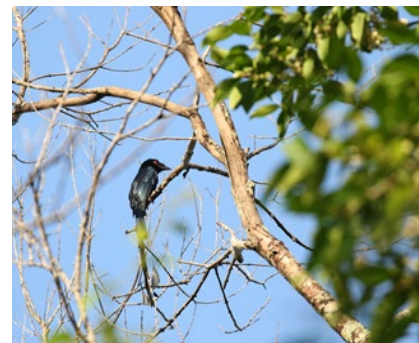


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RECONSTRUCTION OF CHOA CHU KANG WATERWORKS

Non-technical Summary of Environmental Impact Assessment (EIA) Report



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Abbreviations

Abbreviation	Definition
CCKWW	Choa Chu Kang Waterworks
CEMMP	Construction Environmental Management and Monitoring Plan
dB(A)	A-weighted decibel
DTSS	Deep Tunnel Sewerage System
ECM	Earth Control Measure
ECO	Environmental Control Officer
EIA	Environmental Impact Assessment
EMMP	Environmental Management and Monitoring Plan
EPH	Environmental Public Health
EPHA	Environmental Public Health Act
ha	Hectares
IUCN	International Union for the Conservation of Nature
NParks	National Parks Board
NTU	Nanyang Technological University
PUB	Public Utilities Board
RIAM	Rapid Impact Assessment Matrix
TAC	TEMBUSU Asia Consulting Pte Ltd
TPZ	Tree Protection Zone
VSR	Vibration Sensitive Receptor

Glossary

Abundance: The number of a single species recorded at any given time period or location.

Biodiversity: The variety of plant and animal life in the world, habitat or location, a high level of which is usually considered to be important and desirable. Biodiversity can be assessed at more focused taxonomic groups such as “bird biodiversity”, in which case it is interchangeably with “diversity”.

Ecology: The pattern of relations between organisms and their environment.

Fauna: Referring to all animal life present in an area. Animals are defined as any species from the Kingdom Animalia.

Flora: Referring to all plant life present in an area. Plants are defined as any species from the Kingdom Plantae.

Habitat: The natural home or environment of an animal, plant, or other organisms.

Impact: Any positive or negative alteration of existing conditions caused directly or indirectly by the project.

Mitigation Measure: Means to prevent, reduce, or control negative environmental effects of a project, and repair any damage to the environment caused by those effects through replacement, restoration, compensation, or any other means.

Population: The term population can be in reference to the total number of a species found in a given area (e.g., global population, or Singapore population). It is also used as a term to define distinct sub-sets of a species based on the level of inter-mixing. For example, an island may hold two populations of a species if there are two groups of the same species present and those groups are sufficiently prevented (geographically or behaviourally) from mixing, forming separate breeding populations.

Species: The standard classification of living organisms. It is defined as a group of living organisms consisting of similar individuals capable of exchanging genes or interbreeding. It is represented by the second word of the scientific name of an organism. For example, the scientific name of a long-tailed macaque is *Macaca fascicularis*, where *fascicularis* is its species name.

Transect: A predefined line or belt along which observations and/or measurements are taken.

Overview

Long term planning and timely renewal of water infrastructure are key to safeguard Singapore's water security. PUB, Singapore's National Water Agency intends to reconstruct the Choa Chu Kang Waterworks (CCKWW) to ensure our water security. CCKWW, the second largest waterworks in Singapore, was constructed in phases between 1975 and 1981 to supply 80 million gallons per day (MGD) of good and safe drinking water to the western part of Singapore. Drawing water from Kranji, Pandan and Tengah reservoirs, CCKWW is the sole waterworks in the western part of Singapore and a key pillar in our water security. It is paramount to renew and re-construct the aged infrastructure at CCKWW to ensure a continued supply of good and safe drinking water well into the future.

During the reconstruction of CCKWW, which is expected to be completed by 2026, CCKWW must remain in operation to continue serving the western region of Singapore. Taking into account these operational considerations and space constraints within the existing plant, additional land is therefore needed for the new water infrastructure.

PUB has appointed Binnies Singapore Pte Ltd to provide professional engineering services for the detailed design and construction supervision of the project. TEMBUSU Asia Consulting Pte Ltd is commissioned by Binnies Singapore Pte Ltd to provide the consultancy services to conduct an Environmental Impact Assessment (EIA) study for this project and prepare an EIA report for developing the project in an environmentally sensitive manner.

The EIA study was undertaken at the preliminary design stage of the project and it assesses the proposed development's activities and impacts during construction and operation phase. The EIA report has been prepared in accordance with scope of work provided by PUB and outcome of technical agency consultation processes.

Project Description

CCKWW is located within the Western Catchment Area, with Nanyang Technological University (NTU) to its east, forested area to its south, and the rest of the Western Catchment Area to its north and west (see Figure 2.1). The proposed site for reconstruction of CCKWW is adjacent to existing CCKWW.



Figure 1. Location plan of CCKWW

As existing CCKWW treatment infrastructure must remain operational until the new water infrastructure is completed, options for the additional land required to house the new infrastructure were studied. The plot of green-field land to the south of the existing CCKWW plant is proposed for the following reasons:

- Northwest of CCKWW: There is a sludge lagoon that is currently not in use, the soil condition is soft and poor in quality. This is unsuitable for new building construction and for new pipework, which conveys drinking water, to be buried. Any soil improvement works will take ~2 years and adversely impact the expected project completion by 2026. Construction of new facilities to the north would require an additional relift pump system to convey the water from the existing plant to the new land parcel as the north plot is on higher elevation. This results in additional pumping energy and cost.
- Northeast of CCKWW: The land plot is more elevated. This will incur more energy usage and cost due to the need to pump water to a higher ground. 99 flora species were identified during our environmental survey, out of which 68 are native.
- South of CCKWW: The good soil condition is suitable for new construction without the need for further ground treatment / improvement works, which would then enable the project to be completed by 2026. Faster completion results in shorter period of disturbance to the surrounding environment. The greenfield parcel is also at comparatively lower ground level compared with the plot at the north and therefore relift pumping is not needed, hence improving energy efficiency and carbon footprint during the operation of the plant. The design of new facilities is based on compact design to minimise land take. PUB also altered the project footprint away from stream 3 to protect biodiversity. This area consists of Abandoned Plantation and Scrubland type vegetation, 100 flora species were identified during our environmental survey, out of which 68 are native.
- West and Southwest of CCKWW: The land parcel to the west will encroach into areas of good forest, freshwater streams and biodiversity.

- East of CCKWW: The land parcel has been safeguarded by LTA for the construction of the Jurong Region Line Station.

Additionally, an external Sewer pipeline (700 mm diameter) will be laid from Area 2 to the DTSS chamber along PIE/Nanyang Drive through pipe jacking method.

Overview of Construction Work Areas

The project site is divided into 3 main construction work areas (Area 1, Area 2 and Area 3) as shown in Figure 2. All construction activities in Area 1 are within the existing CCKWW plant. Area 1, also known as pre-treatment area, covers approximately 1.2 hectares. All construction activities in Area 2 are in 3.2-ha green-field land parcel, south of existing CCKWW plant. Area 3 covers approximately 600 m long external sewer to be constructed outside the boundary of CCKWW plant by pipe jacking method for connection to the DTSS chamber off PIE/Nanyang Drive.



Figure 2. Development areas within project site

Scope of EIA

This EIA report aims to provide a baseline assessment of the project site, identify the sensitive receptors, assess the potential impacts, recommend appropriate mitigation measures to reduce the residual impacts to acceptable levels. The potential impacts on the following environmental aspects have been considered in this assessment:

- | | |
|-----------------------------|--------------------|
| • Biodiversity | • Vibration |
| • Noise | • Light |
| • Hydrology & Water Quality | • Waste Management |
| • Ambient Air Quality | • Vector Control |

Findings

Overall, it is concluded that environmental impacts from this development project are expected to be of slight to major negative levels, which can be reduced to moderate negative levels and lower by diligently implementing the environmental mitigation measures recommended in this report. The following section summarises the findings for each environmental aspect.

Biodiversity

The project site is located within the Western Water Catchment Area. Baseline surveys were conducted within project study area using various field survey methodologies, including modified gentry plots for flora, visual fauna transects, camera trapping, netting, and trapping of aquatic fauna, and acoustic bat recording. The site consists of various habitat types, of which the native-dominated young secondary forest was the most encountered type. Other habitat types included abandoned kampong and plantation habitats and scrubland habitat. Pockets of native-dominated old secondary forest found on the site and one of the stream habitats were identified to be of high conservation priority.

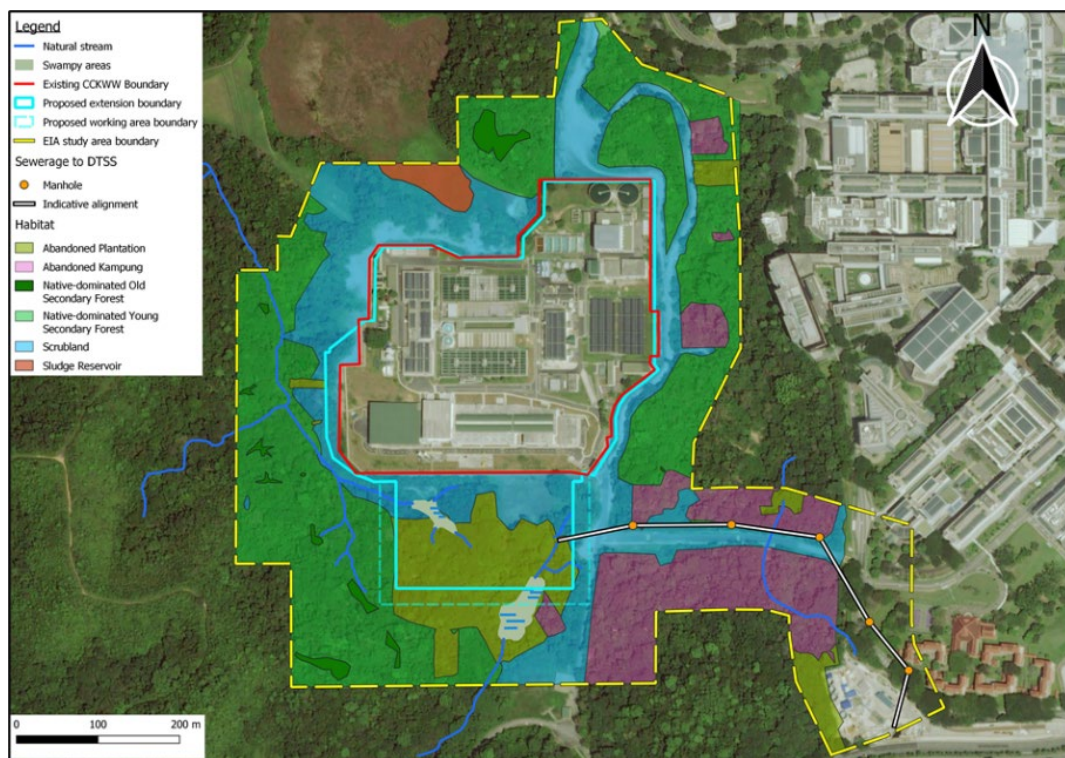


Figure 3. Habitat types within EIA study area

At least 307 flora species and 191 fauna species (birds, mammals, reptiles, amphibians, butterflies, odonates, freshwater fish, molluscs, and decapod crustaceans) were observed during current study within the project study area.

Floristically, the fern *Helminthostachys zeylanica* is the most notable finding as the individual recorded in the present study is the first record of its kind in Singapore. This species is considered Critically Endangered and Endangered in several other countries in Asia. Other Critically Endangered species include the climber *Gynochthodes ridleyi* (previously recorded only at Jurong, Kranji, and Western Catchment) and *Melicope lunu-ankenda*, all of which are

located in the proposed CCKWW extension area. Given that the land used to be a plantation, species cultivated for domestic and commercial purposes can be found here such as Borneo mahogany (*Calophyllum inophyllum*) that is prized in the woodworking industry, para rubber (*Hevea brasiliensis*), and oil palm (*Elaeis guineensis*).

In terms of fauna, this area consists of several threatened species across all taxonomic groups, including straw-headed bulbul (*Pycnonotus zeylanicus*), Sunda pangolin (*Manis javanica*) and very rare elf dragonfly (*Tetrathemis hyalina*). Several species found on the site have specific habitat requirements, such as the locally Vulnerable four-ridged toad and puff-faced water snake (*Homalopsis buccata*), and the locally Near-threatened masked rough-sided frog (*Pulchrana laterimaculata*), all of which are swamp or stream specialists.



Figure 4. Some of the threatened species found on the project site, including the elf dragonfly, puff-faced water snake, and straw-headed bulbul

While not found during the field surveys, rare and other rare and threatened species such as the Malayan porcupine (*Hystrix brachyura*) and leopard cat (*Prionailurus bengalensis*) are known to be found within the Western Catchment area.

Impacts from project activities, including vegetation clearance, increased noise, and increased artificial light, may have undesirable impacts to biodiversity, especially to species of conservation value found within and around the project site. For plant species that are likely to be directly impacted, transplanting will be carried out, where feasible. The footprint for the CCKWW plant extension will also affect two freshwater streams, with the backfilling of the northern section of Stream 2 and the eastern branch of Stream 3. The latter stream, located on the west of the project boundary, is considered to be of conservation value. The project footprint has been adjusted to create a 10m vegetated buffer between the project boundary and the main tributary of Stream 3.

Given the presence of wild pigs, feral dogs, long-tailed macaques, and smooth-coated otters on the site, care should be taken to avoid human-wildlife conflict, particularly during the construction phase. With the implementation of recommended mitigation measures – e.g., training construction staff on wildlife encounters, erecting hoarding to prevent fauna from running onto roads, and designating areas for food and waste disposal – it



Figure 5. Wild pigs at project site

is expected that any such impacts will be reduced to an acceptable level.

Table 1. Key recommended mitigation measures for biodiversity

	Key recommended mitigation measures
Area 1 (Existing CCKWW Plant)	<ul style="list-style-type: none"> • Provide noise barriers / sound proofing around all working areas to decrease the impact of noise to the surrounding fauna. • Avoid demolition activities and minimise heavy construction activities during the night (i.e., 6 pm to 8 am), except in case of work exigency and planned night activities with the implementation of the lighting management plan (LMP) approved by NParks, e.g. construction lights (if any) facing inwards and away from the forest. • Establish proper Earth Control Measures (ECM) Plan approved by PUB prior to start of (pre-) construction activities and effectively implement it throughout the duration of activities.
Area 2 (CCKWW Extension Area)	<ul style="list-style-type: none"> • Adjust working area footprint to minimise direct impacts to natural habitats. • Avoid nightworks (i.e., limit work activities to 8 am – 6 pm) except in case of work exigency planned night activities with the implementation of the lighting management plan (LMP) approved by NParks, e.g. construction lights (if any) facing inwards and away from the forest. • Identify plants of high conservation significance to be transplanted. • Visually inspect trees and holes for nesting birds and species of conservation value prior to felling. • Conduct targeted relocation exercises for native aquatic fauna species. • Conduct phased /directional clearance of vegetation in the direction away from Dunbar Walk. • Hoard up the entire work site and conduct regular monitoring of the hoarding. • Conduct habitat enhancement during the reinstatement period by planting working areas with native riparian vegetation where possible upon completion of works.
Area 3 (Sewer Alignment)	<ul style="list-style-type: none"> • Avoid Stream 1 and other habitats when designing and placing working shafts, trenchwork, and all other working spaces. • Establish proper Earth Control Measures (ECM) Plan approved by PUB prior to start of (pre-) construction activities and effectively implement it throughout the duration of activities. • Avoid nightworks (i.e., limit work activities to 8 am – 6 pm) except in case of work exigency. • Establish Tree Protection Zones (TPZ) for trees to be retained. • Visually inspect trees and holes for nesting birds and species of conservation value prior to felling. • Replant new planting verges with native plant species whenever possible. • Conduct habitat enhancement during the reinstatement period by planting working areas with salvaged native plants where possible upon completion of works.

Hydrology & Water Quality

The project site is a part of the Jurong Lake and Poyan-Tengeh catchment area. There are three natural streams within project study area. The locations of the three streams can be found in Figure 6. Baseline surveys included surface water quality sampling and the characterisation of stream habitats according to their wetted depth and width, canopy cover, substrate type, flow velocity, and riparian vegetation type.

In general, the surface water quality of these streams complied with the applicable standards except for the pH and the Dissolved Oxygen. However, while some of the points within the project site had low pH readings, forested streams in Singapore are known be mildly acidic.

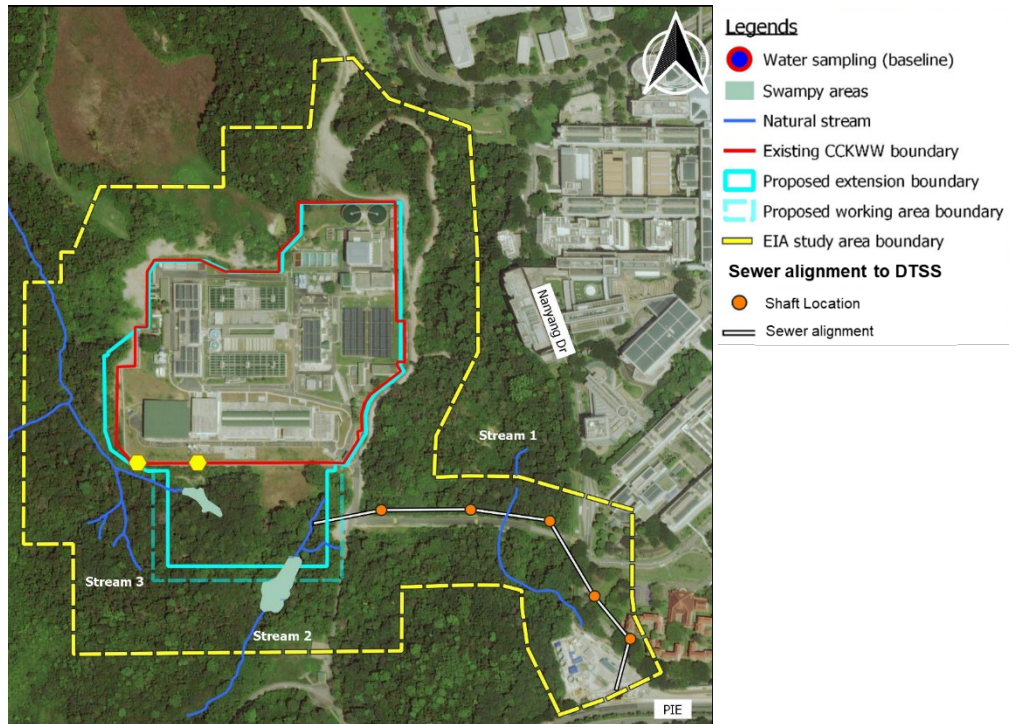


Figure 6. Locations of streams found in project site

Stream 1 is connected to an outlet and occasional treated water discharge is observed. With a higher discharge volume and higher velocity, this stream is flanked by significant bank heights and carry much larger and heavier sediment loads such as cobble and anthropogenic debris, such as bricks and ceramic. A large portion of the stream has banks and beds that consist of clay, resulting in portions of large alluvial sediments next to clear beds of clay bedrock.



Figure 7. Stream 1 found in project site

Stream 2 varied in widths along the different stream portions, from shorter widths of half a metre to as wide as an estimate of 10 metres. While the upper portion of the stream consists of small discharge and small widths, it opens up to a large channel with high discharge, and eventually filters through a grassy wetland to a swampy environment at the lower portion of the stream.



Figure 8. Stream 2 found in project site

Stream 3 is an earth stream that braids into several branches, with some branches that contain temporal discharge during periods of significant precipitation events. Earth streams in this area are generally in a swampy environment with substrate that consist of fine sand to mud, characterised by shallow wetted areas with low discharge and flow velocity.



Figure 9. Stream 3 found in project site

Likely impacts from the construction phase of proposed project includes disturbance to local hydrological pattern due to backfilling of two natural streams within project footprint, impact to water quality due to sediment runoff and trade effluent discharge. The significant impacts to Stream 3, which is of higher conservation value, were avoided by setting back the project footprint to safeguard the main tributary of the stream. Other recommended mitigation measures – such as properly implementing Earth Control Measures (ECMs) and managing trade effluent/sewage discharge – will help to reduce impact on water quality of project area.

Table 2. Key recommended mitigation measures for hydrology and water quality

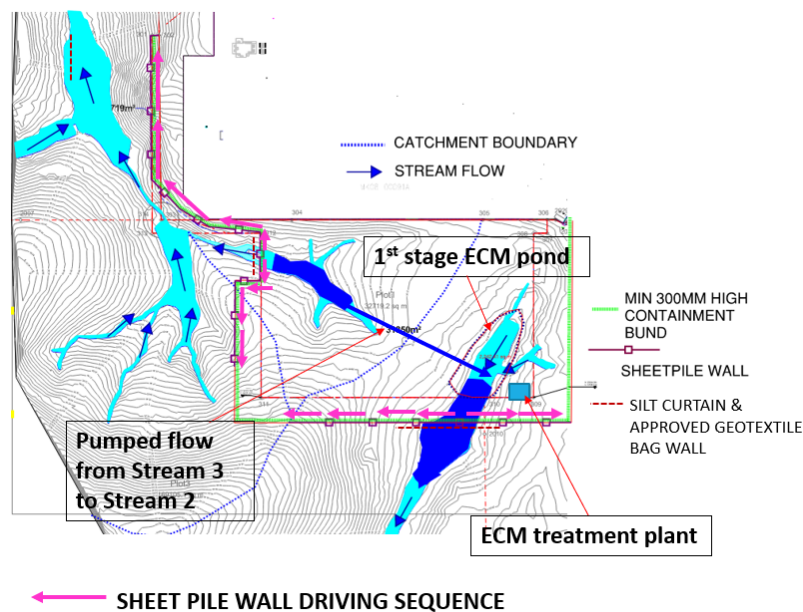
	Key recommended mitigation measures
Area 1 (Existing CCKWW Plant)	<ul style="list-style-type: none"> • Establish a proper Earth Control Measures (ECM) Plan approved by PUB prior to start of (pre-) construction activities and effectively implement it throughout the duration of activities. • ECM treatment plan performance is to be monitored regularly by Environmental Control Officer (ECO) and reviewed regularly by the Qualified Erosion Control Professional (QECP). • All slurry preparation activities are to be conducted within a designated area that has adequate containment measures. • To ensure that slurry water, including bentonite slurry, is contained within the working area and does not enter any watercourses or surface water drains. • Contractor to provide sampling point and inspection for collection of trade effluent to be tested for parameters stipulated in the Regulation, depending on the type of discharge point (e.g., sewer, watercourse).
Area 2 (CCKWW Extension Area)	<ul style="list-style-type: none"> • No stormwater discharge from CCKWW to Stream 3. Regulated stormwater discharge from CCKWW to Stream 2 to prevent flooding and stream erosion. • Conduct targeted translocation of native aquatic fauna from Stream 2 and Stream 3. • Ensure that none of site investigation boreholes are located within 10 m of the natural streams. • Establish a proper Earth Control Measures (ECM) Plan approved by PUB prior to start of (pre-) construction activities and effectively implement it throughout the duration of activities. • No trade effluent discharge to Stream 2 and 3. Provision of minimum 300mm containment bund. • To ensure that bentonite is contained within working area and does not enter any watercourses or surface water drains.
Area 3 (Sewer Alignment)	<ul style="list-style-type: none"> • Establish a proper Earth Control Measures (ECM) Plan approved by PUB prior to start of (pre-) construction activities and effectively implement it throughout the duration of activities. • ECM treatment plan performance is to be monitored regularly by Environmental Control Officer (ECO) and reviewed regularly by the Qualified Erosion Control Professional (QECP). • All slurry preparation activities are to be conducted within a designated area that has adequate containment measures. • To ensure that slurry water, including bentonite slurry, is contained within the working area and does not enter any watercourses or surface water drains.

Implementation of Erosion Control Measures (ECM) and Wastewater Management

Based on the results of the EIA, it is understood that the implementation of proper erosion control measures and waste water management plan are crucial for the protection of the remaining stream habitats during the construction stage. As a minimum, the ECM shall follow the following approaches to mitigate risk of silty water spilling / discharging into nearby streams.

1st stage of ECM

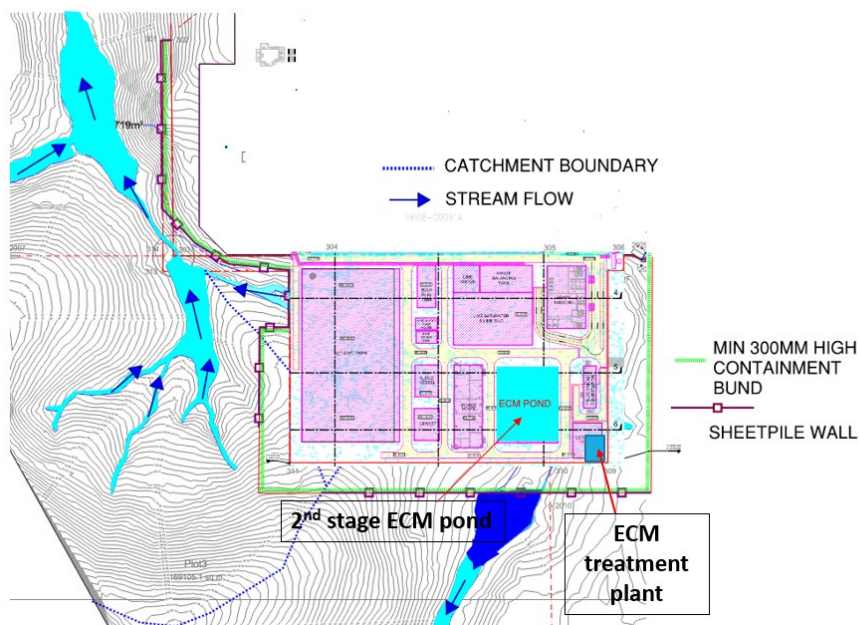
- Installation of silt curtains and approved geotextile walls at Stream 2 to segregate project site from the remaining stream before commencing wildlife shepherding at Stream 2 catchment. ECM treatment plants will be installed at this stage near Stream 2 to treat silty discharge due to vegetation clearance before discharging back to Stream 2. Road access at this stage shall be topped with hardcore and side slopes protected with erosion control blankets or turfing. This same approach shall apply to Stream 3 before commencing wildlife shepherding at Stream 3 catchment. No ECM discharge is allowed via Stream 3 at all times.
- Use of fully interlocked sheet pile wall, complete with waterstop, will be driven with minimum 300mm protrusion above ground, to act as water barrier at both streams outlet and along low lying site areas. The installation sequence shall commence from low to high ground to ensure surface runoff are always contained within site, collected in temporary ECM pond, and treated before discharge to Stream 2.
- A concrete containment bund of minimum 300mm height will be constructed concurrently with the sheet pile walls which not only act as water barrier but also serve as foundation of noise barrier around the site perimeter.
- A minimum runoff coefficient of 0.65 will be adopted in sizing of ECM pond and facilities to cater for 1 in 5 years (4 hours) rainstorm.
- It is also recommended to carry out 1st stage of ECM during dry season period to further reduce risk of silty water spillage into both Stream 2 and 3.



Conceptual layout of 1st Stage ECM

2nd stage of ECM

- a) At this stage, both wildlife shepherding and containment bund construction will have been completed. Earthwork and construction of Stage 2 ECM Pond will commence.
- b) A runoff coefficient of 1.0 is recommended in sizing of ECM pond and facilities to cater for 1 in 5 years (4 hours) rainstorm, taking into consideration the site will progressively be built up. By using a runoff coefficient of 1, comparing to the specified runoff coefficient of 0.8 in the PUB's code of practice on surface water drainage for industrial densely built up area, an additional 25% surplus ECM pond storage capacity will be provided.
- c) All ECM discharge will be via Stream 2. No ECM discharge is allowed via Stream 3 at all times.



Conceptual layout of 2nd Stage ECM

Noise

The project study area is largely vegetated with an internal network of roads for CCKWW plant usage. Main source of noise comes from the traffic in Nanyang Drive at the east of the site, with occasional source being the activities conducted in the area. The identified noise-sensitive receptors comprised of various fauna species inhabiting the forested areas, human receptors situated at adjacent NTU premises, and construction workers on site.

A seven-day continuous (24x7) noise monitoring was carried out at five locations to establish the baseline noise levels. The baseline noise levels generally complied with Singapore's noise regulations but may increase once the construction activities start. Activities involving high-impact stationary and mobile equipment, such as demolition and piling, are identified to be the main sources of noise impact. This may cause disturbance to fauna species and human receptors within and around the project study area throughout the duration of construction.

Prediction of noise levels was conducted with the modelling software SoundPLAN for periods when heavy construction activities take place. The modelling results showed that the noise

levels should be reduced to allowable limits with the proper implementation of noise barriers. Below figures show the results of predicted noise levels before and after implementation of noise barriers.

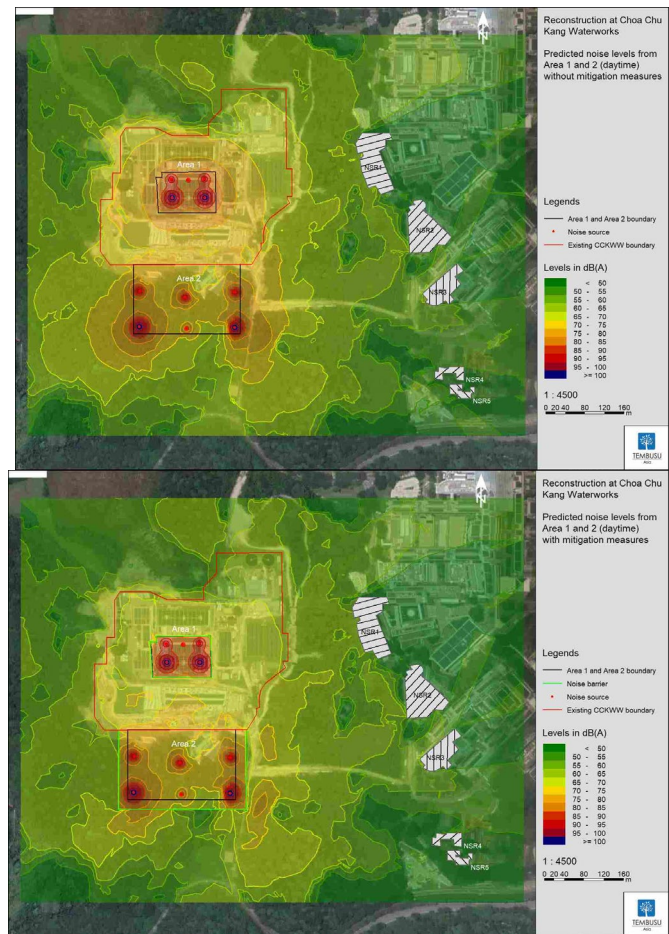


Figure 8. Predicted daytime noise levels from Area 1 & 2 activities without mitigation measures (top) and with mitigation measures (bottom)

Overall, the impact of noise on the sensitive receptors has been assessed as minor and can be further controlled if the recommended noise mitigation measures – e.g., avoiding night-time works, erecting noise barriers, using quieter construction methods, and using construction equipment and vehicles with low noise levels – are suitably designed and implemented.

Table 3. Key recommended mitigation measures for noise

Key recommended mitigation measures	
Area 1 (Existing CCKWW Plant)	<ul style="list-style-type: none"> All the work areas in Area 1 involving demolition activities are to be surrounded by sound barriers. Demolition activities in Area 1 should be avoided during the night (i.e., 6 pm to 8 am). All noise and acoustic barriers should be able to achieve at least 10dB(A) noise reduction from source noise levels. For piling work, to consider the use of quieter piling methods. To consider erection of temporary acoustic barriers around piling equipment. To consider use of a temporary barrier which will allow for relocation as the piling activity moves around site. Demolition activities in Area 1 should be avoided during the night (i.e., 6 pm to 8 am).
Area 2	<ul style="list-style-type: none"> All the work areas are to be surrounded by sound barriers. Installation of 6 m high noise barrier as boundary hoarding. For soil investigation works, to use acoustic enclosures on rig engines and install a silencer at

	Key recommended mitigation measures
(CCKWW Extension Area)	<p>the exhaust pipe of the engines throughout the drilling operations and to erect portable hoarding around drilling rigs.</p> <ul style="list-style-type: none"> • All noise and acoustic barriers should be able to achieve at least 10dB(A) noise reduction from source noise levels. • Use of silent piler for sheet piling work in Area 2 (CCKWW Extension Area) where possible. • For piling work, temporary acoustic barriers around piling equipment and use of quieter piling methods are considered. • To consider erection of temporary acoustic barriers around piling equipment. To consider use of a temporary barrier which will allow for relocation as the piling activity moves around site. • Continuous noise monitoring throughout construction.
Area 3 (Sewer Alignment)	<ul style="list-style-type: none"> • For soil investigation works, to use acoustic enclosures on rig engines and install a silencer at the exhaust pipe of the engines throughout the drilling operations and to erect portable hoarding around drilling rigs. • All noise and acoustic barriers should be able to achieve at least 10dB(A) noise reduction from source noise levels.

Ambient Air Quality

Currently there are no stationary sources of air pollution within project study area as well as its surrounding area. A seven-day continuous (24x7) air monitoring was carried out at two locations to establish the baseline air quality levels. The baseline air quality levels were within Singapore's air quality targets with project study area having considerably good air quality.

There are sensitive biodiversity receptors within project study area and human receptors at NTU premises. Air quality at the site will potentially be affected by activities associated with construction of treatment units, especially from an increase in airborne particulates and heavy-vehicle exhaust emissions. These may create a moderate and direct impact on local air quality and affect sensitive receptors located in the proximity of dust generating construction activities, including biodiversity of project area. These impacts can be brought down to an acceptable level with the implementation of various mitigation measures – e.g., implementing dust suppression plan, installation of dust screens, covering stockpiles of dusty materials with impervious sheeting, and regular watering of construction site.

Table 4. Key recommended mitigation measures for ambient air quality

	Key recommended mitigation measures
For all areas	<ul style="list-style-type: none"> • Use of hoarding at project boundary within work areas to minimise dust generation by attenuating wind forces. • Any soil or stockpiles of dusty material should be properly stored, covered entirely with impervious sheeting, or dampened with water to maintain entire surface wet by contractor. • Soil stockpiles to be located away from sensitive receptors. • Personal protective equipment such as mask shall be worn during the severe air pollution and/or dust exposure periods by construction personnel. • Proper maintenance of construction vehicles and fuel burning equipment. • Provision of additional dust screen near sensitive receptors if required.

Vibration

Currently there are no major sources of vibration within project study area as well as its surrounding area.

There are sensitive human receptors at NTU premises. Additionally, there are sensitive biodiversity receptors (particularly fauna) within the proposed project site. While there is no extensive research done on how vibration emissions affect fauna, it is understood that vibration from anthropogenic sources affects the ability of some fauna, including frogs, to communicate. These sensitive receptors may be disturbed due to heavy construction activities, such as demolition, driven piling, and underground boring during pipe jacking.

The report utilised findings from a preliminary analysis of vibration levels likely to be generated from selected activities to ascertain the likely vibration levels from planned construction methods. The vibration analysis adopted a simplified approach taking into consideration the low vibration amplitudes assessed hence further considerations of area affected and habitat sensitivity are not considered in the assessment.

The potential vibration impacts on sensitive receptors are expected to be of slight negative nature, direct, and local. Duration is anticipated to be short term and reversible as the impact will cease upon completion of the vibration generating construction activities. Further, this impact is to be managed through the mitigation measures/best practices recommended in next section.

Table 5. Key recommended mitigation measures for vibration

Key recommended mitigation measures	
For all areas	<ul style="list-style-type: none"> • Construction works involving the use of heavy equipment should be restricted to daytime only (i.e., 8 am – 6 pm) at Area 2 (CCKWW extension area) and Area 3 (near NTU premises). • Contractors shall be responsible to comply and implement all applicable regulatory and authority requirements and recommendation in this EIA report on ground-borne vibration. • Use of equipment or method which generate lower vibration levels where possible (e.g., silent piler instead of vibro hammer). • To plan and phase excavation, earthmoving and ground piling activities in staggered manner where possible to minimize cumulative impact. • Notify nearby VSRs (e.g., NTU residential building near Area 3) in advance of the construction activities, particularly during pipe jacking works to allay potential concerns. • To develop the vibration monitoring plan in consultation with Qualified Person (QP) and to monitor the vibration levels throughout construction period.

Light

Increased levels of artificial light can affect flora and fauna in various ways through the disruption of circadian cycles of animals and the distortion of day-night cycle of plants. This may lead to increased predation pressure by diurnal carnivores on nocturnal animals, exhaustion from insects attracted to artificial light, disorientation and disruption of foraging by birds, and the alteration of breeding and sleeping cycles of various animals. During the construction phase, impacts to flora and fauna from light pollution should be avoided particularly for sensitive or threatened species.

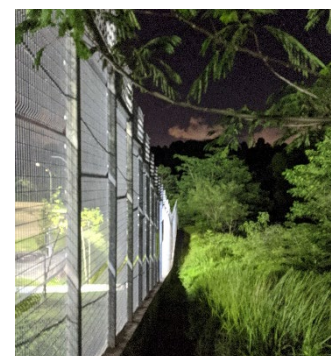


Figure 9. Baseline light conditions on project site

Part of the EIA study area is adjacent to the existing CCKWW plant, where baseline light levels are already high. Impacts of light pollution during the construction period may take place, but such impacts are expected to be minor considering nightworks within forested areas will be avoided as far as practicable or if due to work exigencies and planned night activities, with the implementation of the lighting management plan (LMP) approved by NParks. Additionally, since the baseline levels are high, any nightworks within the existing plant should not significantly contribute to light pollution. Nevertheless, mitigation measures such as adjustment of working hours and appropriate positioning of artificial lights during the construction phase and appropriate design of lights for operational phase (see figure below) are recommended to further reduce the impacts of light pollution.

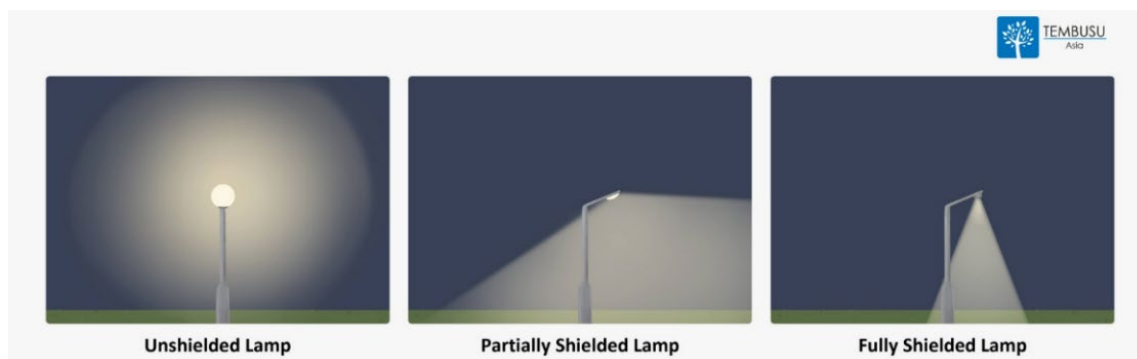


Figure 10. Example of light shielding design

Table 6. Key recommended mitigation measures for light

	Key recommended mitigation measures
Area 1 (Existing CCKWW Plant)	<ul style="list-style-type: none"> • Ensure no additional light impacts are caused due to Area 1 works. • Construction lights to be shielded, facing downwards and away from any forested areas.
Area 2 (CCKWW Extension Area)	<ul style="list-style-type: none"> • Implementation of Lighting Management Plan • Limit construction works, including demobilisation, to daytime working hours (i.e., 8 am to 6 pm) except in case of work exigency and planned night activities, with the implementation of the lighting management plan (LMP) approved by NParks, to reduce unnecessary stress to biodiversity that are sensitive to light. • Construction lights should face downwards and away from forested areas. • Where reasonable and practical, all artificial lights should be turned off outside working hours. • Buffer planting should include thick hedge plants which can reduce the amount of light entering the forest.
Area 3 (Sewer Alignment)	<ul style="list-style-type: none"> • Implementation of Lighting Management Plan • Construction works within the forested parts of Area 3 be kept to daytime working hours (i.e., 8 am to 6 pm) to reduce unnecessary stress to biodiversity that are sensitive to light. • Should nightworks be unavoidable in an emergency, construction lights should face downwards and away from forested areas. • Where reasonable and practical, all artificial lights should be turned off outside working hours.

Waste Management

It is anticipated that the main sources of waste during construction phase will be from cut vegetation, excavated material, general construction waste, personal waste and/or hazardous waste. If not properly disposed and treated, these wastes may pose risks to the project site such as fires, soil contamination, odours, water contamination, and health hazards to workers

in the project site. With the implementation of proposed mitigation measures (e.g., reusing timber wastes for wood industry, implementing a waste management plan, and hiring licensed collectors to properly dispose the waste material – any negative impact is expected to be reduced to an acceptable level.

Table 7. Key recommended mitigation measures for waste management

	Key recommended mitigation measures
For all areas	<ul style="list-style-type: none"> • Develop a solid waste management plan to manage the collection, recycling, and ultimate disposal of all generated wastes in an environmentally responsible manner. • Surplus excavated material and inert wastes (soil, broken rock etc.) shall be reused within project site as backfill, landscaping, erosion control and restoration features wherever practicable. • Surplus excavated material and inert wastes (soil, broken rock etc.) shall be reused within project site as backfill, landscaping, erosion control and restoration features wherever practicable. • All non-hazardous wastes that are generated must be handled and disposed of in accordance with the requirements of the EPHA and the EPH (General Waste Collection) Regulations. • Any hazardous wastes that are generated must be handled and disposed of in accordance with the requirements of the EPHA and the EPH (Toxic Industrial Wastes) Regulations.

Implementation of Wastewater Management

Upon completion of 2nd stage ECM, all slurry tanks installed on site shall be contained within secondary containment bunds and sited away from streams and ECM pond. All slurry is to be disposed of off-site by licensed waste collector.

Designated cement wash pits will be of robust construction to prevent water leaks, sited at designated locations and away from streams. All slurry and silts collected within the cement wash pit shall be disposed of off-site by licensed waste collector.

Vector Control

The primary impact of the construction phase of the project is potential increase in immediate vector population. Secondary to this, an increase in the number of vectors has the potential to increase the likelihood of vector-borne diseases affecting humans. Key mitigation measures include source reduction and effective drainage through implementation of vector control plan. With their implementation, it is expected that these impacts can be reduced to an insignificant level. Considering the sensitive nature of forested area, fogging is not recommended to be carried out as part of vector control measures.

Table 8. Key recommended mitigation measures for vector control

	Key recommended mitigation measures
For all areas	<ul style="list-style-type: none"> • Prepare and implement an NEA-approved Vector Management Plan. • Form an in-house vector control team to check construction sites for breeding of mosquitoes. • Conduct daily checks for vector presence on the site (e.g., discarded receptacles and building wastes, canvas sheets, equipment, puddles on the ground levels, water storage drums, tanks and containers, bulk storage containers, trenches, lift wells, drains and channels) • Building materials shall be stored under shelter as far as practicable; materials shall be stored at least 60 cm above ground to allow water collected below to be treated by the vector control operator. • Worksite shall be kept litter-free and refuse bins shall always be covered tightly. • Weekly monitoring of the NEA’s dengue cluster map shall be undertaken to determine if the workers at construction areas are at risk.

Environmental Management and Monitoring Plan

An Environmental Management and Monitoring Plan (EMMP) has been proposed to manage the identified environmental impacts during construction phase. It also includes environmental monitoring requirements containing on-site visual compliance monitoring and physical monitoring which will help to verify the effective implementation of mitigation measures during construction stage. It is recommended to develop a Construction EMMP (CEMMP) based on the recommended EMMP framework in this EIA report before initiating construction work and to strictly implement the CEMMP requirements throughout construction phase to ensure the development of this project in environmentally sensitive manner.