levels for the operational phase in accordance with the respective NEA guidelines (refer to Section 10.2.1.2).

**Table 10-16 Summary of baseline noise monitoring results for operational noise impact assessment**

| Location | Monitoring Date | $L_{Aeq(15\ mins)}$, dB(A) Day 7am-7pm | | | Evening 7pm-11pm | | | Night 11pm-7am | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Max | Min | Ave | Max | Min | Ave | Max | Min | Ave |
| NM01: Villa Verde Estate | 11 August – 17 August 2022 | 60 | 85 | 76 | 73 | 82 | 76 | 73 | 82 | 77 |
| NM02a: HDB Block 635A Sebja Road (Ground Level) | 29 August – 04 September 2022 | 60 | 85 | 76 | 73 | 82 | 76 | 73 | 82 | 77 |
| NM02b: HDB Block 635A Sebja Road (Level 15) | 29 August – 04 September 2022 | 64 | 71 | 67 | 64 | 68 | 66 | 58 | 69 | 62 |
| NM02c: HDB Block 635A Sebja Road (Level 34) | 29 August – 04 September 2022 | 65 | 72 | 67 | 64 | 68 | 66 | 59 | 70 | 63 |
| NM03: West View Primary School | 09 September - 16 September 2022 | 68 | 84 | 71 | 67 | 72 | 69 | 61 | 73 | 66 |
| NM04a: HDB Block 162 Jalan Teck Whye (Ground Level) | 09 September - 16 September 2022 | 48 | 70 | 55 | 49 | 60 | 54 | 47 | 65 | 55 |
| NM04b: HDB Block 162 Jalan Teck Whye (Level 7) | 09 September - 16 September 2022 | 52 | 71 | 56 | 52 | 66 | 55 | 49 | 63 | 52 |
| NM04c: HDB Block 162 Jalan Teck Whye (Level 13) | 09 September - 16 September 2022 | 53 | 64 | 57 | 54 | 67 | 56 | 50 | 60 | 53 |
| NM05: Green Area within Study Area (Northern) | 11 August – 17 August 2022 | 48 | 66 | 52 | 50 | 60 | 55 | 48 | 60 | 52 |
| NM06: Green Area within Study Area (Southern) | 09 September - 16 September 2022 | 58 | 66 | 60 | 59 | 67 | 60 | 53 | 70 | 58 |

### 10.5.2.3 Corrected noise criteria

Based on the baseline airborne noise monitoring results and noise correction factor introduced in accordance to the adjusted maximum permissible noise levels detailed in Section 10.2.5.1, the corrected noise criteria for airborne noise impact assessment were deduced respectively for the ecological and human receptors in this section for the construction phase.

As discussed in Section 10.2.5.1.2.2, the corrected noise criteria for the operational phase were not deduced and omitted from this Report due to the lack of detailed design information necessary to capture the appropriate baseline noise levels required for the establishment of the corrected noise criterion.

#### 10.5.2.3.1 Construction Phase

Based on the baseline airborne noise monitoring results and noise correction factor introduced in accordance to the adjusted maximum permissible noise levels detailed in Section 10.2.5.1, the corrected noise criteria for airborne noise impact assessment were deduced respectively for the ecological and human receptors in this section for the construction phase.

As discussed in Section 10.2.5.1.2.2, the corrected noise criteria for the operational phase were not deduced and omitted from this report due to the lack of detailed design information necessary to capture the appropriate baseline noise levels required for the establishment of the corrected noise criterion.

##### *10.5.2.3.1.1 Ecological Receptors*

As mentioned in Section 10.2.5.1.1, 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 10-15 were used to establish the assessment criteria for construction noise impact on ecological receptors as reflected in Table 10-17.

Unlike human receptors which are defined as fixed establishments/ buildings, it is difficult to pinpoint the exact locations of mobile ecological receptors to conduct construction noise impact assessment. As such, baseline noise monitoring results at N5 and N6 were selected as representative of the noise levels experienced by the ecological receptors residing/ traversing through the various patches within the Project site as discussed in Section 10.5.2.3.1.1.

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.

It should be noted that only ground-dwelling fauna found at heights of up to 0.5 m were assessed in this EIA under the assumption that ground-dwelling fauna will face the most severe impacts due to noise emissions arising from the construction phase while arboreal fauna typically found at height are likely to flee the area during periods of high noise disturbances.

**Table 10-17 Noise criteria established for Ecological Receptors**

| Location | Noise Criteria for $L_{Aeq(12\ hrs)}$, dB(A) | | Noise Criteria for $L_{Aeq(1\ hr)}$, dB(A) | | Noise Criteria for $L_{Aeq(5\ mins)}$, dB(A) | | |
|---|---|---|---|---|---|---|---|
| | 7am-7pm | 7pm-7am | 7pm-10pm | 10pm-7am | 7am-7pm | 7pm-10pm | 10pm-7am |
| **Overall (Monday – Sunday/ Public Holiday)** | | | | | | | |
| NM05: Green Area within Study Area (Northern) | 54 | 54 | 55 | 54 | 52 | 54 | 53 |
| NM06: Green Area within Study Area (Southern) | 60 | 60 | 61 | 58 | 60 | 60 | 58 |

#### *10.5.2.3.1.2 Human Receptors*

The corrected construction noise criteria for human receptors was deduced using the average recorded baseline noise levels for $L_{Aeq(12\ hrs)}$, $L_{Aeq(1\ hr)}$, and $L_{Aeq(5\ mins)}$ at N1 – N4 to calculate the adjusted maximum permissible noise levels in accordance with the EPM, 2008 [R-33]. Table 10-18 below reflects the corrected construction noise criteria for Weekdays (Monday – Saturday) and Weekends (Sunday/ Public Holidays).

Detailed calculations on the derivation of the corrected construction noise criteria from the correction factors (refer to Section 10.5.2.3.1.2) are provided in Appendix X.

**Table 10-18 Corrected noise criteria for construction phase**

| Location | Types of Affected Buildings | Noise Criteria for $L_{Aeq(12\ hrs)}$, dB(A) | | Noise Criteria for $L_{Aeq(1\ hr)}$, dB(A) | | Noise Criteria for $L_{Aeq(5\ mins)}$, dB(A) | | |
|---|---|---|---|---|---|---|---|---|
| | | 7am-7pm | 7pm-7am | 7pm-10pm | 10pm-7am | 7am-7pm | 7pm-10pm | 10pm-7am |
| **Weekday (Monday – Saturday)** | | | | | | | | |
| **NM01** | (a) Hospitals, Schools, Institutions of Higher Learning, Homes for the Aged or Sick, etc. | 76 | 77 | NA | NA | 79 | 77 | 77 |
| | (b) Residential buildings located less than 150m from the construction site where noise is being emitted | 79 | NA | 77 | 77 | 90 | 78 | 77 |
| | (c) Buildings (Other than those in (a) and (b)) | 79 | 77 | NA | NA | 90 | 78 | 78 |
| **NM02** | (a) Hospitals, Schools, Institutions of Higher Learning, Homes for the Aged or Sick, etc. | 76 | 77 | NA | NA | 79 | 77 | 77 |
| | (b) Residential buildings located less than 150m from the construction site where noise is being emitted | 79 | NA | 77 | 77 | 90 | 78 | 77 |
| | (c) Buildings (Other than those in (a) and (b)) | 79 | 77 | NA | NA | 90 | 78 | 78 |
| **NM03a** | (a) Hospitals, Schools, Institutions of Higher Learning, Homes for the Aged or Sick, etc. | 69 | 65 | NA | NA | 76 | 67 | 64 |
| | (b) Residential buildings located less than 150m from the construction site where noise is being emitted | 76 | NA | 70 | 64 | 90 | 72 | 64 |
| | (c) Buildings (Other than those in (a) and (b)) | 76 | 68 | NA | NA | 90 | 72 | 71 |
| **NM03b** | (a) Hospitals, Schools, Institutions of Higher Learning, Homes for the Aged or Sick, etc. | 69 | 65 | NA | NA | 75 | 67 | 64 |
| | (b) Residential buildings located less than 150m from the construction site | 76 | NA | 70 | 64 | 90 | 72 | 64 |

| Location | Types of Affected Buildings | Noise Criteria for $L_{Aeq(12\ hrs)}$, dB(A) | | Noise Criteria for $L_{Aeq(1\ hr)}$, dB(A) | | Noise Criteria for $L_{Aeq(5\ mins)}$, dB(A) | | |
|---|---|---|---|---|---|---|---|---|
| | | 7am-7pm | 7pm-7am | 7pm-10pm | 10pm-7am | 7am-7pm | 7pm-10pm | 10pm-7am |
| | where noise is being emitted | | | | | | | |
| | (c) Buildings (Other than those in (a) and (b)) | 76 | 68 | NA | NA | 90 | 72 | 71 |
| **NM03c** | (a) Hospitals, Schools, Institutions of Higher Learning, Homes for the Aged or Sick, etc. | 71 | 68 | NA | NA | 77 | 70 | 66 |
| | (b) Residential buildings located less than 150m from the construction site where noise is being emitted | 77 | NA | 71 | 66 | 90 | 73 | 66 |
| | (c) Buildings (Other than those in (a) and (b)) | 77 | 70 | NA | NA | 90 | 73 | 72 |
| **NM04a** | (a) Hospitals, Schools, Institutions of Higher Learning, Homes for the Aged or Sick, etc. | 63 | 57 | NA | NA | 75 | 58 | 58 |
| | (b) Residential buildings located less than 150m from the construction site where noise is being emitted | 75 | NA | 65 | 58 | 90 | 70 | 58 |
| | (c) Buildings (Other than those in (a) and (b)) | 75 | 66 | NA | NA | 90 | 70 | 70 |
| **NM04b** | (a) Hospitals, Schools, Institutions of Higher Learning, Homes for the Aged or Sick, etc. | 62 | 55 | NA | NA | 75 | 58 | 57 |
| | (b) Residential buildings located less than 150m from the construction site where noise is being emitted | 75 | NA | 66 | 57 | 90 | 70 | 57 |
| | (c) Buildings (Other than those in (a) and (b)) | 75 | 65 | NA | NA | 90 | 70 | 70 |
| **NM04c** | (a) Hospitals, Schools, Institutions of Higher Learning, Homes for the Aged or Sick, etc. | 62 | 56 | NA | NA | 75 | 59 | 58 |
| | (b) Residential buildings located less than 150m from the construction site where noise is being emitted | 75 | NA | 66 | 58 | 90 | 70 | 58 |
| | (c) Buildings (Other than those in (a) and (b)) | 75 | 66 | NA | NA | 90 | 70 | 70 |
| **Weekend (Sundays and Public Holidays)** | | | | | | | | |
| **NM01** | (a) Hospitals, Schools, Institutions of Higher Learning, Homes for the Aged or Sick, etc. | 76 | 74 | NIL | | 79 | 74 | 74 |

| Location | Types of Affected Buildings | Noise Criteria for $L_{Aeq(12\ hrs)}$, dB(A) | | Noise Criteria for $L_{Aeq(1\ hr)}$, dB(A) | | Noise Criteria for $L_{Aeq(5\ mins)}$, dB(A) | | |
|---|---|---|---|---|---|---|---|---|
| | | 7am-7pm | 7pm-7am | 7pm-10pm | 10pm-7am | 7am-7pm | 7pm-10pm | 10pm-7am |
| | (b) Residential buildings located less than 150m from the construction site where noise is being emitted | 79 | NA | | | 79 | 74 | 74 |
| | (c) Buildings (Other than those in (a) and (b)) | 79 | 75 | | | 90 | 75 | 75 |
| **NM02** | (a) Hospitals, Schools, Institutions of Higher Learning, Homes for the Aged or Sick, etc. | 76 | 74 | | | 79 | 74 | 74 |
| | (b) Residential buildings located less than 150m from the construction site where noise is being emitted | 79 | NA | | | 79 | 74 | 74 |
| | (c) Buildings (Other than those in (a) and (b)) | 79 | 75 | | | 90 | 75 | 75 |
| **NM03a** | (a) Hospitals, Schools, Institutions of Higher Learning, Homes for the Aged or Sick, etc. | 68 | 64 | | | 79 | 74 | 74 |
| | (b) Residential buildings located less than 150m from the construction site where noise is being emitted | 76 | NA | | | 79 | 74 | 74 |
| | (c) Buildings (Other than those in (a) and (b)) | 76 | 68 | | | 90 | 75 | 75 |
| **NM03b** | (a) Hospitals, Schools, Institutions of Higher Learning, Homes for the Aged or Sick, etc. | 68 | 64 | | | 76 | 66 | 64 |
| | (b) Residential buildings located less than 150m from the construction site where noise is being emitted | 76 | NA | | | 76 | 66 | 64 |
| | (c) Buildings (Other than those in (a) and (b)) | 76 | 68 | | | 90 | 72 | 71 |
| **NM03c** | (a) Hospitals, Schools, Institutions of Higher Learning, Homes for the Aged or Sick, etc. | 70 | 67 | | | 76 | 69 | 66 |
| | (b) Residential buildings located less than 150m from the construction site where noise is being emitted | 76 | NA | | | 76 | 69 | 66 |
| | (c) Buildings (Other than those in (a) and (b)) | 76 | 69. | | | 90 | 73 | 71 |
| **NM04a** | (a) Hospitals, Schools, Institutions of Higher | 61 | 55 | | | 75 | 57 | 58 |

| Location | Types of Affected Buildings | Noise Criteria for $L_{Aeq(12\ hrs)}$, dB(A) | | Noise Criteria for $L_{Aeq(1\ hr)}$, dB(A) | | Noise Criteria for $L_{Aeq(5\ mins)}$, dB(A) | | |
|---|---|---|---|---|---|---|---|---|
| | | 7am-7pm | 7pm-7am | 7pm-10pm | 10pm-7am | 7am-7pm | 7pm-10pm | 10pm-7am |
| | Learning, Homes for the Aged or Sick, etc. | | | | | | | |
| | (b) Residential buildings located less than 150m from the construction site where noise is being emitted | 75 | NA | | | 75 | 57 | 58 |
| | (c) Buildings (Other than those in (a) and (b)) | 75 | 65 | | | 90 | 70 | 70 |
| **NM04b** | (a) Hospitals, Schools, Institutions of Higher Learning, Homes for the Aged or Sick, etc. | 61 | 55 | | | 75 | 58 | 57 |
| | (b) Residential buildings located less than 150m from the construction site where noise is being emitted | 75 | NA | | | 75 | 58 | 57 |
| | (c) Buildings (Other than those in (a) and (b)) | 75 | 65 | | | 90 | 70 | 70 |
| **NM04c** | (a) Hospitals, Schools, Institutions of Higher Learning, Homes for the Aged or Sick, etc. | 61 | 56 | | | 75 | 58 | 57 |
| | (b) Residential buildings located less than 150m from the construction site where noise is being emitted | 75 | NA | | | 75 | 58 | 57 |
| | (c) Buildings (Other than those in (a) and (b)) | 75 | 65 | | | 90 | 70 | 70 |

*Note: In accordance with the EPM 2008 Regulation, $L_{Aeq(1\ hour)}$ is not assessed for Weekends and is hence indicated as NIL.*
*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 HDB in Appendix W.*
*Information of baseline noise levels measured at other timings (i.e., 7pm – 7am, 7pm – 10pm, 10pm – 7am) are for purposes of reference.*
*Night-works or works on Weekends will only be allowed if permission from relevant local agencies is sought and approved.*

#### 10.5.2.3.2 Operational Phase

As part of the requirements of operational noise impact assessment mandated by NEA, baseline noise results captured during noise monitoring shall be used to derive the operational noise criteria for noise impacts over a continuous period of 15 minutes. Due to this, the baseline noise results recorded for $L_{Aeq(15\ mins)}$ reflected in Section 10.5.2.2 shall only serve to reflect the indicative operational baseline noise conditions experienced by the identified NSRs within the Project site. As such, to deduce the applicable corrected operational noise criteria for operational noise impact assessment, Noise Consultant(s) appointed by HDB/ the contractor contracted by HDB shall conduct operational noise impact assessment in accordance with the respective NEA guidelines (refer to Section 10.2.1.2 at the later stages of development upon finalising design plans at the detailed design stage following the methodologies detailed in the NEA guidelines. Hence, the deduction of the corrected operational noise criteria have been omitted from in this EIA.

# 10.6 Minimum Control Measures

This section proposes minimum controls or standard practices commonly implemented in Singapore for the purposes of impact assessment.

## 10.6.1 Construction Phase

The list below is non-exhaustive and should be practised as minimum control to reduce noise levels during the construction phase of the Project:

- All machinery and equipment used shall be labelled with a weather-proof sticker clearly indicating its noise emission level (at source) under normal operating conditions;
- All machinery and equipment used on site should be sound reduced, as far as is practicable;
- Stationary noisy equipment should be housed in enclosures on site where necessary;
- Machine operators and workers must be trained and briefed on quieter work techniques;
- Ad-hoc noise monitoring must be carried out when work progresses during noisy operations;
- Erect noise barriers to minimise noise pollution to biodiversity within the Biodiversity Study Area (see Section 10.8.1.2.2 for more details);
- Restrict construction works involving noisy machinery to 8am – 6pm (daylight hours);
- Additional noise measures should be implemented when noise monitoring indicates the noise levels are approaching or exceeding permissible noise levels; and
- Avoid shouting, whistling, sirens, or similar loud intermittent noises especially near ecologically sensitive receptors which can be impacted by them.

## 10.6.2 Operational Phase

Mechanical ventilation would be designed and sited appropriately during detailed design phases to ensure that boundary noise levels are in compliance with the adjusted boundary noise limits to be derived by an appointed Noise Consultant by HDB/ contractor contracted by HDB as part of quantitative operational noise impact assessment 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 ACMV systems and land traffic 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;
- 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;
- Air conditioning systems should be designed with the air handling units (AHUs) placed at appropriate locations, set as back from the boundary line of the development as possible;
- Acoustic enclosures should be provided for outdoor equipment;
- Road design should be considered as part of land use planning to minimise potential impact of land traffic noise on existing residential buildings;
- Use of low-noise pavement mix for sections of new road networks near existing residential buildings should be considered;
- 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.

# 10.7 Prediction and Evaluation of Airborne Noise Impacts

This section discusses on the predicted noise impacts arising from noise emissions associated with activities of the construction and operational phases proposed for this Project on the noise sensitive ecological and human receptors.

## 10.7.1 Construction Phase

In this section, construction noise impacts arising from Scenario 1: Site Preparation for Earthworks, and Scenario 2: Foundation Works, identified for assessment in Section 10.2.6, are presented for the NSRs.

### 10.7.1.1 Ecological Receptors

As discussed in Section 10.2.2, the assessment of the airborne noise impacts on ecological NSRs shall consider the Biodiversity Study Area, demarcation the Rail Corridor and Pang Sua Canal, suitable in supporting the presence of fauna. Other areas such as the construction worksites, urbanized residential/commercial/industrial sites abutting the Rail Corridor, not suitable in supporting the present of fauna have been deemed as “Not Assessable Areas” pertaining to the assessment of construction noise impacts in ecological NSRs

Ecological receptors within the worksites will not be assessed for airborne noise impacts as they are directly impacted by habitat removal which takes precedence over airborne noise impacts.

#### 10.7.1.1.1 Representative Ecological Receptors

Construction noise predictions for ecological receptors were conducted only for ground-dwelling fauna found at heights of up to 0.5m under the assumption that ground-dwelling fauna will face the most severe impacts due to noise emissions arising from the construction phase, while arboreal fauna typically found at height are likely to flee the area during periods of high noise disturbances.

#### 10.7.1.1.2 Predicted Construction Noise Impacts

Based on the results predicted by the noise models, ecological receptors are predicted to experience noise exceedances of up to 24 dB(A) (see Table 10-20) arising from noise emissions associated with Scenario 1:Site Preparation for Earthworks, and up to 30 dB(A) from noise emissions associated with Scenario 2: Foundation Works. The resulting overall Impact Intensity is **High** (refer to Table 6-5) due to the predicted noise exceedances corresponds to an overall Impact Consequence of **High** (refer to Table 6-6) for both assessment scenarios.

When relating the Impact Consequence with a Likelihood of Occurrence of **Occasional/ Likely** (see Table 10-8), it was determined that the overall Impact Significance arising from the proposed construction activities associated with the assessment scenarios would range from **Moderate** for both scenarios for the time period of $L_{Aeq(12\ hrs)}$, and **Major** for $L_{Aeq(5\ mins)}$, 7am – 7pm (refer to Table 6-8) as reflected in Table 10-20. As such, noise mitigation measures were proposed to mitigate the noise impacts on ecological receptors and shall be discussed in Section 10.8.

The resulting noise contours representative of both assessment scenarios reflecting where noise exceedances were predicted are visualized in Figure 10-5 and Figure 10-7 for $L_{Aeq(12\ hrs)}$ and Figure 10-6 and Figure 10-8 for $L_{Aeq(5\ mins)}$. Construction noise impact assessment for ecological receptors was conducted and summarized in Table 10-20 below. The evaluation was carried out with reference to the assessment methodology outlined in Section 6.4.3.

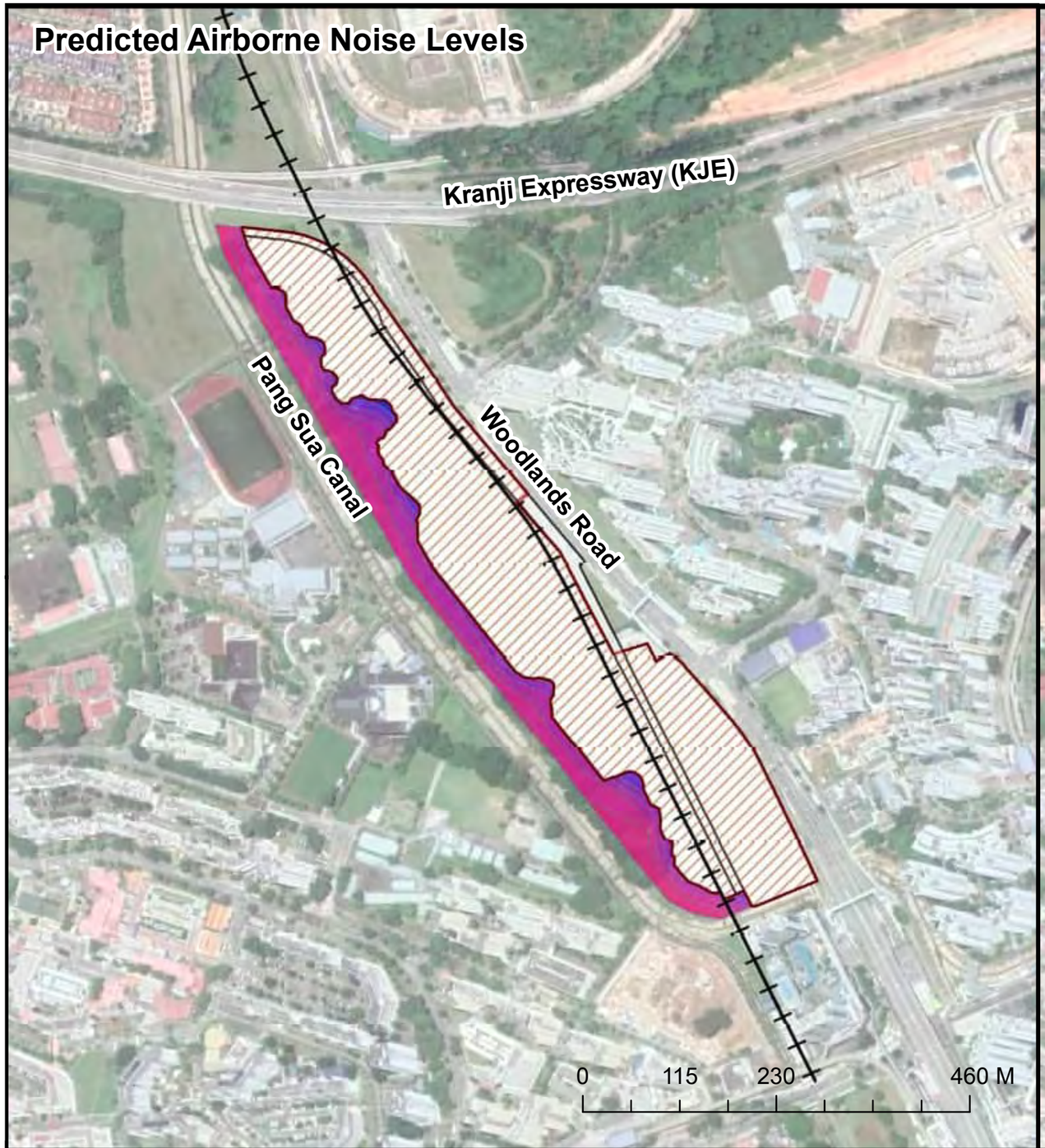
**Table 10-19 List of noise contour maps reflecting ecological impacts**

| Elevation | Construction Schedule | $L_{Aeq}$ | Figure |
|---|---|---|---|
| **Scenario 1: Site Preparation for Earthworks** | | | |
| 0.5 m | Weekdays (7am – 7pm) | $L_{Aeq(12\ hrs)}$ | Figure 10-5 |
| | Weekdays (7am – 7pm) | $L_{Aeq(5\ mins)}$ | Figure 10-6 |
| **Scenario 2: Foundation Works** | | | |
| 0.5 m | Weekdays (7am – 7pm) | $L_{Aeq(12\ hrs)}$ | Figure 10-7 |
| | Weekdays (7am – 7pm) | $L_{Aeq(5\ mins)}$ | Figure 10-8 |

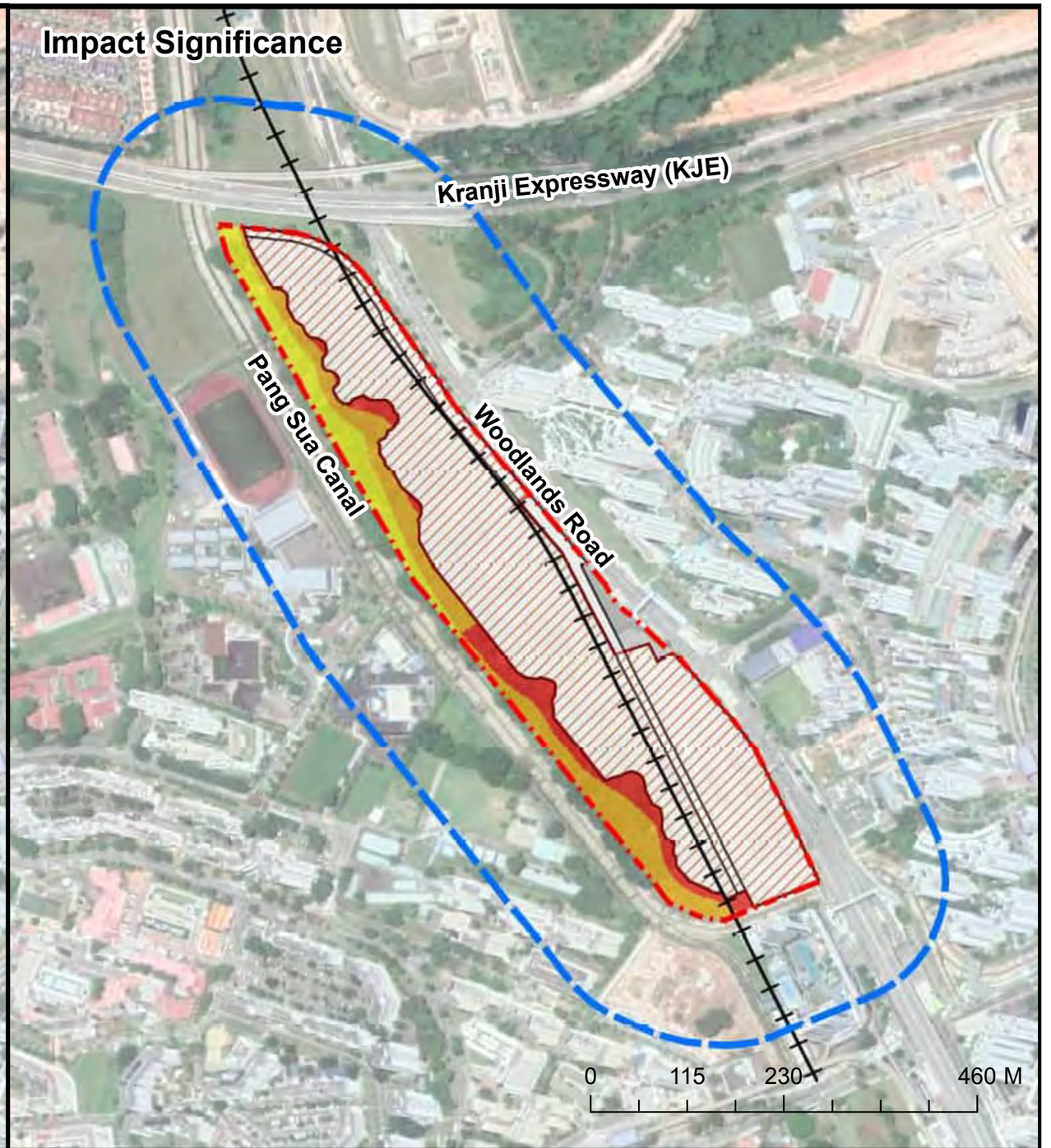
**Table 10-20 Summary of construction noise impacts – ecological impacts**

| Assessment Scenario(s) | Ecological Receptor Sensitivity | Maximum Predicted Noise Level, dB(A) | Exceedances, dB(A) | Impact Intensity | Impact Consequence | Likelihood of Occurrence | Maximum Overall Impact Significance | Area (ha) | Percentage distribution (%) |
|---|---|---|---|---|---|---|---|---|---|
| **LAeq (12hr)** | | | | | | | | | |
| **Scenario 1: Site Preparation for Earthworks** | Priority 1 | 72.0 | 18.0 | High | High | Occasional | Moderate | 1.8 | 44% |
| **Scenario 2: Foundation Works** | Priority 1 | 78.0 | 24.0 | High | High | Occasional | Moderate | 4.1 | 98% |
| **LAeq (5min)** | | | | | | | | | |
| **Scenario 1: Site Preparation for Earthworks** | Priority 1 | 76.0 | 24.0 | High | High | Likely | Major | 2.6 | 63% |
| **Scenario 2: Foundation Works** | Priority 1 | 82.0 | 30.0 | High | High | Likely | Major | 4.1 | 100% |
| ***Note: The colours of the cells corresponds to that of the assessment matrices in Section 6.4.2. The Likelihood of Occurrence reflected relates to the LAeq, dB(A) descriptor where maximum noise levels were predicted.*** | | | | | | | | | |

## Predicted Airborne Noise Levels




## Impact Significance




**Legend**

- Rail Corridor
- Proposed Construction Footprint
- 20231102_Development Boundary

**Impact Significance**

- Negligible
- Minor
- Moderate
- Major

**Predicted Airborne Noise Levels LAeq(12 hours), dB**

- <= 45
- 45 - 48
- 48 - 51
- 51 - 54
- 54 - 57
- 57 - 60
- 60 - 63
- 63 - 66
- 66 - 69
- 69 - 72
- >= 72

N

| Rev. | Date | By | Description | Chk'd | App'd |
|---|---|---|---|---|---|
| - | SEP 2022 | SYT | Draft Final Report | NHT | JAG |

Qualified Person Endorsement : NA

HDB Endorsement : NA

Consultant : AECOM

Client: HOUSING & DEVELOPMENT BOARD

Project Title :

**ENVIRONMENTAL IMPACT ASSESSMENT (EIA) ON CHOA CHU KANG N1**

Figure Title :

**Ecological Noise Sensitive Receptors - Scenario 1: Site Preparation for Earthworks, LAeq(12 hours), 7am - 7pm (Base Scenario Assessment)**

| Designed | Checked | Approved |
|---|---|---|
| SAG | NHT | JAG |
| | Drawn: SYT | Date: SEP 2022 |

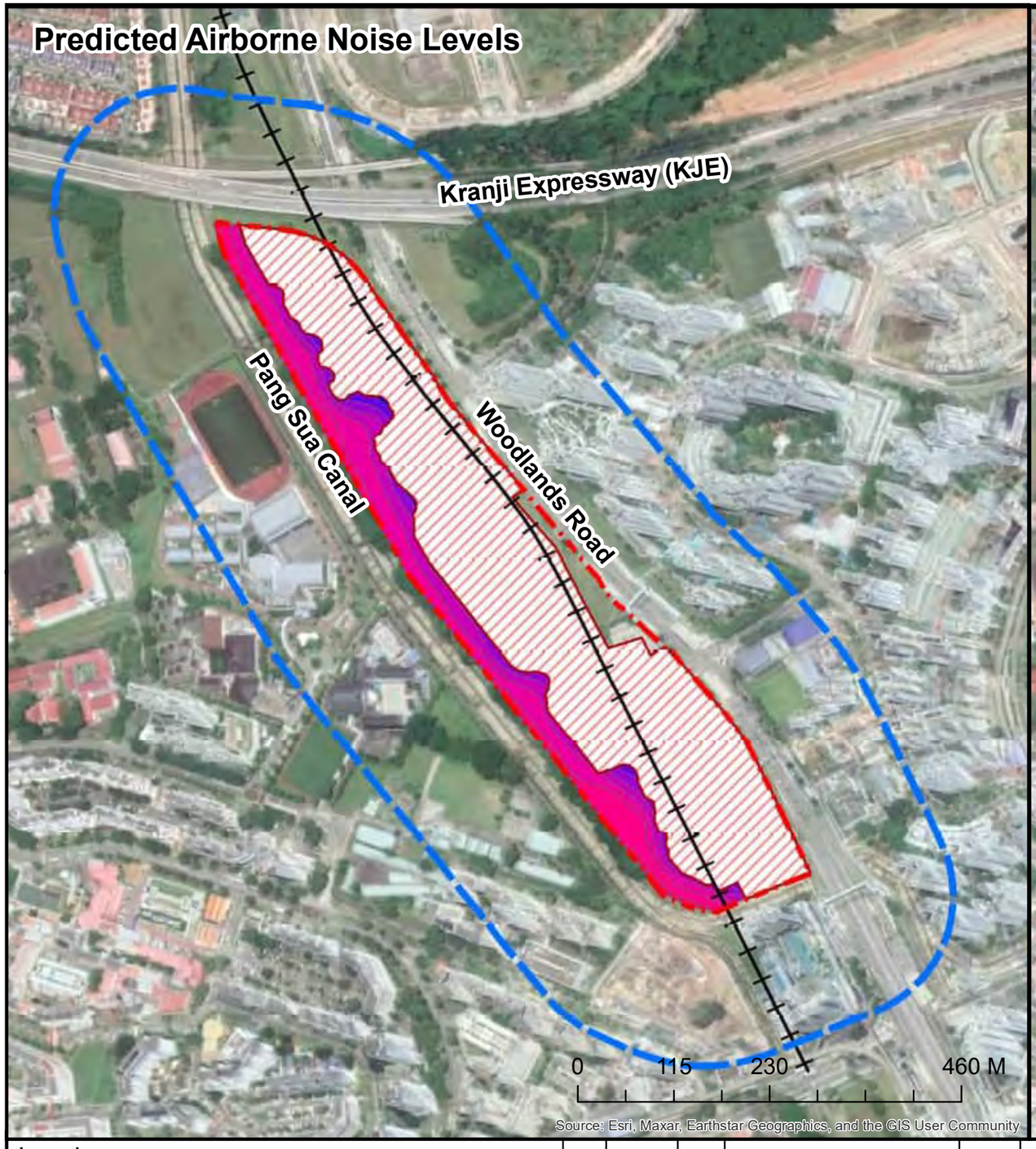
Figure No. : 10 - 5 | Rev. : - | Sheet : 1 of 1

CAD File Name : NA | A3

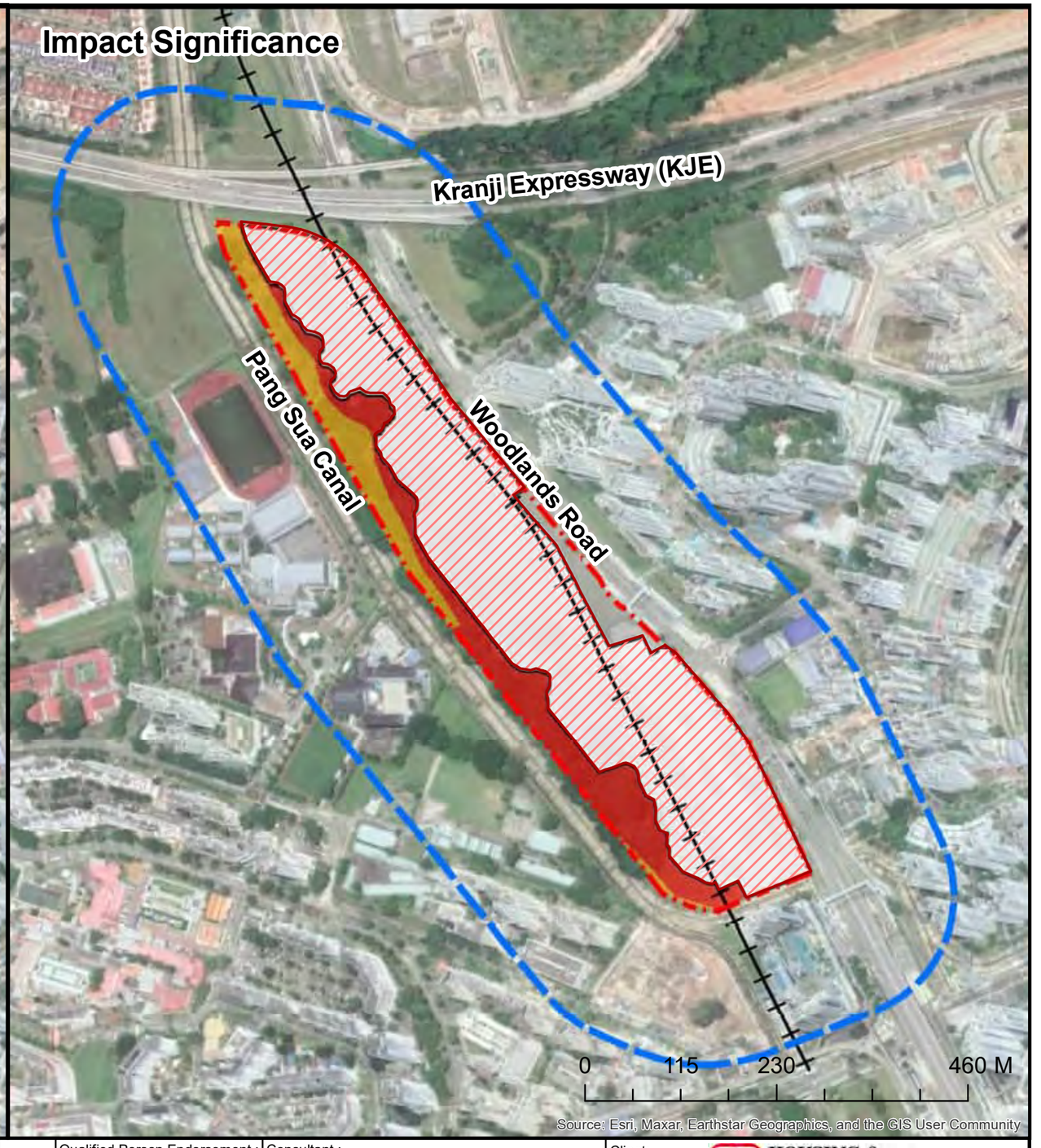
Note: Source of basemap - Google Earth Map

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## Predicted Airborne Noise Levels




## Impact Significance




**Legend**

- CCK N1 Project Site
- Airborne Noise Study Area (150m)
- Original Track Alignment
- Proposed Construction Footprint*
- Proposed Development Boundary*

**Impact Significance**

- Negligible
- Minor
- Moderate
- Major

* exact boundaries/ alignment subject to further changes

**Predicted Airborne Noise Levels LAeq(12 hours), dB**

| | |
|---|---|
| <= 45 | 60 - 63 |
| 45 - 48 | 63 - 66 |
| 48 - 51 | 66 - 69 |
| 51 - 54 | 69 - 72 |
| 54 - 57 | >= 72 |
| 57 - 60 | |

N

| Rev. | Date | By | Description | Chk'd | App'd |
|---|---|---|---|---|---|
| - | SEP 2022 | SYT | Draft Final Report | NHT | JAG |

Qualified Person Endorsement : NA

HDB Endorsement : NA

Consultant : AECOM

Client: HOUSING & DEVELOPMENT BOARD

Project Title :

**ENVIRONMENTAL IMPACT ASSESSMENT (EIA) ON CHOA CHU KANG N1**

Figure Title :

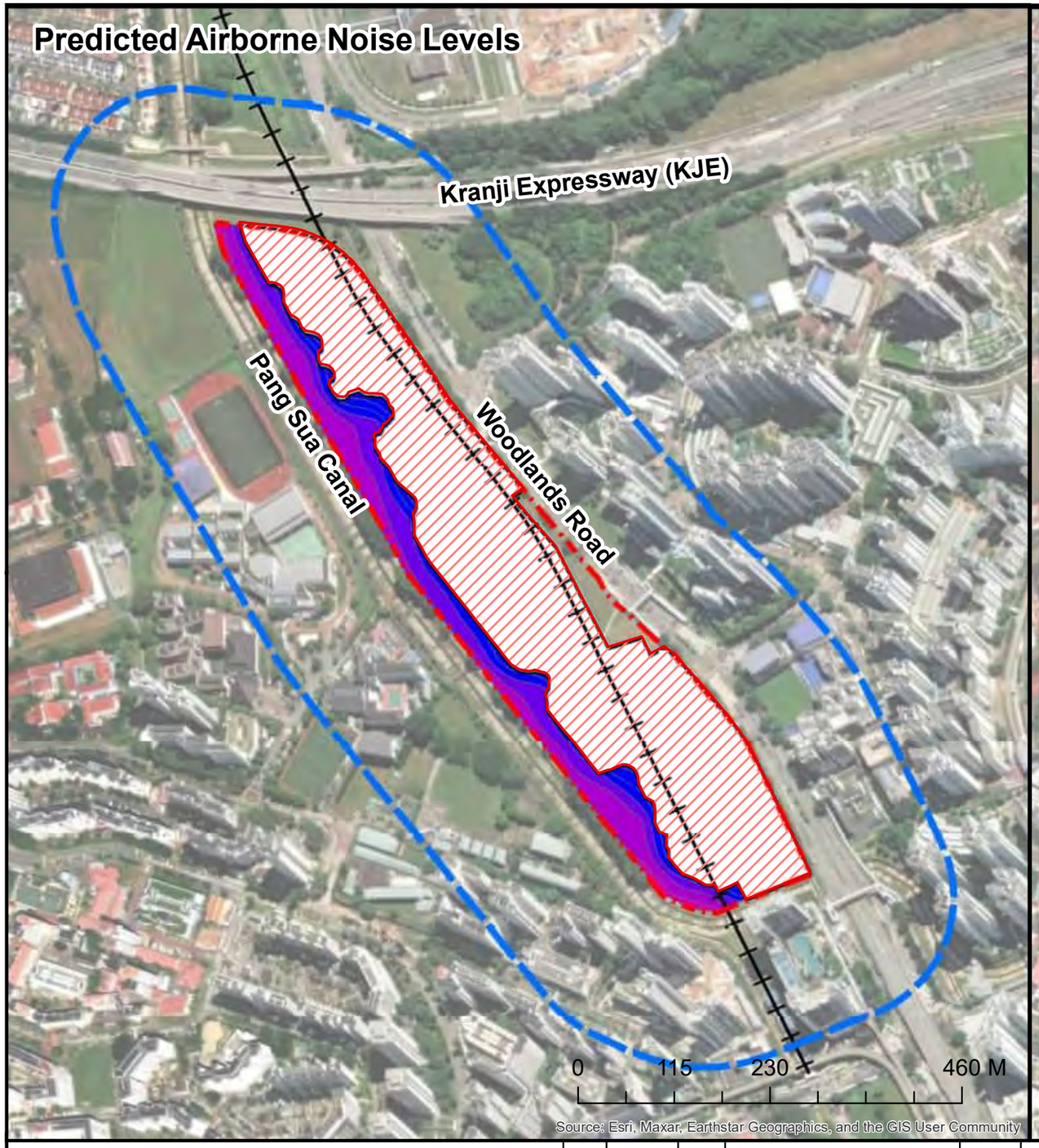
**Ecological Noise Sensitive Receptors - Scenario 1: Site Preparation for Earthworks, LAeq(12 hours), 7am - 7pm (Base Scenario Assessment)**

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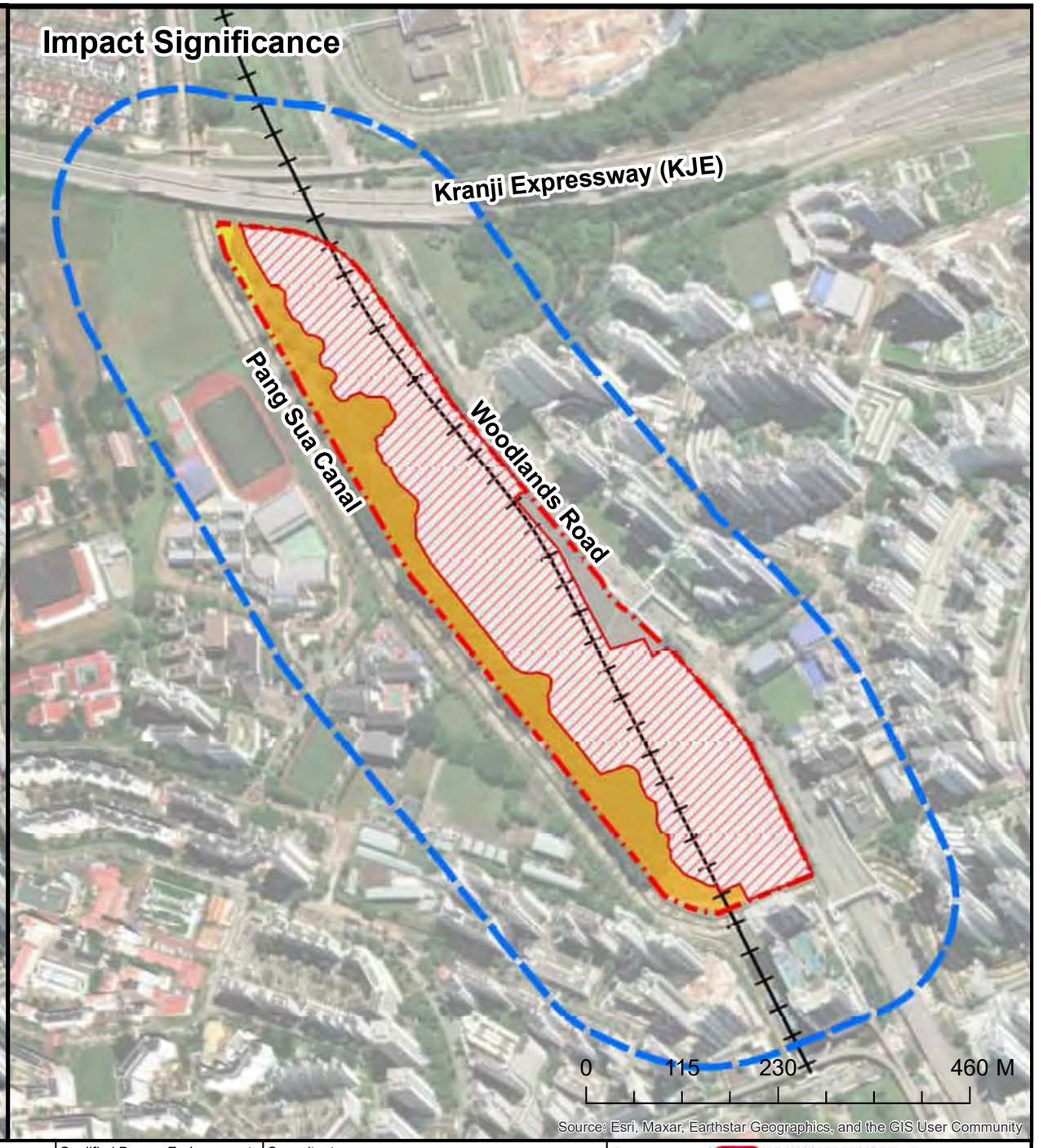
Note: Source of basemap - Google Earth Map

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## Predicted Airborne Noise Levels




## Impact Significance




**Legend**

- CCK N1 Project Site
- Airborne Noise Study Area (150m)
- Original Track Alignment
- Proposed Construction Footprint*
- Proposed Development Boundary*

**Impact Significance**

- Negligible
- Minor
- Moderate
- Major

* exact boundaries/ alignment subject to further changes

**Predicted Airborne Noise Levels LAeq(12 hours), dB**

| | |
|---|---|
| <= 45 | 60 - 63 |
| 45 - 48 | 63 - 66 |
| 48 - 51 | 66 - 69 |
| 51 - 54 | 69 - 72 |
| 54 - 57 | >= 72 |
| 57 - 60 | |

N

| Rev. | Date | By | Description | Chk'd | App'd |
|---|---|---|---|---|---|
| - | SEP 2022 | SYT | Draft Final Report | NHT | JAG |

Qualified Person Endorsement : NA

HDB Endorsement : NA

Consultant : AECOM

Client: HOUSING & DEVELOPMENT BOARD

Project Title :

**ENVIRONMENTAL IMPACT ASSESSMENT (EIA) ON CHOA CHU KANG N1**

Figure Title :

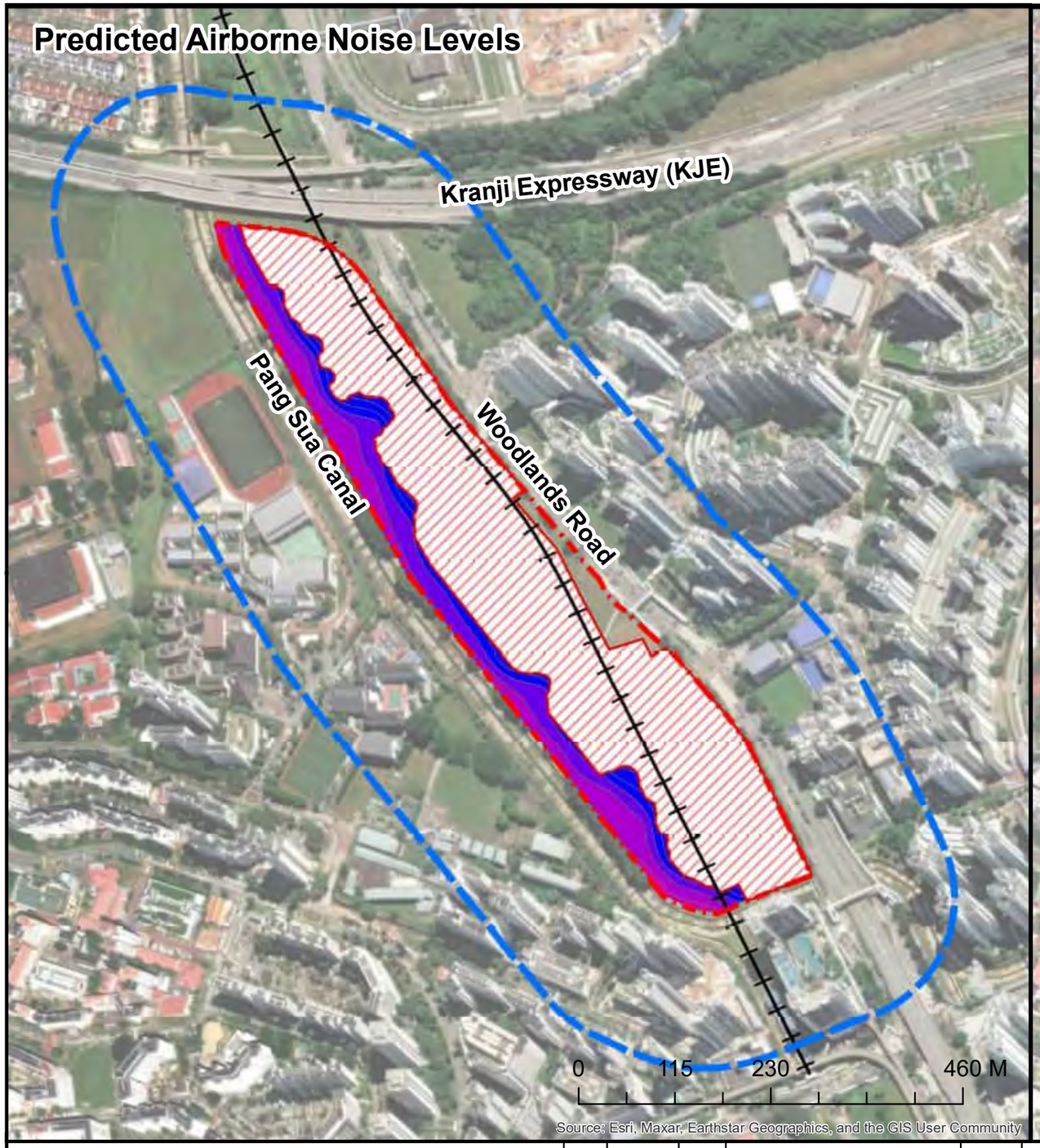
**Ecological Noise Sensitive Receptors - Scenario 1: Site Preparation for Earthworks, LAeq(12 hours), 7am - 7pm (Base Scenario Assessment)**

| Designed | Checked | Approved | Figure No. : | Rev. | Sheet |
|---|---|---|---|---|---|
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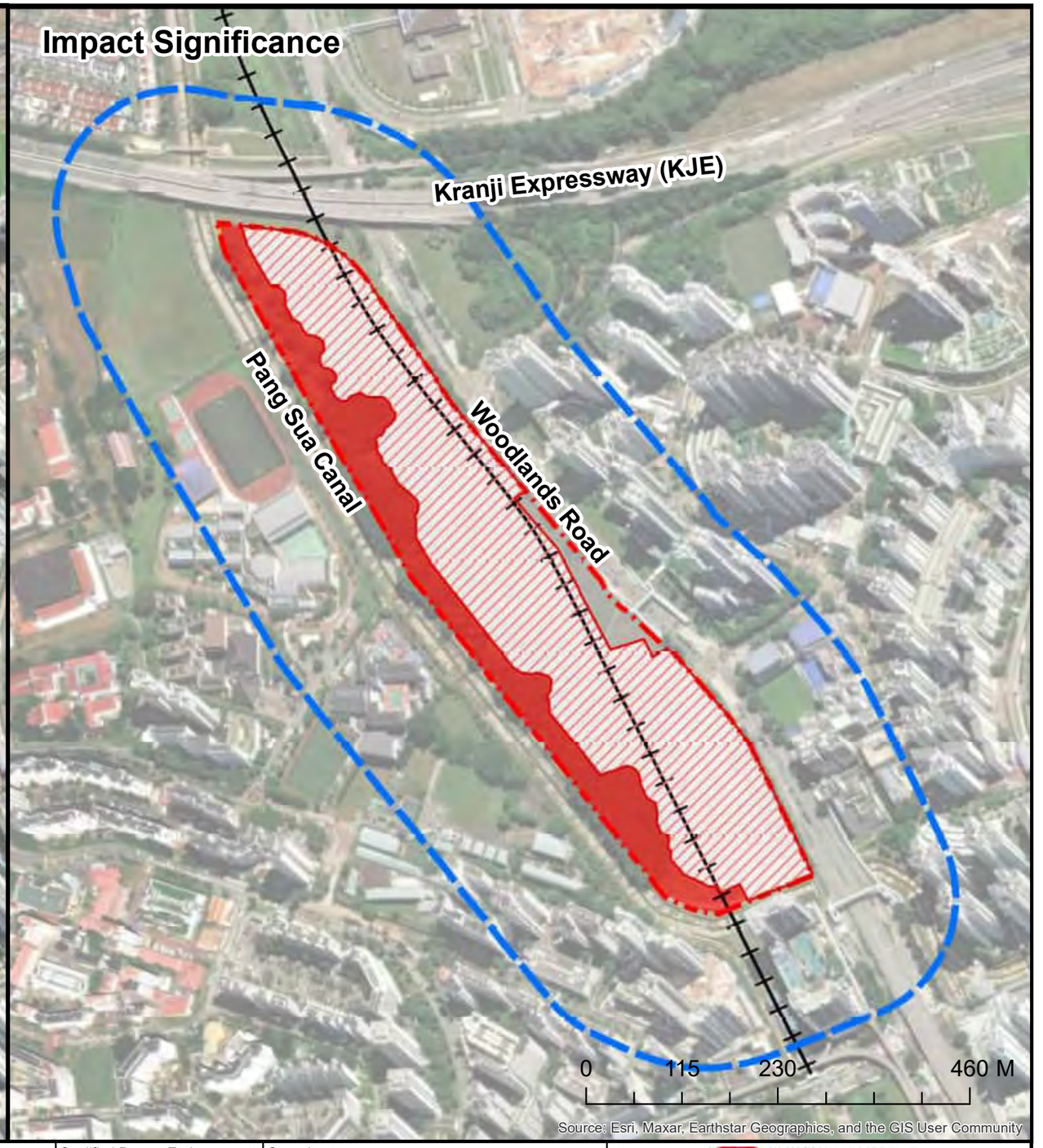
Note: Source of basemap - Google Earth Map

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## Predicted Airborne Noise Levels




## Impact Significance




**Legend**

- CCK N1 Project Site
- Airborne Noise Study Area (150m)
- Original Track Alignment
- Proposed Construction Footprint*
- Proposed Development Boundary*

**Impact Significance**

- Negligible
- Minor
- Moderate
- Major

* exact boundaries/ alignment subject to further changes

**Predicted Airborne Noise Levels LAeq(12 hours), dB**

- <= 45
- 45 - 48
- 48 - 51
- 51 - 54
- 54 - 57
- 57 - 60
- 60 - 63
- 63 - 66
- 66 - 69
- 69 - 72
- >= 72

N

| Rev. | Date | By | Description | Chk'd | App'd |
|---|---|---|---|---|---|
| - | SEP 2022 | SYT | Draft Final Report | NHT | JAG |

Qualified Person Endorsement : NA

HDB Endorsement : NA

Consultant : AECOM

Client: HOUSING & DEVELOPMENT BOARD

Project Title :

**ENVIRONMENTAL IMPACT ASSESSMENT (EIA) ON CHOA CHU KANG N1**

Figure Title :

**Ecological Noise Sensitive Receptors - Scenario 1: Site Preparation for Earthworks, LAeq(12 hours), 7am - 7pm (Base Scenario Assessment)**

| Designed | Checked | Approved |
|---|---|---|
| SAG | NHT | JAG |
| | Drawn: SYT | Date: SEP 2022 |

Figure No. : 10-8 | Rev. : - | Sheet : 1 of 1

CAD File Name : NA | A3

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### 10.7.1.2 Human Receptors

Based on the results predicted by the noise models, two human receptors (Senja Care Home and West View Primary School) are predicted to experience noise exceedances of up to 8.4 dB(A) during Scenario 2: Foundation Works and up to 1.4 dB(A) during Scenario 1: Site Preparation for Earthworks. The resulting overall Impact Intensity ranging from **Negligible** – **High** (refer to Table 6-5) due to the predicted noise exceedances corresponds to an overall Impact Consequence that ranges from **Imperceptible** – **High** (refer to Table 6-6).

When relating the Impact Consequence and Likelihood of Occurrence of both assessment scenarios with a likelihood of **Occasional/ Likely** (refer Table 10-8), it was determined that the overall Impact Significance arising from the proposed construction activities will result in an overall Impact Significance ranging from **Negligible** – **Moderate** (refer to Table 6-8) as reflected in Table 10-22 to Table 10-25 and the evaluation was carried out with reference to the assessment methodology outlined in Section 6.4.3.. As such, noise mitigation measures were proposed to mitigate the noise impacts on human receptors and shall be discussed in Section 10.8.

The resulting noise contours representative of the worst-case Scenarios where noise exceedances were predicted are visualized in Figure 10-9 to Figure 10-12 for $L_{Aeq(12\ hrs)}$ and $L_{Aeq(5\ mins)}$.

**Table 10-21 List of noise contour maps reflecting human impacts**

| Construction Schedule | $L_{Aeq}$ | Figure |
|---|---|---|
| **Scenario 1: Site Preparation for Earthworks** | | |
| Weekdays (7am – 7pm) | $L_{Aeq(12\ hrs)}$ | Figure 10-9 |
| Weekdays (7am – 7pm) | $L_{Aeq(5\ mins)}$ | Figure 10-10 |
| **Scenario 2: Foundation Works** | | |
| Weekdays (7am – 7pm) | $L_{Aeq(12\ hrs)}$ | Figure 10-11 |
| Weekdays (7am – 7pm) | $L_{Aeq(5\ mins)}$ | Figure 10-12 |

**Table 10-22 Summary of construction noise impacts: scenario 1: site preparation for earthworks – human receptors, LAeq (12hr) (7am-7pm)**

| No. | Human Receptors | Receptor Sensitivity | Nearest SLM | Predicted Construction Noise Levels | Corrected Criteria, dB(A) | Maximum Noise Exceedance, dB(A) | Impact Intensity | Impact Consequence | Likelihood | Impact Significance |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Bukit Panjang Exchange (1) | Priority 3 | NM03 | 60.0 | 75 | - | Negligible | Imperceptible | Occasional | Negligible |
| 2 | Bukit Panjang Exchange (2) | Priority 3 | NM03 | 56.2 | 75 | - | Negligible | Imperceptible | Occasional | Negligible |
| 3 | DE142 Gali Batu Bus Depot Site Office | Priority 3 | NM02a | 54.3 | 79 | - | Negligible | Imperceptible | Occasional | Negligible |
| 4 | HDB Blk 162 Jln Teck Whye (ground level) | Priority 2 | NM04a | 57.7 | 75 | - | Negligible | Imperceptible | Occasional | Negligible |
| 5 | HDB Blk 162 Jln Teck Whye (mid-level) | Priority 2 | NM04b | 59.1 | 75 | - | Negligible | Imperceptible | Occasional | Negligible |
| 6 | HDB Blk 162 Jln Teck Whye (top level) | Priority 2 | NM04c | 59.8 | 77 | - | Negligible | Imperceptible | Occasional | Negligible |
| 7 | HDB Blk 163 Jln Teck Whye (ground level) | Priority 2 | NM04a | 57.2 | 75 | - | Negligible | Imperceptible | Occasional | Negligible |
| 8 | HDB Blk 163 Jln Teck Whye (mid-level) | Priority 2 | NM04b | 58.6 | 75 | - | Negligible | Imperceptible | Occasional | Negligible |
| 9 | HDB Blk 163 Jln Teck Whye (top level) | Priority 2 | NM04c | 60.3 | 77 | - | Negligible | Imperceptible | Occasional | Negligible |
| 10 | HDB Blk 164 Jln Teck Whye (ground level) | Priority 2 | NM04a | 56.5 | 75 | - | Negligible | Imperceptible | Occasional | Negligible |

| No. | Human Receptors | Receptor Sensitivity | Nearest SLM | Predicted Construction Noise Levels | Corrected Criteria, dB(A) | Maximum Noise Exceedance, dB(A) | Impact Intensity | Impact Consequence | Likelihood | Impact Significance |
|---|---|---|---|---|---|---|---|---|---|---|
| **11** | HDB Blk 164 Jln Teck Whye (mid-level) | Priority 2 | NM04b | 57.8 | 75 | - | Negligible | Imperceptible | Occasional | Negligible |
| **12** | HDB Blk 164 Jln Teck Whye (top level) | Priority 2 | NM04c | 59.5 | 77 | - | Negligible | Imperceptible | Occasional | Negligible |
| **13** | HDB Blk 606 Senja Road (ground level) | Priority 2 | N1a | 56.4 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **14** | HDB Blk 606 Senja Road (mid-level) | Priority 2 | N1b | 57.9 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **15** | HDB Blk 606 Senja Road (top level) | Priority 2 | N1c | 57.9 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **16** | HDB Blk 632A Senja Road (ground level) | Priority 2 | N1a | 63.2 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **17** | HDB Blk 632A Senja Road (top level) | Priority 2 | N1b | 63.4 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **18** | HDB Blk 632B Senja Road (ground level) | Priority 2 | N1a | 63.1 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **19** | HDB Blk 632B Senja Road (top level) | Priority 2 | N1b | 63.2 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **20** | HDB Blk 633 Senja Road (ground level) | Priority 2 | N1a | 56.1 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |

| No. | Human Receptors | Receptor Sensitivity | Nearest SLM | Predicted Construction Noise Levels | Corrected Criteria, dB(A) | Maximum Noise Exceedance, dB(A) | Impact Intensity | Impact Consequence | Likelihood | Impact Significance |
|---|---|---|---|---|---|---|---|---|---|---|
| **21** | HDB Blk 633A Senja Road (ground level) | Priority 2 | N1a | 61.3 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **22** | HDB Blk 633A Senja Road (mid-level) | Priority 2 | N1b | 61.7 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **23** | HDB Blk 633A Senja Road (top level) | Priority 2 | N1c | 61.7 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **24** | HDB Blk 633B Senja Road (ground level) | Priority 2 | N1a | 62.1 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **25** | HDB Blk 633B Senja Road (mid-level) | Priority 2 | N1b | 62.5 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **26** | HDB Blk 633B Senja Road (top level) | Priority 2 | N1c | 62.3 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **27** | HDB Blk 633C Senja Road (ground level) | Priority 2 | N1a | 60.2 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **28** | HDB Blk 633C Senja Road (mid-level) | Priority 2 | N1b | 61.9 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **29** | HDB Blk 633C Senja Road (top level) | Priority 2 | N1c | 61.5 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **30** | HDB Blk 633D Senja Road (ground level) | Priority 2 | N1a | 58.8 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |

| No. | Human Receptors | Receptor Sensitivity | Nearest SLM | Predicted Construction Noise Levels | Corrected Criteria, dB(A) | Maximum Noise Exceedance, dB(A) | Impact Intensity | Impact Consequence | Likelihood | Impact Significance |
|---|---|---|---|---|---|---|---|---|---|---|
| **31** | HDB Blk 633D Senja Road (mid-level) | Priority 2 | N1b | 60.6 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **32** | HDB Blk 633D Senja Road (top level) | Priority 2 | N1c | 60.6 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **33** | HDB Blk 634A Senja Road (ground level) | Priority 2 | N1a | 63.1 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **34** | HDB Blk 634A Senja Road (mid-level) | Priority 2 | N1b | 63.1 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **35** | HDB Blk 634A Senja Road (top level) | Priority 2 | N1c | 63.1 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **36** | HDB Blk 634B Senja Road (ground level) | Priority 2 | N1a | 56.0 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **37** | HDB Blk 634B Senja Road (mid-level) | Priority 2 | N1b | 58.0 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **38** | HDB Blk 634B Senja Road (top level) | Priority 2 | N1c | 58.0 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **39** | HDB Blk 634C Senja Road (ground level) | Priority 2 | N1a | 61.4 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **40** | HDB Blk 634C Senja Road (mid-level) | Priority 2 | N1b | 61.6 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |

| No. | Human Receptors | Receptor Sensitivity | Nearest SLM | Predicted Construction Noise Levels | Corrected Criteria, dB(A) | Maximum Noise Exceedance, dB(A) | Impact Intensity | Impact Consequence | Likelihood | Impact Significance |
|---|---|---|---|---|---|---|---|---|---|---|
| **41** | HDB Blk 634C Senja Road (top level) | Priority 2 | N1c | 61.6 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **42** | HDB Blk 635 Senja Road (ground level) | Priority 2 | NM02a | 55.5 | 79 | - | Negligible | Imperceptible | Occasional | Negligible |
| **43** | HDB Blk 635 Senja Road (mid-level) | Priority 2 | NM02b | 56.2 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **44** | HDB Blk 635 Senja Road (top level) | Priority 2 | NM02c | 56.0 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **45** | HDB Blk 635A Senja Road (ground level) | Priority 2 | NM02a | 63.1 | 79 | - | Negligible | Imperceptible | Occasional | Negligible |
| **46** | HDB Blk 635A Senja Road (mid-level) | Priority 2 | NM02b | 63.2 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **47** | HDB Blk 635A Senja Road (top level) | Priority 2 | NM02c | 62.5 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **48** | HDB Blk 635B Senja Road (ground level) | Priority 2 | NM02a | 58.6 | 79 | - | Negligible | Imperceptible | Occasional | Negligible |
| **49** | HDB Blk 635B Senja Road (mid-level) | Priority 2 | NM02b | 58.8 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **50** | HDB Blk 635B Senja Road (top level) | Priority 2 | NM02c | 58.8 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |

| No. | Human Receptors | Receptor Sensitivity | Nearest SLM | Predicted Construction Noise Levels | Corrected Criteria, dB(A) | Maximum Noise Exceedance, dB(A) | Impact Intensity | Impact Consequence | Likelihood | Impact Significance |
|---|---|---|---|---|---|---|---|---|---|---|
| **51** | Junction 10 | Priority 3 | NM03 | 61.1 | 75 | - | Negligible | Imperceptible | Occasional | Negligible |
| **52** | 38 Teck Whye Crescent (1) | Priority 3 | NM04a | 58.2 | 75 | - | Negligible | Imperceptible | Occasional | Negligible |
| **53** | 38 Teck Whye Crescent (2) | Priority 3 | NM04a | 58.5 | 75 | - | Negligible | Imperceptible | Occasional | Negligible |
| **54** | 38 Teck Whye Crescent (3) | Priority 3 | NM04a | 55.4 | 75 | - | Negligible | Imperceptible | Occasional | Negligible |
| **55** | 125 Verde View | Priority 2 | NM01 | 51.9 | 79 | - | Negligible | Imperceptible | Occasional | Negligible |
| **56** | 127 Verde View | Priority 2 | NM01 | 54.3 | 79 | - | Negligible | Imperceptible | Occasional | Negligible |
| **57** | 129 Verde View | Priority 2 | NM01 | 52.0 | 79 | - | Negligible | Imperceptible | Occasional | Negligible |
| **58** | Pacific Healthcare Nursing Home | Priority 1 | NM03 | 54.5 | 62 | - | Negligible | Very Low | Occasional | Minor |
| **59** | Pioneer Junior College | Priority 1 | N02 | 60.2 | 75 | - | Negligible | Very Low | Occasional | Minor |
| **60** | Senja Care Home, Vanguard Senior Care Senja Centre | Priority 1 | NM03 | 63.4 | 62 | 1.4 | Low | Low | Occasional | Minor |
| **61** | Senja Soka Centre (1) | Priority 1 | N02 | 52.8 | 75 | - | Negligible | Very Low | Occasional | Minor |
| **62** | Teck Whye Sec Sch (1) | Priority 1 | N02 | 59.9 | 75 | - | Negligible | Very Low | Occasional | Minor |
| **63** | Teck Whye Sec Sch (2) | Priority 1 | N02 | 62.2 | 75 | - | Negligible | Very Low | Occasional | Minor |
| **64** | Teck Whye Sec Sch (3) | Priority 1 | N02 | 53.3 | 75 | - | Negligible | Very Low | Occasional | Minor |
| **65** | The Tennery (1) | Priority 2 | NM03 | 63.7 | 75 | - | Negligible | Imperceptible | Occasional | Negligible |
| **66** | The Tennery (2) | Priority 2 | NM03 | 53.0 | 75 | - | Negligible | Imperceptible | Occasional | Negligible |

| No. | Human Receptors | Receptor Sensitivity | Nearest SLM | Predicted Construction Noise Levels | Corrected Criteria, dB(A) | Maximum Noise Exceedance, dB(A) | Impact Intensity | Impact Consequence | Likelihood | Impact Significance |
|---|---|---|---|---|---|---|---|---|---|---|
| **67** | West View Primary School (1) | Priority 1 | NM03 | 60.5 | 62 | - | Negligible | Very Low | Occasional | Minor |
| **68** | West View Primary School (2) | Priority 1 | NM03 | 62.6 | 62 | 0.6 | Low | Low | Occasional | Minor |

**Table 10-23 Summary of construction noise impacts: scenario 1: site preparation for earthworks – human receptors, LAeq (5min) (7am-7pm)**

| No. | Human Receptors | Receptor Sensitivity | Nearest SLM | Predicted Construction Noise Levels | Corrected Criteria, dB(A) | Maximum Noise Exceedance, dB(A) | Impact Intensity | Impact Consequence | Likelihood | Impact Significance |
|---|---|---|---|---|---|---|---|---|---|---|
| **1** | Bukit Panjang Exchange (1) | Priority 3 | NM03 | 63.0 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **2** | Bukit Panjang Exchange (2) | Priority 3 | NM03 | 59.2 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **3** | DE142 Gali Batu Bus Depot Site Office | Priority 3 | NM02a | 57.3 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **4** | HDB Blk 162 Jln Teck Whye (ground level) | Priority 2 | NM04a | 60.7 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **5** | HDB Blk 162 Jln Teck Whye (mid-level) | Priority 2 | NM04b | 62.1 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **6** | HDB Blk 162 Jln Teck Whye (top level) | Priority 2 | NM04c | 62.8 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **7** | HDB Blk 163 Jln Teck Whye (ground level) | Priority 2 | NM04a | 60.2 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **8** | HDB Blk 163 Jln Teck Whye (mid-level) | Priority 2 | NM04b | 61.6 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **9** | HDB Blk 163 Jln Teck Whye (top level) | Priority 2 | NM04c | 63.3 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **10** | HDB Blk 164 Jln Teck Whye (ground level) | Priority 2 | NM04a | 59.5 | 90 | - | Negligible | Imperceptible | Likely | Negligible |

| No. | Human Receptors | Receptor Sensitivity | Nearest SLM | Predicted Construction Noise Levels | Corrected Criteria, dB(A) | Maximum Noise Exceedance, dB(A) | Impact Intensity | Impact Consequence | Likelihood | Impact Significance |
|---|---|---|---|---|---|---|---|---|---|---|
| **11** | HDB Blk 164 Jln Teck Whye (mid-level) | Priority 2 | NM04b | 60.8 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **12** | HDB Blk 164 Jln Teck Whye (top level) | Priority 2 | NM04c | 62.5 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **13** | HDB Blk 606 Senja Road (ground level) | Priority 2 | N1a | 59.4 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **14** | HDB Blk 606 Senja Road (mid-level) | Priority 2 | N1b | 60.9 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **15** | HDB Blk 606 Senja Road (top level) | Priority 2 | N1c | 60.9 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **16** | HDB Blk 632A Senja Road (ground level) | Priority 2 | N1a | 66.2 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **17** | HDB Blk 632A Senja Road (top level) | Priority 2 | N1b | 66.4 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **18** | HDB Blk 632B Senja Road (ground level) | Priority 2 | N1a | 66.1 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **19** | HDB Blk 632B Senja Road (top level) | Priority 2 | N1b | 66.2 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **20** | HDB Blk 633 Senja Road (ground level) | Priority 2 | N1a | 59.1 | 90 | - | Negligible | Imperceptible | Likely | Negligible |

| No. | Human Receptors | Receptor Sensitivity | Nearest SLM | Predicted Construction Noise Levels | Corrected Criteria, dB(A) | Maximum Noise Exceedance, dB(A) | Impact Intensity | Impact Consequence | Likelihood | Impact Significance |
|---|---|---|---|---|---|---|---|---|---|---|
| **21** | HDB Blk 633A Senja Road (ground level) | Priority 2 | N1a | 64.3 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **22** | HDB Blk 633A Senja Road (mid-level) | Priority 2 | N1b | 64.7 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **23** | HDB Blk 633A Senja Road (top level) | Priority 2 | N1c | 64.7 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **24** | HDB Blk 633B Senja Road (ground level) | Priority 2 | N1a | 65.1 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **25** | HDB Blk 633B Senja Road (mid-level) | Priority 2 | N1b | 65.5 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **26** | HDB Blk 633B Senja Road (top level) | Priority 2 | N1c | 65.3 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **27** | HDB Blk 633C Senja Road (ground level) | Priority 2 | N1a | 63.2 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **28** | HDB Blk 633C Senja Road (mid-level) | Priority 2 | N1b | 64.9 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **29** | HDB Blk 633C Senja Road (top level) | Priority 2 | N1c | 64.5 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **30** | HDB Blk 633D Senja Road (ground level) | Priority 2 | N1a | 61.8 | 90 | - | Negligible | Imperceptible | Likely | Negligible |

| No. | Human Receptors | Receptor Sensitivity | Nearest SLM | Predicted Construction Noise Levels | Corrected Criteria, dB(A) | Maximum Noise Exceedance, dB(A) | Impact Intensity | Impact Consequence | Likelihood | Impact Significance |
|---|---|---|---|---|---|---|---|---|---|---|
| **31** | HDB Blk 633D Senja Road (mid-level) | Priority 2 | N1b | 63.6 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **32** | HDB Blk 633D Senja Road (top level) | Priority 2 | N1c | 63.6 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **33** | HDB Blk 634A Senja Road (ground level) | Priority 2 | N1a | 66.1 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **34** | HDB Blk 634A Senja Road (mid-level) | Priority 2 | N1b | 66.1 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **35** | HDB Blk 634A Senja Road (top level) | Priority 2 | N1c | 66.1 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **36** | HDB Blk 634B Senja Road (ground level) | Priority 2 | N1a | 59.0 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **37** | HDB Blk 634B Senja Road (mid-level) | Priority 2 | N1b | 61.0 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **38** | HDB Blk 634B Senja Road (top level) | Priority 2 | N1c | 61.0 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **39** | HDB Blk 634C Senja Road (ground level) | Priority 2 | N1a | 64.4 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **40** | HDB Blk 634C Senja Road (mid-level) | Priority 2 | N1b | 64.6 | 90 | - | Negligible | Imperceptible | Likely | Negligible |

| No. | Human Receptors | Receptor Sensitivity | Nearest SLM | Predicted Construction Noise Levels | Corrected Criteria, dB(A) | Maximum Noise Exceedance, dB(A) | Impact Intensity | Impact Consequence | Likelihood | Impact Significance |
|---|---|---|---|---|---|---|---|---|---|---|
| **41** | HDB Blk 634C Senja Road (top level) | Priority 2 | N1c | 64.6 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **42** | HDB Blk 635 Senja Road (ground level) | Priority 2 | NM02a | 58.5 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **43** | HDB Blk 635 Senja Road (mid-level) | Priority 2 | NM02b | 59.2 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **44** | HDB Blk 635 Senja Road (top level) | Priority 2 | NM02c | 59.0 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **45** | HDB Blk 635A Senja Road (ground level) | Priority 2 | NM02a | 66.1 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **46** | HDB Blk 635A Senja Road (mid-level) | Priority 2 | NM02b | 66.2 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **47** | HDB Blk 635A Senja Road (top level) | Priority 2 | NM02c | 65.5 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **48** | HDB Blk 635B Senja Road (ground level) | Priority 2 | NM02a | 61.6 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **49** | HDB Blk 635B Senja Road (mid-level) | Priority 2 | NM02b | 61.8 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **50** | HDB Blk 635B Senja Road (top level) | Priority 2 | NM02c | 61.8 | 90 | - | Negligible | Imperceptible | Likely | Negligible |

| No. | Human Receptors | Receptor Sensitivity | Nearest SLM | Predicted Construction Noise Levels | Corrected Criteria, dB(A) | Maximum Noise Exceedance, dB(A) | Impact Intensity | Impact Consequence | Likelihood | Impact Significance |
|---|---|---|---|---|---|---|---|---|---|---|
| **51** | Junction 10 | Priority 3 | NM03 | 64.1 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **52** | 38 Teck Whye Crescent (1) | Priority 3 | NM04a | 61.2 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **53** | 38 Teck Whye Crescent (2) | Priority 3 | NM04a | 61.5 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **54** | 38 Teck Whye Crescent (3) | Priority 3 | NM04a | 58.4 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **55** | 125 Verde View | Priority 2 | NM01 | 54.9 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **56** | 127 Verde View | Priority 2 | NM01 | 57.3 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **57** | 129 Verde View | Priority 2 | NM01 | 55.0 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **58** | Pacific Healthcare Nursing Home | Priority 1 | NM03 | 57.5 | 75 | - | Negligible | Very Low | Likely | Minor |
| **59** | Pioneer Junior College | Priority 1 | N02 | 63.2 | 90 | - | Negligible | Very Low | Likely | Minor |
| **60** | Senja Care Home, Vanguard Senior Care Senja Centre | Priority 1 | NM03 | 66.4 | 75 | - | Negligible | Very Low | Likely | Minor |
| **61** | Senja Soka Centre (1) | Priority 1 | N02 | 55.8 | 90 | - | Negligible | Very Low | Likely | Minor |
| **62** | Teck Whye Sec Sch (1) | Priority 1 | N02 | 62.9 | 90 | - | Negligible | Very Low | Likely | Minor |
| **63** | Teck Whye Sec Sch (2) | Priority 1 | N02 | 65.2 | 90 | - | Negligible | Very Low | Likely | Minor |
| **64** | Teck Whye Sec Sch (3) | Priority 1 | N02 | 56.3 | 90 | - | Negligible | Very Low | Likely | Minor |
| **65** | The Tennery (1) | Priority 2 | NM03 | 66.7 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **66** | The Tennery (2) | Priority 2 | NM03 | 56.0 | 90 | - | Negligible | Imperceptible | Likely | Negligible |

| No. | Human Receptors | Receptor Sensitivity | Nearest SLM | Predicted Construction Noise Levels | Corrected Criteria, dB(A) | Maximum Noise Exceedance, dB(A) | Impact Intensity | Impact Consequence | Likelihood | Impact Significance |
|---|---|---|---|---|---|---|---|---|---|---|
| **67** | West View Primary School (1) | Priority 1 | NM03 | 63.5 | 75 | - | Negligible | Very Low | Likely | Minor |
| **68** | West View Primary School (2) | Priority 1 | NM03 | 65.6 | 75 | - | Negligible | Very Low | Likely | Minor |

**Table 10-24 Summary of construction noise impacts: scenario 2: foundation works – human receptors, LAeq (12hr) (7am-7pm)**

| No. | Human Receptors | Receptor Sensitivity | Nearest SLM | Predicted Construction Noise Levels | Corrected Criteria, dB(A) | Maximum Noise Exceedance, dB(A) | Impact Intensity | Impact Consequence | Likelihood | Impact Significance |
|---|---|---|---|---|---|---|---|---|---|---|
| **1** | Bukit Panjang Exchange (1) | Priority 3 | NM03 | 67.2 | 75 | - | Negligible | Imperceptible | Occasional | Negligible |
| **2** | Bukit Panjang Exchange (2) | Priority 3 | NM03 | 63.2 | 75 | - | Negligible | Imperceptible | Occasional | Negligible |
| **3** | DE142 Gali Batu Bus Depot Site Office | Priority 3 | NM02a | 61.4 | 79 | - | Negligible | Imperceptible | Occasional | Negligible |
| **4** | HDB Blk 162 Jln Teck Whye (ground level) | Priority 2 | NM04a | 65.0 | 75 | - | Negligible | Imperceptible | Occasional | Negligible |
| **5** | HDB Blk 162 Jln Teck Whye (mid-level) | Priority 2 | NM04b | 66.4 | 75 | - | Negligible | Imperceptible | Occasional | Negligible |
| **6** | HDB Blk 162 Jln Teck Whye (top level) | Priority 2 | NM04c | 66.9 | 77 | - | Negligible | Imperceptible | Occasional | Negligible |
| **7** | HDB Blk 163 Jln Teck Whye (ground level) | Priority 2 | NM04a | 64.5 | 75 | - | Negligible | Imperceptible | Occasional | Negligible |
| **8** | HDB Blk 163 Jln Teck Whye (mid-level) | Priority 2 | NM04b | 66.0 | 75 | - | Negligible | Imperceptible | Occasional | Negligible |
| **9** | HDB Blk 163 Jln Teck Whye (top level) | Priority 2 | NM04c | 67.3 | 77 | - | Negligible | Imperceptible | Occasional | Negligible |
| **10** | HDB Blk 164 Jln Teck Whye (ground level) | Priority 2 | NM04a | 63.7 | 75 | - | Negligible | Imperceptible | Occasional | Negligible |

| No. | Human Receptors | Receptor Sensitivity | Nearest SLM | Predicted Construction Noise Levels | Corrected Criteria, dB(A) | Maximum Noise Exceedance, dB(A) | Impact Intensity | Impact Consequence | Likelihood | Impact Significance |
|---|---|---|---|---|---|---|---|---|---|---|
| **11** | HDB Blk 164 Jln Teck Whye (mid-level) | Priority 2 | NM04b | 65.1 | 75 | - | Negligible | Imperceptible | Occasional | Negligible |
| **12** | HDB Blk 164 Jln Teck Whye (top level) | Priority 2 | NM04c | 66.6 | 77 | - | Negligible | Imperceptible | Occasional | Negligible |
| **13** | HDB Blk 606 Senja Road (ground level) | Priority 2 | N1a | 63.4 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **14** | HDB Blk 606 Senja Road (mid-level) | Priority 2 | N1b | 64.9 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **15** | HDB Blk 606 Senja Road (top level) | Priority 2 | N1c | 64.9 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **16** | HDB Blk 632A Senja Road (ground level) | Priority 2 | N1a | 70.3 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **17** | HDB Blk 632A Senja Road (top level) | Priority 2 | N1b | 70.5 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **18** | HDB Blk 632B Senja Road (ground level) | Priority 2 | N1a | 70.2 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **19** | HDB Blk 632B Senja Road (top level) | Priority 2 | N1b | 70.3 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **20** | HDB Blk 633 Senja Road (ground level) | Priority 2 | N1a | 63.2 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |

| No. | Human Receptors | Receptor Sensitivity | Nearest SLM | Predicted Construction Noise Levels | Corrected Criteria, dB(A) | Maximum Noise Exceedance, dB(A) | Impact Intensity | Impact Consequence | Likelihood | Impact Significance |
|---|---|---|---|---|---|---|---|---|---|---|
| **21** | HDB Blk 633A Senja Road (ground level) | Priority 2 | N1a | 68.4 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **22** | HDB Blk 633A Senja Road (mid-level) | Priority 2 | N1b | 68.8 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **23** | HDB Blk 633A Senja Road (top level) | Priority 2 | N1c | 68.8 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **24** | HDB Blk 633B Senja Road (ground level) | Priority 2 | N1a | 69.2 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **25** | HDB Blk 633B Senja Road (mid-level) | Priority 2 | N1b | 69.5 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **26** | HDB Blk 633B Senja Road (top level) | Priority 2 | N1c | 69.5 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **27** | HDB Blk 633C Senja Road (ground level) | Priority 2 | N1a | 67.2 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **28** | HDB Blk 633C Senja Road (mid-level) | Priority 2 | N1b | 68.9 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **29** | HDB Blk 633C Senja Road (top level) | Priority 2 | N1c | 68.9 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **30** | HDB Blk 633D Senja Road (ground level) | Priority 2 | N1a | 65.9 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |

| No. | Human Receptors | Receptor Sensitivity | Nearest SLM | Predicted Construction Noise Levels | Corrected Criteria, dB(A) | Maximum Noise Exceedance, dB(A) | Impact Intensity | Impact Consequence | Likelihood | Impact Significance |
|---|---|---|---|---|---|---|---|---|---|---|
| **31** | HDB Blk 633D Senja Road (mid-level) | Priority 2 | N1b | 67.6 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **32** | HDB Blk 633D Senja Road (top level) | Priority 2 | N1c | 67.6 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **33** | HDB Blk 634A Senja Road (ground level) | Priority 2 | N1a | 70.1 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **34** | HDB Blk 634A Senja Road (mid-level) | Priority 2 | N1b | 70.1 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **35** | HDB Blk 634A Senja Road (top level) | Priority 2 | N1c | 70.1 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **36** | HDB Blk 634B Senja Road (ground level) | Priority 2 | N1a | 63.0 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **37** | HDB Blk 634B Senja Road (mid-level) | Priority 2 | N1b | 64.8 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **38** | HDB Blk 634B Senja Road (top level) | Priority 2 | N1c | 64.8 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **39** | HDB Blk 634C Senja Road (ground level) | Priority 2 | N1a | 68.4 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **40** | HDB Blk 634C Senja Road (mid-level) | Priority 2 | N1b | 68.6 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |

| No. | Human Receptors | Receptor Sensitivity | Nearest SLM | Predicted Construction Noise Levels | Corrected Criteria, dB(A) | Maximum Noise Exceedance, dB(A) | Impact Intensity | Impact Consequence | Likelihood | Impact Significance |
|---|---|---|---|---|---|---|---|---|---|---|
| **41** | HDB Blk 634C Senja Road (top level) | Priority 2 | N1c | 68.6 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **42** | HDB Blk 635 Senja Road (ground level) | Priority 2 | NM02a | 62.5 | 79 | - | Negligible | Imperceptible | Occasional | Negligible |
| **43** | HDB Blk 635 Senja Road (mid-level) | Priority 2 | NM02b | 63.1 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **44** | HDB Blk 635 Senja Road (top level) | Priority 2 | NM02c | 63.1 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **45** | HDB Blk 635A Senja Road (ground level) | Priority 2 | NM02a | 70.2 | 79 | - | Negligible | Imperceptible | Occasional | Negligible |
| **46** | HDB Blk 635A Senja Road (mid-level) | Priority 2 | NM02b | 70.2 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **47** | HDB Blk 635A Senja Road (top level) | Priority 2 | NM02c | 70.2 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **48** | HDB Blk 635B Senja Road (ground level) | Priority 2 | NM02a | 65.6 | 79 | - | Negligible | Imperceptible | Occasional | Negligible |
| **49** | HDB Blk 635B Senja Road (mid-level) | Priority 2 | NM02b | 65.8 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **50** | HDB Blk 635B Senja Road (top level) | Priority 2 | NM02c | 65.8 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |

| No. | Human Receptors | Receptor Sensitivity | Nearest SLM | Predicted Construction Noise Levels | Corrected Criteria, dB(A) | Maximum Noise Exceedance, dB(A) | Impact Intensity | Impact Consequence | Likelihood | Impact Significance |
|---|---|---|---|---|---|---|---|---|---|---|
| **51** | Junction 10 | Priority 3 | NM03 | 68.0 | 75 | - | Negligible | Imperceptible | Occasional | Negligible |
| **52** | 38 Teck Whye Crescent (1) | Priority 3 | NM04a | 65.7 | 75 | - | Negligible | Imperceptible | Occasional | Negligible |
| **53** | 38 Teck Whye Crescent (2) | Priority 3 | NM04a | 65.7 | 75 | - | Negligible | Imperceptible | Occasional | Negligible |
| **54** | 38 Teck Whye Crescent (3) | Priority 3 | NM04a | 62.5 | 75 | - | Negligible | Imperceptible | Occasional | Negligible |
| **55** | 125 Verde View | Priority 2 | NM01 | 58.9 | 79 | - | Negligible | Imperceptible | Occasional | Negligible |
| **56** | 127 Verde View | Priority 2 | NM01 | 61.3 | 79 | - | Negligible | Imperceptible | Occasional | Negligible |
| **57** | 129 Verde View | Priority 2 | NM01 | 59.0 | 79 | - | Negligible | Imperceptible | Occasional | Negligible |
| **58** | Pacific Healthcare Nursing Home | Priority 1 | NM03 | 61.5 | 62 | - | Negligible | Very Low | Occasional | Minor |
| **59** | Pioneer Junior College | Priority 1 | N02 | 67.3 | 75 | - | Negligible | Very Low | Occasional | Minor |
| **60** | Senja Care Home, Vanguard Senior Care Senja Centre | Priority 1 | NM03 | 70.4 | 62 | 8.4 | High | High | Occasional | Moderate |
| **61** | Senja Soka Centre (1) | Priority 1 | N02 | 60.0 | 75 | - | Negligible | Very Low | Occasional | Minor |
| **62** | Teck Whye Sec Sch (1) | Priority 1 | N02 | 66.8 | 75 | - | Negligible | Very Low | Occasional | Minor |
| **63** | Teck Whye Sec Sch (2) | Priority 1 | N02 | 69.3 | 75 | - | Negligible | Very Low | Occasional | Minor |
| **64** | Teck Whye Sec Sch (3) | Priority 1 | N02 | 60.1 | 75 | - | Negligible | Very Low | Occasional | Minor |
| **65** | The Tennery (1) | Priority 2 | NM03 | 70.7 | 75 | - | Negligible | Imperceptible | Occasional | Negligible |
| **66** | The Tennery (2) | Priority 2 | NM03 | 59.9 | 75 | - | Negligible | Imperceptible | Occasional | Negligible |

| No. | Human Receptors | Receptor Sensitivity | Nearest SLM | Predicted Construction Noise Levels | Corrected Criteria, dB(A) | Maximum Noise Exceedance, dB(A) | Impact Intensity | Impact Consequence | Likelihood | Impact Significance |
|---|---|---|---|---|---|---|---|---|---|---|
| **67** | West View Primary School (1) | Priority 1 | NM03 | 67.6 | 62 | 5.6 | High | High | Occasional | Moderate |
| **68** | West View Primary School (2) | Priority 1 | NM03 | 69.6 | 62 | 7.6 | High | High | Occasional | Moderate |

**Table 10-25 Summary of construction noise impacts: scenario 2: foundation works – human receptors, LAeq (5min) (7am-7pm)**

| No. | Human Receptors | Receptor Sensitivity | Nearest SLM | Predicted Construction Noise Levels | Corrected Criteria, dB(A) | Maximum Noise Exceedance, dB(A) | Impact Intensity | Impact Consequence | Likelihood | Impact Significance |
|---|---|---|---|---|---|---|---|---|---|---|
| **1** | Bukit Panjang Exchange (1) | Priority 3 | NM03 | 70.2 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **2** | Bukit Panjang Exchange (2) | Priority 3 | NM03 | 66.2 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **3** | DE142 Gali Batu Bus Depot Site Office | Priority 3 | NM02a | 64.4 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **4** | HDB Blk 162 Jln Teck Whye (ground level) | Priority 2 | NM04a | 68.0 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **5** | HDB Blk 162 Jln Teck Whye (mid-level) | Priority 2 | NM04b | 69.4 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **6** | HDB Blk 162 Jln Teck Whye (top level) | Priority 2 | NM04c | 69.9 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **7** | HDB Blk 163 Jln Teck Whye (ground level) | Priority 2 | NM04a | 67.5 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **8** | HDB Blk 163 Jln Teck Whye (mid-level) | Priority 2 | NM04b | 69.0 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **9** | HDB Blk 163 Jln Teck Whye (top level) | Priority 2 | NM04c | 70.3 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **10** | HDB Blk 164 Jln Teck Whye (ground level) | Priority 2 | NM04a | 66.7 | 90 | - | Negligible | Imperceptible | Likely | Negligible |

| No. | Human Receptors | Receptor Sensitivity | Nearest SLM | Predicted Construction Noise Levels | Corrected Criteria, dB(A) | Maximum Noise Exceedance, dB(A) | Impact Intensity | Impact Consequence | Likelihood | Impact Significance |
|---|---|---|---|---|---|---|---|---|---|---|
| **11** | HDB Blk 164 Jln Teck Whye (mid-level) | Priority 2 | NM04b | 68.1 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **12** | HDB Blk 164 Jln Teck Whye (top level) | Priority 2 | NM04c | 69.6 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **13** | HDB Blk 606 Senja Road (ground level) | Priority 2 | N1a | 66.4 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **14** | HDB Blk 606 Senja Road (mid-level) | Priority 2 | N1b | 67.9 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **15** | HDB Blk 606 Senja Road (top level) | Priority 2 | N1c | 67.9 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **16** | HDB Blk 632A Senja Road (ground level) | Priority 2 | N1a | 73.3 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **17** | HDB Blk 632A Senja Road (top level) | Priority 2 | N1b | 73.5 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **18** | HDB Blk 632B Senja Road (ground level) | Priority 2 | N1a | 73.2 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **19** | HDB Blk 632B Senja Road (top level) | Priority 2 | N1b | 73.3 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **20** | HDB Blk 633 Senja Road (ground level) | Priority 2 | N1a | 66.2 | 90 | - | Negligible | Imperceptible | Likely | Negligible |

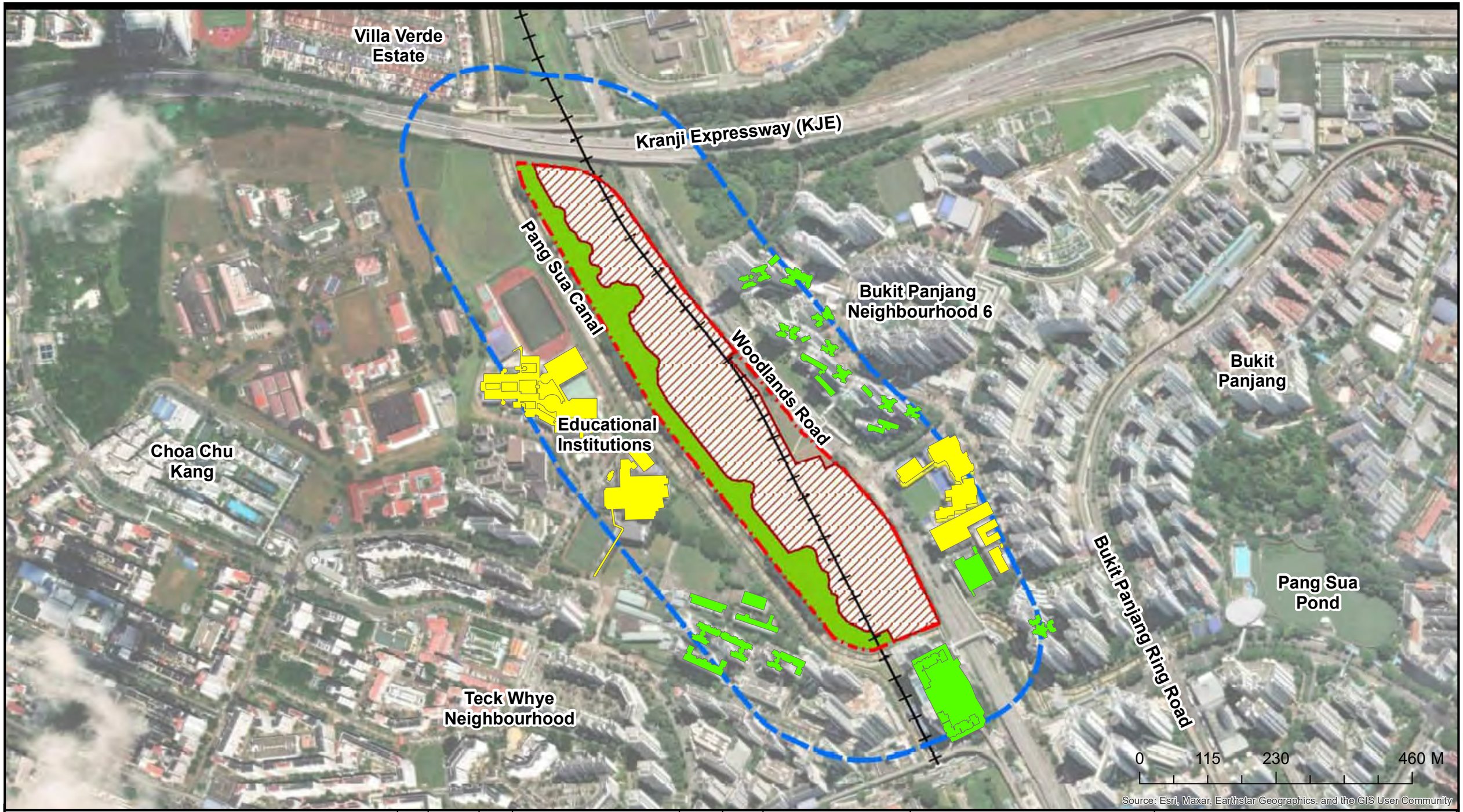
| No. | Human Receptors | Receptor Sensitivity | Nearest SLM | Predicted Construction Noise Levels | Corrected Criteria, dB(A) | Maximum Noise Exceedance, dB(A) | Impact Intensity | Impact Consequence | Likelihood | Impact Significance |
|---|---|---|---|---|---|---|---|---|---|---|
| **21** | HDB Blk 633A Senja Road (ground level) | Priority 2 | N1a | 71.4 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **22** | HDB Blk 633A Senja Road (mid-level) | Priority 2 | N1b | 71.8 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **23** | HDB Blk 633A Senja Road (top level) | Priority 2 | N1c | 71.8 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **24** | HDB Blk 633B Senja Road (ground level) | Priority 2 | N1a | 72.2 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **25** | HDB Blk 633B Senja Road (mid-level) | Priority 2 | N1b | 72.5 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **26** | HDB Blk 633B Senja Road (top level) | Priority 2 | N1c | 72.5 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **27** | HDB Blk 633C Senja Road (ground level) | Priority 2 | N1a | 70.2 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **28** | HDB Blk 633C Senja Road (mid-level) | Priority 2 | N1b | 71.9 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **29** | HDB Blk 633C Senja Road (top level) | Priority 2 | N1c | 71.9 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **30** | HDB Blk 633D Senja Road (ground level) | Priority 2 | N1a | 68.9 | 90 | - | Negligible | Imperceptible | Likely | Negligible |

| No. | Human Receptors | Receptor Sensitivity | Nearest SLM | Predicted Construction Noise Levels | Corrected Criteria, dB(A) | Maximum Noise Exceedance, dB(A) | Impact Intensity | Impact Consequence | Likelihood | Impact Significance |
|---|---|---|---|---|---|---|---|---|---|---|
| **31** | HDB Blk 633D Senja Road (mid-level) | Priority 2 | N1b | 70.6 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **32** | HDB Blk 633D Senja Road (top level) | Priority 2 | N1c | 70.6 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **33** | HDB Blk 634A Senja Road (ground level) | Priority 2 | N1a | 73.1 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **34** | HDB Blk 634A Senja Road (mid-level) | Priority 2 | N1b | 73.1 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **35** | HDB Blk 634A Senja Road (top level) | Priority 2 | N1c | 73.1 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **36** | HDB Blk 634B Senja Road (ground level) | Priority 2 | N1a | 66.0 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **37** | HDB Blk 634B Senja Road (mid-level) | Priority 2 | N1b | 67.8 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **38** | HDB Blk 634B Senja Road (top level) | Priority 2 | N1c | 67.8 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **39** | HDB Blk 634C Senja Road (ground level) | Priority 2 | N1a | 71.4 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **40** | HDB Blk 634C Senja Road (mid-level) | Priority 2 | N1b | 71.6 | 90 | - | Negligible | Imperceptible | Likely | Negligible |

| No. | Human Receptors | Receptor Sensitivity | Nearest SLM | Predicted Construction Noise Levels | Corrected Criteria, dB(A) | Maximum Noise Exceedance, dB(A) | Impact Intensity | Impact Consequence | Likelihood | Impact Significance |
|---|---|---|---|---|---|---|---|---|---|---|
| **41** | HDB Blk 634C Senja Road (top level) | Priority 2 | N1c | 71.6 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **42** | HDB Blk 635 Senja Road (ground level) | Priority 2 | NM02a | 65.5 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **43** | HDB Blk 635 Senja Road (mid-level) | Priority 2 | NM02b | 66.1 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **44** | HDB Blk 635 Senja Road (top level) | Priority 2 | NM02c | 66.1 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **45** | HDB Blk 635A Senja Road (ground level) | Priority 2 | NM02a | 73.2 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **46** | HDB Blk 635A Senja Road (mid-level) | Priority 2 | NM02b | 73.2 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **47** | HDB Blk 635A Senja Road (top level) | Priority 2 | NM02c | 73.2 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **48** | HDB Blk 635B Senja Road (ground level) | Priority 2 | NM02a | 68.6 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **49** | HDB Blk 635B Senja Road (mid-level) | Priority 2 | NM02b | 68.8 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **50** | HDB Blk 635B Senja Road (top level) | Priority 2 | NM02c | 68.8 | 90 | - | Negligible | Imperceptible | Likely | Negligible |

| No. | Human Receptors | Receptor Sensitivity | Nearest SLM | Predicted Construction Noise Levels | Corrected Criteria, dB(A) | Maximum Noise Exceedance, dB(A) | Impact Intensity | Impact Consequence | Likelihood | Impact Significance |
|---|---|---|---|---|---|---|---|---|---|---|
| **51** | Junction 10 | Priority 3 | NM03 | 71.0 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **52** | 38 Teck Whye Crescent (1) | Priority 3 | NM04a | 68.7 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **53** | 38 Teck Whye Crescent (2) | Priority 3 | NM04a | 68.7 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **54** | 38 Teck Whye Crescent (3) | Priority 3 | NM04a | 65.5 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **55** | 125 Verde View | Priority 2 | NM01 | 61.9 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **56** | 127 Verde View | Priority 2 | NM01 | 64.3 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **57** | 129 Verde View | Priority 2 | NM01 | 62.0 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **58** | Pacific Healthcare Nursing Home | Priority 1 | NM03 | 64.5 | 75 | - | Negligible | Very Low | Likely | Minor |
| **59** | Pioneer Junior College | Priority 1 | N02 | 70.3 | 90 | - | Negligible | Very Low | Likely | Minor |
| **60** | Senja Care Home, Vanguard Senior Care Senja Centre | Priority 1 | NM03 | 73.4 | 75 | - | Negligible | Very Low | Likely | Minor |
| **61** | Senja Soka Centre (1) | Priority 1 | N02 | 63.0 | 90 | - | Negligible | Very Low | Likely | Minor |
| **62** | Teck Whye Sec Sch (1) | Priority 1 | N02 | 69.8 | 90 | - | Negligible | Very Low | Likely | Minor |
| **63** | Teck Whye Sec Sch (2) | Priority 1 | N02 | 72.3 | 90 | - | Negligible | Very Low | Likely | Minor |
| **64** | Teck Whye Sec Sch (3) | Priority 1 | N02 | 63.1 | 90 | - | Negligible | Very Low | Likely | Minor |
| **65** | The Tennery (1) | Priority 2 | NM03 | 73.7 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **66** | The Tennery (2) | Priority 2 | NM03 | 62.9 | 90 | - | Negligible | Imperceptible | Likely | Negligible |

| No. | Human Receptors | Receptor Sensitivity | Nearest SLM | Predicted Construction Noise Levels | Corrected Criteria, dB(A) | Maximum Noise Exceedance, dB(A) | Impact Intensity | Impact Consequence | Likelihood | Impact Significance |
|---|---|---|---|---|---|---|---|---|---|---|
| **67** | West View Primary School (1) | Priority 1 | NM03 | 70.6 | 75 | - | Negligible | Very Low | Likely | Minor |
| **68** | West View Primary School (2) | Priority 1 | NM03 | 72.6 | 75 | - | Negligible | Very Low | Likely | Minor |




## Legend

- CCK N1 Project Site
- Airborne Noise Study Area (150m)
- Rail Corridor
- Proposed Construction Footprint*
- Proposed Development Boundary*
- Proposed Ecological Corridor*

**Impact Significance**

- Negligible
- Minor
- Moderate
- Major

* exact boundaries/ alignment subject to further changes

N

| Rev. | Date | By | Description | Chk'd | App'd |
|---|---|---|---|---|---|
| - | SEP 2022 | SYT | Draft Final Report | NHT | JAG |

Qualified Person Endorsement : NA

HDB Endorsement : NA

Consultant : AECOM

Client: HOUSING & DEVELOPMENT BOARD

Project Title :

**ENVIRONMENTAL IMPACT ASSESSMENT (EIA) ON CHOA CHU KANG N1**

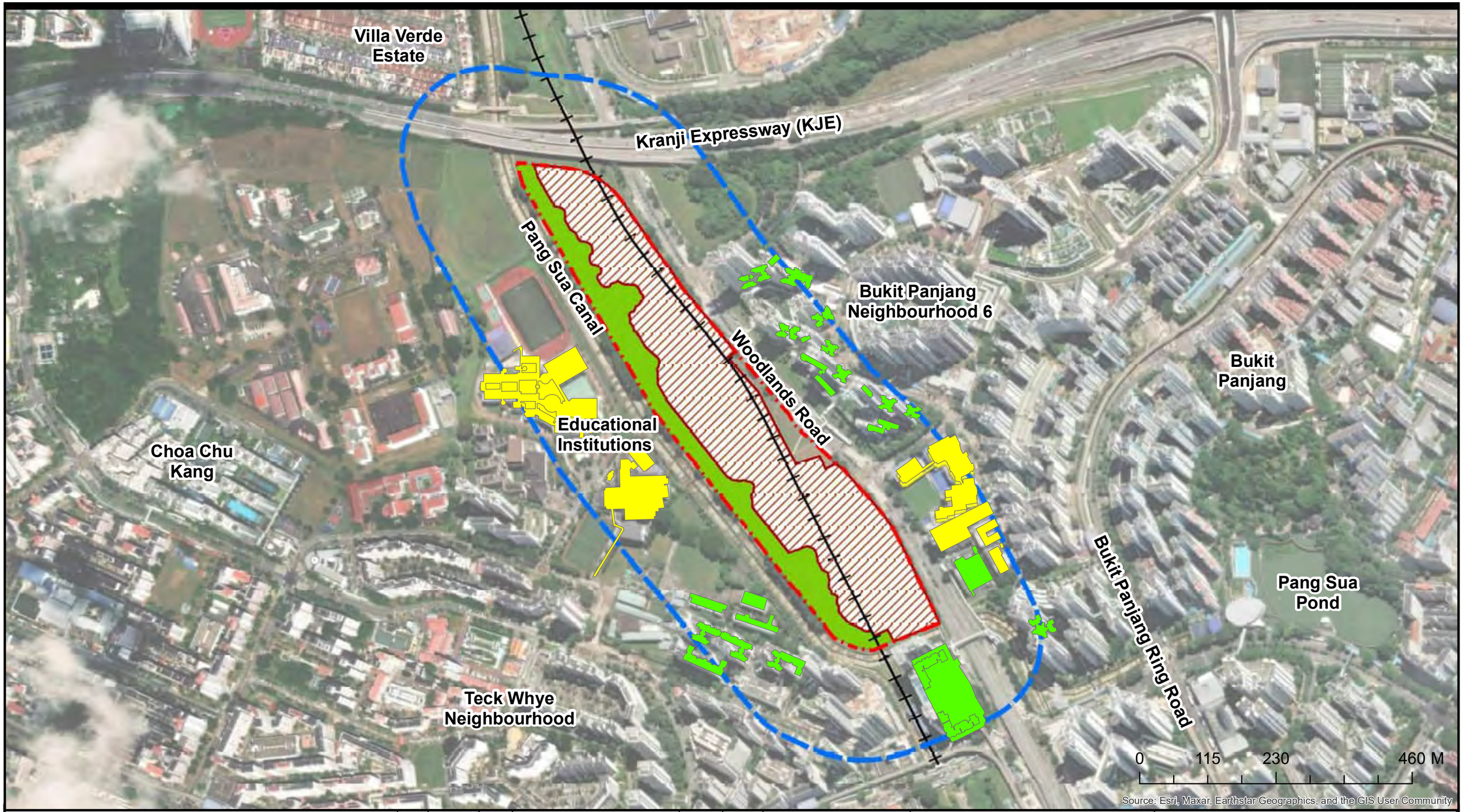
Figure Title :

**Human Noise Sensitive Receptors - Scenario 1: Site Preparation for Earthworks, LAeq(12 hours), 7am - 7pm (Base Assessment Scenario)**

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## Legend

- CCK N1 Project Site
- Airborne Noise Study Area (150m)
- Rail Corridor
- Proposed Construction Footprint*
- Proposed Development Boundary*
- Proposed Ecological Corridor*

**Impact Significance**

- Negligible
- Minor
- Moderate
- Major

* exact boundaries/ alignment subject to further changes

N

| Rev. | Date | By | Description | Chk'd | App'd |
|---|---|---|---|---|---|
| - | SEP 2022 | SYT | Draft Final Report | NHT | JAG |

Qualified Person Endorsement : NA

HDB Endorsement : NA

Consultant : AECOM

Client: HOUSING & DEVELOPMENT BOARD

Project Title :

**ENVIRONMENTAL IMPACT ASSESSMENT (EIA) ON CHOA CHU KANG N1**

Figure Title :

**Human Noise Sensitive Receptors - Scenario 1: Site Preparation for Earthworks, LAeq(12 hours), 7am - 7pm (Base Assessment Scenario)**

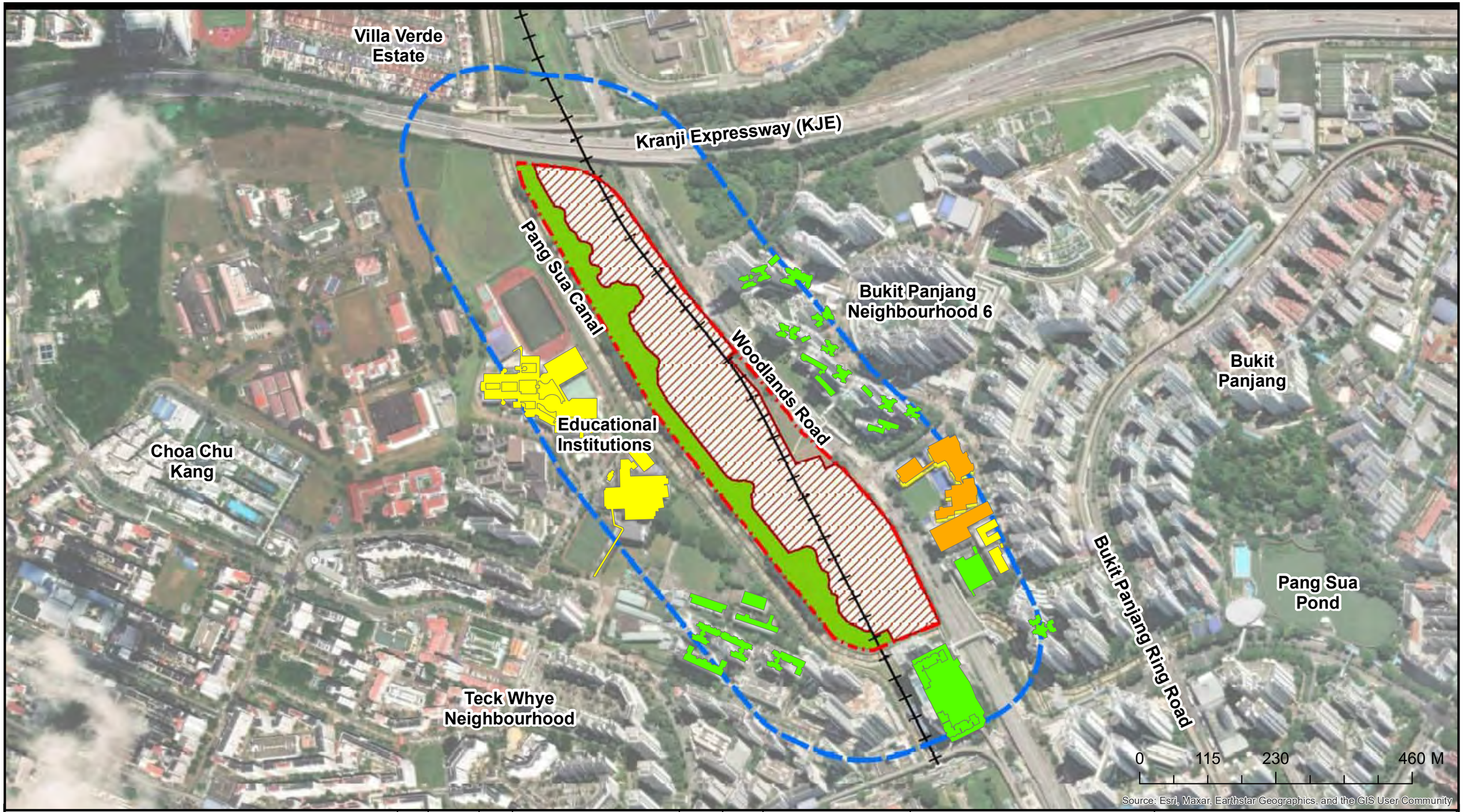
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| | Drawn: SYT | Date: SEP 2022 |

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CAD File Name : NA | A3

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## Legend

- CCK N1 Project Site
- Airborne Noise Study Area (150m)
- Rail Corridor
- Proposed Construction Footprint*
- Proposed Development Boundary*
- Proposed Ecological Corridor*

**Impact Significance**

- Negligible
- Minor
- Moderate
- Major

* exact boundaries/ alignment subject to further changes

N

| Rev. | Date | By | Description | Chk'd | App'd |
|---|---|---|---|---|---|
| - | SEP 2022 | SYT | Draft Final Report | NHT | JAG |

Qualified Person Endorsement : NA

HDB Endorsement : NA

Consultant : AECOM

Client: HOUSING & DEVELOPMENT BOARD

Project Title :

**ENVIRONMENTAL IMPACT ASSESSMENT (EIA) ON CHOA CHU KANG N1**

Figure Title :

**Human Noise Sensitive Receptors - Scenario 1: Site Preparation for Earthworks, LAeq(12 hours), 7am - 7pm (Base Assessment Scenario)**

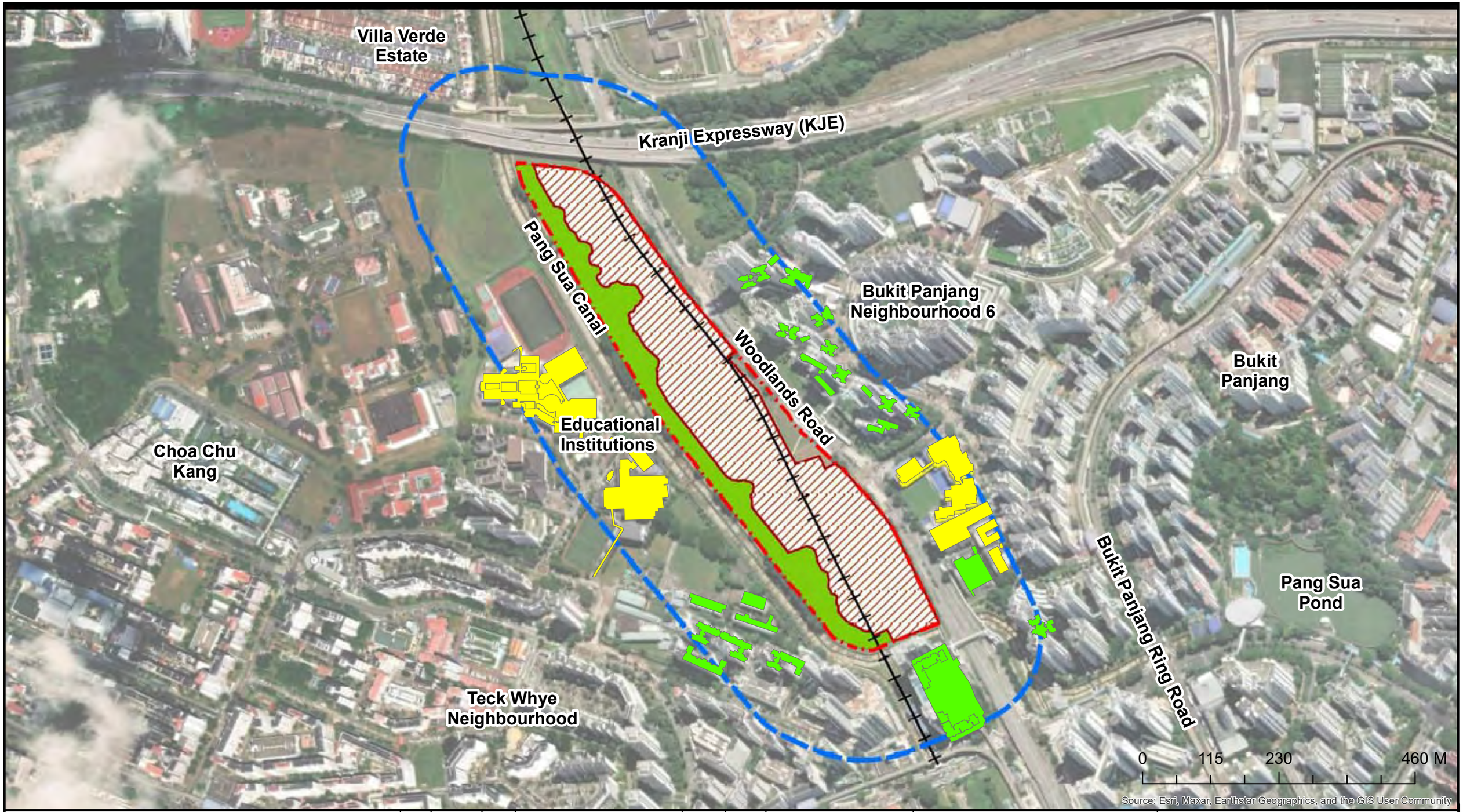
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| SAG | NHT | JAG |
| | Drawn: SYT | Date: SEP 2022 |

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## Legend

- CCK N1 Project Site
- Airborne Noise Study Area (150m)
- Rail Corridor
- Proposed Construction Footprint*
- Proposed Development Boundary*
- Proposed Ecological Corridor*

**Impact Significance**

- Negligible
- Minor
- Moderate
- Major

* exact boundaries/ alignment subject to further changes

N

| Rev. | Date | By | Description | Chk'd | App'd |
|---|---|---|---|---|---|
| - | SEP 2022 | SYT | Draft Final Report | NHT | JAG |

Qualified Person Endorsement : NA

HDB Endorsement : NA

Consultant : AECOM

Client: HOUSING & DEVELOPMENT BOARD

Project Title :

**ENVIRONMENTAL IMPACT ASSESSMENT (EIA) ON CHOA CHU KANG N1**

Figure Title :

**Human Noise Sensitive Receptors - Scenario 1: Site Preparation for Earthworks, LAeq(12 hours), 7am - 7pm (Base Assessment Scenario)**

| Designed | Checked | Approved |
|---|---|---|
| SAG | NHT | JAG |
| | Drawn: SYT | Date: SEP 2022 |

Figure No. : 10 - 12 | Rev. : - | Sheet : 1 of 1

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## 10.7.2 Operational Phase

This section discusses on the operational noise impacts associated with noise emissions arising from ACMV systems of non-industrial buildings and vehicular noise on new/ existing traffic networks within the vicinity of the Project site. As discussed in Section 10.2.1.2, a qualitative means of assessment has been adopted in the assessment for operational noise impacts due to the lack of detailed design information required for the assessment of operational noise impacts relating to ACMV systems and land traffic noise.

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

- ACMV noise from services emitted from non-industrial buildings as part of the Project development; 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 Airborne Noise Study Area.

Operational noise arising from ACMV systems, if any, are expected to persist throughout the day, emitting from proposed non-industrial buildings depending on the nature of the eventual establishment. While land traffic noise emissions are expected to follow traffic trends, peaking during traffic peak hours.

### 10.7.2.1 Ecological Receptors

Ecological receptors considered for assessment for operational noise impacts shall consider similar ecological receptors identified for the construction phase as discussed in Section 10.4.1.1. It should be noted that the larger impact on the area regardless of noise is due to the redevelopment of the forested areas into urbanized developments and the removal/ degradation of habitats.

Whether the fauna species identified within the Project site prior to construction works will remain/ return to these areas or take shelter and/ or develop new habitats elsewhere at nearby CCNR and Khatib Bongsu during the operational phase is uncertain at this stage making it difficult to analyse the potential impact of operational noise on ecological receptors.

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.

#### 10.7.2.1.1 Air Conditioning and Mechanical Ventilation Noise Impact

With reference to information on the proposed developments within the Project site (see Figure 10-1), proposed development establishments have been identified as non-industrial buildings that may potentially emit noise from ACMV systems during periods of operation.

Ecological receptors typically have the propensity for avoiding areas with concentration of human presence such as residential/ commercial estates. As the Ecological Corridor where fauna species are shepherded towards will be surrounded by residential, commercial, and institutional developments upon commencement of the operational phase, it is likely that the ecological receptors will continue to steer clear of these areas, moving deeper into the nearby Ecological Corridor in attempts to avoid encounters with humans.

Besides, it should also be noted that while the Ecological Corridor is surrounded the residential, commercial, and institutional developments, at the current stage, only the Proposed development makes up for the non-industrial buildings that may contribute to the operational noise impacts. Assuming that the noise regulations detailed in the ACMV Guideline, 2018 [R-38] will be met by the contractors of the proposed developments if any non-industrial buildings were to be proposed at the detailed design stage, it was qualitatively assessed that the operational noise impacts experienced by the ecological receptors are likely to be of small magnitude and reversible.

As such, the Impact Intensity for ecological receptors subjected to operational noise from ACMV systems are deduced as **Negligible** (refer to Table 6-5) with a corresponding Impact Consequence of **Very Low** (refer to Table 6-6) depending on the sensitivity of the receptor. With a Likelihood of Occurrence of noise emissions affecting the ecological receptors being **Less Likely**/ **Rare** (see Table 10-8) attributed to their behaviour of avoiding areas with human presence, the overall Impact Significance can be qualitatively assessed as **Negligible** (refer to Table 6-8) for operational noise impacts arising from potential ACMV systems.

#### 10.7.2.1.2 Land Traffic Noise Impact

Studies on land traffic noise impact on fauna species have found that traffic noise indirectly impacts habitat quality and can alter how fauna species use their primary sensory systems to detect or recognize important cues such as the ability to forage, communicate, find mates, and avoid predators. Species diversity, occupancy, reproductive stress, and survival can also be affected through masking induced by traffic noise of both territorial and predatory calls, eliciting avoidance behaviour and stress response [P-46, P-47].

In regard to the land traffic noise impacts arising from the operations of the proposed development will not significantly increase. Therefore, the Impact Intensity for ecological receptors subjected to operational noise from land traffic are deduced as **Low** (refer to Table 6-5) with a corresponding Impact Consequence of **Low** (refer to Table 6-6) depending on the sensitivity of the receptor. With a Likelihood of Occurrence of noise emissions affecting the ecological receptors being **Possible**/ **Occasional** (see Table 10-8) with the mobile ecological receptors being able to retreat deeper into the nearby Biodiversity Study Area during hours of peak traffic, the overall Impact Significance can be qualitatively assessed to range from **Minor** (refer to Table 6-8) for operational noise impacts arising from land traffic.

**Table 10-26 Summary of operational noise impacts – ecological receptors**

| Auditory Sensitivity | Impact Intensity | Impact Consequence | Likelihood | Impact Significance |
|---|---|---|---|---|
| **ACMV Noise Impact** | | | | |
| Priority 1 | Negligible | Very Low | Less Likely/ Rare | Negligible |
| **Land Traffic Noise Impact** | | | | |
| Priority 1 | Low | Low | Possible/ Occasional | Minor |

### 10.7.2.2 Human Receptors

Human receptors for the operational phase should be identified and assessed as part of operational noise impacts arising from noise associated with the ACMV systems of non-industrial buildings, and as part of TNIA for land traffic noise. Both elements should be conducted by Noise Consultant(s) engaged by HDB/ contractor engaged by HDB to conduct ACMV boundary noise impact assessment for the human receptors at the boundaries of the non-industrial buildings, as well as TNIA on nearby residential and noise sensitive receptors affected by vehicular noise on new/ existing traffic networks as per the guidelines discussed in Section 10.2.5.1.2.2 .

Additionally, the contractors of the proposed developments should assess the noise impacts arising from Woodlands Road if within audible range following the same guidelines to determine the potential noise impacts arising from the existing road networks on future residential and noise sensitive receptors to facilitate the planning of the developments within the Project site.

#### 10.7.2.2.1 Air Conditioning and Mechanical Ventilation Boundary Noise Impact Assessment

In accordance with requirements outlined in ACMV Guideline, 2018 [R-38], human receptors at the immediate boundary of the proposed non-industrial buildings shall be assessed for operational noise impacts arising from noise emissions from ACMV systems. Based on current available information of proposed developments within the Project site (refer to Section 3.3), no non-industrial buildings have been planned for construction.

Due to the lack of detailed design information required for assessment of operational noise impacts relating to possible ACMV systems, it was qualitatively assessed that operational noise emissions arising from the non-industrial buildings (if any) may result in non-intrusive increase in noise levels that cannot be detected by the human receptors. As such, the Impact Intensity for human receptors subjected to operational noise from ACMV systems are deduced as **Negligible** (refer to Table 6-5) with a corresponding Impact Consequence of **Imperceptible** – **Very Low** (refer to Table 6-6) depending on the sensitivity of the receptor. With a Likelihood of Occurrence of noise emissions affecting the existing human receptors being **Unlikely**/ **Remote** (see Table 10-8) with no existing human receptors immediately abutting the boundary of non-industrial buildings, the overall Impact Significance can be qualitatively assessed to range from **Negligible** – **Minor** (refer to Table 6-8) for operational noise impacts arising from ACMV systems.

#### 10.7.2.2.2 Land Traffic Noise Impact Assessment

In accordance with the requirements outlined in TNIA Guideline, 2016 [R-37], noise sensitive premises and residential buildings within the 70m Study Area from new/ existing traffic networks are assessed for operational noise impacts arising from vehicular noise. With the proposed establishment of the residential estate (see Figure 10-1) along with the proposed new road networks serving these establishments, vehicular volumes within the Project site and on nearby existing Woodlands Road are likely to see an increase resulting in higher traffic noise levels in the area.

As such, it was qualitatively assessed that the increase in traffic noise levels are likely to be noticeable and mildly intrusive to the existing noise sensitive and residential premises identified in Section 10.4.1.2, with the noise levels potentially resulting in small changes in behaviours residents choosing to close their windows to reduce indoor noise levels, which may slightly affect character of the area but not such that there is a perceived change in quality of life.

Therefore, the Impact Intensity for human receptors subjected to operational noise from land traffic are deduced as **Low** (refer to Table 6-5) with a corresponding Impact Consequence of **Very Low** –**Low** (refer to Table 6-6) depending on the sensitivity of the receptor. With a Likelihood of Occurrence of noise emissions affecting the existing human receptors being **Possible/ Occasional** (see Table 10-8) with the human receptors being fixed and unable to move away from the source, the overall Impact Significance can be qualitatively assessed to range from **Negligible** – **Minor** (refer to Table 6-8) for operational noise impacts arising from land traffic.

**Table 10-27 Summary of operational noise impacts – human receptors**

| Noise Sensitive Human Receptors* | Impact Intensity | Impact Consequence | Likelihood | Impact Significance |
|---|---|---|---|---|
| **ACMV Boundary Noise Impact Assessment** | | | | |
| (a) Noise Sensitive Premises | Negligible | Very Low | Unlikely/ Remote | Minor |
| (b) Residential Premises | Negligible | Imperceptible | Unlikely/ Remote | Negligible |
| **TNIA** | | | | |
| Noise Sensitive Premises | Low | Low | Possible/ Occasional | Minor |
| Residential Premises | Low | Very Low | Possible/ Occasional | Minor |
| *Note: * Refer to the respective noise legislations for definition of human receptors.* | | | | |

# 10.8 Recommended Mitigation Measures

## 10.8.1 Construction Phase

Due to the proximity of the NSRs to the Project site boundary, mitigation measures for the control of noise at source were recommended as per the mitigation principles outlined in Section 6.5.

### 10.8.1.1 Avoid

#### 10.8.1.1.1 High Noise Powered Mechanical Equipment

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

### 10.8.1.2 Minimise

#### 10.8.1.2.1 Extension of Wildlife Shepherding

Under the consideration that less mobile fauna species present in areas bounded by the proposed construction worksites and OCC (a fenced-up area) may end up being trapped and subjected to severe noise impacts once construction works commences, directional wildlife shepherding has been extended to include fauna species found within these areas. The fauna species found within areas not stipulated for proposed developments on the Northern-tip of the Project site were however excluded from wildlife shepherding as fauna located in the area were deemed as not subjected to the potential of being trapped or confined.

As such, all fauna species previously recorded within these areas shall also be displaced upon commencement of works with the exception of those found within the northern tip of the Project site.

#### 10.8.1.2.2 Erect Noise Barriers

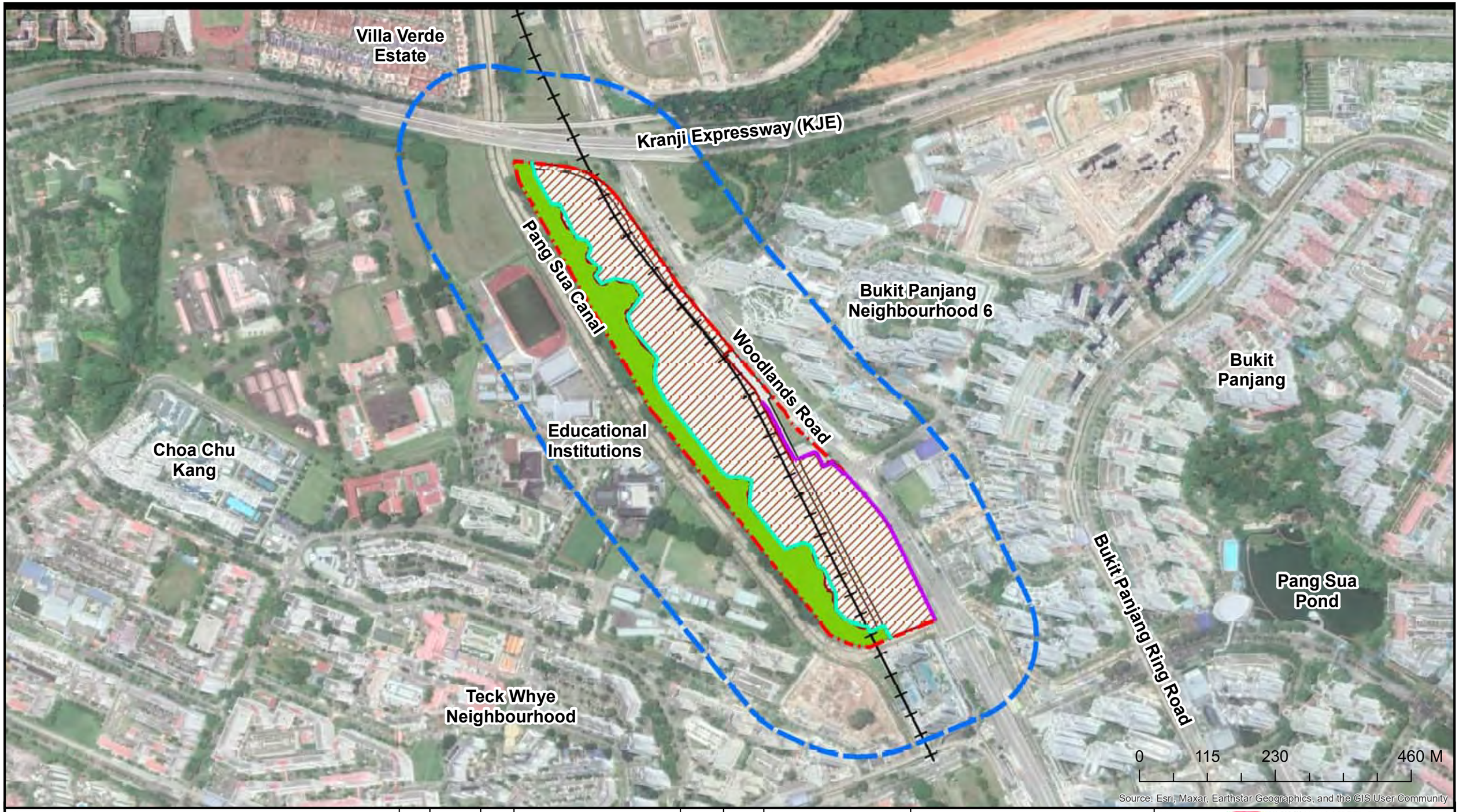
When substitution of noisy equipment is not applicable or feasible, erection of noise barriers should be considered. The barrier height and placement position of a noise barrier are the prime factors in determining its efficiency and are as follows:

- 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 will not require noise barriers.

Following the above suggestions, the height of the noise barriers were determined based on the heights of the receptors in the vicinity of the construction worksites and the viability of implementation with consideration of space required to stabilize and erect the barriers.

Noise barriers of 3 m height (facing along the ecological receptors) and 12m in height (facing West View Primary School and Senja Care Home) were proposed where deemed necessary to be erected at locations along the construction worksites near NSRs predicted to experience considerable noise exceedances as discussed in Section 10.7.1 to mitigate noise impacts to as low as reasonably practicable (ALARP). The placement of the noise barriers are visualized in Figure 10-13

Contractors should note that the erection of noise barriers must not result in additional clearance to vegetation beyond the bounds of the construction worksites area.




## Legend

- Proposed 3m Noise Barrier
- Proposed 12m Noise Barrier
- CCK N1 Project Site
- Airborne Noise Study Area (150m)
- Original Track Alignment
- Proposed Construction Footprint*
- Proposed Development Boundary*
- Proposed Ecological Corridor*

* exact boundaries/ alignment subject to further changes

N

| Rev. | Date | By | Description | Chk'd | App'd |
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| - | SEP 2022 | SYT | Draft Final Report | NHT | JAG |

Qualified Person Endorsement : NA

HDB Endorsement : NA

Consultant : AECOM

Client: HOUSING & DEVELOPMENT BOARD

Project Title :

**ENVIRONMENTAL IMPACT ASSESSMENT (EIA) ON CHOA CHU KANG N1**

Figure Title :

**Proposed Airborne Noise Mitigation Measures**

| Designed | Checked | Approved | Figure No. : | Rev. | Sheet |
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#### 10.8.1.2.3 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 10-28 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 10-28 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 10-28 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 | Manufacturers' enclosure panels to be kept closed. The engines of these vehicles shall not be exposed and clad with the manufacturers' 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 | |
| | 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) [R-32], 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.

#### 10.8.1.2.4 Administrative Controls to further reduce noise

It is recommended to reduce noise impact to avifauna by various administrative controls at the Airborne Noise Study Area. For example, avoid breeding seasons 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.

Other than that, the following administrative control measures should also be observed during the construction stage to further reduce the noise levels, especially on human receptors:

- 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 utilized 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 should be utilized and should be properly maintained during the construction programme;
- 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 utilized, 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.

In addition to the above measures, an EMMP with airborne noise monitoring program was 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 11.13.

## 10.8.2 Operational Phase

At this stage, following preliminary mitigation measures have been proposed for consideration as reflected in Table 10-29 below.

**Table 10-29 Proposed preliminary 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 utilized. |
| | Ample setback of developments with ACMV systems fronting noise sensitive receptors should be provided such as provision of park areas/ ecological setback in line with recommendations for biodiversity impact mitigation in Section 1.1, 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. |
| **Additional road traffic noise from new road networks** | Consider alternative siting of roads away from areas with noise sensitive receptors.<br><br>Consider the provision of park areas/ ecological setback in between new road networks if in proximity to areas with NSRs. |

Due to the lack of literature regarding the possible operational noise impacts arising from the operation of ACMV systems and increased traffic noise on ecological receptors, the approach to mitigate operational noise impacts on human receptors have also been adopted to mitigate noise impacts on the ecological receptors. The approach to mitigate noise arising from ACMV systems and increased land traffic as per Table 10-29 is recommended to be employed to mitigate operational noise where possible.

As discussed in Section 10.2.5.1.2, noise monitoring programme(s) for the operational phase have not been proposed as required information detailed in the respective noise legislations are unavailable at this stage. Usually conducted by an appointed Noise Consultant(s) during the detailed design stage, AECOM recommends the works for ACMV boundary noise impact assessment and TNIA be conducted in the later stages of the development in accordance with the NEA legislations in ACMV Guideline, 2018 [R-38], and TNIA Guideline, 2016 [R-37].

# 10.9 Residual Impacts

The residual construction impact assessment assumes that the mitigation measures proposed in Section 10.8 are implemented at the construction worksites, nearest to the receptors predicted to experience significant Impact Intensity through quantitative and qualitative means of assessment as discussed in Section 10.2.1.

## 10.9.1 Construction Phase

### 10.9.1.1 Residual Ecological Impacts

As discussed in Section 10.7.1.1, noise exceedances of up to 24 dB(A) and 30 dB(A) were predicted for ecological receptors subjected to noise emissions from Scenario 1: Site Preparation for Earthworks and Scenario 2: Foundation Works respectively. Mitigation measures were thereby proposed during the construction phase to mitigate the noise impacts to as low as reasonably practicable. The residual construction impact assessment assumed that mitigation measures (3m height and 12m height noise barrier) proposed in Section 10.8 were implemented at the construction worksites nearest to the ecological receptors predicted to experience noise exceedances by the noise model.

Due to the proximity of the noise sources (i.e., construction worksites) to the ecologically sensitive proposed Ecological Corridor, the proposed noise barriers were found to only be effective in reducing the area of **Moderate** noise Impact Significance to a range of 0.7 ha to 0.9 ha in Scenario 1, and the area of **Major** noise Impact Significance from 2.4 ha to 3.2 ha in Scenario 2. The overall Impact Intensity was predicted to remain unchanged, ranging from **High** (refer to Table 6-5) with a corresponding overall Impact Consequence of **High** (refer to Table 6-6). When relating the overall Impact Consequence to a Likelihood of Occurrence of **Occasional/ Likely** (see Table 10-8), it was determined that the overall residual Impact Significance remained as **Moderate** for the time period of $L_{Aeq(12\ hrs)}$, and **Major** for $L_{Aeq(5\ mins)}$, 7am – 7pm.

The resulting residual noise contours representative of both assessment scenarios were predicted and visualized in Figure 10-14 to Figure 10-17 for $L_{Aeq(12\ hrs)}$ and $L_{Aeq(5\ mins)}$. Construction noise impact assessment for ecological receptors was conducted and summarized in Table 10-31 below. The evaluation was carried out with reference to the assessment methodology outlined in Section 6.4.3.

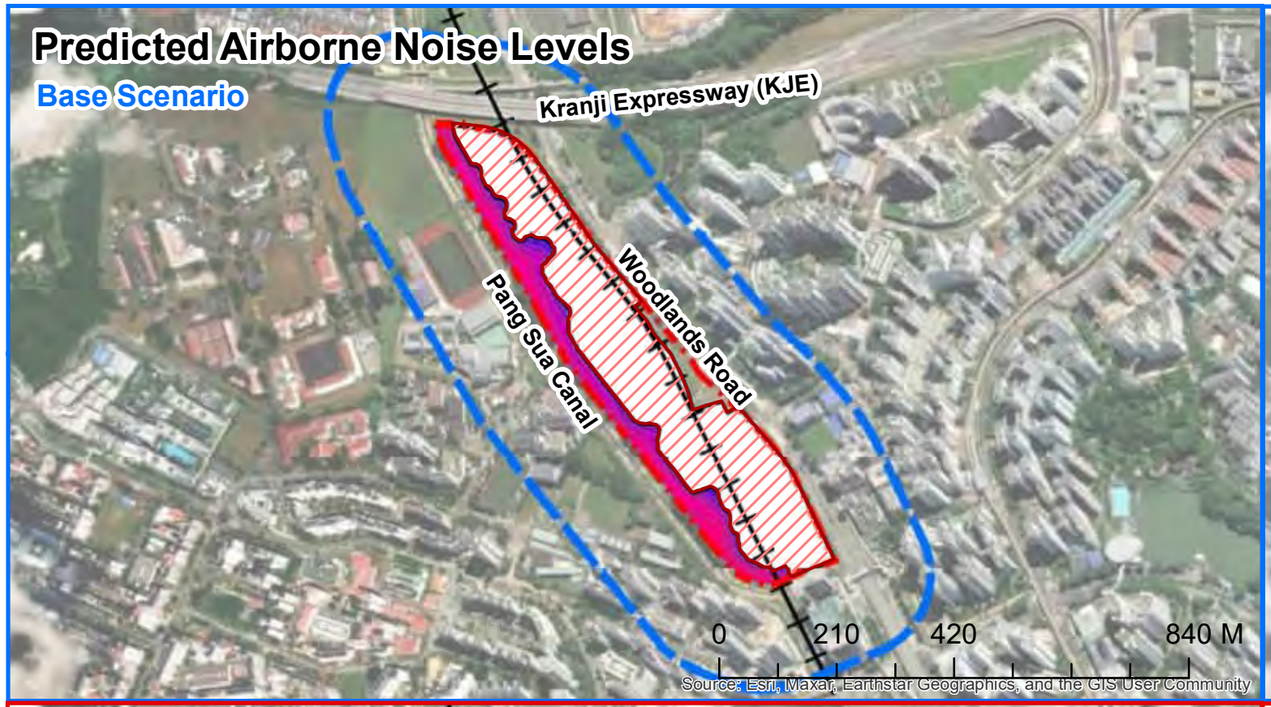
**Table 10-30 List of noise contour maps reflecting residual ecological impacts**

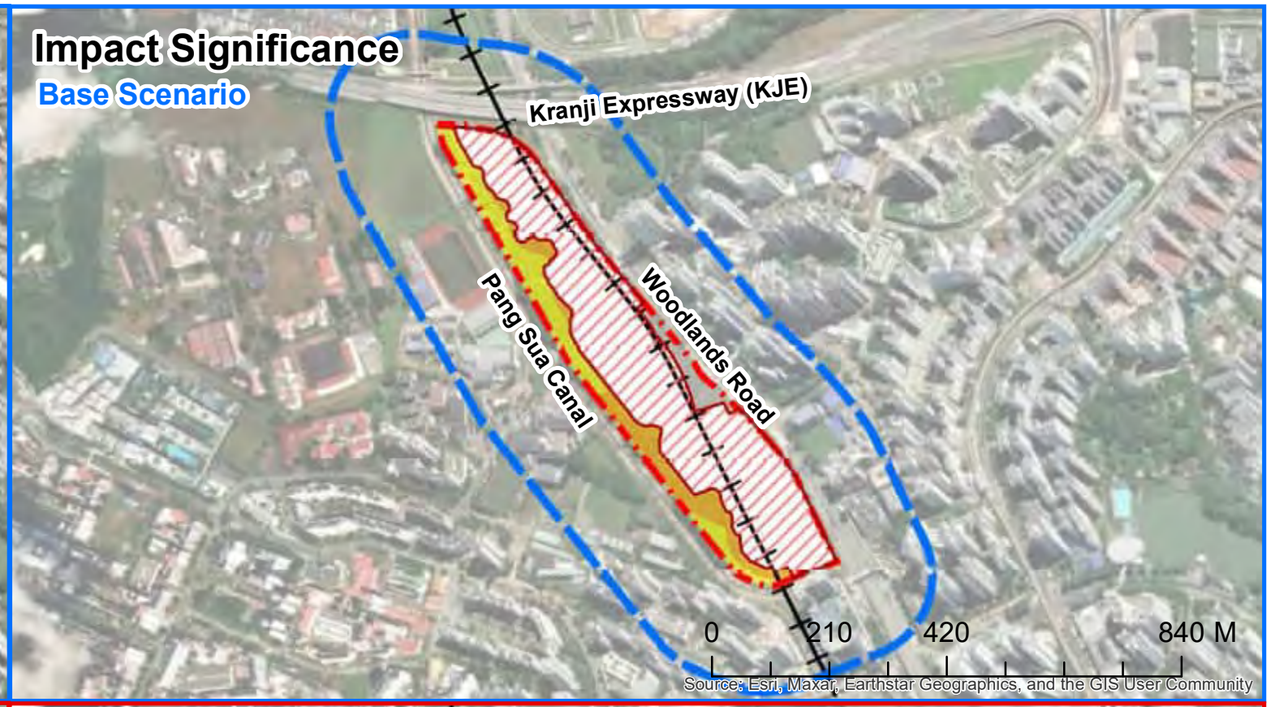
| Elevation | Construction Schedule | $L_{Aeq}$ | Figure |
|---|---|---|---|
| **Scenario 1: Clearance for Construction Area** | | | |
| 0.5m | Weekdays (7am – 7pm) | $L_{Aeq(12\ hrs)}$ | Figure 10-14 |
| | Weekdays (7am – 7pm) | $L_{Aeq(5\ mins)}$ | Figure 10-15 |
| **Scenario 2: Roadworks and Foundation Works** | | | |
| 0.5m | Weekdays (7am – 7pm) | $L_{Aeq(12\ hrs)}$ | Figure 10-16 |
| | Weekdays (7am – 7pm) | $L_{Aeq(5\ mins)}$ | Figure 10-17 |

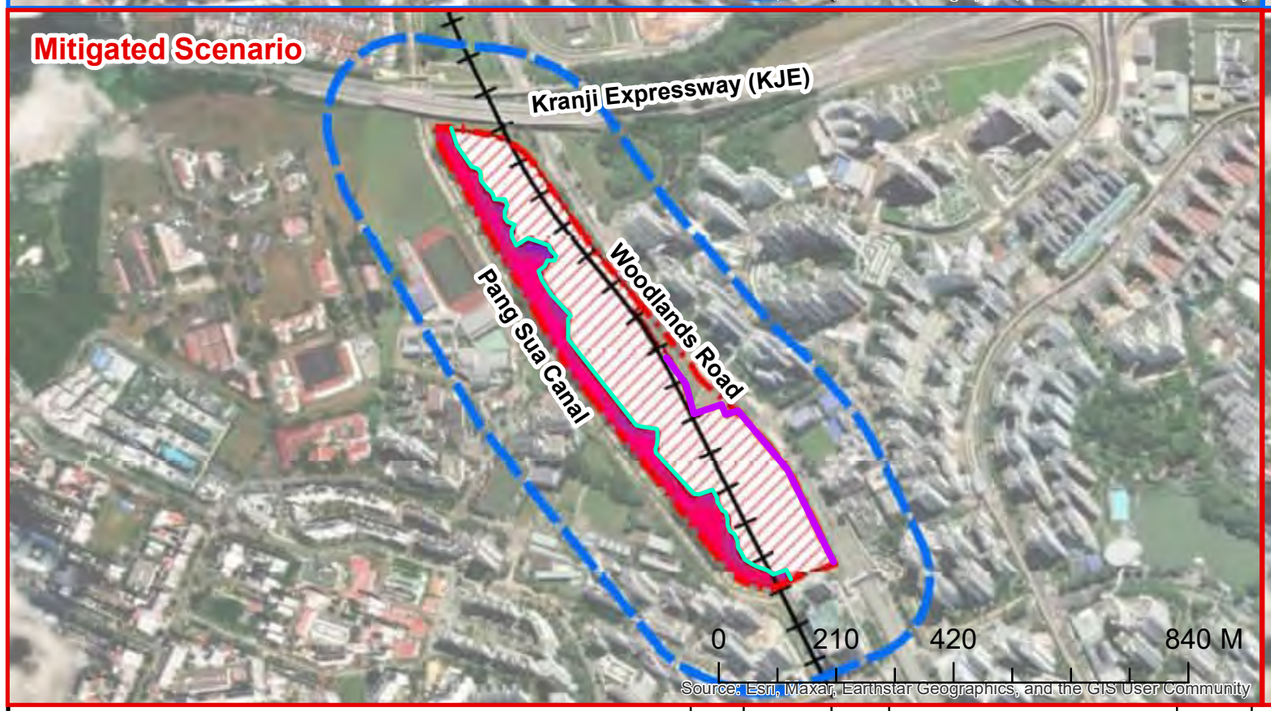
Although the proposed mitigation measures in Section 10.8 were not able to eliminate the noise exceedances, a closer look into the comparison of noise contours for the pre-mitigation (base case) and post-mitigation (mitigated case) cases revealed significant reduction in the Major impact significance areas with the implementation of noise barriers. Observing the residual impact for both humans and ecology, it is strongly recommended to to use portable barriers for equipment that contribute to excessive noise at all times.

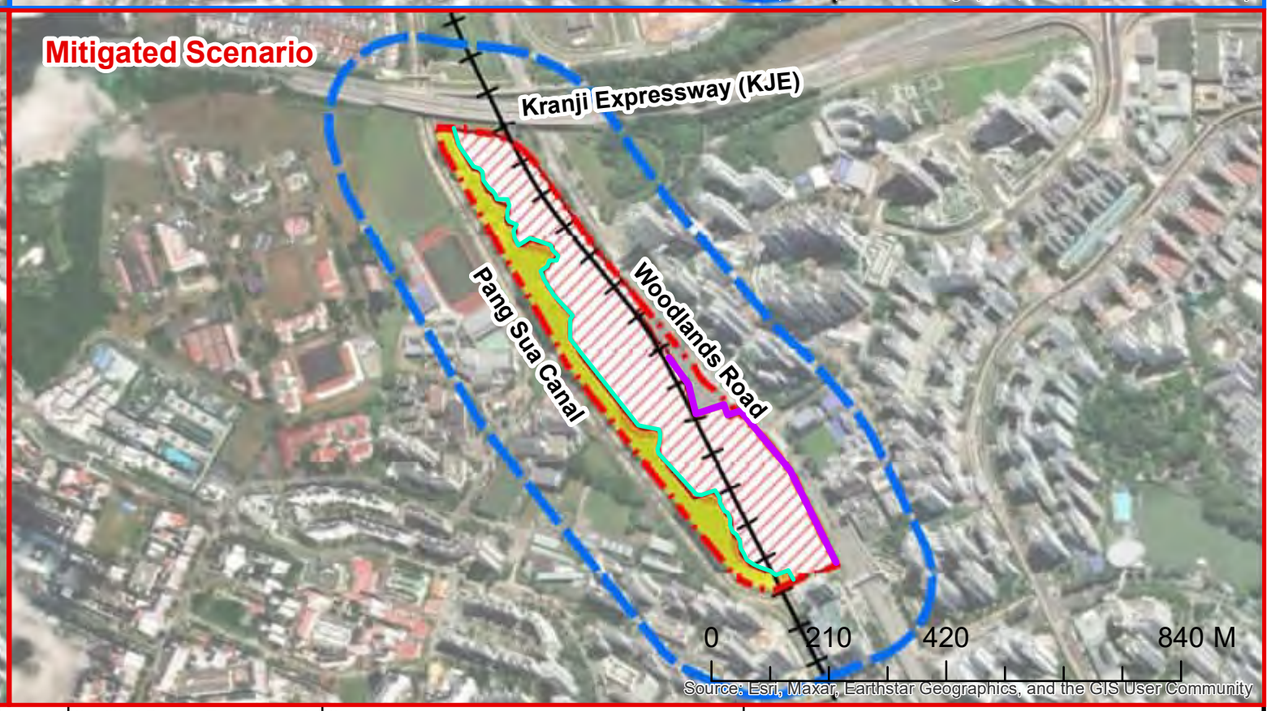
**Table 10-31 Summary of residual construction noise impacts – ecological impacts**

| Assessment Scenario(s) | Auditory Sensitivity | Pre-Mitigated Evaluation | | | | | | | | Post-Mitigated Evaluation | | | | | | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Maximum Predicted Noise Level, dB(A) | Exceedance, dB(A) | Impact Intensity | Impact Consequence | Likelihood of Occurrence* | Impact Significance | Area (ha) | Percentage distribution (%) | Maximum Predicted Noise Level, dB(A) | Exceedance, dB(A) | Impact Intensity | Impact Consequence | Likelihood of Occurrence* | Impact Significance | Area (ha) | Percentage distribution (%) | |
| **LAeq (12hr)** | | | | | | | | | | | | | | | | | | |
| Scenario 1: Site Preparation for Earthworks | Priority 1 | 72.0 | 18.0 | High | High | Occasional | Moderate | 1.8 | 44% | 72.0 | 18.0 | High | High | Occasional | Moderate | 0.7 | 15% | • Area of Major impact significance significantly reduced from 1.8 ha to 0.7 ha<br>• Impact Significance remains unchanged as **Moderate**. |
| Scenario 2: Foundation Works | Priority 1 | 78.0 | 24.0 | High | High | Occasional | Moderate | 4.1 | 98% | 78.0 | 24.0 | High | High | Occasional | Moderate | 2.4 | 59% | • Area of Major impact significance significantly reduced from 4.1 ha to 2.4 ha<br>• Impact Significance remains unchanged as **Moderate**. |
| **LAeq (5min)** | | | | | | | | | | | | | | | | | | |
| Scenario 1: Site Preparation for Earthworks | Priority 1 | 76.0 | 24.0 | High | High | Likely | Major | 2.6 | 63% | 76.0 | 24.0 | High | High | Likely | Major | 0.9 | 22% | • Area of Major impact significance significantly reduce from 2.6 ha to 0.9 ha<br>• Impact Significance remains unchanged as **Major**. |
| Scenario 2: Foundation Works | Priority 1 | 82.0 | 30.0 | High | High | Likely | Major | 4.1 | 100% | 82.0 | 30.0 | High | High | Likely | Major | 3.2 | 78% | • Area of Major impact significance significantly reduce from 4.1 ha to 3.2 ha<br>• Impact Significance remains unchanged as **Major**. |




## Legend

- Proposed 3m Noise Barrier
- Proposed 12m Noise Barrier
- CCK N1 Project Site
- Airborne Noise Study Area (150m)
- Rail Corridor
- Proposed Construction Footprint*
- Proposed Development Boundary*

* exact boundaries/ alignment subject to further changes

**Predicted Airborne Noise Levels LAeq(12 hours), dB**

- <= 45
- 45 - 48
- 48 - 51
- 51 - 54
- 54 - 57
- 57 - 60
- 60 - 63
- 63 - 66
- 66 - 69
- 69 - 72
- >= 72

**Impact Significance**

- Negligible
- Minor
- Moderate
- Major

N

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Qualified Person Endorsement : NA

HDB Endorsement : NA

Consultant : AECOM

Client: HOUSING & DEVELOPMENT BOARD

Project Title :

**ENVIRONMENTAL IMPACT ASSESSMENT (EIA) ON CHOA CHU KANG N1**

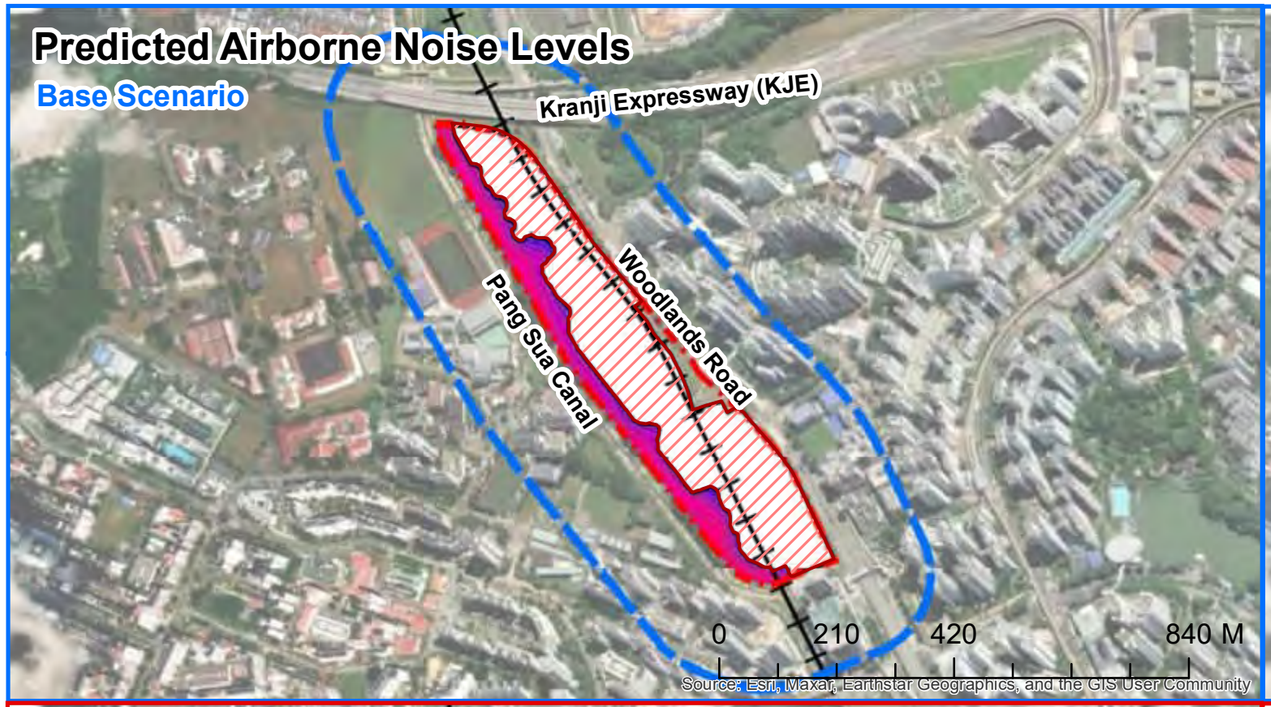
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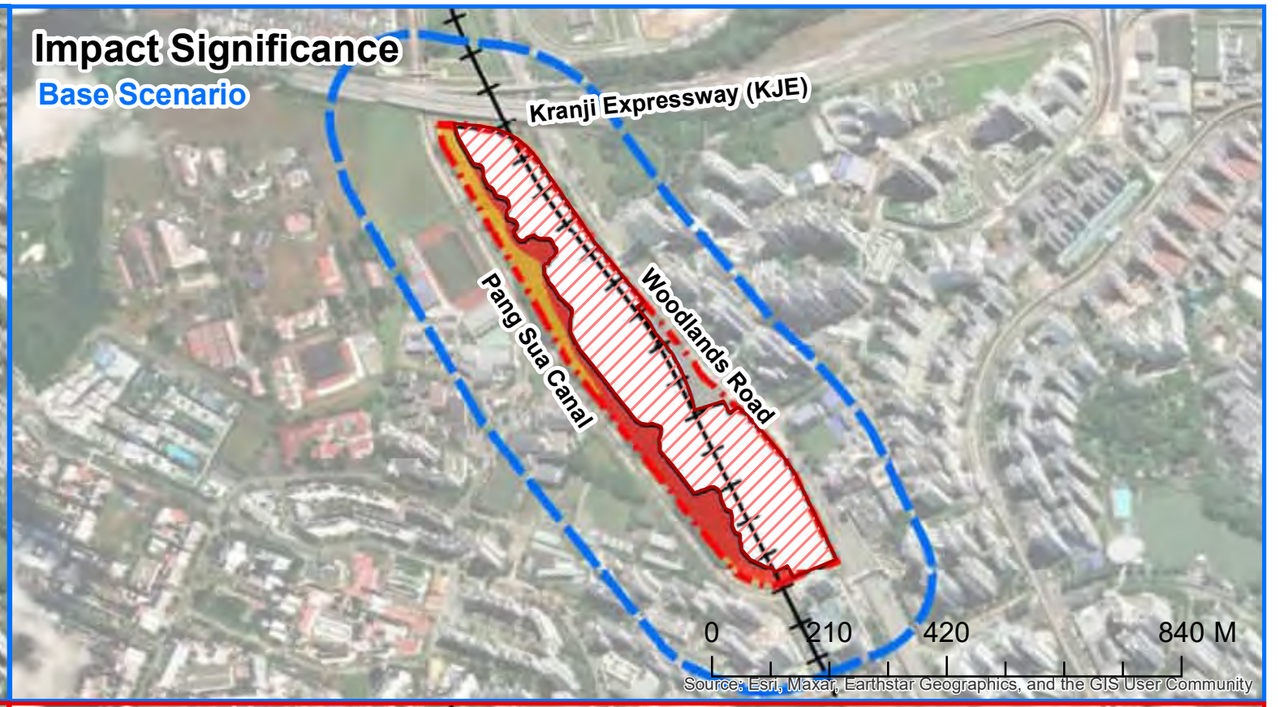
**Ecological Noise Sensitive Receptors - Scenario 1: Site Preparation for Earthworks, LAeq(12 hours), 7am - 7pm (Mitigated Scenario Assessment)**

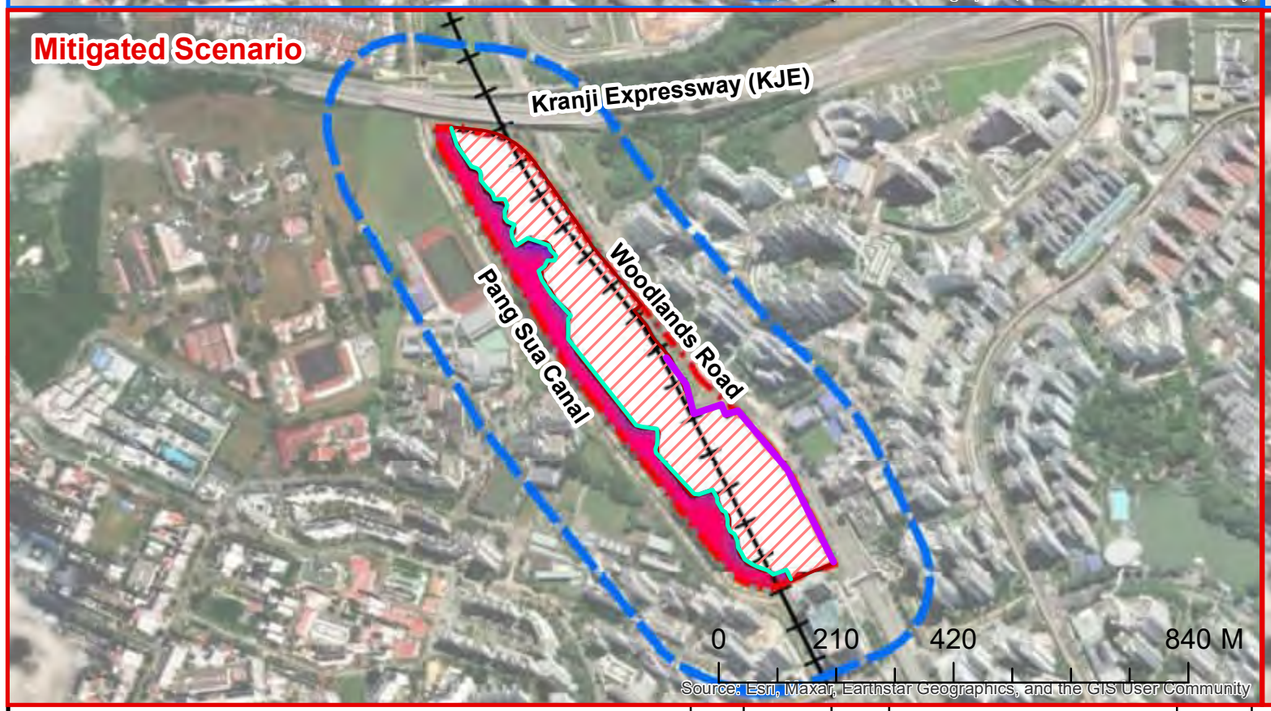
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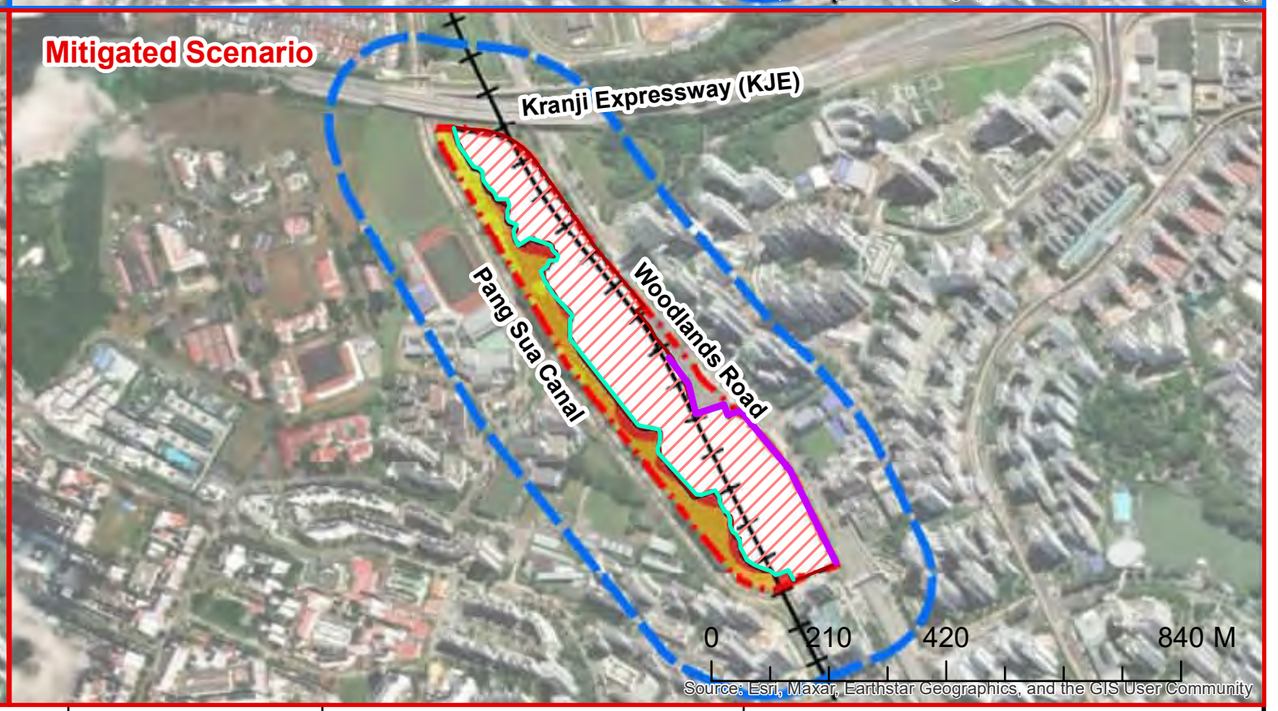
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## Legend

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- Proposed 12m Noise Barrier
- CCK N1 Project Site
- Airborne Noise Study Area (150m)
- Rail Corridor
- Proposed Construction Footprint*
- Proposed Development Boundary*

* exact boundaries/ alignment subject to further changes

**Predicted Airborne Noise Levels LAeq(12 hours), dB**

- <= 45
- 45 - 48
- 48 - 51
- 51 - 54
- 54 - 57
- 57 - 60
- 60 - 63
- 63 - 66
- 66 - 69
- 69 - 72
- >= 72

**Impact Significance**

- Negligible
- Minor
- Moderate
- Major

N

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

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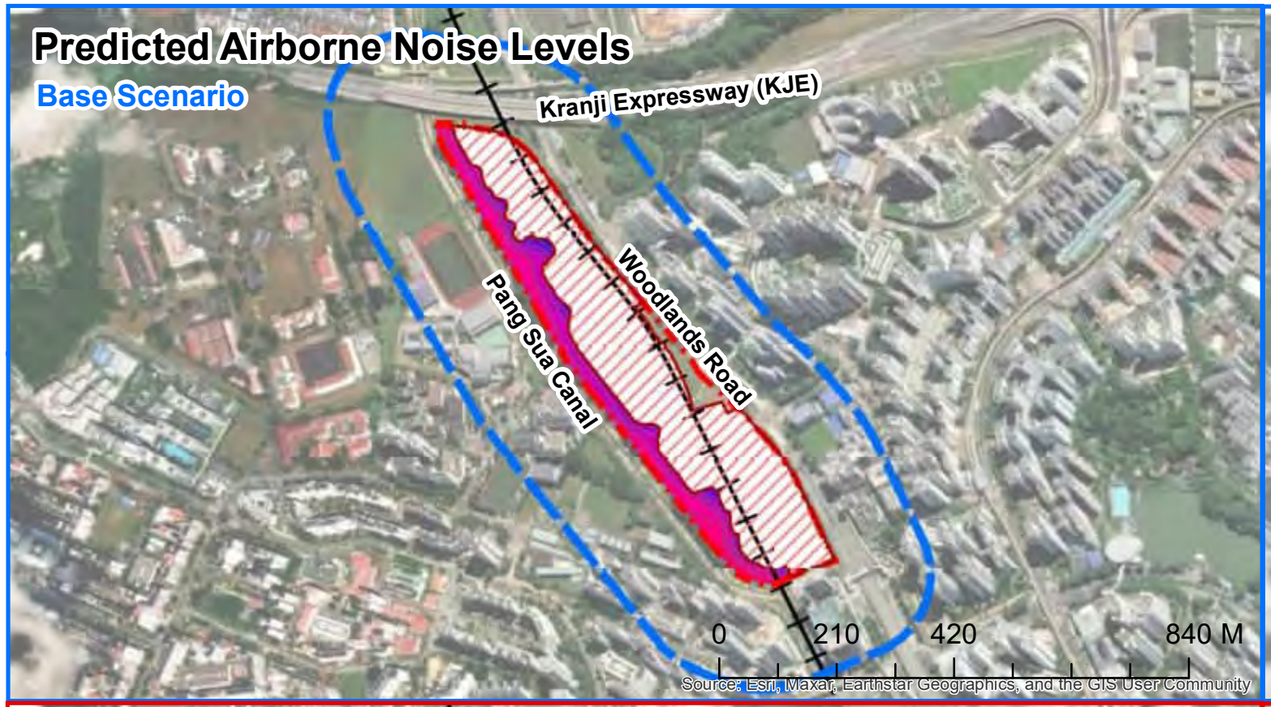
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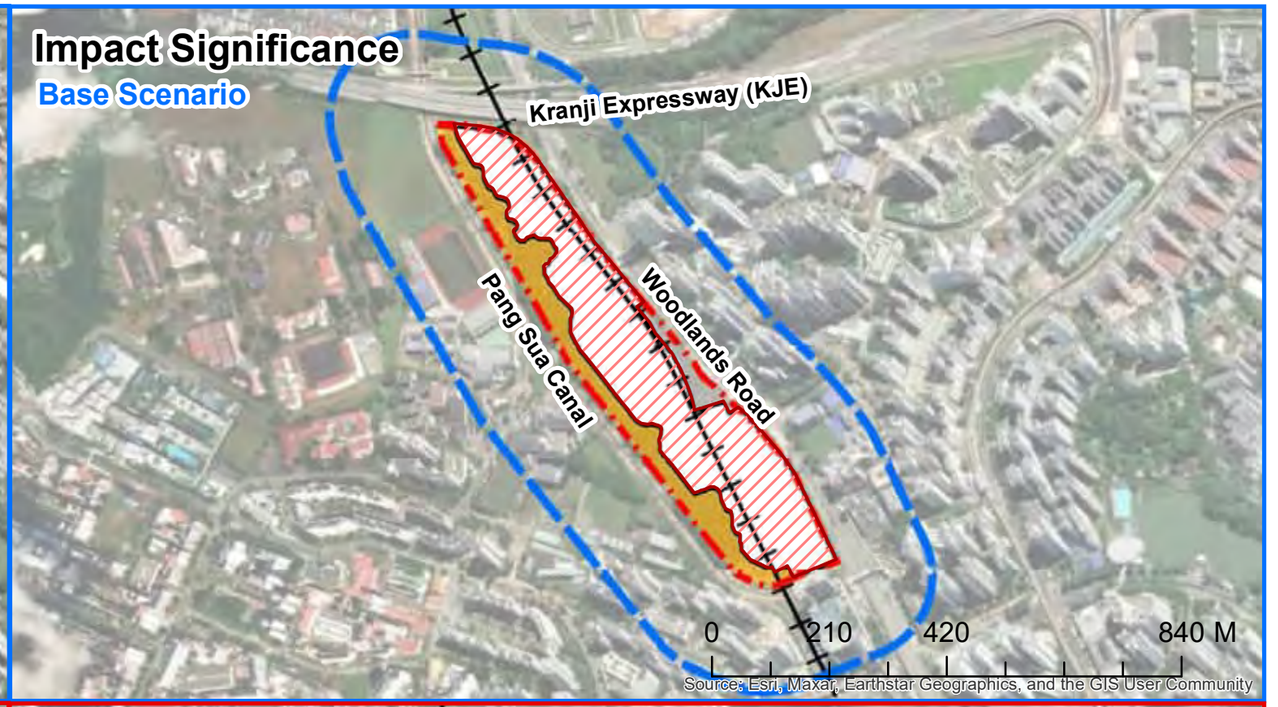
**Ecological Noise Sensitive Receptors - Scenario 1: Site Preparation for Earthworks, LAeq(12 hours), 7am - 7pm (Mitigated Scenario Assessment)**

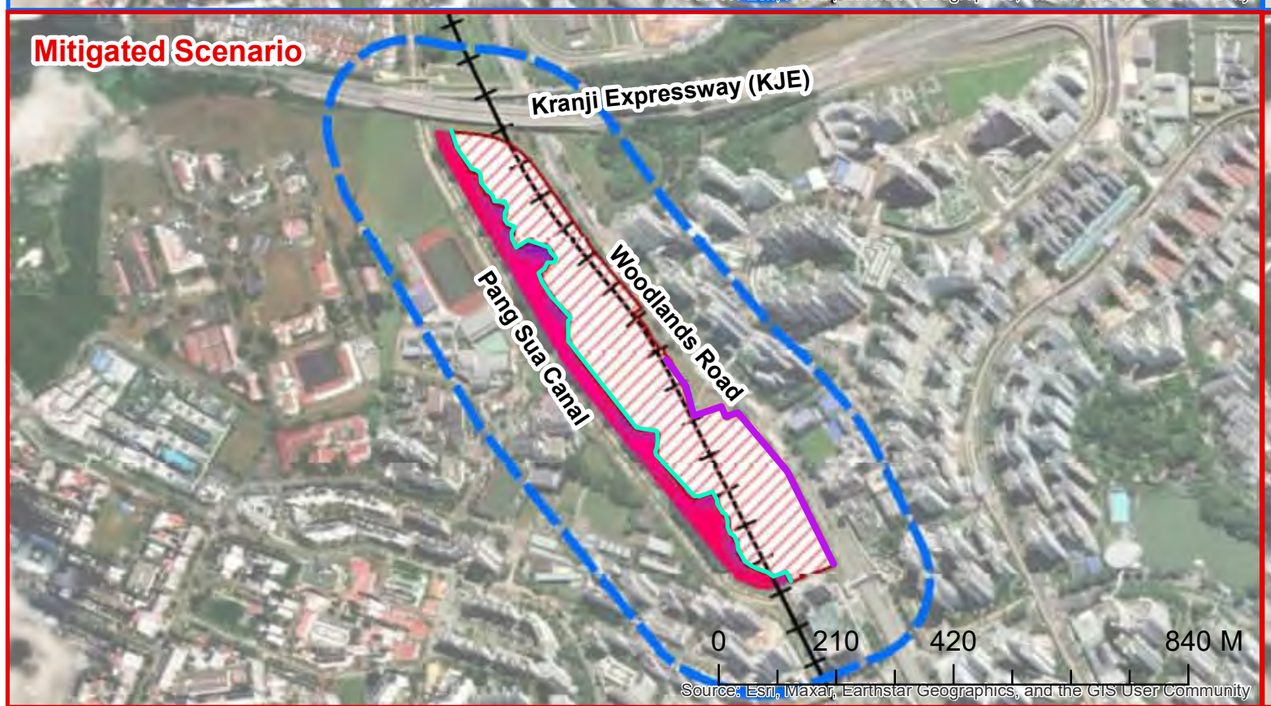
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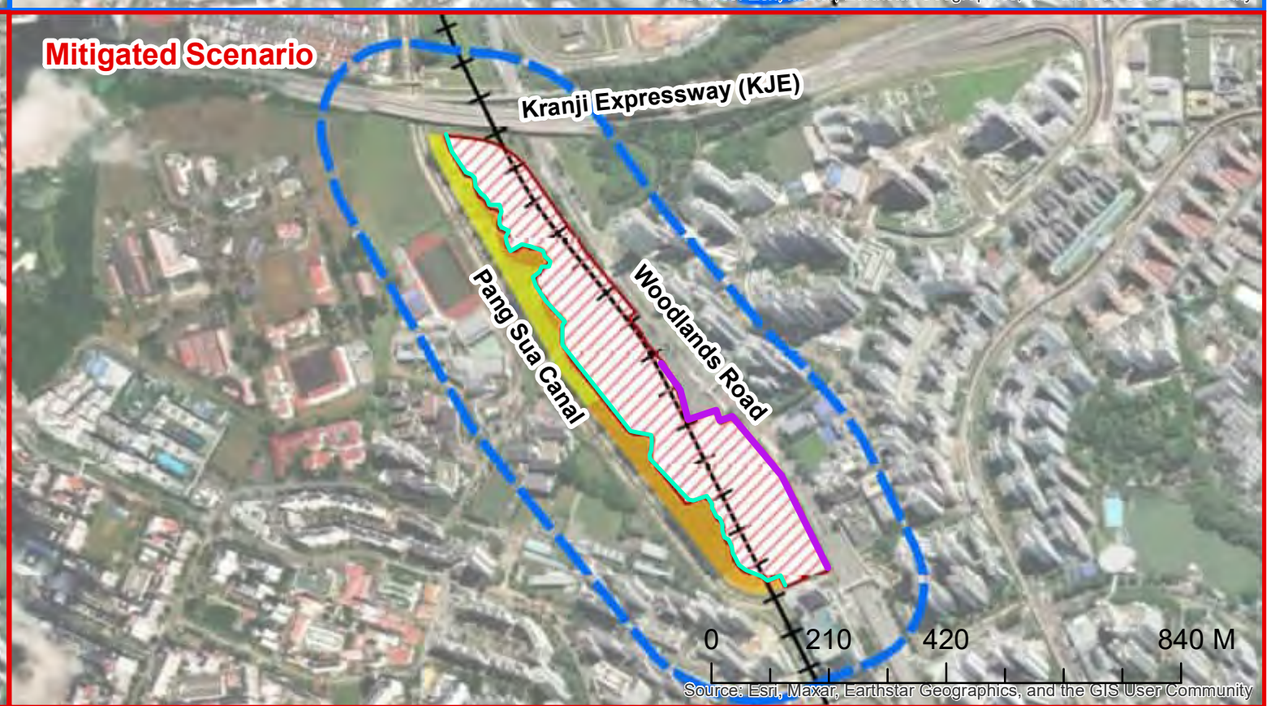
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## Legend

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- Airborne Noise Study Area (150m)
- Rail Corridor
- Proposed Construction Footprint*
- Proposed Development Boundary*

* exact boundaries/ alignment subject to further changes

**Predicted Airborne Noise Levels LAeq(12 hours), dB**

| | |
|---|---|
| <= 45 | 60 - 63 |
| 45 - 48 | 63 - 66 |
| 48 - 51 | 66 - 69 |
| 51 - 54 | 69 - 72 |
| 54 - 57 | >= 72 |
| 57 - 60 | |

**Impact Significance**

- Negligible
- Minor
- Moderate
- Major

N

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

HDB Endorsement : NA

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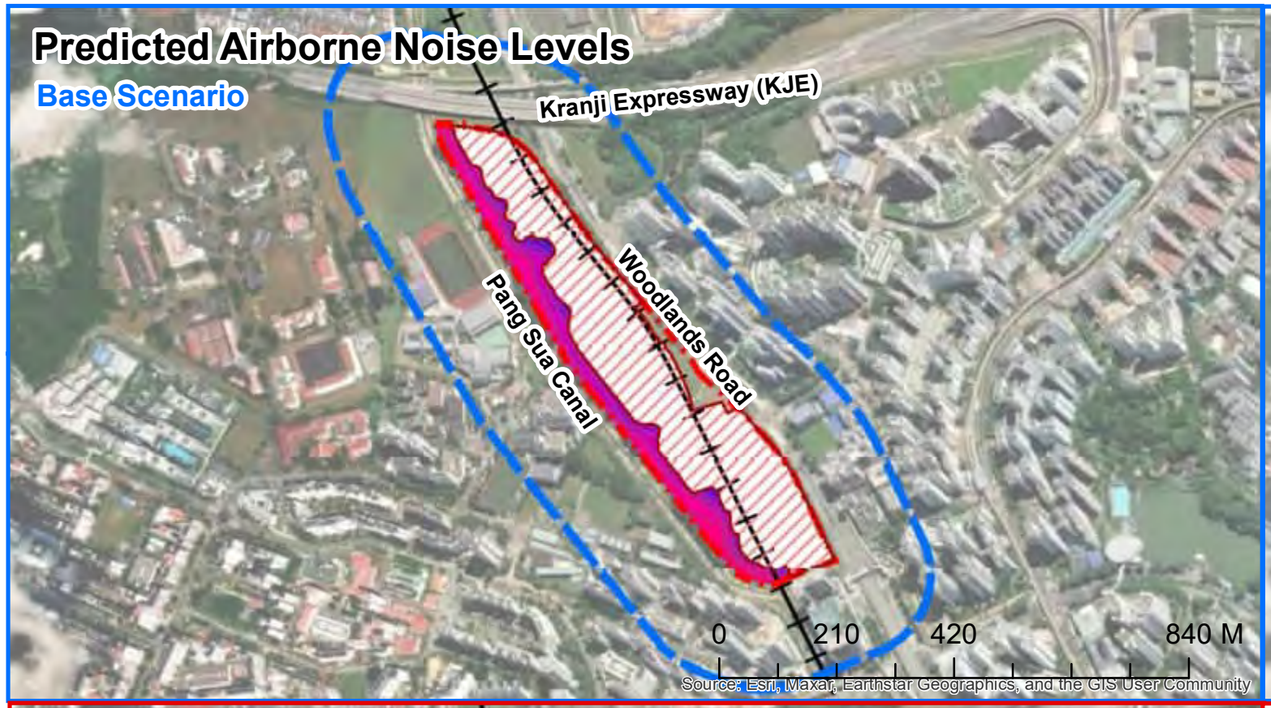
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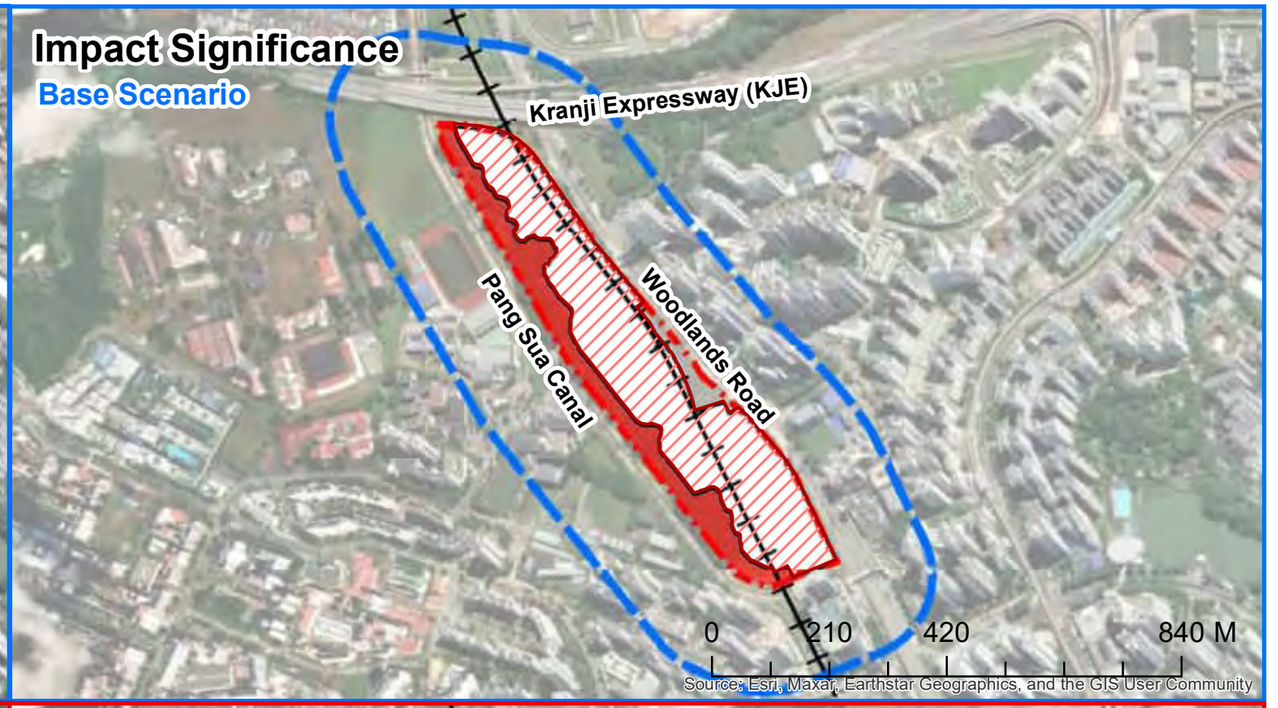
**Ecological Noise Sensitive Receptors - Scenario 1: Site Preparation for Earthworks, LAeq(12 hours), 7am - 7pm (Mitigated Scenario Assessment)**

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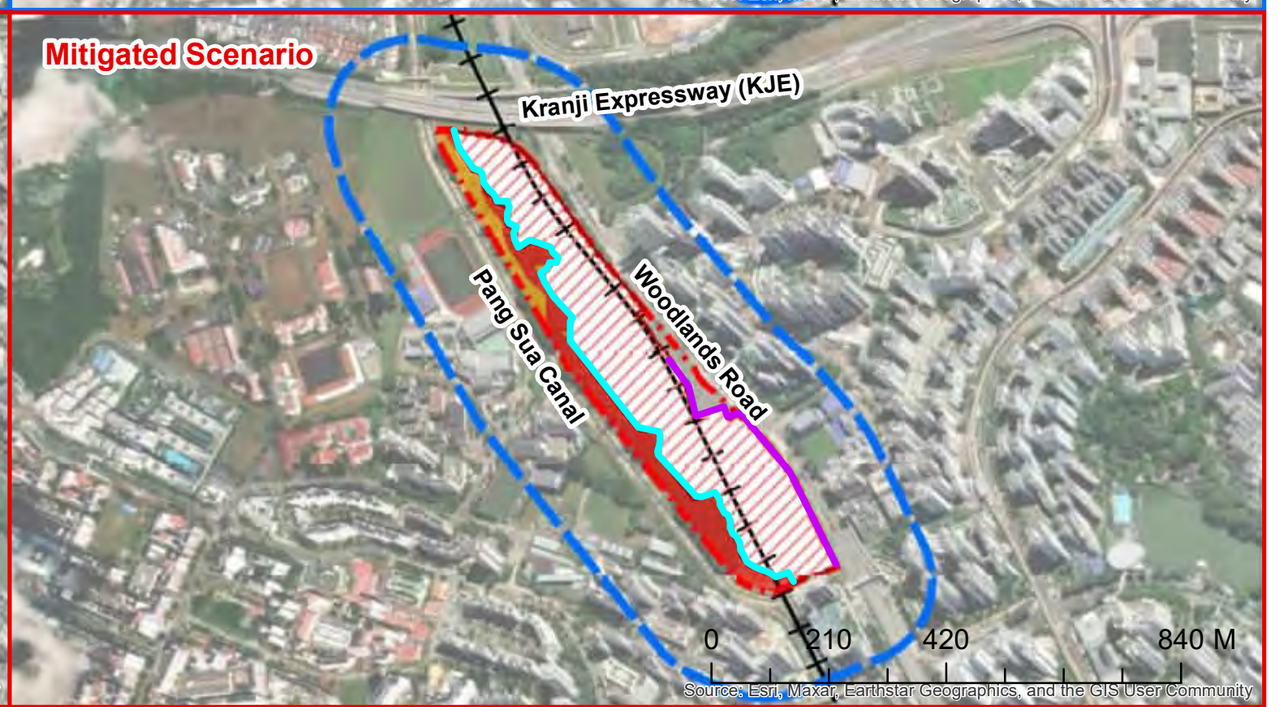
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- Proposed Construction Footprint*
- Proposed Development Boundary*

* exact boundaries/ alignment subject to further changes

**Predicted Airborne Noise Levels LAeq(12 hours), dB**

| | |
|---|---|
| <= 45 | 60 - 63 |
| 45 - 48 | 63 - 66 |
| 48 - 51 | 66 - 69 |
| 51 - 54 | 69 - 72 |
| 54 - 57 | >= 72 |
| 57 - 60 | |

**Impact Significance**

- Negligible
- Minor
- Moderate
- Major

N

| Rev. | Date | By | Description | Chk'd | App'd |
|---|---|---|---|---|---|
| - | SEP 2022 | SYT | Draft Final Report | NHT | JAG |

Qualified Person Endorsement : NA

HDB Endorsement : NA

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Client: HOUSING & DEVELOPMENT BOARD

Project Title :

**ENVIRONMENTAL IMPACT ASSESSMENT (EIA) ON CHOA CHU KANG N1**

Figure Title :

**Ecological Noise Sensitive Receptors - Scenario 1: Site Preparation for Earthworks, LAeq(12 hours), 7am - 7pm (Mitigated Scenario Assessment)**

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| | Drawn SYT | Date SEP 2022 | CAD File Name : NA | | A3 |

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### 10.9.1.2 Residual Human Impacts

As discussed in Section 10.7.1.2, noise exceedances of up to 8.4 dB(A) were predicted for two human receptors (Senja Care Home and West View Primary School) subjected to noise during Scenario 2: Foundation Works and up to 1.4 dB(A) during Scenario 1: Site Preparation for Earthworks and would require the implementation of mitigation measures during the construction phase to mitigate the noise impacts.

The residual construction impact assessment assumed that the mitigation measures 3m height and 12m height noise barrier within Section 10.8 were implemented at the construction worksites nearest to the human receptors

Based on the residual airborne noise impact assessment below, the proposed 3m noise barrier and 12m noise barriers will be beneficial with no noise exceedance predicted for Scenario 1: Site Preparation for Earthworks. While for Scenario 2: Foundation Works, noise reduction of for Senja Care Home from 8.4 dB(A) to 6.9 dB(A), and West View Primary School from 7.6 dB(A) to 1.7 dB(A) were predicted with Impact Intensity remaining unchanged at **High** for Senja Care Home, and **Low** for West View Primary School.

Although the proposed mitigation measures in Section 10.8 were not able to eliminate noise exceedances during Scenario 2, Impact Intensity was predicted from ranging from **Negligible** – **High** (refer to Table 6-5).

When relating a corresponding Impact Consequence ranging from **Imperceptible** – **High** (refer to Table 6-6) to a Likelihood of Occurrence of **Occasional/ Likely** (see Table 10-8), it was determined that the overall residual Impact Significance due to noise impacts arising from the construction phase remained unchanged ranging from **Negligible** – **Moderate** (refer to Table 6-8) as reflected in Table 10-32 to Table 10-35.

The resulting residual noise contours representative of the worst-case Scenario 2: Foundation Works were visualized in Figure 10-18 for $L_{Aeq(12\ hrs)}$.

**Table 10-32 Summary of residual construction noise impacts: scenario 1: site preparation for earthworks – human receptors, LAeq (12hr) (7am-7pm)**

| No. | Human Receptors | Receptor Sensitivity | Nearest SLM | Predicted Construction Noise Levels | Corrected Criteria, dB(A) | Maximum Noise Exceedance, dB(A) | Impact Intensity | Impact Consequence | Likelihood | Impact Significance |
|---|---|---|---|---|---|---|---|---|---|---|
| **1** | Bukit Panjang Exchange (1) | Priority 3 | NM03 | 53.1 | 75 | - | Negligible | Imperceptible | Occasional | Negligible |
| **2** | Bukit Panjang Exchange (2) | Priority 3 | NM03 | 48.9 | 75 | - | Negligible | Imperceptible | Occasional | Negligible |
| **3** | DE142 Gali Batu Bus Depot Site Office | Priority 3 | NM02a | 54.3 | 79 | - | Negligible | Imperceptible | Occasional | Negligible |
| **4** | HDB Blk 162 Jln Teck Whye (ground level) | Priority 2 | NM04a | 56.8 | 75 | - | Negligible | Imperceptible | Occasional | Negligible |
| **5** | HDB Blk 162 Jln Teck Whye (mid-level) | Priority 2 | NM04b | 58.6 | 75 | - | Negligible | Imperceptible | Occasional | Negligible |
| **6** | HDB Blk 162 Jln Teck Whye (top level) | Priority 2 | NM04c | 59.3 | 77 | - | Negligible | Imperceptible | Occasional | Negligible |
| **7** | HDB Blk 163 Jln Teck Whye (ground level) | Priority 2 | NM04a | 56.4 | 75 | - | Negligible | Imperceptible | Occasional | Negligible |
| **8** | HDB Blk 163 Jln Teck Whye (mid-level) | Priority 2 | NM04b | 57.9 | 75 | - | Negligible | Imperceptible | Occasional | Negligible |
| **9** | HDB Blk 163 Jln Teck Whye (top level) | Priority 2 | NM04c | 59.9 | 77 | - | Negligible | Imperceptible | Occasional | Negligible |
| **10** | HDB Blk 164 Jln Teck Whye (ground level) | Priority 2 | NM04a | 55.8 | 75 | - | Negligible | Imperceptible | Occasional | Negligible |
| **11** | HDB Blk 164 Jln Teck Whye (mid-level) | Priority 2 | NM04b | 57.2 | 75 | - | Negligible | Imperceptible | Occasional | Negligible |
| **12** | HDB Blk 164 Jln Teck Whye (top level) | Priority 2 | NM04c | 59.1 | 77 | - | Negligible | Imperceptible | Occasional | Negligible |
| **13** | HDB Blk 606 Senja Road (ground level) | Priority 2 | N1a | 54.4 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **14** | HDB Blk 606 Senja Road (mid-level) | Priority 2 | N1b | 57.1 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **15** | HDB Blk 606 Senja Road (top level) | Priority 2 | N1c | 56.8 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **16** | HDB Blk 632A Senja Road (ground level) | Priority 2 | N1a | 62.3 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **17** | HDB Blk 632A Senja Road (top level) | Priority 2 | N1b | 62.6 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |

| No. | Human Receptors | Receptor Sensitivity | Nearest SLM | Predicted Construction Noise Levels | Corrected Criteria, dB(A) | Maximum Noise Exceedance, dB(A) | Impact Intensity | Impact Consequence | Likelihood | Impact Significance |
|---|---|---|---|---|---|---|---|---|---|---|
| **18** | HDB Blk 632B Senja Road (ground level) | Priority 2 | N1a | 61.0 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **19** | HDB Blk 632B Senja Road (top level) | Priority 2 | N1b | 61.6 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **20** | HDB Blk 633 Senja Road (ground level) | Priority 2 | N1a | 49.9 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **21** | HDB Blk 633A Senja Road (ground level) | Priority 2 | N1a | 60.7 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **22** | HDB Blk 633A Senja Road (mid-level) | Priority 2 | N1b | 61.2 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **23** | HDB Blk 633A Senja Road (top level) | Priority 2 | N1c | 61.0 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **24** | HDB Blk 633B Senja Road (ground level) | Priority 2 | N1a | 61.1 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **25** | HDB Blk 633B Senja Road (mid-level) | Priority 2 | N1b | 62.0 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **26** | HDB Blk 633B Senja Road (top level) | Priority 2 | N1c | 61.8 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **27** | HDB Blk 633C Senja Road (ground level) | Priority 2 | N1a | 59.0 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **28** | HDB Blk 633C Senja Road (mid-level) | Priority 2 | N1b | 60.9 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **29** | HDB Blk 633C Senja Road (top level) | Priority 2 | N1c | 60.8 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **30** | HDB Blk 633D Senja Road (ground level) | Priority 2 | N1a | 57.1 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **31** | HDB Blk 633D Senja Road (mid-level) | Priority 2 | N1b | 59.7 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **32** | HDB Blk 633D Senja Road (top level) | Priority 2 | N1c | 59.7 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **33** | HDB Blk 634A Senja Road (ground level) | Priority 2 | N1a | 62.9 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **34** | HDB Blk 634A Senja Road (mid-level) | Priority 2 | N1b | 63.1 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |

| No. | Human Receptors | Receptor Sensitivity | Nearest SLM | Predicted Construction Noise Levels | Corrected Criteria, dB(A) | Maximum Noise Exceedance, dB(A) | Impact Intensity | Impact Consequence | Likelihood | Impact Significance |
|---|---|---|---|---|---|---|---|---|---|---|
| **35** | HDB Blk 634A Senja Road (top level) | Priority 2 | N1c | 63.1 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **36** | HDB Blk 634B Senja Road (ground level) | Priority 2 | N1a | 55.5 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **37** | HDB Blk 634B Senja Road (mid-level) | Priority 2 | N1b | 58.8 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **38** | HDB Blk 634B Senja Road (top level) | Priority 2 | N1c | 58.8 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **39** | HDB Blk 634C Senja Road (ground level) | Priority 2 | N1a | 60.7 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **40** | HDB Blk 634C Senja Road (mid-level) | Priority 2 | N1b | 61.1 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **41** | HDB Blk 634C Senja Road (top level) | Priority 2 | N1c | 61.1 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **42** | HDB Blk 635 Senja Road (ground level) | Priority 2 | NM02a | 63.1 | 79 | - | Negligible | Imperceptible | Occasional | Negligible |
| **43** | HDB Blk 635 Senja Road (mid-level) | Priority 2 | NM02b | 56.2 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **44** | HDB Blk 635 Senja Road (top level) | Priority 2 | NM02c | 55.8 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **45** | HDB Blk 635A Senja Road (ground level) | Priority 2 | NM02a | 63.1 | 79 | - | Negligible | Imperceptible | Occasional | Negligible |
| **46** | HDB Blk 635A Senja Road (mid-level) | Priority 2 | NM02b | 63.1 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **47** | HDB Blk 635A Senja Road (top level) | Priority 2 | NM02c | 61.9 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **48** | HDB Blk 635B Senja Road (ground level) | Priority 2 | NM02a | 58.5 | 79 | - | Negligible | Imperceptible | Occasional | Negligible |
| **49** | HDB Blk 635B Senja Road (mid-level) | Priority 2 | NM02b | 58.8 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **50** | HDB Blk 635B Senja Road (top level) | Priority 2 | NM02c | 58.7 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **51** | Junction 10 | Priority 3 | NM03 | 60.8 | 75 | - | Negligible | Imperceptible | Occasional | Negligible |
| **52** | 38 Teck Whye Crescent (1) | Priority 3 | NM04a | 56.0 | 75 | - | Negligible | Imperceptible | Occasional | Negligible |

| No. | Human Receptors | Receptor Sensitivity | Nearest SLM | Predicted Construction Noise Levels | Corrected Criteria, dB(A) | Maximum Noise Exceedance, dB(A) | Impact Intensity | Impact Consequence | Likelihood | Impact Significance |
|---|---|---|---|---|---|---|---|---|---|---|
| **53** | 38 Teck Whye Crescent (2) | Priority 3 | NM04a | 57.4 | 75 | - | Negligible | Imperceptible | Occasional | Negligible |
| **54** | 38 Teck Whye Crescent (3) | Priority 3 | NM04a | 54.4 | 75 | - | Negligible | Imperceptible | Occasional | Negligible |
| **55** | 125 Verde View | Priority 2 | NM01 | 51.7 | 79 | - | Negligible | Imperceptible | Occasional | Negligible |
| **56** | 127 Verde View | Priority 2 | NM01 | 54.0 | 79 | - | Negligible | Imperceptible | Occasional | Negligible |
| **57** | 129 Verde View | Priority 2 | NM01 | 51.7 | 79 | - | Negligible | Imperceptible | Occasional | Negligible |
| **58** | Pacific Healthcare Nursing Home | Priority 1 | NM03 | 47.3 | 62 | - | Negligible | Very Low | Occasional | Minor |
| **59** | Pioneer Junior College | Priority 1 | N02 | 59.4 | 75 | - | Negligible | Very Low | Occasional | Minor |
| **60** | Senja Care Home, Vanguard Senior Care Senja Centre | Priority 1 | NM03 | 61.9 | 62 | - | Negligible | Very Low | Occasional | Minor |
| **61** | Senja Soka Centre (1) | Priority 1 | N02 | 48.2 | 75 | - | Negligible | Very Low | Occasional | Minor |
| **62** | Teck Whye Sec Sch (1) | Priority 1 | N02 | 58.2 | 75 | - | Negligible | Very Low | Occasional | Minor |
| **63** | Teck Whye Sec Sch (2) | Priority 1 | N02 | 61.1 | 75 | - | Negligible | Very Low | Occasional | Minor |
| **64** | Teck Whye Sec Sch (3) | Priority 1 | N02 | 51.8 | 75 | - | Negligible | Very Low | Occasional | Minor |
| **65** | The Tennery (1) | Priority 2 | NM03 | 63.6 | 75 | - | Negligible | Imperceptible | Occasional | Negligible |
| **66** | The Tennery (2) | Priority 2 | NM03 | 52.7 | 75 | - | Negligible | Imperceptible | Occasional | Negligible |
| **67** | West View Primary School (1) | Priority 1 | NM03 | 55.4 | 62 | - | Negligible | Very Low | Occasional | Minor |
| **68** | West View Primary School (2) | Priority 1 | NM03 | 56.6 | 62 | - | Negligible | Very Low | Occasional | Minor |

**Table 10-33 Summary of residual construction noise impacts: scenario 1: site preparation for earthworks – human receptors, LAeq (5min) (7am-7pm)**

| No. | Human Receptors | Receptor Sensitivity | Nearest SLM | Predicted Construction Noise Levels | Corrected Criteria, dB(A) | Maximum Noise Exceedance, dB(A) | Impact Intensity | Impact Consequence | Likelihood | Impact Significance |
|---|---|---|---|---|---|---|---|---|---|---|
| **1** | Bukit Panjang Exchange (1) | Priority 3 | NM03 | 56.1 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **2** | Bukit Panjang Exchange (2) | Priority 3 | NM03 | 51.9 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **3** | DE142 Gali Batu Bus Depot Site Office | Priority 3 | NM02a | 57.3 | 90 | - | Negligible | Imperceptible | Likely | Negligible |

| No. | Human Receptors | Receptor Sensitivity | Nearest SLM | Predicted Construction Noise Levels | Corrected Criteria, dB(A) | Maximum Noise Exceedance, dB(A) | Impact Intensity | Impact Consequence | Likelihood | Impact Significance |
|---|---|---|---|---|---|---|---|---|---|---|
| **4** | HDB Blk 162 Jln Teck Whye (ground level) | Priority 2 | NM04a | 59.8 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **5** | HDB Blk 162 Jln Teck Whye (mid-level) | Priority 2 | NM04b | 61.6 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **6** | HDB Blk 162 Jln Teck Whye (top level) | Priority 2 | NM04c | 62.3 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **7** | HDB Blk 163 Jln Teck Whye (ground level) | Priority 2 | NM04a | 59.4 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **8** | HDB Blk 163 Jln Teck Whye (mid-level) | Priority 2 | NM04b | 60.9 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **9** | HDB Blk 163 Jln Teck Whye (top level) | Priority 2 | NM04c | 62.9 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **10** | HDB Blk 164 Jln Teck Whye (ground level) | Priority 2 | NM04a | 58.8 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **11** | HDB Blk 164 Jln Teck Whye (mid-level) | Priority 2 | NM04b | 60.2 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **12** | HDB Blk 164 Jln Teck Whye (top level) | Priority 2 | NM04c | 62.1 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **13** | HDB Blk 606 Senja Road (ground level) | Priority 2 | N1a | 57.4 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **14** | HDB Blk 606 Senja Road (mid-level) | Priority 2 | N1b | 60.1 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **15** | HDB Blk 606 Senja Road (top level) | Priority 2 | N1c | 59.8 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **16** | HDB Blk 632A Senja Road (ground level) | Priority 2 | N1a | 65.3 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **17** | HDB Blk 632A Senja Road (top level) | Priority 2 | N1b | 65.6 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **18** | HDB Blk 632B Senja Road (ground level) | Priority 2 | N1a | 64.0 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **19** | HDB Blk 632B Senja Road (top level) | Priority 2 | N1b | 64.6 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **20** | HDB Blk 633 Senja Road (ground level) | Priority 2 | N1a | 52.9 | 90 | - | Negligible | Imperceptible | Likely | Negligible |

| No. | Human Receptors | Receptor Sensitivity | Nearest SLM | Predicted Construction Noise Levels | Corrected Criteria, dB(A) | Maximum Noise Exceedance, dB(A) | Impact Intensity | Impact Consequence | Likelihood | Impact Significance |
|---|---|---|---|---|---|---|---|---|---|---|
| **21** | HDB Blk 633A Senja Road (ground level) | Priority 2 | N1a | 63.7 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **22** | HDB Blk 633A Senja Road (mid-level) | Priority 2 | N1b | 64.2 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **23** | HDB Blk 633A Senja Road (top level) | Priority 2 | N1c | 64.0 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **24** | HDB Blk 633B Senja Road (ground level) | Priority 2 | N1a | 64.1 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **25** | HDB Blk 633B Senja Road (mid-level) | Priority 2 | N1b | 65.0 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **26** | HDB Blk 633B Senja Road (top level) | Priority 2 | N1c | 64.8 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **27** | HDB Blk 633C Senja Road (ground level) | Priority 2 | N1a | 62.0 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **28** | HDB Blk 633C Senja Road (mid-level) | Priority 2 | N1b | 63.9 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **29** | HDB Blk 633C Senja Road (top level) | Priority 2 | N1c | 63.8 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **30** | HDB Blk 633D Senja Road (ground level) | Priority 2 | N1a | 60.1 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **31** | HDB Blk 633D Senja Road (mid-level) | Priority 2 | N1b | 62.7 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **32** | HDB Blk 633D Senja Road (top level) | Priority 2 | N1c | 62.7 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **33** | HDB Blk 634A Senja Road (ground level) | Priority 2 | N1a | 65.9 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **34** | HDB Blk 634A Senja Road (mid-level) | Priority 2 | N1b | 66.1 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **35** | HDB Blk 634A Senja Road (top level) | Priority 2 | N1c | 66.1 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **36** | HDB Blk 634B Senja Road (ground level) | Priority 2 | N1a | 58.5 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **37** | HDB Blk 634B Senja Road (mid-level) | Priority 2 | N1b | 61.8 | 90 | - | Negligible | Imperceptible | Likely | Negligible |

| No. | Human Receptors | Receptor Sensitivity | Nearest SLM | Predicted Construction Noise Levels | Corrected Criteria, dB(A) | Maximum Noise Exceedance, dB(A) | Impact Intensity | Impact Consequence | Likelihood | Impact Significance |
|---|---|---|---|---|---|---|---|---|---|---|
| **38** | HDB Blk 634B Senja Road (top level) | Priority 2 | N1c | 61.8 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **39** | HDB Blk 634C Senja Road (ground level) | Priority 2 | N1a | 63.7 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **40** | HDB Blk 634C Senja Road (mid-level) | Priority 2 | N1b | 64.1 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **41** | HDB Blk 634C Senja Road (top level) | Priority 2 | N1c | 64.1 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **42** | HDB Blk 635 Senja Road (ground level) | Priority 2 | NM02a | 58.6 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **43** | HDB Blk 635 Senja Road (mid-level) | Priority 2 | NM02b | 59.2 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **44** | HDB Blk 635 Senja Road (top level) | Priority 2 | NM02c | 58.8 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **45** | HDB Blk 635A Senja Road (ground level) | Priority 2 | NM02a | 66.1 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **46** | HDB Blk 635A Senja Road (mid-level) | Priority 2 | NM02b | 66.1 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **47** | HDB Blk 635A Senja Road (top level) | Priority 2 | NM02c | 64.9 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **48** | HDB Blk 635B Senja Road (ground level) | Priority 2 | NM02a | 61.5 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **49** | HDB Blk 635B Senja Road (mid-level) | Priority 2 | NM02b | 61.8 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **50** | HDB Blk 635B Senja Road (top level) | Priority 2 | NM02c | 61.7 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **51** | Junction 10 | Priority 3 | NM03 | 63.8 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **52** | 38 Teck Whye Crescent (1) | Priority 3 | NM04a | 59.0 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **53** | 38 Teck Whye Crescent (2) | Priority 3 | NM04a | 60.4 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **54** | 38 Teck Whye Crescent (3) | Priority 3 | NM04a | 57.4 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **55** | 125 Verde View | Priority 2 | NM01 | 54.7 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **56** | 127 Verde View | Priority 2 | NM01 | 57.0 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **57** | 129 Verde View | Priority 2 | NM01 | 54.7 | 90 | - | Negligible | Imperceptible | Likely | Negligible |

| No. | Human Receptors | Receptor Sensitivity | Nearest SLM | Predicted Construction Noise Levels | Corrected Criteria, dB(A) | Maximum Noise Exceedance, dB(A) | Impact Intensity | Impact Consequence | Likelihood | Impact Significance |
|---|---|---|---|---|---|---|---|---|---|---|
| **58** | Pacific Healthcare Nursing Home | Priority 1 | NM03 | 50.3 | 75 | - | Negligible | Very Low | Likely | Minor |
| **59** | Pioneer Junior College | Priority 1 | N02 | 62.4 | 90 | - | Negligible | Very Low | Likely | Minor |
| **60** | Senja Care Home, Vanguard Senior Care Senja Centre | Priority 1 | NM03 | 64.9 | 75 | - | Negligible | Very Low | Likely | Minor |
| **61** | Senja Soka Centre (1) | Priority 1 | N02 | 51.2 | 90 | - | Negligible | Very Low | Likely | Minor |
| **62** | Teck Whye Sec Sch (1) | Priority 1 | N02 | 61.2 | 90 | - | Negligible | Very Low | Likely | Minor |
| **63** | Teck Whye Sec Sch (2) | Priority 1 | N02 | 64.1 | 90 | - | Negligible | Very Low | Likely | Minor |
| **64** | Teck Whye Sec Sch (3) | Priority 1 | N02 | 54.8 | 90 | - | Negligible | Very Low | Likely | Minor |
| **65** | The Tennery (1) | Priority 2 | NM03 | 66.6 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **66** | The Tennery (2) | Priority 2 | NM03 | 55.7 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **67** | West View Primary School (1) | Priority 1 | NM03 | 58.4 | 75 | - | Negligible | Very Low | Likely | Minor |
| **68** | West View Primary School (2) | Priority 1 | NM03 | 59.6 | 75 | - | Negligible | Very Low | Likely | Minor |

**Table 10-34 Summary of residual construction noise impacts: scenario 2: foundation works – human receptors, LAeq (12hr) (7am-7pm)**

| No. | Human Receptors | Receptor Sensitivity | Nearest SLM | Predicted Construction Noise Levels | Corrected Criteria, dB(A) | Maximum Noise Exceedance, dB(A) | Impact Intensity | Impact Consequence | Likelihood | Impact Significance |
|---|---|---|---|---|---|---|---|---|---|---|
| **1** | Bukit Panjang Exchange (1) | Priority 3 | NM03 | 60.0 | 75 | - | Negligible | Imperceptible | Occasional | Negligible |
| **2** | Bukit Panjang Exchange (2) | Priority 3 | NM03 | 55.8 | 75 | - | Negligible | Imperceptible | Occasional | Negligible |
| **3** | DE142 Gali Batu Bus Depot Site Office | Priority 3 | NM02a | 61.4 | 79 | - | Negligible | Imperceptible | Occasional | Negligible |
| **4** | HDB Blk 162 Jln Teck Whye (ground level) | Priority 2 | NM04a | 64.1 | 75 | - | Negligible | Imperceptible | Occasional | Negligible |
| **5** | HDB Blk 162 Jln Teck Whye (mid-level) | Priority 2 | NM04b | 65.8 | 75 | - | Negligible | Imperceptible | Occasional | Negligible |
| **6** | HDB Blk 162 Jln Teck Whye (top level) | Priority 2 | NM04c | 66.5 | 77 | - | Negligible | Imperceptible | Occasional | Negligible |

| No. | Human Receptors | Receptor Sensitivity | Nearest SLM | Predicted Construction Noise Levels | Corrected Criteria, dB(A) | Maximum Noise Exceedance, dB(A) | Impact Intensity | Impact Consequence | Likelihood | Impact Significance |
|---|---|---|---|---|---|---|---|---|---|---|
| **7** | HDB Blk 163 Jln Teck Whye (ground level) | Priority 2 | NM04a | 63.7 | 75 | - | Negligible | Imperceptible | Occasional | Negligible |
| **8** | HDB Blk 163 Jln Teck Whye (mid-level) | Priority 2 | NM04b | 65.3 | 75 | - | Negligible | Imperceptible | Occasional | Negligible |
| **9** | HDB Blk 163 Jln Teck Whye (top level) | Priority 2 | NM04c | 67.0 | 77 | - | Negligible | Imperceptible | Occasional | Negligible |
| **10** | HDB Blk 164 Jln Teck Whye (ground level) | Priority 2 | NM04a | 63.1 | 75 | - | Negligible | Imperceptible | Occasional | Negligible |
| **11** | HDB Blk 164 Jln Teck Whye (mid-level) | Priority 2 | NM04b | 64.5 | 75 | - | Negligible | Imperceptible | Occasional | Negligible |
| **12** | HDB Blk 164 Jln Teck Whye (top level) | Priority 2 | NM04c | 66.3 | 77 | - | Negligible | Imperceptible | Occasional | Negligible |
| **13** | HDB Blk 606 Senja Road (ground level) | Priority 2 | N1a | 61.6 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **14** | HDB Blk 606 Senja Road (mid-level) | Priority 2 | N1b | 64.1 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **15** | HDB Blk 606 Senja Road (top level) | Priority 2 | N1c | 64.2 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **16** | HDB Blk 632A Senja Road (ground level) | Priority 2 | N1a | 69.7 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **17** | HDB Blk 632A Senja Road (top level) | Priority 2 | N1b | 69.7 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **18** | HDB Blk 632B Senja Road (ground level) | Priority 2 | N1a | 68.4 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **19** | HDB Blk 632B Senja Road (top level) | Priority 2 | N1b | 68.7 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **20** | HDB Blk 633 Senja Road (ground level) | Priority 2 | N1a | 56.8 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **21** | HDB Blk 633A Senja Road (ground level) | Priority 2 | N1a | 67.7 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **22** | HDB Blk 633A Senja Road (mid-level) | Priority 2 | N1b | 68.2 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **23** | HDB Blk 633A Senja Road (top level) | Priority 2 | N1c | 68.2 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |

| No. | Human Receptors | Receptor Sensitivity | Nearest SLM | Predicted Construction Noise Levels | Corrected Criteria, dB(A) | Maximum Noise Exceedance, dB(A) | Impact Intensity | Impact Consequence | Likelihood | Impact Significance |
|---|---|---|---|---|---|---|---|---|---|---|
| **24** | HDB Blk 633B Senja Road (ground level) | Priority 2 | N1a | 68.2 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **25** | HDB Blk 633B Senja Road (mid-level) | Priority 2 | N1b | 69.1 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **26** | HDB Blk 633B Senja Road (top level) | Priority 2 | N1c | 69.1 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **27** | HDB Blk 633C Senja Road (ground level) | Priority 2 | N1a | 66.0 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **28** | HDB Blk 633C Senja Road (mid-level) | Priority 2 | N1b | 67.9 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **29** | HDB Blk 633C Senja Road (top level) | Priority 2 | N1c | 67.9 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **30** | HDB Blk 633D Senja Road (ground level) | Priority 2 | N1a | 64.1 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **31** | HDB Blk 633D Senja Road (mid-level) | Priority 2 | N1b | 66.6 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **32** | HDB Blk 633D Senja Road (top level) | Priority 2 | N1c | 66.6 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **33** | HDB Blk 634A Senja Road (ground level) | Priority 2 | N1a | 69.9 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **34** | HDB Blk 634A Senja Road (mid-level) | Priority 2 | N1b | 69.9 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **35** | HDB Blk 634A Senja Road (top level) | Priority 2 | N1c | 69.9 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **36** | HDB Blk 634B Senja Road (ground level) | Priority 2 | N1a | 62.4 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **37** | HDB Blk 634B Senja Road (mid-level) | Priority 2 | N1b | 64.1 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **38** | HDB Blk 634B Senja Road (top level) | Priority 2 | N1c | 64.1 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **39** | HDB Blk 634C Senja Road (ground level) | Priority 2 | N1a | 67.8 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **40** | HDB Blk 634C Senja Road (mid-level) | Priority 2 | N1b | 68.2 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |

| No. | Human Receptors | Receptor Sensitivity | Nearest SLM | Predicted Construction Noise Levels | Corrected Criteria, dB(A) | Maximum Noise Exceedance, dB(A) | Impact Intensity | Impact Consequence | Likelihood | Impact Significance |
|---|---|---|---|---|---|---|---|---|---|---|
| **41** | HDB Blk 634C Senja Road (top level) | Priority 2 | N1c | 68.2 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **42** | HDB Blk 635 Senja Road (ground level) | Priority 2 | NM02a | 62.5 | 79 | - | Negligible | Imperceptible | Occasional | Negligible |
| **43** | HDB Blk 635 Senja Road (mid-level) | Priority 2 | NM02b | 63.1 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **44** | HDB Blk 635 Senja Road (top level) | Priority 2 | NM02c | 63.1 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **45** | HDB Blk 635A Senja Road (ground level) | Priority 2 | NM02a | 70.1 | 79 | - | Negligible | Imperceptible | Occasional | Negligible |
| **46** | HDB Blk 635A Senja Road (mid-level) | Priority 2 | NM02b | 70.1 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **47** | HDB Blk 635A Senja Road (top level) | Priority 2 | NM02c | 70.1 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **48** | HDB Blk 635B Senja Road (ground level) | Priority 2 | NM02a | 65.6 | 79 | - | Negligible | Imperceptible | Occasional | Negligible |
| **49** | HDB Blk 635B Senja Road (mid-level) | Priority 2 | NM02b | 65.8 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **50** | HDB Blk 635B Senja Road (top level) | Priority 2 | NM02c | 65.8 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **51** | Junction 10 | Priority 3 | NM03 | 67.7 | 75 | - | Negligible | Imperceptible | Occasional | Negligible |
| **52** | 38 Teck Whye Crescent (1) | Priority 3 | NM04a | 64.0 | 75 | - | Negligible | Imperceptible | Occasional | Negligible |
| **53** | 38 Teck Whye Crescent (2) | Priority 3 | NM04a | 64.7 | 75 | - | Negligible | Imperceptible | Occasional | Negligible |
| **54** | 38 Teck Whye Crescent (3) | Priority 3 | NM04a | 61.6 | 75 | - | Negligible | Imperceptible | Occasional | Negligible |
| **55** | 125 Verde View | Priority 2 | NM01 | 58.7 | 79 | - | Negligible | Imperceptible | Occasional | Negligible |
| **56** | 127 Verde View | Priority 2 | NM01 | 61.0 | 79 | - | Negligible | Imperceptible | Occasional | Negligible |
| **57** | 129 Verde View | Priority 2 | NM01 | 58.7 | 79 | - | Negligible | Imperceptible | Occasional | Negligible |
| **58** | Pacific Healthcare Nursing Home | Priority 1 | NM03 | 54.2 | 62 | - | Negligible | Very Low | Occasional | Minor |
| **59** | Pioneer Junior College | Priority 1 | N02 | 66.4 | 75 | - | Negligible | Very Low | Occasional | Minor |
| **60** | Senja Care Home, Vanguard Senior Care Senja Centre | Priority 1 | NM03 | 68.9 | 62 | 6.9 | High | High | Occasional | Moderate |
| **61** | Senja Soka Centre (1) | Priority 1 | N02 | 55.2 | 75 | - | Negligible | Very Low | Occasional | Minor |

| No. | Human Receptors | Receptor Sensitivity | Nearest SLM | Predicted Construction Noise Levels | Corrected Criteria, dB(A) | Maximum Noise Exceedance, dB(A) | Impact Intensity | Impact Consequence | Likelihood | Impact Significance |
|---|---|---|---|---|---|---|---|---|---|---|
| **62** | Teck Whye Sec Sch (1) | Priority 1 | N02 | 65.6 | 75 | - | Negligible | Very Low | Occasional | Minor |
| **63** | Teck Whye Sec Sch (2) | Priority 1 | N02 | 68.5 | 75 | - | Negligible | Very Low | Occasional | Minor |
| **64** | Teck Whye Sec Sch (3) | Priority 1 | N02 | 58.8 | 75 | - | Negligible | Very Low | Occasional | Minor |
| **65** | The Tennery (1) | Priority 2 | NM03 | 70.6 | 75 | - | Negligible | Imperceptible | Occasional | Negligible |
| **66** | The Tennery (2) | Priority 2 | NM03 | 59.5 | 75 | - | Negligible | Imperceptible | Occasional | Negligible |
| **67** | West View Primary School (1) | Priority 1 | NM03 | 62.4 | 62 | 0.4 | Low | Low | Occasional | Minor |
| **68** | West View Primary School (2) | Priority 1 | NM03 | 63.7 | 62 | 1.7 | Medium | Low | Occasional | Minor |

**Table 10-35 Summary of construction noise impacts: scenario 2: foundation works – human receptors, LAeq (5min) (7am-7pm)**

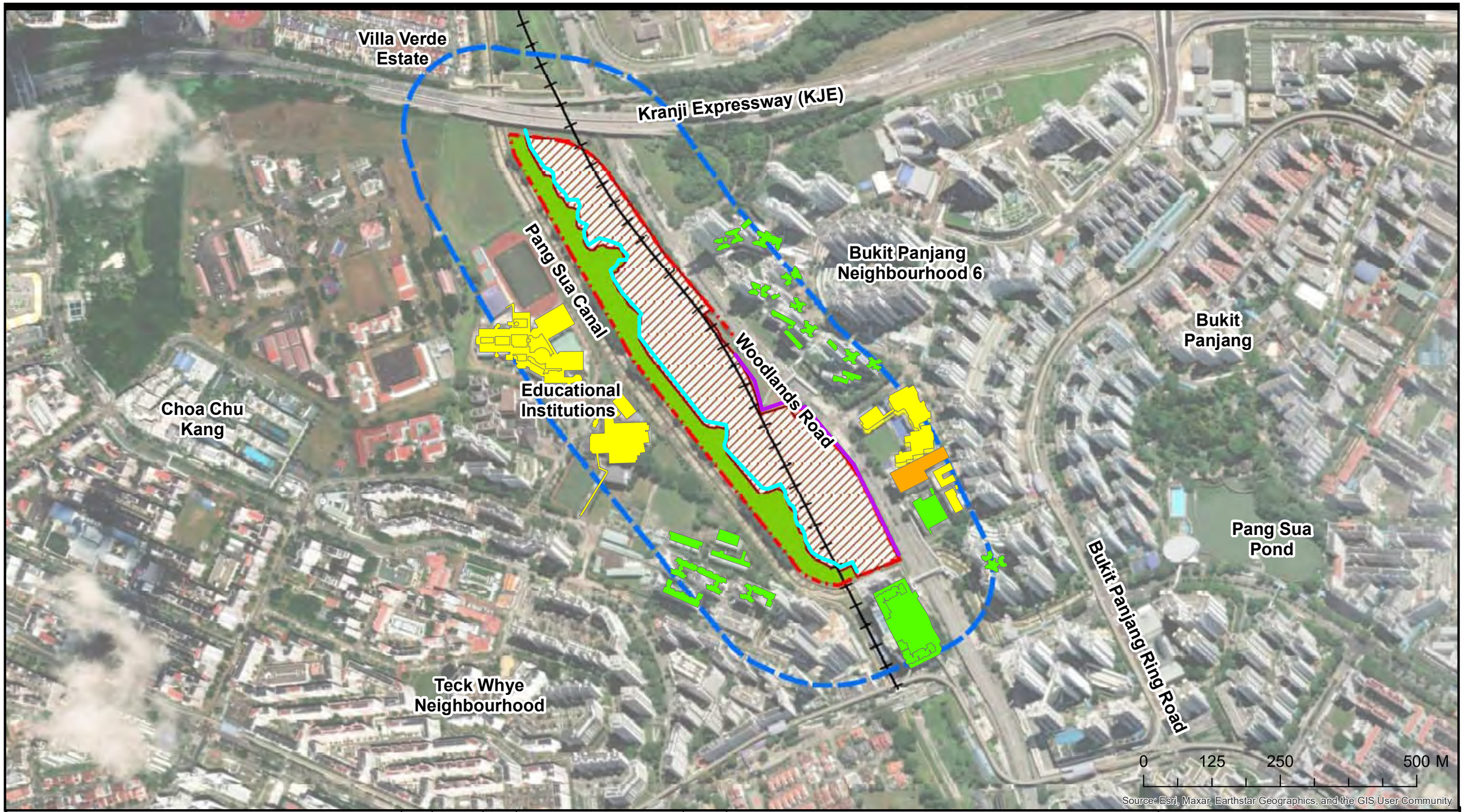
| No. | Human Receptors | Receptor Sensitivity | Nearest SLM | Predicted Construction Noise Levels | Corrected Criteria, dB(A) | Maximum Noise Exceedance, dB(A) | Impact Intensity | Impact Consequence | Likelihood | Impact Significance |
|---|---|---|---|---|---|---|---|---|---|---|
| **1** | Bukit Panjang Exchange (1) | Priority 3 | NM03 | 63.0 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **2** | Bukit Panjang Exchange (2) | Priority 3 | NM03 | 58.8 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **3** | DE142 Gali Batu Bus Depot Site Office | Priority 3 | NM02a | 64.4 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **4** | HDB Blk 162 Jln Teck Whye (ground level) | Priority 2 | NM04a | 67.1 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **5** | HDB Blk 162 Jln Teck Whye (mid-level) | Priority 2 | NM04b | 68.8 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **6** | HDB Blk 162 Jln Teck Whye (top level) | Priority 2 | NM04c | 69.5 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **7** | HDB Blk 163 Jln Teck Whye (ground level) | Priority 2 | NM04a | 66.7 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **8** | HDB Blk 163 Jln Teck Whye (mid-level) | Priority 2 | NM04b | 68.3 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **9** | HDB Blk 163 Jln Teck Whye (top level) | Priority 2 | NM04c | 70.0 | 90 | - | Negligible | Imperceptible | Likely | Negligible |

| No. | Human Receptors | Receptor Sensitivity | Nearest SLM | Predicted Construction Noise Levels | Corrected Criteria, dB(A) | Maximum Noise Exceedance, dB(A) | Impact Intensity | Impact Consequence | Likelihood | Impact Significance |
|---|---|---|---|---|---|---|---|---|---|---|
| **10** | HDB Blk 164 Jln Teck Whye (ground level) | Priority 2 | NM04a | 66.1 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **11** | HDB Blk 164 Jln Teck Whye (mid-level) | Priority 2 | NM04b | 67.5 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **12** | HDB Blk 164 Jln Teck Whye (top level) | Priority 2 | NM04c | 69.3 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **13** | HDB Blk 606 Senja Road (ground level) | Priority 2 | N1a | 64.6 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **14** | HDB Blk 606 Senja Road (mid-level) | Priority 2 | N1b | 67.1 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **15** | HDB Blk 606 Senja Road (top level) | Priority 2 | N1c | 67.2 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **16** | HDB Blk 632A Senja Road (ground level) | Priority 2 | N1a | 72.7 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **17** | HDB Blk 632A Senja Road (top level) | Priority 2 | N1b | 72.7 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **18** | HDB Blk 632B Senja Road (ground level) | Priority 2 | N1a | 71.4 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **19** | HDB Blk 632B Senja Road (top level) | Priority 2 | N1b | 71.7 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **20** | HDB Blk 633 Senja Road (ground level) | Priority 2 | N1a | 59.8 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **21** | HDB Blk 633A Senja Road (ground level) | Priority 2 | N1a | 70.7 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **22** | HDB Blk 633A Senja Road (mid-level) | Priority 2 | N1b | 71.2 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **23** | HDB Blk 633A Senja Road (top level) | Priority 2 | N1c | 71.2 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **24** | HDB Blk 633B Senja Road (ground level) | Priority 2 | N1a | 71.2 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **25** | HDB Blk 633B Senja Road (mid-level) | Priority 2 | N1b | 72.1 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **26** | HDB Blk 633B Senja Road (top level) | Priority 2 | N1c | 72.1 | 90 | - | Negligible | Imperceptible | Likely | Negligible |

| No. | Human Receptors | Receptor Sensitivity | Nearest SLM | Predicted Construction Noise Levels | Corrected Criteria, dB(A) | Maximum Noise Exceedance, dB(A) | Impact Intensity | Impact Consequence | Likelihood | Impact Significance |
|---|---|---|---|---|---|---|---|---|---|---|
| **27** | HDB Blk 633C Senja Road (ground level) | Priority 2 | N1a | 69.0 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **28** | HDB Blk 633C Senja Road (mid-level) | Priority 2 | N1b | 70.9 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **29** | HDB Blk 633C Senja Road (top level) | Priority 2 | N1c | 70.9 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **30** | HDB Blk 633D Senja Road (ground level) | Priority 2 | N1a | 67.1 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **31** | HDB Blk 633D Senja Road (mid-level) | Priority 2 | N1b | 69.6 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **32** | HDB Blk 633D Senja Road (top level) | Priority 2 | N1c | 69.6 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **33** | HDB Blk 634A Senja Road (ground level) | Priority 2 | N1a | 72.9 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **34** | HDB Blk 634A Senja Road (mid-level) | Priority 2 | N1b | 72.9 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **35** | HDB Blk 634A Senja Road (top level) | Priority 2 | N1c | 72.9 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **36** | HDB Blk 634B Senja Road (ground level) | Priority 2 | N1a | 65.4 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **37** | HDB Blk 634B Senja Road (mid-level) | Priority 2 | N1b | 67.1 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **38** | HDB Blk 634B Senja Road (top level) | Priority 2 | N1c | 67.1 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **39** | HDB Blk 634C Senja Road (ground level) | Priority 2 | N1a | 70.8 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **40** | HDB Blk 634C Senja Road (mid-level) | Priority 2 | N1b | 71.2 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **41** | HDB Blk 634C Senja Road (top level) | Priority 2 | N1c | 71.2 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **42** | HDB Blk 635 Senja Road (ground level) | Priority 2 | NM02a | 65.5 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **43** | HDB Blk 635 Senja Road (mid-level) | Priority 2 | NM02b | 66.1 | 90 | - | Negligible | Imperceptible | Likely | Negligible |

| No. | Human Receptors | Receptor Sensitivity | Nearest SLM | Predicted Construction Noise Levels | Corrected Criteria, dB(A) | Maximum Noise Exceedance, dB(A) | Impact Intensity | Impact Consequence | Likelihood | Impact Significance |
|---|---|---|---|---|---|---|---|---|---|---|
| **44** | HDB Blk 635 Senja Road (top level) | Priority 2 | NM02c | 66.1 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **45** | HDB Blk 635A Senja Road (ground level) | Priority 2 | NM02a | 73.1 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **46** | HDB Blk 635A Senja Road (mid-level) | Priority 2 | NM02b | 73.1 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **47** | HDB Blk 635A Senja Road (top level) | Priority 2 | NM02c | 73.1 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **48** | HDB Blk 635B Senja Road (ground level) | Priority 2 | NM02a | 68.6 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **49** | HDB Blk 635B Senja Road (mid-level) | Priority 2 | NM02b | 68.8 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **50** | HDB Blk 635B Senja Road (top level) | Priority 2 | NM02c | 68.8 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **51** | Junction 10 | Priority 3 | NM03 | 70.7 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **52** | 38 Teck Whye Crescent (1) | Priority 3 | NM04a | 67.0 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **53** | 38 Teck Whye Crescent (2) | Priority 3 | NM04a | 67.7 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **54** | 38 Teck Whye Crescent (3) | Priority 3 | NM04a | 64.6 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **55** | 125 Verde View | Priority 2 | NM01 | 61.7 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **56** | 127 Verde View | Priority 2 | NM01 | 64.0 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **57** | 129 Verde View | Priority 2 | NM01 | 61.7 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **58** | Pacific Healthcare Nursing Home | Priority 1 | NM03 | 57.2 | 75 | - | Negligible | Very Low | Likely | Minor |
| **59** | Pioneer Junior College | Priority 1 | N02 | 69.4 | 90 | - | Negligible | Very Low | Likely | Minor |
| **60** | Senja Care Home, Vanguard Senior Care Senja Centre | Priority 1 | NM03 | 71.9 | 75 | - | Negligible | Very Low | Likely | Minor |
| **61** | Senja Soka Centre (1) | Priority 1 | N02 | 58.2 | 90 | - | Negligible | Very Low | Likely | Minor |
| **62** | Teck Whye Sec Sch (1) | Priority 1 | N02 | 68.6 | 90 | - | Negligible | Very Low | Likely | Minor |
| **63** | Teck Whye Sec Sch (2) | Priority 1 | N02 | 71.5 | 90 | - | Negligible | Very Low | Likely | Minor |
| **64** | Teck Whye Sec Sch (3) | Priority 1 | N02 | 61.8 | 90 | - | Negligible | Very Low | Likely | Minor |
| **65** | The Tennery (1) | Priority 2 | NM03 | 73.6 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **66** | The Tennery (2) | Priority 2 | NM03 | 62.5 | 90 | - | Negligible | Imperceptible | Likely | Negligible |

| No. | Human Receptors | Receptor Sensitivity | Nearest SLM | Predicted Construction Noise Levels | Corrected Criteria, dB(A) | Maximum Noise Exceedance, dB(A) | Impact Intensity | Impact Consequence | Likelihood | Impact Significance |
|---|---|---|---|---|---|---|---|---|---|---|
| **67** | West View Primary School (1) | Priority 1 | NM03 | 65.4 | 75 | - | Negligible | Very Low | Likely | Minor |
| **68** | West View Primary School (2) | Priority 1 | NM03 | 66.7 | 75 | - | Negligible | Very Low | Likely | Minor |




## Legend

- Proposed 3m Noise Barrier
- Proposed 12m Noise Barrier
- CCK N1 Project Site
- Airborne Noise Study Area (150m)
- Rail Corridor
- Proposed Construction Footprint*
- Proposed Development Boundary*
- Proposed Ecological Corridor*

* exact boundaries/ alignment subject to further changes

**Impact Significance**

- Negligible
- Minor
- Moderate
- Major

N

| Rev. | Date | By | Description | Chk'd | App'd |
|---|---|---|---|---|---|
| - | SEP 2022 | SYT | Draft Final Report | NHT | JAG |

Qualified Person Endorsement : NA

HDB Endorsement : NA

Consultant : AECOM

Client: HOUSING & DEVELOPMENT BOARD

Project Title :

**ENVIRONMENTAL IMPACT ASSESSMENT (EIA) ON CHOA CHU KANG N1**

Figure Title :

**Human Noise Sensitive Receptors - Scenario 1: Site Preparation for Earthworks, LAeq(12 hours), 7am - 7pm (Base Assessment Scenario)**

| Designed | Checked | Approved |
|---|---|---|
| SAG | NHT | JAG |
| | Drawn: SYT | Date: SEP 2022 |

Figure No. : 10 - 18 | Rev. : - | Sheet : 1 of 1

CAD File Name : NA | A3

Note: Source of basemap - Google Earth Map

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## 10.9.2 Operational Phase

### 10.9.2.1 Ecological Impacts

The residual operational noise impact assessment assumes that mitigation measures proposed within Section 10.8.2 have been implemented at developments identified as potential sources of operational noise. The Impact Intensity at the receptors are expected to be reduced with the adopted 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.

Since the initial impact assessment with minimum controls was considered insignificant (**Negligible** to **Minor**), no residual impact assessment was undertaken, hence the impact significance remained the same.

**Table 10-36 Summary of residual operational noise impacts – ecological receptors**

| Auditory Sensitivity | Impact Intensity | Impact Consequence | Likelihood | Impact Significance |
|---|---|---|---|---|
| **ACMV Noise Impact** | | | | |
| Priority 1 | Negligible | Very Low | Less Likely/ Rare | Negligible |
| **Land Traffic Noise Impact** | | | | |
| Priority 1 | Low | Low | Possible/ Occasional | Minor |

### 10.9.2.2 Human Impacts

As discussed in Section 10.2.1.2, it is mandatory that the proposed developments comply with the NEA noise legislations (i.e., ACMV Guideline, 2018 [R-38] and TNIA Guideline, 2016 [R-38]). This is usually conducted by appointed Noise Consultant(s) during the development stage. As such, AECOM recommends that HDB/ contractor contracted by HDB 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.

Since the initial impact assessment with minimum controls was considered insignificant (**Negligible** to **Minor**), no residual impact assessment was undertaken, hence the impact significance remained the same.

**Table 10-37 Summary of residual operational noise impacts – human receptors**

| Noise Sensitive Human Receptors* | Impact Intensity | Impact Consequence | Likelihood | Impact Significance |
|---|---|---|---|---|
| **ACMV Boundary Noise Impact Assessment** | | | | |
| (a) Noise Sensitive Premises | Negligible | Very Low | Unlikely/ Remote | Minor |
| (b) Residential Premises | Negligible | Imperceptible | Unlikely/ Remote | Negligible |
| **TNIA** | | | | |
| Noise Sensitive Premises | Low | Low | Possible/ Occasional | Minor |
| Residential Premises | Low | Very Low | Possible/ Occasional | Minor |
| *Note: * Refer to the respective noise legislations for definition of human receptors.* | | | | |

# 10.10 Cumulative Impacts from Other Concurrent Developments

It is known that construction activities are planned to occur in the vicinity of the Project as highlighted in Section 3.3. Hence, cumulative impacts from other relevant major concurrent development in the vicinity of the Project shall be assessed and considered.

## 10.10.1 Construction Phase

Three (3) nearby concurrent Projects: the Nearby Future Development by Other Agency; the NParks Upcoming Bukit Panjang North PC (along Kranji Expressway and Woodlands Road); and the NParks Rail Corridor North Enhancement Works have been identified in Section 3.2.1 as the concurrent developments that may contribute to cumulative noise impacts.

The impact significance post-mitigation for the proposed development ranges from **Moderate** to **Major** for ecological receptors and, **Negligible** to **Moderate** for human receptors. Due to the presence of these concurrent construction sites, the construction footprint in this area is expected to be larger. Therefore, the concurrent constructions may result in an increase in overall noise impacts due to cumulative noise in the vicinity of HDB CCK N1.

Information on construction works for the Nearby Future Development by Other Agency are available in an agreement on information exchange between the Agency and HDB and are assessed in the following sections quantitatively for cumulative noise impacts on ecological and human receptors.

### 10.10.1.1 Nearby Future Development by Other Agency

The cumulative construction noise impact assessment assumes that the mitigation measures proposed in Section 10.8 are implemented at the construction worksites, nearest to the receptors predicted to experience significant Impact Intensity through quantitative and qualitative assessment.

Construction works for the nearby future developments by other agency are expected to coincide with Scenario 2: Foundation Works of this Project and are assessed accordingly.

#### 10.10.1.1.1 Cumulative Ecological Impacts

As discussed in Section 10.9, residual noise exceedances of up to 12 dB(A) and 24 dB(A) were predicted for ecological receptors subjected to noise emissions from Scenario 2: Foundation Works upon the implementation of mitigation measures proposed in Section 10.8.

Due to construction works by other agency (see Figure 10-19), noise impacts were predicted to increase with cumulative noise exceedances of up to 13 dB(A) and 29 dB(A). The overall Impact Intensity was predicted to remain unchanged at **High** (refer to Table 6-5) with a corresponding overall Impact Significance of **High** (see Table 6-8). When relating the overall Impact Consequence to a Likelihood of Occurrence of **Occasional/ Likely**, it was determined that the overall cumulative Impact Significance remained at **Moderate** for the time period of $L_{Aeq(12\ hrs)}$, and **Major** for $L_{Aeq(5\ mins)}$, 7am – 7pm.

Likewise, the areal distribution of Impact Significance were predicted to increase from 2.4 ha to 4.0 ha with overall Impact Significance remaining unchanged as **Moderate** for the time period of $L_{Aeq(12\ hrs)}$, and **Major** for $L_{Aeq(5\ mins)}$, 7am – 7pm.

The resulting cumulative noise contours representative of Scenario 2: Foundation Works were predicted and visualized in Figure 10-19 and Figure 10-20 for $L_{Aeq(12\ hrs)}$ and $L_{Aeq(5\ mins)}$ respectively, with cumulative noise impact assessment results presented in Table 10-39 below. The evaluation was carried out with reference to the assessment methodology outlined in Section 6.4.3.

**Table 10-38 List of noise contour maps reflecting cumulative ecological impacts**

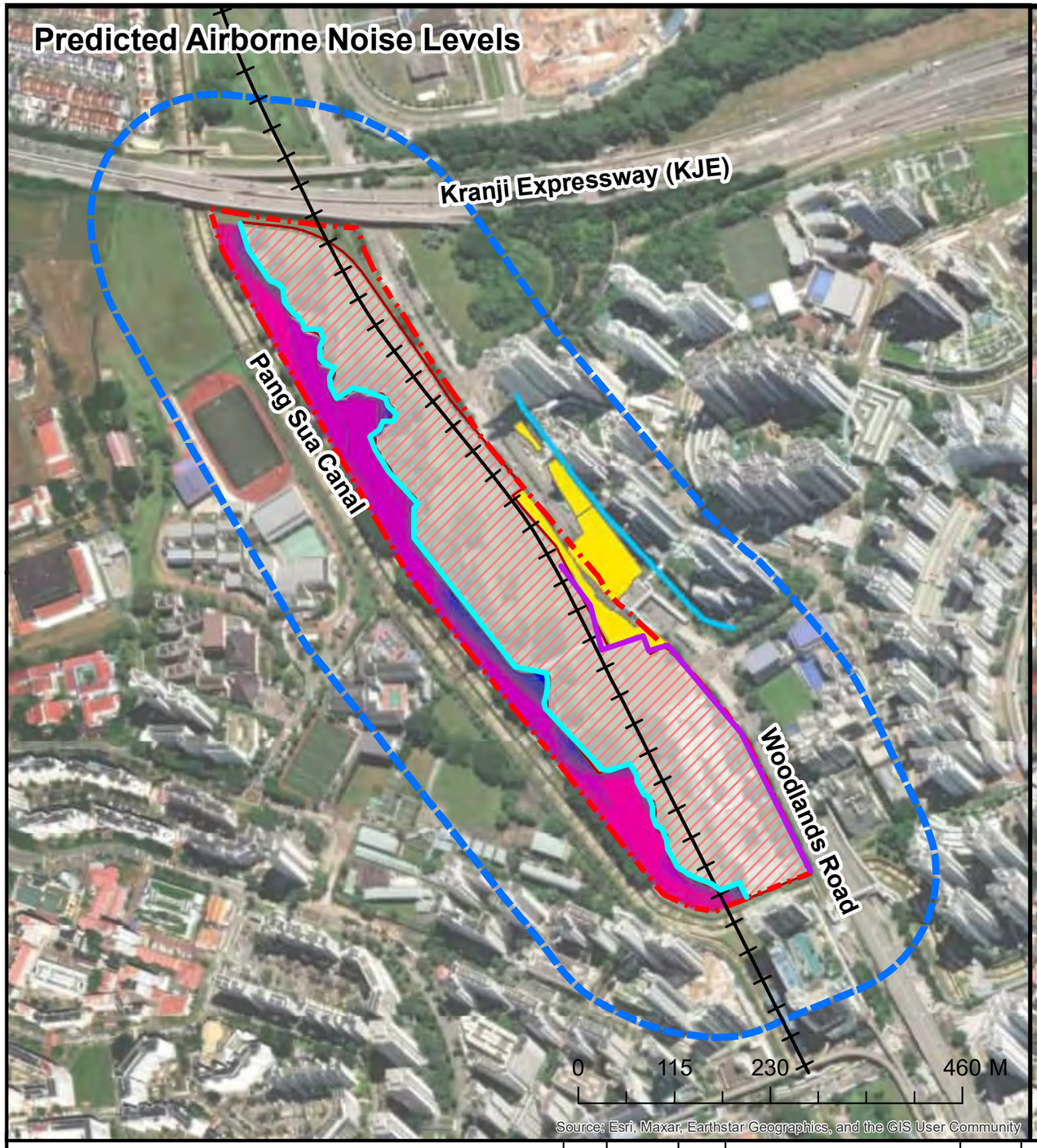
| Elevation | Construction Schedule | $L_{Aeq}$ | Figure |
|---|---|---|---|
| **Scenario 2: Roadworks and Foundation Works** | | | |
| 0.5m | Weekdays (7am – 7pm) | $L_{Aeq(12\ hrs)}$ | Figure 10-19 |
| | Weekdays (7am – 7pm) | $L_{Aeq(5\ mins)}$ | Figure 10-20 |

Although an increment of construction noise impacts on ecological receptors were expected as a result of cumulative noise levels from construction works at the nearby future development by other agency, a closer look into the comparison of noise contours for the pre-mitigation (base case) and post-mitigation (mitigated case) cases revealed significant reduction in the areas of **Moderate** and **Major** Impact Significance with the implementation of noise barriers. Observing the cumulative impact for both humans and ecology, it is strongly recommended to use portable barriers for equipment that contribute to excessive noise at all times

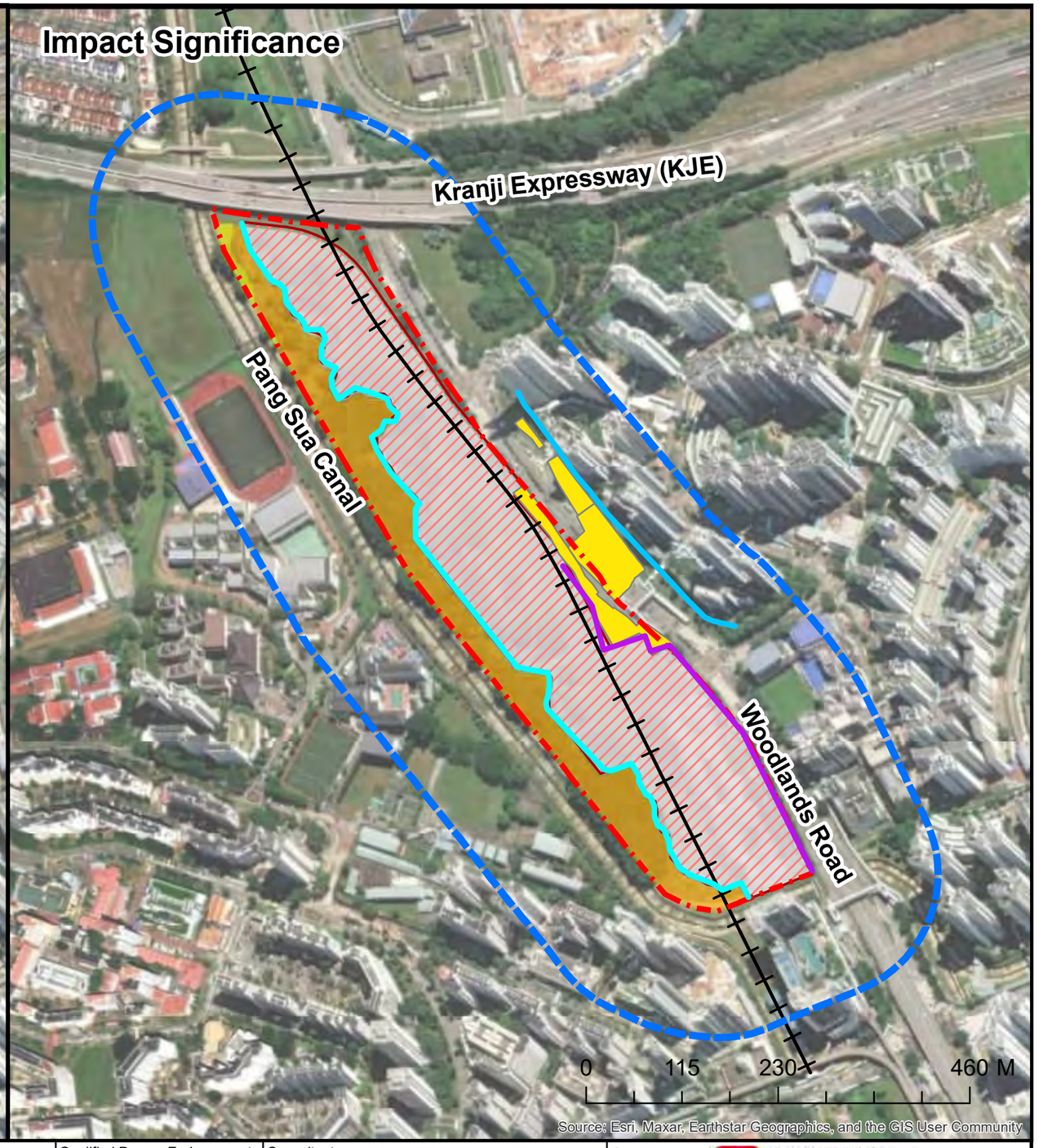
**Table 10-39 Summary of cumulative construction noise impacts – ecological impacts**

| Assessment Scenario(s) | Auditory Sensitivity | Post-Mitigated Evaluation | | | | | | | | Cumulative Evaluation | | | | | | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Maximum Predicted Noise Level, dB(A) | Exceedance, dB(A) | Impact Intensity | Impact Consequence | Likelihood of Occurrence | Impact Significance | Area (ha) | Percentage distribution (%) | Maximum Predicted Noise Level, dB(A) | Exceedance, dB(A) | Impact Intensity | Impact Consequence | Likelihood of Occurrence | Impact Significance | Area (ha) | Percentage distribution (%) | |
| **LAeq (12hr)** | | | | | | | | | | | | | | | | | | |
| Scenario 2: Foundation Works | Priority 1 | 78.0 | 24.0 | High | High | Occasional | Moderate | 2.4 | 59% | 83.0 | 29.0 | High | High | Occasional | Moderate | 4.0 | 95% | • Area of Major impact significance increased from 2.4 ha to 4.0 ha<br>• Impact Significance remains unchanged as **Moderate**. |
| **LAeq (5min)** | | | | | | | | | | | | | | | | | | |
| Scenario 2: Foundation Works | Priority 1 | 82.0 | 12.0 | High | High | Likely | Major | 3.2 | 78% | 83.0 | 13.0 | High | High | Likely | Major | 3.6 | 86% | • Area of Major impact significance increased from 3.2 ha to 3.6 ha<br>• Impact Significance remains unchanged as **Moderate**. |

## Predicted Airborne Noise Levels




## Impact Significance




**Legend**

- Proposed 12m Noise Barrier
- Proposed 3m Noise Barrier
- CCK N1 Project Site
- 150m Airborne Noise Study Area
- Original Track Alignment
- Proposed Construction Footprint*
- Proposed Development Boundary*

**Other Concurrent Developments**

- LTA DTL2e Proposed 12m Noise Barrier
- LTA DTL2e Docking Shaft Construction Footprint

**Predicted Airborne Noise Levels LAeq(12hrs), dB**

| | |
|---|---|
| <= 46 | 61 - 64 |
| 46 - 49 | 64 - 67 |
| 49 - 52 | 67 - 70 |
| 52 - 55 | 70 - 73 |
| 55 - 58 | 73 - 76 |
| 58 - 61 | >= 76 |

**Impact Significance**

- Negligible
- Minor
- Moderate
- Major

* exact boundary/ alignment subject to further changes

N

| Rev. | Date | By | Description | Chk'd | App'd |
|---|---|---|---|---|---|
| - | AUG 2023 | SYT | EMMP Specification | AW | JAG |

Qualified Person Endorsement : NA

HDB Endorsement : NA

Consultant : AECOM

Client: HOUSING & DEVELOPMENT BOARD

Project Title :

**Specialist Consultancy Services at HDB Development (Choa Chu Kang)**

Figure Title :

**Ecological Noise Sensitive Receptors - Scenario 2: Foundation Works, LAeq(5 mins), 10pm - 7am (Cumulative Scenario Assessment)**

| Designed | Checked | Approved |
|---|---|---|
| SAG | AW | JAG |
| | Drawn: SYT | Date: AUG 2023 |

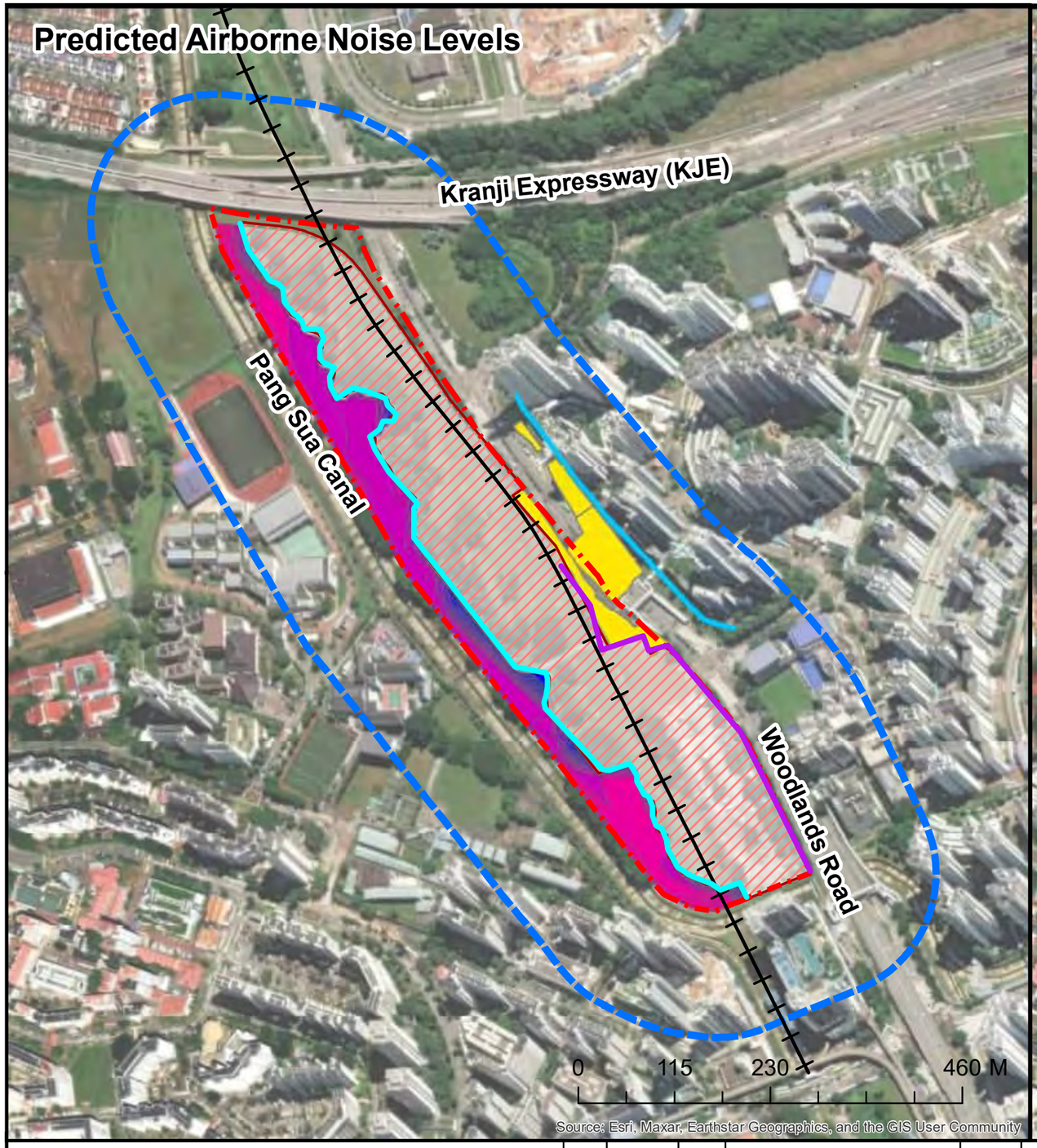
Figure No. : 10 - 19 | Rev. : - | Sheet : 1 of 1

CAD File Name : NA | A3

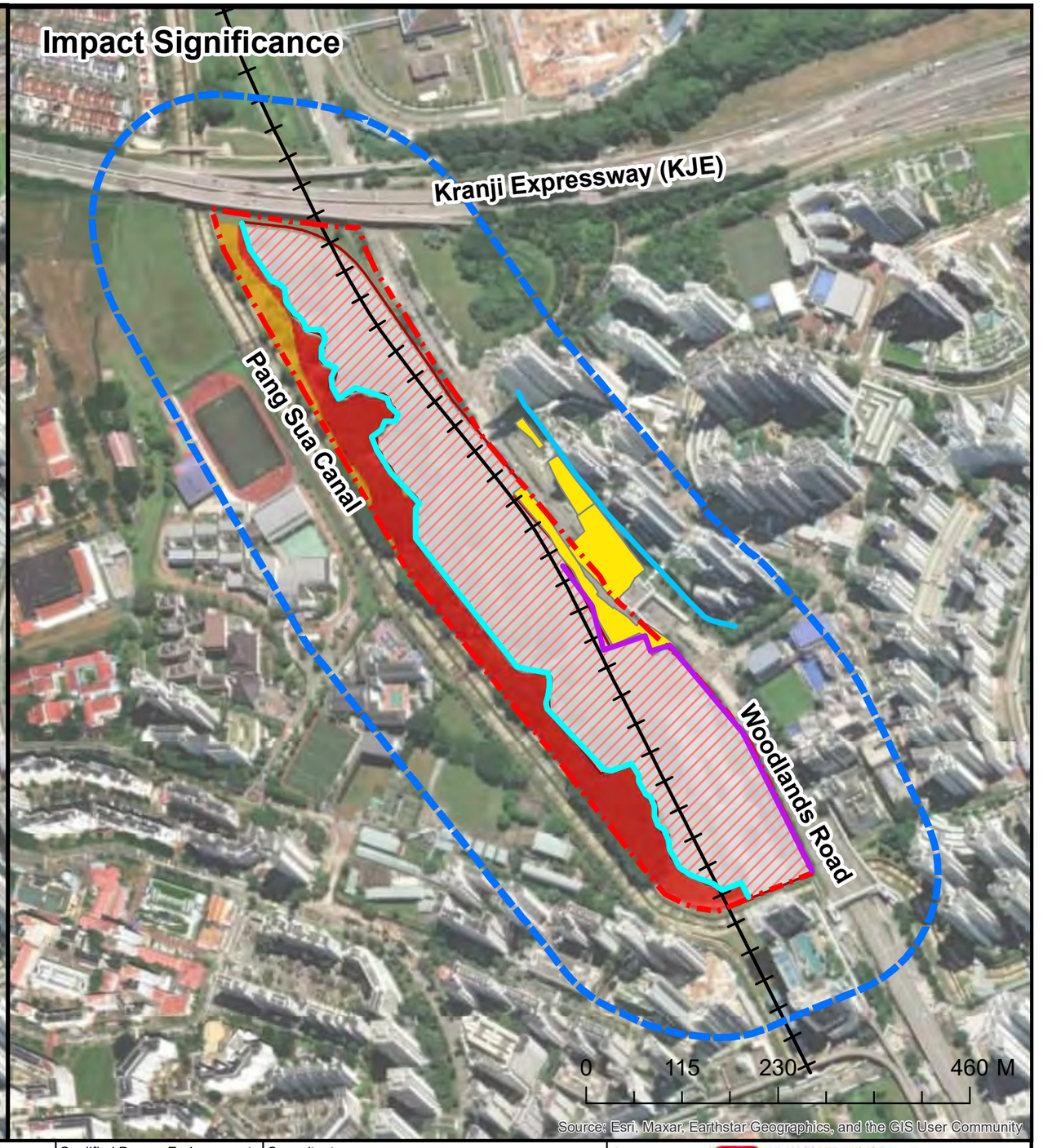
Note: Source of basemap - Google Earth Map

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## Predicted Airborne Noise Levels




## Impact Significance




**Legend**

- Proposed 12m Noise Barrier
- Proposed 3m Noise Barrier
- CCK N1 Project Site
- 150m Airborne Noise Study Area
- Original Track Alignment
- Proposed Construction Footprint*
- Proposed Development Boundary*

**Other Concurrent Developments**

- LTA DTL2e Proposed 12m Noise Barrier
- LTA DTL2e Docking Shaft Construction Footprint

**Predicted Airborne Noise Levels LAeq(5 mins), dB**

| | |
|---|---|
| <= 46 | 61 - 64 |
| 46 - 49 | 64 - 67 |
| 49 - 52 | 67 - 70 |
| 52 - 55 | 70 - 73 |
| 55 - 58 | 73 - 76 |
| 58 - 61 | >= 76 |

**Impact Significance**

- Negligible
- Minor
- Moderate
- Major

* exact boundary/ alignment subject to further changes

N

| Rev. | Date | By | Description | Chk'd | App'd |
|---|---|---|---|---|---|
| - | AUG 2023 | SYT | EMMP Specification | AW | JAG |

Qualified Person Endorsement : NA

HDB Endorsement : NA

Consultant : AECOM

Client: HOUSING & DEVELOPMENT BOARD

Project Title :

**Specialist Consultancy Services at HDB Development (Choa Chu Kang)**

Figure Title :

**Ecological Noise Sensitive Receptors - Scenario 2: Foundation Works, LAeq(5 mins), 10pm - 7am (Cumulative Scenario Assessment)**

| Designed | Checked | Approved |
|---|---|---|
| SAG | AW | JAG |
| | Drawn: SYT | Date: AUG 2023 |

Figure No. : 10 - 20 | Rev. : - | Sheet : 1 of 1

CAD File Name : NA | A3

Note: Source of basemap - Google Earth Map

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#### 10.10.1.1.2 Cumulative Human Impacts

As discussed in Section 10.9, residual noise exceedances of up to 7.6 dB(A) at Senja Care Home, and 1.7 dB(A) at West View Primary School were predicted for human receptors subjected to noise emissions from Scenario 2: Foundation Works upon the implementation of mitigation measures proposed in Section 10.8.

Due to construction works by other agency (see Figure 10-21), noise impacts were predicted to increase with cumulative noise exceedances of up to 7.1 dB(A) for Senja Care Home, a minor reduction due to proposed mitigation measures for the future development by other agency. While for West View Primary School, an increase of noise exceedance to up to 2.4 dB(A) were predicted as a result of cumulative noise impacts.

The overall Impact Intensity was predicted to remain unchanged at **High** (refer to Table 6-5) for Senja Care Home and **Low** for West View Primary School, with a corresponding overall Impact Consequence of **Low** and **High** (see Table 6-6) for the respective human receptors. When relating the overall Impact Consequence to a Likelihood of Occurrence of **Occasional/ Likely**, it was determined that the overall cumulative Impact Significance remained at **Moderate** for Senja Care Home and **Minor** for West View Primary School. Observing the cumulative impact for both humans and ecology, it is strongly recommended to use portable barriers for equipment that contribute to excessive noise at all times.

The resulting residual noise contours representative of the worst-case Scenario 2: Foundation Works were visualized in Figure 10-21 for $L_{Aeq(12\ hrs)}$.

**Table 10-40 Summary of cumulative construction noise impacts: scenario 2: foundation works – human receptors, LAeq (12hr) (7am-7pm)**

| No. | Human Receptors | Receptor Sensitivity | Nearest SLM | Predicted Construction Noise Levels | Corrected Criteria, dB(A) | Maximum Noise Exceedance, dB(A) | Impact Intensity | Impact Consequence | Likelihood | Impact Significance |
|---|---|---|---|---|---|---|---|---|---|---|
| **1** | Bukit Panjang Exchange (1) | Priority 3 | NM03 | 60.5 | 75 | - | Negligible | Imperceptible | Occasional | Negligible |
| **2** | Bukit Panjang Exchange (2) | Priority 3 | NM03 | 55.9 | 75 | - | Negligible | Imperceptible | Occasional | Negligible |
| **3** | DE142 Gali Batu Bus Depot Site Office | Priority 3 | NM02a | 61.4 | 79 | - | Negligible | Imperceptible | Occasional | Negligible |
| **4** | HDB Blk 162 Jln Teck Whye (ground level) | Priority 2 | NM04a | 63.9 | 75 | - | Negligible | Imperceptible | Occasional | Negligible |
| **5** | HDB Blk 162 Jln Teck Whye (mid-level) | Priority 2 | NM04b | 65.7 | 75 | - | Negligible | Imperceptible | Occasional | Negligible |
| **6** | HDB Blk 162 Jln Teck Whye (top level) | Priority 2 | NM04c | 66.5 | 77 | - | Negligible | Imperceptible | Occasional | Negligible |
| **7** | HDB Blk 163 Jln Teck Whye (ground level) | Priority 2 | NM04a | 63.5 | 75 | - | Negligible | Imperceptible | Occasional | Negligible |
| **8** | HDB Blk 163 Jln Teck Whye (mid-level) | Priority 2 | NM04b | 65.1 | 75 | - | Negligible | Imperceptible | Occasional | Negligible |
| **9** | HDB Blk 163 Jln Teck Whye (top level) | Priority 2 | NM04c | 67.0 | 77 | - | Negligible | Imperceptible | Occasional | Negligible |
| **10** | HDB Blk 164 Jln Teck Whye (ground level) | Priority 2 | NM04a | 62.9 | 75 | - | Negligible | Imperceptible | Occasional | Negligible |
| **11** | HDB Blk 164 Jln Teck Whye (mid-level) | Priority 2 | NM04b | 64.4 | 75 | - | Negligible | Imperceptible | Occasional | Negligible |
| **12** | HDB Blk 164 Jln Teck Whye (top level) | Priority 2 | NM04c | 66.3 | 77 | - | Negligible | Imperceptible | Occasional | Negligible |
| **13** | HDB Blk 606 Senja Road (ground level) | Priority 2 | N1a | 61.6 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **14** | HDB Blk 606 Senja Road (mid-level) | Priority 2 | N1b | 64.3 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **15** | HDB Blk 606 Senja Road (top level) | Priority 2 | N1c | 64.4 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **16** | HDB Blk 632A Senja Road (ground level) | Priority 2 | N1a | 72.7 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **17** | HDB Blk 632A Senja Road (top level) | Priority 2 | N1b | 72.6 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |

| No. | Human Receptors | Receptor Sensitivity | Nearest SLM | Predicted Construction Noise Levels | Corrected Criteria, dB(A) | Maximum Noise Exceedance, dB(A) | Impact Intensity | Impact Consequence | Likelihood | Impact Significance |
|---|---|---|---|---|---|---|---|---|---|---|
| **18** | HDB Blk 632B Senja Road (ground level) | Priority 2 | N1a | 69.1 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **19** | HDB Blk 632B Senja Road (top level) | Priority 2 | N1b | 69.4 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **20** | HDB Blk 633 Senja Road (ground level) | Priority 2 | N1a | 52.6 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **21** | HDB Blk 633A Senja Road (ground level) | Priority 2 | N1a | 68.3 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **22** | HDB Blk 633A Senja Road (mid-level) | Priority 2 | N1b | 69.6 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **23** | HDB Blk 633A Senja Road (top level) | Priority 2 | N1c | 69.6 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **24** | HDB Blk 633B Senja Road (ground level) | Priority 2 | N1a | 68.6 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **25** | HDB Blk 633B Senja Road (mid-level) | Priority 2 | N1b | 70.2 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **26** | HDB Blk 633B Senja Road (top level) | Priority 2 | N1c | 69.9 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **27** | HDB Blk 633C Senja Road (ground level) | Priority 2 | N1a | 67.1 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **28** | HDB Blk 633C Senja Road (mid-level) | Priority 2 | N1b | 68.6 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **29** | HDB Blk 633C Senja Road (top level) | Priority 2 | N1c | 68.5 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **30** | HDB Blk 633D Senja Road (ground level) | Priority 2 | N1a | 64.2 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **31** | HDB Blk 633D Senja Road (mid-level) | Priority 2 | N1b | 67.3 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **32** | HDB Blk 633D Senja Road (top level) | Priority 2 | N1c | 67.3 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **33** | HDB Blk 634A Senja Road (ground level) | Priority 2 | N1a | 71.1 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **34** | HDB Blk 634A Senja Road (mid-level) | Priority 2 | N1b | 71.0 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |

| No. | Human Receptors | Receptor Sensitivity | Nearest SLM | Predicted Construction Noise Levels | Corrected Criteria, dB(A) | Maximum Noise Exceedance, dB(A) | Impact Intensity | Impact Consequence | Likelihood | Impact Significance |
|---|---|---|---|---|---|---|---|---|---|---|
| **35** | HDB Blk 634A Senja Road (top level) | Priority 2 | N1c | 71.0 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **36** | HDB Blk 634B Senja Road (ground level) | Priority 2 | N1a | 62.5 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **37** | HDB Blk 634B Senja Road (mid-level) | Priority 2 | N1b | 65.3 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **38** | HDB Blk 634B Senja Road (top level) | Priority 2 | N1c | 65.3 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **39** | HDB Blk 634C Senja Road (ground level) | Priority 2 | N1a | 69.2 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **40** | HDB Blk 634C Senja Road (mid-level) | Priority 2 | N1b | 69.6 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **41** | HDB Blk 634C Senja Road (top level) | Priority 2 | N1c | 69.5 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **42** | HDB Blk 635 Senja Road (ground level) | Priority 2 | NM02a | 62.4 | 79 | - | Negligible | Imperceptible | Occasional | Negligible |
| **43** | HDB Blk 635 Senja Road (mid-level) | Priority 2 | NM02b | 63.2 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **44** | HDB Blk 635 Senja Road (top level) | Priority 2 | NM02c | 62.8 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **45** | HDB Blk 635A Senja Road (ground level) | Priority 2 | NM02a | 70.4 | 79 | - | Negligible | Imperceptible | Occasional | Negligible |
| **46** | HDB Blk 635A Senja Road (mid-level) | Priority 2 | NM02b | 70.5 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **47** | HDB Blk 635A Senja Road (top level) | Priority 2 | NM02c | 69.5 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **48** | HDB Blk 635B Senja Road (ground level) | Priority 2 | NM02a | 65.6 | 79 | - | Negligible | Imperceptible | Occasional | Negligible |
| **49** | HDB Blk 635B Senja Road (mid-level) | Priority 2 | NM02b | 65.8 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **50** | HDB Blk 635B Senja Road (top level) | Priority 2 | NM02c | 65.8 | 76 | - | Negligible | Imperceptible | Occasional | Negligible |
| **51** | Junction 10 | Priority 3 | NM03 | 66.1 | 75 | - | Negligible | Imperceptible | Occasional | Negligible |
| **52** | 38 Teck Whye Crescent (1) | Priority 3 | NM04a | 63.3 | 75 | - | Negligible | Imperceptible | Occasional | Negligible |

| No. | Human Receptors | Receptor Sensitivity | Nearest SLM | Predicted Construction Noise Levels | Corrected Criteria, dB(A) | Maximum Noise Exceedance, dB(A) | Impact Intensity | Impact Consequence | Likelihood | Impact Significance |
|---|---|---|---|---|---|---|---|---|---|---|
| **53** | 38 Teck Whye Crescent (2) | Priority 3 | NM04a | 64.4 | 75 | - | Negligible | Imperceptible | Occasional | Negligible |
| **54** | 38 Teck Whye Crescent (3) | Priority 3 | NM04a | 61.5 | 75 | - | Negligible | Imperceptible | Occasional | Negligible |
| **55** | 125 Verde View | Priority 2 | NM01 | 58.8 | 79 | - | Negligible | Imperceptible | Occasional | Negligible |
| **56** | 127 Verde View | Priority 2 | NM01 | 61.1 | 79 | - | Negligible | Imperceptible | Occasional | Negligible |
| **57** | 129 Verde View | Priority 2 | NM01 | 58.8 | 79 | - | Negligible | Imperceptible | Occasional | Negligible |
| **58** | Pacific Healthcare Nursing Home | Priority 1 | NM03 | 54.1 | 62 | - | Negligible | Very Low | Occasional | Minor |
| **59** | Pioneer Junior College | Priority 1 | N02 | 66.5 | 75 | - | Negligible | Very Low | Occasional | Minor |
| **60** | Senja Care Home, Vanguard Senior Care Senja Centre | Priority 1 | NM03 | 69.1 | 62 | 7.1 | High | High | Occasional | Moderate |
| **61** | Senja Soka Centre (1) | Priority 1 | N02 | 45.3 | 75 | - | Negligible | Very Low | Occasional | Minor |
| **62** | Teck Whye Sec Sch (1) | Priority 1 | N02 | 55.7 | 75 | - | Negligible | Very Low | Occasional | Minor |
| **63** | Teck Whye Sec Sch (2) | Priority 1 | N02 | 65.5 | 75 | - | Negligible | Very Low | Occasional | Minor |
| **64** | Teck Whye Sec Sch (3) | Priority 1 | N02 | 58.8 | 75 | - | Negligible | Very Low | Occasional | Minor |
| **65** | The Tennery (1) | Priority 2 | NM03 | 70.6 | 75 | - | Negligible | Imperceptible | Occasional | Negligible |
| **66** | The Tennery (2) | Priority 2 | NM03 | 59.4 | 75 | - | Negligible | Imperceptible | Occasional | Negligible |
| **67** | West View Primary School (1) | Priority 1 | NM03 | 63.5 | 62 | 1.5 | Low | Low | Occasional | Minor |
| **68** | West View Primary School (2) | Priority 1 | NM03 | 64.4 | 62 | 2.4 | Low | Low | Occasional | Minor |

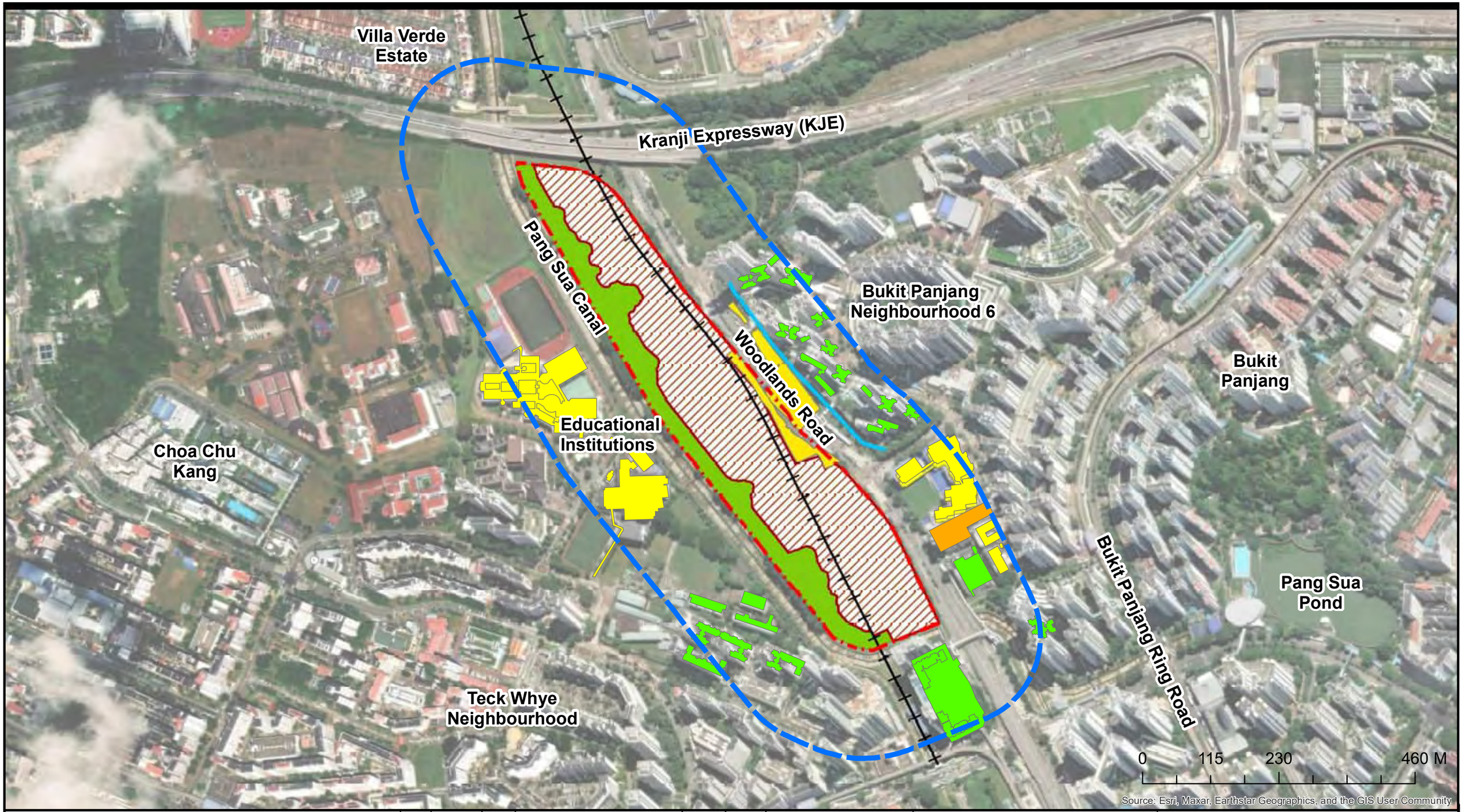
**Table 10-41 Summary of cumulative construction noise impacts: scenario 2: foundation works – human receptors, LAeq (5min) (7am-7pm)**

| No. | Human Receptors | Receptor Sensitivity | Nearest SLM | Predicted Construction Noise Levels | Corrected Criteria, dB(A) | Maximum Noise Exceedance, dB(A) | Impact Intensity | Impact Consequence | Likelihood | Impact Significance |
|---|---|---|---|---|---|---|---|---|---|---|
| **1** | Bukit Panjang Exchange (1) | Priority 3 | NM03 | 63.5 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **2** | Bukit Panjang Exchange (2) | Priority 3 | NM03 | 58.9 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **3** | DE142 Gali Batu Bus Depot Site Office | Priority 3 | NM02a | 64.4 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **4** | HDB Blk 162 Jln Teck Whye (ground level) | Priority 2 | NM04a | 66.9 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **5** | HDB Blk 162 Jln Teck Whye (mid-level) | Priority 2 | NM04b | 68.7 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **6** | HDB Blk 162 Jln Teck Whye (top level) | Priority 2 | NM04c | 69.5 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **7** | HDB Blk 163 Jln Teck Whye (ground level) | Priority 2 | NM04a | 66.5 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **8** | HDB Blk 163 Jln Teck Whye (mid-level) | Priority 2 | NM04b | 68.1 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **9** | HDB Blk 163 Jln Teck Whye (top level) | Priority 2 | NM04c | 70.0 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **10** | HDB Blk 164 Jln Teck Whye (ground level) | Priority 2 | NM04a | 65.9 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **11** | HDB Blk 164 Jln Teck Whye (mid-level) | Priority 2 | NM04b | 67.4 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **12** | HDB Blk 164 Jln Teck Whye (top level) | Priority 2 | NM04c | 69.3 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **13** | HDB Blk 606 Senja Road (ground level) | Priority 2 | N1a | 65.6 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **14** | HDB Blk 606 Senja Road (mid-level) | Priority 2 | N1b | 67.3 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **15** | HDB Blk 606 Senja Road (top level) | Priority 2 | N1c | 67.4 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **16** | HDB Blk 632A Senja Road (ground level) | Priority 2 | N1a | 75.7 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **17** | HDB Blk 632A Senja Road (top level) | Priority 2 | N1b | 75.6 | 90 | - | Negligible | Imperceptible | Likely | Negligible |

| No. | Human Receptors | Receptor Sensitivity | Nearest SLM | Predicted Construction Noise Levels | Corrected Criteria, dB(A) | Maximum Noise Exceedance, dB(A) | Impact Intensity | Impact Consequence | Likelihood | Impact Significance |
|---|---|---|---|---|---|---|---|---|---|---|
| **18** | HDB Blk 632B Senja Road (ground level) | Priority 2 | N1a | 72.1 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **19** | HDB Blk 632B Senja Road (top level) | Priority 2 | N1b | 72.4 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **20** | HDB Blk 633 Senja Road (ground level) | Priority 2 | N1a | 55.6 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **21** | HDB Blk 633A Senja Road (ground level) | Priority 2 | N1a | 71.3 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **22** | HDB Blk 633A Senja Road (mid-level) | Priority 2 | N1b | 72.6 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **23** | HDB Blk 633A Senja Road (top level) | Priority 2 | N1c | 72.6 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **24** | HDB Blk 633B Senja Road (ground level) | Priority 2 | N1a | 71.6 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **25** | HDB Blk 633B Senja Road (mid-level) | Priority 2 | N1b | 73.2 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **26** | HDB Blk 633B Senja Road (top level) | Priority 2 | N1c | 72.9 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **27** | HDB Blk 633C Senja Road (ground level) | Priority 2 | N1a | 70.1 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **28** | HDB Blk 633C Senja Road (mid-level) | Priority 2 | N1b | 71.6 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **29** | HDB Blk 633C Senja Road (top level) | Priority 2 | N1c | 71.5 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **30** | HDB Blk 633D Senja Road (ground level) | Priority 2 | N1a | 67.2 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **31** | HDB Blk 633D Senja Road (mid-level) | Priority 2 | N1b | 70.3 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **32** | HDB Blk 633D Senja Road (top level) | Priority 2 | N1c | 70.3 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **33** | HDB Blk 634A Senja Road (ground level) | Priority 2 | N1a | 74.1 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **34** | HDB Blk 634A Senja Road (mid-level) | Priority 2 | N1b | 74.0 | 90 | - | Negligible | Imperceptible | Likely | Negligible |

| No. | Human Receptors | Receptor Sensitivity | Nearest SLM | Predicted Construction Noise Levels | Corrected Criteria, dB(A) | Maximum Noise Exceedance, dB(A) | Impact Intensity | Impact Consequence | Likelihood | Impact Significance |
|---|---|---|---|---|---|---|---|---|---|---|
| **35** | HDB Blk 634A Senja Road (top level) | Priority 2 | N1c | 74.0 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **36** | HDB Blk 634B Senja Road (ground level) | Priority 2 | N1a | 65.5 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **37** | HDB Blk 634B Senja Road (mid-level) | Priority 2 | N1b | 68.3 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **38** | HDB Blk 634B Senja Road (top level) | Priority 2 | N1c | 68.3 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **39** | HDB Blk 634C Senja Road (ground level) | Priority 2 | N1a | 72.2 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **40** | HDB Blk 634C Senja Road (mid-level) | Priority 2 | N1b | 72.6 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **41** | HDB Blk 634C Senja Road (top level) | Priority 2 | N1c | 72.5 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **42** | HDB Blk 635 Senja Road (ground level) | Priority 2 | NM02a | 65.4 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **43** | HDB Blk 635 Senja Road (mid-level) | Priority 2 | NM02b | 66.2 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **44** | HDB Blk 635 Senja Road (top level) | Priority 2 | NM02c | 65.8 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **45** | HDB Blk 635A Senja Road (ground level) | Priority 2 | NM02a | 73.4 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **46** | HDB Blk 635A Senja Road (mid-level) | Priority 2 | NM02b | 73.5 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **47** | HDB Blk 635A Senja Road (top level) | Priority 2 | NM02c | 72.5 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **48** | HDB Blk 635B Senja Road (ground level) | Priority 2 | NM02a | 68.6 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **49** | HDB Blk 635B Senja Road (mid-level) | Priority 2 | NM02b | 68.8 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **50** | HDB Blk 635B Senja Road (top level) | Priority 2 | NM02c | 68.8 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **51** | Junction 10 | Priority 3 | NM03 | 69.1 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **52** | 38 Teck Whye Crescent (1) | Priority 3 | NM04a | 66.2 | 90 | - | Negligible | Imperceptible | Likely | Negligible |

| No. | Human Receptors | Receptor Sensitivity | Nearest SLM | Predicted Construction Noise Levels | Corrected Criteria, dB(A) | Maximum Noise Exceedance, dB(A) | Impact Intensity | Impact Consequence | Likelihood | Impact Significance |
|---|---|---|---|---|---|---|---|---|---|---|
| **53** | 38 Teck Whye Crescent (2) | Priority 3 | NM04a | 67.4 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **54** | 38 Teck Whye Crescent (3) | Priority 3 | NM04a | 64.4 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **55** | 125 Verde View | Priority 2 | NM01 | 61.7 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **56** | 127 Verde View | Priority 2 | NM01 | 64.0 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **57** | 129 Verde View | Priority 2 | NM01 | 61.7 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **58** | Pacific Healthcare Nursing Home | Priority 1 | NM03 | 57.1 | 75 | - | Negligible | Very Low | Likely | Minor |
| **59** | Pioneer Junior College | Priority 1 | N02 | 69.4 | 90 | - | Negligible | Very Low | Likely | Minor |
| **60** | Senja Care Home, Vanguard Senior Care Senja Centre | Priority 1 | NM03 | 72.1 | 75 | - | Negligible | Very Low | Likely | Minor |
| **61** | Senja Soka Centre (1) | Priority 1 | N02 | 48.3 | 90 | - | Negligible | Very Low | Likely | Minor |
| **62** | Teck Whye Sec Sch (1) | Priority 1 | N02 | 58.7 | 90 | - | Negligible | Very Low | Likely | Minor |
| **63** | Teck Whye Sec Sch (2) | Priority 1 | N02 | 68.4 | 90 | - | Negligible | Very Low | Likely | Minor |
| **64** | Teck Whye Sec Sch (3) | Priority 1 | N02 | 71.2 | 90 | - | Negligible | Very Low | Likely | Minor |
| **65** | The Tennery (1) | Priority 2 | NM03 | 61.8 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **66** | The Tennery (2) | Priority 2 | NM03 | 73.5 | 90 | - | Negligible | Imperceptible | Likely | Negligible |
| **67** | West View Primary School (1) | Priority 1 | NM03 | 66.2 | 75 | - | Negligible | Very Low | Likely | Minor |
| **68** | West View Primary School (2) | Priority 1 | NM03 | 67.0 | 75 | - | Negligible | Very Low | Likely | Minor |




## Legend

- CCK N1 Project Site
- Airborne Noise Study Area (150m)
- Rail Corridor
- Proposed Construction Footprint*
- Proposed Development Boundary*
- Proposed Ecological Corridor*

**Impact Significance**

- Negligible
- Minor
- Moderate
- Major

**Other Concurrent Developments**

- LTA DTL2e Proposed 12m Noise Barrier
- LTA DTL2e Docking Shaft Construction Footprint

* exact boundaries/ alignment subject to further changes

N

| Rev. | Date | By | Description | Chk'd | App'd |
|---|---|---|---|---|---|
| - | SEP 2022 | SYT | Draft Final Report | NHT | JAG |

Qualified Person Endorsement : NA

HDB Endorsement : NA

Consultant : AECOM

Client: HOUSING & DEVELOPMENT BOARD

Project Title :

**ENVIRONMENTAL IMPACT ASSESSMENT (EIA) ON CHOA CHU KANG N1**

Figure Title :

**Human Noise Sensitive Receptors - Scenario 1: Site Preparation for Earthworks, LAeq(12 hours), 7am - 7pm (Base Assessment Scenario)**

| Designed | Checked | Approved |
|---|---|---|
| SAG | NHT | JAG |
| | Drawn: SYT | Date: SEP 2022 |

Figure No. : 10 - 21 | Rev. : - | Sheet : 1 of 1

CAD File Name : NA | A3

Note: Source of basemap - Google Earth Map

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### 10.10.2 Operational Phase

No cumulative impacts were considered during operational phase.

## 10.11 Summary of Key Findings

In this study, noise impact assessment was carried out for both the construction and operational phases of the proposed developments within the Project site to assess the noise impacts on the ecological and human receptors identified in this Project.

### 10.11.1 Construction Phase

A quantitative means of assessment detailing noise levels predicted with noise models based on inputs of effective SWL of proposed PMEs was conducted for the construction phase for Scenario 1: Site Preparation for Earthworks and Scenario 2: Foundation Works. The assessment scenarios were established to determine the noise impacts arising from the construction phase during the clearance of site for the proposed construction worksites, and the worst-case noisiest scenario to represent the worst potential peak time of construction phase instead of the entire duration.

Baseline airborne noise monitoring was conducted at six (6) locations within the 150m Airborne Noise Study Area established in accordance with noise legislations outlined in EPM, 2008 [R-33]. For human receptors, recorded $L_{Aeq(12\ hrs)}$, $L_{Aeq(1\ hr)}$, and $L_{Aeq(5\ mins)}$ noise levels were compared against the EPM, 2008 [R-33] guidelines to develop a Project-specific criterion for the construction phase. The Project-specific corrected noise criteria were then used as part of construction noise impact assessment for human receptors (see Section 10.2.5.1.1.2). While for ecological receptors, the average baseline noise monitoring results were adopted to assess for impact on fauna species identified in this Project as a conservative means of assessment (see Section 10.2.5.1.1.1).

Noise sensitive ecological and human receptors were identified with the 150m Airborne Noise Study Area established in accordance with noise legislations outlined in EPM, 2008 [R-33]. The identified NSRs where then assessed against the impact evaluation matrices in Section 6.4.3 with noise contours reflecting the extent of noise propagation from source to receptors provided. Mitigation measures were also introduced following predicted noise exceedances for both ecological and human receptors as detailed below:

#### 10.11.1.1 Ecological Receptors

Ecological receptors subjected to noise emissions from both assessment scenarios were predicted to experience noise exceedances of up to 24 dB(A) for Scenario 1, and up to 30 dB(A) for Scenario 2. The resulting overall Impact Significance of both assessment scenarios were evaluated as **Moderate** and **Majo**r (see Table 10-20) for the time period of $L_{Aeq(12\ hrs)}$, and $L_{Aeq(5\ mins)}$ for 7am – 7pm respectively.

Mitigation measures were proposed to mitigate the noise impacts on ecological receptors to as low as reasonably practicable (ALARP) as discussed in Section 10.8.1. Noise barriers of 3m and 12 m height were proposed along the construction worksites near the NSRs predicted to experienced noise exceedances.

However, due to the proximity of the noise sources (i.e., construction worksites) to the Ecological Corridor, the proposed noise barriers were found to only be effective in reducing major noise impact significance area to a range of 0.7 ha to 0.9 ha in Scenario 1, and a range of 2.4 ha to 3.2 ha in Scenario 2. The overall residual Impact Significance remained unchanged at **Moderate** and **Major** (see Table 10-31) for Scenario 1 and 2 respectively.

As discussed in Section 10.7.1.1, noise exceedances of up to 24 dB(A) and 30 dB(A) were predicted for ecological receptors subjected to noise emissions from Scenario 1: Site Preparation for Earthworks and Scenario 2: Foundation Works respectively. Mitigation measures were thereby proposed during the construction phase to mitigate the noise impacts to as low as reasonably practicable. The residual construction impact assessment assumed that mitigation measures (3m height and 12m height noise barrier) proposed in Section 10.8 were implemented at the construction worksites nearest to the ecological receptors predicted to experience noise exceedances by the noise model.

Although the proposed mitigation measures in Section 10.8 were not able to eliminate the noise exceedances, a closer look into the comparison of noise contours for the pre-mitigation (base case) and post-mitigation (mitigated case) cases revealed significant reduction in the **Moderate** and **Major** impact significance areas with the implementation of noise barriers for the respective scenarios.

Cumulative airborne noise impacts from other concurrent developments in proximity to the Project site were also studied with with the nearby construction of future development by other agency. It was predicted that construction works by other agency nearby will result in cumulative noise exceedances of up to 13 dB(A) and 29 dB(A). The overall Impact Intensity was predicted to remain unchanged at **High** (refer to Table 6-5) with a corresponding overall Impact Significance of **High** (see Table 6-8).

When relating the overall Impact Consequence to a Likelihood of Occurrence of **Occasional/ Likely**, it was determined that the overall cumulative Impact Significance remained at **Moderate** for the time period of $L_{Aeq(12\ hrs)}$, and **Major** for $L_{Aeq(5\ mins)}$, 7am – 7pm. Likewise, the areal distribution of Impact Significance were predicted to increase from 2.4 ha to 4.0 ha with overall Impact Significance remaining unchanged as **Moderate** for the time period of $L_{Aeq(12\ hrs)}$, and **Major** for $L_{Aeq(5\ mins)}$, 7am – 7pm.

At this stage, as the Project schedule provided by HDB is still tentative as mentioned in Section 3.2.1, it is highly recommended that the contractor on board for the design and building phases re-assess the construction of the construction developments based on the residual impacts assessed for the ecological receptors potentially impacted by the construction phase.

Observing the residual impact for both humans and ecology, it is strongly recommended to use portable barriers for equipment that contribute to excessive noise at all times.

#### 10.11.1.2 Human Receptors

Based on the results predicted by the noise models, two human receptors (Senja Care Home and West View Primary School) are predicted to experience noise exceedances of up to 8.4 dB(A) during Scenario 2: Foundation Works and up to 1.4 dB(A) during Scenario 1: Site Preparation for Earthworks. The resulting overall Impact Significance for Scenario 2 was evaluated to range from **Negligible** – **Moderate** (see Table 10-24), while that for Scenario 1 was evaluated as **Negligible** – **Minor**.

Mitigation measures were proposed to mitigate the noise impacts for human receptors subjected to noise from Scenario 1 to ALARP as discussed in Section 10.8. Noise barriers of 3m and 12m height were proposed along the construction worksites near the NSRs predicted to experienced noise exceedances (refer to Section 10.8.1).

However, due to the height of the establishments and the limitations in height of noise barriers (see Section 10.8.1.2.1), the proposed noise barriers were found to only be effective in reducing noise minimally with a residual noise level of up to 7.6 dB(A) with the residual Impact Significance remaining unchanged at a range of **Negligible** – **Moderate** (see in Table 10-34).

Based on the residual airborne noise impact assessment below, the proposed 3m noise barrier and 12m noise barriers will be beneficial with no noise exceedance predicted for Scenario 1: Site Preparation for Earthworks. While for Scenario 2: Foundation Works, noise reduction of for Senja Care Home from 8.4 dB(A) to 6.9 dB(A), and West View Primary School from 7.6 dB(A) to 1.7 dB(A) were predicted with Impact Intensity remaining unchanged at **High** for Senja Care Home, and **Low** for West View Primary School.

Although the proposed mitigation measures in Section 10.8 were not able to eliminate noise exceedances during Scenario 2, Impact Intensity was predicted from ranging from **Negligible** – **High**, and only one receptor were experienced with **High** Impact Intensity(see Table 10-34).

Cumulative airborne noise impacts from other concurrent developments in proximity to the Project site were also studied with the nearby construction of future development by other agency. It was predicted that construction works on the nearby future development by other agency will result in cumulative noise exceedances of up to 7.1 dB(A) for Senja Care Home, a minor reduction due to proposed noise barrier by other agency. While for West View Primary School, an increase of noise exceedance to up to 2.4 dB(A) were predicted as a result of cumulative noise impacts.

The overall Impact Intensity was predicted to remain unchanged at **High** (refer to Table 6-5) for Senja Care Home and **Low** for West View Primary School, with a corresponding overall Impact Consequence of **Low** and **High** (see Table 6-6) for the respective human receptors. When relating the overall Impact Consequence to a Likelihood of Occurrence of **Occasional/ Likely**, it was determined that the overall cumulative Impact Significance remained at **Moderate** for Senja Care Home and **Minor** for West View Primary School. Observing the cumulative impact for both humans and ecology, it is strongly recommended to use portable barriers for equipment that contribute to excessive noise at all times.

At this stage, as the Project schedule provided by HDB is still tentative as mentioned as mentioned in Section 3.2.1, it is highly recommended that the contractor on board for the design and building phases re-assess the construction of the construction developments based on the residual impacts assessed for the human receptors potentially impacted by the construction phase.

## 10.11.2 Operational Phase

As discussed in Section 10.2.1.2, a qualitative means of assessment has been adopted in the assessment for operational noise impacts due to the lack of detailed design information required for the assessment of operational noise impacts relating to ACMV systems and land traffic noise.

Please note that as only qualitative impact assessment is conducted for the operational phase with limited information at the current design stage, quantitative operational noise impact assessment must be conducted as mandated by law in accordance with relevant NEA noise legislations. As such, AECOM recommends that Noise Consultant(s) appointed by HDB/ the contractor contracted by HDB shall conduct operational noise impact assessment in accordance with the respective NEA guidelines (refer to Section 10.2.1.2) at the later stages of development.

### 10.11.2.1 Ecological Receptors

Ecological receptors considered for assessment for operational noise impacts shall consider similar ecological receptors identified for the construction phase as discussed in Section 10.4.1.1. It should be noted that the larger impact on the area regardless of noise is due to the redevelopment of the forested areas into urbanized developments and the removal/ degradation of habitats.

Whether the fauna species identified within the Project site prior to construction works will remain/ return to these areas or take shelter and/ or develop new habitats elsewhere at nearby CCNR and Khatib Bongsu during the operational phase is uncertain at this stage making it difficult to analyse the potential impact of operational noise on ecological receptors.

Ecological receptors subjected to noise emissions from ACMV systems were qualitatively assessed to experience an Impact Significance of **Negligible** (see Table 10-26) based on their propensity for avoiding urbanized areas with human presence where the non-industrial buildings are proposed to be sited. While ecological receptors subjected to land traffic noise were qualitatively assessed to experience a **Minor** Impact Significance ranging, with land traffic noise impact on fauna species found to indirectly alter habitat quality and the introduction of vehicular noise in an area previously undisturbed by anthropogenic noise permanently changing the characteristics of the area with noise impacts lasting for a long time.

Preliminary mitigation measures were correspondingly introduced in Section 10.8.2 to mitigate the potential operational noise impacts in the form of Best Available Technology (BAT) and Best Environmental Practice (BEP) noise control measures.

Since the initial impact assessment with minimum controls was considered insignificant (**Negligible** to **Minor**), no residual impact assessment was undertaken, hence the impact significance remained the same.

At this stage, as the Project schedule provided by HDB is still tentative as mentioned as mentioned in Section 3.2.1, it is highly recommended that the contractor on board for the design and building phases re-assess the construction of the construction developments based on the residual impacts assessed for the ecological receptors potentially impacted by the operational phase.

### 10.11.2.2 Human Receptors

Human receptors should be identified and assessed as part of operational noise impacts arising from noise associated with the ACMV systems of non-industrial buildings, and as part of TNIA for land traffic noise.

Human receptors subjected to noise emissions from ACMV systems were qualitatively assessed to experience an Impact Significance ranging from **Negligible** – **Minor** (see Table 10-27) as the siting of the proposed non-industrial buildings do not immediately abut existing noise sensitive and residential premises identified in Section 10.4. While human receptors subjected to land traffic noise were qualitatively assessed to experience an Impact Significance ranging from **Minor**, with land traffic noise impact on human receptors potentially resulting in small changes in behaviours residents choosing to close their windows to reduce indoor noise levels, which may slightly affect character of the area but not such that there is a perceived change in quality of life.

Preliminary mitigation measures were correspondingly introduced in Section 10.8.2 to mitigate the potential operational noise impacts in the form of Best Available Technology (BAT) and Best Environmental Practice (BEP) noise control measures.

Since the initial impact assessment with minimum controls was considered insignificant (**Negligible** to **Minor**), no residual impact assessment was undertaken, hence the impact significance remained the same.

At this stage, as the Project schedule provided by HDB is still tentative as mentioned as mentioned in Section 3.2.1, it is highly recommended that the contractor on board for the design and building phases re-assess the construction of the construction developments based on the residual impacts assessed for the human receptors potentially impacted by the operational phase.

### Table 10-42 Summary of airborne noise impact assessment (overall)

| Potential Source of Impact | Impact Significance with Minimum Control | Residual Impact Significance with Mitigation Measures (if required) |
|---|---|---|
| **Construction Phase** | | |
| **Scenario 1: Site Preparation for Earthworks** | | |
| Ecological Receptors | Moderate | Moderate[1] |
| Human Receptors | Negligible – Minor | Negligible – Minor |
| **Scenario 2: Foundation Works** | | |
| Ecological Receptors | Major | Major[2] |
| Human Receptors | Negligible – Moderate | Negligible – Moderate |
| **Operational Phase** | | |
| **Air Conditioning and Mechanical Ventilation Noise Impact** | | |
| Ecological Receptors | Minor | Minor[3] |
| Human Receptors | Negligible – Minor | Negligible – Minor[3] |
| **Land Traffic Noise Impact** | | |
| Ecological Receptors | Minor | Minor[3] |
| Human Receptors | Minor | Minor[3] |

Note

[1] Area of Moderate impact significance significantly reduced (Base scenario – 4.1 ha, Post-mitigated scenario- 3.2 ha)

[2] Area of Major impact significance significantly reduced (Base scenario – 4.1 ha, Post-mitigated scenario- 2.4 ha)

[3] Since the initial impact assessment with minimum controls was considered insignificant (Negligible to Minor), no residual impact assessment was undertaken, hence the impact significance remained the same.

# 11 Environmental Management and Monitoring Plan

The proposed Environmental Management and Monitoring Plan (EMMP) is prepared for environmental impacts of the construction and operational phases associated with the Project, and that were assessed in this EIA study, namely biodiversity, water resources (hydrology, surface water quality, groundwater quality and level), air quality and airborne noise. The EMMP details how the recommended mitigation measures prepared for the impact assessment are to be implemented and specifies recommended monitoring measures to assess the effectiveness of the mitigation measures. This document is also intended to provide a broad framework for the Environmental Control Officer (ECO) to develop a more contract-specific EMMP, as per their responsibilities in Section 11.4.5. Since the project will evolve over time, the EMMP is an adaptive document meant to be amended where necessary. Copies of the EMMP must be kept on-site for reference at all times.

This section outlines the objectives of the EMMP, the project organisation, describes the roles and responsibilities relevant to implementation of the EMMP, and summarises the EMMP requirements for each discipline.

## 11.1 EMMP Objectives

The EMMP details the implementation and deliverables of the recommended mitigation measures identified from the impact assessment for each technical discipline. The EMMP progressively scrutinizes pre-construction, construction and operational activities as they ensue and applies flexible monitoring and management procedures to protect the project's environmental values throughout the construction and operational phases. The objective of the EMMP is twofold:

a) Environmental monitoring focuses on overseeing that impacts to the project's environmental values from construction and operation are within the anticipated level and tackle unforeseen impacts that may arise; and

b) It also tracks the effectiveness of the recommended mitigation measures to allow amendment or review of the mitigation measures to better address any issues faced during construction and operation of the project.

Environmental management employs a more active approach to ensure that impacts to flora and fauna are directly avoided through documentation, auditing and enforcement.

## 11.2 Project Organisation during the Construction Phase

The roles and responsibilities of the various parties responsible for implementing the EMMP during the construction phase are outlined below. The proposed Project organization and lines of communication with respect to environmental protection works are presented in Figure 11-1.

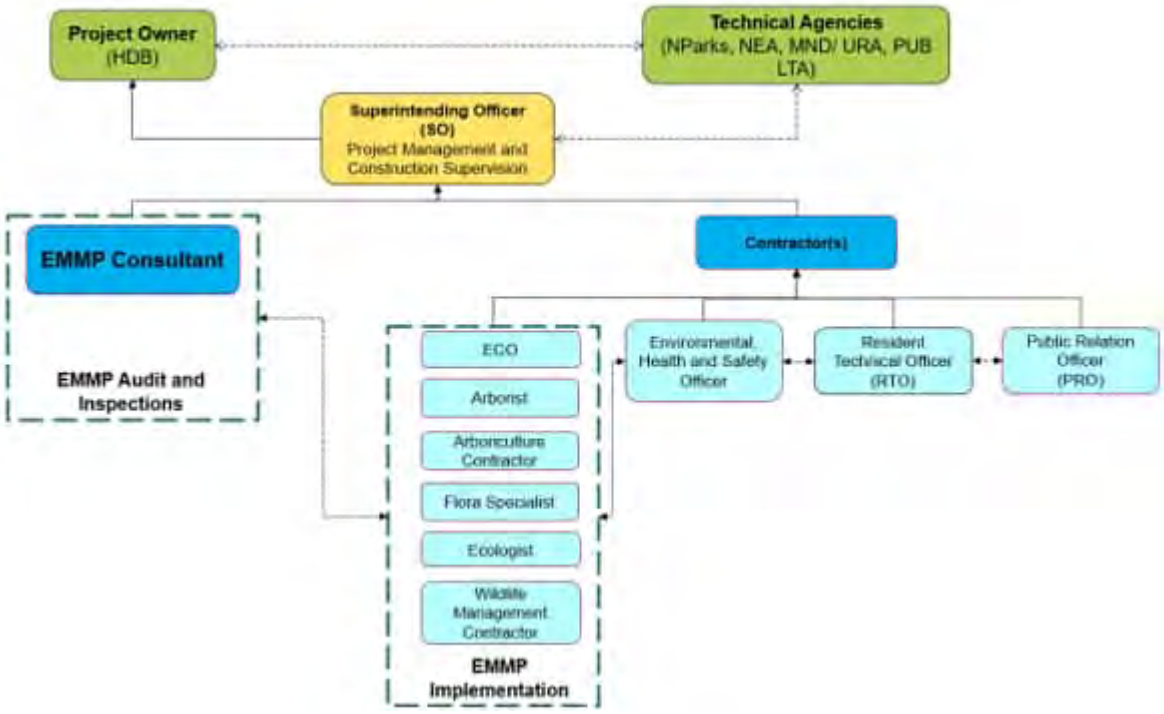



**Figure 11-1 Project organization and lines of communication during the construction phase**

# 11.3 Project Organisation during the Operational Phase

The roles and responsibilities of the various parties responsible for implementing the EMMP during the operational phase are outlined below. The proposed Project organization and lines of communication with respect to environmental protection works are presented in Figure 11-2.

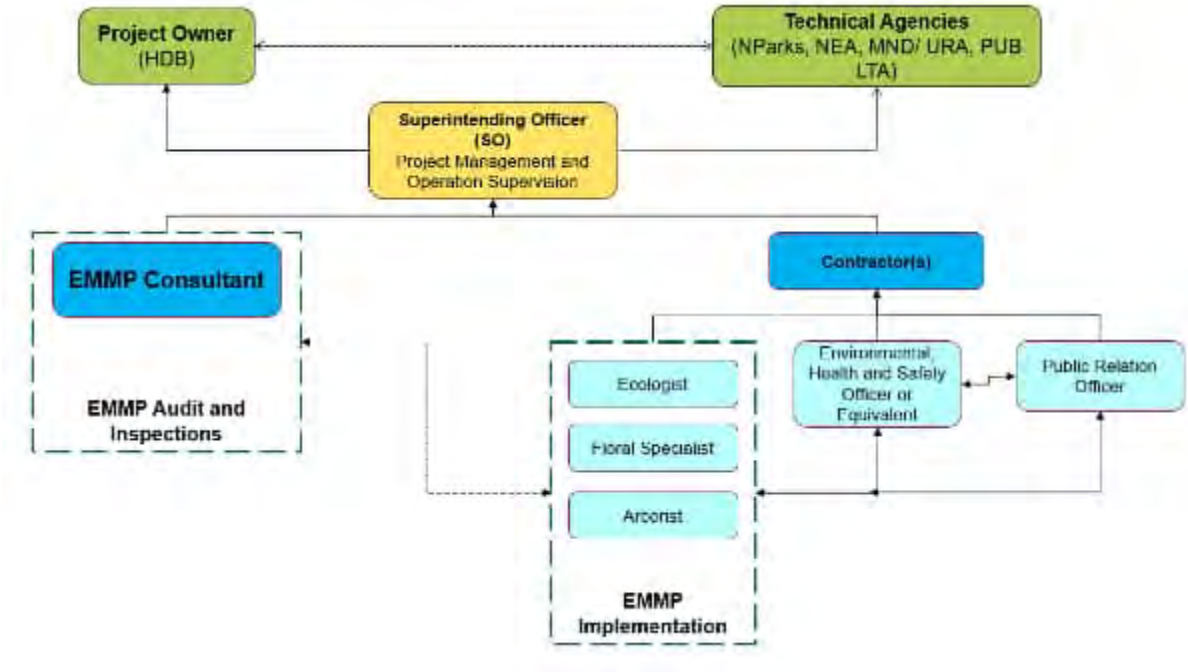



**Figure 11-2 Project organization and lines of communication during the operational phase**

# 11.4 Roles and Responsibilities of the EMMP for the Construction Phase

## 11.4.1 Technical Agencies

Technical agencies constitute, but are not limited to NParks, PUB, MND/ URA, NEA and LTA. These agencies will assess and approve the detailed EMMP for the construction and operational phases prior to commencement of works and where required during the course of the project.

## 11.4.2 Project Owner (HDB) and Resident Technical Officer

The HDB, 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) (Contractor), HDB are required to:

- Ensure resources are available to achieve the requirements of the EMMP;
- Provide leadership in the development and 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.

## 11.4.3 The Contractor

The term “Contractor” refers to all construction contractors and sub-contractors working onsite at any time. In addition to reporting to the Superintending Officer (SO), the Contractor should:

- Work under the relevant contract scope, specifications, and other tender conditions;
- Ensure that the roles of RTO, SO, Environmental, Health and Safety Officer (EHS Officer), ECO, Certified Arborist, and Fauna Specialist(s) are adequately resourced;
- Participate in the required environmental site audits undertaken by the ECO and undertake any corrective actions;
- Provide up-to-date information to the RTO, SO, ECO, Certified Arborist, and Fauna Specialist(s) regarding any work activities which may contribute or continuously create adverse environmental conditions, or any changes to the work plan;
- Implement measures to reduce impacts where emission/ discharge levels are exceeded; and
- Prepare a detailed contract-specific EMMP, incorporating the relevant mitigation measures and monitoring works recommended in this EIA Report and seek technical agencies’ approval prior to the commencement of any works. This detailed EMMP will include, as a minimum, a Standard Operating Procedure (SOP) detailing:
  - 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 ecology, water pollution, air, noise, waste);
  - Existing legislation and environmental best practices to be implemented; and
  - Contingency planning during emergency situations.

Besides, for site and/ or vegetation clearance before the commencement of actual construction, the Contractor will engage a certified Qualified Erosion Control Professional (QECP) to prepare an Erosion Control Plan (ECP) and obtain approval from the PUB.

For tree-felling, the Contractor will also map the trees on site and the trees planned for removal or retention and NParks' approval, where the Contractor will consider the following requirements:

- An area rich in trees of conservation interest, the contractor should employ a certified arborist to map the trees carefully while applying for tree felling approval. This is to gauge the health, species, size and conservation significance of the tree;
- If there are trees that must be transplanted, this should be done prior to commencing site clearance; and
- If the area is rich in wildlife, the contractor will consult wildlife specialist and prepare a wildlife shepherding plan, obtain NParks' approval and execute it prior to/ along the site clearance process.

### 11.4.4 The Superintending Officer (SO)

The Superintending Officer is responsible for overseeing the construction works undertaken by various staff, contractors and sub-contractors. The SO should ensure that the construction and operation works are performed by the contractors and personnel in accordance with the specification, contractual requirements, and EMMP. The SO should also:

- Communicate the requirements of this plan to all staff, contractors and sub-contractors;
- Monitor all staff, contractor's and sub-contractor's compliance with contract specifications and regulatory requirements, including the implementation of the environmental mitigation and monitoring measures and ensure their effectiveness, and other aspects of the environmental audit program;
- Coordinate with the project's EHS Officer to monitor and participate in the implementation of the environmental audit program, with assistance from ECO, and ensure that the requirements in the environmental audit program are correctly followed;
- Implement measures to reduce impacts where emission/ discharge levels are exceeded;
- Coordinate with the Project Owner and RTO for submission of environmental audit reports;
- Carry out any complaint investigations as per Section 11.8;
- Resolve any non-compliance issues; and
- Promote environmental awareness and responsibility and lead by example.

It is suggested for the Project Owner (HDB) to engage an independent EMMP consultant to perform environmental audits throughout the construction phase to ensure that environmental protection measures and monitoring (as stipulated in developed EMMP) are properly implemented at all the work areas during the construction phase.

The external environmental audit exercise would also include the documentation review of on-site monitoring records against the proposed measures. This is to ensure proper implementation of minimum control measures, mitigation measures and EMMP, as well as to identify and/ or resolve potential environmental incompliances and potential gaps, if any, observed during the site visits and audits.

### 11.4.5 The Environmental Control Officer (ECO)

The registered Environmental Control Officer will be employed by the Contractor but may not be in any way as an associated body of the Contractor, the SO or the Project's SHE team. The ECO is responsible for implementing the elements of the environmental monitoring program that fall within their responsibilities as outlined in the Code of Practice for Environmental Control Officers (Environmental Health Department, 2000). He/ she should be a registered ECO with NEA and has at least two years' experience in environmental monitoring and auditing works. Resources to implement the environmental monitoring program should be allocated time to fulfil the environmental audit requirements during construction works as specified in the EIA Report. The ECO's duties include:

- Coordinate with the SO regarding equipment, locations, and schedule of monitoring and auditing works, with assistance from the EHS Officer;
- Assist the SO with the resolution of near misses/ incidents, non-compliance issues, and complaint management; and
- Assist the EHS Officer with reporting of monitoring results to the SO.

### 11.4.6 The Environmental, Health and Safety Officer (EHS Officer)

The Environmental, Health and Safety Officer will be employed by the Contractor and will be responsible for the overall environmental, health and safety during the construction phase of the Project. With respect to EMMP, their duty is to:

- Carry out monitoring of environmental parameters and conduct laboratory analysis;
- Conduct regular site inspections, report monitoring results, and audit environmental performance as required in the EMMP;
- Coordinate with the SO and ECO regarding equipment, locations and schedule of monitoring and auditing works;
- Analyse environmental monitoring data and audit findings, review the adequacy of implementation of mitigation measures, identify adverse environmental impacts, and liaise with the SO and ECO;
- Formulate and implement the environmental audit program and carry out regular site audits against the Contractor's site practices, equipment and work methodologies with respect to pollution control and environmental mitigation, and effect proactive actions to pre-empt problems in coordination with the SO and ECO;
- Monitor compliance with conditions in the EMMP, relevant environmental protection, pollution prevention and control regulations and contract specifications;
- Report the results of the environmental monitoring program, and any required changes to meet the requirements of the EMMP and legal obligations to the SO in a timely manner; and
- Assist the SO with the resolution of near misses/ incidents, non-compliance issues, and complaint management.

### 11.4.7 Arborist

An Arborist certified by the International Society of Arboriculture (ISA) plays an important role as part of the biodiversity monitoring programme during both construction and commissioning phases of this Project. He/ She will 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. The Arborist will be employed by a Contractor. A detailed description of biodiversity monitoring programme is provided in Section 11.10, 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.

### 11.4.8 Arboriculture Contractor

The Arboriculture 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 will 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 will 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 will be responsible for pruning and maintenance of retained trees, as well as felling of trees during the construction phase of this Project.

### 11.4.9 Flora Specialist

For this Project, a Flora Specialist plays an important role in the implementation of flora-related EMMP measures (e.g. Flora Management Plans) as part of the biodiversity monitoring program during both construction and commissioning phases of this Project. He/ She will possess previous work experience in developments of similar size or complexity who is able to demonstrate capability in implementing flora management plans. Flora Specialist will be employed by the Contractor. A detailed description of biodiversity monitoring programme is provided in Section 11.10, where the key responsibilities of the Flora Specialist are listed as follows:

The key responsibilities of a qualified Flora Specialist during construction phase include but not limited to:

- Review soil investigation locations 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; and
- Carry out monthly flora inspection and reporting.

### 11.4.10 Ecologist

For this Project, an Ecologist 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, who can also be known as a Fauna Specialist. He/ She will 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 11.10, where the key responsibilities of the Ecologist are listed as follows:

**Construction Phase**

The key responsibilities of a qualified Ecologist during construction phase include but not limited to:

- 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.

The Ecologist will be employed by the Contractor.

### 11.4.11 Wildlife Management Contractor

For this Project, the wildlife management contractor (with at least one [1] veterinary professional with experience within the team) would be responsible in carrying out animal rescue, trapping and transport of large fauna if any human-wildlife conflicts are encountered during construction and commissioning phase on site and it will be employed by the Contractor. The wildlife management contractor will be listed under NParks' public register of certified wildlife management contractors and have experience carrying out animal rescue, trapping and transport of large fauna.

A detailed description of biodiversity monitoring programme is provided in Section 11.10, where the key responsibilities of the wildlife management contractor are listed as follows:

**Construction Phase**

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.

## 11.5 Roles and Responsibilities of the EMMP for the Operational Phase

### 11.5.1 Technical Agencies

Technical agencies constitute, but are not limited to NParks, PUB, NEA, LTA and MND/ URA. These agencies will assess and approve the detailed EMMP for the construction and operational phases, prior to commencement of works and, where required, during the course of the project.

### 11.5.2 Project Owner (HDB)

The HDB is a statutory board in Singapore under the Ministry of National Development responsible for public housing in Singapore, which is also the Project Owner for this Project. Therefore, it is responsible for overseeing and managing the environmental monitoring detailed in the EMMP for the operational phase. The HDB 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 and the HDB regarding implementation of the EMMP.

### 11.5.3 EHS Officer (or Equivalent)

The EHS Officer will be appointed by HDB and is responsible for the overall environmental, health and safety during the operational phase of the Project. With respect to the EMMP, the EHS Officer is required to:

- Carry out monitoring of environmental parameters and conduct any required laboratory analysis;
- Conduct site inspections, report monitoring results, and coordinate environmental auditing as stipulated in the EMMP;
- Coordinate with HDB regarding equipment, locations, and schedule of monitoring and auditing works;
- Analyse environmental monitoring data and audit findings, review the adequacy of implementation of mitigation measures, identify adverse environmental impacts, and liaise with HDB;
- Monitor compliance with conditions in the EMMP, relevant environmental protection and control regulations; and
- Report the results of the environmental monitoring program, and any required changes, to meet the requirements of the EMMP to HDB in a timely manner.

### 11.5.4 Public Relation Officer

The Public Relation Officer (PRO) is responsible for handling complaints and managing feedback and investigative work. The PRO shall be supported by the Project Owner, SO, EHS Officer 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 SO and EHS Officer immediately;
- Investigate the complaint with the SO and EHS Officer to determine its validity and assess whether the source of the problem is due to construction works;
- If a complaint is valid and due to operational works, liaise with the EHS Officer on the mitigation measures and seek agreement from the SO;
- Review the current situation and the EHS Officer’s implementation of the mitigation measures;
- Engage the EHS Officer 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 EHS Officer) to the SO and/ or HDB; 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 SO and EHS Officer to gather all the necessary information and resources necessary to complete a complaint investigation. Following the investigation, the Project/ Operation Manager and EHS Officer shall undertake appropriate mitigation measures. Follow-up is required by the PRO to ensure that the mitigation measures have been appropriately implemented. The ccomplaint investigation report and corrective action plan should be prepared and approved by HDB and/ or other relevant Authorities within 24 hr upon receipt of complaints.

## 11.6 Construction Site Audit

Site surveillance provides a direct means to assess and ensure the Project's environmental protection and pollution control measures are in compliance with the contract specifications and the EMMP. The ECO should inspect the construction activities regularly and routinely to ensure that the appropriate environmental protection and pollution control mitigation measures are properly and timely implemented, based on the EMMP’s recommendations. With well-defined pollution control and impact mitigation measures outlined, and a well-established efficient remedial

action reporting system, the site inspection is an effective "tool" to ensure acceptable environmental performance at the construction site.

The ECO is responsible to formulate environmental site inspections, deficiencies and the remedial action reporting system, and to carry out the site inspections. After consultation with Project's SO and EHS Officer, the ECO should prepare a procedure for the site inspections, deficiencies, remedial action, and reporting requirements. This documentation will be agreed to by the RTO and Contractor representative and approved by the Project Owner within 21 days of the commencement of the construction contract.

Site inspections should be carried out by SO Independent Environmental/ EMMP Consultant at least once every two weeks (i.e. biweekly) for all the work areas during the construction phase. The inspections should cover the onsite environmental situation, pollution control and mitigation measures. Offsite environmental situations, which may be affected by onsite activities (directly or indirectly), should also be reviewed. Observed site conditions, with regards to defined environmental parameters will be noted, collated and submitted to the Project Owner (HDB) (inclusive of recommendations for improvements to the protection and pollution control and for taking corrective actions, if any). Monthly EMMP audit reports with collated and analysed obtained data will be submitted to the Project Owner (HDB) and SO Rep.

## 11.7 Operational Phase Audit

During the operation of the Project, annual monitoring (minimum frequency) for all environmental parameters should be conducted to ensure that all implemented measures are meeting their intended purpose, and that any potential changes in Project conditions such as increased traffic, track lighting, etc. are not having an adverse impact over and above the impacts identified in this assessment. A log tracking all maintenance procedures of equipment and carrying out of audits should be maintained by the Project Owner and the EHS Officer.

A minimum of annual monitoring periods also enables the Project Owner and EHS Officer to address any potential issues, not originally identified during the current impact assessment, that may arise during the course of the Project. In this instance, the Project Owner should consider the impacts and, in consultation with the Technical Agencies and qualified professionals, develop measures to mitigate any identified impacts.

## 11.8 Complaint Handling

The Public Relation Officer (PRO) is responsible for handling complaints and managing feedback and investigative work. The PRO will be supported by the Project Owner, ECO, Contractor representatives, and any other relevant party.

During the construction 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, SO, and EHS Officer immediately;
- Investigate the complaint with the ECO to determine its validity and assess whether the source of the problem is due to construction works (the target time for response to the complainant is proposed to be 48 hours);
- If a complaint is valid and due to construction works, liaise with the ECO and EHS Officer on the mitigation measures and seek agreement from SO;
- Review the current situation and the ECO's and SO's implementation of the mitigation measures;
- Engage the ECO to undertake additional monitoring and auditing 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 complaint report (as well as the implementation of mitigation measures and the effectiveness of the mitigation measures as advised by the ECO) to the Project Owner, RTO and the SO; and
- Log a record of the complaint, investigation, follow-up actions and the results in the environmental audit reports.

The ECO and SO should provide all the necessary information and assistance to the PRO in order to complete the complaint investigation. Following the investigation, the Contractor should promptly undertake the mitigation measures. The PRO and SO should ensure that the measures have been appropriately implemented. The

Contractor, RTO, and SO should also be responsible for the reporting of complaint investigation results and followed up actions to the Project Owner.

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 EHS Officer immediately;
- Investigate the complaint with the ECO to determine its validity and assess whether the source of the problem is due to construction works (the target time for response to the complainant is proposed to be 48 hours);
- If a complaint is valid and due to construction works, liaise with the ECO and EHS Officer on the mitigation measures and seek agreement from SO;
- Review the current situation and the ECO's and SO's implementation of the mitigation measures;
- Engage the ECO to undertake additional monitoring and auditing to verify the complaint if necessary. Ensure that any valid reasons for complaints do not re-occur by noting the root cause of the complaint and revising (if necessary) the work methods, procedures, machines and/ or equipment, etc.;
- Submit complaint report (as well as the implementation of mitigation measures and the effectiveness of the mitigation measures as advised by the ECO) to the Project Owner, RTO and the SO; and
- Log a record of the complaint, investigation, follow-up actions and the results in the environmental audit reports.

The PRO should work with the Project Owner and EHS Officer to gather all the necessary information and resources necessary to complete a complaint investigation. Following the investigation, the Project Manager and EHS Officer to undertake appropriate mitigation measures. Follow is required by the PRO to ensure that the mitigation measures have been appropriately implemented. Reporting of the complaint investigation results and followed up actions should be provided to the Project Owner and the Authorities.

## 11.9 Submission of Monthly Reports to Technical Agencies

During the construction phase, monthly reports on the implementation of construction EMMP should be submitted to the HDB and other Technical Agencies by the Contractor for record purposes. These reports will also be reviewed by Independent EMMP consultant, employed by SO. The reports will 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.

# 11.10 Biodiversity Monitoring Programme Requirement

During the construction and operational phase of the Project, adequate EMMP for flora and fauna need to be developed in order to minimise and manage predicted construction and operational impacts. The biodiversity monitoring programme, as detailed in the sections below, will be carried out by the Contractor, under supervision of the SO and independent Consultant.

## 11.10.1 Construction Phase

At the construction phase, EMMP for both flora and fauna are essential in minimising and managing construction impacts.

### 11.10.1.1 Arboriculture Management Programme

The 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 (i.e., up to 15 m from the contract boundary).

Arboriculture Management Programme should include the following works:

**Tree Protection**

- Where there are trees to be retained within the worksite, specifications shall be formulated by the Arborist for the setting up of TPZ to meet NParks requirements (refer to Appendix N);
- 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; and
- The Contractor's method statements for site clearance, tree felling and setting up of TPZ for any retained trees 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.

**Sapling Harvesting and Tree Transplantation**

- Prior to site clearance works, any viable saplings and conservation significant trees that are suitable for harvesting shall be identified by the Arborist. Guidelines for sapling harvesting and tree transplantation are detailed in Appendix O;
- The Contractor's method statement 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;
- 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
- Where practicable, saplings, seeds and seed banks will be retained within the soil profiles for use in forest restoration; and
- 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.

**Monthly Tree Inspection**

The following shall be conducted by the Arborist during the monthly tree inspection, or when necessary:

- Review of method statements of construction works in proximity to retained trees, if any, to determine if additional tree removal is required post-site clearance.
- Whenever reasonable and practicable, cleared vegetation in particular at sloped areas shall be covered with mulch or with 100% biodegradable fauna-friendly ECBs to control erosion of exposed soil. Exposed ground shall be revegetated as soon as possible to stabilise surfaces and minimise re-entrainment of dust and potential for erosion of waste spoil to watercourses;
- Monitoring of the condition of trees at the edge of the recommended areas of conservation (RAC) 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;
- 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, if any. 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;
- Where tree disease outbreaks are identified, the appointed Arborist, shall advise measures to manage them, when necessary, as part of tree maintenance and care. Guidelines are provided Appendix N; and
- Inspection of the integrity of TPZs, if any.

### 11.10.1.2 Flora Management Programme

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 site 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 site 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; and
- Specific measures shall be undertaken to control and manage flora species within the Project area that have been identified to be invasive. The Ecologist shall also be consulted for other weed and invasive species that may also provide important foraging resources.

**In-fill Planting Palette and Plant Salvaging for Reforestation and Landscaping**

- For the non-native plant species used during in-fill planting, all flora and grasses species used during the reforestation and other landscape planting shall not be listed as weeds or invasive species. Non-native species that are chosen should be those that have a slow seeding rate. For native plant species, it is recommended for the plant to be sourced from native indigenous stock, subjected to availability of plant species.;
- 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; and
- The flora specialist shall formulate a salvaging protocol in consultation with NParks if salvaging of plant material is being carried out on site.

**Monthly Flora Inspection**

- Monthly flora inspections will be conducted within the worksite boundary and in forested areas adjacent to the worksite (i.e., RAC/ Ecological Corridor) up to 15 m from the hoarding;
- Identification of any unauthorized removal of flora within the RAC or beyond the demarcated Project worksite (Figure 7-29);
- 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;
- Inspection of forest edge effects and recommendation of mitigation measures, where necessary;
- Inspection 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; and
- Monitoring of the health of all retained and planted flora, including identification of diseases and recommendations for treatment.



**Figure 11-3 Monitoring of vegetation and trees along the hoarding line for unauthorised vegetation clearance and forest edge effects**

The flora specialists, arborists and the arboriculture contractor engaged should meet the expected qualifications as described in Section 11.4.9, Section 11.4.7 and Section 11.4.8, 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 (refer to Appendix N; Annex A); 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.

### 11.10.1.3 Fauna Management Programme

Fauna management will consist of managing fauna within and around all designated work areas. It consists of (1) monthly site inspections, (2) pre-site clearance inspections, (3) biodiversity awareness training, and (4) Wildlife Response Plan in event of animal encounters. The objectives of fauna management are to (1) minimise negative impacts to fauna, particularly to species of conservation significance and (2) prevent human wildlife conflicts.

The following should be inspected for during monthly fauna site inspections (Figure 11-4):

- Visual inspection of sensitive habitats in the vicinity (i.e., Ecological Corridor) to determine if the construction has cause damage or degradation
- Presence of trapped/ injured/ dead fauna within worksite
- Potential fauna entrapments (e.g., ECBs, TPZs, pits, drains, ponds, trenches, tanks)
- Gaps in hoarding that may allow entry of ground-dwelling fauna and snakes
- Improperly disposed/ stored food and food packaging
- Reporting and documentation of all findings and recommendations (Appendix P).



**Figure 11-4 Photographs showing monthly fauna monitoring and inspection on-site**

**Pre-site Clearance Fauna Inspection**

Pre-site clearance inspection should be implemented in conjunction with directional site clearance. Part of pre-site clearance involves pre-felling inspections. This is to minimise fauna injury and mortality during tree felling and vegetation clearance. Site clearance should be executed outside of the key bird breeding season (March to July) where possible. Refer to Figure 11-5 for pre-felling inspection protocol and Appendix Q for Pre-felling Inspection Form.

Directional site clearance should be carried out from the southern to northern end to avoid trapping fauna within the worksite (Figure 11-7). Hoardings should be installed adjacent to Woodlands Road before being installed around the boundary of the proposed development. The boundary of the RAC should also be delineated on the Project site before hand to avoid excessive clearance of vegetation. Since different parts of the Project site will be developed at different time, it is recommended for the development to be split in to three parcellations for the directional clearance. The parcellation will exclude the heavy vehicle carpark. A temporary hoarding should also be erected around the boundary of the carpark due to the presence of a concrete drain. This is so to prevent any fauna, such as snakes, from falling into the drain during site clearance. The parcellation that would be cleared first (i.e. southern portions) should be sealed after the site clearance to prevent any fauna from returning into the active worksite. These procedures should be planned and overseen by an Ecologist.

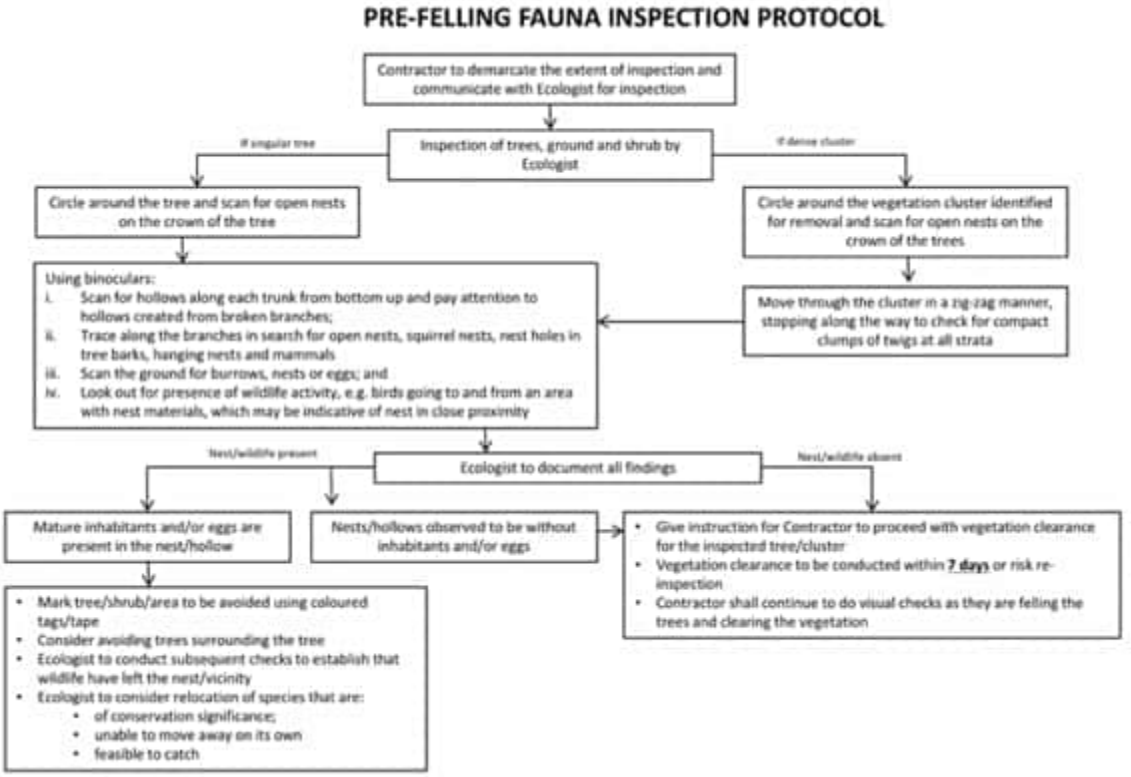



**Figure 11-5 Pre-felling inspection protocol**

**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; and
- 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.

**Wildlife Response Plan**

The Wildlife Response Plan should be formulated by an Ecologist and enacted when a trapped/ injured/ dead/ dangerous animal is encountered around or within the worksite. The objective of the Wildlife Response Plan is to minimise animal injury and mortality (Figure 11-6). The plan should also detail the chain of command, personnel involved (including wildlife management specialists and veterinarian), and the roles of the various stakeholders. This should be emphasized during the toolbox briefings. All wildlife encounters are to be documented within 24 h using the Wildlife Incident Form (Appendix R).

Where species of conservation significance are affected by the development, relocation works should be planned (e.g. bamboo bats). Where fauna is trapped on-site, options should be explored to remove them from site (e.g. partitioning worksite, use of one-way exit door).

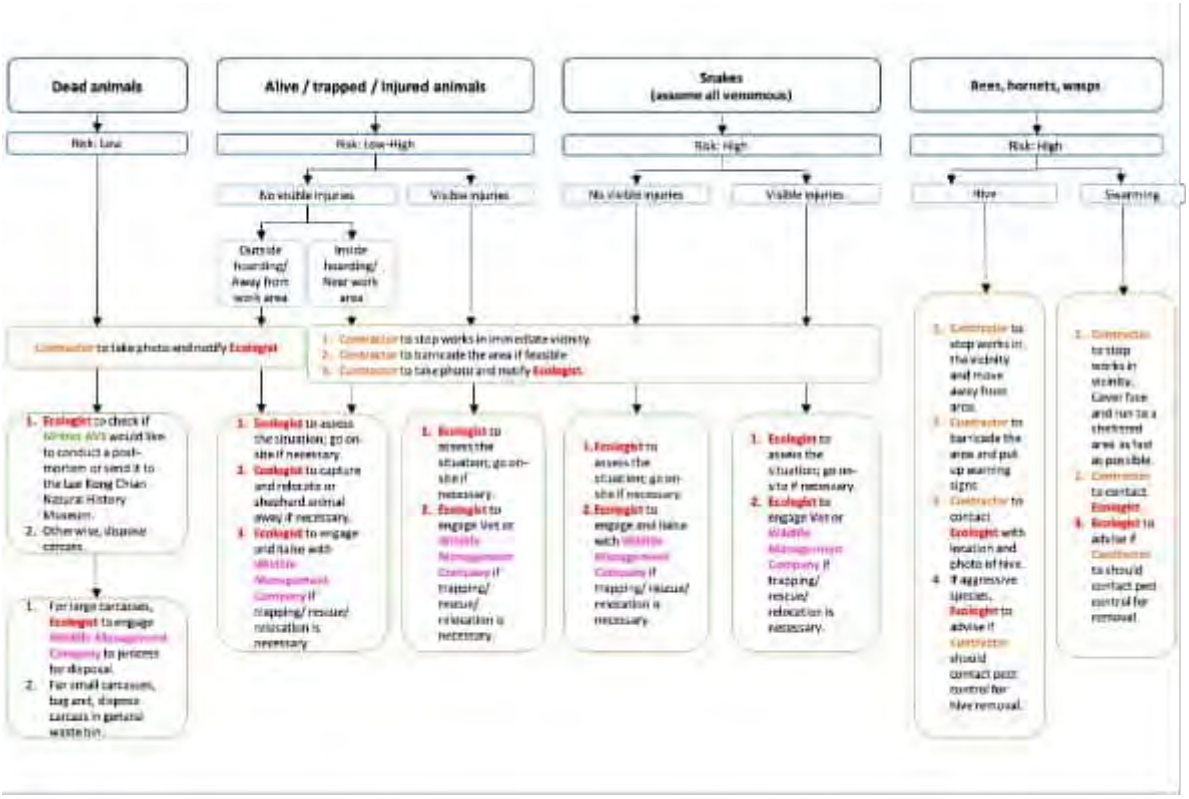
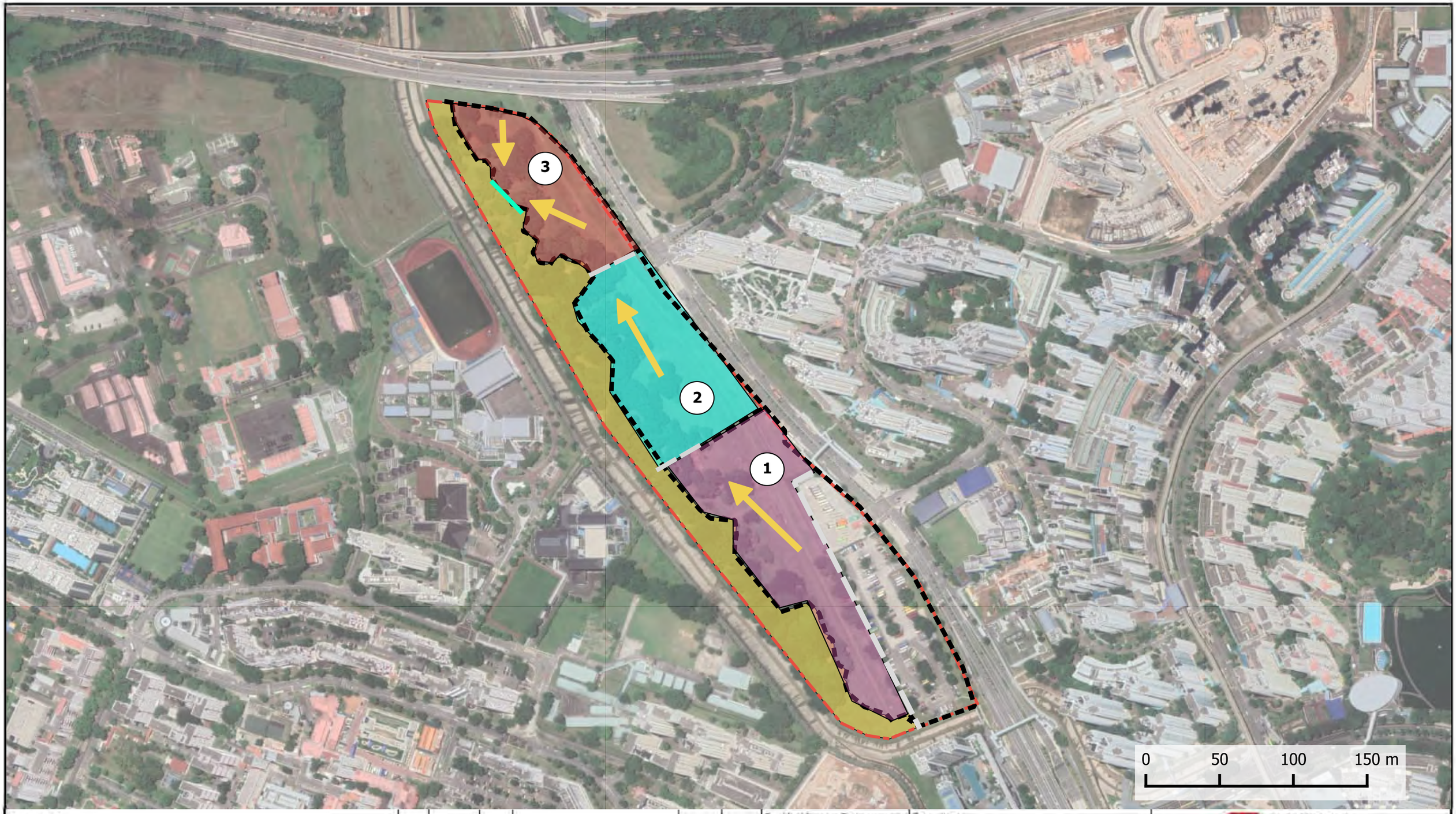



**Figure 11-6 A flow chart of Wildlife Response Plan**




**Legend**

- CCK N1 IA Study Boundary
- Recommended Area of Conservation
- Hoarding Boundary
- Temporary Exit (to be sealed after site clearance)
- Direction of Clearance
- Temporary Hoarding (to be removed after site clearance of each parcellation)

N

| Rev | Date | By | Description | Chk'd | App'd |
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| - | JAN 2023 | ZA | Final Report | NHT | JAG |

Qualified Person Endorsement : NA

HDB Endorsement : NA

Consultant : AECOM

HOUSING & DEVELOPMENT BOARD

Project Title :

**ENVIRONMENTAL IMPACT ASSESSMENT (EIA) ON CHOA CHU KANG N1**

Figure Title :

Recommended direction of site clearing for CCK N1

| Designed | Checked | Approved | Figure No. | Rev. | Sheet |
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| ZA | NHT | JAG | 11-7 | - | 1 of 1 |
| | Drawn : ZA | Date : JAN 2023 | CAD File Name : NA | | A3 |

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## 11.10.2 Operational Phase

At the operational phase, it is recommended to monitor the flora and fauna for at least six months into the operational phase. This will help to determine the effectiveness of mitigation measures (e.g., ecological bridges and fauna underpass) proposed during the design phase.

### 11.10.2.1 Flora Monitoring Programme

The flora monitoring aims to identify impacts arising from operational activities to the conserved area, and rectify issues when identified. The programme should include the following:

- Assess impact of operational activities on the physiological health and structural stability of the RAC at proximity to the development;
- Ensure that the enhancement and in-fill planting and vegetation buffers that were recommended in Section 7.8.1.3 are responding well to development surrounding; and
- Monitor and assess potential edge effects (e.g., predictable failures, accelerated growth of climbers on canopy, change in species composition at the edge) at the boundary of the RAC/ Ecological Corridor adjacent to the development.

### 11.10.2.2 Fauna Monitoring Programme

The fauna monitoring aims to identify impacts arising from operational activities to fauna residing within the RAC/ Ecological Corridor and rectify issues when identified. The programme also aims to monitor is the proposed ecological bridge, fauna underpass and the RAC/ Ecological Corridor is being used by fauna species during the operational phase. Camera traps can be used to monitor the activity of the aforementioned sites.

# 11.11 Water Resources Monitoring Programme Requirement

## 11.11.1 Construction Phase

In order to ensure that procedures are followed appropriately, the construction phase of the projects should be accompanied by an EMMP. The proposed water resources monitoring programme, as detailed below, should be carried out by the Contractor, under supervision of SO and Independent EMMP Consultant. Monthly audit on the site should also be carried out by EMMP consultant.

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).

Effluent will be discharged from sedimentation ponds during the construction phase, and therefore the monitoring of sedimentation pond effluent was recommended to be undertaken to ensure that the surface water quality will be in 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's NEA Allowable Limits for Trade Effluent Discharge to Sewer/ Watercourse/ Controlled Watercourse.

**Table 11-1 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 at all the construction sites throughout the construction period.<br><br>• Monthly monitoring for temperature, pH, conductivity, TDS and DO at all the discharge point locations at the construction sites throughout the construction period. |
| | pH | |
| | Conductivity (µS/cm) | |
| | 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 discharge points and throughout the construction period. |
| | Chemical Oxygen Demand (COD) | |
| | Total Suspended Solids (TSS) | |
| | Ammoniacal Nitrogen ($NH_4$-N) | |
| | 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) | |
| | 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 watercourses, surface runoff from the construction site should be drained to the ECM treatment system to be filtered and to reduce peak runoff. The cut-off 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.

A summary of the recommended monitoring for groundwater is provided in the table below.

**Table 11-2 Recommended monitoring program during construction phase (groundwater)**

| Location | Parameters | Frequency and Duration |
|---|---|---|
| Within the development boundary | Groundwater Level | • Continuous monitoring of groundwater level throughout the lifetime of the construction phase as per the instrumentation and monitoring plan developed by the QP;<br>• Visual monitoring of spoil generated to be conducted daily. Refer to Figure 8-8 and Figure 8-9 of suspected contaminated soils and groundwaters;<br>• Records on chemical waste from the waste generator should be properly kept and records produced when requested;<br>• Inspection of hazardous chemical/substances storage condition weekly during construction phase; and<br>• Environmental audits, quarterly during construction phase. |
| At locations within the Project site where excavated soil and extracted groundwater are collected and stored | Improper management of excavated soil and extracted groundwater | |
| At locations within the Project site where toxic chemical waste is generated/ stored | Toxic chemical waste generation and management | |
| At locations within the Project site where hazardous chemicals/ substances are used/ stored | Improper handling of hazardous chemicals/ substances | |

## 11.11.2 Operational Phase

The operational phase of the Project should be accompanied by an EMMP to ensure the proposed development will have minor impact on the surrounding watercourses. Water quality monitoring is essential as discharge of excess contaminants, especially pH and suspended solids may lead to severe consequences (e.g. turbid waters) 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 proposed development, it is recommended to monitor water quality following Singapore NEA's Allowable Limits for Trade Effluent Discharge to Sewer/ Watercourse/ Controlled Watercourse.

**Table 11-3 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 of the Project site, during the first three (3) months of operation period. |
| | pH | |
| | Conductivity | |
| | Total Dissolved Solids (TDS) | |
| | Turbidity | |
| | Dissolved Oxygen (DO) | |
| Ex-situ | Biochemical Oxygen Demand ($BOD_5$) | Monthly monitoring for all the ex-situ parameters at the main outlets/ drains of the Project site, during the first three (3) months of operation period. |
| | Chemical Oxygen Demand (COD) | |
| | Total Suspended Solids (TSS) | |
| | Total Nitrogen (TN) | |
| | Nitrate ($NO_3$-N) | |
| | Total Phosphorus (TP) | |
| | Orthophosphate ($PO_4$) | |
| | 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. A summary of recommended monitoring for groundwater is shown in the table below. Monthly audit of the whole site should be carried out by EMMP consultant during the first three (3) months of operation period.

**Table 11-4 Recommended monitoring program during operational phase (groundwater)**

| Location | Parameters | Frequency and Duration |
|---|---|---|
| At location within the Study Area where waste (e.g. liquid, solid) is generated/ stored | Solid and liquid waste generation | • Monitoring records of the amount and type of waste (e.g. liquid, solid, toxic chemical) generated during the first three (3) months of operation period.<br>• Inspection of hazardous chemical/ substances storage conditions during the first three (3) months of operation period. |
| At locations within the Study Area where hazardous chemicals/ substances are used/ stored | Improper handling of hazardous chemicals/ substances | |

# 11.12 Air Quality Monitoring Programme Requirement

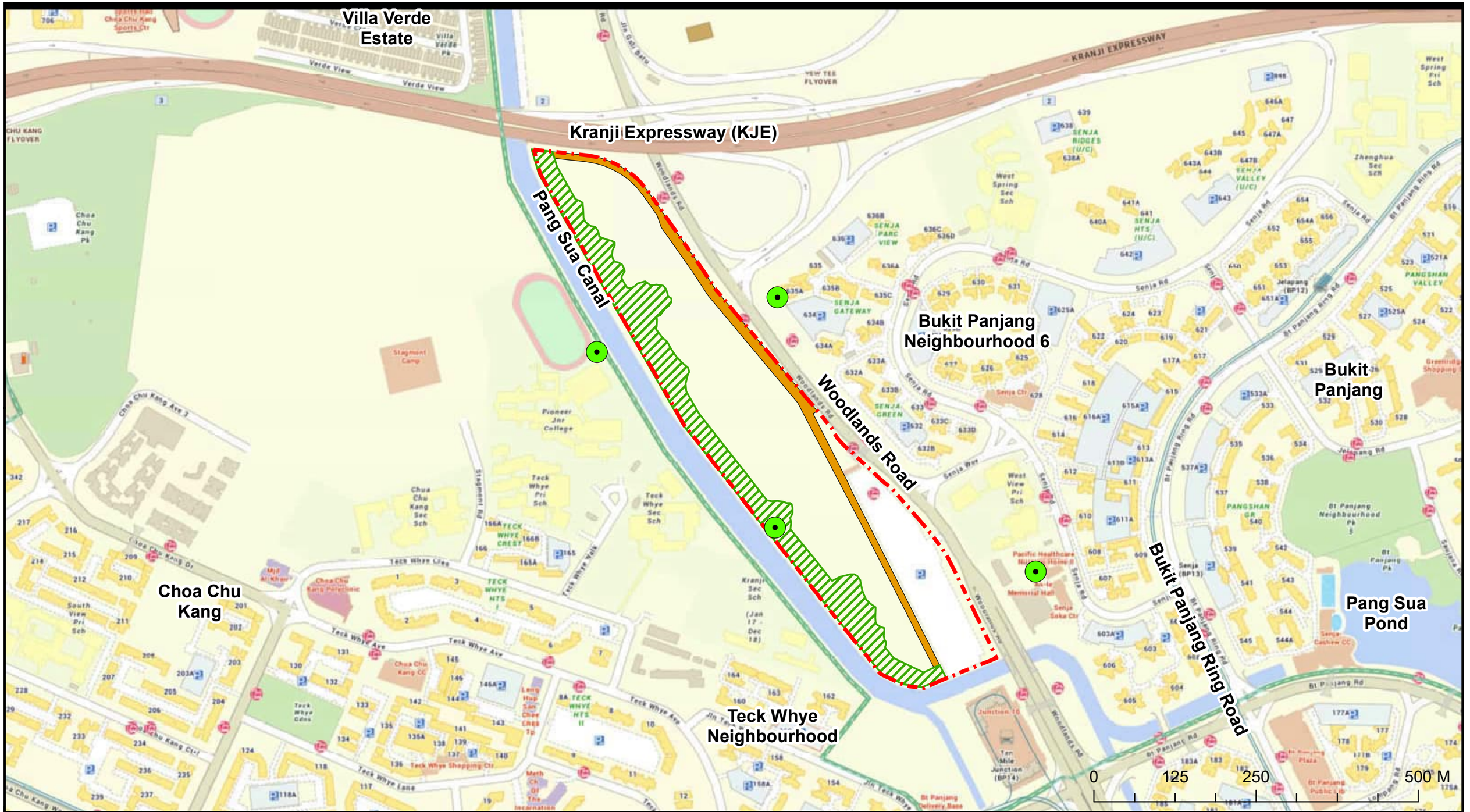
## 11.12.1 Construction Phase

As noted in the mitigation measures (Section 9.8.1), 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 as well as a few human receptors during construction phase. As requested by NEA, USEPA FRM/FEM air monitoring equipment is recommended for all air monitoring activities. If non-USEPA FRM/FEM equipment is proposed for monitoring, collocation with the USEPA FRM/FEM air monitoring equipment prior to the deployment (or planned monitoring period) should be conducted to ensure the performance of the non-USEPA FRM/FEM equipment. Correction/adjustment factor obtained from this collocation study, if determined during collocation, can be applied to the data from the non-USEPA equipment to improve the accuracy of the data. However, if the correlation is poor, the non-USEPA FRM/FEM equipment should not be used and a different equipment/unit should be proposed. Guidance provided by USEPA, such as "How to Evaluate Low-Cost Sensors by Collocation with Federal Reference Method Monitors" [R-51] and "Air Sensor Guidebook" [R-52], will be referred for determining 'passing mark' for the collocation exercise. Based on the collocation results, equipment with lower 'passing mark' will be deployed at ecological area, else dust deposition monitoring will be used for these ecologically sensitive areas. Equipment with better 'passing mark' will be used for human receptor testing and regulatory comparison purpose.

Based on a review of sensitive receptors around the construction worksite areas, a continuous monitoring program as per Table 11-5 is proposed to be conducted during construction phase of the Project. The proposed locations are presented in Figure 11-8.

**Table 11-5 Recommended monitoring program during construction phase (air quality)**

| Location | Parameters | Frequency and Duration | Triggers |
|---|---|---|---|
| Monitoring at the following locations:<br>• HDB Block 635A Senja Road<br>• Pacific Healthcare Nursing Home II @ Bukit Panjang<br>• Jurong Pioneer Junior College<br>• Proposed Ecological Corridor (natural area to be retained within Project site) | $PM_{10}$ and $PM_{2.5}$ | • 1-week monitoring of mentioned parameters at each selected location before commencement of construction phase<br>• Bi-annual 1-month monitoring of mentioned parameters at each selected location during construction phase, except for earthworks and site clearance stages<br>• Continuous monitoring of mentioned parameters at each selected location during earthworks and site clearance stages | Investigation and corrective actions to be taken, when<br>1. Any of the following documentation are found inadequate / missing: Air Pollution Control Plan; Compliance certificate of an Off-Road Diesel engine; or Monitoring Log.<br>2. If the monitored parameters exceed Singapore long term air quality targets.<br>3. If complaints are received due to project activities.<br>4. If visual non-compliance to any of the minimum control or mitigation measures are observed on-site. |




## Legend

- Proposed EMMP Monitoring Locations
- CCK N1 Project Site

**Future Receptors**

- Proposed Ecological Corridor*
- Retained Rail Corridor Alignment

Note: *Exact boundaries/ alignment subject to further changes.

N

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| 01 | MAR 2023 | TTR | Final Report | NHT | JAG |
| - | JAN 2023 | TTR | Final Report | NHT | JAG |

Qualified Person Endorsement : NA

HDB Endorsement : NA

Consultant : AECOM

Client: HOUSING & DEVELOPMENT BOARD

Project Title :

**ENVIRONMENTAL IMPACT ASSESSMENT (EIA) ON CHOA CHU KANG N1**

Figure Title :

**Proposed EMMP air monitoring locations**

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### 11.12.2 Operational Phase

During operational phase, ambient air quality monitoring may not be required.

# 11.13 Airborne Noise Monitoring Programme Requirement

## 11.13.1 Construction Phase

As noted in Section 10.8.1, the airborne noise monitoring programme can be implemented if required. Based on a review of the noise sensitive receptors around the Project site, a continuous monitoring programme as per Table 11-6 is proposed to be conducted during the construction phase.

**Table 11-6 Recommended airborne noise monitoring programme during construction phase**

| No. | Location | Parameters | Frequency and Duration |
|---|---|---|---|
| 1 | Senja Care Home, Vanguard Senior Care Senja Centre | $L_{Aeq(12\ hrs)}$, $L_{Aeq(1\ hr)}$, and $L_{Aeq(5\ mins)}$ | Before commencement of any construction works (including site clearance)<br>• One-time airborne noise monitoring for 1 week at the proposed locations, for establishment of latest baseline.<br><br>During Construction Phase<br>• Continuous monitoring at the proposed locations for the entire duration of construction. |
| 2 | West View Primary School | | |
| 3 | Within Green Area | | |

## 11.13.2 Operational Phase

No noise monitoring programme were proposed for the operational phase due to the lack of information required regarding the ACMV system designs and land traffic volumes. Usually conducted by an appointed Noise Consultant, AECOM recommends that the works for ACMV boundary noise impact assessment and land 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 10.2.5.1.2.

# 11.14 Vector Monitoring Programme Requirement

This section provides a vector monitoring programme to minimise the occurrence of potential impacts of vector populations near the Study Area 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 creates these suitable breeding habitats in order to control the mosquito population within the Study Area. Rodent (including rats) infestations are problematic as they can spread diseases through their urine and droppings and chew up wires, pipes and insulation [W-27]. 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-28]. 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.

## 11.14.1 Construction Phase

This vector monitoring program is dedicated for the construction worksites of this Project only. Areas outside of the Project boundary 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-31] and NEA's Mosquito and Rodent Control Measures [W-29, W-28], 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-32, W-33].
- **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-31].
- **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 [10]" activities at each construction site.

The recommended monitoring program for vectors is summarised in Table 11-7 below.

**Table 11-7 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<br>• Weekly inspection by an external NEA-licensed Pest Control Operator. |

## 11.14.2 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-46,W-28, W-30].

[10] 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.

# 11.15 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;
- Site log for all monitoring activities and complaints;
- Construction Logistics Plan;
- Standard Operating Procedures for processes identified in Table 11-8 and Table 11-9 below;
- Emergency Response Plan;
- Inventory of wastewater streams;
- Training protocols for staff, where appropriate; and
- Maintenance and Audit Schedules.

## 11.15.1 Construction Phase

The EMMP for construction phase of the project is described in table below.

**Table 11-8 Proposed environmental management and monitoring 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[11,12] |
|---|---|---|---|---|---|---|---|---|---|
| **Biodiversity** | Minimisation of construction impacts to flora/ vegetation | • Mark out site boundary (via hoarding);<br>• Set up Tree Protection Zones (TPZs) around trees or other plant specimens to be retained within the worksites, if any;<br>• Tag trees (with or without TPZs) meant to be protected or transplanted to avoid accidental removal, if required; and<br>• Establishment of TPZs | • Record locations, species and quantity of transplant candidates that are affected by construction (if any); and<br>• Verification and review of footprints for hoarding, access roads and soil investigation works | Flora and Arboriculture | Within development boundary | Prior to site clearance | Not Applicable | CT<br>(ECO, Floral Specialist) | Corrective actions will need to be taken if:<br>• Hoarding alignment does not follow the hoarding plans of the Project<br>Flora specialist will report to SO for downstream reporting |
| | | • Establishment of TPZs;<br>• Inspect the integrity of the TPZs ;<br>• Review method statements of construction works in proximity to retained trees;<br>• Implement soil erosion control measures as soon as vegetation has been removed and soil is exposed; and<br>• Identify excessive or unauthorized tree removal | • Identify trees that require management and maintenance such as tree care and pruning;<br>• 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;<br>• Check for mechanical damage on trees that may impair stability;<br>• Determine if there are any unauthorized removal of flora within areas of conservation (if any) or beyond the demarcated worksite;<br>• Identify areas with soil erosion and degradation that have resulted from construction activities;<br>• Monitoring of the condition of trees at the edge of the recommended areas of conservation (RAC) to determine the physiological health and structural stability of trees;<br>• 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;<br>• Inspection of invasive flora species and weeds and recommendation to remove them where necessary;<br>• Identification of forest edge effects and recommendation of mitigation measures, where necessary;<br>• Identify areas that are responding poorly due to the development impacts | | Within development boundary and 15m beyond hoarding line | Monthly for duration of construction | To be included in monthly report | CT<br>(ECO, Floral Specialist, Arborist) | Corrective actions will need to be taken if:<br>• Depending on the extent of the excessive clearance, flora specialist will report to SO for downstream reporting to NParks;<br>• The structure and health of the trees along the new forest edge has deteriorate and are deemed unsafe by an appointed Arborist;<br>• Encroachment into or removal of TPZs resulting in impairment of structural stability and/or physiological health of trees |

[11] Resident Technical Officer (RTO) and Site Officers (SO, WSHO and ECO) check the Study Area for construction progress and implementation of environmental mitigation measures.
[12] If there is trigger then all the mitigation and management measures should be audited in detail for compliance and corrective action must be taken in liaison with the Project Owner.

| Environmental Parameter | Environmental Issue | Minimum Control Measures | Mitigation Measures | Monitoring Parameter | Monitoring Locations | Recommended Frequency of Monitoring | Monthly Reporting | Site Responsibility | Triggers[11,12] |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |
| | • Minimisation of construction impacts to fauna<br>• Minimisation of human-wildlife conflict | • Installation of site hoardings<br>• Implementation of pre-site clearance fauna inspection<br>• Implementation of directional clearing | • The Site must be hoarded up entirely. It should commence from the side of development nearest to the road, i.e. to start hoarding from the boundary nearest to Woodlands Rd first then move inwards, so as to prevent any roadkill;<br>• The hoarding must not have any gaps between the panels and are to extend at least 300mm into the ground;<br>• The access gates, when shut, must not have any gaps between the panels and must be flush as close to the ground as possible; and<br>• Implementation of directional clearing after hoarding is implemented | Fauna | Within development boundary | Prior to site clearance | To be included in monthly report | CT<br>(ECO, Ecologist) | N/A |
| | | • Ensure proper storage of machineries likely to leech harmful chemicals and fuel-powered equipment;<br>• Store the aforementioned equipment away from waterbodies and/or sensitive habitats; and<br>• Ensure that noise minimum control measures (as detailed in the Airborne Noise section below) are adhered to. | • Assess habitat quality (e.g., water quality, pollution via improper disposed/ stored food and food packaging);<br>• Check for presence of trapped/ injured/ dead fauna, potential fauna entrapments and gaps in site hoarding; and<br>• Conduct toolbox briefings on biodiversity awareness. | | Within development boundary | Monthly for duration of construction | To be included in monthly reports. | CT<br>(ECO, Ecologist) | Corrective actions will need to be taken if:<br>• Rubbish and/or construction waste from construction materials is observed in the RAC; and<br>• Excessive disturbance generated by construction activities is detected |
| | | • Execute wildlife response plan when a trapped/ injured/ dead/ dangerous animal is encountered around or within the worksite according to Section 10 of Wildlife Act | • Record of number of occurrences of human-wildlife conflict | | Within development boundary | Daily monitoring and record-keeping | To be included in monthly report | CT<br>(ECO, Ecologist) | Wildlife response plan will be activated when fauna is encountered within development boundary |
| **Water Resources (Hydrology and Surface Water Quality)** | • Solid & Toxic Waste Generation<br>• Liquid Effluent and stormwater run-off Generation<br>• Improper Management of Chemical Substances<br>• Storage and Disposal of Domestic Liquid and Construction Solid Wastes<br>• Temporary Land Use Change | • Drain diversion for the watercourses impacted by this development (i.e., drains D2 and D4) should be provided before the commencement of construction works.<br>• Develop stormwater drainage system designed with reference to PUB COP (e.g. perimeter drains) that will effectively drain away runoff originating within, upstream of and adjacent to the work site. Proposed system should not cause flooding in its vicinity.<br>• 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;<br>• Implementation of CCTV including SIDS at the public drain to monitor the surface run-off discharges from the sites as per the Public Utilities Board of Singapore's (PUB) circular on Preventing Muddy Waters from the Construction Sites (October 2015); and<br>• 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.).<br>• A full inventory of all anticipated wastewater streams and volumes should be finalised before the onset of the construction works;<br>• No unmanaged discharge of wastewater stream permitted; | Not Applicable | All water quality parameters identified in Table 11-1. And any flooding issues should be recorded and inspected. | Before discharge outlets of construction sites. | • Permanent TSS monitor installed at every discharge outlet;<br>• Implementation of CCTV including a SIDS at every discharge outlet to monitor the surface run-off discharges from the sites;<br>• Daily inspections of drains, to check for blockage or visual changes in water quality<br>• Monthly water quality monitoring for all discharge point locations and other public drains during construction phase;<br>• Intensity of the laboratory analysis will be increased | To be included in monthly report | CT<br>(ECO) | Investigation and corrective actions to be taken, when:<br>• The following documentation are found inadequate/ missing:<br>• ECM Plan;<br>• Monitoring Log;<br>• Training Log;<br>• Audit Reports;<br>• If the monitored parameters exceed applicable values of NEA Trade Effluent Discharge Limits at discharge point (refer to Table 8-1);<br>• If the monitored parameters exceed applicable |

| Environmental Parameter | Environmental Issue | Minimum Control Measures | Mitigation Measures | Monitoring Parameter | Monitoring Locations | Recommended Frequency of Monitoring | Monthly Reporting | Site Responsibility | Triggers[11,12] |
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| | | • Reduce, reuse, and recycle hierarchy principle to be applied to wastewater on-site;<br>• Hazardous wastewater, such as oily water, thinners, solvents, or paints, are to be stored and removed for treatment and disposal off-site by an approved Waste Management Contractor. Hazardous liquids to be handled as Hazardous Waste;<br>• Adequate drainage, cut-off drains sump pit, road kerb, piping, toe wall and/or channelling of construction process wastewater streams (e.g. concrete batching, wash water, etc.) to be assured through detailed design for capture and treatment in the settling ponds. Where applicable (e.g. in the vicinity of liquid storage or refuelling areas), this infrastructure shall include oil-water separators to capture inadvertent spills or leaked oils or greases;<br>• Appropriate disposal of any waste listed in the Environmental Public Health (General Waste Collection) Regulations by licensed waste operator/ collector.<br>• Runoff within, upstream of, and adjacent to the work site shall be effectively drained away without causing flooding in the vicinity;<br>• Appropriate permits for discharge to be obtained from relevant authority prior to discharge. No trade effluent other than that of a nature or type approved by NEA Director-General shall be discharged into any watercourse or land.<br>• 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; and<br>• Geotechnical aspect of site's slope stability (such as Earth Retaining and Stabilising structures (ERSS) to be included in detailed design engineering for the construction phase.<br>• Development of SOP for safe handling, transfer and storage of toxic waste; housekeeping checks once a day to ensure all toxic waste is cleared from site;<br>• Appropriate tests to ascertain the presence/ absence of contamination of the excavated earth and sand;<br>• Appropriate storage area (enclosed on at least 3 sides, covered and with adequate ventilation);<br>• Appropriate construction material for toxic waste storage containers with leak detection tests conducted periodically;<br>• Provision of secondary containment for all toxic waste stored in bulk as per the requirements in the COPPC/SS593;<br>• 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;<br>• Consignment notification/ tracking system and transport emergency response plan for transport of toxic waste;<br>• Appropriate disposal of toxic waste as per required in the Environmental Public Health (Toxic Industrial Waste) Regulations by licensed waste operator/ collector. | | | (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<br>• Daily inspection on perimeter drains to ensure no surface runoff flowing out from the site untreated done by the site officer with monthly audit done by EMMP consultant. | | | values of Water Quality Criteria for Aquatic Life at natural stream (refer to Table 8-1);<br>• If any flooding or clogging issues observed;<br>• If complaints are received due to project activities; and<br>• If visual non-compliance to any of the minimum control or mitigation measures are observed on-site. |
| **Water Resources (Groundwater Quality and Level)** | • Decreased infiltration into the ground due to increased runoff from hard standing surfaces<br>• Groundwater extraction during construction activities that require soil dewatering | • The Contractor is required to installation piezometers to monitor the changes in groundwater level in compliance with Building Control Regulations 2003 as part of its instrumentation and monitoring plan to be endorsed by the QP<br>• Proper Earth Retaining Stabilising Structures (ERSS) should be selected and designed to limit groundwater settlement<br>• Plan soil dewatering in phases to avoid as much as practicably possible groundwater drawdown | No additional mitigation measures needed. | Groundwater Level | Actual monitoring location to be decided by QP | • To continuously monitor the groundwater level throughout the lifetime of the construction phase | To be included in monthly report | CT<br>(ECO) | Investigation and corrective actions to be taken there is a significant drawdown of groundwater level. |
| | • Seepage of contaminants from excavated contaminated soil | • Identify all types of solid waste and implement comprehensive waste management system at the site in order to ensure proper disposal and prevent pollution to the environment. This contractor should conduct a construction risk assessment and prepare a | No additional mitigation measures needed. | Records on waste generated and hazardous chemicals used | • At locations where toxic and solid wastes are generated and store. | • Monitoring records of the amount and type of toxic chemical waste | | CT<br>(ECO) | Investigation and corrective actions to be taken, when: |

| Environmental Parameter | Environmental Issue | Minimum Control Measures | Mitigation Measures | Monitoring Parameter | Monitoring Locations | Recommended Frequency of Monitoring | Monthly Reporting | Site Responsibility | Triggers[11,12] |
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| | (if encountered) into the underlying soil and groundwater<br>• Soil erosion of exposed soil from excavations and stockpiles<br>• Seepage of contaminants from extracted contaminated groundwater (if encountered) into the underlying soil and groundwater<br>• Discharge of toxic chemical waste<br>• Discharge or leakage of chemicals used for refuelling and maintenance of vehicles, machinery and equipment | comprehensive construction health, safety and environment plan. If health impacts to workers are foreseen due to the handling of such waste, necessary precautionary measures as per the safety data sheets (SDS) including personal protective equipment should be implemented on site.<br>• Use approved materials, of the same or better quality as the surrounding area, for backfilling works. All backfilled material shall be free of debris, and of good material soil.<br>• Handle and dispose excavated soil following the procedure shown in Figure 8-8. This flow chart explains how to handle excavated soils, and identify potential areas of contamination as well as potential of contamination (POC) in excavated soils. If the POC soils are tested for exceedance in DIVs, the soils can be disposed of to toxic waste collectors or undergo soil treatment. If contaminated soils were sent for treatment to an acceptable standard such as the DIV, the treated soil can be disposed in the staging ground or through a general waste collector, depending on the level of the contaminants during the staging ground testing.<br>• Upon receipt of results on the tested parameters (chemicals, heavy metals) exceeding the regulatory limits, the construction contractor should further assess the potential inhalation and dermal contact impacts of the exceeded parameters to the site workers exposed to areas where soil and/or groundwater contamination is identified. The risk assessment should be conducted before the commencement of construction activities and the findings incorporated into the contractors' construction risk assessment and health, safety and environment plan. If health impacts to workers are foreseen, necessary precautionary measures, as per the respective chemical SDS, should be implemented on site.<br>• A site management plan should include plans of safe handling, transfer and storage of excavated soils following the procedure in Figure 8-8.<br>• Discharge of extracted groundwater shall be to an area approved for such disposal by the NEA and the proposed location as identified in Figure 8-8 and following the process set out in Figure 8-9. Based on the results of the soil and groundwater baseline study, the detected concentrations in groundwater do not exceed the DIVs. However, it is recommended that the construction contractor to be vigilant of site conditions and extracted groundwater to be tested at regular intervals, especially for extracted groundwater with oily sheens or noticeable odour. If a contaminant concentration in excess of the DIV is detected, the contractor shall assess the potential inhalation and dermal impacts of the chemical identified and assess potential health and safety considerations for exposure to groundwater before commencement of construction activities. Such contaminated wastewater may need to be disposed of to a licenced toxic waste collector.<br>• Identify all types of toxic chemical waste and implement comprehensive waste management system at the site in order to ensure proper disposal and prevent pollution to the environment. This contractor should conduct a construction risk assessment and prepare a comprehensive construction health, safety and environment plan. If health impacts to workers are foreseen due to the handling of such waste, necessary precautionary measures as per the safety data sheets (SDS) including personal protective equipment should be implemented on site.<br>• Inspect all equipment prior to entering the site for fuel/hydraulic lines, leaking tanks, and other potential faulty parts that could potentially cause contamination to soil or groundwater.<br>• Dispose all construction debris (under category C&D) at the gazetted Government dumping grounds or at such other sites or locations as directed by NEA.<br>• Store generated toxic chemical waste under shelter within concrete bund walls or in storage containers with good ventilation. Spill trays shall be provided for all waste containers Spill trays shall be regularly maintained to prevent rain from washing out the pollutive substances. | | at the construction site should be properly kept and records produced when requested. | • At locations where hazardous chemicals/ substances are used and stored | generated, once a week.<br>• Inspection of hazardous chemical/substances storage conditions, once a week.<br>• Environmental audits, quarterly. | | | • There are no/poor records of toxic chemical waste amount and type; and<br>• There is evidence of poor handling/storage of toxic chemical waste and hazardous chemical. |

| Environmental Parameter | Environmental Issue | Minimum Control Measures | Mitigation Measures | Monitoring Parameter | Monitoring Locations | Recommended Frequency of Monitoring | Monthly Reporting | Site Responsibility | Triggers[11,12] |
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| | | • Note that the Earth Control Measures (ECM) is for the containment and treatment of silty discharge due to the impact of rainwater. ECM is not meant for the treatment of wastewater due to construction activities (such as pipe-jacking and bore-piling works) which shall be treated to comply with the requirements under prevailing legislation.<br>• The wastewater from construction activities should be stored and removed for treatment and disposal off-site by an approved Waste Management Contractor.<br>• Remove any hazardous substance or chemical if there are safer alternatives.<br>• Ensure all hazardous substance and chemical containers are labelled its movement is recorded and returned to the designated storage areas when not in use.<br>• Assess the SDS of all the hazardous substances and chemicals prior to its entry to site for its suitability in terms of SHE hazards and consider safer alternatives.<br>• Ensure no trade effluent other than that of a nature or type approved by NEA Director-General shall be discharged into any watercourse or land.<br>• Ensure all activities involving repair, servicing, engine overhaul works, etc. shall be carried out on an area which is appropriately contained (e.g. concreted area and with proper containment/sumps) and all wastes are channelled for appropriate treatment or disposal to meet the regulations.<br>• Store chemicals stored under shelter within concrete bund walls or in storage containers with good ventilation. Spill trays shall be provided for all drums, plants and machinery and potential pollutive substances used on site. Spill trays shall be regularly maintained to prevent rain from washing out the pollutive substances.<br>• Provide emergency spill kits on site in the event of any chemical spillages. The emergency response team shall also be competent in the use of these spill kits.<br>• Contractor will need to seek approval from relevant authorities (e.g., PUB & NEA) as per NEA's Trade Effluent Discharge Limits if the treated groundwater will be disposed to controlled watercourse If such discharges are not approved, the trade effluent will be stored, treated, or recycled on site and finally disposed of. The extracted groundwater to be discharged should be tested in regular intervals, especially if oily sheens or odour are observed. | | | | | | |
| **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;<br>• No demolition of permanent structure is expected as part of the project;<br>• No concrete batching plant to be located on-site; and<br>• 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 throughout construction period.<br>Communications:<br>• Develop and implement a stakeholder communications plan that includes community engagement before work commences on site.<br>• 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.<br>• Develop and implement an Air Pollution Control Plan (APCP)<br>Site Management:<br>• 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.<br>• Make the complaints log available to the local authority when asked.<br>• 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.<br>• Hold liaison meetings with other high-risk construction sites within 500m of the site boundary, if any, to ensure plans are co-ordinated and dust and particulate matter emissions are minimised.<br>Monitoring: | $PM_{10}$, $PM_{2.5}$ | • HDB Block 635A Senja Road<br>• Pacific Healthcare Nursing Home II @ Bukit Panjang<br>• Jurong Pioneer Junior College<br>• Proposed Ecological Corridor (natural area to be retained within Project site) | • 1-week monitoring of mentioned parameters before commencement of construction phase<br>• <u>Bi-annual</u> 1-month monitoring of mentioned parameters at each selected location during construction phase, except for earthworks and site clearance stages<br>• <u>Continuous</u> monitoring of mentioned parameters at each selected location during earthworks and site clearance stages | To be included in monthly report | CT<br>(ECO) | Investigation and corrective actions to be taken, when<br>1. Any of the following documentation are found inadequate / missing: Air Pollution Control Plan; Compliance certificate of an Off-Road Diesel engine; or Monitoring Log.<br>2. If the monitored parameters exceed Singapore long term air quality targets.<br>3. If complaints are received due to project activities. |

| Environmental Parameter | Environmental Issue | Minimum Control Measures | Mitigation Measures | Monitoring Parameter | Monitoring Locations | Recommended Frequency of Monitoring | Monthly Reporting | Site Responsibility | Triggers[11,12] |
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| | | | • 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 100m of site boundary. Cleaning should be provided if necessary.<br>• Carry out regular site inspections to monitor and record compliance with the Air Pollution Control Plan.<br>• Increase the frequency of site inspections during prolonged dry or windy conditions.<br>• Conduct monitoring for $PM_{10}$ and $PM_{2.5}$ at suitable locations (refer to Section 11.12.1)<br>Preparing and maintaining the site:<br>• Plan site layout so that machinery and dust causing activities are located away from receptors, where possible.<br>• 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.<br>• Fully enclose specific activities where there is a known high potential for dust production and the site will be active for an extensive period of time.<br>• Keep site fencing, barriers, and scaffolding clean by cleaning regularly using wet methods (dry methods may give rise to fugitive dust).<br>• 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.<br>Operating vehicle/machinery and sustainable travel:<br>• 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.<br>• Produce a Construction Logistics Plan to manage the sustainable delivery of goods and materials.<br>• Ensure all vehicles and engine powered equipment comply with the legislative requirements of Singapore<br>• 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.<br>• Where practicable, avoid the use of diesel- or petrol-powered generators and use mains electricity or battery powered equipment<br>Construction:<br>• 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.<br>• Ensure an adequate water supply on the site for effective dust/particulate matter suppression/mitigation, using non-potable water where possible and appropriate.<br>• Use enclosed chutes and conveyors and covered skips wherever possible.<br>• Minimise drop heights from conveyors, loading shovels, hoppers and other loading or handling equipment and use fine water sprays on such equipment wherever appropriate.<br>• 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.<br>Waste Management:<br>Avoid burning of waste or other materials | | | | | | 4. 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[11,12] |
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| | | | MITIGATION MEASURES FOR EARTHWORKS<br>• Closed turfing to the exposed areas where possible and maintain proper storage of soil stockpiles to stabilise surfaces as soon as practicable.<br>• 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.<br>• Only remove the cover in intended working areas and not all at once.<br><br>MITIGATION MEASURES FOR CONSTRUCTION<br>• Avoid scabbling (roughening of concrete surfaces) if possible.<br>• 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.<br>• 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.<br>• For smaller supplies of fine power materials ensure bags are sealed after use and stored appropriately to prevent dust.<br><br>MITIGATION MEASURES FOR TRACKOUT<br>• 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.<br>• Avoid dry sweeping of large areas.<br>• Ensure vehicles entering and leaving sites are covered to prevent escape of materials during transport.<br>• Inspect on-site haul routes for integrity and instigate necessary repairs to the surface as soon as reasonably practicable.<br>• Record all inspections of haul routes and any subsequent action in a site log book.<br>• Install hard surfaced haul routes, which are regularly damped down with fixed or mobile sprinkler systems, or mobile water bowsers and regularly cleaned.<br>• Implement a wheel washing system (with rumble grids to dislodge accumulated dust and mud prior to leaving the site where reasonably practicable).<br>• 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.<br>• Site access gates to be located at least 10m 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.) | • 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;<br>• Only well-maintained construction plants should be utilized on-site, and construction plants should be serviced regularly during the entire construction period;<br>• 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:<br>• Silencers or mufflers on construction equipment should be utilized and should be properly maintained during the construction programme;<br>• 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;<br>• 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; | MITIGATION MEASURES FOR GENERAL CONSTRUCTION NOISE CONTROL:<br>• 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 prioritized; and<br>• 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.<br><br>MITIGATION MEASURES FOR CONSTRUCTION NOISE:<br>• Noise barriers of 3m and 12m height are proposed at the construction boundary fronting noise sensitive receptors (see Figure 10-3); and | $L_{Aeq(12\ hrs)}$, $L_{Aeq(1hr)}$, and $L_{Aeq(5\ mins)}$ | • Senja Care Home, Vanguard Senior Care Senja Centre;<br>• West View Primary School;<br>• Within Green Area. | Before commencement of any construction works (including site clearance)<br>• One-time airborne noise monitoring for 1 week at the proposed locations, for establishment of latest baseline.<br><br>During Construction Phase<br>• Continuous monitoring at the proposed locations for the entire duration of construction. | To be included in monthly report | CT | Investigation and corrective actions to be taken, when any of the following documentation are found inadequate / missing:<br>• Construction Noise Management Plan;<br>• Monitoring Log.<br>1. If the monitored parameters exceed applicable values of EPM regulations. |

| Environmental Parameter | Environmental Issue | Minimum Control Measures | Mitigation Measures | Monitoring Parameter | Monitoring Locations | Recommended Frequency of Monitoring | Monthly Reporting | Site Responsibility | Triggers[11,12] |
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| | | • 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;<br>• 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;<br>• Plan the layout of the site by considering using materials and other large structural equipment as noise barriers;<br>• 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;<br>• Material stockpiles and other structures will be effectively utilized, wherever practicable, in screening noise from on-site construction activities;<br>• All handheld percussive breakers and air compressors used on site will comply with local legislation and requirements;<br>• Activities may be scheduled to minimise noise generated at certain areas during periods which may be particularly sensitive to noise;<br>• Works using machines or vehicles that generate noise should be prohibited in the night and the dawn;<br>• 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;<br>• 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<br>• 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. | • Extension of wildlife shepherding to fauna species potentially trapped within areas bounded by the proposed construction worksites and OCC. | | | • Records on noise levels from construction sites should be properly kept and produced when requested. | | | 2. If complaints are received due to project activities.<br>3. If visual non-compliance to any of the minimum control or mitigation measures are observed on-site.<br>4. If there are any cracks / leaks present on the noise barrier erected. |
| **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.<br>• 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 11.14.1)<br>• 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.<br>• Scheduled daily housekeeping to ensure clearance of stagnant water and unwanted items are discarded properly.<br>• Site entrance shall be paved to avoid ground depression.<br>• Milled waste can be used to level the ground before laying steel plates.<br>• Provide movable roof over shaft to prevent rainwater ingress.<br>• Pump shall be deployed to clear water at areas where drainage is not possible, as well as for larger recessed surfaces.<br>• Install pitched roof on top and/or seal up bottom of site container office.<br>• After trees clearance, top of tree stumps has to be either remove thoroughly or patched up. | Not Applicable. | • Inspection of potential mosquitoes breeding grounds (water ponding)<br>• Inspection of rodent burrows<br>• 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<br>• Weekly inspection by an external NEA-licensed PCO. | To be included in monthly report | CT<br>(ECO / SHE personnel) | Investigation and corrective actions (i.e. Stop Work Orders) to be taken, when:<br>a. Worksite is found to have vector-breeding habitats.<br>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[11,12] |
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| | | • Pipette can be used for larvae-checking at the hard-to-reach parts of a tree.<br>• 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.<br>• Store food in rodent proof storage containers/ cabinets with at least 60 cm clearance above ground level.<br>• 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. | | | | | | |

## 11.15.2 Operational Phase

The EMMP for operational phase of the project is described in Table 11-9.

**Table 11-9 Proposed environmental management and monitoring 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[13,14] |
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| **Biodiversity** | Minimisation of operational impacts to flora/vegetation | Not Applicable | • Identify of areas that are responding poorly due to operational activities<br>• Ensure that in-fill planting and vegetation buffers is responding well to development surrounding<br>• Monitor and assess potential edge effects within at the boundary of the RAC | Flora and Arboriculture | Adjacent forest to development boundary | Monthly for duration of 6 months of operational period. | CT (EHS, Floral Specialist, Arborist) | Not Applicable |
| | | Not Applicable | • Ensure integrity of the RAC<br>• Identify signs of edge effects on new forest edge of the RAC (if any) | | | | | |
| | Minimisation of operational impacts to fauna | Not Applicable | • Recording of number of number of occurrences of roadkills should there be any internal roads within Project site and major roads in proximity to the Project site<br>• Monitor the proposed eco-bridge and fauna underpass to see if it is being used by any fauna species | Fauna | Adjacent forest to development boundary | | CT (EHS, Ecologist) | |
| **Water Resources (Hydrology and Surface Water Quality)** | • Stormwater run-off generation<br>• Permanent land use change<br>• 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.;<br>• 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;<br>• Potential increase of peak-flow due to the change in the land use at the new developments can be mitigated by providing detention tanks within the Study Area. Detention tanks 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.<br>• 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;<br>• Provide more pervious areas to increase the seepage of surface water into the soil;<br>• Geotechnical aspect of site's slope stability (such as ERSS) to be included in detailed design engineering for the operational phase;<br>• To prepare sufficient disposal bins surrounding of the Project to avoid improper disposal of waste;<br>• To conduct regular inspection on wastes' storage system of the Project;<br>• To monitor the proposed water features and its surroundings with CCTV surveillance regularly to ensure no contamination occurred;<br>• To develop an emergency response plan and conduct adequate training to maintenance workers to cope the accidental water contamination; and<br>• Raising awareness of various stakeholders with community/stakeholder engagement (e.g. signage boards, warning signs, etc.). | Not Applicable | All parameters identified in Table 11-3.<br>And any flooding issues should be recorded and inspected. | At the main outlets/ drains of the Study Area, in the vicinity of 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. | EHS Officer | Investigation and corrective actions to be taken, when:<br>• If the monitored parameters of all discharge points exceed applicable values of NEA Trade Effluent Discharge Limits at discharge point (refer to Table 8-1);<br>• If any flooding issues observed;<br>• If complaints are received due to project activities; and<br>• If visual non-compliance to any of the minimum control or mitigation measures are observed on-site. |

[13] Resident Technical Officer (RTO) and Site Officers (SO, WSHO and ECO) check the Study Area for construction progress and implementation of environmental mitigation measures.
[14] If there is trigger then all the mitigation and management measures should be audited in detail for compliance and corrective action must be taken in liaison with the Project Owner.

| Environmental Parameter | Environmental Issue | Minimum Control Measures | Mitigation Measures | Monitoring Parameter | Monitoring Locations | Recommended Frequency of Monitoring | Site Responsibility | Triggers[13,14] |
|---|---|---|---|---|---|---|---|---|
| **Water Resources (Groundwater Quality and Level)** | • More areas with impervious surfaces in the new development leading to decrease in infiltration of surface water/ stormwater into the soil | • Incorporate more pervious surfaces in the development plan | No additional mitigation measures needed. | Not Applicable | Not Applicable | Not Applicable | Not Applicable | Not Applicable |
| | • Heavy rain and stormwater wash-off pollutants built-up in the new development area and discharge to surrounding soil and groundwater<br>• Discharge or leakage of waste and chemicals into the soil | • Ensure no trade effluent other than that of a nature or type approved by NEA Director-General shall be discharged into any watercourse or land.<br>• Store all toxic chemical waste and hazardous substances/chemicals at designated sheltered area provided with access-controlled entrance and concrete bund walls or in storage of containers with good ventilation. Spill trays shall be provided for all chemical drums and potentially pollutive substances. Spill trays shall be regularly maintained to prevent the rain from washing out the pollutive substances<br>• Dispose all toxic waste chemicals (if any) to licensed Toxic Industrial Waste (TIW) collectors for treatment<br>• Ensure all hazardous chemicals/substances are labelled, its movement is recorded and returned to the designated storage areas when not in use<br>• Ensure all activities including repair, servicing, engine overhaul works, etc. involving the use of hazardous chemicals/substances are carried out on an area which is appropriately contained (e.g. concreted area and with proper containment/sumps).<br>• Provide emergency spill kits on site in the event of any chemical spillages. The emergency response team shall also be competent in the use of these spill kits | No additional mitigation measures needed. | • Records on waste generated and hazardous chemicals used at the Study Area should be properly kept and records produced when requested. | • At locations where toxic chemical waste are generated and store.<br>• At locations where hazardous chemicals/substances are used and stored. | • Monitoring records of the amount and type of waste generated, monthly.<br>• Inspection of hazardous chemical/substances storage conditions, monthly. | CT, EHS | • Investigation and corrective actions to be taken, when:<br>• There are no/poor records of toxic chemical waste amount and type; and<br>• There is evidence of poor handling/storage of toxic chemical waste and hazardous chemical |
| **Air Quality** | Air Quality impact from dust nuisance from the emissions from vehicle exhaust due to increased traffic | 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, Land Traffic Noise | MINIMUM CONTROLS FOR ACMV NOISE:<br>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 the NEA ACMV Guideline, 2018 [R-38]. In addition, mitigation measures will be provided by the appointed Noise Consultants during the prelim design stage.<br>• Use low air-conditioning and mechanical ventilation system equipment;<br>• 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;<br>• Acoustic treatment if any to be designed and implemented;<br>• 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<br>• Acoustic enclosures for outdoor equipment.<br><br>MINIMUM CONTROLS FOR TRAFFIC NOISE:<br>• Consider alternative siting of new road networks away from noise sensitive receptors at pre-design stage; and<br>• 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 the NEA TNIA Guideline, 2016 [R-37].<br><br>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 | MITIGATION MEASURES FOR ACMV NOISE:<br>• Noise attenuators and other Best Available Technology (BAT) and Best Environmental Practice (BEP) noise control measures shall be utilized; and<br>• 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.<br><br>MITIGATION MEASURES FOR TRAFFIC NOISE:<br>• 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<br>• Consider alternative siting of roads away from areas with noise sensitive receptors. | Not applicable | Not applicable | Not applicable | Not applicable | Not applicable |

| Environmental Parameter | Environmental Issue | Minimum Control Measures | Mitigation Measures | Monitoring Parameter | Monitoring Locations | Recommended Frequency of Monitoring | Site Responsibility | Triggers[13,14] |
|---|---|---|---|---|---|---|---|---|
| | | later stage to assess noise impacts arising from the operational phase related activities as mandated by law at later stages of the Project. | | | | | | |
| **Vector** | 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/in the development.<br>• Weekly inspections for potential breeding sites should be conducted for areas such as unused containers in open areas and under bushes, open 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;<br>• Fortnightly application of sand granular insecticides gully traps, manhole cover handle depressions, lightning conductor pits, stop-cock pits, valve chambers, and sumps;<br>• 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;<br>• 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;<br>• Fortnightly application of sand granular insecticide to sources of stagnant water in schools and boarding schools (e.g. toilet bowls, cisterns, and gully traps in toilets), during school vacation. | 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/ public committee and other relevant party | Not applicable |

# 12 Conclusion

This section will present the summary of conclusions and recommendations from the assessed potential environmental impacts. The unmitigated impact significance and potential residual impact significance of the assessed environmental aspects are summarised in table below.

**Table 12-1 Summary of potential residual impact significance during construction phase**

| Environmental Parameter | EIA Section | Unmitigated Impact Significance | Key Project Specific Mitigation Measures (if any) | Residual Impact Significance |
|---|---|---|---|---|
| **Biodiversity** | Section 7 | Negligible – Major<br><br>(Major from loss of vegetation, Mortality (Flora), Loss of/ or Reduction in Habitats and Food Sources) | • Avoid the RAC set as future Ecological Corridor that was set by HDB and NParks by setting up hoardings around the perimeter of the proposed development<br>• Restrict entry of site personnel into the RAC/ Ecological Corridor<br>• Set up Tree Protection Zones (TPZs) for any trees that will be retained within the Project site, when needed.<br>• Ensure no works outside of the worksite or agreed working space, especially into the RAC/ Ecological Corridor. This includes additional clearance of vegetation for material storage, access routes, trampling and vegetation damage<br>• Practise due diligence in proper storage and handling of machinery to prevent leeching of oil or harmful materials such as bentonite slurry; store and handle harmful materials well away from waterbodies.<br>• Ensure minimum control measures as well as engineering controls are in place to prevent contamination and siltation into the RAC/ Ecological Corridor.<br>• Ensure any associated slope stabilisation and grading works will not impact topography of areas outside work site and, water quality and hydrology of the waterbodies within the Project site. Care should be taken to prevent siltation into the RAC/ Ecological Corridor.<br>• Conduct regular monitoring to identify any impacts to the RAC/ Ecological Corridor adjacent to the worksite.<br>• Conduct regular inspections to ensure contractor compliance to the EMMP.<br>• Erect Tree Protection Zones (TPZs) to prevent encroachment of construction activities and excessive vegetation clearance | Negligible – Major<br><br>(Major from loss of vegetation, Mortality (Flora), Loss of/or Reduction in Habitats and Food Sources) |

| Environmental Parameter | EIA Section | Unmitigated Impact Significance | Key Project Specific Mitigation Measures (if any) | Residual Impact Significance |
|---|---|---|---|---|
| | | | around retained trees or areas, if any.<br>• Ensure silt fences and other silt control measures along the worksite hoarding are installed and maintained properly.<br>• Install worksite hoardings prior to the start of site clearance; begin installation of hoarding along Woodlands Road.<br>• Carry out directional site clearance from built-up areas towards the conserved area to avoid trapping ground-dwelling fauna within the worksite (Figure 11-7).<br>• Keep an opening in the hoarding when site clearance works are ongoing to allow fauna to exit from the worksite to the north of the Project site on their own. This should be planned and overseen by an Ecologist.<br>• Conduct pre-felling fauna inspections before felling any trees or removing any vegetation.<br>• Conduct detection, rescue, release, and/ or translocation of bamboo bats (*Tylonycteris* spp.) prior to the felling of bamboo clusters,if any. This should be planned and executed by an Ecologist.<br>• Use only fully biodegradable erosion control blankets (ECB) to avoid trapping fossorial fauna such as snakes.<br>• Reduce light spillage into adjacent areas by adopting the measures listed in Section 166:<br>• Train site personnel on biodiversity awareness and actions to take when encountering wildlife.<br>• Formulate a fauna response plan to be executed when trapped/ injured/ dead/ dangerous fauna is found on-site.<br>• Ensure good housekeeping controls such as provision of wildlife-proof bins and eating areas.<br>• Minimise night-time works to prevent disturbances to nocturnal fauna; restrict working hours to 08:00 h –1800 h.<br>• Where night-time works are not avoidable, review construction method statements and site lighting plan with the EMMP Specialist and Ecologist before the commencement of nights works. | |

| Environmental Parameter | EIA Section | Unmitigated Impact Significance | Key Project Specific Mitigation Measures (if any) | Residual Impact Significance |
|---|---|---|---|---|
| | | | | |
| **Water Resources (Hydrology and Water Quality)** | Section 8 | Negligible to Minor | No additional mitigation measures have been proposed. | N.A. |
| **Water Resources (Groundwater Quality and Level)** | Section 8 | Negligible to Minor | No additional mitigation measures have been proposed. | N.A. |
| **Air Quality** | Section 9 | Moderate to Major | • Implement dust control measures e.g. dust screens, etc.<br>• Install hard surfaced haul routes.<br>• Only use cutting, grinding and sawing equipment with dust suppression water spray mechanisms.<br>• Erect hoarding around dusty activities and site boundary min. 1.8 m height in line with BCA guideline.<br>• Impose and signpost maximum speed-limit of 25 km/hr on paved roads and 15 km/hr on unpaved roads and work areas.<br>• No burning of waste allowed on site.<br>• Closed turfing to the exposed areas where possible and maintain proper storage of soil stockpiles.. | Minor |
| **Airborne Noise** | | | | |
| **Ecological Receptors** | Section 10 | Major | • Use equipment with lower noise levels;<br>• Noise barriers (3 m and 12 m height) are proposed to be erected along boundary of worksites facing noise sensitive receptors in order to mitigate the construction noise to the noise sensitive receptors; and<br>• Implement airborne noise monitoring programme as part of EMMP as pre-emptive measures to assess potential impacts arising from uncontrolled/ unpredicted events. | Major |
| **Human Receptors** | | Negligible – Moderate | | Negligible – Moderate |

**Table 12-2 Summary of potential residual impact significance during operational phase**

| Environmental Parameter | EIA Section | Unmitigated Impact Significance | Key Mitigation Measures (if any) | Residual Impact Significance |
|---|---|---|---|---|
| **Biodiversity** | Section 7 | Negligible – Moderate<br><br>(Moderate from Habitat degradation Loss/ reduction of ecological connectivity for faunal movement, Poaching, Light disturbances, Accidental injury or mortality and Human-wildlife conflict) | Design considerations to incorporate during the design stage to reduce impact during operational phase:<br>• Minimise ecological light pollution via in fill planting and vegetation buffers surround the RAC/ Ecological Corridor<br>• Integrate bird-friendly design for buildings and landscaping as well as lighting strategies as part of design strategies<br>• Enhance the RAC/ Ecological Corridor via in-fill planting and vegetation buffers by adopting a native planting palette. This is recommended to be done during pre-construction phase<br>• Enhance terrestrial connectivity by creating ecological bridge at the south of the Project site and fauna underpass along south of Pang Sua Canal<br>• Adopt road calming measures such as speed bumps and speed limits to minimise roadkill accidents.<br><br>Other measures:<br>• Unused areas cleared for works during construction should be replanted.<br>• Use of wildlife-proof bins and proper waste management<br>• Limit human activities in the RAC/ Ecological Corridor<br>• Conduct regular site inspections in the initial phase (recommended first 6 months) to ensure proposed mitigating measures are effective and to monitor usage of propose ecological bridge and fauna underpass<br>• Education sign boards to educate the public on how to identify, interact with, and respond to wildlife and to prevent encroachment into the Ecological Corridor | Negligible – Moderate<br><br>(Moderate from Loss/reduction of ecological connectivity for faunal movement only) |
| **Water Resources (Hydrology and Water Quality)** | Section 8 | Negligible – Minor | No additional mitigation measures have been proposed. | N.A. |
| **Water Resources** | Section 8 | Negligible – Minor | No additional mitigation measures have been proposed. | N.A. |

| Environmental Parameter | EIA Section | Unmitigated Impact Significance | Key Mitigation Measures (if any) | Residual Impact Significance |
|---|---|---|---|---|
| **(Hydrology and Water Quality)** | | | | |
| **Air Quality** | Section 9 | Minor | No additional site-specific mitigation measures to be proposed as the predicted increase in air quality pollutant levels is likely to be insignificant, due to:<br>• Current large traffic volume along existing roads, and thus, any increase in traffic due to the development will not lead to a significant change in air quality.<br>• Continued implementation of increasingly stringent Euro emission standards on new vehicles. | Minor |
| **Airborne Noise** | | | | |
| **Ecological Receptors** | Section 10 | Minor | • Utilize noise attenuators and other Best Available Technology (BAT) and Best Environmental Practice (BEP) to mitigate potential noise from air conditioning and mechanical ventilation (ACMV) systems;<br>• Utilize low speed postings, speed humps, speed limit signages at drop-off points and parking areas to mitigate noise from increased road traffic; and<br>• Consider alternative siting of roads away from areas with noise sensitive receptors.<br><br>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. | Minor |
| **Human Receptors** | | Negligible – Minor | | Negligible – Minor |

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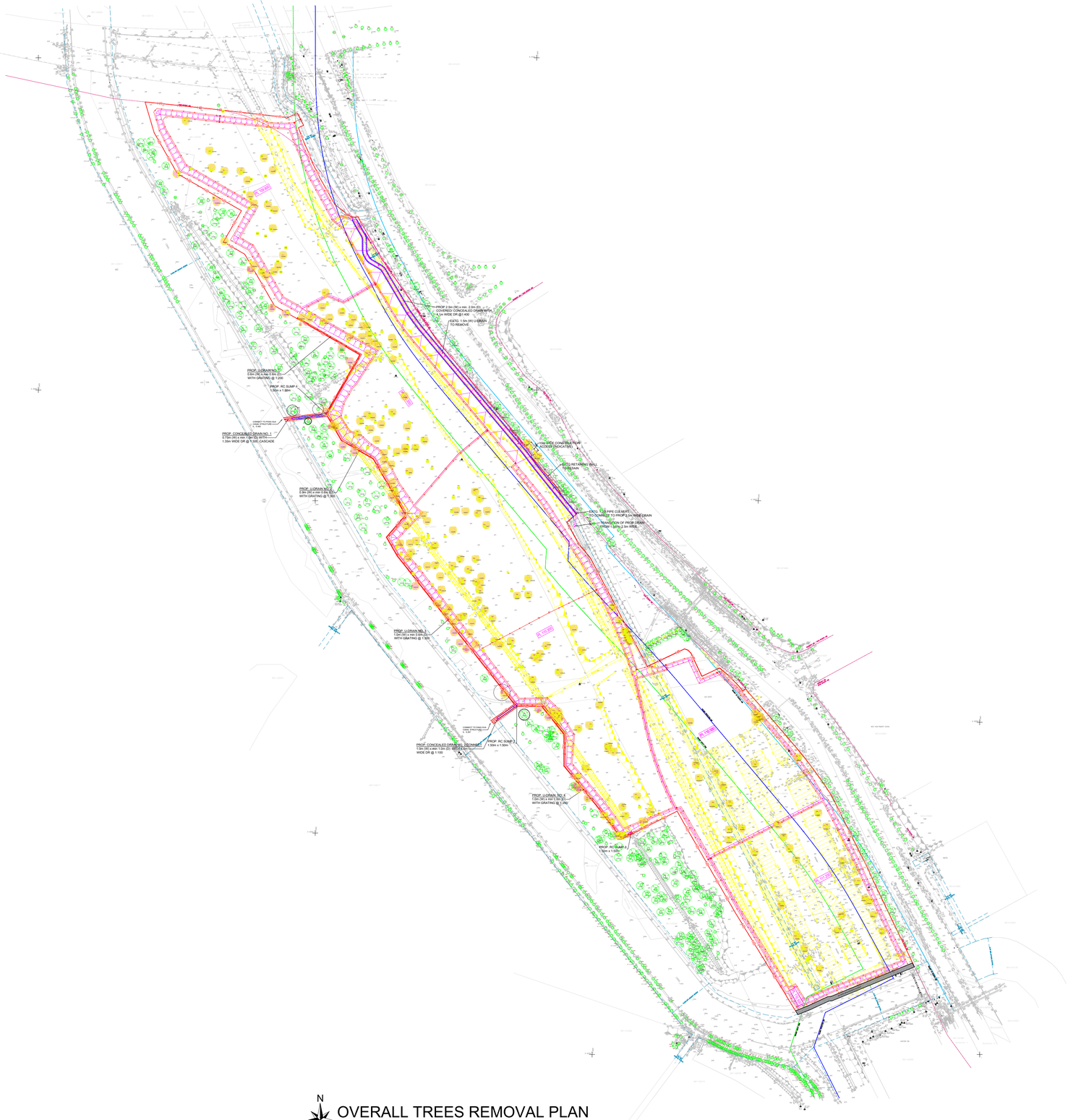
aecom.com

# Appendix B
# Flora and Fauna Management and Monitoring Plan

Delivering a better world

# Appendix B.1
# Tree Felling Plan

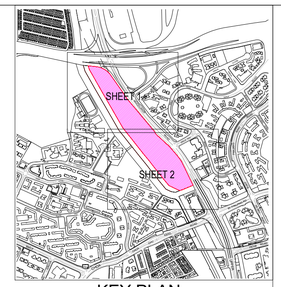
Delivering a better world




N

OVERALL TREES REMOVAL PLAN
SCALE 1:2000

0 10 20 30 40 50 100 Metres
Scale 1:2000




KEY PLAN
SCALE 1:20000

## LEGEND:

- EXISTING SLOPE
- PROPOSED SLOPE
- PROPOSED DRAIN & SUMP
- EXISTING DRAIN TO REMOVE
- PL 110.00 - PROPOSED PLATFORM LEVEL
- XXXX - EXISTING TREES TO REMOVE(UNDER TOL)
- XXXX - EXISTING TREES TO REMOVE
- XXXX - EXISTING TREES TO RETAIN
- PROPOSED NOISE BARRIER (3m height)
- PROPOSED NOISE BARRIER (12m height)
- PROPOSED HOARDING
- ROAD RESERVE LINE
- PROPOSED SILT TRAP
- PROPOSED DRAIN RESERVE
- PROPOSED COVERED DRAIN
- TREE PROTECTION ZONE

## NOTES:

1. THIS DRAWING IS TO READ IN CONJUNCTION WITH OTHER DRAWINGS FOR MORE DETAILS.
2. THE CONTRACTOR TO INFORM SO REP IMMEDIATELY IF ANY DISCREPANCIES FOUND.
3. THE CONTRACTOR TO COORDINATE WITH NPARKS ON TREE REMOVAL ISSUE.
4. TREE REMOVAL IS SUBJECTED TO NPARKS APPROVAL.

FOR SUBMISSION

Project Reference No: E3478-01008-2022

| Rev. | Description | Date | Designed By |
|---|---|---|---|
| | | | |

Qualified Person Endorsement :

PROFESSIONAL ENGINEER
CIVIL
FOO SEE LIM
3478
SINGAPORE

CLIENT:

HOUSING & DEVELOPMENT BOARD

HDB HUB 480 LORONG 6 TOA PAYOH
SINGAPORE 310480

CLIENT SIGNATURE :

DRAWING NO. | REVISION:

PRECINCT NAME : | BUILDING

PROJECT TITLE :

SITE PREPARATION WORKS AT CHOA CHU KANG TOWN N1

LOT NO :
03379L 03370T, 03378C, 02536M, 99761N, 03382V, 03755A, 03537C, 02574L, 02596L, 02537W, 00597C, 02538V, 03900P, 02537C, 02514L, 02538P, 02907W, 02595L, 03512K, 03909M, 03910C, 03914P, 03915A, 02095W, 03827A, 00512K, 00512X, 02531K
01728A

MUKIM NO :
MK 11
MK 14

JOB TITLE :

SITE PREPARATION WORKS AT CHOA CHU KANG TOWN N1

DRAWING TITLE :

OVERALL TREES REMOVAL PLAN

| SCALE : | 1 : 2000 | DATE : | OCT 2023 |
|---|---|---|---|
| DRAWN BY : | LWC | CHECKED BY : | MCL |

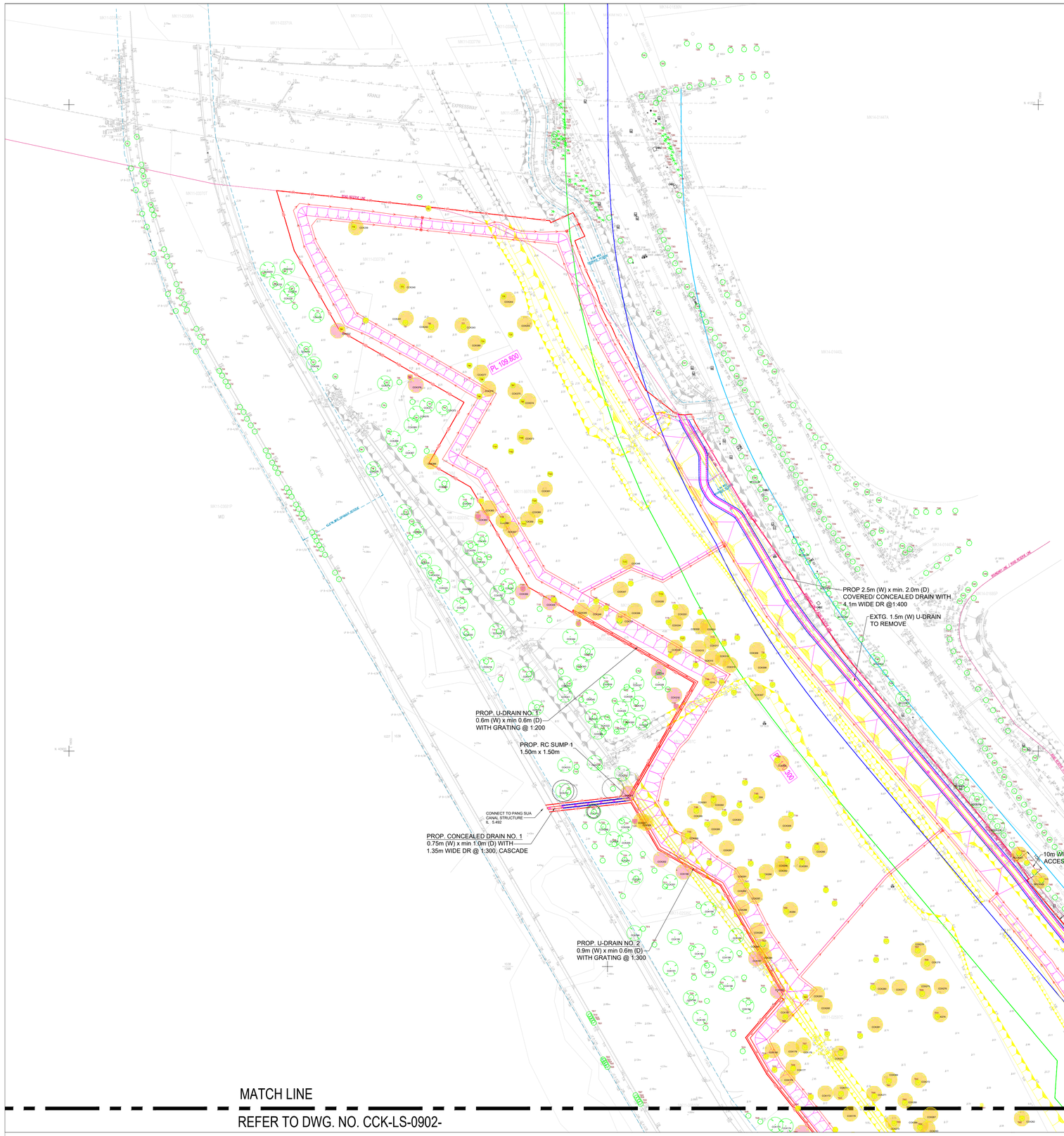
Consultant:

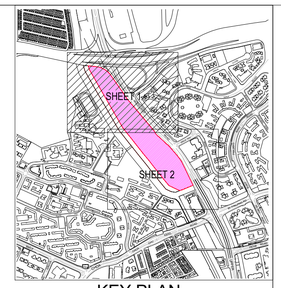
MEINHARDT INFRASTRUCTURE

MEINHARDT INFRASTRUCTURE PTE LTD
168 JALAN BUKIT MERAH,
#12-01 CONNECTION ONE
SINGAPORE 150168
TEL : 63779700 FAX : 63779733

DRAWING NO. 208009-01-F2109-CCK-LS-0900 | REVISION: -

| LWC | FSL |
|---|---|
| DESIGN ENGINEER | QUALIFIED PERSON |




KEY PLAN
SCALE 1:20000

## LEGEND:

- EXISTING SLOPE
- PROPOSED SLOPE
- PROPOSED DRAIN & SUMP
- EXISTING DRAIN TO REMOVE
- PROPOSED PLATFORM LEVEL
- EXISTING TREES TO REMOVE(UNDER TOL)
- EXISTING TREES TO REMOVE
- EXISTING TREES TO RETAIN
- PROPOSED NOISE BARRIER (3m height)
- PROPOSED NOISE BARRIER (12m height)
- PROPOSED HOARDING
- ROAD RESERVE LINE
- PROPOSED SILT TRAP
- PROPOSED DRAIN RESERVE
- PROPOSED COVERED DRAIN
- TREE PROTECTION ZONE

## NOTES:

1. THIS DRAWING IS TO READ IN CONJUNCTION WITH OTHER DRAWINGS FOR MORE DETAILS.
2. THE CONTRACTOR TO INFORM SO REP IMMEDIATELY IF ANY DISCREPANCIES FOUND.
3. THE CONTRACTOR TO COORDINATE WITH NPARKS ON TREE REMOVAL ISSUE.
4. TREE REMOVAL IS SUBJECTED TO NPARKS APPROVAL.

0 5 10 20 50 Metres
Scale 1:1000

N

TREES REMOVAL PLAN
SCALE 1:1000

FOR SUBMISSION

Project Reference No: E3478-01008-2022

| Rev. | Description | Date | Designed By |
|---|---|---|---|
| | | | |

Qualified Person Endorsement :

PROFESSIONAL ENGINEER
CIVIL
FOO SEE LIM
3478
SINGAPORE

CLIENT:

HOUSING & DEVELOPMENT BOARD

HDB HUB 480 LORONG 6 TOA PAYOH
SINGAPORE 310480

CLIENT SIGNATURE :

DRAWING NO. | REVISION:

PRECINCT NAME : | BUILDING

PROJECT TITLE :

SITE PREPARATION WORKS AT CHOA CHU KANG TOWN N1

LOT NO. :
03377N, 03370T, 03378C, 02536M, 99761N, 03382V, 03755A, 02535C, 02534L, 02596L, 02537R, 02597C, 02538V, 03900P, 03902A, 00515M, 02538P, 03904N, 03906L, 03912K, 03908M, 03910C, 03914P, 03916A, 02095W, 03827A, 00510K, 00512X, 02531K
01728A

MUKIM NO :
MK 11
MK 14

JOB TITLE :

SITE PREPARATION WORKS AT CHOA CHU KANG TOWN N1

DRAWING TITLE :

TREES REMOVAL PLAN
(SHEET 1 OF 2)

SCALE : 1 : 1000 | DATE : OCT 2023

DRAWN BY : LWC | CHECKED BY : MCL

Consultant:

MEINHARDT INFRASTRUCTURE

MEINHARDT INFRASTRUCTURE PTE LTD
168 JALAN BUKIT MERAH,
#12-01 CONNECTION ONE
SINGAPORE 150168
TEL : 63779700 FAX : 63779733

DRAWING NO. 208009-01-F2109-CCK-LS-0901 | REVISION: -

LWC
DESIGN ENGINEER

FSL
QUALIFIED PERSON

MATCH LINE

REFER TO DWG. NO. CCK-LS-0901-

PROP. U-DRAIN NO. 3
1.0m (W) x min 0.6m (D)
WITH GRATING @ 1:300

PL 110.300

CONNECT TO PANG SUA CANAL STRUCTURE
IL 6.267

PROP. RC SUMP 2
1.50m x 1.50m

PROP. CONCEALED DRAIN NO. 2 CONNECT
1.0m (W) x min 1.0m (D) WITH 1.6m WIDE DR @ 1:100

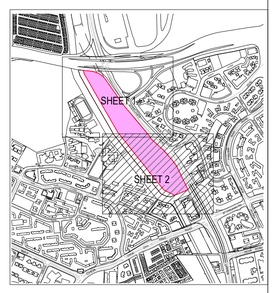
PROP. U-DRAIN NO. 4
1.0m (W) x min 1.0m (D)
WITH GRATING @ 1:200

PL 110.500

PROP. RC SUMP 3
1.50m x 1.50m

PL 111.200

PL 110.350




KEY PLAN
SCALE 1:20000

## LEGEND:

- EXISTING SLOPE
- PROPOSED SLOPE
- PROPOSED DRAIN & SUMP
- EXISTING DRAIN TO REMOVE
- PL 110.00 - PROPOSED PLATFORM LEVEL
- XXXX - EXISTING TREES TO REMOVE(UNDER TOL)
- XXXX - EXISTING TREES TO REMOVE
- XXXX - EXISTING TREES TO RETAIN
- PROPOSED NOISE BARRIER (3m height)
- PROPOSED NOISE BARRIER (12m height)
- PROPOSED HOARDING
- ROAD RESERVE LINE
- PROPOSED SILT TRAP
- PROPOSED DRAIN RESERVE
- PROPOSED COVERED DRAIN
- TREE PROTECTION ZONE

## NOTES:

1. THIS DRAWING IS TO READ IN CONJUNCTION WITH OTHER DRAWINGS FOR MORE DETAILS.
2. THE CONTRACTOR TO INFORM SO REP IMMEDIATELY IF ANY DISCREPANCIES FOUND.
3. THE CONTRACTOR TO COORDINATE WITH NPARKS ON TREE REMOVAL ISSUE.
4. TREE REMOVAL IS SUBJECTED TO NPARKS APPROVAL.

N

TREES REMOVAL PLAN
SCALE 1:1000

0 5 10 20 50 Metres
Scale 1:1000

FOR SUBMISSION

Project Reference No: E3478-01008-2022

| Rev. | Description | Date | Designed By |
|---|---|---|---|
| | | | |

Qualified Person Endorsement :

PROFESSIONAL ENGINEER
CIVIL
FOO SEE LIM
3478
SINGAPORE

CLIENT:

HOUSING & DEVELOPMENT BOARD

HDB HUB 480 LORONG 6 TOA PAYOH
SINGAPORE 310480

CLIENT SIGNATURE :

DRAWING NO. | REVISION:

PRECINCT NAME : | BUILDING

PROJECT TITLE :

SITE PREPARATION WORKS AT CHOA CHU KANG TOWN N1

LOT NO : 03379N, 03370T, 03376C, 02536M, 99761N, 03382V, 03755A, 02535C, 02534L, 02596L, 02537M, 02597C, 02538V, 03909P, 03902A, 00515M, 02539P, 03904N, 03906L, 03912K, 03908M, 03910C, 03914P, 03916A, 02095W, 03827A, 00510K, 00512X, 02531K
01728A

MUKIM NO : MK 11, MK 14

JOB TITLE :

SITE PREPARATION WORKS AT CHOA CHU KANG TOWN N1

DRAWING TITLE :

TREES REMOVAL PLAN
(SHEET 2 OF 2)

SCALE : 1 : 1000 | DATE : OCT 2023

DRAWN BY : LWC | CHECKED BY : MCL

Consultant:

MEINHARDT INFRASTRUCTURE

MEINHARDT INFRASTRUCTURE PTE LTD
168 JALAN BUKIT MERAH,
#12-01 CONNECTION ONE
SINGAPORE 150168
TEL : 63779700 FAX : 63779733

DRAWING NO. 208009-01-F2109-CCK-LS-0902 | REVISION: -

LWC
DESIGN ENGINEER

FSL
QUALIFIED PERSON

| Tag ID | Girth/ spread (m) | Height (m) | *Species* | *Remark* |
|---|---|---|---|---|
| CCK001 | 2.950 | 10.000 | *Samanea saman* | *To Fell* |
| CCK002 | 2.100 | 10.000 | *Mangifera indica* | *To Fell* |
| CCK003 | 1.850 | 9.000 | *Samanea saman* | *To Fell* |
| CCK004 | 1.250 | 10.000 | *Samanea saman* | *To Fell* |
| CCK005 | 3.000 | 10.000 | *Samanea saman* | *To Fell* |
| CCK006 | 2.550 | 10.000 | *Samanea saman* | *To Fell* |
| CCK007 | 3.950 | 11.000 | *Samanea saman* | *To Fell* |
| CCK008 | 3.000 | 10.000 | *Samanea saman* | *To Fell* |
| CCK009 | 2.850 | 10.000 | *Samanea saman* | *To Fell* |
| CCK010 | 1.400 | 8.000 | *Samanea saman* | *To Fell* |
| CCK011 | 1.600 | 8.000 | *Samanea saman* | *To Fell* |
| CCK012 | 2.600 | 9.000 | *Samanea saman* | *To Fell* |
| CCK013 | 2.000 | 7.000 | *Samanea saman* | *To Fell* |
| CCK014 | 2.650 | 7.000 | *Samanea saman* | *To Fell* |
| CCK015 | 1.900 | 10.000 | *Samanea saman* | *To Fell* |
| CCK016 | 0.950 | 6.000 | *Samanea saman* | *To Fell* |
| CCK017 | 2.400 | 9.000 | *Samanea saman* | *To Fell* |
| CCK018 | 1.000 | 9.000 | *Samanea saman* | *To Fell* |
| CCK019 | 2.200 | 9.000 | *Peltophorum pterocarpum* | *To Fell* |
| CCK020 | 1.400 | 9.000 | *Samanea saman* | *To Fell* |
| CCK021 | 1.850 | 8.000 | *Samanea saman* | *To Fell* |
| CCK022 | 4.800 | 11.000 | *Samanea saman* | *To Fell* |
| CCK023 | 2.400 | 9.000 | *Mangifera indica* | *To Fell* |
| CCK024 | 3.350 | 9.000 | *Samanea saman* | *To Fell* |
| CCK025 | 1.300 | 9.000 | *Samanea saman* | *To Fell* |
| CCK026 | 0.700 | 5.000 | *Averrhoa carambola* | *To Fell* |
| CCK027 | 1.100 | 6.000 | *Averrhoa carambola* | *To Fell* |
| CCK028 | 1.000 | 6.000 | *Averrhoa carambola* | *To Fell* |
| CCK029 | 0.700 | 6.000 | *Mangifera indica* | *To Fell* |
| CCK030 | 1.600 | 13.000 | *Mangifera indica* | *To Fell* |
| CCK031 | 1.600 | 12.000 | *Mangifera odorata* | *To Fell* |
| CCK032 | 1.400 | 5.000 | *Averrhoa carambola* | *To Fell* |
| CCK033 | 0.950 | 10.000 | *Pterocarpus indicus* | *To Fell* |
| CCK034 | 1.650 | 14.000 | *Dimocarpus longan subsp. malesianus* | *To Fell* |
| CCK035 | 1.100 | 13.000 | *Dimocarpus longan subsp. malesianus* | *To Fell* |
| CCK036 | 1.800 | 14.000 | *Dimocarpus longan subsp. malesianus* | *To Fell* |
| CCK037 | 2.800 | 10.000 | *Samanea saman* | *To Fell* |
| CCK038 | 3.800 | 12.000 | *Pterocarpus indicus* | *To Fell* |
| CCK039 | 5.200 | 16.000 | *Pterocarpus indicus* | *To Fell* |
| CCK040 | 2.400 | 16.000 | *Terminalia catappa* | *To Fell* |
| CCK041 | 1.100 | 12.000 | *Terminalia catappa* | *To Fell* |
| CCK042 | 1.800 | 12.000 | *Terminalia catappa* | *To Fell* |
| CCK043 | 4.400 | 15.000 | *Samanea saman* | *To Fell* |
| CCK044 | 1.800 | 11.000 | *Syzygium cf. malaccense* | *To Fell* |
| CCK045 | 1.200 | 12.000 | *Nephelium lappaceum* | *To Fell* |
| CCK046 | 1.800 | 15.000 | *Samanea saman* | *To Fell* |
| CCK047 | 2.600 | 15.000 | *Samanea saman* | *To Fell* |
| CCK048 | 3.850 | 15.000 | *Samanea saman* | *To Retain* |
| CCK049 | 3.400 | 15.000 | *Samanea saman* | *To Retain* |
| CCK050 | 1.250 | 12.000 | *Samanea saman* | *To Retain* |
| CCK051 | 1.200 | 13.000 | *Samanea saman* | *To Retain* |
| CCK052 | 3.400 | 15.000 | *Samanea saman* | *To Retain* |
| CCK053 | 2.600 | 15.000 | *Samanea saman* | *To Retain* |
| CCK054 | 1.500 | 15.000 | *Samanea saman* | *To Retain* |
| CCK055 | 2.600 | 15.000 | *Samanea saman* | *To Retain* |
| CCK056 | 1.500 | 11.000 | *Samanea saman* | *To Retain* |
| CCK057 | 2.100 | 15.000 | *Samanea saman* | *To Retain* |
| CCK058 | 2.400 | 14.000 | *Samanea saman* | *To Retain* |
| CCK059 | 2.100 | 13.000 | *Samanea saman* | *To Retain* |
| CCK060 | 2.600 | 15.000 | *Samanea saman* | *To Retain* |
| CCK061 | 1.550 | 15.000 | *Samanea saman* | *To Retain* |
| CCK062 | 3.100 | 15.000 | *Samanea saman* | *To Retain* |
| CCK063 | 1.900 | 15.000 | *Samanea saman* | *To Retain* |
| CCK064 | 2.750 | 15.000 | *Samanea saman* | *To Retain* |
| CCK065 | 0.450 | 6.000 | *Dimocarpus longan subsp. malesianus* | *To Retain* |
| CCK066 | 0.550 | 6.000 | *Dimocarpus longan subsp. malesianus* | *To Retain* |
| CCK067 | 3.500 | 15.000 | *Samanea saman* | *To Retain* |
| CCK068 | 0.750 | 8.000 | *Artocarpus heterophyllus* | *To Retain* |
| CCK069 | 3.050 | 15.000 | *Samanea saman* | *To Retain* |
| CCK070 | 2.200 | 14.000 | *Samanea saman* | *To Retain* |

| Tag ID | Girth/ spread (m) | Height (m) | *Species* | *Remark* |
|---|---|---|---|---|
| CCK071 | 1.450 | 13.000 | *Samanea saman* | *To Retain* |
| CCK072 | 2.500 | 15.000 | *Samanea saman* | *To Retain* |
| CCK073 | 3.300 | 15.000 | *Samanea saman* | *To Retain* |
| CCK074 | 0.900 | 9.000 | *Samanea saman* | *To Retain* |
| CCK075 | 0.550 | 9.000 | *Sandoricum koetjape* | *To Retain* |
| CCK076 | 3.200 | 15.000 | *Samanea saman* | *To Retain* |
| CCK077 | 1.050 | 12.000 | *Artocarpus heterophyllus* | *To Retain* |
| CCK078 | 3.800 | 15.000 | *Samanea saman* | *To Retain* |
| CCK079 | 0.600 | 10.000 | *Mangifera indica* | *To Retain* |
| CCK080 | 3.100 | 15.000 | *Samanea saman* | *To Retain* |
| CCK081 | 2.000 | 12.000 | *Samanea saman* | *To Retain* |
| CCK082 | 3.900 | 15.000 | *Samanea saman* | *To Retain* |
| CCK083 | 2.100 | 13.000 | *Samanea saman* | *To Retain* |
| CCK084 | 1.500 | 8.000 | *Samanea saman* | *To Retain* |
| CCK085 | 0.500 | 8.000 | *Artocarpus integer* | *To Retain* |
| CCK086 | 2.850 | 16.000 | *Samanea saman* | *To Retain* |
| CCK087 | 0.700 | 5.000 | *Artocarpus heterophyllus* | *To Retain* |
| CCK088 | 0.500 | 3.000 | *Artocarpus heterophyllus* | *To Retain* |
| CCK089 | 2.100 | 13.000 | *Samanea saman* | *To Retain* |
| CCK090 | 3.200 | 12.000 | *Samanea saman* | *To Retain* |
| CCK091 | 1.350 | 13.000 | *Samanea saman* | *To Retain* |
| CCK092 | 1.150 | 14.000 | *Samanea saman* | *To Retain* |
| CCK093 | 1.650 | 15.000 | *Samanea saman* | *To Retain* |
| CCK094 | 1.550 | 14.000 | *Samanea saman* | *To Retain* |
| CCK095 | 1.550 | 14.000 | *Samanea saman* | *To Retain* |
| CCK096 | 1.700 | 14.000 | *Samanea saman* | *To Retain* |
| CCK097 | 1.550 | 15.000 | *Samanea saman* | *To Retain* |
| CCK098 | 1.500 | 15.000 | *Samanea saman* | *To Retain* |
| CCK099 | 3.100 | 14.000 | *Samanea saman* | *To Retain* |
| CCK100 | 2.350 | 12.000 | *Samanea saman* | *To Retain* |
| CCK101 | 2.450 | 14.000 | *Samanea saman* | *To Retain* |
| CCK102 | 3.200 | 13.000 | *Samanea saman* | *To Retain* |
| CCK103 | 0.600 | 9.000 | *Durio zibethinus* | *To Retain* |
| CCK104 | 0.900 | 10.000 | *Durio zibethinus* | *To Retain* |
| CCK105 | 2.300 | 12.000 | *Samanea saman* | *To Retain* |
| CCK106 | 2.750 | 12.000 | *Samanea saman* | *To Retain* |
| CCK107 | 4.100 | 14.000 | *Samanea saman* | *To Retain* |
| CCk108 | 1.950 | 12.000 | *Samanea saman* | *To Retain* |
| CCK109 | 0.600 | 9.000 | *Durio zibethinus* | *To Retain* |
| CCK110 | 1.600 | 16.000 | *Durio zibethinus* | *To Retain* |
| CCK111 | 1.100 | 12.000 | *Mangifera indica* | *To Retain* |
| CCK112 | 0.500 | 9.000 | *Durio zibethinus* | *To Retain* |
| CCK113 | 1.300 | 16.000 | *Durio zibethinus* | *To Retain* |
| CCK114 | 1.800 | 13.000 | *Mangifera odorata* | *To Retain* |
| CCK115 | 1.000 | 11.000 | *Nephelium lappaceum* | *To Retain* |
| CCK116 | 3.700 | 14.000 | *Samanea saman* | *To Retain* |
| CCK117 | 3.000 | 15.000 | *Samanea saman* | *To Retain* |
| CCK118 | 1.250 | 13.000 | *Mangifera indica* | *To Fell* |
| CCK119 | 1.100 | 10.000 | *Nephelium lappaceum* | *To Fell* |
| CCK120 | 3.700 | 16.000 | *Artocarpus altilis* | *To Fell* |
| CCK121 | 1.400 | 12.000 | *Artocarpus altilis* | *To Fell* |
| CCK122 | 1.500 | 16.000 | *Durio zibethinus* | *To Retain* |
| CCK123 | 1.250 | 12.000 | *Mangifera indica* | *To Retain* |
| CCK124 | 0.350 | 8.000 | *Mangifera indica* | *To Retain* |
| CCK125 | 2.300 | 15.000 | *Mangifera indica* | *To Retain* |
| CCK126 | 1.400 | 13.000 | *Baccaurea motleyana* | *To Fell* |
| CCK127 | 2.800 | 17.000 | *Durio zibethinus* | *To Fell* |
| CCK128 | 2.050 | 13.000 | *Sandoricum koetjape* | *To Retain* |
| CCK129 | 3.700 | 15.000 | *Samanea saman* | *To Fell* |
| CCK130 | 1.550 | 10.000 | *Nephelium lappaceum* | *To Fell* |
| CCK131 | 1.200 | 14.000 | *Mangifera indica* | *To Fell* |
| CCK132 | 1.700 | 14.000 | *Mangifera indica* | *To Retain* |
| CCK133 | 1.100 | 6.000 | *Artocarpus heterophyllus* | *To Retain* |
| CCK134 | 3.200 | 15.000 | *Samanea saman* | *To Fell* |
| CCK135 | 1.100 | 8.000 | *Artocarpus heterophyllus* | *To Fell* |
| CCK136 | 0.950 | 8.000 | *Artocarpus heterophyllus* | *To Retain* |
| CCK137 | 0.850 | 10.000 | *Canarium odontophyllum* | *To Retain* |
| CCK138 | 1.000 | 6.000 | *Chukrasia tabularis* | *To Retain* |
| CCK139 | 3.700 | 18.000 | *Samanea saman* | *To Retain* |
| CCK140 | 2.700 | 17.000 | *Artocarpus altilis* | *To Retain* |
| CCK141 | 1.650 | 17.000 | *Artocarpus altilis* | *To Retain* |
| CCK142 | 1.800 | 16.000 | *Artocarpus altilis* | *To Retain* |

| Tag ID | Girth/ spread (m) | Height (m) | *Species* | *Remark* |
|---|---|---|---|---|
| CCK143 | 2.900 | 16.000 | *Artocarpus altilis* | *To Retain* |
| CCK144 | 2.600 | 17.000 | *Samanea saman* | *To Retain* |
| CCK145 | 1.900 | 15.000 | *Samanea saman* | *To Retain* |
| CCK146 | 1.100 | 8.000 | *Artocarpus heterophyllus* | *To Retain* |
| CCK147 | 1.700 | 10.000 | *Artocarpus altilis* | *To Retain* |
| CCK148 | 1.950 | 17.000 | *Artocarpus altilis* | *To Fell* |
| CCK149 | 3.700 | 17.000 | *Samanea saman* | *To Fell* |
| CCK150 | 2.800 | 16.000 | *Samanea saman* | *To Retain* |
| CCK151 | 2.600 | 16.000 | *Samanea saman* | *To Retain* |
| CCK152 | 3.900 | 15.000 | *Ficus benjamina* | *To Fell* |
| CCK153 | 5.400 | 15.000 | *Pterocarpus indicus* | *To Retain* |
| CCK154 | 2.950 | 15.000 | *Khaya senegalensis* | *To Fell* |
| CCK155 | 2.850 | 13.000 | *Khaya senegalensis* | *To Fell* |
| CCK156 | 2.500 | 12.000 | *Khaya senegalensis* | *To Fell* |
| CCK157 | 2.300 | 12.000 | *Khaya senegalensis* | *To Fell* |
| CCK158 | 3.200 | 14.000 | *Khaya senegalensis* | *To Retain* |
| CCK159 | 2.200 | 12.000 | *Khaya senegalensis* | *To Fell* |
| CCK160 | 2.200 | 12.000 | *Khaya senegalensis* | *To Fell* |
| CCK161 | 2.900 | 12.000 | *Khaya senegalensis* | *To Fell* |
| CCK162 | 2.850 | 12.000 | *Khaya senegalensis* | *To Fell* |
| CCK163 | 2.600 | 12.000 | *Khaya senegalensis* | *To Fell* |
| CCK164 | 2.300 | 12.000 | *Khaya senegalensis* | *To Fell* |
| CCK165 | 3.500 | 12.000 | *Khaya senegalensis* | *To Fell* |
| CCK166 | 3.700 | 15.000 | *Khaya senegalensis* | *To Fell* |
| CCK167 | 3.200 | 14.000 | *Khaya senegalensis* | *To Fell* |
| CCK168 | 3.200 | 14.000 | *Khaya senegalensis* | *To Fell* |
| CCK169 | 2.400 | 13.000 | *Khaya senegalensis* | *To Fell* |
| CCK170 | 2.900 | 13.000 | *Khaya senegalensis* | *To Fell* |
| CCK171 | 2.300 | 13.000 | *Khaya senegalensis* | *To Fell* |
| CCK172 | 3.400 | 14.000 | *Khaya senegalensis* | *To Fell* |
| CCK173 | 3.200 | 14.000 | *Khaya senegalensis* | *To Fell* |
| CCK174 | 3.400 | 14.000 | *Khaya senegalensis* | *To Retain* |
| CCK175 | 3.000 | 13.000 | *Khaya senegalensis* | *To Retain* |
| CCK176 | 3.050 | 13.000 | *Khaya senegalensis* | *To Fell* |
| CCK177 | 1.500 | 11.000 | *Khaya senegalensis* | *To Fell* |
| CCK178 | 2.750 | 13.000 | *Khaya senegalensis* | *To Fell* |
| CCK179 | 2.500 | 12.000 | *Khaya senegalensis* | *To Fell* |
| CCK180 | 2.000 | 9.000 | *Khaya senegalensis* | *To Fell* |
| CCK181 | 2.900 | 12.000 | *Khaya senegalensis* | *To Fell* |
| CCK182 | 3.400 | 14.000 | *Samanea saman* | *To Fell* |
| CCK183 | 2.700 | 14.000 | *Samanea saman* | *To Fell* |
| CCK184 | 2.550 | 11.000 | *Samanea saman* | *To Retain* |
| CCK185 | 2.200 | 13.000 | *Samanea saman* | *To Retain* |
| CCK186 | 2.200 | 12.000 | *Samanea saman* | *To Retain* |
| CCK187 | 3.200 | 16.000 | *Ficus benjamina* | *To Fell* |
| CCK188 | 2.000 | 12.000 | *Dimocarpus longan subsp. malesianus* | *To Retain* |
| CCK189 | 1.700 | 14.000 | *Samanea saman* | *To Retain* |
| CCK190 | 2.350 | 15.000 | *Samanea saman* | *To Retain* |
| CCK191 | 1.800 | 15.000 | *Samanea saman* | *To Retain* |
| CCK192 | 3.200 | 15.000 | *Samanea saman* | *To Retain* |
| CCK193 | 2.800 | 15.000 | *Samanea saman* | *To Retain* |
| CCK194 | 3.100 | 15.000 | *Samanea saman* | *To Retain* |
| CCK195 | 2.800 | 15.000 | *Samanea saman* | *To Retain* |
| CCK196 | 2.700 | 14.000 | *Samanea saman* | *To Retain* |
| CCK197 | 2.250 | 15.000 | *Samanea saman* | *To Retain* |
| CCK198 | 2.000 | 14.000 | *Mangifera indica* | *To Fell* |
| CCK199 | 2.100 | 15.000 | *Samanea saman* | *To Fell* |
| CCK200 | 2.950 | 14.000 | *Samanea saman* | *To Retain* |
| CCK201 | 2.200 | 12.000 | *Samanea saman* | *To Retain* |
| CCK202 | 2.500 | 13.000 | *Samanea saman* | *To Fell* |
| CCK203 | 2.500 | 13.000 | *Samanea saman* | *To Retain* |
| CCK204 | 1.500 | 7.000 | *Samanea saman* | *To Retain* |
| CCK205 | 1.500 | 14.000 | *Samanea saman* | *To Retain* |
| CCK206 | 2.600 | 14.000 | *Samanea saman* | *To Fell* |
| CCK207 | 2.000 | 14.000 | *Samanea saman* | *To Fell* |
| CCK208 | 1.900 | 14.000 | *Samanea saman* | *To Retain* |
| CCK209 | 2.400 | 12.000 | *Samanea saman* | *To Retain* |
| CCK210 | 1.500 | 12.000 | *Samanea saman* | *To Retain* |
| CCK211 | 2.300 | 12.000 | *Samanea saman* | *To Fell* |
| CCK212 | 2.400 | 14.000 | *Samanea saman* | *To Retain* |
| CCK213 | 3.100 | 14.000 | *Samanea saman* | *To Retain* |
| CCK214 | 2.300 | 14.000 | *Samanea saman* | *To Retain* |

SUBMISSION

| Rev. | Description | Date | Designed By |
|---|---|---|---|
| | | | |

Qualified Person Endorsement :

PROFESSIONAL ENGINEER
CIVIL
FOO SEE LIM
3478
SINGAPORE

CLIENT:

HOUSING & DEVELOPMENT BOARD

HDB HUB 480 LORONG 6 TOA PAYOH
SINGAPORE 310480

CLIENT SIGNATURE :

DRAWING NO. | REVISION:

PRECINCT NAME : | BUILDING

PROJECT TITLE :

SITE PREPARATION WORKS AT CHOA CHU KANG TOWN N1

LOT NO : 03373N, 03370T, 03376C, 02536M, 89761N, 03382V, 03755A, 02539C, 02534L, 02596L, 02577K, 02597C, 02538V, 03905P, 03902A, 00515M, 02539F, 03904N, 03906L, 03912K, 03908M, 03910C, 03914P, 03916A, 02095K, 03827A, 00510K, 00512K, 02531K, 01728A

MUKIM NO : MK 11, MK 14

JOB TITLE :

SITE PREPARATION WORKS AT CHOA CHU KANG TOWN N1

DRAWING TITLE :

TREES TABULATION (SHEET 1 OF 2)

SCALE : 1 : 500 | DATE : JULY 2023

DRAWN BY : LWC | CHECKED BY : GT

Consultant:

MEINHARDT INFRASTRUCTURE

MEINHARDT INFRASTRUCTURE PTE LTD
168 JALAN BUKIT MERAH,
#12-01 CONNECTION ONE
SINGAPORE 150168
TEL : 63779700 FAX : 63779733

DRAWING NO. 208009-01-F2109-CCK-LS-0910 | REVISION: -

LWC
DESIGN ENGINEER

FSL
QUALIFIED PERSON

| Tag ID | Girth/ spread (m) | Height (m) | Species | Remark |
|---|---|---|---|---|
| CCK215 | 2.200 | 12.000 | *Samanea saman* | *To Retain* |
| CCK216 | 3.200 | 14.000 | *Samanea saman* | *To Retain* |
| CCK217 | 2.600 | 10.000 | *Tabebuia rosea* | *To Retain* |
| CCK218 | 3.200 | 10.000 | *Tabebuia rosea* | *To Retain* |
| CCK219 | 3.000 | 10.000 | *Tabebuia rosea* | *To Retain* |
| CCK220 | 2.800 | 10.000 | *Tabebuia rosea* | *To Retain* |
| CCK221 | 2.200 | 10.000 | *Tabebuia rosea* | *To Retain* |
| CCK222 | 3.000 | 10.000 | *Tabebuia rosea* | *To Retain* |
| CCK223 | 3.400 | 10.000 | *Tabebuia rosea* | *To Retain* |
| CCK224 | 1.750 | 10.000 | *Tabebuia rosea* | *To Retain* |
| CCK225 | 1.900 | 9.000 | *Tabebuia rosea* | *To Retain* |
| CCK226 | 1.850 | 10.000 | *Tabebuia rosea* | *To Retain* |
| CCK227 | 2.400 | 10.000 | *Tabebuia rosea* | *To Retain* |
| CCK228 | 3.000 | 8.000 | *Tabebuia rosea* | *To Retain* |
| CCK229 | 2.900 | 9.000 | *Tabebuia rosea* | *To Retain* |
| CCK230 | 2.800 | 9.000 | *Tabebuia rosea* | *To Retain* |
| CCK231 | 3.600 | 13.000 | *Khaya senegalensis* | *To Retain* |
| CCK232 | 2.700 | 13.000 | *Khaya senegalensis* | *To Retain* |
| CCK233 | 3.200 | 13.000 | *Khaya senegalensis* | *To Retain* |
| CCK234 | 3.100 | 12.000 | *Khaya senegalensis* | *To Retain* |
| CCK235 | 2.900 | 9.000 | *Khaya senegalensis* | *To Retain* |
| CCK236 | 1.300 | 9.000 | *Tabebuia rosea* | *To Retain* |
| CCK237 | 3.600 | 10.000 | *Tabebuia rosea* | *To Fell* |
| | | | | |
| CCK239 | 3.800 | 12.000 | *Khaya senegalensis* | *To Fell* |
| CCK240 | 2.900 | 12.000 | *Khaya senegalensis* | *To Fell* |
| CCK241 | 2.450 | 10.000 | *Khaya senegalensis* | *To Fell* |
| CCK242 | 3.400 | 12.000 | *Khaya senegalensis* | *To Fell* |
| CCK243 | 2.600 | 11.000 | *Khaya senegalensis* | *To Fell* |
| CCK244 | 2.700 | 8.000 | *Khaya senegalensis* | *To Fell* |
| CCK245 | 3.000 | 8.000 | *Khaya senegalensis* | *To Fell* |
| CCK246 | 1.400 | 14.000 | *Durio zibethinus* | *To Fell* |
| CCK247 | 2.300 | 8.000 | *Mangifera indica* | *To Fell* |
| CCK248 | 4.500 | 12.000 | *Samanea saman* | *To Fell* |
| CCK249 | 2.400 | 16.000 | *Pterocarpus indicus* | *To Fell* |
| CCK250 | 1.600 | 14.000 | *Pterocarpus indicus* | *To Fell* |
| CCK251 | 2.600 | 12.000 | *Pterocarpus indicus* | *To Fell* |
| CCK252 | 1.050 | 9.000 | *Artocarpus heterophyllus* | *To Fell* |
| CCK253 | 1.600 | 9.000 | *Khaya senegalensis* | *To Fell* |
| CCK254 | 1.350 | 6.000 | *Khaya senegalensis* | *To Fell* |
| CCK255 | 2.200 | 9.000 | *Mangifera indica* | *To Fell* |
| CCK256 | 1.900 | 8.000 | *Mangifera indica* | *To Fell* |
| CCK257 | 2.800 | 14.000 | *Khaya senegalensis* | *To Fell* |
| CCK258 | 3.200 | 14.000 | *Khaya senegalensis* | *To Fell* |
| CCK259 | 2.200 | 10.000 | *Khaya senegalensis* | *To Fell* |
| CCK260 | 1.300 | 8.000 | *Khaya senegalensis* | *To Fell* |
| | | | | |
| CCK262 | 2.400 | 14.000 | *Khaya senegalensis* | *To Fell* |
| CCK263 | 2.400 | 12.000 | *Khaya senegalensis* | *To Fell* |
| CCK264 | 2.500 | 13.000 | *Khaya senegalensis* | *To Fell* |
| CCK265 | 1.000 | 10.000 | *Khaya senegalensis* | *To Fell* |
| CCK266 | 2.100 | 13.000 | *Khaya senegalensis* | *To Fell* |
| CCK267 | 2.000 | 11.000 | *Khaya senegalensis* | *To Fell* |
| CCK268 | 2.800 | 14.000 | *Khaya senegalensis* | *To Fell* |
| CCK269 | 2.300 | 13.000 | *Khaya senegalensis* | *To Fell* |
| CCK270 | 2.050 | 11.000 | *Khaya senegalensis* | *To Fell* |
| CCK271 | 3.100 | 16.000 | *Khaya senegalensis* | *To Fell* |
| CCK272 | 3.200 | 17.000 | *Khaya senegalensis* | *To Fell* |
| CCK273 | 2.850 | 13.000 | *Khaya senegalensis* | *To Fell* |
| CCK274 | 1.400 | 6.000 | *Hura crepitans* | *To Fell* |
| CCK275 | 3.500 | 15.000 | *Khaya senegalensis* | *To Fell* |
| CCK276 | 1.950 | 10.000 | *Khaya senegalensis* | *To Fell* |
| CCK277 | 2.900 | 15.000 | *Khaya senegalensis* | *To Fell* |
| CCK278 | 2.300 | 10.000 | *Khaya senegalensis* | *To Fell* |
| CCK279 | 2.000 | 9.000 | *Khaya senegalensis* | *To Fell* |
| CCK280 | 1.900 | 10.000 | *Khaya senegalensis* | *To Fell* |
| CCK281 | 2.400 | 18.000 | *Khaya senegalensis* | *To Fell* |
| CCK282 | 3.600 | 18.000 | *Khaya senegalensis* | *To Fell* |
| CCK283 | 2.800 | 18.000 | *Khaya senegalensis* | *To Fell* |
| CCK284 | 2.600 | 17.000 | *Khaya senegalensis* | *To Fell* |
| CCK285 | 3.300 | 18.000 | *Khaya senegalensis* | *To Fell* |
| CCK286 | 3.400 | 20.000 | *Khaya senegalensis* | *To Fell* |
| CCK287 | 1.700 | 8.000 | *Khaya senegalensis* | *To Fell* |

| Tag ID | Girth/ spread (m) | Height (m) | Species | Remark |
|---|---|---|---|---|
| | | | | *To Fell* |
| | | | | *To Fell* |
| | | | | *To Fell* |

TREES TABULATION

| Nos | Common Names | Botanical Names | Girth | Height | Spread | Remark |
|---|---|---|---|---|---|---|
| T1 | Fern tree | Filicium decipiens | 0.3 | 3.0 | 1.0 | To Retain |
| T2 | Sea Gutta | Planchonella Obovate | 0.2 | 2.0 | 1.0 | To Retain |
| T3 | Sea Gutta | Planchonella Obovate | 0.3 | 2.0 | 1.0 | To Retain |
| T4 | Fern tree | Filicium decipiens | 0.2 | 2.0 | 1.0 | To Retain |
| T5 | Jambu Kelat | Eugenia Oleina | 0.1 | 2.0 | 1.0 | To Retain |
| T6 | Fern tree | Filicium decipiens | 0.3 | 2.0 | 1.0 | To Retain |
| T7 | Longan | Dimocarpus longan | 0.2 | 3.0 | 1.0 | To Retain |
| T8 | Sea Gutta | Planchonella Obovate | 0.2 | 2.0 | 1.0 | To Retain |
| T9 | Jambu Kelat | Eugenia Oleina | 0.1 | 3.0 | 1.0 | To Retain |
| T10 | Jambu Kelat | Eugenia Oleina | 0.2 | 3.0 | 1.0 | To Retain |
| T11 | Sea Gutta | Planchonella Obovate | 0.2 | 3.0 | 2.0 | To Retain |
| T12 | Fern tree | Filicium decipiens | 0.2 | 3.0 | 2.0 | To Retain |
| T13 | Jambu Kelat | Eugenia Oleina | 0.2 | 3.0 | 1.0 | To Retain |
| T14 | Jambu Kelat | Eugenia Oleina | 0.8 | 3.0 | 1.0 | To Retain |
| T15 | Sugar Apple | Annona squamosa | 0.2 | 4.0 | 1.0 | To Retain |
| T16 | Fern tree | Filicium decipiens | 0.3 | 4.0 | 2.0 | To Retain |
| T17 | Jambu Kelat | Eugenia Oleina | 0.1 | 2.0 | 1.0 | To Retain |
| T18 | Senegal Mahogany | Khaya senegalensis | 0.1 | 2.0 | 1.0 | To Retain |
| T19 | Sea Gutta | Planchonella Obovate | 0.3 | 3.0 | 1.0 | To Retain |
| T20 | Jambu Kelat | Eugenia Oleina | 0.2 | 3.0 | 2.0 | To Retain |
| T21 | Fern tree | Filicium decipiens | 0.3 | 3.0 | 2.0 | To Retain |
| T22 | Jambu Kelat | Eugenia Oleina | 0.1 | 2.0 | 1.0 | To Retain |
| T23 | Gaint Bird of Paradise | Strelitzia Nicolai | 0.1 | 2.0 | 1.0 | To Retain |
| T24 | Sea Gutta | Planchonella Obovate | 0.4 | 3.0 | 1.0 | To Retain |
| T25 | Senegal Mahogany | Khaya senegalensis | 0.2 | 3.0 | 1.0 | To Retain |
| T26 | Senegal Mahogany | Khaya senegalensis | 0.1 | 2.0 | 1.0 | To Retain |
| T27 | Fern tree | Filicium decipiens | 0.3 | 3.0 | 1.0 | To Retain |
| T28 | Sea Gutta | Planchonella Obovate | 0.4 | 3.0 | 2.0 | To Retain |
| T29 | Sea Gutta | Planchonella Obovate | 0.1 | 3.0 | 1.0 | To Retain |
| T30 | Fern tree | Filicium decipiens | 0.2 | 3.0 | 2.0 | To Retain |
| T31 | Jambu Kelat | Eugenia Oleina | 0.1 | 2.0 | 1.0 | To Retain |
| T32 | Jambu Kelat | Eugenia Oleina | 0.2 | 3.0 | 1.0 | To Retain |
| T33 | Jambu Kelat | Eugenia Oleina | 0.1 | 2.0 | 1.0 | To Retain |
| T34 | Jambu Kelat | Eugenia Oleina | 0.2 | 3.0 | 1.0 | To Retain |
| T35 | Fern tree | Filicium decipiens | 0.3 | 3.0 | 2.0 | To Retain |
| T36 | Jambu Kelat | Eugenia Oleina | 0.1 | 2.0 | 1.0 | To Retain |
| T37 | Jambu Kelat | Eugenia Oleina | 0.1 | 2.0 | 1.0 | To Retain |
| T38 | Senegal Mahogany | Khaya senegalensis | 2.3 | 20.0 | 15.0 | To Fell |
| T39 | Fern tree | Filicium decipiens | 0.2 | 3.0 | 1.0 | To Retain |
| T40 | Sea Gutta | Planchonella Obovate | 0.1 | 2.0 | 1.0 | To Retain |
| T41 | Jambu Kelat | Eugenia Oleina | 0.1 | 2.0 | 1.0 | To Retain |
| T42 | Jambu Kelat | Eugenia Oleina | 0.1 | 2.0 | 1.0 | To Retain |
| T43 | Jambu Kelat | Eugenia Oleina | 0.1 | 2.0 | 1.0 | To Retain |
| T44 | Sea Gutta | Planchonella Obovate | 0.1 | 2.0 | 1.0 | To Retain |
| T45 | Jambu Kelat | Eugenia Oleina | 0.2 | 3.0 | 1.0 | To Retain |
| T46 | Jambu Kelat | Eugenia Oleina | 0.1 | 2.0 | 1.0 | To Retain |
| T47 | Jambu Kelat | Eugenia Oleina | 0.3 | 6.0 | 2.0 | To Retain |
| T48 | Neram | Dipterocarpus oblongifolius | 0.3 | 3.0 | 1.0 | To Retain |
| T49 | Jambu Kelat | Eugenia Oleina | 0.2 | 3.0 | 1.0 | To Retain |
| T50 | Jambu Kelat | Eugenia Oleina | 0.2 | 2.0 | 1.0 | To Retain |
| T51 | Jambu Kelat | Eugenia Oleina | 0.1 | 2.0 | 1.0 | To Retain |
| T52 | Jambu Kelat | Eugenia Oleina | 0.1 | 2.0 | 1.0 | To Retain |
| T53 | Jambu Kelat | Eugenia Oleina | 0.1 | 2.0 | 1.0 | To Retain |
| T54 | Jambu Kelat | Eugenia Oleina | 0.1 | 3.0 | 2.0 | To Retain |
| T55 | Jambu Kelat | Eugenia Oleina | 0.1 | 3.0 | 1.0 | To Retain |
| T56 | Jambu Kelat | Eugenia Oleina | 0.2 | 3.0 | 1.0 | To Retain |
| T57 | Jambu Kelat | Eugenia Oleina | 0.2 | 3.0 | 1.0 | To Retain |
| T58 | Chengal Pasir | Hopea odorata | 0.5 | 4.0 | 2.0 | To Retain |
| T59 | Senegal Mahogany | Khaya senegalensis | 2.5 | 25.0 | 18.0 | To Retain |
| T60 | Senegal Mahogany | Khaya senegalensis | 2.6 | 25.0 | 18.0 | To Retain |
| T61 | Senegal Mahogany | Khaya senegalensis | 2.4 | 25.0 | 18.0 | To Retain |
| T62 | Senegal Mahogany | Khaya senegalensis | 2.5 | 25.0 | 18.0 | To Retain |
| T63 | Rosy Trumpet Tree | Tabebuia Rosea | 1.8 | 15.0 | 8.0 | To Retain |
| T64 | Rosy Trumpet Tree | Tabebuia Rosea | 1.9 | 18.0 | 10.0 | To Retain |
| T65 | Rosy Trumpet Tree | Tabebuia Rosea | 2.1 | 15.0 | 8.0 | To Retain |
| T66 | Rosy Trumpet Tree | Tabebuia Rosea | 2.4 | 18.0 | 12.0 | To Fell |
| T67 | Rosy Trumpet Tree | Tabebuia Rosea | 2.2 | 18.0 | 11.0 | To Retain |
| | | | | | | |
| | | | | | | |
| T70 | Senegal Mahogany | Khaya senegalensis | 2.8 | 20.0 | 12.0 | To Fell |
| | | | | | | |
| T72 | Rosy Trumpet Tree | Tabebuia Rosea | 1.2 | 12.0 | 8.0 | To Fell |
| T73 | Senegal Mahogany | Khaya senegalensis | 2.4 | 25.0 | 18.0 | To Fell |
| T74 | Senegal Mahogany | Khaya senegalensis | 2.0 | 20.0 | 12.0 | To Retain |
| T75 | Senegal Mahogany | Khaya senegalensis | 2.2 | 20.0 | 12.0 | To Fell |
| T76 | Senegal Mahogany | Khaya senegalensis | 2.9 | 25.0 | 19.0 | To Fell |
| T77 | Senegal Mahogany | Khaya senegalensis | 2.9 | 25.0 | 18.0 | To Fell |
| T78 | Senegal Mahogany | Khaya senegalensis | 2.8 | 25.0 | 18.0 | To Fell |
| T79 | Senegal Mahogany | Khaya senegalensis | 2.9 | 25.0 | 18.0 | To Fell |
| T80 | Senegal Mahogany | Khaya senegalensis | 2.1 | 25.0 | 18.0 | To Fell |
| T81 | Senegal Mahogany | Khaya senegalensis | 2.2 | 25.0 | 18.0 | To Fell |
| T82 | Rosy Trumpet Tree | Tabebuia Rosea | 1.9 | 15.0 | 8.0 | To Retain |
| | | | | | | |
| T84 | Rosy Trumpet Tree | Tabebuia Rosea | 1.8 | 15.0 | 8.0 | To Fell |
| T85 | Senegal Mahogany | Khaya senegalensis | 2.7 | 25.0 | 18.0 | To Fell |
| T86 | Senegal Mahogany | Khaya senegalensis | 2.7 | 25.0 | 18.0 | To Fell |
| T87 | Senegal Mahogany | Khaya senegalensis | 2.1 | 25.0 | 18.0 | To Fell |
| T88 | Senegal Mahogany | Khaya senegalensis | 2.2 | 25.0 | 19.0 | To Fell |
| T89 | Senegal Mahogany | Khaya senegalensis | 2.3 | 25.0 | 18.0 | To Fell |
| T90 | Senegal Mahogany | Khaya senegalensis | 2.3 | 25.0 | 18.0 | To Retain |
| T91 | Rosy Trumpet Tree | Tabebuia Rosea | 1.3 | 15.0 | 8.0 | To Retain |
| T92 | Rosy Trumpet Tree | Tabebuia Rosea | 2.1 | 15.0 | 8.0 | To Retain |
| | | | | | | |
| T94 | Rosy Trumpet Tree | Tabebuia Rosea | 2.2 | 15.0 | 8.0 | To Retain |
| T95 | Rosy Trumpet Tree | Tabebuia Rosea | 2.2 | 15.0 | 8.0 | To Retain |
| | | | | | | |
| T97 | Rosy Trumpet Tree | Tabebuia Rosea | 2.1 | 12.0 | 8.0 | To Retain |
| T98 | Rosy Trumpet Tree | Tabebuia Rosea | 2.4 | 15.0 | 8.0 | To Retain |
| T99 | Rosy Trumpet Tree | Tabebuia Rosea | 1.4 | 8.0 | 6.0 | To Retain |
| T100 | Senegal Mahogany | Khaya senegalensis | 2.5 | 25.0 | 18.0 | To Fell |
| T101 | Senegal Mahogany | Khaya senegalensis | 2.2 | 25.0 | 18.0 | To Fell |
| T102 | Senegal Mahogany | Khaya senegalensis | 2.5 | 25.0 | 18.0 | To Fell |
| T103 | Senegal Mahogany | Khaya senegalensis | 2.9 | 30.0 | 20.0 | To Fell |
| T104 | Indian Banyan | Ficus benghalensis | 2.5 | 18.0 | 12.0 | To Retain |
| T105 | Rosy Trumpet Tree | Tabebuia Rosea | 1.3 | 15.0 | 8.0 | To Retain |
| T106 | Rosy Trumpet Tree | Tabebuia Rosea | 1.7 | 15.0 | 8.0 | To Fell |
| T107 | Rosy Trumpet Tree | Tabebuia Rosea | 1.4 | 15.0 | 8.0 | To Fell |
| T108 | Senegal Mahogany | Khaya senegalensis | 1.4 | 18.0 | 12.0 | To Fell |
| T109 | Senegal Mahogany | Khaya senegalensis | 1.8 | 18.0 | 12.0 | To Fell |
| T110 | Senegal Mahogany | Khaya senegalensis | 2.0 | 18.0 | 12.0 | To Fell |
| T111 | Senegal Mahogany | Khaya senegalensis | 1.7 | 18.0 | 12.0 | To Fell |
| | | | | | | |
| T113 | Rosy Trumpet Tree | Tabebuia Rosea | 1.2 | 15.0 | 10.0 | To Retain |
| T114 | Rosy Trumpet Tree | Tabebuia Rosea | 2.1 | 15.0 | 10.0 | To Retain |
| T115 | Rosy Trumpet Tree | Tabebuia Rosea | 1.8 | 15.0 | 10.0 | To Retain |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| T119 | Rosy Trumpet Tree | Tabebuia Rosea | 1.4 | 15.0 | 10.0 | To Retain |
| T120 | Rosy Trumpet Tree | Tabebuia Rosea | 1.4 | 15.0 | 10.0 | To Fell |
| T121 | Rosy Trumpet Tree | Tabebuia Rosea | 2.1 | 15.0 | 10.0 | To Retain |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| T125 | Rosy Trumpet Tree | Tabebuia Rosea | 1.3 | 15.0 | 8.0 | To Retain |
| T126 | Rosy Trumpet Tree | Tabebuia Rosea | 2.3 | 15.0 | 8.0 | To Retain |

TREES TABULATION

| Nos | Common Names | Botanical Names | Girth | Height | Spread | Remark |
|---|---|---|---|---|---|---|
| T127 | Rosy Trumpet Tree | Tabebuia Rosea | 2.1 | 15.0 | 8.0 | To Retain |
| T128 | Rosy Trumpet Tree | Tabebuia Rosea | 2.3 | 15.0 | 8.0 | To Retain |
| T129 | Rosy Trumpet Tree | Tabebuia Rosea | 2.4 | 15.0 | 8.0 | To Retain |
| | | | | | | |
| T131 | Rosy Trumpet Tree | Tabebuia Rosea | 2.4 | 15.0 | 8.0 | To Retain |
| T132 | Rosy Trumpet Tree | Tabebuia Rosea | 2.8 | 15.0 | 8.0 | To Retain |
| | | | | | | |
| T134 | Rosy Trumpet Tree | Tabebuia Rosea | 1.8 | 15.0 | 8.0 | To Retain |
| T135 | Rosy Trumpet Tree | Tabebuia Rosea | 1.5 | 15.0 | 10.0 | To Retain |
| T136 | Senegal Mahogany | Khaya senegalensis | 2.4 | 20.0 | 15.0 | To Fell |
| T137 | Rosy Trumpet Tree | Tabebuia Rosea | 1.6 | 15.0 | 7.0 | To Retain |
| T138 | Senegal Mahogany | Khaya senegalensis | 2.2 | 18.0 | 12.0 | To Fell |
| T139 | Senegal Mahogany | Khaya senegalensis | 2.3 | 20.0 | 15.0 | To Fell |
| T140 | Senegal Mahogany | Khaya senegalensis | 0.9 | 12.0 | 8.0 | To Fell |
| T141 | Indian Banyan | Ficus benghalensis | 4.0 | 30.0 | 20.0 | To Fell |
| T142 | Rain Tree | Samanea Saman | 2.0 | 20.0 | 15.0 | To Retain |
| T143 | Rain Tree | Samanea Saman | 2.1 | 20.0 | 15.0 | To Retain |
| T144 | Rain Tree | Samanea Saman | 2.5 | 15.0 | 10.0 | To Retain |
| T145 | Rain Tree | Samanea Saman | 1.6 | 15.0 | 10.0 | To Retain |
| T146 | Rain Tree | Samanea Saman | 2.2 | 18.0 | 12.0 | To Retain |
| T147 | Rain Tree | Samanea Saman | 2.4 | 15.0 | 10.0 | To Retain |
| T148 | Rain Tree | Samanea Saman | 2.2 | 15.0 | 10.0 | To Retain |
| T149 | Rain Tree | Samanea Saman | 2.1 | 15.0 | 10.0 | To Retain |
| T150 | Rain Tree | Samanea Saman | 1.8 | 18.0 | 10.0 | To Retain |
| T151 | Rain Tree | Samanea Saman | 1.8 | 18.0 | 10.0 | To Retain |
| T152 | Rain Tree | Samanea Saman | 1.7 | 18.0 | 10.0 | To Retain |
| T153 | Rain Tree | Samanea Saman | 2.1 | 15.0 | 8.0 | To Retain |
| T154 | Rain Tree | Samanea Saman | 2.0 | 12.0 | 7.0 | To Retain |
| T155 | Rain Tree | Samanea Saman | 1.8 | 15.0 | 10.0 | To Retain |
| | | | | | | |
| T157 | Rain Tree | Samanea Saman | 2.1 | 15.0 | 10.0 | To Retain |
| T158 | Rain Tree | Samanea Saman | 1.6 | 18.0 | 5.0 | To Retain |
| T159 | Rain Tree | Samanea Saman | 1.6 | 18.0 | 6.0 | To Retain |
| T160 | Rain Tree | Samanea Saman | 2.4 | 15.0 | 10.0 | To Retain |
| T161 | Rain Tree | Samanea Saman | 1.6 | 15.0 | 8.0 | To Retain |
| T162 | Rain Tree | Samanea Saman | 1.7 | 15.0 | 8.0 | To Retain |
| T163 | Rain Tree | Samanea Saman | 1.2 | 15.0 | 6.0 | To Retain |
| T164 | Rain Tree | Samanea Saman | 1.3 | 12.0 | 6.0 | To Retain |
| T165 | Rain Tree | Samanea Saman | 2.1 | 18.0 | 10.0 | To Retain |
| T166 | Rain Tree | Samanea Saman | 2.2 | 15.0 | 10.0 | To Fell |
| T167 | Rain Tree | Samanea Saman | 1.8 | 15.0 | 6.0 | To Fell |
| T168 | Senegal Mahogany | Khaya senegalensis | 2.2 | 20.0 | 15.0 | To Fell |
| T169 | Senegal Mahogany | Khaya senegalensis | 1.8 | 20.0 | 15.0 | To Fell |
| T170 | Senegal Mahogany | Khaya senegalensis | 1.7 | 20.0 | 15.0 | To Fell |
| T171 | Senegal Mahogany | Khaya senegalensis | 2.4 | 20.0 | 15.0 | To Fell |
| T172 | Senegal Mahogany | Khaya senegalensis | 1.6 | 18.0 | 20.0 | To Fell |
| T173 | Senegal Mahogany | Khaya senegalensis | 2.5 | 18.0 | 12.0 | To Fell |
| T174 | Senegal Mahogany | Khaya senegalensis | 2.4 | 18.0 | 15.0 | To Fell |
| T175 | Senegal Mahogany | Khaya senegalensis | 1.6 | 15.0 | 6.0 | To Fell |
| T176 | Senegal Mahogany | Khaya senegalensis | 1.6 | 15.0 | 6.0 | To Fell |
| T177 | Senegal Mahogany | Khaya senegalensis | 1.4 | 15.0 | 8.0 | To Fell |
| T178 | Senegal Mahogany | Khaya senegalensis | 2.6 | 20.0 | 15.0 | To Fell |
| T179 | Senegal Mahogany | Khaya senegalensis | 0.9 | 8.0 | 5.0 | To Fell |
| T180 | Senegal Mahogany | Khaya senegalensis | 2.0 | 20.0 | 12.0 | To Fell |
| T181 | Senegal Mahogany | Khaya senegalensis | 2.3 | 20.0 | 15.0 | To Fell |
| T182 | Kayu Manis | Cinnamomum verum | 0.5 | 6.0 | 3.0 | To Fell |
| T183 | Senegal Mahogany | Khaya senegalensis | 2.4 | 25.0 | 18.0 | To Fell |
| T184 | Senegal Mahogany | Khaya senegalensis | 2.8 | 25.0 | 18.0 | To Fell |
| T185 | Senegal Mahogany | Khaya senegalensis | 2.3 | 25.0 | 15.0 | To Fell |
| T186 | Senegal Mahogany | Khaya senegalensis | 2.4 | 25.0 | 15.0 | To Fell |
| T187 | Senegal Mahogany | Khaya senegalensis | 2.9 | 25.0 | 18.0 | To Fell |
| T188 | Senegal Mahogany | Khaya senegalensis | 2.1 | 25.0 | 15.0 | To Fell |
| T189 | Senegal Mahogany | Khaya senegalensis | 2.5 | 25.0 | 18.0 | To Fell |
| T190 | Senegal Mahogany | Khaya senegalensis | 2.1 | 25.0 | 15.0 | To Fell |
| T191 | Senegal Mahogany | Khaya senegalensis | 2.3 | 25.0 | 18.0 | To Fell |
| | | | | | | |
| T193 | Senegal Mahogany | Khaya senegalensis | 2.3 | 25.0 | 15.0 | To Fell |
| T194 | Senegal Mahogany | Khaya senegalensis | 2.6 | 25.0 | 15.0 | To Fell |
| T195 | Senegal Mahogany | Khaya senegalensis | 2.1 | 20.0 | 12.0 | To Fell |
| T196 | Senegal Mahogany | Khaya senegalensis | 1.8 | 20.0 | 12.0 | To Fell |
| T197 | Senegal Mahogany | Khaya senegalensis | 2.2 | 20.0 | 12.0 | To Fell |
| T198 | Senegal Mahogany | Khaya senegalensis | 1.8 | 20.0 | 12.0 | To Fell |
| T199 | Senegal Mahogany | Khaya senegalensis | 2.4 | 20.0 | 12.0 | To Fell |
| T200 | Senegal Mahogany | Khaya senegalensis | 2.2 | 20.0 | 12.0 | To Fell |
| T201 | Rain Tree | Samanea Saman | 1.3 | 12.0 | 7.0 | To Retain |
| T202 | Rain Tree | Samanea Saman | 1.8 | 18.0 | 10.0 | To Retain |
| T203 | Rain Tree | Samanea Saman | 1.1 | 15.0 | 8.0 | To Retain |
| T204 | Rain Tree | Samanea Saman | 1.8 | 15.0 | 8.0 | To Retain |
| T205 | Rain Tree | Samanea Saman | 1.7 | 15.0 | 8.0 | To Fell |
| T206 | Rain Tree | Samanea Saman | 1.3 | 15.0 | 8.0 | To Retain |
| T207 | Rain Tree | Samanea Saman | 2.0 | 18.0 | 10.0 | To Retain |
| T208 | Rain Tree | Samanea Saman | 1.3 | 15.0 | 8.0 | To Retain |
| T209 | Rain Tree | Samanea Saman | 1.8 | 15.0 | 8.0 | To Retain |
| T210 | Rain Tree | Samanea Saman | 1.7 | 15.0 | 8.0 | To Retain |
| T211 | Rain Tree | Samanea Saman | 1.6 | 15.0 | 8.0 | To Retain |
| | | | | | | |
| T213 | Rosy Trumpet Tree | Tabebuia Rosea | 0.6 | 5.0 | 2.0 | To Retain |
| | | | | | | |
| T215 | Rain Tree | Samanea Saman | 0.6 | 6.0 | 4.0 | To Retain |
| T216 | Golden Cane Plam | Dypsis lutescens | Cluster | 6.0 | 2.0 | To Retain |
| T217 | Golden Cane Plam | Dypsis lutescens | Cluster | 6.0 | 2.0 | To Retain |
| T218 | Golden Cane Plam | Dypsis lutescens | Cluster | 6.0 | 2.0 | To Retain |
| T219 | Golden Cane Plam | Dypsis lutescens | Cluster | 6.0 | 2.0 | To Retain |
| T220 | Golden Cane Plam | Dypsis lutescens | Cluster | 6.0 | 2.0 | To Retain |
| T221 | Golden Cane Plam | Dypsis lutescens | Cluster | 6.0 | 2.0 | To Retain |
| T222 | Golden Cane Plam | Dypsis lutescens | Cluster | 6.0 | 2.0 | To Retain |
| T223 | Golden Cane Plam | Dypsis lutescens | Cluster | 6.0 | 2.0 | To Retain |
| T224 | Golden Cane Plam | Dypsis lutescens | Cluster | 6.0 | 2.0 | To Retain |
| T225 | Golden Cane Plam | Dypsis lutescens | Cluster | 6.0 | 2.0 | To Retain |
| T226 | Golden Cane Plam | Dypsis lutescens | Cluster | 6.0 | 2.0 | To Retain |
| T227 | Golden Cane Plam | Dypsis lutescens | Cluster | 6.0 | 2.0 | To Retain |
| T228 | Golden Cane Plam | Dypsis lutescens | Cluster | 6.0 | 2.0 | To Retain |
| T229 | Golden Cane Plam | Dypsis lutescens | Cluster | 6.0 | 2.0 | To Retain |
| T230 | Golden Cane Plam | Dypsis lutescens | Cluster | 6.0 | 2.0 | To Retain |
| T231 | Golden Cane Plam | Dypsis lutescens | Cluster | 6.0 | 2.0 | To Retain |
| T232 | Golden Cane Plam | Dypsis lutescens | Cluster | 6.0 | 2.0 | To Retain |
| T233 | Golden Cane Plam | Dypsis lutescens | Cluster | 6.0 | 2.0 | To Retain |
| T234 | Golden Cane Plam | Dypsis lutescens | Cluster | 6.0 | 2.0 | To Retain |
| T235 | Golden Cane Plam | Dypsis lutescens | Cluster | 6.0 | 2.0 | To Retain |
| T236 | Golden Cane Plam | Dypsis lutescens | Cluster | 6.0 | 2.0 | To Retain |
| T237 | Golden Cane Plam | Dypsis lutescens | Cluster | 6.0 | 2.0 | To Retain |
| T238 | Golden Cane Plam | Dypsis lutescens | Cluster | 6.0 | 2.0 | To Retain |
| T239 | Golden Cane Plam | Dypsis lutescens | Cluster | 6.0 | 2.0 | To Retain |
| T240 | Neram | Dipterocarpus oblongifolius | 0.2 | 4.0 | 1.0 | To Retain |
| T241 | Macarthur Palm | Ptychosperma macarthurii | Cluster | 6.0 | 2.0 | To Retain |
| T242 | Macarthur Palm | Ptychosperma macarthurii | Cluster | 6.0 | 2.0 | To Retain |
| T243 | Macarthur Palm | Ptychosperma macarthurii | Cluster | 6.0 | 2.0 | To Retain |
| T244 | Macarthur Palm | Ptychosperma macarthurii | Cluster | 6.0 | 2.0 | To Retain |
| T245 | Macarthur Palm | Ptychosperma macarthurii | Cluster | 6.0 | 2.0 | To Retain |
| T246 | Macarthur Palm | Ptychosperma macarthurii | Cluster | 6.0 | 2.0 | To Retain |
| T247 | Macarthur Palm | Ptychosperma macarthurii | Cluster | 6.0 | 2.0 | To Retain |
| T248 | Macarthur Palm | Ptychosperma macarthurii | Cluster | 6.0 | 2.0 | To Retain |
| T249 | African Mahogany | Khaya grandifoliola | 1.3 | 15.0 | 8.0 | To Retain |
| T250 | Macarthur Palm | Ptychosperma macarthurii | Cluster | 6.0 | 2.0 | To Retain |
| T251 | Macarthur Palm | Ptychosperma macarthurii | Cluster | 6.0 | 2.0 | To Retain |
| T252 | Macarthur Palm | Ptychosperma macarthurii | Cluster | 6.0 | 2.0 | To Retain |

TREES TABULATION

| Nos | Common Names | Botanical Names | Girth | Height | Spread | Remark |
|---|---|---|---|---|---|---|
| T253 | Macarthur Palm | Ptychosperma macarthurii | Cluster | 6.0 | 2.0 | To Retain |
| T254 | Macarthur Palm | Acacia mangium | Cluster | 6.0 | 2.0 | To Retain |
| T255 | Macarthur Palm | Acacia mangium | Cluster | 6.0 | 2.0 | To Retain |
| T256 | Macarthur Palm | Acacia mangium | Cluster | 6.0 | 2.0 | To Retain |
| T257 | African Mahogany | Khaya grandifoliola | 2.0 | 15.0 | 10.0 | To Retain |
| T258 | African Oil Palm | Elaeis guineensis | 1.5 | 8.0 | 3.0 | To Retain |
| T259 | African Mahogany | Khaya grandifoliola | 2.1 | 15.0 | 10.0 | To Retain |
| T260 | African Mahogany | Khaya grandifoliola | 1.9 | 15.0 | 10.0 | To Retain |
| T261 | Rain Tree | Samanea Saman | 0.6 | 6.0 | 4.0 | To Retain |
| T262 | Rain Tree | Samanea Saman | 0.7 | 6.0 | 4.0 | To Retain |
| T263 | Kelumpang | Sterculia Foetida | 0.3 | 4.0 | 2.0 | To Retain |
| T264 | Kelumpang | Sterculia Foetida | 0.3 | 4.0 | 2.0 | To Retain |
| T265 | Kelumpang | Sterculia Foetida | 0.3 | 4.0 | 2.0 | To Retain |
| T266 | Kelumpang | Sterculia Foetida | 0.3 | 4.0 | 2.0 | To Retain |
| T267 | Kelumpang | Sterculia Foetida | 0.3 | 4.0 | 2.0 | To Retain |
| T268 | Kelumpang | Sterculia Foetida | 0.3 | 4.0 | 2.0 | To Retain |
| T269 | Kelumpang | Sterculia Foetida | 0.3 | 5.0 | 2.0 | To Retain |
| T270 | Rosy Trumpet Tree | Tabebuia Rosea | 1.1 | 8.0 | 5.0 | To Retain |
| T271 | Kelumpang | Sterculia Foetida | 0.3 | 5.0 | 2.0 | To Retain |
| T272 | Kelumpang | Sterculia Foetida | 0.3 | 5.0 | 2.0 | To Retain |
| T273 | Kelumpang | Sterculia Foetida | 0.3 | 5.0 | 2.0 | To Retain |
| T274 | Kelumpang | Sterculia Foetida | 0.3 | 5.0 | 2.0 | To Retain |
| T275 | Kelumpang | Sterculia Foetida | 0.3 | 5.0 | 2.0 | To Retain |
| T276 | Kelumpang | Sterculia Foetida | 0.3 | 5.0 | 2.0 | To Retain |
| T277 | Kelumpang | Sterculia Foetida | 0.3 | 5.0 | 2.0 | To Retain |
| T278 | Kelumpang | Sterculia Foetida | 0.3 | 5.0 | 2.0 | To Retain |
| T279 | Kelumpang | Sterculia Foetida | 0.3 | 5.0 | 2.0 | To Retain |
| T280 | Golden Cane Plam | Dypsis lutescens | Cluster | 6.0 | 2.0 | To Retain |
| T281 | Golden Cane Plam | Dypsis lutescens | Cluster | 6.0 | 2.0 | To Retain |
| T282 | Golden Cane Plam | Dypsis lutescens | Cluster | 6.0 | 2.0 | To Retain |
| T283 | Golden Cane Plam | Dypsis lutescens | Cluster | 6.0 | 2.0 | To Retain |
| T284 | Golden Cane Plam | Dypsis lutescens | Cluster | 6.0 | 2.0 | To Retain |
| T285 | Golden Cane Plam | Dypsis lutescens | Cluster | 6.0 | 2.0 | To Retain |
| T286 | Golden Cane Plam | Dypsis lutescens | Cluster | 6.0 | 2.0 | To Retain |
| T287 | Golden Cane Plam | Dypsis lutescens | Cluster | 6.0 | 2.0 | To Retain |
| T288 | Golden Cane Plam | Dypsis lutescens | Cluster | 6.0 | 2.0 | To Retain |
| T289 | Golden Cane Plam | Dypsis lutescens | Cluster | 6.0 | 2.0 | To Retain |
| T290 | Golden Cane Plam | Dypsis lutescens | Cluster | 6.0 | 2.0 | To Retain |
| T291 | Golden Cane Plam | Dypsis lutescens | Cluster | 6.0 | 2.0 | To Retain |
| T292 | Golden Cane Plam | Dypsis lutescens | Cluster | 6.0 | 2.0 | To Retain |
| T293 | Golden Cane Plam | Dypsis lutescens | Cluster | 6.0 | 2.0 | To Retain |
| T294 | Golden Cane Plam | Dypsis lutescens | Cluster | 6.0 | 2.0 | To Retain |
| T295 | Golden Cane Plam | Dypsis lutescens | Cluster | 6.0 | 2.0 | To Retain |
| T296 | Golden Cane Plam | Dypsis lutescens | Cluster | 6.0 | 2.0 | To Retain |
| T297 | Golden Cane Plam | Dypsis lutescens | Cluster | 6.0 | 2.0 | To Retain |
| T298 | Golden Cane Plam | Dypsis lutescens | Cluster | 6.0 | 2.0 | To Retain |
| T299 | Cotton Tree | Ceiba pentandra | 0.2 | 4.0 | 1.0 | To Retain |
| T300 | River Tristania | Tristaniopsis Whiteana | 0.2 | 4.0 | 1.0 | To Retain |
| T301 | River Tristania | Tristaniopsis Whiteana | 0.2 | 4.0 | 1.0 | To Retain |
| T302 | Chengal Pasir | Hopea odorata | 0.2 | 4.0 | 1.0 | To Retain |
| T303 | River Tristania | Tristaniopsis Whiteana | 0.2 | 3.0 | 1.0 | To Retain |
| T304 | Chengal Pasir | Hopea odorata | 0.2 | 4.0 | 1.0 | To Retain |
| T305 | River Tristania | Tristaniopsis Whiteana | 0.2 | 3.0 | 1.0 | To Retain |
| T306 | Chengal Pasir | Hopea odorata | 0.2 | 4.0 | 1.0 | To Retain |
| T307 | River Tristania | Tristaniopsis Whiteana | 0.2 | 3.0 | 1.0 | To Retain |
| T308 | Chengal Pasir | Hopea odorata | 0.2 | 4.0 | 1.0 | To Retain |
| T309 | River Tristania | Tristaniopsis Whiteana | 0.2 | 3.0 | 1.0 | To Retain |
| T310 | African Mahogany | Khaya grandifoliola | 1.1 | 12.0 | 8.0 | To Retain |
| T311 | River Tristania | Tristaniopsis Whiteana | 0.2 | 4.0 | 1.0 | To Retain |
| T312 | Rain Tree | Samanea Saman | 0.7 | 7.0 | 4.0 | To Retain |
| T313 | River Tristania | Tristaniopsis Whiteana | 0.2 | 4.0 | 1.0 | To Retain |
| T314 | River Tristania | Tristaniopsis Whiteana | 0.2 | 4.0 | 1.0 | To Retain |
| T315 | Rain Tree | Samanea Saman | 0.6 | 7.0 | 4.0 | To Retain |
| T316 | Chengal Pasir | Hopea odorata | 0.2 | 4.0 | 1.0 | To Retain |
| T317 | River Tristania | Tristaniopsis Whiteana | 0.2 | 3.0 | 1.0 | To Retain |
| T318 | Chengal Pasir | Hopea odorata | 0.2 | 4.0 | 1.0 | To Retain |
| T319 | River Tristania | Tristaniopsis Whiteana | 0.2 | 3.0 | 1.0 | To Retain |
| T320 | Chengal Pasir | Hopea odorata | 0.2 | 4.0 | 1.0 | To Retain |
| T321 | African Mahogany | Khaya grandifoliola | 1.3 | 12.0 | 8.0 | To Retain |
| T322 | River Tristania | Tristaniopsis Whiteana | 0.2 | 3.0 | 1.0 | To Retain |
| T323 | River Tristania | Tristaniopsis Whiteana | 0.2 | 3.0 | 1.0 | To Retain |
| T324 | River Tristania | Tristaniopsis Whiteana | 0.2 | 3.0 | 1.0 | To Retain |
| T325 | Chengal Pasir | Hopea odorata | 0.2 | 4.0 | 1.0 | To Retain |
| T326 | River Tristania | Tristaniopsis Whiteana | 0.2 | 3.0 | 1.0 | To Retain |
| T327 | Chengal Pasir | Hopea odorata | 0.2 | 4.0 | 1.0 | To Retain |
| T328 | Chengal Pasir | Hopea odorata | 0.2 | 4.0 | 1.0 | To Retain |
| T329 | Rain Tree | Samanea Saman | 0.7 | 7.0 | 4.0 | To Retain |
| T330 | River Tristania | Tristaniopsis Whiteana | 0.2 | 4.0 | 1.0 | To Retain |
| T332 | River Tristania | Tristaniopsis Whiteana | 0.2 | 4.0 | 1.0 | To Retain |
| T333 | Rain Tree | Samanea Saman | 0.6 | 6.0 | 4.0 | To Retain |
| T334 | River Tristania | Tristaniopsis Whiteana | 0.2 | 4.0 | 1.0 | To Retain |
| T335 | River Tristania | Tristaniopsis Whiteana | 0.2 | 4.0 | 1.0 | To Retain |
| T336 | Rain Tree | Samanea Saman | 0.6 | 6.0 | 4.0 | To Retain |
| T337 | River Tristania | Tristaniopsis Whiteana | 0.2 | 3.0 | 1.0 | To Retain |
| T338 | River Tristania | Tristaniopsis Whiteana | 0.2 | 3.0 | 1.0 | To Retain |
| T339 | River Tristania | Tristaniopsis Whiteana | 0.2 | 3.0 | 1.0 | To Retain |
| T340 | Chengal Pasir | Hopea odorata | 0.2 | 4.0 | 1.0 | To Retain |
| T341 | River Tristania | Tristaniopsis Whiteana | 0.2 | 3.0 | 1.0 | To Retain |
| T342 | Chengal Pasir | Hopea odorata | 0.2 | 4.0 | 1.0 | To Retain |
| T343 | River Tristania | Tristaniopsis Whiteana | 0.2 | 3.0 | 1.0 | To Retain |
| T344 | Chengal Pasir | Hopea odorata | 0.2 | 4.0 | 1.0 | To Retain |
| T345 | River Tristania | Tristaniopsis Whiteana | 0.2 | 3.0 | 1.0 | To Retain |
| T346 | Chengal Pasir | Hopea odorata | 0.2 | 4.0 | 1.0 | To Retain |
| T347 | River Tristania | Tristaniopsis Wh

TREES TABULATION

| Nos | Common Names | Botanical Names | Girth | Height | Spread | Remark |
|---|---|---|---|---|---|---|
| T631 | Senegal Mahogany | Khaya senegalensis | 2.3 | 20.0 | 15.0 | To Fell |
| T632 | Senegal Mahogany | Khaya senegalensis | 2.4 | 20.0 | 15.0 | To Fell |
| T633 | Senegal Mahogany | Khaya senegalensis | 2.1 | 20.0 | 15.0 | To Retain |
| T634 | Senegal Mahogany | Khaya senegalensis | 2.2 | 20.0 | 15.0 | To Fell |
| T635 | Senegal Mahogany | Khaya senegalensis | 2.4 | 20.0 | 15.0 | To Fell |
| T636 | Senegal Mahogany | Khaya senegalensis | 1.8 | 20.0 | 15.0 | To Fell |
| T637 | Senegal Mahogany | Khaya senegalensis | 2.2 | 20.0 | 15.0 | To Fell |
| T638 | Senegal Mahogany | Khaya senegalensis | 2.2 | 20.0 | 15.0 | To Fell |
| T639 | Senegal Mahogany | Khaya senegalensis | 2.2 | 18.0 | 12.0 | To Fell |
| T640 | Senegal Mahogany | Khaya senegalensis | 2.2 | 18.0 | 12.0 | To Fell |
| T641 | Senegal Mahogany | Khaya senegalensis | 2.1 | 20.0 | 15.0 | To Fell |
| T642 | Senegal Mahogany | Khaya senegalensis | 2.1 | 18.0 | 10.0 | To Fell |
| T643 | Senegal Mahogany | Khaya senegalensis | 2.3 | 20.0 | 15.0 | To Fell |
| T644 | Senegal Mahogany | Khaya senegalensis | 2.3 | 20.0 | 15.0 | To Fell |
| T645 | Senegal Mahogany | Khaya senegalensis | 2.4 | 25.0 | 15.0 | To Fell |
| T646 | Senegal Mahogany | Khaya senegalensis | 2.3 | 25.0 | 15.0 | To Fell |
| T647 | Senegal Mahogany | Khaya senegalensis | 2.5 | 25.0 | 15.0 | To Fell |
| T648 | Senegal Mahogany | Khaya senegalensis | 2.5 | 25.0 | 15.0 | To Retain |
| T649 | Senegal Mahogany | Khaya senegalensis | 2.5 | 25.0 | 15.0 | To Retain |
| T650 | Senegal Mahogany | Khaya senegalensis | 2.4 | 25.0 | 15.0 | To Retain |
| T651 | Senegal Mahogany | Khaya senegalensis | 2.4 | 25.0 | 15.0 | To Fell |
| T652 | Senegal Mahogany | Khaya senegalensis | 2.3 | 25.0 | 15.0 | To Fell |
| T653 | Senegal Mahogany | Khaya senegalensis | 2.3 | 25.0 | 15.0 | To Fell |
| T654 | Senegal Mahogany | Khaya senegalensis | 2.3 | 20.0 | 15.0 | To Fell |
| T655 | Senegal Mahogany | Khaya senegalensis | 2.1 | 20.0 | 15.0 | To Fell |
| T656 | Senegal Mahogany | Khaya senegalensis | 2.2 | 25.0 | 15.0 | To Retain |
| T657 | Senegal Mahogany | Khaya senegalensis | 2.1 | 25.0 | 15.0 | To Fell |
| T658 | Senegal Mahogany | Khaya senegalensis | 2.2 | 20.0 | 15.0 | To Fell |
| T659 | Senegal Mahogany | Khaya senegalensis | 2.2 | 20.0 | 15.0 | To Fell |
| | | | | | | |
| T661 | Bimbo | | Cluster | 6.0 | 3.0 | To Fell |
| T662 | Senegal Mahogany | Khaya senegalensis | 2.1 | 18.0 | 12.0 | To Fell |
| T663 | Senegal Mahogany | Khaya senegalensis | 1.3 | 15.0 | 10.0 | To Fell |
| T664 | Senegal Mahogany | Khaya senegalensis | 1.4 | 15.0 | 10.0 | To Fell |
| T665 | Senegal Mahogany | Khaya senegalensis | 1.9 | 15.0 | 10.0 | To Fell |
| T666 | Senegal Mahogany | Khaya senegalensis | 1.9 | 15.0 | 10.0 | To Fell |
| T667 | Senegal Mahogany | Khaya senegalensis | 2.2 | 20.0 | 15.0 | To Fell |
| | | | | | | |
| T669 | Senegal Mahogany | Khaya senegalensis | 2.3 | 20.0 | 15.0 | To Fell |
| T670 | Senegal Mahogany | Khaya senegalensis | 2.3 | 25.0 | 15.0 | To Fell |
| T671 | Senegal Mahogany | Khaya senegalensis | 2.5 | 25.0 | 15.0 | To Fell |
| T672 | Senegal Mahogany | Khaya senegalensis | 2.4 | 25.0 | 15.0 | To Retain |
| T673 | Senegal Mahogany | Khaya senegalensis | 2.4 | 25.0 | 15.0 | To Retain |
| T674 | Senegal Mahogany | Khaya senegalensis | 2.3 | 25.0 | 15.0 | To Fell |
| | | | | | | |
| | | | | | | |
| T677 | Senegal Mahogany | Khaya senegalensis | 2.3 | 25.0 | 15.0 | To Retain |
| T678 | Senegal Mahogany | Khaya senegalensis | 2.2 | 25.0 | 15.0 | To Fell |
| | | | | | | |
| T680 | Senegal Mahogany | Khaya senegalensis | 2.2 | 25.0 | 15.0 | To Fell |
| T681 | Senegal Mahogany | Khaya senegalensis | 2.1 | 25.0 | 15.0 | To Fell |
| T682 | Senegal Mahogany | Khaya senegalensis | 2.1 | 20.0 | 15.0 | To Fell |
| T683 | Senegal Mahogany | Khaya senegalensis | 2.2 | 20.0 | 15.0 | To Fell |
| T684 | Senegal Mahogany | Khaya senegalensis | 2.2 | 20.0 | 15.0 | To Fell |
| T685 | Angsana | Pterocarpus Indicus | 2.8 | 25.0 | 15.0 | To Fell |
| T686 | Angsana | Pterocarpus Indicus | 1.4 | 20.0 | 6.0 | To Fell |
| T687 | Angsana | Pterocarpus Indicus | 2.4 | 20.0 | 12.0 | To Fell |
| T688 | Rain Tree | Samanea Saman | 3.2 | 25.0 | 20.0 | To Fell |
| T689 | Indian Mango | Mangifera indica | 2.1 | 12.0 | 8.0 | To Fell |
| T690 | Jackfruit | Artocarpus heterophyllus | 0.5 | 6.0 | 3.0 | To Fell |
| T691 | Jackfruit | Artocarpus heterophyllus | 0.9 | 8.0 | 5.0 | To Fell |
| T692 | Angsana | Pterocarpus Indicus | 3.5 | 30.0 | 20.0 | To Retain |
| T693 | Rain Tree | Samanea Saman | 0.5 | 5.0 | 4.0 | To Retain |
| T694 | Snakewood | Cecropia peltata | 0.6 | 6.0 | 4.0 | To Retain |
| | | | | | | |
| T696 | Durian | Durio zibethinus | 1.3 | 15.0 | 4.0 | To Fell |
| T697 | Breadfruit | Artocarpus altilis | 1.8 | 18.0 | 8.0 | To Fell |
| T698 | Indian Banyan | Ficus benghalensis | 1.6 | 12.0 | 7.0 | To Retain |
| T699 | Rain Tree | Samanea Saman | 2.4 | 25.0 | 15.0 | To Retain |
| T700 | Rain Tree | Samanea Saman | 2.2 | 25.0 | 15.0 | To Retain |
| T701 | Rain Tree | Samanea Saman | 1.8 | 18.0 | 12.0 | To Retain |
| T702 | Rain Tree | Samanea Saman | 2.4 | 25.0 | 15.0 | To Retain |
| T703 | Jackfruit | Artocarpus heterophyllus | 1.0 | 8.0 | 5.0 | To Retain |
| T704 | Rain Tree | Samanea Saman | 2.4 | 25.0 | 15.0 | To Retain |
| T705 | Breadfruit | Artocarpus altilis | 2.0 | 20.0 | 6.0 | To Retain |
| T706 | Breadfruit | Artocarpus altilis | 1.7 | 20.0 | 6.0 | To Retain |
| T707 | Breadfruit | Artocarpus altilis | 0.3 | 5.0 | 1.0 | To Retain |
| T708 | Breadfruit | Artocarpus altilis | 1.7 | 20.0 | 5.0 | To Retain |
| T709 | Breadfruit | Artocarpus altilis | 2.1 | 20.0 | 5.0 | To Retain |
| T710 | Kayu Manis | Cinnamomum verum | 0.5 | 5.0 | 3.0 | To Retain |
| T711 | Rain Tree | Samanea Saman | 2.6 | 30.0 | 25.0 | To Retain |
| T712 | Angsana | Pterocarpus Indicus | 0.9 | 8.0 | 6.0 | To Fell |
| T713 | Rambutan | Nephelium Lappaceum | 0.9 | 12.0 | 7.0 | To Fell |
| T714 | Rambutan | Nephelium Lappaceum | 1.4 | 15.0 | 8.0 | To Fell |
| T715 | Rambutan | Nephelium Lappaceum | 1.8 | 18.0 | 12.0 | To Fell |
| T716 | Angsana | Pterocarpus Indicus | 3.0 | 25.0 | 18.0 | To Fell |
| T717 | Angsana | Pterocarpus Indicus | 2.8 | 18.0 | 7.0 | To Fell |
| T718 | Rain Tree | Samanea Saman | 2.1 | 18.0 | 12.0 | To Fell |
| T719 | Sea Almond | Terminalia Catappa | 1.5 | 18.0 | 8.0 | To Fell |
| T720 | Sea Almond | Terminalia Catappa | 0.9 | 15.0 | 6.0 | To Fell |
| T721 | Sea Almond | Terminalia Catappa | 1.3 | 18.0 | 8.0 | To Fell |
| T722 | Jackfruit | Artocarpus heterophyllus | 1.1 | 8.0 | 4.0 | To Fell |
| T723 | Rain Tree | Samanea Saman | 2.8 | 25.0 | 20.0 | To Fell |
| T724 | Hop Tree | Arfeuillea arborescens | 0.7 | 6.0 | 4.0 | To Retain |
| T725 | Neem Tree | Azadirachta indica | 0.5 | 6.0 | 3.0 | To Retain |
| T727 | Indian Mango | Mangifera indica | 1.8 | 18.0 | 8.0 | To Retain |
| T728 | Jackfruit | Artocarpus heterophyllus | 0.9 | 7.0 | 4.0 | To Retain |
| | | | | | | |
| T729 | Indian Mango | Mangifera indica | 1.1 | 15.0 | 8.0 | To Fell |
| T730 | Malay Apple | Syzygium Malaccense | 1.3 | 10.0 | 6.0 | To Fell |
| | | | | | | |
| T732 | Rain Tree | Samanea Saman | 3.1 | 30.0 | 20.0 | To Retain |
| T733 | Rambutan | Nephelium Lappaceum | 2.2 | 25.0 | 18.0 | To Retain |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| T738 | Rambutan | Nephelium Lappaceum | 1.4 | 15.0 | 8.0 | To Fell |
| | | | | | | |
| T740 | Rambutan | Nephelium Lappaceum | 1.4 | 15.0 | 8.0 | To Fell |
| T741 | Rambutan | Nephelium Lappaceum | 1.2 | 12.0 | 7.0 | To Fell |
| T742 | White Champaca | Magnolia x alba | 1.6 | 18.0 | 8.0 | To Fell |
| T743 | Rain Tree | Samanea Saman | 3.1 | 30.0 | 20.0 | To Fell |
| T744 | Rain Tree | Samanea Saman | 1.3 | 15.0 | 8.0 | To Fell |
| T745 | African Tulip Tree | Spathodea Campanulata | 2.4 | 18.0 | 8.0 | To Fell |
| T746 | Rain Tree | Samanea Saman | 2.4 | 25.0 | 18.0 | To Fell |
| T747 | Rain Tree | Samanea Saman | 2.6 | 25.0 | 18.0 | To Fell |
| | | | | | | |
| | | | | | | |
| T750 | Indian Mango | Mangifera indica | 1.4 | 15.0 | 8.0 | To Fell |
| T751 | Rambutan | Nephelium Lappaceum | 1.2 | 8.0 | 6.0 | To Fell |
| T752 | Cheese Fruit | Morinda Citrifolia | 3.2 | 30.0 | 25.0 | To Fell |
| T753 | Durian | Durio zibethinus | 1.6 | 30.0 | 12.0 | To Retain |
| T754 | Indian Mango | Mangifera indica | 2.1 | 25.0 | 10.0 | To Retain |
| T755 | Indian Mango | Mangifera indica | 0.5 | 8.0 | 1.0 | To Retain |
| T756 | Indian Mango | Mangifera indica | 1.3 | 18.0 | 8.0 | To Retain |

TREES TABULATION

| Nos | Common Names | Botanical Names | Girth | Height | Spread | Remark |
|---|---|---|---|---|---|---|
| | | | | | | |
| T758 | Rain Tree | Samanea Saman | 2.9 | 25.0 | 18.0 | To Retain |
| T759 | Rain Tree | Samanea Saman | 3.0 | 25.0 | 20.0 | To Retain |
| T760 | Rambutan | Nephelium Lappaceum | 1.3 | 8.0 | 6.0 | To Retain |
| T761 | Rambutan | Nephelium Lappaceum | 0.9 | 8.0 | 6.0 | To Retain |
| T762 | Durian | Durio zibethinus | 1.3 | 15.0 | 6.0 | To Retain |
| T763 | Durian | Durio zibethinus | 0.5 | 8.0 | 2.0 | To Retain |
| T764 | Indian Mango | Mangifera indica | 1.0 | 12.0 | 6.0 | To Retain |
| T765 | Durian | Durio zibethinus | 1.3 | 15.0 | 6.0 | To Retain |
| T766 | Durian | Durio zibethinus | 0.5 | 8.0 | 2.0 | To Retain |
| T767 | Rain Tree | Samanea Saman | 1.9 | 18.0 | 8.0 | To Retain |
| T768 | Rain Tree | Samanea Saman | 1.4 | 18.0 | 6.0 | To Retain |
| T769 | Rain Tree | Samanea Saman | 1.3 | 15.0 | 7.0 | To Retain |
| T770 | Rain Tree | Samanea Saman | 2.4 | 25.0 | 18.0 | To Retain |
| | Kayu Manis | | | | | |
| T773 | Rain Tree | Samanea Saman | 2.8 | 25.0 | 18.0 | To Retain |
| T774 | Rain Tree | Samanea Saman | 1.2 | 15.0 | 7.0 | To Retain |
| T775 | Rain Tree | Samanea Saman | 3.2 | 25.0 | 20.0 | To Retain |
| T776 | Rain Tree | Samanea Saman | 1.8 | 20.0 | 12.0 | To Retain |
| | | | | | | |
| T778 | Rain Tree | Samanea Saman | 2.6 | 25.0 | 15.0 | To Retain |
| T779 | Rain Tree | Samanea Saman | 2.1 | 25.0 | 15.0 | To Retain |
| T780 | Rain Tree | Samanea Saman | 2.4 | 25.0 | 15.0 | To Retain |
| | | | | | | |
| T782 | Rain Tree | Samanea Saman | 2.6 | 25.0 | 18.0 | To Retain |
| T783 | Jackfruit | Artocarpus heterophyllus | 0.4 | 6.0 | 2.0 | To Fell |
| T784 | Jambu Air Laut | Syzygium Grande | 1.9 | 27.0 | 10.0 | To Fell |
| T785 | Katong Laut | Cynometra ramiflora | 0.7 | 12.0 | 5.0 | To Fell |
| T786 | Rain Tree | Samanea Saman | 1.9 | 17.0 | 20.0 | To Fell |
| T787 | Rain Tree | Samanea Saman | 1.2 | 22.0 | 13.0 | To Fell |
| T788 | Rain Tree | Samanea Saman | 1.0 | 8.0 | 5.0 | To Fell |
| T789 | Katong Laut | Cynometra ramiflora | 0.7 | 12.0 | 5.0 | To Fell |
| T790 | Katong Laut | Cynometra ramiflora | 0.9 | 12.0 | 5.0 | To Fell |
| T791 | Rain Tree | Samanea Saman | 2.6 | 22.0 | 20.0 | To Fell |
| T792 | Kayu Manis | Cinnamomum verum | 1.0 | 11.0 | 5.0 | To Fell |
| T793 | Kayu Manis | Cinnamomum verum | 0.7 | 11.0 | 5.0 | To Fell |
| T794 | Rain Tree | Samanea Saman | 1.5 | 19.0 | 17.0 | To Fell |
| T795 | Tiup-Tiup | Adinandra dumosa | 0.2 | 6.0 | 1.0 | To Retain |
| T796 | Kayu Manis | Cinnamomum verum | 0.6 | 10.0 | 5.0 | To Fell |
| T797 | Kayu Manis | Cinnamomum verum | 0.6 | 12.0 | 5.0 | To Fell |
| T798 | Kayu Manis | Cinnamomum verum | 0.6 | 10.0 | 5.0 | To Fell |
| T799 | Tiup-Tiup | Adinandra dumosa | 0.2 | 5.0 | 1.0 | To Retain |
| T800 | Rain Tree | Samanea Saman | 2.7 | 19.0 | 15.0 | To Fell |
| T801 | Rain Tree | Samanea Saman | 2.3 | 17.0 | 20.0 | To Fell |
| T802 | Rain Tree | Samanea Saman | 1.7 | 10.0 | 6.0 | To Fell |
| T803 | Rain Tree | Samanea Saman | 1.2 | 9.0 | 7.0 | To Fell |
| T804 | Rain Tree | Samanea Saman | 1.2 | 10.0 | 6.0 | To Fell |
| T805 | Rain Tree | Samanea Saman | 1.1 | 7.0 | 13.0 | To Fell |
| T806 | Rain Tree | Samanea Saman | 2.9 | 15.0 | 15.0 | To Fell |
| T807 | Indian Mango | Mangifera indica | 1.2 | 16.0 | 4.0 | To Fell |
| T808 | Rain Tree | Samanea Saman | 0.7 | 5.0 | 4.0 | To Retain |
| T809 | Tiup-Tiup | Adinandra dumosa | 0.2 | 4.0 | 1.0 | To Retain |
| T810 | Tiup-Tiup | Adinandra dumosa | 0.1 | 4.0 | 1.0 | To Retain |
| T811 | Rain Tree | Samanea Saman | 0.6 | 4.0 | 1.0 | To Retain |
| T812 | Tiup-Tiup | Adinandra dumosa | 0.2 | 4.0 | 1.0 | To Retain |
| T813 | Rain Tree | Samanea Saman | 0.6 | 6.0 | 4.0 | To Fell |
| T814 | Tiup-Tiup | Adinandra dumosa | 0.1 | 3.0 | 1.0 | To Retain |
| T815 | Tiup-Tiup | Adinandra dumosa | 0.1 | 3.0 | 1.0 | To Retain |
| T816 | Tiup-Tiup | Adinandra dumosa | 0.1 | 3.0 | 1.0 | To Retain |
| T817 | Happiness Tree | Garcinia subelliptica | 0.3 | 3.0 | 1.0 | To Retain |
| T818 | Happiness Tree | Garcinia subelliptica | 0.3 | 3.0 | 1.0 | To Retain |
| T819 | Happiness Tree | Garcinia subelliptica | 0.3 | 3.0 | 1.0 | To Retain |
| T820 | Happiness Tree | Garcinia subelliptica | 0.3 | 3.0 | 1.0 | To Retain |
| T821 | Happiness Tree | Garcinia subelliptica | 0.3 | 3.0 | 1.0 | To Retain |
| T822 | Happiness Tree | Garcinia subelliptica | 0.3 | 3.0 | 1.0 | To Retain |
| T823 | Happiness Tree | Garcinia subelliptica | 0.3 | 3.0 | 1.0 | To Retain |
| T824 | Happiness Tree | Garcinia subelliptica | 0.3 | 3.0 | 1.0 | To Retain |
| T825 | Happiness Tree | Garcinia subelliptica | 0.3 | 3.0 | 1.0 | To Retain |
| T826 | Happiness Tree | Garcinia subelliptica | 0.3 | 3.0 | 1.0 | To Retain |
| T827 | Happiness Tree | Garcinia subelliptica | 0.3 | 3.0 | 1.0 | To Retain |
| T828 | Happiness Tree | Garcinia subelliptica | 0.3 | 3.0 | 1.0 | To Retain |
| T829 | Happiness Tree | Garcinia subelliptica | 0.3 | 3.0 | 1.0 | To Retain |
| T830 | Happiness Tree | Garcinia subelliptica | 0.3 | 3.0 | 1.0 | To Retain |
| T831 | Happiness Tree | Garcinia subelliptica | 0.3 | 3.0 | 1.0 | To Retain |
| T832 | Happiness Tree | Garcinia subelliptica | 0.3 | 3.0 | 1.0 | To Retain |
| T833 | Happiness Tree | Garcinia subelliptica | 0.3 | 3.0 | 1.0 | To Retain |
| T834 | Happiness Tree | Garcinia subelliptica | 0.3 | 3.0 | 1.0 | To Retain |
| T835 | Happiness Tree | Garcinia subelliptica | 0.3 | 3.0 | 1.0 | To Retain |
| T836 | Happiness Tree | Garcinia subelliptica | 0.3 | 3.0 | 1.0 | To Retain |
| T837 | African Tulip Tree | Spathodea Campanulata | 0.7 | 8.0 | 4.0 | To Retain |
| T838 | African Tulip Tree | Spathodea Campanulata | 1.3 | 12.0 | 7.0 | To Retain |
| T839 | African Tulip Tree | Spathodea Campanulata | 1.3 | 12.0 | 7.0 | To Retain |
| T840 | African Tulip Tree | Spathodea Campanulata | 0.7 | 8.0 | 4.0 | To Retain |
| T841 | Happiness Tree | Garcinia subelliptica | 0.3 | 3.0 | 1.0 | To Retain |
| T842 | Happiness Tree | Garcinia subelliptica | 0.3 | 3.0 | 1.0 | To Retain |
| T843 | Happiness Tree | Garcinia subelliptica | 0.3 | 3.0 | 1.0 | To Retain |
| T844 | Happiness Tree | Garcinia subelliptica | 0.3 | 3.0 | 1.0 | To Retain |
| T845 | Happiness Tree | Garcinia subelliptica | 0.3 | 3.0 | 1.0 | To Retain |
| T846 | Happiness Tree | Garcinia subelliptica | 0.3 | 3.0 | 1.0 | To Retain |
| T847 | Happiness Tree | Garcinia subelliptica | 0.3 | 3.0 | 1.0 | To Retain |
| T848 | Happiness Tree | Garcinia subelliptica | 0.3 | 3.0 | 1.0 | To Retain |
| T849 | Happiness Tree | Garcinia subelliptica | 0.3 | 3.0 | 1.0 | To Retain |
| T850 | Happiness Tree | Garcinia subelliptica | 0.3 | 3.0 | 1.0 | To Retain |
| T851 | Happiness Tree | Garcinia subelliptica | 0.3 | 3.0 | 1.0 | To Retain |
| T852 | Happiness Tree | Garcinia subelliptica | 0.3 | 3.0 | 1.0 | To Retain |
| T853 | Happiness Tree | Garcinia subelliptica | 0.3 | 3.0 | 1.0 | To Retain |
| T854 | Happiness Tree | Garcinia subelliptica | 0.3 | 3.0 | 1.0 | To Retain |
| T855 | Happiness Tree | Garcinia subelliptica | 0.3 | 3.0 | 1.0 | To Retain |
| T856 | Happiness Tree | Garcinia subelliptica | 0.3 | 3.0 | 1.0 | To Retain |
| T857 | Happiness Tree | Garcinia subelliptica | 0.3 | 3.0 | 1.0 | To Retain |
| T858 | Happiness Tree | Garcinia subelliptica | 0.3 | 3.0 | 1.0 | To Retain |
| T859 | Happiness Tree | Garcinia subelliptica | 0.3 | 3.0 | 1.0 | To Retain |
| T860 | Happiness Tree | Garcinia subelliptica | 0.3 | 3.0 | 1.0 | To Retain |
| T861 | Rosy Trumpet Tree | Tabebuia Rosea | 0.3 | 4.0 | 2.0 | To Retain |
| T862 | Salam | Syzygium Cumini | 0.2 | 4.0 | 1.0 | To Retain |
| T863 | Salam | Syzygium Cumini | 0.2 | 4.0 | 1.0 | To Retain |
| T864 | Rosy Trumpet Tree | Tabebuia Rosea | 0.2 | 3.0 | 1.0 | To Retain |
| T865 | Rain Tree | Samanea Saman | 0.3 | 4.0 | 2.0 | To Retain |
| T866 | Rosy Trumpet Tree | Tabebuia Rosea | 0.2 | 3.0 | 1.0 | To Retain |
| T867 | Binjai | Mangifera caesia | 0.2 | 5.0 | 1.0 | To Retain |
| T868 | Rain Tree | Samanea Saman | 0.5 | 6.0 | 4.0 | To Retain |
| T869 | Rosy Trumpet Tree | Tabebuia Rosea | 0.3 | 4.0 | 2.0 | To Retain |
| T870 | Kasai Daun Bessar | Pometia Pinnata | 0.1 | 4.0 | 1.0 | To Retain |
| T871 | Rosy Trumpet Tree | Tabebuia Rosea | 0.3 | 4.0 | 2.0 | To Retain |
| T872 | Rain Tree | Samanea Saman | 0.3 | 4.0 | 2.0 | To Retain |
| T873 | Rosy Trumpet Tree | Tabebuia Rosea | 0.2 | 4.0 | 2.0 | To Retain |
| T874 | Salam | Syzygium Cumini | 0.1 | 3.0 | 1.0 | To Retain |
| T875 | Rosy Trumpet Tree | Tabebuia Rosea | 0.2 | 3.0 | 1.0 | To Retain |
| T876 | Binjai | Mangifera caesia | 0.3 | 6.0 | 2.0 | To Retain |
| T877 | Salam | Syzygium Cumini | 0.1 | 4.0 | 1.0 | To Retain |
| T878 | Rosy Trumpet Tree | Tabebuia Rosea | 0.2 | 4.0 | 2.0 | To Retain |
| T879 | Salam | Syzygium Cumini | 0.1 | 3.0 | 1.0 | To Retain |
| T880 | Rain Tree | Samanea Saman | 0.1 | 3.0 | 1.0 | To Retain |
| T881 | Salam | Syzygium Cumini | 0.1 | 3.0 | 1.0 | To Retain |
| T882 | Rosy Trumpet Tree | Tabebuia Rosea | 0.2 | 4.0 | 2.0 | To Retain |

TREES TABULATION

| Nos | Common Names | Botanical Names | Girth | Height | Spread | Remark |
|---|---|---|---|---|---|---|
| T883 | Rosy Trumpet Tree | Tabebuia Rosea | 0.2 | 4.0 | 1.0 | To Retain |
| T884 | Linden Hibiscus | Talipariti Tiliaceum | 0.2 | 1.0 | 1.0 | To Retain |
| T885 | Linden Hibiscus | Talipariti Tiliaceum | 0.2 | 1.0 | 1.0 | To Retain |
| T886 | Linden Hibiscus | Talipariti Tiliaceum | 0.2 | 1.0 | 1.0 | To Retain |
| T887 | Linden Hibiscus | Talipariti Tiliaceum | 0.2 | 1.0 | 1.0 | To Retain |
| T888 | Linden Hibiscus | Talipariti Tiliaceum | 0.2 | 1.0 | 1.0 | To Retain |
| T889 | Linden Hibiscus | Talipariti Tiliaceum | 0.2 | 1.0 | 1.0 | To Retain |
| T890 | Malang-Malang | Calophyllum soulattri | 0.5 | 5.0 | 2.0 | To Retain |
| T891 | Linden Hibiscus | Talipariti Tiliaceum | 0.2 | 1.0 | 1.0 | To Retain |
| T892 | Linden Hibiscus | Talipariti Tiliaceum | 0.2 | 1.0 | 1.0 | To Retain |
| T893 | Linden Hibiscus | Talipariti Tiliaceum | 0.2 | 1.0 | 1.0 | To Retain |
| T894 | Linden Hibiscus | Talipariti Tiliaceum | 0.2 | 1.0 | 1.0 | To Retain |
| T895 | Salam | Syzygium Cumini | 0.2 | 5.0 | 1.0 | To Retain |
| T896 | Kasai Daun Bessar | Pometia Pinnata | 0.1 | 4.0 | 1.0 | To Retain |
| T897 | Rosy Trumpet Tree | Tabebuia Rosea | 0.2 | 5.0 | 2.0 | To Retain |
| T898 | Rosy Trumpet Tree | Tabebuia Rosea | 0.2 | 4.0 | 1.0 | To Retain |
| T899 | Linden Hibiscus | Talipariti Tiliaceum | 0.1 | 1.0 | 1.0 | To Retain |
| T900 | Linden Hibiscus | Talipariti Tiliaceum | 0.1 | 1.0 | 1.0 | To Retain |
| T901 | Salam | Syzygium Cumini | 0.2 | 4.0 | 1.0 | To Retain |
| T902 | Salam | Syzygium Cumini | 0.2 | 4.0 | 1.0 | To Retain |
| T903 | Linden Hibiscus | Talipariti Tiliaceum | 0.1 | 1.0 | 1.0 | To Retain |
| T904 | Linden Hibiscus | Talipariti Tiliaceum | 0.1 | 1.0 | 1.0 | To Retain |
| T905 | Salam | Syzygium Cumini | 0.2 | 4.0 | 2.0 | To Retain |
| T906 | Kasai Daun Bessar | Pometia Pinnata | 0.1 | 3.0 | 1.0 | To Retain |
| T907 | Tiup-Tiup | Adinandra dumosa | 0.1 | 3.0 | 1.0 | To Retain |
| T908 | Linden Hibiscus | Talipariti Tiliaceum | 0.1 | 1.0 | 1.0 | To Retain |
| T909 | Linden Hibiscus | Talipariti Tiliaceum | 0.1 | 1.0 | 1.0 | To Retain |
| T910 | Hop Tree | Arfeuillea arborescens | 0.1 | 5.0 | 1.0 | To Retain |
| T911 | Silverback | Rhodamnia Cinerea | 0.2 | 4.0 | 2.0 | To Retain |
| T912 | Chengal Pasir | Hopea odorata | 0.4 | 6.0 | 2.0 | To Retain |
| T913 | Jambu Kelat | Eugenia Oleina | 0.2 | 4.0 | 1.0 | To Retain |
| T914 | Silverback | Rhodamnia Cinerea | 0.4 | 6.0 | 1.0 | To Retain |
| T915 | Chengal Pasir | Hopea odorata | 0.4 | 6.0 | 1.0 | To Retain |
| T916 | Sugar Apple | Annona squamosa | 0.3 | 2.0 | 1.0 | To Retain |
| T917 | Jambu Kelat | Eugenia Oleina | 0.2 | 2.0 | 1.0 | To Retain |
| T918 | Silverback | Rhodamnia Cinerea | 0.4 | 5.0 | 2.0 | To Retain |
| T919 | Jambu Kelat | Eugenia Oleina | 0.1 | 4.0 | 1.0 | To Retain |
| T920 | Kelumpang | Sterculia Foetida | 0.2 | 5.0 | 1.0 | To Retain |
| T921 | Chengal Pasir | Hopea odorata | 0.3 | 5.0 | 1.0 | To Retain |
| T922 | Silverback | Rhodamnia Cinerea | 0.3 | 6.0 | 1.0 | To Retain |
| T923 | Happiness Tree | Garcinia subelliptica | 0.3 | 5.0 | 2.0 | To Retain |
| T924 | Jambu Kelat | Eugenia Oleina | 0.2 | 5.0 | 2.0 | To Retain |
| T925 | Chengal Pasir | Hopea odorata | 0.4 | 6.0 | 3.0 | To Retain |
| T926 | Silverback | Rhodamnia Cinerea | 0.4 | 6.0 | 1.0 | To Retain |
| T927 | Chengal Pasir | Hopea odorata | 0.4 | 4.0 | 2.0 | To Retain |
| T928 | Mempat | Cratoxylum formosum | 0.2 | 4.0 | 2.0 | To Retain |
| T929 | Chengal Pasir | Hopea odorata | 0.3 | 4.0 | 2.0 | To Retain |
| T930 | Silverback | Rhodamnia Cinerea | 0.3 | 4.0 | 2.0 | To Retain |
| T931 | Mempat | Cratoxylum formosum | 0.2 | 4.0 | 2.0 | To Retain |
| T932 | Chengal Pasir | Hopea odorata | 0.3 | 4.0 | 3.0 | To Retain |
| T933 | Silverback | Rhodamnia Cinerea | 0.3 | 4.0 | 2.0 | To Retain |
| T934 | Chengal Pasir | Hopea odorata | 0.4 | 4.0 | 2.0 | To Retain |
| T935 | Silverback | Rhodamnia Cinerea | 0.4 | 6.0 | 2.0 | To Retain |
| T936 | Salam | Syzygium Cumini | 0.2 | 4.0 | 1.0 | To Retain |
| T937 | Salam | Syzygium Cumini | 0.2 | 4.0 | 1.0 | To Retain |
| T938 | Salam | Syzygium Cumini | 0.2 | 4.0 | 1.0 | To Retain |
| T939 | Malang-Malang | Calophyllum soulattri | 0.3 | 3.0 | 2.0 | To Retain |
| T940 | Rosy Trumpet Tree | Tabebuia Rosea | 0.3 | 3.0 | 2.0 | To Retain |
| T941 | Rain Tree | Samanea Saman | 0.4 | 5.0 | 3.0 | To Retain |
| T942 | Indian Banyan | Ficus benghalensis | 1.4 | 8.0 | 7.0 | To Fell |
| T943 | Salam | Syzygium Cumini | 0.2 | 4.0 | 1.0 | To Retain |
| T944 | Rosy Trumpet Tree | Tabebuia Rosea | 0.2 | 4.0 | 1.0 | To Retain |
| T945 | Malang-Malang | Calophyllum soulattri | 0.4 | 4.0 | 2.0 | To Retain |
| T946 | Salam | Syzygium Cumini | 0.2 | 4.0 | 1.0 | To Retain |
| T947 | Rosy Trumpet Tree | Tabebuia Rosea | 0.2 | 4.0 | 1.0 | To Retain |
| T948 | Salam | Syzygium Cumini | 0.2 | 4.0 | 1.0 | To Retain |
| T949 | Kasai Daun Bessar | Pometia Pinnata | 0.1 | 3.0 | 1.0 | To Retain |
| T950 | Rosy Trumpet Tree | Tabebuia Rosea | 0.2 | 4.0 | 1.0 | To Retain |
| T951 | Salam | Syzygium Cumini | 0.2 | 4.0 | 1.0 | To Retain |
| T952 | Salam | Syzygium Cumini | 0.2 | 4.0 | 1.0 | To Retain |
| T953 | Salam | Syzygium Cumini | 0.2 | 4.0 | 1.0 | To Retain |
| T954 | Rosy Trumpet Tree | Tabebuia Rosea | 0.2 | 4.0 | 1.0 | To Retain |
| T955 | Kasai Daun Bessar | Pometia Pinnata | 0.1 | 3.0 | 1.0 | To Retain |
| T956 | Rosy Trumpet Tree | Tabebuia Rosea | 0.2 | 4.0 | 1.0 | To Retain |
| T957 | Salam | Syzygium Cumini | 0.2 | 4.0 | 1.0 | To Retain |
| T958 | Salam | Syzygium Cumini | 0.2 | 4.0 | 1.0 | To Retain |
| T959 | Rosy Trumpet Tree | Tabebuia Rosea | 0.2 | 4.0 | 1.0 | To Retain |
| T960 | Kasai Daun Bessar | Pometia Pinnata | 0.1 | 4.0 | 1.0 | To Retain |
| T961 | Salam | Syzygium Cumini | 0.3 | 4.0 | 1.0 | To Retain |
| T962 | Rosy Trumpet Tree | Tabebuia Rosea | 0.3 | 4.0 | 2.0 | To Retain |
| T963 | Malang-Malang | Calophyllum soulattri | 0.4 | 4.0 | 2.0 | To Retain |
| T964 | Chengal Pasir | Hopea odorata | 0.2 | 4.0 | 1.0 | To Retain |
| T965 | Salam | Syzygium Cumini | 0.3 | 4.0 | 1.0 | To Retain |
| T966 | Salam | Syzygium Cumini | 0.3 | 4.0 | 1.0 | To Retain |
| T967 | Salam | Syzygium Cumini | 0.3 | 4.0 | 1.0 | To Retain |
| T968 | Kasai Daun Bessar | Pometia Pinnata | 0.1 | 4.0 | 1.0 | To Retain |
| T969 | Rosy Trumpet Tree | Tabebuia Rosea | 0.2 | 4.0 | 1.0 | To Retain |
| T970 | Salam | Syzygium Cumini | 0.2 | 4.0 | 1.0 | To Retain |
| T971 | Salam | Syzygium Cumini | 0.2 | 4.0 | 1.0 | To Retain |
| T972 | Salam | Syzygium Cumini | 0.2 | 4.0 | 1.0 | To Retain |
| T973 | Jambu Kelat | Eugenia Oleina | 0.5 | 7.0 | 4.0 | To Retain |
| T974 | Jambu Kelat | Eugenia Oleina | 0.5 | 7.0 | 4.0 | To Retain |
| T975 | Jambu Kelat | Eugenia Oleina | 0.5 | 7.0 | 4.0 | To Retain |
| T976 | Jambu Kelat | Eugenia Oleina | 0.5 | 7.0 | 4.0 | To Retain |
| T977 | Coconut | Cocos nucifera | 0.7 | 6.0 | 2.0 | To Retain |
| T978 | Jambu Kelat | Eugenia Oleina | 0.6 | 7.0 | 4.0 | To Retain |
| T979 | Jambu Kelat | Eugenia Oleina | 0.6 | 7.0 | 4.0 | To Retain |
| T980 | Jambu Kelat | Eugenia Oleina | 0.5 | 7.0 | 4.0 | To Retain |
| T981 | Cotton Tree | Ceiba pentandra | 0.2 | 4.0 | 1.0 | To Retain |
| T982 | Neram | Dipterocarpus oblongifolius | 0.2 | 4.0 | 1.0 | To Retain |
|

# Appendix B.2
# Guidelines for Sapling Harvesting and Tree Transplantation and Tree Maintenance

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# Guidelines for Sapling Harvesting

## Content Requirements

This document summarises the guidelines for sapling harvesting and tree transplantation before the commencement of construction works, and directives to tree maintenance and preservation of the retained trees during construction or other disturbances on the site. The content and extent of these guidelines should be suited depending on the characteristics of the site, including type of construction, tree species, tree location and other relevant factors.

## Sapling Harvesting and Tree Planting

This section outlines the general scope for sapling harvesting and tree transplanting prior to construction. Additional measures may be added by the attending arborist on a case-by-case basis.

## Specimen Selection

Before site clearance works, any viable saplings and conservation significant trees that are suitable for harvesting shall be identified by the Arborist. Saplings or trees suitable for transplanting should:

I. Display good physiological health and vitality;
II. Free from structural defects; and,
III. Demonstrate healthy branching pattern

As a guideline, the size of the root ball to be extracted will be determined by the girth of the saplings or trees to be harvested, as per the information presented in the following table:

| 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 |

Before transplanting, several preparatory steps must be taken to ensure successful transplantation and the plant's well-being. These steps include:

1. Clearing: dead branches and climbers will be removed from the plant, and, if necessary, the canopy load and spread will be adjusted in consultation with the Arborist.

2. Trenching: manual trenching will be conducted to determine the ideal shape and size of the root ball to be extracted.
3. Feeder Root Preservation: whenever possible, feeder roots will be retained without cutting to facilitate the plant's ability to establish itself after transplantation.
4. Burlapping: the root ball will be carefully wrapped with cellophane sheeting to minimize desiccation effects and protect the root system during the transplanting process.
5. Canopy Protection: if instructed by the Flora specialist or Arborist, the leaves of the canopy may be enclosed and covered with cellophane or clear plastic bags to safeguard the plant during transportation.
6. Root Ball Securing: to prevent the risk of the root ball disintegrating during handling and transportation, it will be securely fastened to the trunk.
7. Gentle Handling: throughout the process of handling and carrying the plant, utmost care will be taken to avoid any damage to its vegetative parts.

When moving or translocating trees or other vegetation within the Project area, an arborist must assess the method statement suggested by the contractor for tree transplantation and provide any further advice needed to preserve the health of the tree during transplanting. At the time of extraction, during the lifting procedures, and during installation at the receiving site, the root balls must be secure and unbroken, as guaranteed by the transplanting contract. For each individual tree, the transplant effort must be documented in order to prove unbroken root balls at all of the aforementioned stages. To maintain the long-term survival of transplanted trees, appropriate irrigation and health monitoring are required. If a tree shows signs of stress, such as peeling bark or wilted foliage, advice from an arborist should be sought.

## Tree Maintenance and Care

The general rules for tree management and care during construction projects are described in this section. Additional measures may be added by the attending arborist on a case-by-case basis.

When disease outbreaks occur, the arborist must provide management strategies. Measures can include reducing stressors (dust, water, etc.) and applying specific pesticides and fungicides to control epidemics. If the plant poses a threat to other nearby plants, it could need to be removed or quarantined.

Additional watering must be done to improve moisture differentials around forest edges in areas where vegetation is clearly suffering as a result of site clearance and where the edges of the forest are exposed.

Pesticides and herbicides should be used sparingly. Techniques that reduce spray or non-target spray drift must be adopted if herbicides or insecticides are used in the Project area. These methods include drilling injection and cut-and-paint methods, among others. Herbicide and pesticide applications must always be carried out in line with the applicable Material Safety Data Sheet (MSDS). Any instances of misuse, spills, or harm to non-target species must be reported and investigated properly.

The Contractor must provide supplementary watering for conserved trees inside TPZs and at

the forest edge (up to 10 m) surrounding the development boundary when the site goes seven days without receiving any precipitation. After a significant downpour, any snapped hanging branches that represent an immediate risk to site workers should be taken down.

# Appendix B.3
# Method Statement for Tree Protection and Conservation Guidelines

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# Method Statement for Tree Protection and Conservation Guidelines

## Content Requirements

The purpose of this document is to provide specific measures that should be implemented on site during site clearance, earthworks and construction stages to ensure the trees proposed to be retained are protected. The information provided in the document is dependent on site and project specific factors such as construction type, species of tree present on site, locations of trees etc.

## Tree Protection and Conservation Guidelines

General provisions for tree protection, before, during and after construction are outlined below. Whilst this attempts to be exhaustive, the project arborist may provide additional site-specific measures on an ongoing basis during site works.

### *Pre-Demolition/Piling/Construction Protocol*

1. Pre-Construction Meeting
    - The project arborist is expected to meet with the Contractor for a pre-construction meeting to explain the tree protection and monitoring requirements outlined in this document.
    - The Contractor must complete the Verification of Tree Protection Checklist provided in Annex A prior to site works commencing.

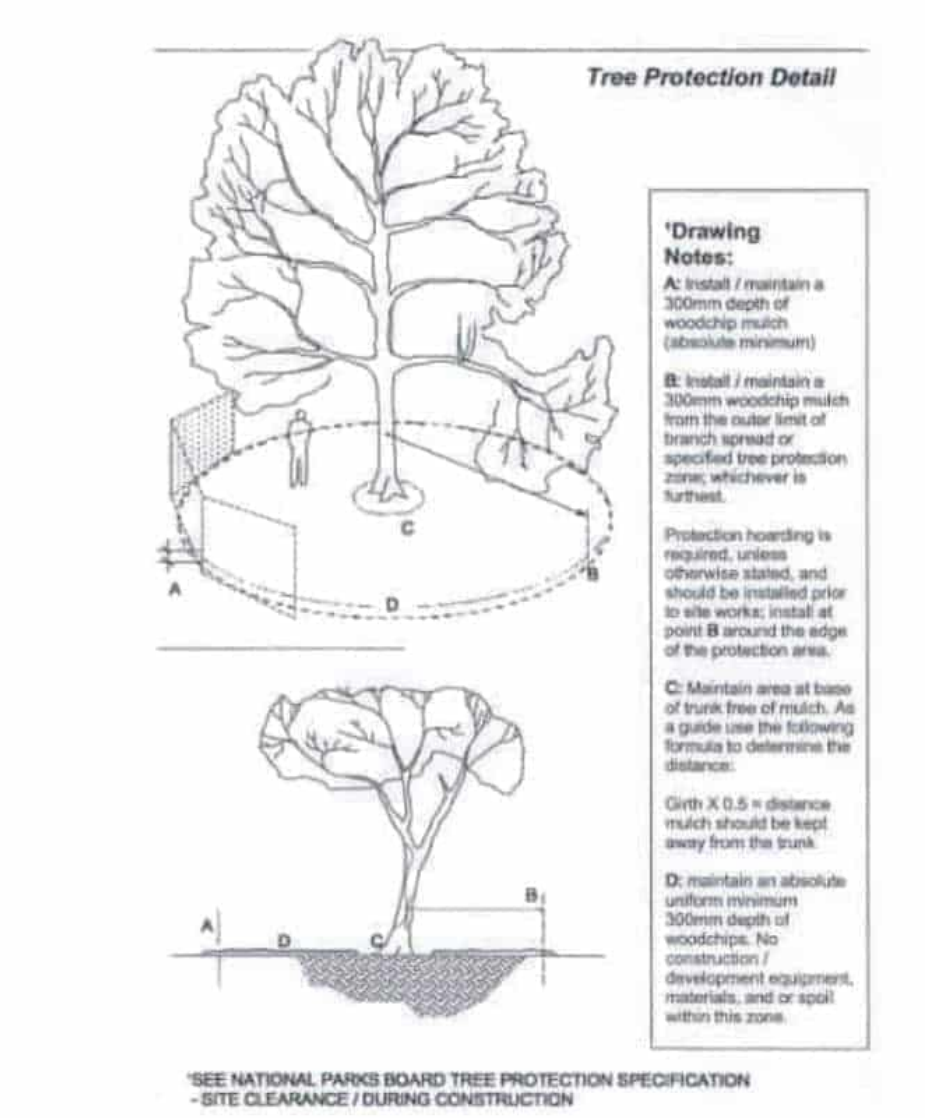
2. Tree Protection Zones

Tree Protection Zones (TPZ) must be installed around all trees earmarked to be retained within the site boundary and those which are situated near the site boundary where the root system may overlap underneath the soil into the site. TPZs must be installed prior to site clearance, piling works, grading, trenching, or other activities which can cause soil disturbance. These should be implemented as follows:

- Barrier Specification: TPZ barriers should be temporary structures 1.8m in height that are firmly placed into the ground and made of a hard material.
- Ground Protection: a mulching material, such as woodchips or compost, should be laid within the TPZ to a depth of 100mm. To prevent the introduction of harmful termites when using woodchips, ensure that a termicide treatment is applied. Further to this, a complete fertiliser should be applied to the mulch e.g., N:P:K 15:15:15.
- Signage and Prohibited Entry: signage that states “KEEP OUT! TREE PROTECTION ZONE” should be installed on all sides of the TPZ fencing for each protected tree. All

signs should be clearly visible, waterproof, and be a minimum of 300mm in width. Entry to the TPZ is prohibited for the entirety of site works.

- Fencing Installation: all TPZ fencing must be approved by the project arborists and approved by the relevant technical authority prior to site works commencing. The diagram below showcases how a TPZ should be set up.




- Tree Pruning and Removal: during site works, it may be necessary to prune trees to make space for structures or for proposed construction activities. At no time must the Contractor or construction personnel attempt to prune or remove trees with TPZs. Approval must be sought with the arborist prior to pruning commencing.

  Where trees adjacent to protected or retained trees are to be removed, planning should be undertaken in collaboration with an arborist. Tree removal should not be achieved by lumberjack (one cut) methods or through pushing by excavators/heavy machinery. Only

directional felling methods (notch and back-cut) are to be deployed when removing trees.

Where trees proposed to be removed have branches or roots that intertwine or extend into protected tree areas, roots or canopies, the advice of an arborist should be sought to determine an appropriate removal plan. At no point should removal of these trees be attempted by the demolition/construction crew, nor should they be removed by grading or by using heavy equipment. Where the arborist outlines that entangled roots are to remain, the stump of the tree to be removed shall have its roots severed before extracting them.

- Site Clearance: in order to avoid lumber jack felling of trees that have the potential to damage the tree canopy of protected trees, it is recommended that a qualified arboriculture contractor is engaged to fell trees in close proximity/adjacent to protected trees, ensuring that felled trees fall away from TPZs.

  When carrying out tree felling works near TPZs, the Contractor should always:

  - Employ directional felling i.e., notch and back cut approach;
  - Undertake selective pruning of canopy branches where branches are entangled with those of a protected trees;
  - Deploy cranes to tension tree trunks in the direction of the drop;
  - Ensure that branch removal is undertaken in a controlled manner using ropes and cranes to avoid damage to shorter, adjacent trees, when tree removal is required for trees with a tall canopy;
  - Avoid pruning of protected trees/trees with TPZs unless consultation and approval from the project arborist has been provided; and
  - Avoid tree removal by pushing with an excavator or heavy machinery.

### *Protocol During Demolition/Piling/Construction*

1. TPZ Restrictions:

   No machinery, construction materials, debris or other construction waste should be stored within the TPZ, as the weight and presence of said materials has the potential to increase soil compaction and reduce the soil's ability for water infiltration or gaseous exchange.
   No activities, in particular those which relate to ground disturbance, trenching, grading or construction activities are allowed to occur within the TPZ, except for activities approved by the project arborist and/or the relevant technical authority.
   Excavation works within the TPZ are strictly prohibited, unless approved by the project arborist. All works undertaken within the TPZ agreed with the project arborist, must be completed through manual trenching with manual or power hand tools that will not result in root/tree damage.

In the instance that tree roots must be severed, it should only be undertaken using appropriate equipment (e.g., pruning saw or chain saw) that has been agreed with project arborist, who will need to supervise the works.

At no point should trees be used as an anchor to support structures during the construction stage. Tying, nailing or pasting materials on trees is prohibited, with the exception of tags that identify protected trees.



**Figure 1: Construction material and heavy machinery are prohibited within the TPZ**



**Figure 2: Trial trench by skilled workers using hand tools exposing root architecture**



Figure 3: Using tree as anchor may damage its bark.



Figure 4: No nails shall be driven into the tree as it promotes infiltration of pests/diseases

- Any phytotoxic chemicals/materials stored on site, must be stored or mixed at least 2.5m away from any TPZ, as such chemicals can significantly alter the cation exchange capacity and pH of the soil, which can reduce the efficiency of nutrient uptake and create an environment that is too toxic for the roots to grow. Phytotoxic materials include fuels, oils, chemicals, and paints.

  Furthermore, construction slug should never be deposited within the TPZ. Such sludge when layered over and within TPZs has the potential to significantly alter water infiltration and gaseous exchange rates within the soil and root absorption area of a tree, given that most construction slug is high in clay content.

In order to protect soil during demolition/drilling/construction activities pertaining to concrete structures, canvass sheets or eco-mats must be laid onto the soil near the tree.



**Figure 5: Construction cement deposited at tree base.**



**Figure 6: Tree showing signs of decline overtime.**

Grading near trees: lowering the grade around trees can have both immediate and long-term negative impacts on trees, as typically, most tree roots are found within the top 1m of soil, with most fine roots, those which absorb water and nutrients, present within the top 300mm. Therefore, the following must be adhered to when considering grading nearby protected trees:

- No grade changes are permitted within TPZs;
- Where grade changes are required outside of TPZs, they can only be implemented where they will not significantly alter drainage;

- Grade changes under specifically approved circumstances shall not allow more than 200mm of allow more than 150mm of existing soil to be removed from natural grade, unless mitigated or compensated for;
- Where grade fills are over 200mm or impervious overlays are used, these should incorporate an approved permanent aeration system, permeable material or other approved compensatory measure; and,
- Where grade cuts exceed 150mm, retaining walls or an appropriate transition equivalent should be incorporated.



**Figure 7: Inappropriate installation/maintenance of TPZ during construction.**

2. Use of Heavy Machinery/Vehicles in Close Proximity to TPZs

   Use of heavy machinery and vehicles (e.g., excavators, piling cranes or 10 wheelers) should be limited near TPZs.
   Temporary access/passageways should be designed or planned to avoid protected trees.

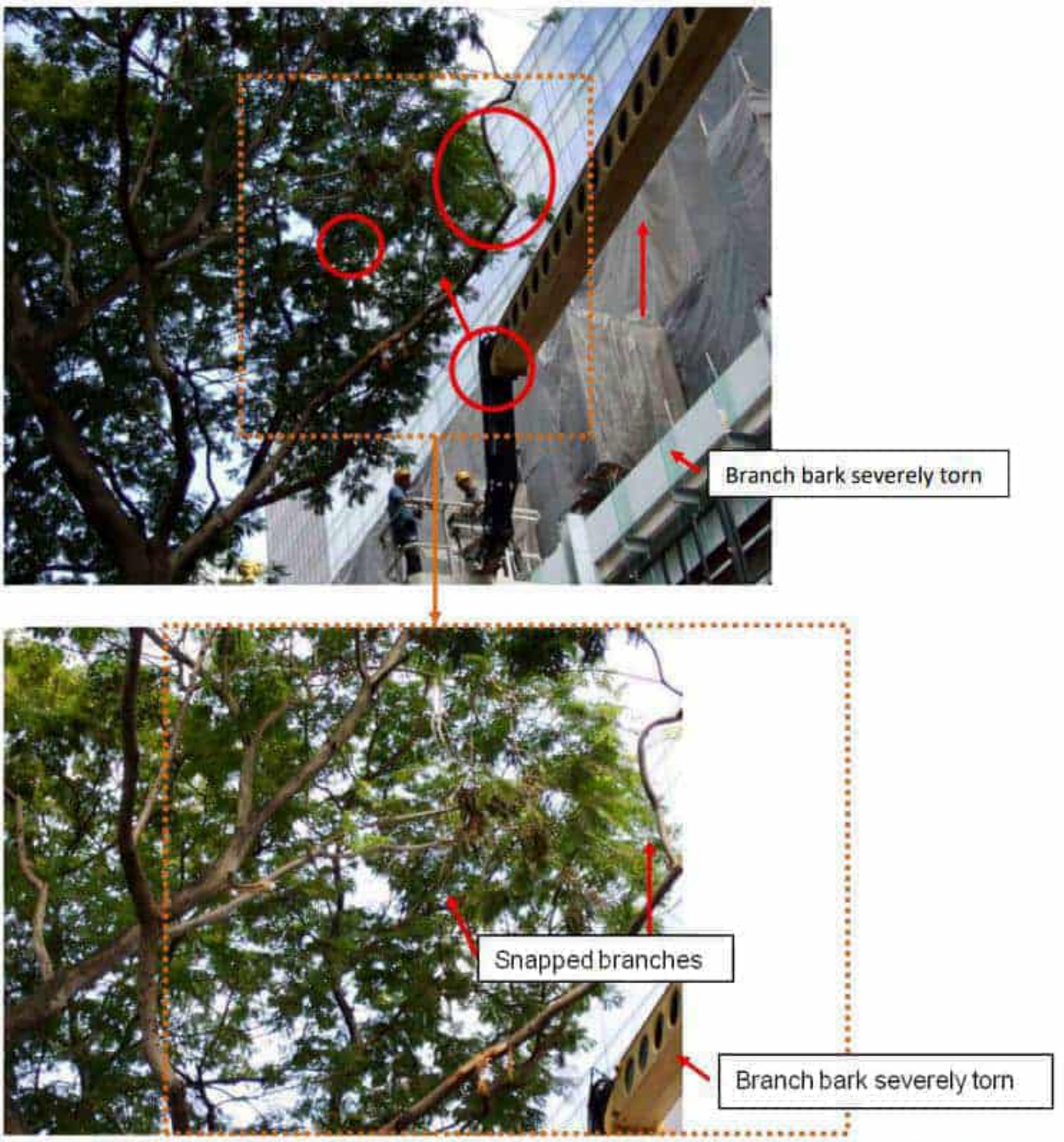



**Figure 8: Tree branches were severed due to the negligence of the crane operator.**

3. Considerations for Drainage:

   If water ponding conditions occur or develop during the course of construction due to a change in grade/platform levels, construction activities or other factors, the Contractor is responsible to improve the drainage around/within affected TPZs. This should be planned in collaboration with the project arborist.

4. Trenching, Excavation, Boring and Use of Equipment:

Any trenching, excavation or boring activities required to be undertaken within the TPZ will be strictly limited to activities deemed appropriate and approved by the project architect and/or the project arborist. Further to this, alternatives should be explored to place trenching outside of root zones.
Root exposure: during hot, dry, weather, avoid exposing roots. Any trenches created should be backfilled as soon as possible with soil and soaked with water the same day. As a rule of thumb, small roots can die within 10-15 minutes of exposure with larger roots not surviving beyond an hour. In the instance that the trench must be kept open for longer than this duration, all roots must be wrapped in peat moss and burlap to ensure moisture is retained.

- Root Severance: cutting of roots greater than 0.2m in diameter must be approved prior by the project arborist. As an alternative, consider tunnelling beneath the roots. When excavating for the creation of foundations, footings, gradings, trenching or walls within the TPZ, all roots outside the TPZ should be cleanly severed to the depth of planned excavation. All roots should be cut cleanly with a sharp saw.




**Figure 9: Tunneling under roots.**

- Excavation: excavation, demolition or extraction of materials from within the TPZ should only be performed using equipment that is situated outside of the TPZ. Within the TPZ, permitted methods for excavation include hand digging, hydraulic or pneumatic excavation.



**Figure 10: Root exploratory works using an air spade. Air spading avoids damage of structural and even feeder roots of the tree.**

- Use of Heavy Equipment: use of heavy vehicles and equipment such as Ditch-Witches or steal tread tractors are prohibited unless approved by the project arborist. When approval is granted, a protective root buffer will be required.

5. Tree Care:

During the construction stage, it is essential that the following measures are implemented to reduce any stress effects on protected trees. The project arborist will advise on the quantum, duration and extent of measures. These are as follows:

- Fertilisation

1. ***Vertical Trenches and Nutrient Sinks:***
   Vertical trenches and nutrient sinks should be created. Nutrient sinks reduce construction stress by conditioning the soil, increasing microbiological activity within the soil and increasing organic matter. Nutrient sinks should fall to a depth of 300mm and be filled with 12% Humic acid (1:100 dilution) and high grade compost. For trees greater than 2m in girth, a minimum of 24 vertical trenches or nutrient sinks are required. Where trees are under 2m in girth, the project arborist is to advise on the quantum of trenches, considering site specific conditions, tree species and pre-construction measures. Nutrient sinks must be topped up every three months.

2. ***Biostimulant Soil Injection***

This is a mandatory requirement is the TPZ has been infringed into, if soil compaction has compared, or if tree condition has observably declined (i.e., twig die back has occurred at canopy, leaf colour/size/density has occurred, or there has been a reduction in live crown rations).

  - Purpose: to decompact soil to reduce compaction to less than 400psi in the first 500mm of the soil to prevent further tree stress.
  - Method: soil is decompacted using a hydraulic pressurised delivery of biostimulants that hydrates and aerates the soil at the same time.
  - Humic Acid: should be used as a soil conditioner and chelating agent to facilitate the release of nutrients and reduce leaching, whilst improving the water holding capacity of the soil.

In order to increase soil microbiology to increase tree vigor after damage has occurred, the following should be applied:

  - Liquid Gypsum/Dolomite: should be used a soil conditioner to improve soil structure and facilitate the release of nutrients in clay soils typical of local conditions.
  - Mollases: high CE for immediate uptake.
  - Fish Kelp: a protein source and organic fertiliser.
  - Slow Release Fertiliser (Osmocote).

- Irrigation:
  - During drought periods, watering should be provided to protected trees.
  - Duration of watering and extent is dependent on site conditions and tree species present. Consult the project arborist for site specific information.
  - Watering should be carried out until initial signs of inundation in the soil is observed i.e., water infiltration is visibly seen to significantly slow down.

- Myconate Treatment:
  - Triggers and stimulates the growth of existing mycorrhizae.

- Pesticide Treatment:
  - Required to control pests such as termites, borers, caterpillars, as and when deemed as a problem.
  - Bactericides or fungicides should also be applied as required or determined by the project arborist to control microbe pathogens.

- Additional Pruning:
  - If additional pruning is required at any stage of the works, the project arborist should be consulted and must approve any pruning plans. Whilst pruning may be required to facilitate the development, some pruning may be required for the health of the tree, which may include:

    - Crown Cleansing: the removal of dead branches;
    - Crown Lifting: pruning of the crown to lift the crown to avoid new amenities; and,
    - Crown thinning: pruning to reduce the amount and thickness of canopy branches and loading.
  - All of the aforementioned works may require supervision by the project arborist to ensure compliance with the outlined protocol.

6. Engaging Arboricultural Contractors

   It is recommended that any arboriculture contractor used as part of the project has at least 8 years of work experience and is able to produce track records of work experience in developments of similar size and/or complexity.

   Contractors must have:

   - Experience and knowledge meeting NParks' safety requirements for working at height;
   - Experience and knowledge meeting LTA's requirements for temporary works along roadsides (where applicable); and,
   - Have a certified arborist to supervise the pruning/felling/planting works.

   All arborists engaged in tree climbing and chainsaw works must possess a valid basic tree climbing certification based upon demonstrated competence in the WSQ module conducted by CUGE or an equivalent WSQ approved training organisation.

   Each member of the arboricultural contractor must possess the following valid competences:

   - Operation of chainsaw for groundwork (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)
   - Operate and work from an elevated work platform (CUGE-ARB-3501)

### *Post-Construction Protocol*

1. Soft Landscaping:

   Site preparation, groundworks and implementation of landscaping near protected trees must be undertaken with care not to damage any trees.

   The only time TPZs can be removed is to allow for landscaping near said trees. Nonetheless, when working near trees, only hand tools are permitted to be used to cultivate the soil and planting of shrubs must be no closer than 300mm from the existing root collar.

   Furthermore, changes to ground levels and compacting of soil must be avoided within close proximity to trees during landscaping.




**Figure 10: New plantings at a minimum distance of 300mm (all round) from root collar**

# ANNEX A: VERIFICATION OF TREE PROTECTION CHECKLIST

The project contractor or construction supervisor shall verify in writing that all preconstruction tree preservation conditions have been met as follows:

Submitted by: _____

Company/Project: _____

Date/Time: _____

| S/N | Action | Checked (☑) | Remarks |
|---|---|---|---|
| 1 | Installation of tree fencing around identified trees within/near site (hard material at 1.8m tall) | | |
| 2 | Tree protection zone (TPZ) dimensions meets specifications (from NParks and/or attending arborist) | | |
| 3 | Warning signs prominently displayed on all sides of the fencing, including designated tree number | | |
| 4 | Removal of construction material (ie machinery, debris, tools etc) within TPZ | | |
| 5 | Mulching of high grade compost of 100mm thick around identified trees | | |
| 6 | Completion of tree pruning (if necessary) under the supervision/written approval with the attending arborist | | |
| 7 | Establishment of a tree maintenance schedule according to arborist recommendations (to be submitted to attending arborist) | | |

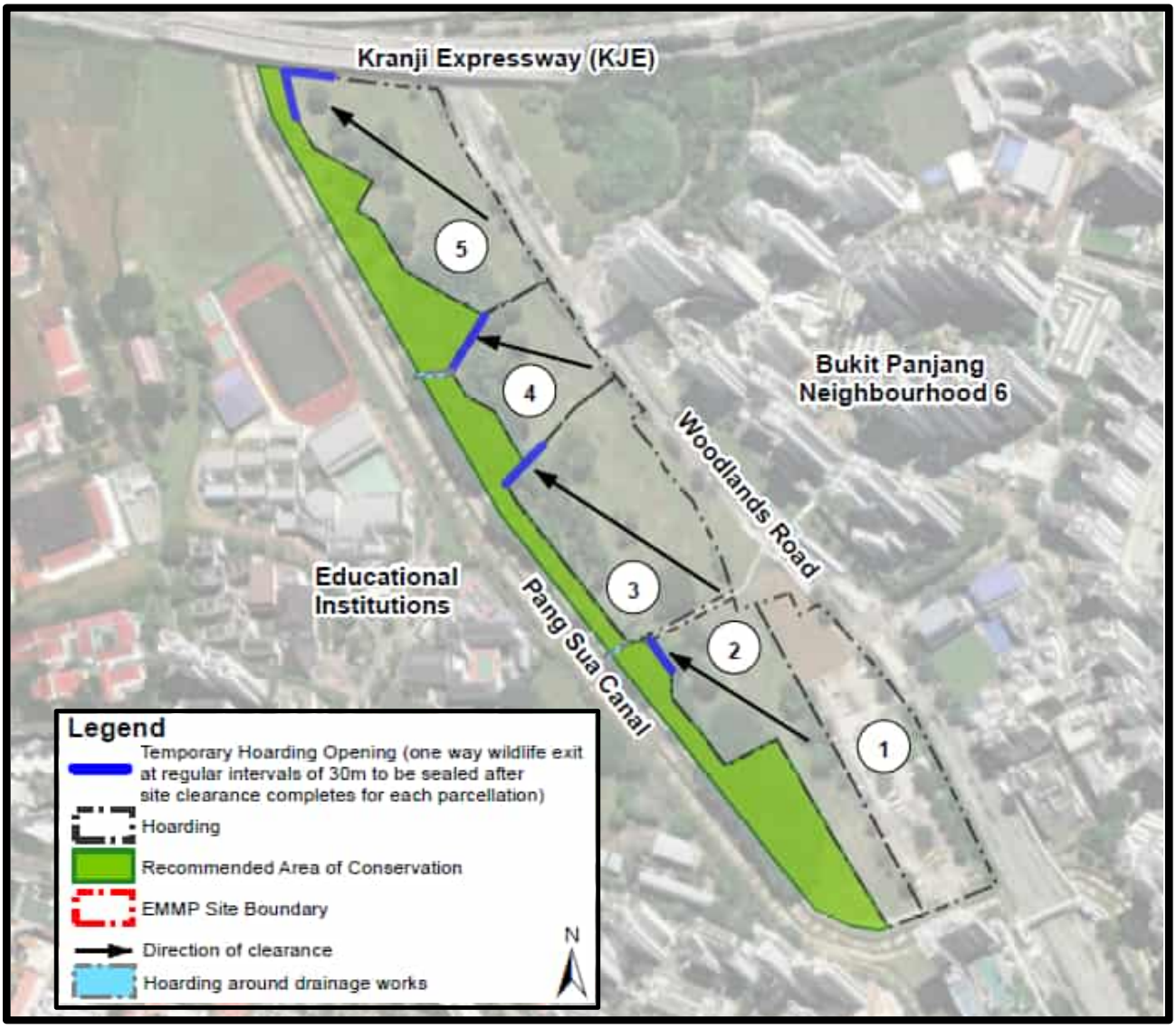
Verified by (attending arborist): _____

Date/Time: _____

# Appendix B.4
# Wildlife Shepherding Plan

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# Wildlife Shepherding Plan




**Sequencing Plan:** the entire worksite boundary will be hoarded prior to works commencing. Subsequently,the boundaries between Areas 1 to 3 will be hoarded prior to site clearance of that area. For example, hoarding between areas 1 and 2 will occur prior to clearance of area 1; with hoarding between area 2 and 3 occurring before clearance of area 2.

**Temporary Hoarding Opening:** within these designated areas, one-way wildlife exits will be provided at 30m intervals allowing passage of fauna to move from the area being cleared into the subsequent area or directly into the Recommended Area of Conservation.

# Appendix C
# Wildlife Incident Form

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# WILDLIFE INCIDENT FORM

| | |
|---|---|
| Date (YYYY/MM/DD): | Time: |
| Description of Location: | GPS Coordinates: |
| Wildlife Observed: | Animal Condition:<br>☐ Alive ☐ Killed ☐ Dead ☐ Injured<br>Animal Activity:<br>☐ Moving ☐ Resting ☐ Trapped |
| Photographs Taken:<br>☐ Yes ☐ No | NParks Notified:<br>☐ Yes ☐ No<br>Name of NParks Staff Notified:<br>_____ |
| Describe Incident (e.g., activities being carried out; what animal was doing; personnel involved): | |
| Actions Taken: | |
| Reported by:<br>_____<br>Contact #:<br>_____ | Reported to:<br>_____<br>Contact #:<br>_____ |
| Remarks: | |

# Appendix D Environmental Incident Form

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**INCIDENT REPORT**

Date: 06 August 2023

To : XXX
Contract Name /Phase: Specialist Consultancy Services at HDB Development (Choa Chu Kang)
Contract Period : 5 Aug 2023 to 4 Feb 2028

I wish to report the following incident.

**a) Location**
xxx

**b) Branch Office / Town Council**
xxx

**c) Constituency / Division**
xxxx

**d) Type of Works & Incident Location**
xxx

**e) Date and Time of Incident**
Date:
Time:

**f) Description of Incident**
xxxx

**g) Likely Cause of Incident**
xxxx

**h) Implication to resident**
xxx

**i) Presence of Journalists (based on available information on site)**
* Yes / No

**j) Action Taken by Consultant / Contractor**

**Contractor:**

xxxxx

**Consultant:**

Xxxxxx

**k) Any Implications / Follow-up Actions**

xxxxxx

**l) Contact Person for Follow-Up (Name, Tel, etc)**

Name:
Designation:
H/P:

**m)** **Scanned Images**

Provide a picture of the location of the incident with some description of what happen

Attached the following documents
records of injured person hospital visit with diagnosis and a brief description of what happen

**n)** **Remarks**

xxxxxxx

Report submitted by Safety Officer

_____
Name / Designation / Signature of WSHO
Date:
Time:

*To delete accordingly.

# Appendix E
# Feedback Management Form

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## Appendix F – Feedback Management Form

### Table 1 Verbal Feedback Register Form

| S/N | Date | Contract Site | Location and Problem | Follow-Up Action | 1st Response |
|---|---|---|---|---|---|
| **SAFETY** | | | | | |
| | | | | | |
| | | | | | |
| **DAMAGE TO PROPERTY** | | | | | |
| | | | | | |
| | | | | | |
| **DRAINAGE AND WATER** | | | | | |
| | | | | | |
| | | | | | |
| **AIR** | | | | | |
| | | | | | |
| | | | | | |
| **NOISE & VIBRATION** | | | | | |
| | | | | | |
| | | | | | |
| **HOUSEKEEPING** | | | | | |
| | | | | | |
| | | | | | |
| **INCONVENIENCE TO PUBLIC** | | | | | |
| | | | | | |
| | | | | | |
| **REQUESTS/OTHERS** | | | | | |
| | | | | | |
| **ROAD DIVERSIONS/TRAFFIC** | | | | | |
| | | | | | |

**Table 2 Written Feedback Register Form**

| S/N | Date | Contract Site | Location and Problem | Follow-Up Action | 1st Response |
|---|---|---|---|---|---|
| **SAFETY** | | | | | |
| | | | | | |
| | | | | | |
| **DAMAGE TO PROPERTY** | | | | | |
| | | | | | |
| | | | | | |
| **DRAINAGE AND WATER** | | | | | |
| | | | | | |
| | | | | | |
| **AIR** | | | | | |
| | | | | | |
| | | | | | |
| **NOISE & VIBRATION** | | | | | |
| | | | | | |
| | | | | | |
| **HOUSEKEEPING** | | | | | |
| | | | | | |
| | | | | | |
| **INCONVENIENCE TO PUBLIC** | | | | | |
| | | | | | |
| | | | | | |
| **REQUESTS/OTHERS** | | | | | |
| | | | | | |
| **ROAD DIVERSIONS/TRAFFIC** | | | | | |
| | | | | | |

**Table 3 Stakeholders' Engagement Report**

| Contract | Engagement Activities | Remarks | OIC |
|---|---|---|---|
| | **Circulars**<br>• Sent XX circular on Date to who for <purpose><br>• Display XX circular on Date at where for <purpose><br><br>**Phone Calls/SMS/Emails**<br>• Sent email on Date to Who of What for <purpose><br>• Sent SMS on Date to Who of What for <purpose><br>• Call Who on Date for <purpose><br><br>**Face-To-Face Engagement**<br>• Date, Who, Where and Details<br><br>**Event**<br>• Organized/Conducted what event on Date at Where for/to <purpose> | Names of Project Team members present | |

# Appendix F
# Dust Control Plan

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# Dust Management Plan

**PROJECT: SITE PREPARATION WORKS AT CHOA CHU KANG TOWN N1 D/354/23**

| | | |
|---|---|---|
| Prepared by: | Mr. Farhan<br>(WSHE Manager) | Date: 06/10/2023 |
| Approved by: | Mr. Raymond Er<br>(Project Manager) | Date: 06/10/2023 |

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## 1. Introduction

The dust management plan outlines the program on dust management and surveillance to ensure that dust control is effective to meet requirements.

Site clearance and civil engineering works has work process that generates dust which includes dry access. Lorry or dump trucks who cross over dried soil of concrete dust may generate dust. Hence site has to take control measures to eliminate or minimize dust generation.

Dust particles vary in size and visibility. The smaller the particles, the longer it stays in the air and the further it can travel. Large dust particles fall out of the air relatively close to where they are created.

Large dust particles tend to be trapped in the nose and mouth when trapped during breathing and can be readily been breathed out harmlessly.

Small particles on the other hand are invisible and able to penetrate deeply into the lungs while some particles can be transmitted to the blood stream. Some of the effect of small particle dust includes; asthma, hay fever, irritation to the eyes, coughing and sneezing.

## 2. Objective

The objective of a construction Dust Management Plan (DMP) is to help developers and contractors estimate the dust impact and plan for measures to ensure compliance with the construction permissible limits and to reduce dust exposure.

The dust management plan should be carried out prior to the award of contract so that alternative construction methods, scheduling and any measures required for dust mitigation could be incorporated as part of the contract requirements.

Steps will be taken to reduce the potential for particulate emissions during construction activities. The plan includes activity-specific dust control criteria and dust suppression procedures.

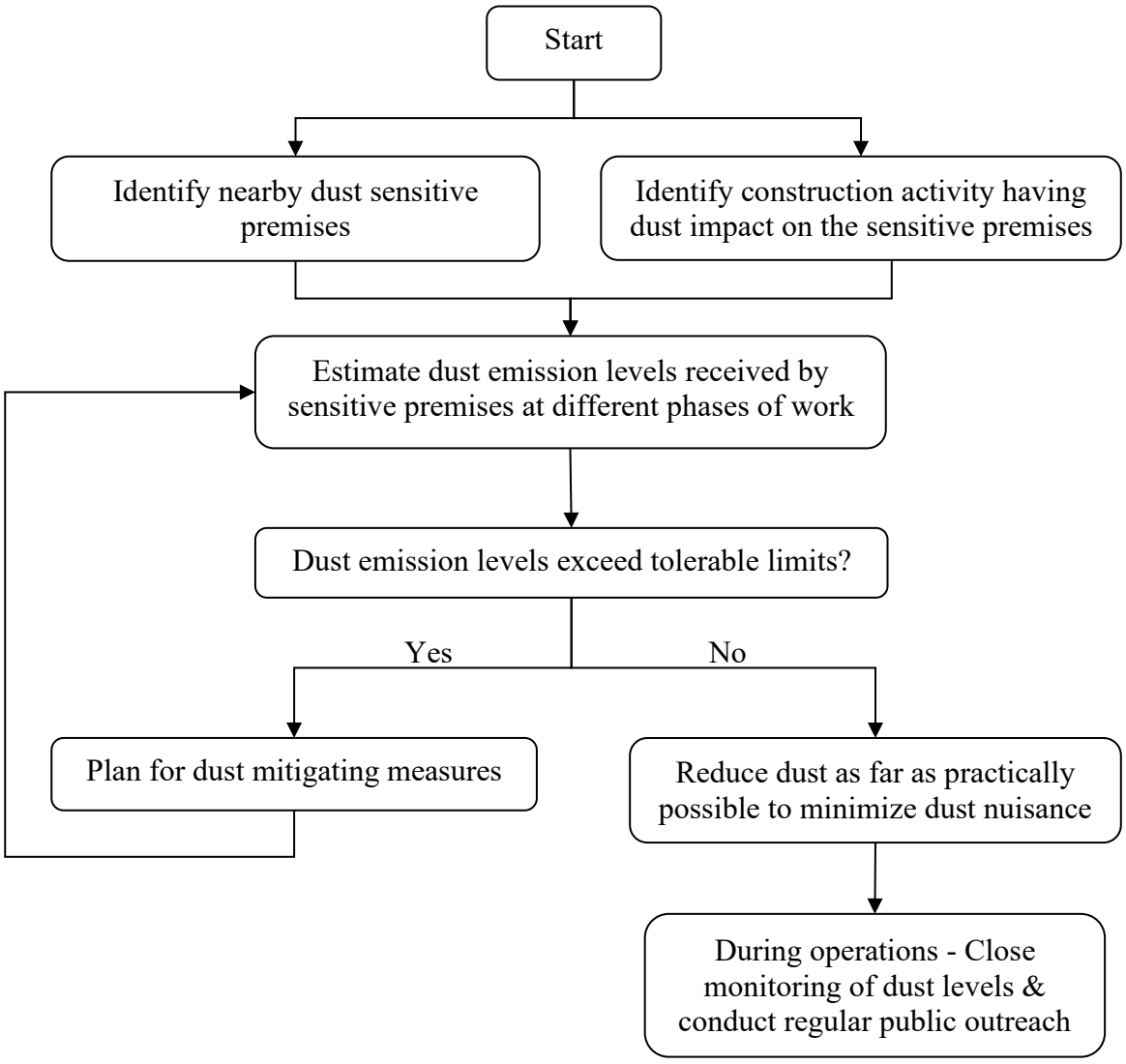
Best dust control practices will be implemented throughout the project. Dust control practices include wetting active demolition areas and vehicle access minimizing or ceasing activity during periods of high wind, sweeping or wetting paved areas, wetting unpaved areas, application of dust suppressant materials as well as covering stockpiles.

The DMP provides specific information about the generation and control of dust emissions during the demolition, stockpiling, and other activities associated with. The following sections detail potential dust sources and dust control methods.

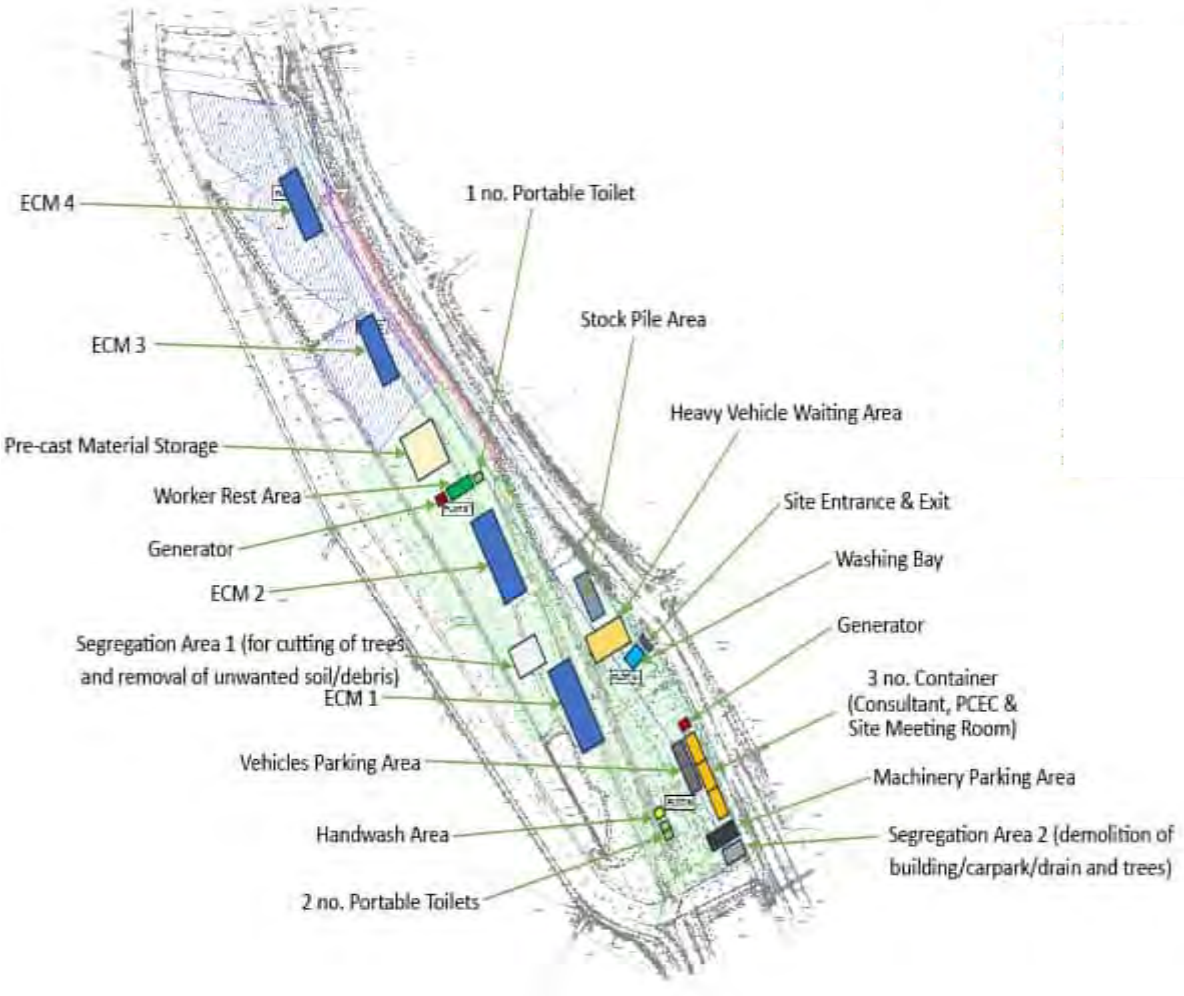
## 3. Site Preparation and Facilities Layout Plan

Upon site possession, site survey will be carried out immediately. Thereafter, construction site access, washing bay, diversion of existing services, site office set up, hoarding erection, instrumentation will be carried out. Earth Control Management (ECM) plant will be set up prior to earth works.

**Dust control Preparations Flowchart**



**Site Facility Layout Plan for Choa Chu Kang Town N1 – D/354/23**




## 4. Dust Generation Sources

- ***Sand and aggregate piles*** that are disturbed will cause fine sand dust to be airborne, especially during dry weather.
- ***Machinery movement*** on site will cause fine dust to be airborne, especially when the floor is bare and dry.
- ***Concrete mixing*** utilizes sand, aggregates, cement and water in the process of introducing sand and cement into the mixer, sand and cement dusts can be entrained into the air.
- ***Vehicles or mechanical plant*** use diesel oil as fuel emits soot particles due to incomplete combustion of diesel fuel.
- ***Illegal open burning*** of building materials such as timber, paper, plastic, cardboards, etc. creates dust in the form of fine ashes and soot particles.
- ***Land clearing and earthworks, demolition, excavation, piling*** causes dust to be entrained in the air and aggravates in case of dry weather.

## 5. Dust Control Team

Dust control team consist of the following members:

- ✓ Environment Control Officer
- ✓ Site Supervisors and Foreman
- ✓ Water Truck Drivers
- ✓ Environmental Workers

## 6. Dust Control Equipment

Dust control equipment consist of the following:

- ✓ Canvas Sheets to cover stockpiles and bare earths
- ✓ Water pumps and enough water hose to wetting dry ground and site access
- ✓ Water Truck with sprinklers

## 7. Dust Control Measures

Dust control measures include the following:

- Cover or water daily any on-site stockpiles of debris, dirt or other dusty material.
- Use adequate water and/or other dust palliatives shall be used on all disturbed areas to avoid particle blow-off.
- Ensure all vehicle tyres are washed before exiting from site.
- Set the maximum speed limit for all vehicle as low as 10km/h.
- Wash down or sweep paved access as necessary to control track out or fugitive dust.
- Cover or tarp all vehicles hauling dirt or spoils on public roads if sufficient freeboard is not available to prevent material blow-off during transport.
- Ground cover would be re-established through watering on the disturbed parts of the construction area.
- Storage of sand & aggregates placed in proper pits and covered to prevent excessive entrainment of fines by strong winds or when large heavy vehicle passes by.
- Storage periods should be as short as possible. During hot dry weather, the sand heaps should be wetted regularly to keep dust down.
- Disposal of cement bags, solvent, paint and fuel containers to prevent residual dust and fumes emanating from these sources.
- Removal of refuse and construction debris on a daily basis to avoid sources for generation of dust.
- Educate workers and staffs on dust control method.
- Hoarding or screen to be erected around dusty activities and at site boundary wherever possible.
- Site fencing and barriers will be kept clean by cleaning regularly using wet methods.
- Use cutting, grinding or sawing equipment fitted with, or in conjunction with, suitable dust suppression techniques such as water sprays or local extraction whenever possible.

## 8. Additional Control Measures

To apply the following additional control measures when needed:

- Engage water truck full time to wet access continuously.
- Deploy a gatekeeper to monitor and control traffic flow.
- Instruct gate keeper to monitor the cleanliness of vehicles exiting the site and ensure that they are clean before exiting.
- Carry out earth works and hardcore crushing works according to the wind directions.
- Install more speed warning signage along the site access to make sure all drivers are aware on speed control.
- All truck drivers are instructed by traffic controller to drive by designated site root only and follow the traffic rules implemented at site.
- Neighbour contractors who share the same site access must comply with our site standards on environmental control.

## 9. Public Relations

The contractor should establish and maintain good relations with people living and working close to the construction site. Good relations will help towards allaying people's fears and annoyance of the disamenities resulting from construction work. The contractor should keep people informed of progress and manage complaints fairly and promptly. The contractor should appoint personnel to be in charge of public relations as the point of contact with the public.

Public relations should be carried out even if dust levels do not exceed tolerable limits. The public should be informed in advance of any scheduled work which would result in unusual dust pollution. The contractor should also inform the public of the mitigating measures implemented to assure them that the risk of dust emitting into the air is minimised and under control.

Some of the methods the contractor should consider in community outreach are:

- Providing a hotline for public to feedback
- Distribute flyers, newsletters, circulars
- Manage complaints and explaining cause of noise
- Door-to-door visits
- Updating stakeholder through face-to-face engagement / engagement meeting
- Setting up a liaison office for the public (for longer term projects)

## 10. Feedback to Management

Feedbacks will be forwarded to ECO for recording purpose and follow ups:

- Details of the caller would be noted down, e.g., name, contact and residential address, etc.
- From the information given, the region would be traced and located.
- The work activities around the region would be required to stop.
- The dust control team will be deployed to take necessary actions to rectify the dust issue and prevent reoccurrence.

## 11.Dust Generating Activities and Preventive Measures

Examples of dust generating activities and good practices on dust control at worksites:

a. Spray water on vehicle tyres at water bay area before exiting the site



b. Wetting of site access and bare ground



c. Cover stockpiles to prevent dust generation



d. Display speed limit and warning signages



e. Install speed hump at site access to control vehicles' speed and manage dust generation



# Appendix G
# Noise Management Plan

Delivering a better world

# Noise Management Plan

## PROJECT: SITE PREPARATION WORKS AT CHO CHU KANG TOWN N1

| | | | |
|---|---|---|---|
| Prepared by: | Mr. Marcus Gugana Puli Thevan (Environmental Control Officer) | Date | 03/08/2023 |
| Approved by: | Mr. Er Raymond Reng (Project Manager) | Date | 03/08/2023 |

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# 1. Introduction

The noise management plan outlines the program on noise management and surveillance to ensure that noise control is effective to meet requirements.

The objective of a construction noise management plan (NMP) is to help developers and contractors estimate the noise impact and plan for measures to ensure compliance with the construction noise permissible limits and to reduce noise nuisance to nearby sensitive receivers.

The NMP should be carried out prior to the award of contract so that alternative construction methods, scheduling and any measures required for noise mitigation could be incorporated as part of the contract requirements.

# 2. Procedures for preparation of noise management plan

The NMP should contain information presented in the form of a template as shown in Appendix B.

The information to be presented should include but not limited to the following:

a) Project and contact information;

b) Identification of nearby sensitive premises;

c) Site layout with locations of equipment;

d) Schedule of work

-showing the estimated time for each phase of construction

-demonstrating consideration of noisy activities;

e) List of powered equipment and their noise emission levels;

f) Noise assessment including total anticipated noise emission levels;

g) Noise control measures with estimated noise reduction levels;

h) Background noise monitoring and locations of noise meters;

i) Public relations strategies;

j) Supporting documents (i.e. site map, photographs, equipment certificates etc)

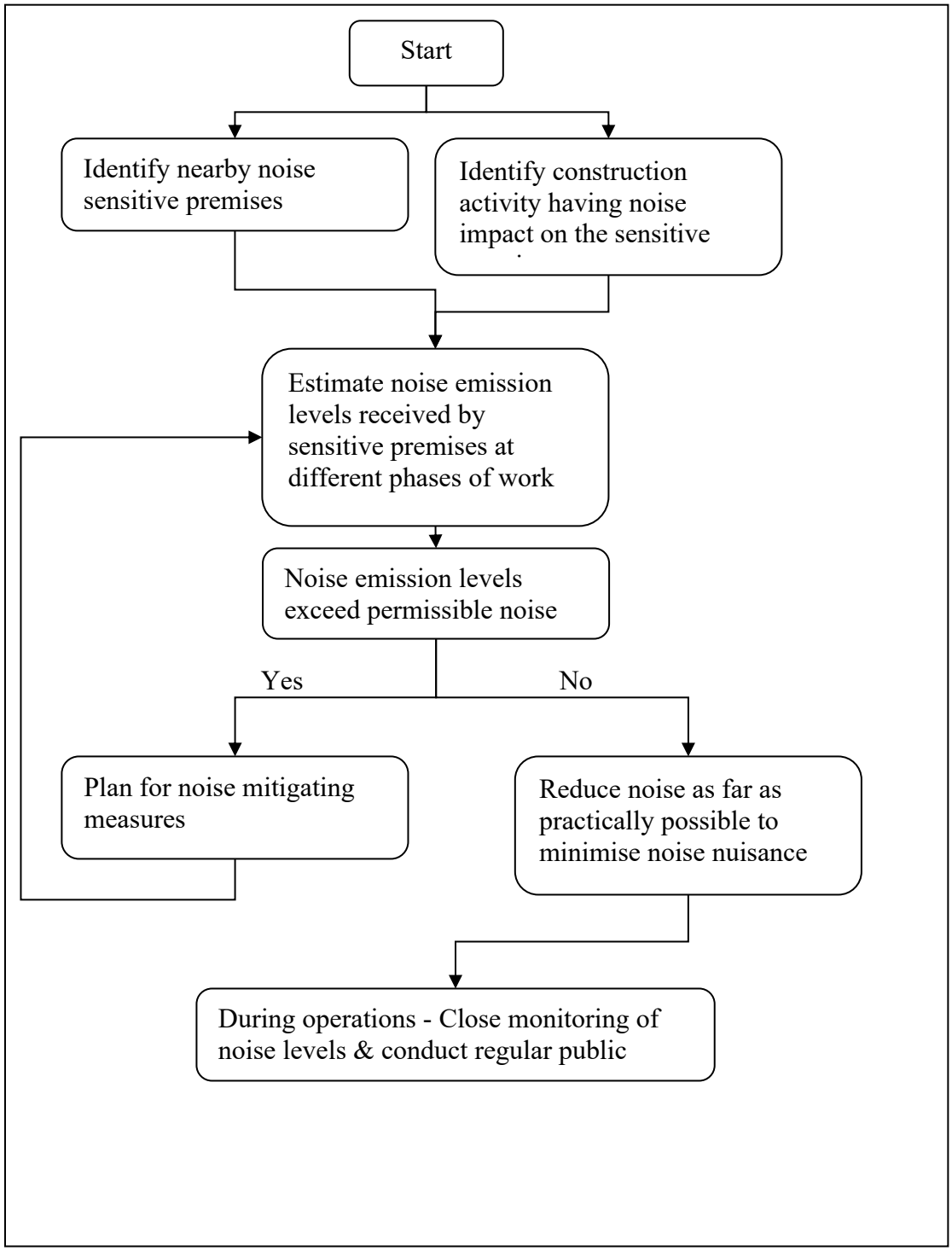
Total noise levels received at the sensitive premises at different phases of the construction work should be estimated and compared against the applicable construction noise permissible limits. The developer or contractor may refer to “SS CP 49 – Code of Practice for Noise Control on

Construction and Demolition Sites" for procedures to estimate construction noise from known activities.

If noise levels are found to be exceeding, noise mitigating measures should be planned and implemented to bring down the noise levels well within permissible limits. Noise mitigation could be performed at source, pathway, or receiver. Usually, noise mitigation at the source may be most effective and cheapest. If the noise levels cannot be substantially brought down by mitigation at the source, a combination of mitigating measures at source, pathway and receiver should be considered.

Regardless of the noise levels, more sensitive people may still complain about noise nuisance. Contractors should establish and maintain good community relations with people staying nearby. This could be done by regularly updating people of the work schedule, gaining rapport and understanding, managing their feedback and see how best to meet their requests.

**Flow chart for Preparing NMP**



## 3. Noise Control

Control of Noise Source

Where possible, noise should be controlled at its source. Noise may be emitted from worker's manual activities, noisy equipment, engines, vehicles and on-site plants. Noise control measures include training of workers, use of newer machines, insulating noisy machines, retrofitting noisy machines and setting up enclosures around noisy machines etc.

Proper Scheduling

Noise can be controlled by proper scheduling of noisy activities over the project period as well as on a daily basis. When planning for the project schedule, the contractor shall factor in the no-work rule on Sundays and public holidays, and restrict the duration of noisy activities in order to control noise levels within permissible limits.

On a daily basis, the contractor should supervise the working hours of noisy activities to ensure that noise levels will stay within permissible limits. In addition the contractor should also be mindful of nature of the land use in the area, and reduce noise and other nuisance and far as practically possible.

Location of Noisy Equipment

Increasing the distance between noise source and the sensitive premises is the most effective method to control noise. Stationary plants such as compressors and generators should be sited furthest away from noise sensitive premises

Noise Barriers

In situations where it is not possible to reduce a noise problem by increasing the distance between the source and receiver, noise barriers might have to be considered. For maximum benefit the noise barriers should be either close to the noise source or to the receiver. Tall noise barriers can be built around the site perimeter to double up as a hoarding, or along the façade of residential buildings. Removal of a direct line-of-sight between the noise source and sensitive premises may be advantageous physically and psychologically. Site buildings such as site office and storage may be close together to act as noise shield between noise source and sensitive premises.

## 4. Noise Barrier Requirement

Noise barriers can provide an attenuation of around 5dB to 10dB when a line-of-sight between the noise source and the receiver is removed. Specifically designed and positioned noise barriers could provide greater attenuation.

The developer or contractor may refer to CP49 or BS5228 for the design and calculation of noise attenuation by noise barriers.

## 5. Public Relations

The contractor should establish and maintain good relations with people living and working near to the construction site. Good relations will help towards allaying people's fears and annoyance of the disamenities resulting from construction work. The contractor should keep people informed of progress and manage complaints fairly and promptly. The contractor should appoint personnel to be in charge of public relations as the point of contact with the public.

Public relations should be carried out even if noise levels do not exceed permissible limits as people may still be annoyed by noise nuisance. The public should be informed in advance of any scheduled work which would result in unusually loud noise or other nuisance. The contractor should also inform the public of the mitigating measures implemented to assure them that noise impact has been properly controlled.

Some of the methods the contractor should consider in community outreach are:

- Providing a hotline for public to feedback
- Distribute flyers, newsletters, circulars
- Manage complaints and explaining cause of noise
- Door-to-door visits
- Updating stakeholder through face-to-face engagement / engagement meeting
- Setting up a liaison office for the public (for longer term projects)

## 6. Recommended measures

The Contractor should take all practicable steps as outlined in SS CP 49 to reduce noise arising from site activities to the minimum. These steps include, but not limited to:

a) All machinery and plant must be sound reduced prior to entering the site.
b) Noisy plant must be housed in an acoustic shed.
c) Noisy activities must be barricaded with portable sound barriers/panels.
d) All plant/machinery/equipment must be pasted with a weather-proof sticker clearly indicating its noise emission level (at source) under normal operating condition.
e) All machinery in operation must have their covers properly always shut.
f) Noise barriers should be erected before any work commences if the site is within proximity to residences and/or sensitive buildings
g) The contractor should commit sufficient effort and time into public relation works to establish good rapport with the community.
h) For sites near to schools, the contractor should note that all construction works, which generate substantial noise, should not be carried out during the school examination periods
i) For sites near to schools, the Contractor should obtain an official confirmation of the examination schedules from the School Administrator including revision of schedules.
j) All compressors, generators, welding sets etc should be of sound reduced models fitted with properly lined and sealed acoustic covers which shall be kept closed whenever the machines are in use and all ancillary pneumatic percussive tools shall be fitted with mufflers or silencers of the type recommended by the manufacturer.
k) All machines in intermittent use should be shut down or throttled down to a minimum in the intervening periods between works.
l) All pile driving should be carried out by a recognized noise reducing system. Rotary drills and busters actuated by hydraulic or electrical power should, where practicable, be used for excavating hard material. Noisy construction plant such as cement batching plant, should be sited as far away as possible from occupied buildings. Noise barriers should be erected to shield noise from such plants.
m) Care should be taken when loading or unloading vehicles, to reduce impact noises. Access to the working areas shall ensure minimum disturbance to people in occupied buildings.

## 7. Noise monitoring

Noise meter Requirement

The noise meter should be installed at the most sensitive premises nearest to the construction site. The noise meter should be at a location with clear line-of-sight to the construction site, not near to large reflecting surfaces, not likely to be tempered by the public and not interfered by other sound sources. A good example is the rooftop of a residential apartment overlooking the construction site.

Large construction sites and construction sites surrounded by sensitive premises that are far apart may require installing more than 1 noise meter.

Real-time noise monitoring systems which are sent for calibration or servicing should be replaced by at least a normal noise monitoring system. During this interim period, the noise chart must be submitted to NEA on a weekly basis

Background Noise Monitoring & Correction

In order to take into account effects of background noise on site, a background noise study should be carried out prior to construction work. The background noise study should be carried out over a minimum period of 1 week, on a 24 hour basis. Daily noise levels should be tabulated in terms of Leq during the daytime (7am-7pm), evening (7pm-10pm), night (10pm-12am) and past midnight (12am-7am). Leq levels of the background noise should be calculated for weekdays, Saturdays and Sundays for daytime, evening and night.

The noise monitoring system should be adjusted according to the average background noise levels so as to allow the correct triggering of SMS alert when construction noise levels exceed the corrected permissible limits. The permissible noise limits should be corrected according to the correction table in Annex D.

Contractors should submit the background noise study with the proposed corrected permissible noise limits. Please provide the login details of your noise meter and the duration for which your background study (1-2 weeks without work) was carried out in Annex C. Thereafter, please fill in the table with the corrected limits based on the background noise levels and the suitable correction factor. .

Reference
Singapore Standard CP 49:1998 - Code of Practice for Noise Control on Construction and Demolition Sites

BSI British Standards BS 5228-1:2009 - Code of practice for noise and vibration control on construction and open sites – Part 1: Noise

Annex A

# Construction Noise Maximum Permissible Limits

**Maximum Permissible Noise Levels for Construction Work Commenced on or after 1st October 2007**

Mondays to Saturdays

| Types of affected buildings | 7am - 7pm | 7pm - 10pm | 10pm - 7am |
|---|---|---|---|
| (a) Hospital, schools, institutions of higher learning, homes for aged sick, etc | 60 dBA (Leq* 12 hrs) | 50 dBA (Leq 12 hrs) | |
| | 75 dBA (Leq 5 mins) | 55 dBA (Leq 5 mins) | |
| (b) Residential buildings located less than 150m from the construction site | 75 dBA (Leq 12 hrs) | 65 dBA (Leq 1 hr) | 55dBA (Leq 1hr) |
| | 90 dBA (Leq 5 mins) | 70 dBA (Leq 5 mins) | 55 dBA (Leq 5 mins) |
| (c) Buildings other than those in (a) and (b) above | 75 dBA (Leq 12 hrs) | 65 dBA (Leq 12 hrs) | |
| | 90 dBA (Leq 5 mins) | 70 dBA (Leq 5 mins) | |

Sundays and Public Holidays

| Types of affected buildings | 7am - 7pm | 7pm - 10pm | 10pm - 7am |
|---|---|---|---|
| (a) Hospital, schools, institutions of higher learning, homes for aged sick, etc | 60 dBA (Leq* 12 hrs) | 50 dBA (Leq 12 hrs) | |
| | 75 dBA (Leq 5 mins) | 55 dBA (Leq 5 mins) | |
| (b) Residential buildings located less than 150m from the construction site | 75 dBA (Leq 12 hrs) | - | - |
| | 75 dBA (Leq 5 mins) | 55 dBA (Leq 5 mins) | |
| (c) Buildings other than those in (a) and (b) above | 75 dBA (Leq 12 hrs) | 65 dBA (Leq 12 hrs) | |
| | 90 dBA (Leq 5 mins) | 70 dBA (Leq 5 mins) | |

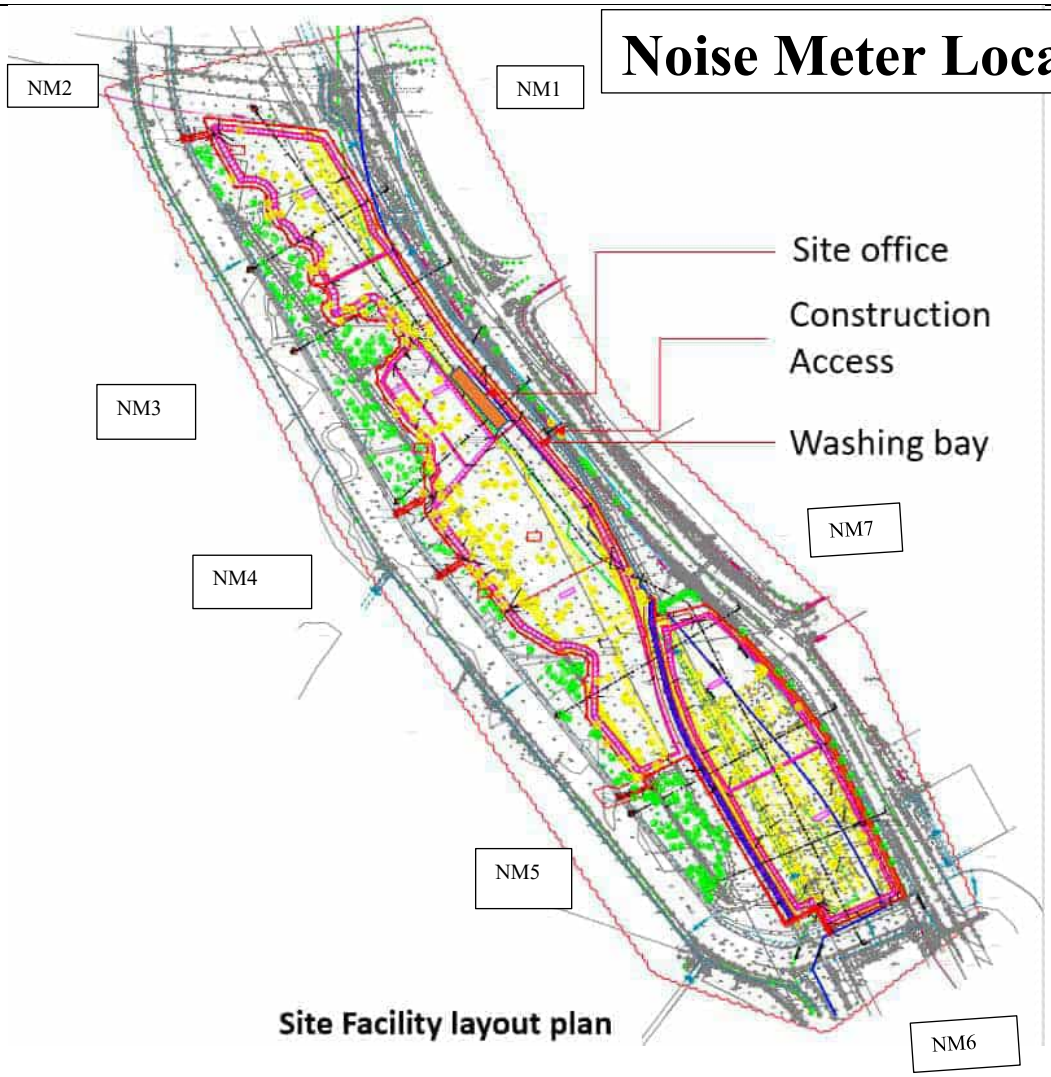
* - reckoned as the equivalent continuous noise level over the specified period, i.e. 5 mins, 1 hr or 12 hrs.

Annex B

## Submission Template

| | | |
|---|---|---|
| **1** | **GENERAL INFORMATION** | |
| 1.1 | Project Name | Site Preparation works at Cho chu kang town N1 |
| 1.2 | Contractor Name | Peng Chuan Engineering Construction Pte Ltd |
| 1.3 | Developer Name | HDB |
| 1.4 | Site Location | Cho chu kang town N1 |
| 1.5 | Project Cost | $6,418, 000 |
| 1.6 | Contact Details | |
| | Project Manager | Er Raymond Reng |
| | ECO | Marcus Gugana Puli Thevan |
| 1.7 | Start Date (BCA permit approval date) | TBA |
| 1.8 | Expected Completion of Project | 2nd Quarter 2025 |

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| **2** | **SURROUNDING INFORMATION** | |
| 2.1 | Provide site map (presented on OneMap) with indication and the location of the site:<br>  <br><br>**Site Facility layout plan** | |
| 3 | ON-SITE INFORMATION | |
| 3.1 | Provide site map showing the following:<br>- How is the site going to be utilized throughout the project?<br>- Noise meter location | |




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| 4 | CONSTRUCTION ACTIVITIES | | |
| 4.1 | What are the construction activities that will be carried out and their schedule? | Type of work | Duration (state the months) |
| | | Demolition | |
| | | Excavation | 24 months |
| | | Piling | |
| | | Structural | |
| | | Architectural | |

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| **5** | **POWERED EQUIPMENT** | | |
| 5.1 | List the type and number of powered equipment expected to be used (e.g. generators, tower cranes etc) | Generators | |
| 5.2 | List the type and number of powered equipment to be used for demolition (e.g. crushers, excavators, breakers etc) | Excavator with Crusher attachment, Excavator with Breaker Attachment, generator for Mist Cannon | |
| 5.3 | List the type and number of powered equipment to be used for piling (e.g. bored pile, jack-in pile etc) | NA | |
| **6** | **NOISE ASSESSMENT** | | |
| 6.1 | What is the risk of noise from work affecting neighbor's? State the reason for the level of risk selected.<br>- Low (existing noise levels high, small-scale work)<br>- Medium (some powered equipment used)<br>- High (several powered equipment; near | Medium, excavators working near Noise Sensitive Premises. | |

| | | |
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| | to sensitive premises) | |
| **7** | **NOISE CONTROL MEASURES** | |
| 7.1 | What are the proposed measures to ensure compliance with NEA's noise limits? E.g. scheduling of work, close monitoring of noise readings | Scheduling works during the day, noise monitoring device, hoarding |
| 7.2 | What are the actions to be taken should the noise levels exceed limits i.e. Leq (5 minutes)? | - Investigate and find the source of noise<br>- Stop work, rectify, and continue. |
| 7.3 | What are the measures to control noise source? Provide the location of these measures on the site map<br><br>E.g. low noise piling methods, use of quiet power generators, enclosures for plant, use of precast concrete units, re-useable formwork, fixed mains power, controls on delivery times, maintenance | -Monthly maintenance<br>-Avoid bringing old machineries to site<br>-No using of breaker on site |

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| | plan, staff training/ induction | |
| 7.4 | What are the measures to control noise path? Provide the location of these measures on the site map<br><br>E.g. Noise barrier, screening<br><br>tate the specifications of the noise barrier | Panel Hoarding |
| **8** | **NOISE MONITORING** | |
| 8.1 | Has a pre-work site noise survey been conducted? If yes, what are the measured noise levels?<br><br>-After takeover of site and installation of Noise Meters | |
| 8.2 | Are real-time noise meters installed at appropriate locations? Provide location of the noise monitors on site map and picture(s) of noise meter(s) installed.<br><br>-Refer to question 3.1 | |
| 8.3 | Are the noise meters certified? Provide certificate to prove that noise meter is of Type 1 and certified by IEC 61672.<br><br>-Yes | |
| 8.4 | What is the background noise level and correction factor used? | -Will monitor and get a baseline reading after takeover of site and installation of Noise Meters |
| 8.5 | Have the permissible noise limits for your noise meters been adjusted by NEA? | NA |
| 8.6 | Provide the internet link for access to the real-time monitoring data and | -Will provide after takeover of site and installation of Noise Meters |

| | | |
|---|---|---|
| | also the login ID and password | |
| **9** | **PUBLIC RELATIONS** | |
| 9.1 | Name and contact of officer in charge of PR | Bai Ziwei |
| 9.2 | How is the community going to be notified of the construction works? How often will they be notified? | - Circulars pasted on lift landings surrounding the site |
| 9.3 | What method will be used? (e.g. newsletters, signboards)<br><br>Provide samples | -Circulars pasted on lift landings |
| 9.4 | What are the channels for public feedback? Is a contact number provided for public feedback? How would you deal with noise complaints? | -Yes, PRO contact number is provided on the circulars<br>-Investigate the source of noise and rectify the issue. |
| 9.5 | If site is near noise sensitive premises such as schools, what arrangements have you worked out with them to minimize nuisance? | -Stop noisy works during exams<br>-No schools within 1km vicinity of site |

# Appendix H
# Public Communications Plan

Delivering a better world

# Public Communications Plan

## PROJECT: SITE PREPARATION WORKS AT CHO CHU KANG TOWN N1

| | | | |
|---|---|---|---|
| Prepared by: | Mr. Bai Ziwei<br>(Project Coordinator) | Date | 10/10/2023 |
| Approved by: | Mr. Raymond Er<br>(Project Manager) | Date | 10/10/2023 |

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# 1. Introduction

The public communications plan outlines the program of communication with stakeholders affected by the construction work along with the avail relaying channels to reduce the impact.

Site clearance and civil engineering works has work process that will have a disruptive effect on the lives of residents in the vicinity. Lorry access and moving of other plants and machinery will unavoidably result in formation of dust and noise.

The objectives of a construction public communications plan are as follow:

a) To establish contacts and maintain good relationships with the stakeholders;
b) To garner support and understanding from the stakeholders;
c) To pre-empt feedback and inform the stakeholders in advance of works that will cause inconvenience to them;
d) To empathize with the stakeholder' situation and address their concerns raised promptly;
e) To engage the stakeholders regularly to keep them updated on the progress and development of the project; and
f) To provide a communication channel for the stakeholders to raise their suggestions or feedback to Peng Chuan Engineering Construction Pte. Ltd. and HDB.

The public communications plan should be carried out prior to the award of contract so that alternative construction methods, scheduling and any measures required to maintain good relationship with stakeholders could be incorporated as part of the contract requirements.

The contractor should establish and maintain good relations with people living and working near to the construction site. Good relations will help towards allaying people's fears and annoyance of the di s-amenities resulting from construction work. The contractor should keep people informed of progress and manage complaints fairly and promptly. The contractor should appoint personnel to be in charge of public relations as the point of contact with the public.

Public relations should be carried out to mitigate potential negative impacts such as dust emissions, noise/ air pollutions, damage to property, pedestrians'/ motorists' safety, environmental hazards, etc. The public should be informed in advance of any scheduled work which would result in unusually pollution. The contractor should also inform the public of the mitigating measures implemented to assure them of their safety.

Some of the methods the contractor should consider in community outreach are:

- Providing a hotline for public to feedback
- Distribute flyers, newsletters, circulars
- Manage complaints and explaining cause of noise
- Door-to-door visits
- Updating stakeholder through face-to-face engagement / engagement meeting
- Setting up a liaison office for the public (for longer term projects)

## Project Overview




## 2. Procedures for preparation of public communications plan

It should contain information presented that is relevant to the project. The information to be presented should include but not limited to the following:

a) Project and contact information;

b) Identification of nearby sensitive premises;

c) Site layout with locations of equipment;

d) Measure to ease pollution implemented

e) Channel of communication with stakeholders

f) Standard operating procedure for response

d) Schedule of work

- showing the estimated time period for each phase of construction
- demonstrating consideration of dusty activities;

g) Supporting documents (i.e. site map, photographs, equipment certificates etc.)

Regardless of the mitigating measure implemented, feedbacks are bound to be received as disruption is caused during construction activities. This plan aims to establish and maintain good community relations with people staying nearby. This could be achieved by regularly updating people of the work schedule, gaining rapport and understanding, managing their feedback and see how best to meet their requests.

## 3. Public Relation Measures

Availability of Feedback channel

Where possible, information for the feedback channel should be made available so that effective communication can take place. Such information could be pasted around the hoarding or pasted at HDB/Condo Lift landing area. With a direct feedback channel, Contractor will be able to quickly discuss and implement mitigating measures.

Proper Scheduling

When planning for the project schedule, the contractor shall factor in the no-work rule on Sundays and public holidays and restrict the duration of dusty activities to control dust levels within tolerable limits. There are also certain times where other stakeholders may request a work activity such as noisy work. be performed later in the day. Should it not affect progress of the project, it may be implemented to show that feedbacks have been taken into account.

Location of dusty or noisy Equipment

Increasing the distance between source and the sensitive premises is the most effective method reduce the disturbance cause. Stationary plants such as compressors and generators should be sited furthest away from dust sensitive premises.

Barricade/ Barriers

In situations where it is not possible to reduce a dust problem by increasing the distance between the source and receiver, barriers might have to be considered. Such as noise barriers, for maximum benefit the noise barriers should be either close to the noise source or to the receiver. Removal of a direct line-of-sight between the source and sensitive premises may be advantageous physically and psychologically.

Site buildings such as site office and storage may be close together to act as dust shield between dust source and sensitive premises.

## 4. Conclusion

The purpose of having a public communication plan is that it helps to outline the key objectives for the Contractor as how the project is managed with regards to sensitive premises. Through an communication plan, it aims to achieve that project progress is not impeded by external forces and able to meet delivery date.

- Keeping project stakeholders informed about the project schedule, progress, and upcoming milestones. Emphasizing communication can lead to a more tolerant and friendly “neighbour” and quicken work progress.
- Establishment of Public Relations Officer (PRO) serving as the main point of contact for project stakeholders regardingany questions, concerns, and complaints that arise during construction. Dedicated personnel thatresponse to such feedback is effective in presenting the Contractor’s dedication to work with thestakeholders through this project.
- Putting time back into Project Team. Effectively communicating with all project stakeholders relieves our clients of the need to address complaints and information requests.
- Reduce backlash of complaints. Through providing a channel, it can reduce the amount of investigation and miscommunication which can easily occur when the feedback trickles down back to the contractor. It might result in the misunderstood stakeholder escalating a minor inconvenience which is unnecessary.

# Appendix I
# Lighting Management Plan

Delivering a better world

# Lighting Management Plan for Night-time Construction Works

### Purpose of the Lighting Management Plan

The objective of the lighting management plan for a construction site is to define the guidelines governing the choice, placement, installation, and utilization of lighting fixtures during night construction operations. The main goal is to regulate the utilization of artificial nighttime lighting within the construction site, prioritizing the safety of workers, while simultaneously mitigating adverse impacts on nearby forested areas and wildlife. In essence, the illumination should be employed only under the following conditions: (1) when necessary, (2) where necessary, (3) at appropriate luminosity levels for specific construction tasks, and (4) with a light spectrum suitable for wildlife.

This document to all stages of the Construction Phase. This document also applies to all construction workers and their activities as they perform their duties for the project.

## Scope of Works

Only safety-critical tasks that cannot be completed during the daytime are permitted at night. Night work is defined as work performed before or after the allotted working hours of 8:00 a.m. to 5:00 p.m.

Before carrying out nighttime construction activity, permission must be acquired from the relevant authorities (i.e., NParks). To get the relevant Authorities' approval, the Contractor must prepare and submit their application for works, which must include a works-specific lighting management plan. When carrying out nighttime construction work, it is important to comply to any regulations established by the authorities.

## General Measures

The Contractor shall provide a works-specific lighting management plan for the works they intend to perform prior to the commencement of nighttime construction activities. This is to confirm the execution of the agreed-upon work schedule, as well as the timing and execution of the lighting control measures. Construction work done at night can only begin once the lighting management plan has been agreed upon with the EMMP Consultants and permission to begin work has been received from the relevant authorities.

The following general management actions will be put into practice:

- The Contractor should plan out the various building tasks so that they may all be completed during the day. Construction projects should only be carried out at night if they cannot be completed during the day, such as safety-critical projects.
    - Night-time construction projects should be avoided from March to July, when resident birds are at their peak nesting period.

- A works-specific lighting management plan that details (1) the site lighting plan, (2) a light monitoring plan for the nighttime construction works, and (3) the relevant construction technique statements should be created by the contractor. Before work starts and as needed (such as when there are significant changes to the lighting plan), these should be reviewed by the EMMP Consultant.
- Prior to beginning nighttime construction, the Contractor needs to measure light levels to establish a baseline.
- Before the job starts, a briefing on night work should be given to all staff members involved to inform them of safety precautions and wildlife response.
- Should any fauna incidents arise during the night works, the EMMP Consultant, who is on call, would be alerted right away.

## Lighting Management Measures

The lighting level provided at the work site should just only be enough to perform the construction or maintenance work, while ensuring the safety and security of the workers. There should be no excessive installation of lighting to minimise light spillage to the adjacent establishments and forested areas. This is to ensure the impact and disturbances to humans and other environmental sensitive receptors are minimal. Generally, lighting should only be provisioned (1) when it is strictly needed, (2) where it is need, (3) in the appropriate amount for a specific task, and (4) with the appropriate level and spectrum.

The contractor should adhere to the following measures:

- For lighting equipment:
  - Use warm lighting spectrum where possible during construction works after 6.00p.m. (i.e., soft white and warm white light bulbs, preferably at <2700K); and
  - Avoid the use of high UV and broad-spectrum lights (except for safety reasons).
- Minimise light spillage into adjacent sensitive areas by ensuring the following while maintaining the safety:
  - Ensure that lighting is only used when and where necessary, worksite to remain dark as much as possible;
  - Ensure that no direct light sources that are visible from the forest edge;
  - Ensure that the direction of the lighting used for construction works are away from the forested areas and tilted downwards as much as possible to prevent disturbance towards wildlife;
  - Ensure that the lighting used are directed/placed such that there is no unintended reflection of light towards the forested areas;
  - Temporary enclosures / barriers should be erected at the work area if necessary;
  - An opaque hoarding/screen should be installed at the night works area adjacent to forested areas;
  - Keep windows, doors and any openings closed and/or sealed for any indoor construction works, especially those facing the forested areas;

  - For welding works or other works requiring ventilation (e.g., painting, wallpapering, etc.), it is recommended that tarps be fitted loosely around the openings (e.g., windows, doors, etc.) to reduce artificial lighting from escaping the building while allowing sufficient air flow;
  - Light attenuating structures and/or materials (e.g., curtains, tarps, blackout coverings, etc.) should be used to cover glass walls as well as windows and doorways in rooms;
  - Ensure any lighting equipment is turned off when not in use, when it is safe to do so and after the end of night works.;
- During emergency (e.g., life safety, construction safety, and health hazard), the rescue operations and securing the safety of the site and personnel is of utmost importance. All available lights and equipment should be used for rescue operations;
- When workers step outside of the worksite to access sanitary facilities, the flashlights/headlamps used should be kept pointed towards the ground and away from forested areas for safety purposes. Restrict movements outside of the construction sites by workers to use designated sanitary facilities if possible;
- Light monitoring will be conducted using a light meter to monitor and document light levels around the worksite once every night during the night works. In areas where light levels exceed that of the baseline light levels, the site lighting plan should be reviewed to reduce light levels; and
- If there are any wildlife encounters during night works (e.g., trapped, injured, and dead wildlife by site lighting), the Wildlife Response Plan should be activated.

## Safety Measures and Risk Assessments

Risk assessment and standard work procedures will be conducted/developed prior to the start of night-time works. The Contractor will follow the processes highlighted in the Emergency Response Plan of the Environmental Management and Monitoring Plan.

In case of any wildlife encounters, the Wildlife Response Plan will be adhered to, similar to daytime works.

# Lighting Sample Guidelines




**Figure 1 Light source should be fully shielded and directed only at the work site to minimize light spillage**

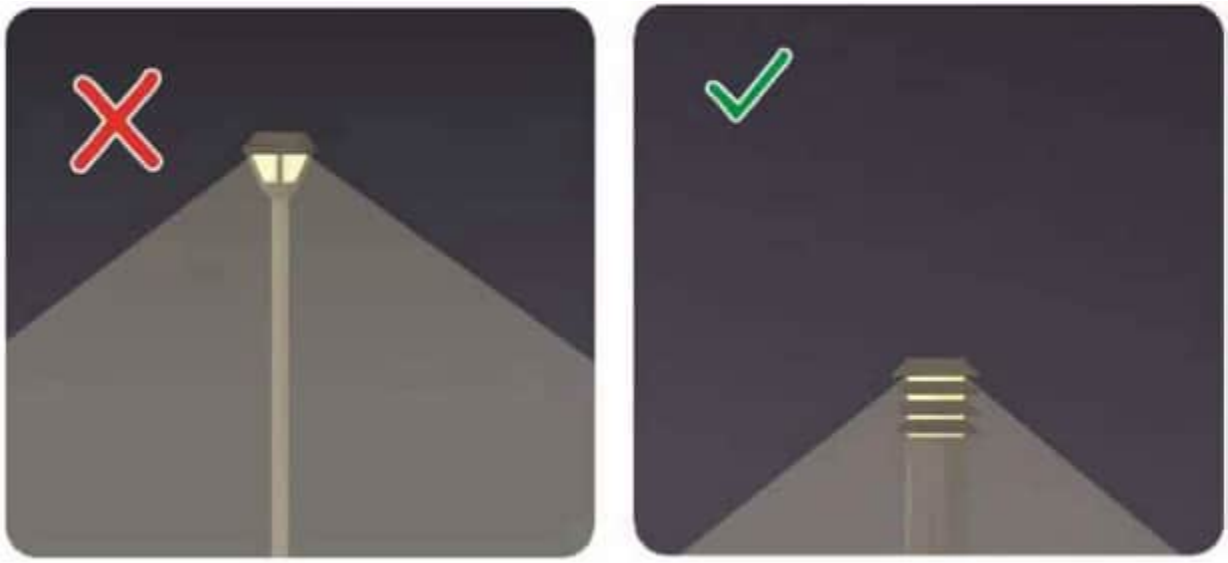


**Figure 2 Lighting should be mounted as low as possible and shielded to avoid light spillage at construction site**




**Figure 3 Lighting should be directed at only the work site where it is necessary for work safety**

Note: High hoarding (not indicated in figure) should be installed around area with nighttime work

# Appendix J
# Hoarding Plan

Delivering a better world

MEINHARDT INFRASTRUCTURE

Consulting Engineers, Planners & Managers

# SITE PREPARATION WORKS AT CHOA CHU KANG TOWN N1



## Hoarding Plan for CCK Town N1

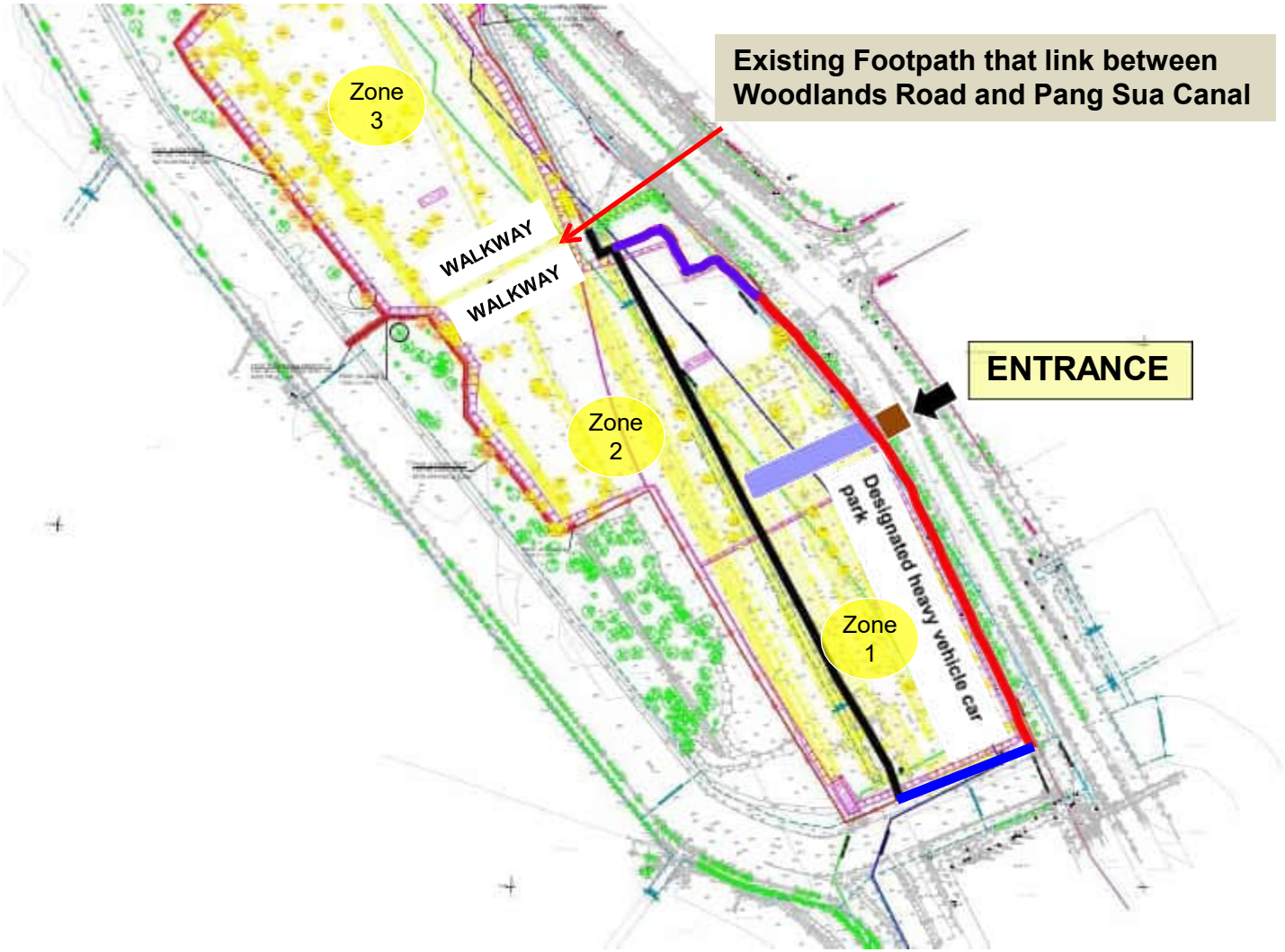
## Proposed Timeline for hoarding sequence




**Timeline Breakdown:**

- **Zone 1: W1-W12 WEEKS**
- **Zone 2: W13-W19 WEEKS**
- **Zone 3: W20-W27 WEEKS**
- **Zone 4: W28-W34 WEEKS**
- **Zone 5: W35-W40 WEEKS**

**Zone 1 – Since Zone 1 is designated as the heavy vehicle car park, it is assume that no wildlife is present in this area. Consequently, site clearance for Zone 1 will commence without the need for the shepherding process.**



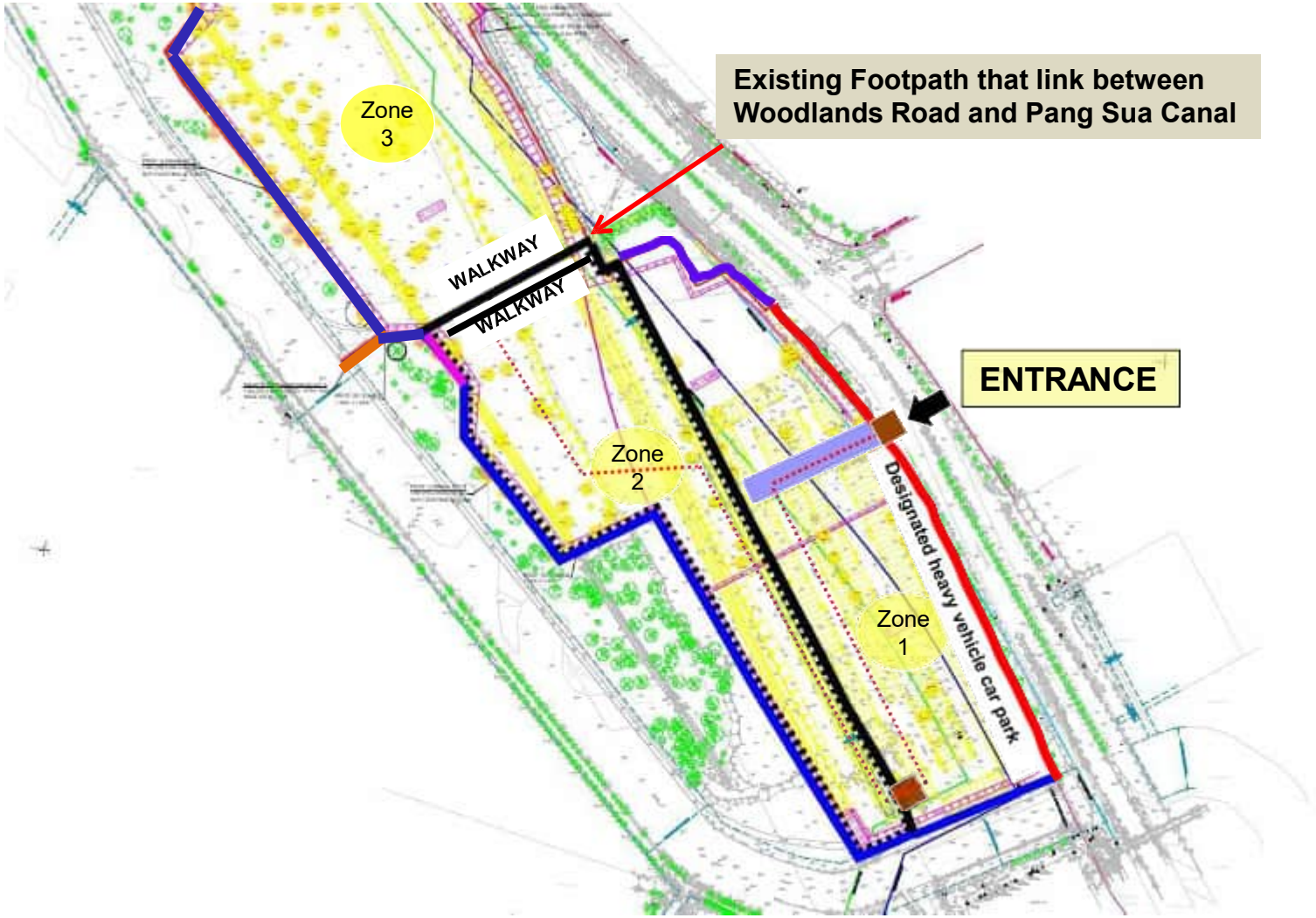

## Timeline Breakdown:

| | |
|---|---|
| Pre-felling checking | = 1 days |
| Tree Felling | = 3 days |
| Silent Period | = 3 days |
| Site Clearance | =14 days |
| Total | = 21 days |

## LEGENDS:

- : Proposed 3m noise barrier
- : Proposed 12m noise barrier
- : 2.4m metal hoarding
- : 6m width working space for hoarding
- : Wildlife shepherding opening
- : Wildlife shepherding direction
- : Road access
- : Proposed 2m height hoarding
- : gate for vehicle access
- : vehicle route plan

## Zone 2 - Step 1: Install 3m noise barrier / 2.4m metal hoarding along boundaries



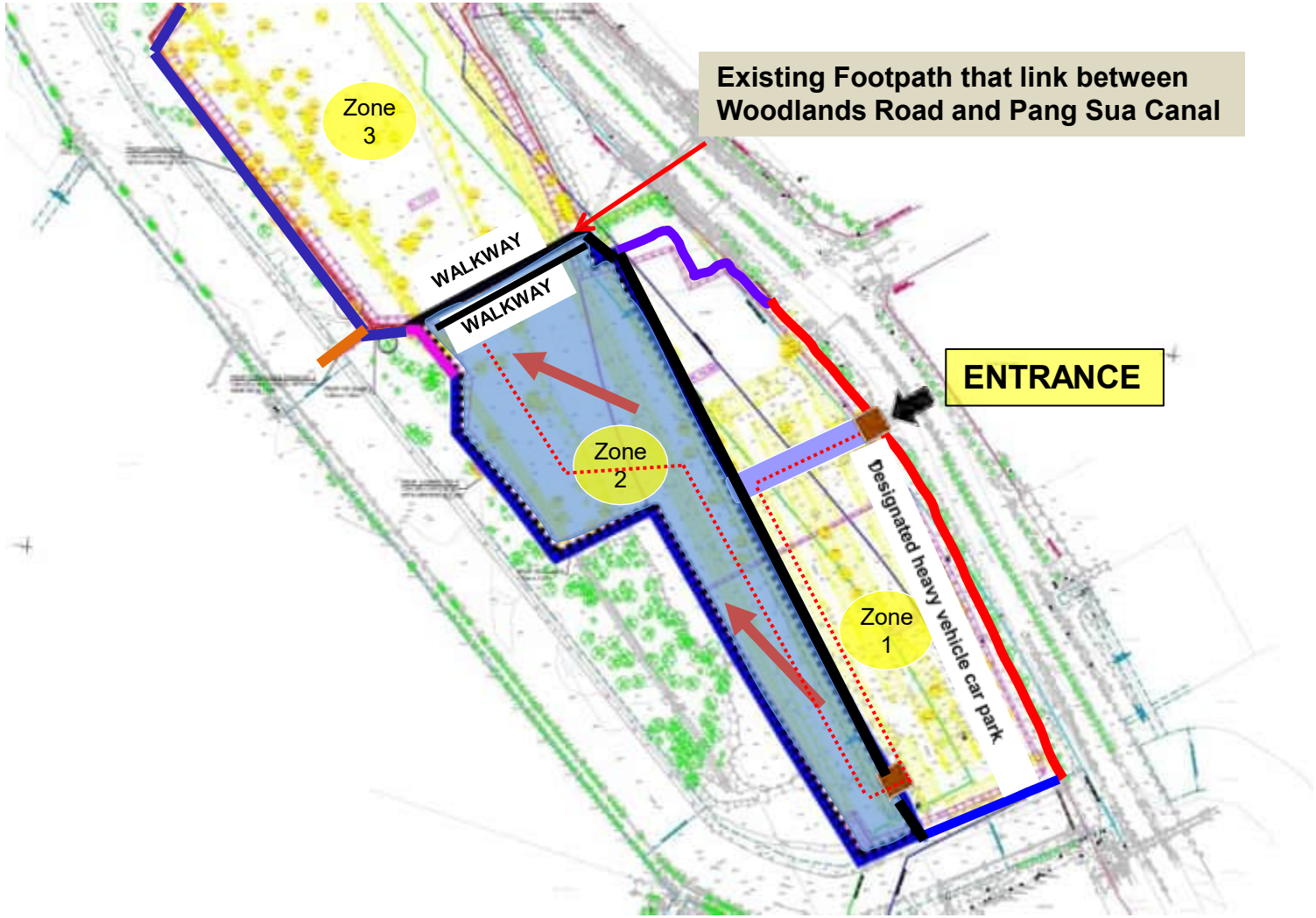

**Timeline Breakdown:**

| | |
|---|---|
| Pre-felling checking | = 1 days |
| Tree Felling | = 3 days |
| Silent Period | = 3 days |
| Site Clearance | =14 days |
| Total | = 21 days |

**LEGENDS:**

- : Proposed 3m noise barrier
- : Proposed 12m noise barrier
- : 2.4m metal hoarding
- : 6m width working space for hoarding
- : Wildlife shepherding opening
- : Wildlife shepherding direction
- : Road access
- : Proposed 2m height hoarding
- : gate for vehicle access
- : vehicle route plan
- : Temporary Hoarding

## Zone 2 - Step 2: Wildlife shepherding and site clearance (Timeline = 21 days)



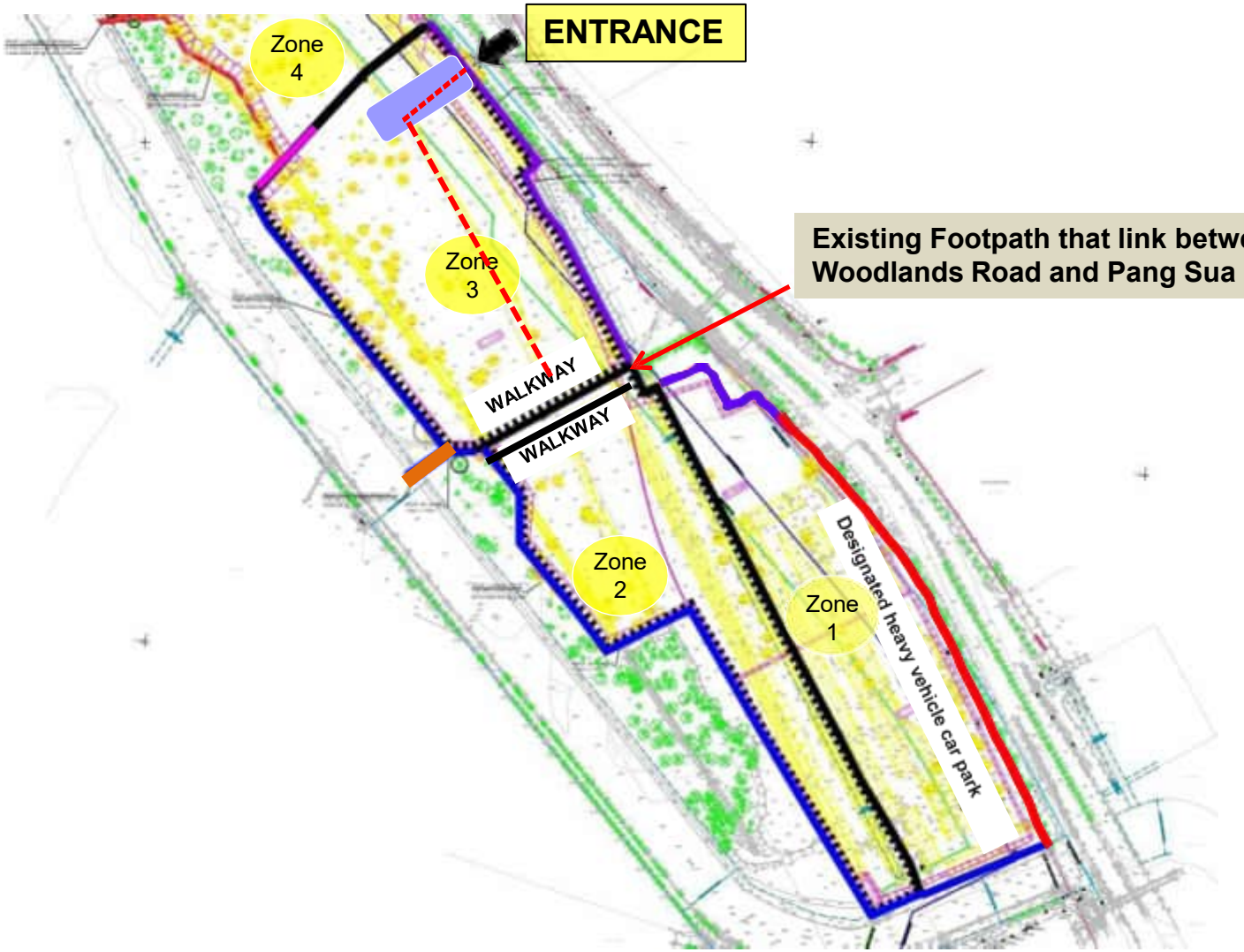

**Timeline Breakdown:**

| | |
|---|---|
| Pre-felling checking | = 1 days |
| Tree Felling | = 3 days |
| Silent Period | = 3 days |
| Site Clearance | =14 days |
| Total | = 21 days |

**LEGENDS:**

- : Proposed 3m noise barrier
- : Proposed 12m noise barrier
- : 2.4m metal hoarding
- : 6m width working space for hoarding
- : Wildlife shepherding opening
- : Wildlife shepherding direction
- : Road access
- : Proposed 2m height hoarding
- : gate for vehicle access
- : vehicle route plan
- : Temporary Hoarding

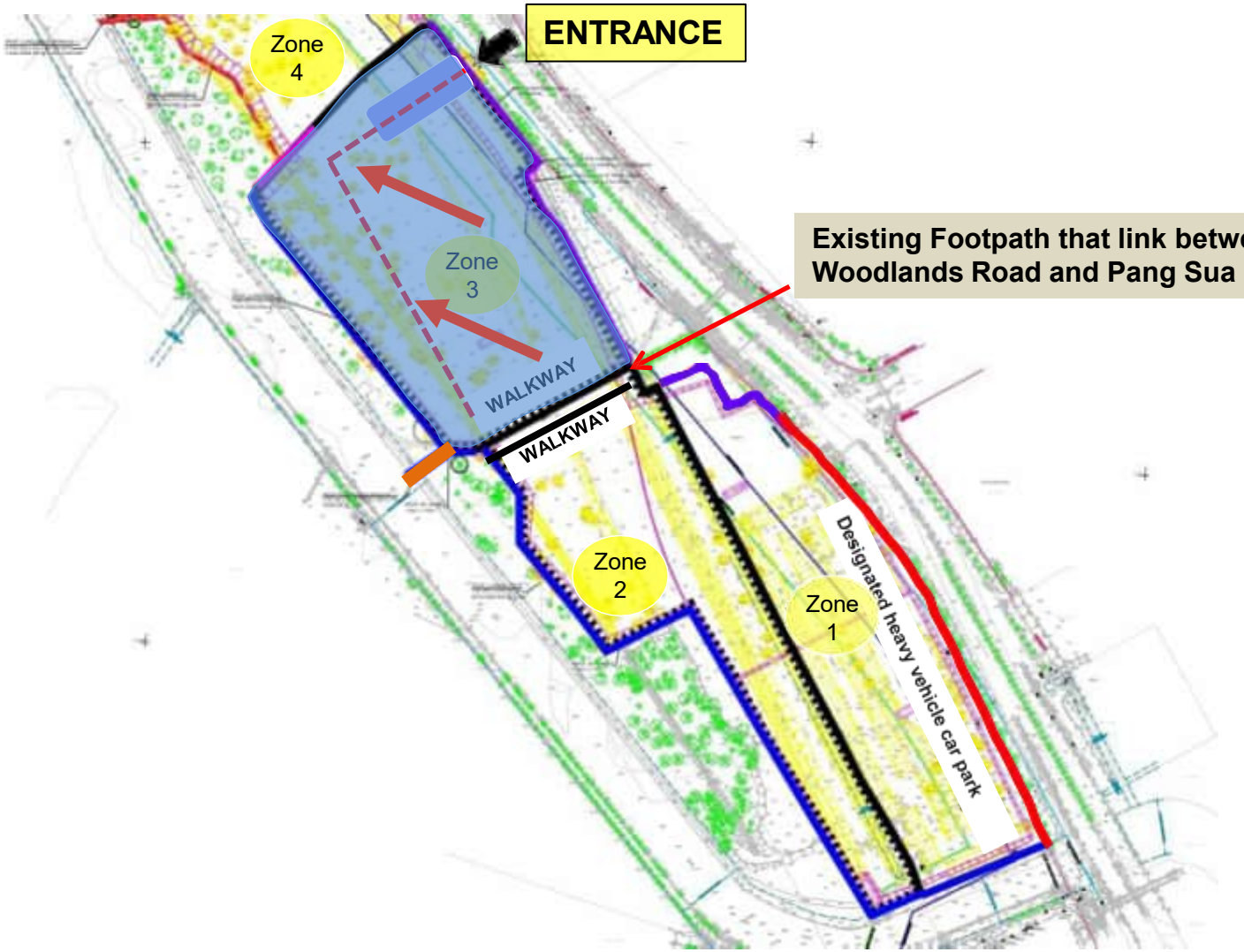
## Zone 3 - Step 1: Install 3m noise barrier/ 2.4m metal hoarding & 2m hoarding along boundaries




**LEGENDS:**

- : Proposed 3m noise barrier
- : Proposed 12m noise barrier
- : 2.4m metal hoarding
- : 6m width working space for hoarding
- : Wildlife shepherding opening
- : Wildlife shepherding direction
- : Road access
- : Proposed 2m height hoarding
- : gate for vehicle access
- : vehicle route plan
- : Temporary Hoarding

## Zone 3 - Step 2: Wildlife shepherding and site clearance (Timeline = 21 days)




**Existing Footpath that link between Woodlands Road and Pang Sua Canal**

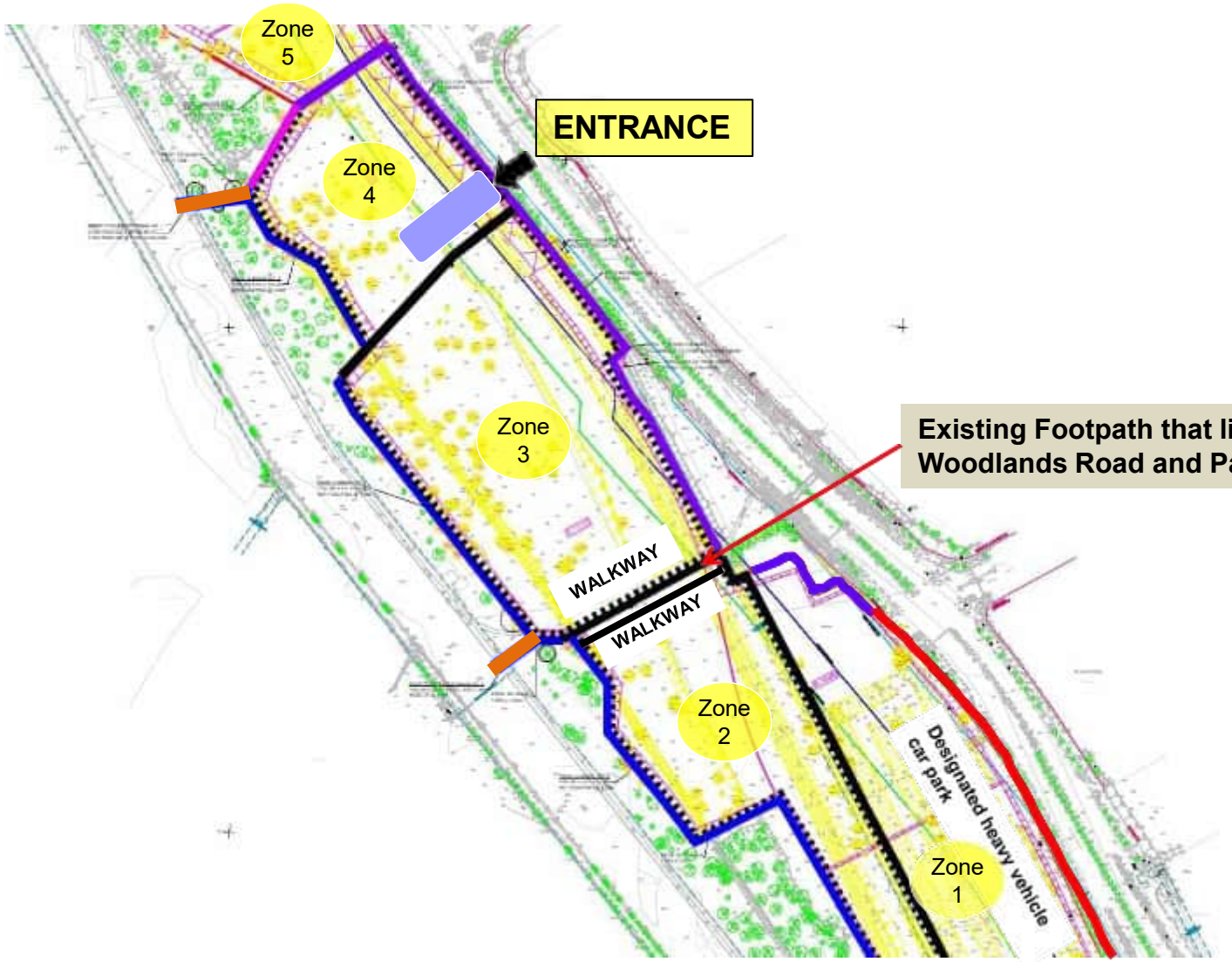
**Timeline Breakdown:**

| | |
|---|---|
| Pre-felling checking | = 1 days |
| Tree Felling | = 3 days |
| Silent Period | = 3 days |
| Site Clearance | =14 days |
| Total | = 21 days |

**LEGENDS:**

- : Proposed 3m noise barrier
- : Proposed 12m noise barrier
- : 2.4m metal hoarding
- : 6m width working space for hoarding
- : Wildlife shepherding opening
- : Wildlife shepherding direction
- : Road access
- : Proposed 2m height hoarding
- : gate for vehicle access
- : vehicle route plan
- : Temporary Hoarding

## Zone 4 - Step 1: Install 3m noise barrier/ 2m hoarding along boundaries




**Existing Footpath that link between Woodlands Road and Pang Sua Canal**

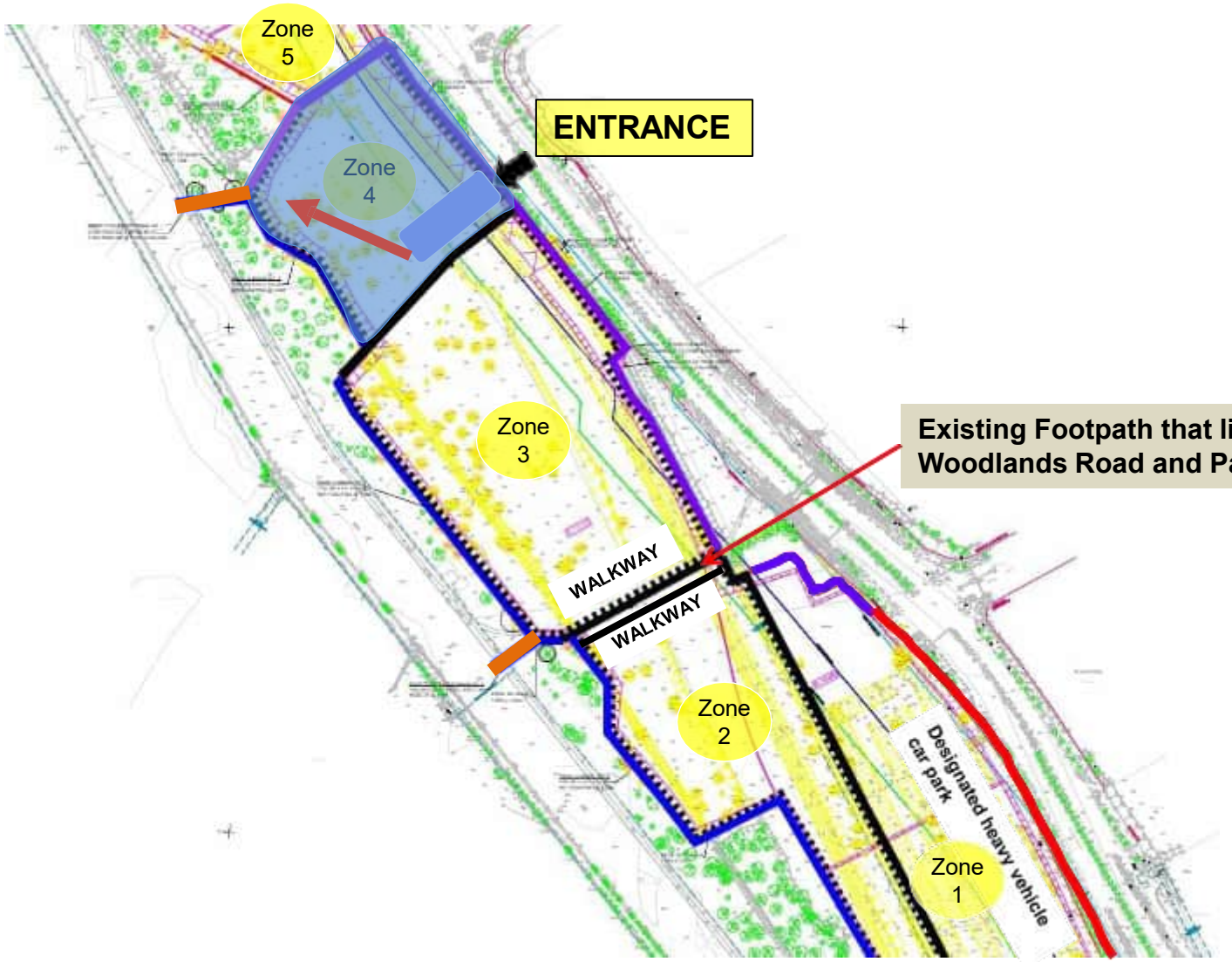
### Timeline Breakdown:

| | |
|---|---|
| Pre-felling checking | = 1 days |
| Tree Felling | = 3 days |
| Silent Period | = 3 days |
| Site Clearance | =14 days |
| Total | = 21 days |

### LEGENDS:

- : Proposed 3m noise barrier
- : Proposed 12m noise barrier
- : 2.4m metal hoarding
- : 6m width working space for hoarding
- : Wildlife shepherding opening
- : Wildlife shepherding direction
- : Road access
- : Proposed 2m height hoarding
- : gate for vehicle access
- : vehicle route plan
- : Temporary Hoarding

## Zone 4 – Step 2: Wildlife shepherding and site clearance




**Existing Footpath that link between Woodlands Road and Pang Sua Canal**

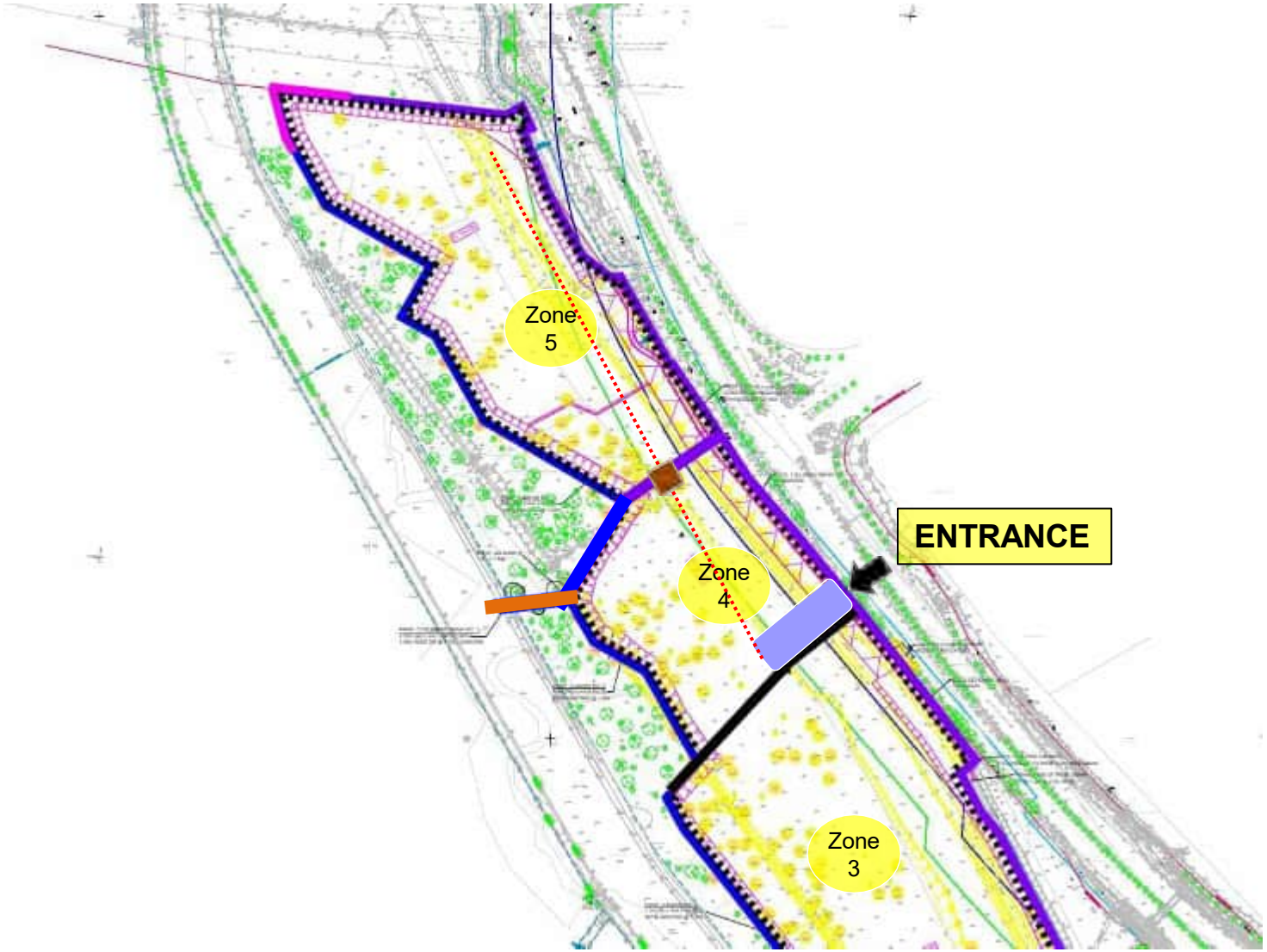
**Timeline Breakdown:**

| | |
|---|---|
| Pre-felling checking | = 1 days |
| Tree Felling | = 3 days |
| Silent Period | = 3 days |
| Site Clearance | =14 days |
| Total | = 21 days |

**LEGENDS:**

- : Proposed 3m noise barrier
- : Proposed 12m noise barrier
- : 2.4m metal hoarding
- : 6m width working space for hoarding
- : Wildlife shepherding opening
- : Wildlife shepherding direction
- : Road access
- : Proposed 2m height hoarding
- : gate for vehicle access
- : vehicle route plan
- : Temporary Hoarding

## Zone 5 - Step 1: Install 3m noise barrier/ 2m hoarding along boundaries




**LEGENDS:**

- : Proposed 3m noise barrier
- : Proposed 12m noise barrier
- : 2.4m metal hoarding
- : 6m width working space for hoarding
- : Wildlife shepherding opening
- : Wildlife shepherding direction
- : Road access
- : Proposed 2m height hoarding
- : gate for vehicle access
- : vehicle route plan
- : Temporary Hoarding

## Zone 5 - Step 2: Wildlife shepherding and site clearance (Timeline = 21 days)




**Timeline Breakdown:**

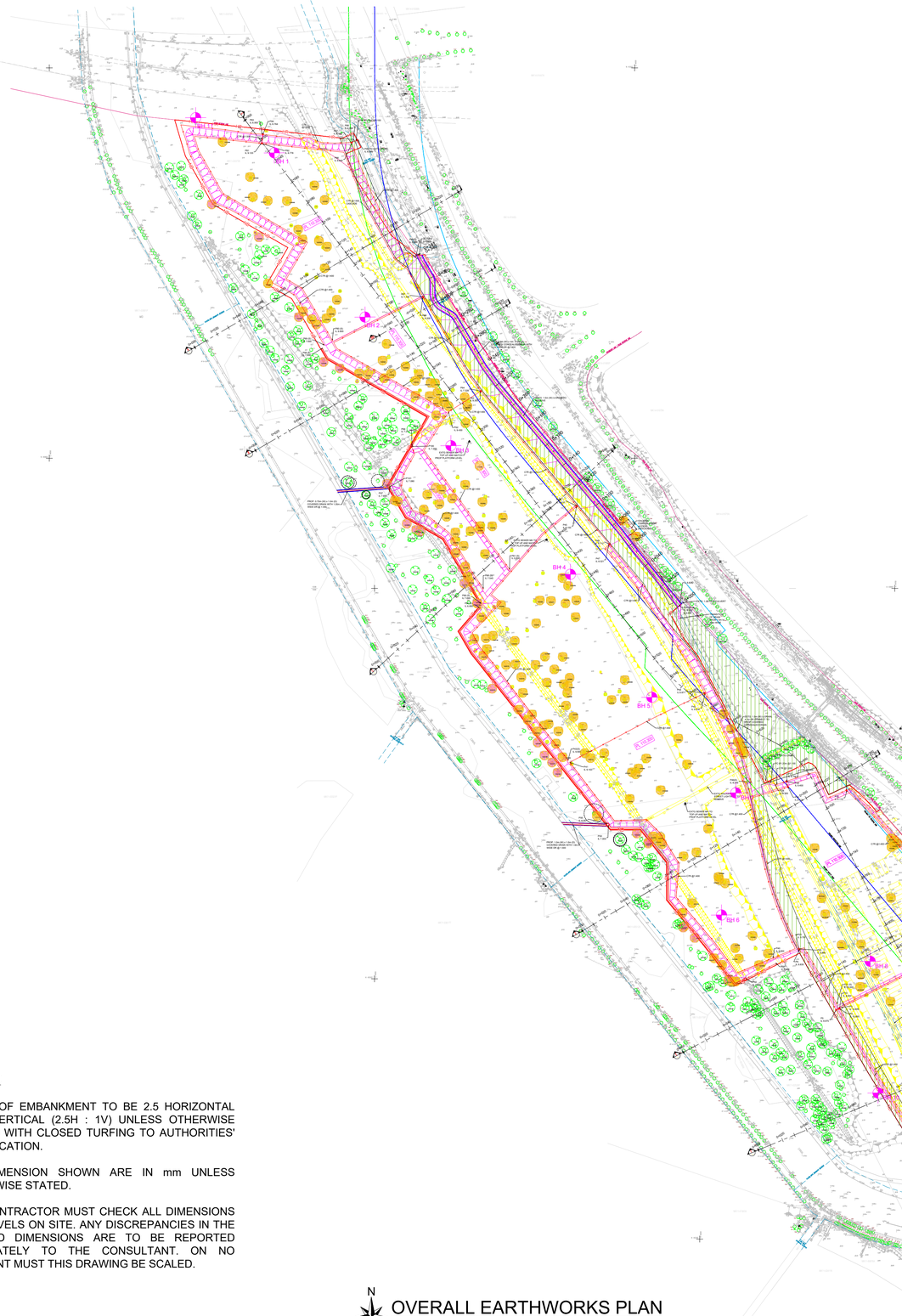
| | |
|---|---|
| Pre-felling checking | = 1 days |
| Tree Felling | = 3 days |
| Silent Period | = 3 days |
| Site Clearance | =14 days |
| Total | = 21 days |

**LEGENDS:**

- : Proposed 3m noise barrier
- : Proposed 12m noise barrier
- : 2.4m metal hoarding
- : 6m width working space for hoarding
- : Wildlife shepherding opening
- : Wildlife shepherding direction
- : Road access
- : Proposed 2m height hoarding
- : gate for vehicle access
- : vehicle route plan
- : Temporary Hoarding

# Appendix K
# Earth Control Measures Plan

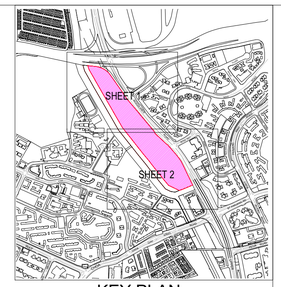
Delivering a better world




N

OVERALL EARTHWORKS PLAN
SCALE 1:2000

0 10 20 30 40 50 100 Metres
Scale 1: 2000




KEY PLAN
SCALE 1:20000

LEGEND:

- EXISTING SLOPE
- PROPOSED SLOPE
- PROPOSED DRAIN & SUMP
- EXISTING DRAIN TO REMOVE
- PROPOSED PLATFORM LEVEL
- EXISTING TREES TO REMOVE
- EXISTING TREES TO RETAIN
- PROPOSED NOISE BARRIER (3m height)
- PROPOSED NOISE BARRIER (12m height)
- PROPOSED HOARDING
- ROAD RESERVE LINE
- PROPOSED SILT TRAP
- PROPOSED DRAIN RESERVE
- PROPOSED COVERED DRAIN/ CONCEALED DRAIN
- ACCESS CHAMBER WITH GRATING AT 50m INTERVAL

NOTES:

1. SLOPE OF EMBANKMENT TO BE 2.5 HORIZONTAL TO 1 VERTICAL (2.5H : 1V) UNLESS OTHERWISE STATED WITH CLOSED TURFING TO AUTHORITIES' SPECIFICATION.
2. ALL DIMENSION SHOWN ARE IN mm UNLESS OTHERWISE STATED.
3. THE CONTRACTOR MUST CHECK ALL DIMENSIONS AND LEVELS ON SITE. ANY DISCREPANCIES IN THE FIGURED DIMENSIONS ARE TO BE REPORTED IMMEDIATELY TO THE CONSULTANT. ON NO ACCOUNT MUST THIS DRAWING BE SCALED.

SUBMISSION

| Rev. | Description | Date | Designed By |
|---|---|---|---|
| | | | |

Qualified Person Endorsement :

CLIENT:

HOUSING & DEVELOPMENT BOARD

HDB HUB 480 LORONG 6 TOA PAYOH
SINGAPORE 310480

CLIENT SIGNATURE :

DRAWING NO. | REVISION:

PRECINCT NAME : | BUILDING

PROJECT TITLE :

SITE PREPARATION WORKS AT CHOA CHU KANG TOWN N1

LOT NO :
03373N, 03370T, 03376C, 02536M, 99761N, 03382V, 03755A, 02535C, 02534L, 02596L, 02537M, 02597C, 02538V, 03909P, 03902A, 00515M, 02539P, 03904N, 03906L, 03912K, 03908M, 03910C, 03914P, 03916A, 02095W, 03827A, 00510K, 00512K, 02531K
01728A

MUKIM NO :
MK 11
MK 14

JOB TITLE :

SITE PREPARATION WORKS AT CHOA CHU KANG TOWN N1

DRAWING TITLE :

OVERALL EARTHWORKS PLAN

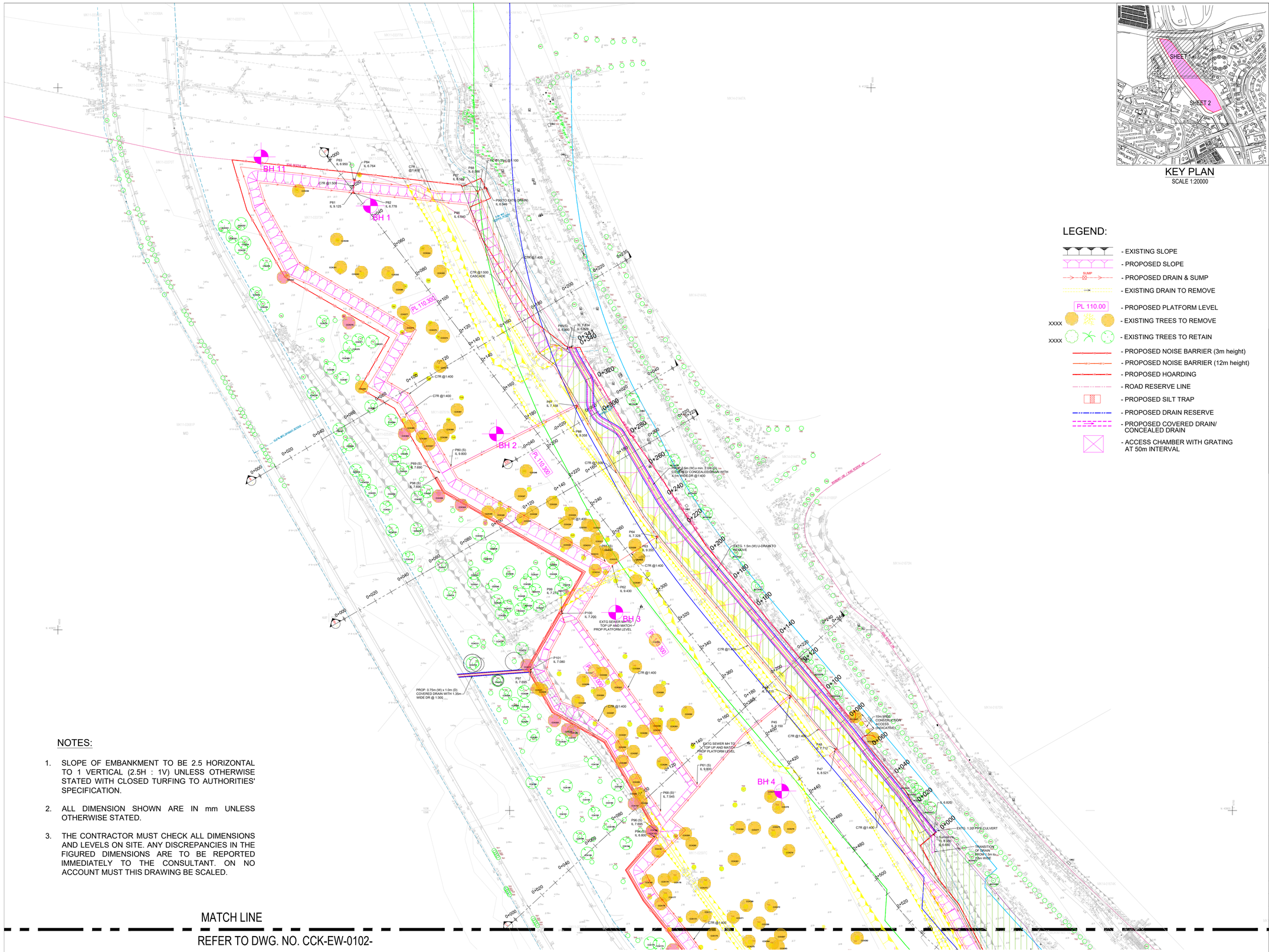
| SCALE : | AS SHOWN | DATE : | JULY 2023 |
|---|---|---|---|
| DRAWN BY : | LWC | CHECKED BY : | GT |

Consultant:

MEINHARDT INFRASTRUCTURE PTE LTD
168 JALAN BUKIT MERAH,
#12-01 CONNECTION ONE
SINGAPORE 150168
TEL : 63779700 FAX : 63779733

DRAWING NO: 208009-01-F2109-CCK-EW-0100 | REVISION: -

| LWC | FSL |
|---|---|
| DESIGN ENGINEER | QUALIFIED PERSON |







KEY PLAN
SCALE 1:20000

## LEGEND:

- EXISTING SLOPE
- PROPOSED SLOPE
- PROPOSED DRAIN & SUMP
- EXISTING DRAIN TO REMOVE
- PROPOSED PLATFORM LEVEL
- EXISTING TREES TO REMOVE
- EXISTING TREES TO RETAIN
- PROPOSED NOISE BARRIER (3m height)
- PROPOSED NOISE BARRIER (12m height)
- PROPOSED HOARDING
- ROAD RESERVE LINE
- PROPOSED SILT TRAP
- PROPOSED DRAIN RESERVE
- PROPOSED COVERED DRAIN/ CONCEALED DRAIN
- ACCESS CHAMBER WITH GRATING AT 50m INTERVAL

## NOTES:

1. SLOPE OF EMBANKMENT TO BE 2.5 HORIZONTAL TO 1 VERTICAL (2.5H : 1V) UNLESS OTHERWISE STATED WITH CLOSED TURFING TO AUTHORITIES' SPECIFICATION.
2. ALL DIMENSION SHOWN ARE IN mm UNLESS OTHERWISE STATED.
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SUBMISSION

| Rev. | Description | Date | Designed By |
|---|---|---|---|
| | | | |

Qualified Person Endorsement :

CLIENT:

HOUSING & DEVELOPMENT BOARD

HDB HUB 480 LORONG 6 TOA PAYOH
SINGAPORE 310480

CLIENT SIGNATURE :

DRAWING NO. | REVISION:

PRECINCT NAME : | BUILDING

PROJECT TITLE :

SITE PREPARATION WORKS AT CHOA CHU KANG TOWN N1

LOT NO : 03373N, 03370T, 03376C, 02536M, 99761N, 03382V, 03755A, 02535C, 02534L, 02596L, 02537M, 02597C, 02538V, 03902P, 03902A, 00515M, 02539P, 03904N, 03906L, 03912K, 03908M, 03910C, 03914P, 03916A, 02095K, 03827A, 00510K, 00512K, 02531K 01728A

MUKIM NO : MK 11, MK 14

JOB TITLE :

SITE PREPARATION WORKS AT CHOA CHU KANG TOWN N1

DRAWING TITLE :

EARTHWORKS PLAN (SHEET 1 OF 2)

| SCALE : | AS SHOWN | DATE : | JULY 2023 |
|---|---|---|---|
| DRAWN BY : | LWC | CHECKED BY : | GT |

Consultant:

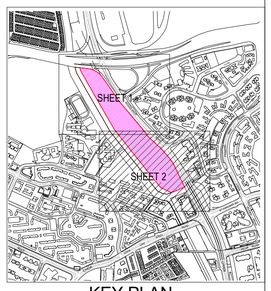
MEINHARDT INFRASTRUCTURE PTE LTD
168 JALAN BUKIT MERAH,
#12-01 CONNECTION ONE
SINGAPORE 150168
TEL : 63779700 FAX : 63779733

DRAWING NO: 208009-01-F2109-CCK-EW-0101 | REVISION: -

| LWC | FSL |
|---|---|
| DESIGN ENGINEER | QUALIFIED PERSON |

MATCH LINE

REFER TO DWG. NO. CCK-EW-0101-




KEY PLAN

SCALE 1:20000

NOTES:

1. SLOPE OF EMBANKMENT TO BE 2.5 HORIZONTAL TO 1 VERTICAL (2.5H : 1V) UNLESS OTHERWISE STATED WITH CLOSED TURFING TO AUTHORITIES' SPECIFICATION.
2. ALL DIMENSION SHOWN ARE IN mm UNLESS OTHERWISE STATED.
3. THE CONTRACTOR MUST CHECK ALL DIMENSIONS AND LEVELS ON SITE. ANY DISCREPANCIES IN THE FIGURED DIMENSIONS ARE TO BE REPORTED IMMEDIATELY TO THE CONSULTANT. ON NO ACCOUNT MUST THIS DRAWING BE SCALED.

LEGEND:

- EXISTING SLOPE
- PROPOSED SLOPE
- PROPOSED DRAIN & SUMP
- EXISTING DRAIN TO REMOVE
- PROPOSED PLATFORM LEVEL
- EXISTING TREES TO REMOVE
- EXISTING TREES TO RETAIN
- PROPOSED NOISE BARRIER (3m height)
- PROPOSED NOISE BARRIER (12m height)
- PROPOSED HOARDING
- ROAD RESERVE LINE
- PROPOSED SILT TRAP
- PROPOSED DRAIN RESERVE
- PROPOSED COVERED DRAIN/ CONCEALED DRAIN
- ACCESS CHAMBER WITH GRATING AT 50m INTERVAL

0 5 10 20 50 Metres

Scale 1:1000

EARTHWORKS PLAN

SCALE 1:1000

SUBMISSION

| Rev. | Description | Date | Designed By |
|---|---|---|---|
| | | | |

Qualified Person Endorsement :

CLIENT:

HOUSING & DEVELOPMENT BOARD

HDB HUB 480 LORONG 6 TOA PAYOH
SINGAPORE 310480

CLIENT SIGNATURE :

DRAWING NO. | REVISION:

PRECINCT NAME : | BUILDING

PROJECT TITLE :

SITE PREPARATION WORKS AT CHOA CHU KANG TOWN N1

LOT NO :
03373N, 03370T, 03376C, 02536M, 99761N, 03382V, 03755A, 02535C, 02534L, 02596L, 02537M, 02597C, 02538V, 03909P, 03902A, 00515M, 02539P, 03904N, 03906L, 03912K, 03908M, 03910C, 03914P, 03916A, 02095W, 03827A, 00510K, 00512K, 02531K, 01728A

MUKIM NO :
MK 11
MK 14

JOB TITLE :

SITE PREPARATION WORKS AT CHOA CHU KANG TOWN N1

DRAWING TITLE :

EARTHWORKS PLAN
(SHEET 2 OF 2)

SCALE : AS SHOWN | DATE : JULY 2023

DRAWN BY : LWC | CHECKED BY : GT

Consultant:

MEINHARDT INFRASTRUCTURE PTE LTD
168 JALAN BUKIT MERAH,
#12-01 CONNECTION ONE
SINGAPORE 150168
TEL : 63779700 FAX : 63779733

DRAWING NO: 208009-01-F2109-CCK-EW-0102 | REVISION: -

LWC
DESIGN ENGINEER

FSL
QUALIFIED PERSON

# Appendix L
# Site Environmental Control Plan

Delivering a better world

**SITE ENVIRONMENTAL CONTROL PROGRAMME**

**PROJECT: SITE PREPARATION WORKS AT CHO CHU KANG NEW TOWN N1**

**CONTRACTOR: PENG CHUAN ENGINEERING CONSTRUCTION PTE LTD**

## Section A: General Details

1. Is this a revision of a previously submitted SECP?

First Submission

*Amendment made was:*

a. NA

## Details of Construction Site

2. Name of Construction Company

Peng Chuan Engineering Construction Pte Ltd

3. BCA Project Reference No.

TBA

4. Division of Construction Site

Division done in 4 phase.

5. Address of Construction Site and Land Lot Number

Cho Chu Kang New town N1

6. Contract Sum of Project

$6,418, 000

7. Number of Workers housed in on site

NIL

8. Commencement Date from Letter of Award (LOA)

07 August 2023

## Section B: Details of ECO (CS)

1. Details of ECO(CS) Employment

| Name of Appointed ECO(CS) | ECO(CS) Registration Number (e.g. FXXXXR, SXXXXQ, SXXXXP) | Type of Employment | Contact Number | Contractual Start Date of ECO(CS) (DDMMYYYY) |
|---|---|---|---|---|
| Marcus Gugana Puli thevan | F4515P | Full Time | 83635343 | 07082023 |

2. Contact Information of Project Manager

| Name of Project Manager | Email Address | Contact Number |
|---|---|---|
| Er Raymond Reng | raymonder@pcgroup.com.sg | 9325 0547 |

## Section C: General Waste Collector (GWC) and Vector Control Operator (VCO)

Details of General Waste Collector (GWC) engaged
(Occupier must update and re-submit the SECP when the GWC is changed.)

3. Name and licence number of GWC (Class A/B)

| Name of GWC | Licence number of GWC |
|---|---|
| Leading Bio-energy (S) Pte Ld | A-17-016E-000 |

*4.* Details of Vector Control Operator (VCO) engaged
(Please state if more than one VCO will be engaged)
(Occupier must update and re-submit the SECP when the VCO is changed)

| Name of VCO | Licence number of VCO (e.g. VCOXXXXXXXX) | Contractual Start Date of VCO (DDMMYYYY) | Contractual End Date of VCO (DDMMYYYY) |
|---|---|---|---|
| Pest-Pro Management Pte Ltd | NEA201005550C | 07082023 | 06062025 |

5. Scope of work of Vector Control Operator (s)

- Oiling and Fogging (Weekly)

- Rodent Control

## Section D: Declare Environmental Management Plans

### D1. Site Layout

6. Please indicate the total area of the construction site

-19356m

7. Please attach the Site Layout that shows the following areas:

a) Waste collection point(s) accessible to waste collection vehicles b) Paved main access roads, with wash bay
c) Workers Quarters
d) Toilet Facilities

e) Canteens and/or rest areas for meals



## D2. Vector Control Programme

Surveillance

Please describe in detail:

1. high-risk areas to inspect and,
2. the inspection frequency of such areas

| | |
|---|---|
| 8 | Surveillance (Demolition works) |
| | Zone 1<br><br>Site Office area<br><br>-Area between roof and ceiling for the container office<br><br>-Food waste and food waste bin<br><br>-Water bearing receptacles and hand washing area and toilet<br><br>-Storage area<br><br>-Internal drains<br><br>-Machineries<br><br>Zone 2<br><br>-Storage areas<br><br>-Internal drains<br><br>-Water bearing receptacles<br><br>-Toilets<br><br>Zone 3<br><br>-Storage areas<br><br>-Internal drains |

| | |
|---|---|
| | -Water bearing receptacles |

Mitigation Measures

1. Please describe in detail the mitigation measures on site (e.g. Clear overgrown vegetation and water-bearing receptacles) in different stages of work (Preliminary works, Sub-structure stage) (Inclusive of Search and destroy of mosquito habitat)

| | |
|---|---|
| 9 | Surveillance (site Clearance and civil engineering works) |
| | -Inspection to be done ECO daily |




-Pest Control to be done weekly (day to be announced). Start from Zone 1 office to Zone 4.

-Internal oiling to be done twice weekly on Monday and Wednesday. Start from Zone 1 office to Zone 4

-Search and destroy to be done twice weekly on Monday and Wednesday. Start from Zone 1 office to Zone 4

| | |
|---|---|
| | -Housekeeping to be done daily after works at respective work areas<br><br>-Housekeeping checklist to be done weekly.<br><br>-Daily checks on machinery such as ECM Treatment plant and excavator buckets<br><br>-Clear overgrown vegetation weekly. Target to be done on Saturdays.<br><br>-Disposal of water-bearing receptacles during inspection by safety personnel<br><br>-Depression of ground levels to be levelled by excavator<br><br>-Skip bins to be replaced weekly.<br><br>-Overturn pails or water bearing receptacles near toilets<br><br>-Clear obstruction in internal drainage during Search and Destroy (Mondays and Wednesdays) |

## D3. Waste Management

10. Is there a waste disposal monitoring framework in place?
*Yes*

11. Are there enough bins provided for each type of waste to ensure no spillage at any time?

Yes

a) Organic Waste

Yes

b) Construction Waste

Yes

c) Recyclables

Yes

## D4. Dust Abatement

12. Describe the dust abatement measures implemented.

Use of lorry with water storage to water access if its dry to prevent dust pollution.

13. Ensure that concrete batching plants must have a Written Permission (WP) from the Director, Pollution Control Department to occupy and operate as a Scheduled Premises. The operation of the concrete batching plant must comply with all the conditions stipulated in the WP.

Not Applicable

## D5. Noise Control

For projects located within 150 metres from noise-sensitive premises, upon notice, you may be required to prepare a Noise Management Plan (NMP) with more details for submission to the NEA Pollution Control Department. For more information on regulations on Construction Noise, please visit the URL (https://sso.agc.gov.sg/SL/EPMA1999-RG2)

14. Describe the noise control measures implemented (e.g. Installation of noise barriers).

-Physical and machinery works to stop at 7pm.

-Real time noise monitoring

## D6. Earth Control

You are reminded to submit an Earth Control Management (ECM) Plan endorsed by a Qualified Erosion Control Professional (QECP) to the PUB Catchments and Waterways Division to obtain necessary clearance before earth works start. Please refer to https://www.pub.gov.sg/drainage/earthcontrolmeasures for more information on ECM.

15. Name of Earth Control Measures Officer

Marcus Gugana Puli Thevan

## A Copy of the SECP submission will be forwarded to the following E-Mail(s)

16. Email address of ECO(CS): marcusgpt@pcgroup.com.sg

17. Email address of Project Manager: nagarajans@pcgroup.com.sg

## Section E: Declaration Form

18. Please attach a signed PDF version of the declaration form below. The file size is limited to 3MB.

### Section E: Declaration Form

☑ By submitting this form, I confirm that the information provided in the SECP is true and correct.

This SECP is prepared by:

Marcus Gugana Puli Thevan

(Name of ECO(CS)

and submitted by;

Er Raymond Reng

(Name of Occupier)

aecom.com