Environmental Design Criteria and Standards

AAP01-000-GEG-GGEN-00002

Approved Rev	Approver Name Approver Position	Signature	Date
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1 Purpose

The purpose of the Environmental Design Criteria and Standards is to establish the minimum environmental requirements as inputs into pre-Front-End Engineering Design (pre-FEED) packages of infrastructure works and activities associated with AAPowerLink; the Project. This document will be updated and refined as required over the design life of the Project.

The design criteria have been developed by reviewing and confirming applicable standards across each jurisdiction: Australia; Indonesia; Singapore; and internationally, with reference to the IFC Performance Standard safeguards and Equator Principal IV requirements. The sources of the noted limits are referenced. While the design criteria will be applied across the Project, several requirements are specific to one jurisdiction. This is noted in the section header.

2 Scope

This document applies to all project components, works and activities across all jurisdictions of the Project. The Project comprises the following six key components:

- Powell Creek Solar Precinct in the Barkly Region of the NT where electricity will be generated, stored, and transmitted
- OHTL to transmit electricity from the Solar Precinct to Darwin
- Darwin Converter Site including VSCs, energy storage and network connection to supply electricity to the Darwin region
- Cable Transition Facilities at Murrumujuk and Gunn Point Beach to transition power cables between land and sea
- Subsea Cable System extending from the Cable Transition Facilities to Singapore
- Singapore Converter Station to receive electricity and supply the Singapore electrical network.

The Solar Precinct will have a peak generation capacity of approximately 17-20 GW, subject to final modelling. The proposed transmission system rating is approximately 6.4 GW for the OHTL and 4 GW for the Subsea Cable System. The project design life for operation is 70 years.

3 Definitions and Abbreviations

Project acronyms and definitions are included in the Project Glossary and Definitions Procedure, document number AAP01-000-GPP-GAQ-00005. Acronyms specific to this document are listed in Table 3-1.

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Table 3-1: Definitions and Abbreviations

Term	Definition
AAPowerLink	Australia-Asia PowerLink
ABC – Singapore	Active, Beautiful, Clean Waters (Singapore)
AS	Australian Standard
AS/NZS	Australia / New Zealand Standard
CFU	Colony Forming Unit
dBA	Decibel A scale
EHS	Environmental, Health, and Safety (EHS) Guidelines
EIS	Environmental Impact Statement
EMF	Electrical Magnetic Field
EPA	Environment Protection Authority
ha	hectare
Hz	Hertz
ICNIRP	International Commission on Non-Ionizing Radiation Protection
IFC	International Finance Corporation
ISO	International Organisation for Standardisation
L	Litre
LAS	Land Application System
LAeq	Equivalent Continuous Sound Level
m	metre
mm	millimetre
mg	milligrams
MPN	Most Probably Number
NEPM	National Environment Protection Measures (Cwth)
NT	Northern Territory t
OHTL	Overhead Transmission Line
PUB	Singapore's National Water Agency
s	Second (time)

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Term	Definition
SCS	Singapore Converter Site
STS	Secondary Treatment System
TCAs	Tree Conservation Areas
TPZ	Tree Protection Zone
TSS	Traffic Separation Scheme
µT	micro Tesla
V	Volt
VSC	Voltage Source Converters
WAP	Water Allocation Plan (NT)
WDC	Water Control District (NT)
WHO	World Health Organisation
WMS	Wastewater Management System
WQO	Water Quality Objective

4 Air Quality

4.1 Ambient Air Quality Objectives

Ambient air quality objectives are described in Table 4-1. The objectives for each parameter consist of one or more concentration limits, each with an associated averaging period. These objectives do not apply to individual facilities or at point emission sources. However, they can be considered and applied to design considerations (e.g., siting and emission loading). These objectives are set to be protective of human health or other sensitive environmental receptors and should be measured at the boundary of the downwind project area, or nearest sensitive receptor(s).

Table 4-1: Ambient Air Quality

Term	Period	Concentration	Source
Carbon monoxide (CO)	1 hour	30 mg/m^3	3
	8 hours	10 mg/m^3	3/1
	24 hours	4 mg/m^3	3
Nitrogen Dioxide (NO_2)	1 hour	0.151 mg/m^3	1
	24 hours	25 µg/m^3	3
	1 year	10 µg/m^3	3/1

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Term	Period	Concentration	Source
Photochemical oxidants (Ozone O_3)	8 hours	100 µg/m^3	2/1
Photochemical oxidants (Ozone O_3)	Peak Season	60 µg/m^3	2
Sulfur dioxide (SO_2)	1 hour	0.262 mg/m^3	1
	24 hours	40 µg/m^3	2/1
	WHO Final	20 µg/m^3	2
Lead	1 year	0.50 µg/m^3	1
PM_{10}	24 hours	45 µg/m^3	2
	1 year	15 µg/m^3	2
$PM_{2.5}$	24 hours	15 µg/m^3	2
	1 year	5 µg/m^3	2
Total Suspended Particles (TSP)	1 year	90 µg/m^3	3
Deposited Dust	1 year incremental	2 g/m²/month	3
	1 year total	4 g/m²/month	3

Source 1: *National Environment Protection (Ambient Air Quality) Measure* - Australia
Source 2: World Health Organisation Global Air Quality Guidelines 2021
Source 3: NSW EPA Approved Methods for the Modelling and Assessment of Air Pollutants in NSW

4.2 Point Source Emission Limits

Point source emission limits are described in Table 4-2. The limits for each parameter consist of one or more concentrations, each with an associated averaging period. These limits apply to individual facilities or sources. These limits are set to be protective of human health or to protect sensitive environmental receptors and are measured directly at the facility or emission source.

Table 4-2: Point Source Emission Limits

Parameter	Period	Concentration	Source
Nitrogen Dioxide (NO_2)	1 hour	350 mg/m^3	2
Photochemical oxidants (Ozone O_3)	1 hour	100 µg/m^3	2
Solid Particles (total)	1 hour	50 mg/m^3	2
Smoke	6 minutes rolling average	Ringelmann 1 or 20% opacity	2

Source 2: Protection of the Environment Operations (Clean Air) Regulation 2021 (Schedule 4 – general activities and plant) (NSW).

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The limits described in Table 4-2 are for general activities and plant and provide a guideline. Point source emissions limits for specific equipment, such as combustion engines, are described in the regulation Schedule 1 to Schedule 3 of the Protection of the Environment Operations (Clean Air) Regulation 2021 (NSW), which describes limits applicable to permanent installation of afterburners, thermal treatment plants, landfill gas flares, crushing and grinding activities and electrical generation. Refer to these schedules for equipment specific point source emission limits.

5 Surface Water

The Project is within a number of Water Control Districts (WCD). Water within the NT is regulated under the *Water Act 1992* (NT) and associated regulations. Water quality for runoff in a Water Quality District must meet the objectives defined in the Australian and New Zealand Guidelines for Fresh and Marine Water Quality.

Table 5-1: Water Control District

Project Component	Water Control District (WCD)
Solar Precinct	Daly Roper Beetaloo
OHTL	Daly Roper Beetaloo – to Pine Creek
Darwin Convertor Site	Darwin Rural
Cable Transition Facilities	Darwin Rural
Subsea Cable System	Nil
Singapore Convertor Site	Nil

5.1 Surface Water Discharge

Drainage structures will be installed to capture and manage runoff. Dewatering refers to the removal of ponded stormwater and the subsequent reuse or discharge of that water. Discharges must comply with on-site release criteria in accordance with Table 5-2, prior to releasing any water from a construction site.

Across the jurisdictions, different terminology is used to describe surface water runoff or discharge from project areas. This is important to note in relation to the design criteria to be applied during the construction and operational phases of the Project.

Table 5-2:Terminology for Surface Water Runoff

Jurisdiction	Terminology	Definition
Australia (Australian and New Zealand Guidelines for Fresh and Marine Water Quality.)	Surface water runoff/ Stormwater	Water flowing over ground surfaces in natural streams and drains as a direct result of rainfall over a catchment
Singapore	Trade Effluent	Any liquid, including particles of matter and other substances suspended in the liquid, that is the outflow from any trade,

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Jurisdiction	Terminology	Definition
		business, or manufacture or of any works of engineering or building construction.
World Bank (World Bank Group EHS Guidelines, Wastewater and Ambient Water Quality)	Stormwater	Any surface runoff and flows resulting from precipitation, drainage, or other sources.

5.2 Surface Water Discharge Limits

On-site Dewatering Water Quality Release Criteria are described below. This is a selection of the discharge criteria.

Table 5-3: Water Quality Discharge Limits

Indicators	Criteria
Turbidity	<20
Total suspended solids	<50 mg/L
pH	6.5-8.5
Dissolved Oxygen	90th percentile >80% saturation or 6 mg/L
Litter	No visible litter washed from site
Oil and grease	No visible oil or grease

Source: NT EPA Guidelines to Prevent Pollution from Building Sites, as well as Regulation 4 (1) of the Sewerage and Drainage (Surface Water Drainage) Regulations (Singapore)

5.3 Surface Water Management Design Requirements

Table 5-4: Surface Water Management Design Considerations

Element	Watercourse
Run off management for operations1 (The Code of Practice on Surface Water Drainage – Part II (Singapore))	New erection works for commercial, industrial, institutional and residential developments greater than or equal to 0.2 ha in size are required to control the peak run-off discharged. Peak run-off reduction can be achieved through implementation of ABC Waters design features and/or structural detention and retention features (detention tanks, retention/sedimentation ponds, wetlands, bioretention swales, bioretention or rain gardens, porous pavements).
Roadside Drainage	All roads, roadside drainage and culverts will be designed in accordance with: • Best Practice Erosion and Sediment Control Guidelines (IECA 208) • Guide to Road Design Part 5: Drainage – General and Hydrology Considerations.

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5.4 Ground Water Borehole Design

The siting, design, materials, and construction method used in a bore all influence the quantity and quality of water obtained and the protection of the groundwater resource. The chosen bore design will need to consider:

- Intended purpose of the bore
- Geological and hydrogeological conditions, including the groundwater quality
- Drilling methods and construction methods.

Chapter three of the Minimum Construction Requirements for Water Bores in Australia (MCR)[1] outlines the basic design requirements for a commercial or higher yielding water supply bore.

6 Land

6.1 Riparian Vegetation Buffers

When designing infrastructure around water bodies the following buffers as per Table 6-1 are required to protect riparian vegetation.

Table 6-1: Buffers required to protect riparian vegetation

Riparian Class	Stream Order	Minimum buffer width (m)	Measured from
Drainage Depression	Not applicable	25	Outer edge of the drainage depression (extent of the associated poorly drained soils and associated vegetation).
Intermittent streams	First	25	The outer edge of the riparian vegetation or levee (whichever is the greater). If braided channels are present the edge of the outer most stream channel.
Intermittent streams	Second	50	
Creeks	Third and fourth	100	
Rivers	Fifth or higher	250	
Wetlands and GDEs	Low value	50	Buffers are measured from the outer edge of areas that are dominated by plants adapted to seasonally saturated and/or inundated conditions.
Wetlands and GDEs	Medium value	100	
Wetlands and GDEs	High value	250	
Sinkholes	All	100	External perimeter of sinkhole.

Source: Land Clearing Guidelines (NT)

6.2 Designated Tree Protection Zone (Singapore Only)

A green buffer is the planting area within and along the boundary of a premises adjoining a public road. It serves as a buffer between the development and the road. A green buffer is required along the sides of the development boundaries that front a public road. The width of the green buffer, which is a segment within the road buffer, is dependent on the road category Table 6-2. Green buffers should generally be flat to the ratio of 1:40. If the site does not permit, the proposed slope should not be steeper than the ratio of 1:2.5.

[1] National Uniform Drillers Licensing Committee 2020 (AU)

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Table 6-2: Green Buffer Requirements for Developmental Boundaries Fronting Roads

Classification of Road Based on Road Interpretation Plan	Proposed Use/Development	Green Buffer Width
Category 1	All developments	5 m
Category 2	Residential/educational	5 m
	Commercial, industrial, institutional, multi-storey, carpark, or place of worship	3 m
Category 3	All developments	3 m
Category 4	All developments	3 m

6.3 Peripheral Planting Verges (Singapore Only)

A minimum of a 2 m wide peripheral planting verge is to be provided along all sides of development boundaries except where it fronts a public road. In such situations, a green buffer that corresponds to the road category shall be required.

The 2 m wide tree planting verge should generally be flat with a ratio of 1:40. If the site does not permit, the proposed slope should not be steeper than the ration of 1:2.5.

Some developments are exempted from the provision of green buffers and/or peripheral planting verges along specific sides of the development. These are described in Table 6-3.

Table 6-3: Specific Developments Exempted from Provision of Green Buffers and/or Peripheral Planting Verges

Development	Type of Planting Area Exempted
Industrial and warehouse developments on land zoned as “Business 1, Business 1-White, Business 2” and “Business 2-White under URA Master Plan	Peripheral planting verges for the sides of premises adjoining another industrial or warehouse development.
All developments	Tree planting verges for open air parking area at street level used as a loading/unloading bay.

6.4 Overhead Wires or Towers

Overhead wires associated with powerlines present a hazard to birds. Design of any overhead wires or towers must consider the following elements listed in Table 6-4. A combination of factors may be used to reduce the risk to birds.

The World Bank Guideline for Electric Power Transmission and Distribution also recommends maintaining 1.5 m spacing between energised components and grounded hardware or, where spacing is not feasible, covering energised parts and hardware.

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Table 6-4: Design Considerations to prevent impacts to birds from OHTL

Pole structure type	Minimum conductor-conductor/ground clearance	Add on mitigation/comment
Terminal structures (transformers)	-	All terminal structures should be constructed with sufficient insulation on jumper wires and surge arrestors.
Strain structures (where jumpers are used)	-	At least two jumper wires should be suspended below the cross-arm, and the third jumper insulated. Alternatively, all jumpers should be insulated.
Take-off structures	-	All jumpers should be insulated.
Switches/isolators	-	Switches should be designed so that perching by birds on switch year is unlikely, and/or all dangerous components are insulated. Switch gear should preferably be mounted below the cross-arm. Alternatively insulated perch sites are installed way above the switch gear over the whole length.
Intermediate structures with horizontal configuration of lines	Large enough to accommodate the wingspan of the largest perching bird species in the country (2.4 m) if all three phases are above the cross arm. Alternatively, two outer conductors should be suspended below cross-arm. Wedge-tailed Eagle has a wingspan of 2.3 m and the Brolga has a wingspan of 2.4 m. The EIS commits to a 12 m clearance.	If three conductors are positioned above cross-arm, centre conductor can be insulated in order to achieve the necessary clearance between two outer conductors. Horizontal separation of lines presents a lower risk from bird collision than vertical separation.
Intermediate structures with vertical or 'delta' configuration of lines	Large enough to accommodate the 'tip-of-toe to tip-of-beak or outstretched wing' or 'head to foot' dimension of largest species present. The Brolga is1.3 m in height and likely to need >2 m separation to account for outstretched wings. The EIS commits to a 12 m clearance.	On staggered vertical structures of 66 kV to 132 kV add on mitigation in the form of 'Bird Perch' and diagonal bar to prevent perching on cross-arms could also be applied.
Wires (preferentially the earth wire or if not present the conductors)	-	Line markers/bird diverters on wires in high collision risk areas. Must be as large as possible (at least 20 cm height by 10 cm width), installed at least every 10 m and in contrasting colours to background (considering a variety of weather conditions).

Source: (Guidelines on how to avoid or mitigate impact of electricity power grids on migratory birds in the African-Eurasian region (Prinsen et al. 2011)), (Reducing Avian Collisions with Powerlines (APLIC 2012)), (Assessment and mitigation of impact of powerlines and guyed meteorological masts on birds (Scottish National Heritage 2016).)

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7 Hazardous Substances and Dangerous Goods

Dangerous Goods (identified under the Globally Harmonized System of Classification and Labelling of Chemicals (GHS)) are regulated under the *Dangerous Goods Act 1998* (NT). Design requirements are listed in Table 7-1.

Specific details regarding the storage and handling of these substances must comply with are as follows:

- Australian Standards AS1940 Storage and handling of flammable liquids
- AS3780 storage and handling of corrosive substances
- AS4326 storage and handling of oxidising agents
- AS4452 storage and handling of toxic substances.

Table 7-1: Hazardous Materials and Dangerous Goods Design Requirements

Component	Requirement
General	Labelling of containers or pipework containing dangerous goods All Hazardous Chemical and Dangerous good must be stored in appropriate containers and clearly labelled.
Storage Shelter	Sheltered Fenced up, and under lock and key Provided with kerb/hump all-round the storage area Provided with fire protection and safety facilities Equipped with leak detection and warning devices and emergency scrubbing systems for storage of toxic gases.
Storage - General	Dangerous Goods and Hazardous Substances will not be stored within 200 m of a watercourse or groundwater bore, and mobile refuelling will not occur within 50 m of a watercourse. Along the OHTL Corridor, no fuels, chemicals, or hazardous substances will be stored. Chemical storage area must have: • Net capacity of bund shall be 110% of largest storage tank or 25% of total tanks within bund, whichever is largest • If a water-based fire suppression system is installed the required bund capacity increases by the total volume output of the system over a 20-minute period • Eye wash and handwash facilities as well as a safety shower for areas storing over 2,000 L of chemicals.
Offset Distances	Dangerous Goods and Hazardous Substances will not be stored within 200 m of a watercourse or groundwater bore. Mobile refuelling will not occur within 50 m of a watercourse of groundwater bore. Any Dangerous Goods and Hazardous Substances stored at Land Sea Joint Station will be >300 m from beach and on bunded storages.
Transportation	The containers, tankers, and vehicles must be properly labelled and carry appropriate hazard warning panels.

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Component	Requirement
	The containers and tankers used for bulk chemical transportation must be designed, manufactured, and tested in accordance with internationally accepted standards. All transportation of controlled Hazardous Substances must strictly adhere to National Environment Agency's approved routes (Singapore) (Appendix 3)

Additionally, the *Environmental Protection and Management Act 1999* (Singapore) and Environmental Management and Protection (Hazardous Substances) Regulation (Singapore), also includes provisions for the safe handling and storage of toxic substances.

8 Wastewater

8.1 Primary Treatment Systems

Primary treatment refers to the separation of suspended wastewater by settlement and/or flotation in septic tanks prior to effluent discharge to either secondary treatment process or to a land application system. The following performance requirements apply:

- Retain the average daily flow for at least 24 hours to settle the solids and float the scum effectively so there is a clear zone at the level of the discharge outlet
- Store the accumulating sludge and scum
- Require sludge removal when sludge accumulation reduces settling volume below 24 hours retention, at no less than three to five year intervals
- No potential for overflows or cross-contamination from the primary chamber to any secondary chamber (e.g., where the primary chamber is within the whole treatment plant unit, the walls of the primary chamber must be of full height and sealed).

8.2 Secondary Treatment System (STS)

STS refers to aerobic biological treatment process, including settlement and/or filtering of wastewater. Secondary treated wastewater is expected to be equal to or better than 20 g/m^3 five-day biochemical oxygen demand (BOD) and 30 g/m^3 suspended solids. Table 8-1 prescribes the design criteria for an STS.

Table 8-1: Secondary Treatment Systems Design Criteria

Treatment Systems	Component	Design Criteria
Secondary treatment system	Secondary	Table 2.1 of AS 1546.3:2017 On-site domestic wastewater treatment units – Part 3: Secondary treatment systems.
	Advanced secondary	Table 2.1 of AS 1546.3:2017 On-site domestic wastewater treatment units – Part 3: Secondary treatment systems.
	Secondary with nutrient reduction	See Table 2.2 of AS 1546.3:2017 On-site domestic wastewater treatment units – Part 3: Secondary treatment systems. Required levels of total nitrogen and total phosphorus determined on a case-by-case basis based on nutrient loading constraints or limitations identified during the site and soil evaluation stage.

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Treatment Systems	Component	Design Criteria
Other components	Outlet filter	If drip irrigation system is designed for land application of the treated effluent, the effluent disc filter must be: • Fitted in the discharge pipe, between the discharge point from the treatment process and the irrigation lines. • Designed to retain all solids greater than 120-130 µm within the wastewater treatment unit.
	Alarm system	A malfunction alarm system must be installed to activate in the event of aeration system equipment failure or other electrical/mechanical malfunction, and/or in the event of a high water level in any of chamber within the wastewater treatment unit and/or in the pump chamber. An audible alarm unit, as well as a visual alarm unit, must be located in a prominent place on the property.
	Safety components	There must be a leak-proof and durable lid on the top or side of the whole WMS that prevents ingress of surface water runoff and is secured to prevent access by unauthorised personnel and yet is readily accessible for maintenance or replacement. All risers must be sealed.
	Emergency storage	A minimum emergency storage volume of at least 24 hours capacity above the alarm trigger level is required in the pump chamber. Otherwise, a combination of the equivalent emergency storage must be provided within the whole WMS, with automatic overflow between sections. Excess wastewater must not have access to the clarifier chamber, or otherwise lead to cross contamination of other sections.
	Electrical equipment	All electrical connections and components in the WMS must be in equipment accordance with the AS/NZS Standards for Electrical Installations.
	Service life	The design life of a secondary treatment system and associated fittings should be a minimum of 15 years and installed and maintained in accordance with the manufacturer's instructions.
	Other design standards	WMS utilising secondary treatment must be manufactured to the Standards in AS 1546:3 2017, particularly in terms of the design requirements and must also be in accordance with the other relevant design criteria specified in this document, whichever is the more stringent. The key criteria that must be noted within AS 1546.3:2017 are design flows and loads (the average influent quality the plant must be designed to handle), and design considerations (a variety of additional design provisions that must be included within the wastewater treatment unit). AS 1546.3:2017 also provides provisions for the design of tanks and fittings, tank construction, emergency storage capacity, materials selection, mechanical equipment, electrical equipment, effluent pumps, alarm systems, and disinfection criteria.

In areas which are not connected to a sewer, the following disposal methods are recommended by the NT Guidance notes on Wastewater Management.

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Table 8-2: Wastewater Disposal Option for Unsewered areas

Water Based	WMS	Effluent recycling options	Effluent disposal options
	Primary treatment anaerobic (septic tank) Aerobic biological filter (wet composting, vermiculture)	N/A	Absorption trenches/beds Evapotranspiration beds Low pressure effluent distribution (LPED) Mounds Non-discharge systems
	Septic tank systems Secondary treatment systems	Subsurface irrigation Surface irrigation	
	Methods of greywater use	Refer to AS1546:4:2016	

8.3 Wastewater Recycling – Low Exposure Use

Following appropriate wastewater treatment as prescribed in Table 8-2, water can be recycled. The term low exposure covers the uses of water that are generally associated with a low level of exposure such as irrigation of public open spaces, pasture and fodder crops, heavily processed food crops, non-food crops and dust suppression on construction sites. Guideline values for low exposure uses recycled water are prescribed in Table 8-3.

Table 8-3: Guideline values for recycled water (low exposure uses)

Class of recycled water	Guideline Values
A+	Less than 1 E. coli cfu / 100 mL or less than 1 E. coli MPN / 100 mL in at least 95% of samples taken in the previous 12 months
A	Less than 10 E. coli cfu / 100 mL or less than 10 E. coli MPN / 100 mL in at least 95% of samples taken in the previous 12 months

Source: Code of Practice for Water Recycling (nt.gov.au)

8.4 Land Application Systems (LAS)

The land application system receives treater effluent and provides further treatment and discharge of effluent. As per the NT Code of Practice Wastewater Management, to meet the performance objectives, LAS shall:

- Be of sufficient capacity to receive, treat, and absorb all treated wastewater flows
- Complete the uptake and absorption of the final effluent within the boundaries of the property
- Avoid the likelihood of creating unpleasant odours, or the accumulation of offensive matter
- Not cause a public health nuisance in terms of the *Public and Environmental Health Act 2011* (NT)
- Not cause or likely to cause environmental harm in terms of the *Waste Management and Pollution Control Act 1998* (NT)
- Land application areas must be located outside the 1 in 100-year coastal inundation areas.

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Refer to *AS/NZS 1547:2012* – Appendix K – Land application system – Guidance on selection for guidance on land application systems regarding identified site and soil constraints.

Table 8-4: Land Application Systems Design Criteria

Land Application Method	Design Criteria
Irrigation Systems - General	• Shallow irrigation systems are well suited to moderate draining soils. • The spray head is not greater than 500 mm above the finished irrigation surface. • All wetted diameters for each spray head are not greater than 2 m and are contained inside the designated irrigation area. • All surface irrigation including spray irrigation systems are not recommended due to their higher environmental and public health risks. • Extreme care is required during design when determining the areal loading rate and to locate the irrigation area. The irrigation area must be located to avoid any potential for contamination of natural springs or runoff to surface water and cultural sites.
Irrigation Systems - Shallow subsurface drip irrigation system	• The default for recycling secondary quality effluent is pressure-compensating subsurface irrigation (with disc or mesh filters and scour and vacuum valves) which evenly distributes effluent throughout the irrigation area.

Source: NT Code of Practice for Wastewater Management

Table 8-5 prescribes the minimum setback distances for the land application area to the edge of site feature.

Table 8-5: Minimum setback distances from edge of land application area to edge of site feature

Land Application Area	Minimum Setbacks
Surface spray and from secondary treatment system	On a flat or gently sloping site (i.e., gradient) *add 3 m if site features are >10% downslope: • 3 m from allotment boundary • 3 m from wastewater system, septic tank, pump sump, pre-treatment apparatus, diversion trench • 2 m from any other WMS land application area • 3 m from any building, including those erected on adjoining allotments • 3 m from a stormwater drain.

Table 8-6 prescribes the minimum setback distances from edge of land application area to surface water/groundwater/bores/floodplains.

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Table 8-6: Minimum setback distances from edge of land application area to surface

Feature	Setback for primary treated effluent	Setback for secondary treated effluent	Additional Information
Surface Waters			
Dam, reservoir, waterway for domestic potable water supply	200 m	100 m	
Waterway, wetland (continuous or ephemeral, nonpotable); estuaries, coastal foreshore areas, Dams, reservoirs or lakes (stock and domestic, non-potable)	60 m	30 m	Measured to the 'mean high water spring tide.'
Groundwater Bores			
Water utility production bore			Refer Guidance Notes for Wastewater Management.
Domestic bore used for potable water supply	100 m	50 m	
Water Table			
Depth to seasonal water table			Refer to 'Depth to seasonal water table' in AS/NZS 1547:2012 - Table K1 Land application systems – Limitations due to site, soil and climatic factors.
Duration of continuous season soil saturation			Refer to 'Duration of continuous season soil saturation' in AS/NZS 1547:2012 - Table K1 Land application systems – Limitations due to site, soil and climatic factors.
Shallow permanent water table			Refer to 'Shallow permanent water table' in AS/NZS 1547:2012 - Table K2 Selecting the land application system to fit the site and soil.
Hardpan or rock			
Shallow soil and very shallow soils over creviced bedrock			Refer to 'Shallow soil' and 'Very shallow soils over creviced bedrock' in AS/NZS 1547:2012 - Table K2 Selecting the land application system to fit the site and soil.

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9 Noise

The Noise Technical Report (Appendix L Draft EIS 2022 H366646-00000-247-030-0001) prescribes the following design criteria:

- Locate site access roads, laydown areas and stationary equipment (e.g., generators) as far away as possible from sensitive receptors
- Design access roads and laydown areas to minimise reversing of trucks/equipment
- All equipment must be designed to meet these noise limits at the nearest sensitive receptor.

As the operations of all sites are 24 hours, seven days per week, the more stringent noise levels are considered in Table 9-1. All other non-residential recommended assigned operational noise levels are in Table 9-2.

Table 9-1: Recommended assigned operational noise levels for airborne noise at non-residential sensitive land uses

Receptor	Noise Amenity Area	Time of Day	LAeq dBA
Classrooms at schools and other educational institutions	All	Noisiest 1 hour when in use	35 dBA (internal)
Hospital Wards and operating theatres	All	Noisiest 1 hour	35 dBA (internal) 50 dbA (external)
Places of worship	All	When in use	40 dBA (internal)
Active Recreation Areas	All	When in use	55 dBA (external)
Passive Recreation Areas	All	When in use	50 dBA (external)
Industrial Premises	All	When in use	70 dBA (external)
Commercial Premises	All	When in use	65 dBA (external)

Criteria during operations is based on residential rural amenity limits listed in Table 9-2.

Table 9-2: Recommended assigned operational noise levels for airborne noise at rural residential zones

Receptor	Day (7am to 6pm)	Evening (6pm to 10pm)	Night (10pm-7am)
Residential Amenity[1]	50 dBA	45 dBA	40 dBA

Source 1: NT Noise Guidelines for rural residential zones.

10 Vibration

The recommended assigned noise levels for continuous, impulsive, and intermittent vibration to be applied in the NT is contained in sections 2.3 and 2.4 of the publication titled, Assessing Vibration: a technical guideline, (NSW EPA) February 2006. The technical guideline recommends assigned noise levels as described in Table 10-1 and Table 10-2 for vibration levels to protect the health and wellbeing of the community.

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Table 10-1: Acceptable vibration dose values for continuous and impulsive vibration (m/s)

Location	Assessment Period[1]	Z axis preferred value	x/y axes preferred values	Max z axis value	Max x/y axes value
Continuous					
Critical areas[2]	Day or night time	0.0050	0.0036	0.010	0.0072
Residences	Day	0.010	0.0071	0.020	0.014
	Night	0.007	0.005	0.014	0.010
Offices, schools, educational institutions and places of worship	Day or night time	0.020	0.014	0.040	0.028
Workshops	Day or night time	0.04	0.029	0.08	0.058
Impulsive vibrations					
Critical areas	Day or night time	0.0050	0.0036	0.010	0.0072
Residences	Day	0.30	0.21	0.60	0.42
	Night	0.10	0.071	0.20	0.14
Offices, schools, educational institutions and places of worship	Day or night time	0.64	0.46	1.28	0.92
Workshops	Day or night time	0.64	0.46	1.28	0.92

Source 1: Daytime is 7am-10pm, Night-time is 10pm-7am
Source 2: Examples include hospital operating theatres where sensitive operations are occurring.

Table 10-2: Acceptable vibration dose values for intermittent vibration (m/s)

Location	Daytime preferred value	Daytime maximum value	Night-time preferred value	Night-time maximum value
Critical areas	0.10	0.20	0.10	0.20
Residences	0.20	0.40	0.13	0.26
Offices, schools, educational institutions and places of worship	0.40	0.80	0.40	0.80

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Location	Daytime preferred value	Daytime maximum value	Night-time preferred value	Night-time maximum value
Workshops	0.80	1.60	0.80	1.60

11 Electric and Magnetic Fields

Although there is public and scientific concern over the potential health effects associated with exposure to EMF (albeit not only high voltage power lines and substations - also from everyday household uses of electricity), there is no empirical data demonstrating adverse health effects from exposure to typical EMF levels from power transmissions lines and equipment. However, while the evidence of adverse health risks is weak, it is still sufficient to warrant limited concern.

As per World Bank Group Electric Power Transmission and Distribution Guidelines, Table 11-1 lists the exposure limits for general public exposure to electric and magnetic fields published by the International Commission on Non-Ionizing Radiation Protection ICNIRP).

If EMF levels are confirmed or expected to be above the recommended exposure limits, application of engineering techniques should be considered to the reduce the EMF produced by power lines, substations, or transformers.

Table 11-1: ICNIRP Exposure limits for General Public to Electric and Magnetic Fields

Frequency	Electric Field (V/m)	Magnetic Field (μT)
50 Hz	5000	100
60 Hz	4150`	83

12 Marine

Guidelines on Best Environmental Practices in Cable Installation and Operation (OSPAR 2012), in the absence of a specific ISO/AS/NZ Standards or another legislated standard which applies specifically to the Australian context.

Table 12-1: Cable Burial Depth Based on Water Depth

Depth	Cable Burial Depth
Coastline to 10 m	> 2 m below seabed
10 m to 15 m	≥ 1 m below seabed
15 m to 28 m	≥ 0.5 m below seabed
>28 m	On seabed, stabilized

Source: Ministry of Transportation regulation No. PM 129 of 2016 on “Shipping Routes at Sea and Buildings and/or Installations in Waters[2]”(

[2] Peraturan Menteri Perhubungan Republik Indonesia Nomor PM 129 Tahun 2016 Tentang Alur-Pelayaran Di Laut dan Bagunan dan/atau Instalasi di Perairan

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13 Light

The National Light Pollution Guidelines specify the following design principles for good lighting design:

- Artificial light can be prevented from shining above the horizontal plane by ensuring the luminaire is mounted horizontally relative to the ground and not at an angle or mounted on a building so that the structure prevents the light shining above the horizontal plane
- Internal light sources should include block out blinds or shutters for transparent portions of a building
- Utilise low glare lighting
- Utilise non-reflective, dark coloured surfaces
- Light will be shielded with exterior cut off fixtures to limit light emissions at a vertical angle of no more than 90 degrees from straight down.

Most wildlife is sensitive to short wavelength (blue/violet) light, so as a general rule, only lights with no short wavelength should be used to avoid unintended effects in areas where wildlife are present.

Additionally, the AS/NZS 4282:2019 Control of the obtrusive effects of outdoor lighting are to be adhered to.

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Appendix 1 – Standards, Codes and Guidelines

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Standards, Design Standards and Government Publications	Jurisdiction
Approved Methods for the Modelling and Assessment of Air Pollutants	Australia (NSW)
AS/NZS 4282:2019 Control of the Obtrusive Effects of Outdoor Lighting	Australia
AS 1546.3:2017 On-site Domestic Wastewater Treatment Units	Australia
AS1546:4:2016 Domestic Wastewater & Greywater Treatment	Australia
AS 2436 Guide to Noise and Vibration Control on Construction, Maintenance and Demolition Site	Australia
AS/NZS 1547:2012 Land Application Systems	Australia
AS1940 Storage and Handling of Flammable Liquids	Australia
AS3780 Storage and Handling of Corrosive Substances	Australia
AS4326 Storage and Handling of Oxidising Agents	Australia
AS4452 Storage and Handling of Toxic Substances	Australia
AS/NZS 4282:2019 Control of the Obtrusive Effects of Outdoor Lighting	Australia
Assessing Vibration: A Technical Guideline	Australia (NSW)
Assessment and mitigation of impact of powerlines and guyed meteorological masts on birds (Scottish National Heritage, 2016)	International
Australian and New Zealand Guidelines for Fresh and Marine Water Quality	Australia (Cwth)
Best Practice Erosion and Sediment Control, IECA	Australia
Code of Practice for Onsite Wastewater Management	Australia (NT)
Code of Practice for Wastewater Management	Australia (NT)
Code of Practice for Water Recycling	Australia (NT)
Dangerous Goods Act 1998	Australia (NT)
Engineering Procedures for ABC Waters design features	Singapore
Environmental, Health, and Safety Guidelines on Noise Management (IFC, 2007)	International
Environmental Management and Protection (Hazardous Substances) Regulation	Singapore
Guide to Road Design Part 5: Drainage – General and Hydrology Considerations	Australia
Guidelines on Best Environmental Practices in Cable Installation and Operation OSPAR 2012	Australia
Guidelines on how to avoid or mitigate impact of electricity power grids on migratory birds in the African-Eurasian region (Prinsen et al., 2011)	International
Guidelines on Limiting Exposure to Electromagnetic Fields (ICNIRP, 2020)	International

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Standards, Design Standards and Government Publications	Jurisdiction
Guidelines to Prevent Pollution from Building Sites	Australia (NT)
Guide to Road Design Part 5: Drainage – General and Hydrology Considerations	Australia
Land Clearing Guidelines	Australia (NT)
Minimum Construction Requirements for Water Bores in Australia (MCR) National Uniform Drillers Licensing Committee 2020 (AU)	Australia
National Environment Protection (Ambient Air Quality) Measures	Australia (Cwth)
Noise Guidelines for Rural Residential Zones	Australia (NT)
Peraturan Menteri Perhubungan Republik Indonesia Nomor PM 129 Tahun 2016 Tentang Alur-Pelayaran Di Laut dan Bagunan dan/atau Instalasi di Perairan	Indonesia
Protection of the Environment Operations (Clean Air) Regulation 2021	Australia (NSW)
Public and Environmental Health Act 2011	Australia (NT)
Reducing Avian Collisions with Powerlines (APLIC 2012)	International
Sewerage and Drainage (Surface Water Drainage) Regulations	Singapore
The Code of Practice on Surface Water Drainage	Singapore
Waste Management and Pollution Control Act 1998	Australia (NT)
Water Act 1992	Australia (NT)
World Bank Group Electric Power Transmission and Distribution Guidelines	International
World Bank Group EHS Guidelines, Wastewater and Ambient Water Quality	International
World Bank Group EHS Guidelines, Noise Management	International
World Health Organisation Global Air Quality Guidelines 2021	International

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Appendix 2 – Additional References

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Referenced Project Documents	Notes
AAPowerLink Environmental Impact Statement, 2022	Nil
Douglas Partners, Report on Geotechnical Desktop Study Proposed Solar Farm AOI2 and AOI4 (preferred site of the AAPowerLink project), 8 March 2021	Nil
Douglas Partners, Report on Preliminary Geotechnical Investigation Proposed Solar Farm, 7 October 2021	Nil
Hatch Noise Technical Report (Appendix L Draft EIS 2022 H366646-00000-247-030-0001	
Phronis Consulting Preliminary Issue Maverick 5P 13B Drawings, September 2021	Nil
Phronis Consulting Site Option 4 Solar Precinct Pre-Feasibility-Civil Concept Design, October 2021	It is noted that Phronis has not issued the final version of the concept design report. This citation will be updated following the receipt of the final report.

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Appendix 3 –National Environment Agency's Approved Routes for Hazardous Substances (Singapore)

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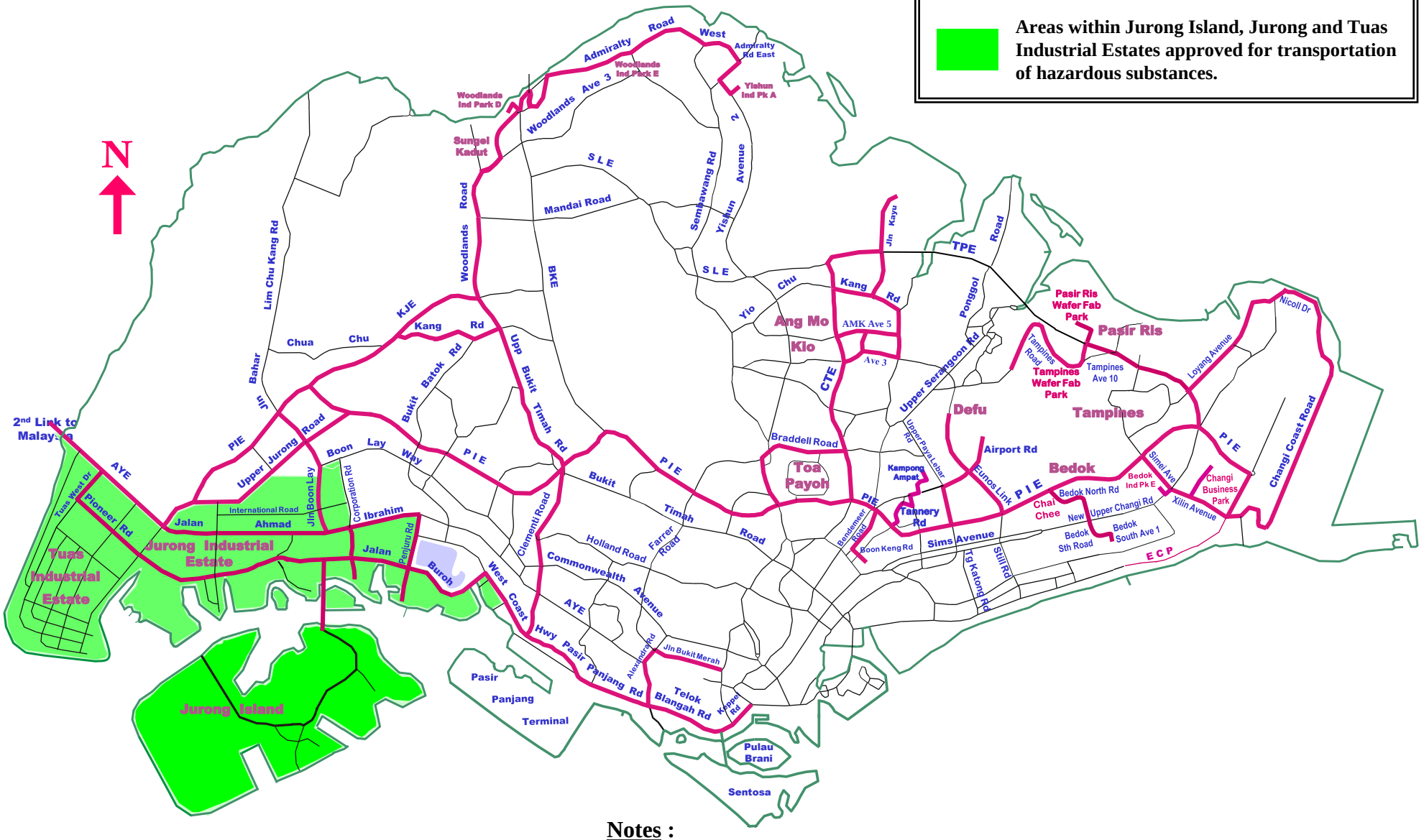

Notes :

The Underground CTE, Fort Canning, KPE Tunnels, Benjamin Sheares Bridge, SLE, AYE, BKE & Bartley-Tampines Viaduct and Marina Coastal Expressway are prohibited routes for transport of Hazardous Substances

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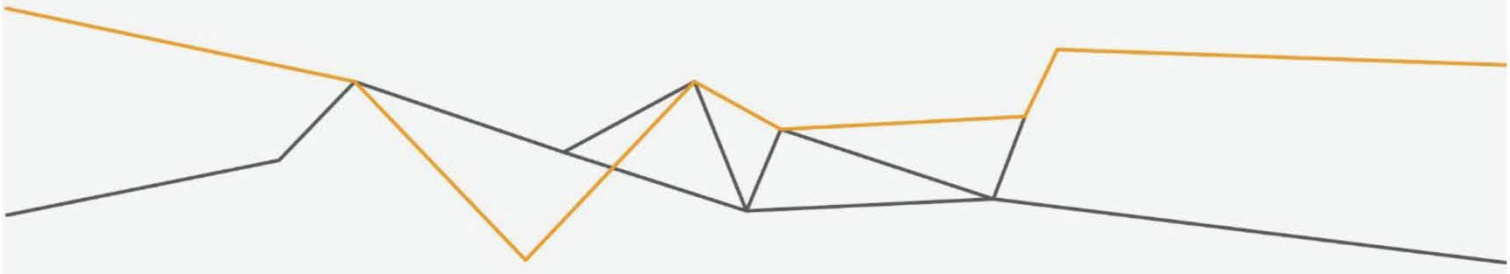

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