



# Floating Photovoltaic System on Kranji Reservoir – Environmental Impact Assessment (EIA)

Volume 5 – Appendix 8.1 to 12.2

Version 1.0 (Final)

May 2024

Project No.: 0566575

- 
1. This Report has been prepared exclusively for the use and benefit of Environmental Resources Management (S) Pte Ltd's ("ERM") Client, the Renewable Energy User selected by EDB ("Client"), to assist in determining the technical feasibility and environmental impact of the potential deployment of a large-scale floating photovoltaic system to generate renewable energy for private sector consumption in Singapore ("System"). A Developer/ Owner (to be selected and appointed) will own, design, install, operate and maintain the System.
  2. This Report has been prepared by ERM in accordance with generally accepted consultancy principles and is subject to the scope, materiality, guidelines, qualifications, methodology and assumptions that are set out or otherwise referenced in the Report and the terms of reference agreed between ERM and the Client, and is published on the express condition that ERM, the Client and their respective affiliates, officers, employees, agents, representatives and advisors ("Disclaiming Parties") each fully disclaims all liabilities or responsibilities whatsoever for any use of or reliance on this Report by any third party. The Disclaiming Parties (a) make no representations or warranties (express or implied) to any third party as to the accuracy, reliability, currency, adequacy or completeness of the Contents or with respect to the use of or reliance on any Contents disclosed in this Report and (b) assume no liability whatsoever with respect to or arising from any error, omission, inadequacy, incompleteness or mis-statements in the Contents and/or the use of or reliance on any Contents disclosed in this Report. Any use of or reliance on this Report by any third party is solely at its own risk and the Disclaiming Parties are fully released from any and all liabilities for direct, indirect, consequential or special loss or damage whether arising in contract, warranty, express or implied, tort or otherwise, and irrespective of fault, negligence and strict liability.
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## Signature Page

May 2024

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# Floating Photovoltaic System on Kranji Reservoir – Environmental Impact Assessment (EIA)

Volume 5 – Appendix 8.1 to 12.2



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## **APPENDIX 8.1 VEHICULAR EMISSION STANDARDS**

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## APPENDIX 8.1: VEHICULAR EMISSION STANDARDS

**Table 1: Exhaust Emission Standards for Motor Vehicles**

Class of Vehicle	Status <sup>(a)</sup>	Exhaust Emission Standards
<i>Gasoline Direct Injection Technology</i>		
Passenger car	After 1 April 2023	<ul style="list-style-type: none"> <li>Euro VI standard;</li> <li>JPN2009<sup>(b)</sup> and Euro VI Particle Numbers Limit; or</li> <li>JPN2018<sup>(c)</sup> and Euro VI Particle Numbers Limit.</li> </ul>
Motor Vehicle		<ul style="list-style-type: none"> <li>Euro VI standard (WLTP)<sup>(d)</sup>; or</li> <li>JPN2018; and</li> <li>Euro VI PN limit (WLTP).</li> </ul>
<i>Without Gasoline Diesel Injection Technology</i>		
Passenger car	After 1 April 2023	<ul style="list-style-type: none"> <li>Euro VI standard;</li> <li>JPN2009; or</li> <li>JPN2018.</li> </ul>
Motor Vehicle		<ul style="list-style-type: none"> <li>Euro VI standard (WLTP); or</li> <li>JPN2018.</li> </ul>
<i>Motorcycles and scooters</i>		
Two-wheeled with engine capacity not exceeding 200 cm <sup>3</sup>	On or after 1 January 2018, but before 1 January 2020	Row B of the table mentioned in paragraph 2.2.1.1.5 of Annex II of Chapter 5 of Directive 97/24/EC of the European Parliament and of the Council of the European Union, as amended by Directive 2002/51/EC of the European Parliament and of the Council of the European Union of 19 July 2002
Two-wheeled with engine capacity not exceeding 200 cm <sup>3</sup>	On or after 1 January 2020	Category L3e and L4e in the fourth row of table A1 mentioned in Annex VI(A) of Regulation (EU) No 168/2013 of the European Parliament and of the Council of the European Union of 15 January 2013
Two-wheeled with engine capacity exceeding 200 cm <sup>3</sup>	On or after 1 January 2018	
Three-wheeled		Category L5e-A in the fourth row, and vehicle category L5e-B in the fifth row, of table A1 mentioned in Annex VI(A) of Regulation (EU) No 168/2013 of the European Parliament and of the Council of the European Union of 15 January 2013.
<p><b>Notes:</b></p> <p>(a) Every licensed motor vehicle that is in use (whether registered in Singapore before, on or after 1st July 1999) shall conform to the standard for exhaust emission specified in the Fifth Schedule of EPMA (Vehicular Emissions) Regulations (Amendments) 2023.</p> <p>(b) Refers to paragraph 1(1) and (3) of Article 41 of the Japanese Ministry of Land, Infrastructure and Transport Announcement No. 619 dated 15 July 2002.</p> <p>(c) Refers to paragraph 1(3)B of Article 41 of the Japanese Ministry of Land, Infrastructure and Transport Announcement No. 619 dated 15 July 2002.</p> <p>(d) Refers to Worldwide Harmonised Light-duty Test Procedure.</p>		

Source: Environmental Protection and Management (Vehicular Emissions) Regulations, 2008

**Table 2: Exhaust Emission Limits for In-Use Motor Vehicles**

Class of Vehicle	Date of Registration	Emission Limits for Carbon Monoxide <sup>(a)</sup>
Petrol driven motor vehicle (apart from motorcycle)	On or after 1 July 1992	3.5% by volume
	1 October 1986 - Before 1 July 1992	4.5% by volume
Motorcycle	On or after 1 October 1986	4.5% by volume

Class of Vehicle	Date of Registration	Emission Limits for Carbon Monoxide <sup>(a)</sup>
	Before 1 October 1986	6% by volume
<p><b>Notes:</b>                      (a) Taken as a percentage of total volume of exhaust emissions.</p> <p><b>Additional requirements:</b></p> <ul style="list-style-type: none"> <li>• Every in-use diesel driven motor vehicle must not emit smoke of opacity greater than 40 Hartridge Smoke Units (HSU).</li> <li>• Every in-use motor vehicle must not emit any visible smoke or vapour.</li> <li>• Every in-use petrol driven motor vehicle must be equipped with a silencer, expansion chamber or contrivance to reduce the noise caused by the escape of exhaust gases from the engine.</li> <li>• All parts of the exhaust system of any petrol driven motor vehicle must be in good condition and comply with exhaust requirements.</li> </ul>		

Source: Environmental Protection and Management (Vehicular Emissions) Regulations, 2008

**Table 3: Standards for Emissions from Off-Road Diesel Engines**

Net Power (P) (kW)	Emission Standards
8 ≤ P < 19	Japan Tier I, EU Stage II, US Tier II
19 ≤ P < 560	Japan Tier I, EU Stage II
P > 560	US Tier II

Source: Environmental Protection and Management (Off-Road Diesel Engine Emissions) Regulations, 2012

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## **APPENDIX 8.2 LIST OF AIR SENSITIVE RECEPTORS**

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## APPENDIX 8.2: LIST OF AIR SENSITIVE RECEPTORS

**Table 1: List of Air Sensitive Receptors**

ASR ID	Land Use	Land Use Type	Receptor Sensitivity	Nearest Project Boundary	Shortest Distance (m) from Nearest Project Boundary
1	Sungei Buloh Wetland Reserve Visitor Centre	Park	Low	Reservoir Project Site	386
2	PUB office, Kranji Way	Business 2	Medium	Reservoir Project Site	21
3	NSRCC Kranji Sanctuary Golf Course	Sports & Recreation	Medium	Reservoir Project Site	281
4	FMB Trading and Engineering Pte Ltd	Business 2	Medium	Reservoir Project Site	23
5	Kranji Link	Business 2	Medium	Reservoir Project Site	148
6	Wan Sing Engineering	Business 2	Medium	Reservoir Project Site	166
7	Siong Kee Building	Business 2	Medium	Reservoir Project Site	163
8	HSS Eating House	Business 2	Medium	Reservoir Project Site	34
9	Sashin	Business 2	Medium	Proposed temporary Staging/Launching Area and integrated Project Substation (with O&M Facility)	118
10	Fastweld Engineering Construction	Business 2	Medium	Proposed temporary Staging/Launching Area and integrated Project Substation (with O&M Facility)	125
11	Hock Eek Seng Machinery	Business 2	Medium	Proposed temporary Staging/Launching Area and integrated Project Substation (with O&M Facility)	213
12	Ah Boon Vicil Engineering	Business 2	Medium	Proposed temporary Staging/Launching Area and integrated Project Substation (with O&M Facility)	260



ASR ID	Land Use	Land Use Type	Receptor Sensitivity	Nearest Project Boundary	Shortest Distance (m) from Nearest Project Boundary
13	Hock Chuan Hong Corporation	Business 2	Medium	Proposed temporary Staging/Launching Area and integrated Project Substation (with O&M Facility)	218
14	Ley Choon Group Holdings	Business 2	Medium	Proposed temporary Staging/Launching Area and integrated Project Substation (with O&M Facility)	52
15	Eng Hua Furniture Manufacturing	Business 2	Medium	Proposed temporary Staging/Launching Area and integrated Project Substation (with O&M Facility)	35
16	Eng Seng Cement Products	Business 2	Medium	Proposed temporary Staging/Launching Area and integrated Project Substation (with O&M Facility)	41
17	Wason Industries	Business 2	Medium	Reservoir Project Site	74
18	Prospaq Group	Business 2	Medium	Reservoir Project Site	140
19	Ecowise Holdings	Business 2	Medium	Proposed temporary Staging/Launching Area and integrated Project Substation (with O&M Facility)	182
20	Teng Lee Green Pack	Business 2	Medium	Proposed temporary Staging/Launching Area and integrated Project Substation (with O&M Facility)	213
21	Kiat Lee Landscape & Building	Transportation	Medium	Proposed temporary Staging/Launching Area and integrated Project Substation (with O&M Facility)	324
22	Starsin Trading	Business 2	Medium	Proposed temporary Staging/Launching Area and integrated Project Substation (with O&M Facility)	2

ASR ID	Land Use	Land Use Type	Receptor Sensitivity	Nearest Project Boundary	Shortest Distance (m) from Nearest Project Boundary
23	Koh Civil Engineering	Business 2	Medium	Proposed temporary Staging/Launching Area and integrated Project Substation (with O&M Facility)	49
24	Vivo PPVC Centre	Business 2	Medium	Proposed temporary Staging/Launching Area and integrated Project Substation (with O&M Facility)	7
25	Co-Top Marketing	Business 2	Medium	Reservoir Project Site	22
26	Tiong Hwa StreeI	Business 2	Medium	Reservoir Project Site	38
27	Aroyal Construction Pte Ltd	Business 2	Medium	Reservoir Project Site	216
28	Ocean Granites	Business 2	Medium	Reservoir Project Site	45
29	Wee Guan Construction Pte Ltd	Business 2	Medium	Reservoir Project Site	55
30	Marina Technology	Business 2	Medium	Reservoir Project Site	177
31	Centennial Metals International	Business 2	Medium	Reservoir Project Site	128
32	Prime Timber Industries	Business 2	Medium	Reservoir Project Site	190
33	Kim Timber	Business 2	Medium	Reservoir Project Site	167
34	Kin Wan Corporation	Business 2	Medium	Reservoir Project Site	17
35	Guan Peng Hardware	Business 2	Medium	Reservoir Project Site	40
36	Koon Seng Building	Business 2	Medium	Reservoir Project Site	100
37	Kay Huat Trading Co.	Business 2	Medium	Reservoir Project Site	141
38	Duratec Equipment	Business 2	Medium	Reservoir Project Site	210
39	Wah Tat Hardware	Business 2	Medium	Reservoir Project Site	225
40	Multico	Business 2	Medium	Reservoir Project Site	260
41	M&F Industrial (s) Pte Ltd	Business 2	Medium	Reservoir Project Site	326
42	Kranji Reservoir Fishing Ground A	Park	Low	Reservoir Project Site	18
43	Kranji Reservoir Fishing Ground B	Park	Low	Reservoir Project Site	24
44	Polygan Design Pte Ltd	Business 2	Medium	Reservoir Project Site	113

ASR ID	Land Use	Land Use Type	Receptor Sensitivity	Nearest Project Boundary	Shortest Distance (m) from Nearest Project Boundary
45	Star Ready-Mix Pte Ltd	Business 2	Medium	Reservoir Project Site	77
46	HEC Electrical Construction Pte Ltd	Business 2	Medium	Reservoir Project Site	92
47	Kranji Marshes	Park	Low	Reservoir Project Site	319
48	Kranji Reservoir Park B	Park	Low	Reservoir Project Site	92
49	Kranji Way Dormitory	Dormitory	High	Reservoir Project Site	200
<p><i>Note: Land Use categorised based on site observation as land use was not indicated/ correct on URA Master Plan 2019.</i></p>					

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**APPENDIX 8.3 BASELINE AMBIENT AIR QUALITY SURVEY REPORT**

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Date: 02 December 2021

## **AMBIENT AIR QUALITY MONITORING REPORT FOR PROJECT**

**FOR**

**ENVIRONMENTAL RESOURCES MANAGEMENT (S) PTE LTD  
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\_\_\_\_\_  
Edmundo Il Dio Casapao  
Environmental Engineer

  
\_\_\_\_\_  
Tan Teong Huat  
Assistant General Manager (ENV)

The results reported herein have been performed in accordance with the terms of accreditation under the Singapore Accreditation Council and comply with the requirements specified in ISO/IEC 17025. This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted, unless the sampling was conducted by ALS. The laboratory declares that the test results relate only to the items tested. This report may not be reproduced except with prior written approval from the testing laboratory and shall not be used for advertising purposes.

# Executive Summary

ALS Technichem (S) Pte Ltd is appointed by Environmental Resources Management (S) Pte Ltd to carry out Ambient Air Monitoring for Project. The monitoring was undertaken to determine the ambient air quality of Particulate Matter as 2.5um and 10um (PM<sub>2.5</sub> and PM<sub>10</sub>) and Dust Deposition for 7 days continuously from 26 October 2021 to 02 November 2021. The objective of this monitoring is to establish ambient levels at air sensitive receptors (ASRs) and The compare the results if in compliance with the limits stipulated by Singapore Ambient Air Quality Targets by 2020 and the Long-Term Targets.

The Particulate Matter monitoring results are summarized in Table 4.1. The results for PM<sub>10</sub> is in compliance with the Singapore Ambient Air Quality Targets by 2020 for all 7 days. The results range from 11.7 to 18.0 µg<sup>m</sup><sup>-3</sup>.

For PM<sub>2.5</sub>, the monitoring results for AQ01 comply to both Singapore Ambient Air Quality Long Term Targets for 2020 as well as Singapore Ambient Air Quality Long Term Targets for all 7 days. The results range from 8.14 to 13.8µg<sup>m</sup><sup>-3</sup>.

Currently, there is no established limit for Dust Deposition as summarized in Table 4.2.

It should be noted that the Ambient Air Monitoring project was carried out to the best of our knowledge and ability as well as responsibility towards the code of practice in the performance and reliability of our business to be accurate, precise and representative at the date/time and locations sampled so as to achieve a satisfactory baseline study.



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# List of Abbreviations

PM <sub>10</sub>	Particulate matter with aerodynamic diameter less than 10µm
PM <sub>2.5</sub>	Particulate matter with aerodynamic diameter less than 2.5µm
µgm <sup>-3</sup>	Microgram per cubic metre
mgm <sup>-3</sup>	Milgram per cubic metre
LOR	Limit of Reporting





# 1.0 Monitoring Requirement

## 1.1 Introduction

ALS Technichem (S) Pte Ltd (hereafter as “ALS”) has been appointed as the contractor to perform Ambient Air Monitoring at the selected location for Project. The monitoring was requested by Environmental Resources Management (S) Pte Ltd (hereafter as “ERM”).

The ambient air monitoring is aimed to provide an air quality baseline information on the targeted area which was pre-determined by ERM and to evaluate the results whether it is in compliance against National Environmental Agency- Singapore Ambient Air Quality Targets by 2020 and the Long-Term Targets.

## 1.2 Scope of Work

The scope of works for the ambient air quality monitoring includes:

1. Preparation of an Ambient Air Monitoring Plan;
2. Ambient air monitoring station setup and sampling at selected sampling location, identified as AQ01. The sampling point was dictated by ERM;
3. Collected air samples were analysed for:
  - Particulate Matter as 10um and 2.5um (PM<sub>10</sub> & PM<sub>2.5</sub>); and
  - Dust Deposition
4. Assessing the analytical results against Singapore Ambient Air Quality Targets by 2020 and the Long-Term Targets
5. Providing a report outlining the findings and results of the study.

## 1.3 Monitoring Requirement

Ambient air monitoring was conducted at AQ01. Particulate Matter as 10um and 2.5um (PM<sub>10</sub> & PM<sub>2.5</sub>) and Dust Deposition were monitored as required. Monitored parameters were dictated by ERM and compared with the Singapore Ambient Air Quality Targets by



2020 and the Long-Term Targets. Table 1.1 lists the details of the limits of each parameter in this study.

**Table 1.1: Summary of test parameters and limits for ambient air monitoring**

Parameters	Limits (mgm <sup>-3</sup> or µgm <sup>-3</sup> )	Guidelines
PM <sub>2.5</sub>	25 µgm <sup>-3</sup> (24-hour averaging period)	Singapore Ambient Air Quality Long-Term Targets
	37.5µg/m <sup>3</sup> (24-hour averaging period)	Singapore Ambient Air Quality Targets by 2020
PM <sub>10</sub>	50 µgm <sup>-3</sup> (24-hour averaging period)	Singapore Ambient Air Quality Targets by 2020
Dust Deposition	Not Established (NE)	

## 2.0 Sampling and Field Monitoring

### 2.1 Sampling Equipment

The following equipment was mobilized and used during the environmental monitoring activities.

Parameter	Instrument Type
Particulate matter (PM <sub>10</sub> & PM <sub>2.5</sub> )	TSI Environmental DustTrak Monitoring System
Dust Deposition	Dust Deposition Gauge



2.2 Monitoring Location (★ indicates air monitoring location)



Figure 2.1: AQ01, open space near Sungei Buloh Wetland Reserve Visitor Centre



## 2.3 Detail Ambient Air Monitoring Point

The air monitoring point identified as AQ01 was dictated by ERM. The details of the monitoring point are listed in Table 2.1 below.

**Table 2.1: Details of monitoring points**

Sampling ID	Monitoring Point	Parameter	Sampling Start		Sampling Stop	
			Date	Time (hr)	Date	Time (hr)
AQ01	Open space near Sungei Buloh Wetland Reserve Visitor Centre	PM <sub>10</sub> & PM <sub>2.5</sub> (24 hours) and Dust Deposition	26 Oct 2021	1300	02 Nov 2021	1300



## 3.0 Sampling and Analysis Methodology

Brief method description, method reference and reporting limit of the analytical methods are provided in Table 3.1.

**Table 3.1: Summary of methodologies and limit of reporting (LOR)**


No.	Parameter	Referenced Analytical Method	Description of Method	LOR
1.	Particulate matter (PM <sub>10</sub> & PM <sub>2.5</sub> )	TSI Environmental DustTrak Monitoring System Operation Manual	Concentrations of PM <sub>10</sub> & PM <sub>2.5</sub> were measured by Light scattering laser photometer principle using an Environmental DustTrak Monitoring Equipment coupled with heated inlet for 5 minutes interval data log over 7 days continuous sampling period	1.0 µgm <sup>-3</sup>
2.	Dust Deposition	Australian Standard AS3580.10.1-1991	Dust Level was determined by collecting the deposited particulate matters that suspended throughout and then settles from the air. The quantitative analysis of solid matters collected together with rain water into the amber bottle was determined by gravimetric method	0.1 gm <sup>-2</sup> mth <sup>-1</sup>



### 3.1 Quality Assurance / Quality Control

The certificate of field equipment calibration is attached below.

ATS-ENV-6898




## CERTIFICATE OF CALIBRATION AND TESTING

TSI Singapore Pte Ltd 150, Kampong Ampat  
#05-05, KA Centre Singapore 368324  
Phone: +65 6595 6391

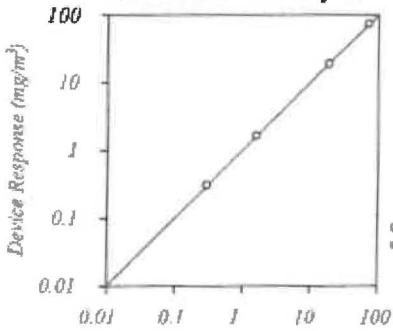
Environment Conditions			Model	8543
Temperature	22.2	°C	Serial Number	8543192904
Relative Humidity	44	%RH		
Barometric Pressure	1006.1	hPa		

As Left  
 As Found

In Tolerance  
 Out of Tolerance



### Concentration Linearity Plot




System ID: DT1104-01


FLOW AND PRESSURE VERIFICATION				SYSTEM DT1104-01			
Parameter	Standard	Measured	Allowable Range	Parameter	Standard	Measured	Allowable Range
Flow lpm	3.00	3.02	2.88 ~ 3.12	Pressure kPa	100.4	100.4	95.37 ~ 105.41
Full Flow lpm	N/A	5.99	>3.80				

TSI Incorporated does hereby certify that all materials, components, and workmanship used in the manufacture of this equipment are in strict accordance with the applicable specifications agreed upon by TSI and the customer and with all published specifications. All performance and acceptance tests required under this contract were successfully conducted according to required specifications. There is no NIST standard for optical mass measurements. Calibration of this instrument performed by TSI has been done using every oil and has been nominally adjusted to respirable mass of standard ISO 12103-1. All test dust (Arizona dust) One calibration ratio is greater than 1.2:1.

Measurement Variable	System ID	Last Cal.	Cal. Due	Measurement Variable	System ID	Last Cal.	Cal. Due
DC Voltage	E020115	14-01-21	31-01-22	Photometer	E020114	29-01-21	31-07-21
Microbalance	E020125	27-01-20	31-01-22	1 um PSL	698880	n/a	n/a
3 um PSL	206030	n/a	n/a	10 um PSL	212453	n/a	n/a
Pressure	E020123	29-01-21	31-01-22	Flowmeter	E020119	28-04-20	30-04-21

  
 \_\_\_\_\_  
 Calibrated

15 March, 2021  
 \_\_\_\_\_  
 Date

  
 23 Mar 2021

TSI PA 23001 ET



## 4.0 Results of Monitoring

**Table 4.1: Summary of results for Particulate Matter as PM<sub>2.5</sub>, and PM<sub>10</sub> based on 24-hour average at AQ01**

Sampling Point	Day	Particulate Matter, 2.5um (PM <sub>2.5</sub> ), µgm <sup>-3</sup>	Particulate Matter, 10um (PM <sub>10</sub> ), µgm <sup>-3</sup>
AQ01 (Open space near Sungei Buloh Wetland Reserve Visitor Centre)	26 to 27 Oct 2021	13.3	16.1
	27 to 28 Oct 2021	10.6	16.7
	28 to 29 Oct 2021	8.94	15.0
	29 to 30 Oct 2021	8.14	11.7
	30 to 31 Oct 2020	13.8	18.0
	31 Oct to 01 Nov 2021	11.6	15.9
	01 to 02 Nov 2021	11.4	15.9
<b>Limits (µgm<sup>-3</sup>)</b>		25 <sup>a</sup> 37.5 <sup>b</sup>	50 <sup>b</sup>

**Notes:**

<sup>a</sup> Denotes as per client request, the results are compared to the limits stipulated by Singapore Ambient Air Quality Long Term Targets

<sup>b</sup> Denotes results are compared to the limits stipulated by Singapore Ambient Air Quality Targets by 2020.



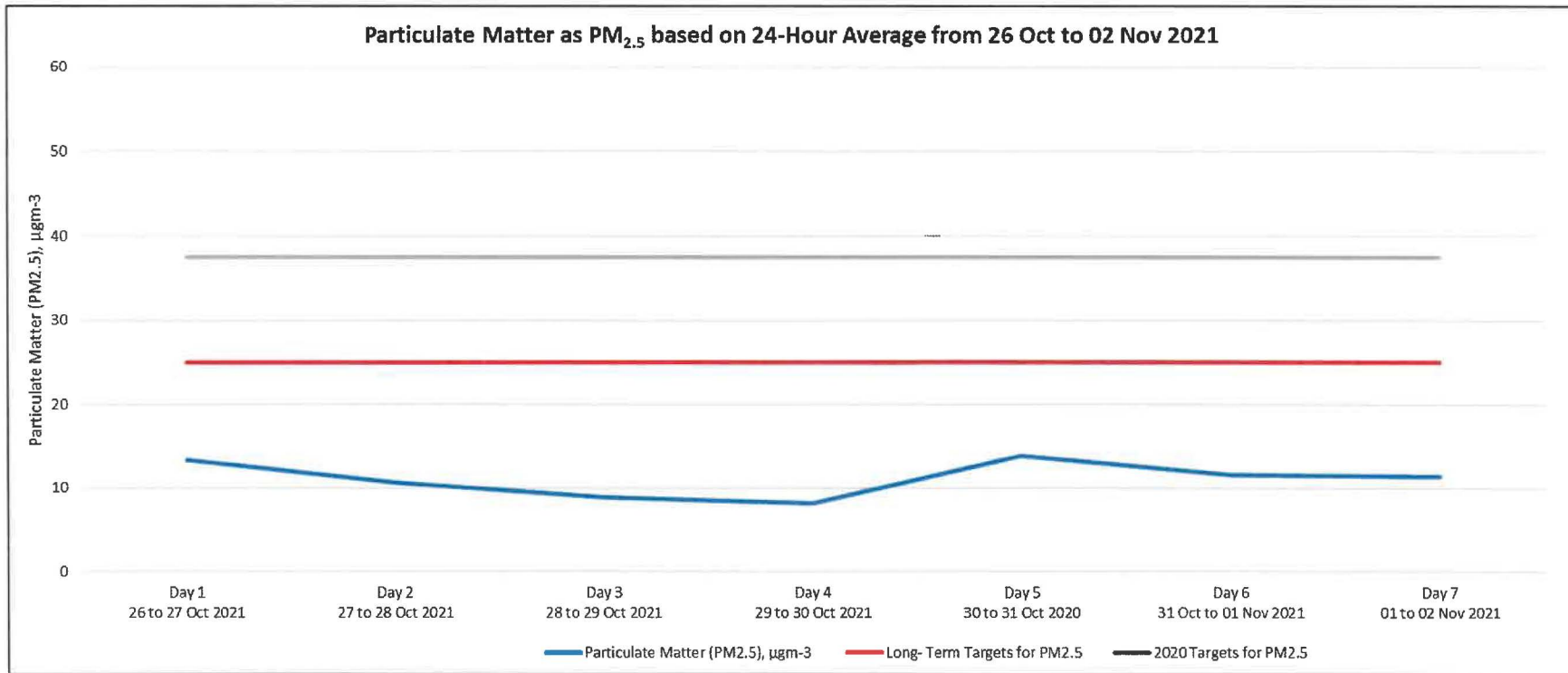


Figure 4.1: 24-Hour Average for PM<sub>2.5</sub> at AQ01 from 26 Oct to 02 Nov 2021





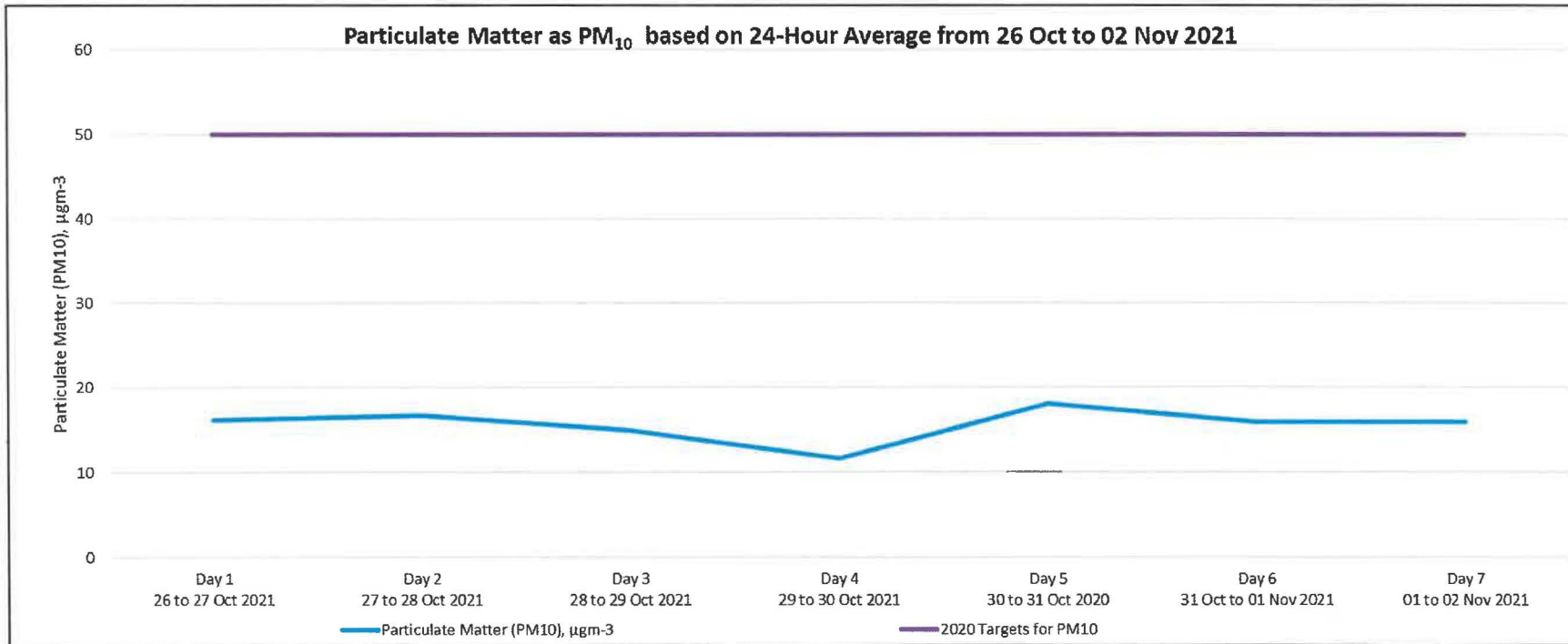


Figure 4.2: 24-Hour Average for PM<sub>10</sub> at AQ01 from 26 Oct to 02 Nov 2021



**Table 4.2: Concentration of Dust Deposition for AQ01**

<b>Location (Period of Monitoring)</b>	<b>Dust Deposition, gm<sup>-2</sup>.mth<sup>-1</sup></b>
<b>AQ01</b> open space near Sungei Buloh Wetland Reserve Visitor Centre (26 Oct to 02 Nov 2021)	7.63



## 7.0 Conclusion

The PM<sub>10</sub> and PM<sub>2.5</sub> monitoring results for AQ01 are summarized in Table 4.1. The results for PM<sub>10</sub> in compliance to the Singapore Ambient Air Quality Targets by 2020 for all 7 days. The results range 11.7 to 18.0 µgm<sup>-3</sup>.

For PM<sub>2.5</sub>, the monitoring results for AQ01 are in compliance to both Singapore Ambient Air Quality Long Term Targets for 2020 as well as Singapore Ambient Air Quality Long Term Targets for all 7 days. The results range from 8.14 to 13.8µgm<sup>-3</sup>.

Currently, there is no established limit for Dust Deposition as summarized in Table 4.2.

It should be noted that the Ambient Air Monitoring project was carried out to the best of our knowledge and ability as well as responsibility towards the code of practice in the performance and reliability of our business to be accurate, precise and representative at the date/time and locations sampled so as to achieve a satisfactory baseline study.



**APPENDIX 1: Site Photos**



**AQ01 open space near Sungei Buloh Wetland Reserve Visitor Centre**





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Co Reg No: 198403076R

Our Ref: SG2203633-001

Date: 18 May 2022

## **AMBIENT AIR QUALITY MONITORING REPORT FOR PROJECT**

**FOR**

**ENVIRONMENTAL RESOURCES MANAGEMENT (S) PTE LTD  
120 ROBINSON ROAD #10-01  
SINGAPORE 068913**

  
Yong Li Sheng  
Field Engineer

  
Tan Teong Huat  
Assistant General Manager (ENV)

The results reported herein have been performed in accordance with the terms of accreditation under the Singapore Accreditation Council and comply with the requirements specified in ISO/IEC 17025. This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted, unless the sampling was conducted by ALS. The laboratory declares that the test results relate only to the items tested. This report may not be reproduced except with prior written approval from the testing laboratory and shall not be used for advertising purposes.

# Executive Summary

ALS Technichem (S) Pte Ltd is appointed by Environmental Resources Management (S) Pte Ltd to carry out Ambient Air Monitoring for Project. The monitoring was undertaken to determine the ambient air quality of Particulate Matter as 2.5um and 10um (PM<sub>2.5</sub> and PM<sub>10</sub>) and Dust Deposition for 7 days continuously from 05 to 12 April 2022. The objective of this monitoring is to establish baseline air measurement to represent potential nearby Air Sensitive Receptors (ASRs) and to determine whether the results are in compliance to the limits stipulated by Singapore Ambient Air Quality Targets by 2020 and the Long-Term Targets.

The Particulate Matter monitoring results are summarized in Table 4.1. The PM<sub>2.5</sub> monitoring results for all 7 days are in compliance to the Singapore Ambient Air Quality Targets by 2020.

The results of PM<sub>2.5</sub> concentrations comply to the Singapore Ambient Air Quality Long Term Targets for PM<sub>2.5</sub> except for Day 7. The results range from 7.82 to 28.9 µgm<sup>-3</sup>.

For PM<sub>10</sub>, the monitoring results for all locations comply to both Singapore Ambient Air Quality Targets by 2020 and Singapore Ambient Air Quality Long Term Targets. The results range from 15.3 to 39.3 µgm<sup>-3</sup>.

Currently, there is no established limit for Dust Deposition as summarized in Table 4.2.

It should be noted that the Ambient Air Monitoring project was carried out to the best of our knowledge and ability as well as responsibility towards the code of practice in the performance and reliability of our business to be accurate, precise and representative at the date/time and locations sampled so as to achieve a satisfactory baseline study.



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# List of Abbreviations

PM <sub>2.5</sub>	Particulate matter with aerodynamic diameter less than 2.5µm
PM <sub>10</sub>	Particulate matter with aerodynamic diameter less than 10µm
µgm <sup>-3</sup>	Microgram per cubic metre
mgm <sup>-3</sup>	Milgram per cubic metre
LOR	Limit of Reporting





# 1.0 Monitoring Requirement

## 1.1 Introduction

ALS Technichem (S) Pte Ltd (hereafter as “ALS”) has been appointed as the contractor to perform Ambient Air Monitoring at the selected location for Project. The monitoring was requested by Environmental Resources Management (S) Pte Ltd (hereafter as “ERM”).

The ambient air monitoring is aimed to provide an air quality baseline information on the targeted area which was pre-determined by ERM and to evaluate the results whether it is in compliance against National Environmental Agency- Singapore Ambient Air Quality Targets by 2020 and the Long-Term Targets.

## 1.2 Scope of Work

The scope of works for the ambient air quality monitoring includes:

1. Preparation of an Ambient Air Monitoring Plan;
2. Ambient air monitoring station setup and sampling at selected sampling location, identified as AQ02. The sampling point was dictated by ERM;
3. Collected air samples were analysed for:
  - Particulate Matter as 2.5um and 10um (PM<sub>2.5</sub> & PM<sub>10</sub>); and
  - Dust Deposition
4. Assessing the analytical results against Singapore Ambient Air Quality Targets by 2020 and the Long-Term Targets
5. Providing a report outlining the findings and results of the study.

## 1.3 Monitoring Requirement

Ambient air monitoring was conducted at AQ02. Particulate Matter as 2.5um and 10um (PM<sub>2.5</sub> & PM<sub>10</sub>) and Dust Deposition were monitored as required. Monitored parameters were dictated by ERM and compared with the Singapore Ambient Air Quality Targets by



2020 and the Long-Term Targets. Table 1.1 lists the details of the limits of each parameter in this study.

**Table 1.1: Summary of test parameters and limits for ambient air monitoring**

Parameters	Limits (mgm <sup>-3</sup> or µgm <sup>-3</sup> )	Guidelines
PM <sub>2.5</sub>	25 µgm <sup>-3</sup> (24-hour averaging period)	Singapore Ambient Air Quality Long-Term Targets
	37.5µg/m <sup>3</sup> (24-hour averaging period)	Singapore Ambient Air Quality Targets by 2020
PM <sub>10</sub>	50 µgm <sup>-3</sup> (24-hour averaging period)	Singapore Ambient Air Quality Targets by 2020
Dust Deposition	Not Established (NE)	

## 2.0 Sampling and Field Monitoring

### 2.1 Sampling Equipment

The following equipment was mobilized and used during the environmental monitoring activities.

Parameter	Instrument Type
Particulate matter (PM <sub>2.5</sub> & PM <sub>10</sub> )	TSI Environmental DustTrak Monitoring System
Dust Deposition	Dust Deposition Gauge



2.2 Monitoring Location (★ indicates air monitoring location)

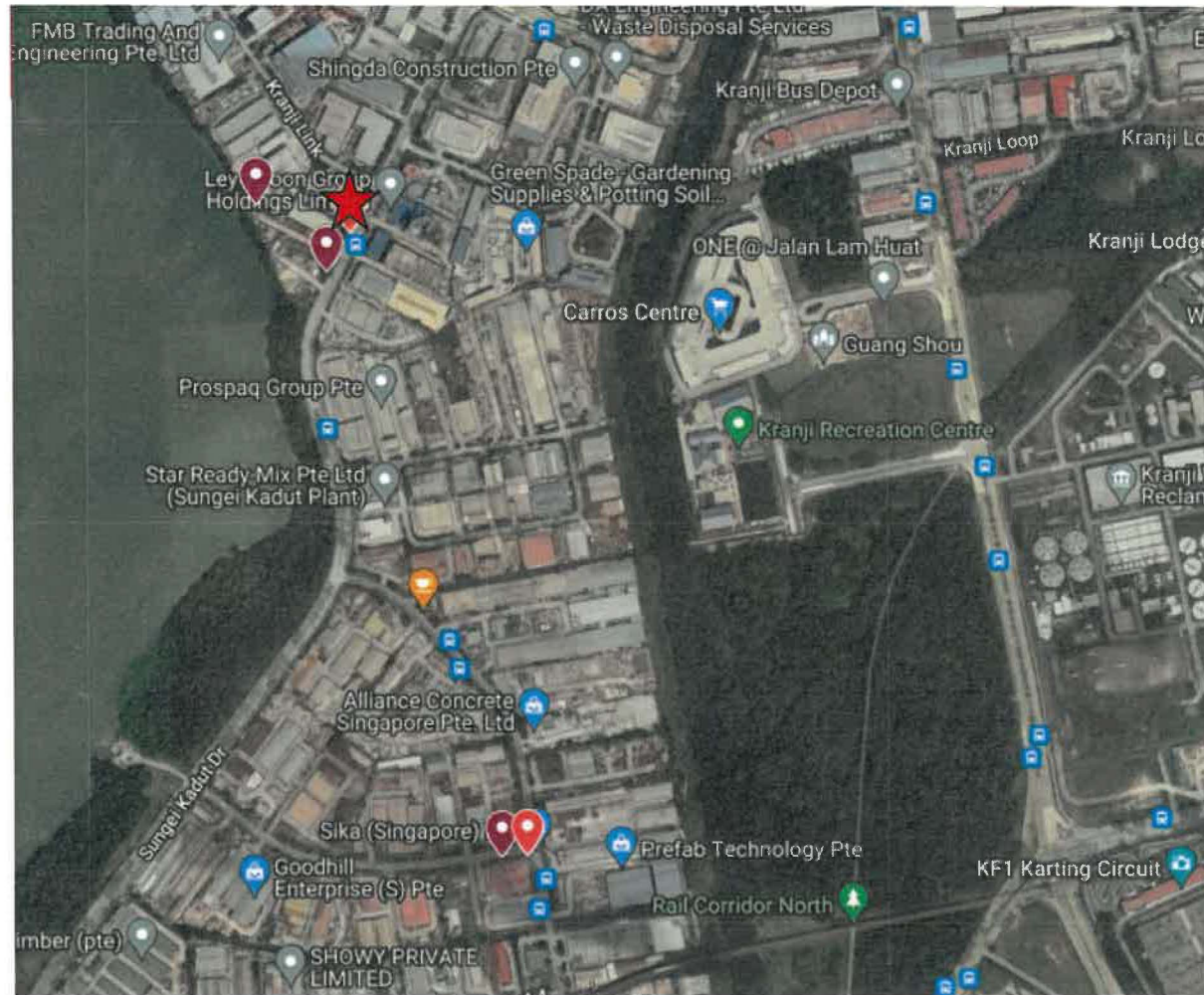


Figure 2.1: AQ02 Monitoring Location



### 2.3 Detail Ambient Air Monitoring Point

The air monitoring point identified as AQ02 was dictated by ERM. The details of the monitoring point are listed in Table 2.1 below.

**Table 2.1: Details of monitoring points**

Sampling ID	Monitoring Point	Parameter	Sampling Start		Sampling Stop	
			Date	Time (hr)	Date	Time (hr)
AQ02	Entrance of Star Sin Trading along 12 Sungei Kadut Drive	PM <sub>10</sub> & PM <sub>2.5</sub> (24 hours) and Dust Deposition	05 Apr 2022	11:00	12 Apr 2022	10:55



### 3.0 Sampling and Analysis Methodology

Brief method description, method reference and reporting limit of the analytical methods are provided in Table 3.1.

**Table 3.1: Summary of methodologies and limit of reporting (LOR)**


No.	Parameter	Referenced Analytical Method	Description of Method	LOR
1.	Particulate matter (PM <sub>2.5</sub> & PM <sub>10</sub> )	TSI Environmental DustTrak Monitoring System Operation Manual	Concentrations of PM <sub>10</sub> & PM <sub>2.5</sub> were measured by Light scattering laser photometer principle using an Environmental DustTrak Monitoring Equipment coupled with heated inlet for 5 minutes interval data log over 7 days continuous sampling period	1.0 µgm <sup>-3</sup>
2.	Dust Deposition	Australian Standard AS3580.10.1-1991	Dust Level was determined by collecting the deposited particulate matters that suspended throughout and then settles from the air. The quantitative analysis of solid matters collected together with rain water into the amber bottle was determined by gravimetric method	0.1 gm <sup>-2</sup> mth <sup>-1</sup>



### 3.1 Quality Assurance / Quality Control

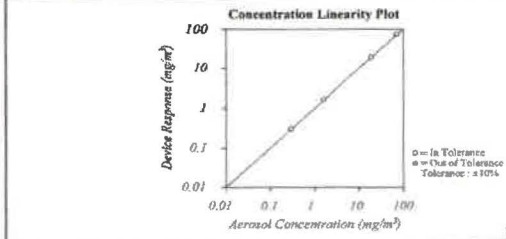
The certificate of field equipment calibration is attached below.

MS-ENV-689 A


**CERTIFICATE OF CALIBRATION AND TESTING**  
TSI Singapore Pte Ltd 150, Kampong Ampas  
 #05-05, N.A. Centre Singapore 348324  
 Phone: +65 6795 6391

<b>Environment Conditions</b>		<b>Model</b>	<b>8543</b>
Temperature	22.2 °C	<b>Serial Number</b>	<b>8543192904</b>
Relative Humidity	44 %RH		
Barometric Pressure	1006.1 hPa		

As Left       In Tolerance      **BY INSTRUMENT MANUFACTURER**  
 As Found       Out of Tolerance

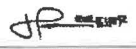


System ID: D1194-01


FLOW AND PRESSURE VERIFICATION				SYSTEM D1194-01			
Parameter	Standard	Measured	Allowable Range	Parameter	Standard	Measured	Allowable Range
Flow Lpm	3.00	3.02	2.95 - 3.12	Pressure kPa	100.4	100.4	93.37 - 105.41
Fault Flow Lpm	N/A	5.99	>2.80				

TSI Incorporated does hereby certify that all materials, components, and workmanship used in the manufacture of this equipment are in strict accordance with the applicable specifications agreed upon by TSI and the customer and with all published specifications. All performance and acceptance tests required under this contract were successfully conducted according to required specifications. There is no NIST standard for this or these measurements. Calibration of this instrument performed by TSI has been done using every oil and has been normally adjusted to comparable mass of particles (D<sub>p</sub> 1.10µm, at 1 bar and 100% RH). Our calibration ratio is greater than 1.1.

Measurement Variable	System ID	Last Cal.	Cal. Due	Measurement Variable	System ID	Last Cal.	Cal. Due
DIC Voltage	E020115	14-01-21	31-01-22	Fluorescence	E020114	28-01-21	31-07-23
Microbiomas	E020125	27-01-20	31-01-22	1 um PSL	608889	n/a	n/a
3 um PSL	206036	n/a	n/a	10 um PSL	212455	n/a	n/a
Pressure	3020123	28-01-21	31-01-22	Fluorescence	E020119	28-04-20	30-04-21

  
 \_\_\_\_\_  
 Calibrated

15 March, 2021  
 \_\_\_\_\_  
 Date





## 4.0 Results of Monitoring

**Table 4.1: Summary of results for Particulate Matter as PM<sub>2.5</sub>, and PM<sub>10</sub> based on 24-hour average at AQ02**

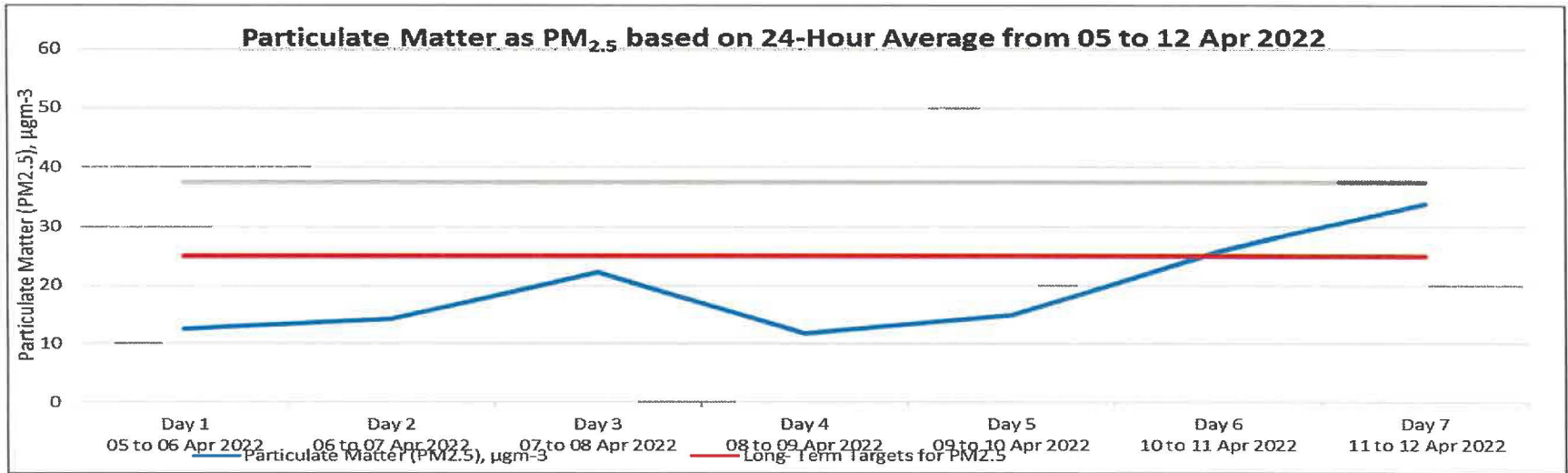
Sampling Point	Day	Particulate Matter, 2.5um (PM <sub>2.5</sub> ), µgm <sup>-3</sup>	Particulate Matter, 10um (PM <sub>10</sub> ), µgm <sup>-3</sup>
AQ02 (Entrance of Star Sin Trading along 12 Sungei Kadut Drive)	05 to 06 Apr 2022	11.3	17.9
	06 to 07 Apr 2022	10.0	15.3
	07 to 08 Apr 2022	17.0	23.2
	08 to 09 Apr 2022	7.82	16.3
	09 to 10 Apr 2022	12.8	21.4
	10 to 11 Apr 2022	20.8	27.6
	11 to 12 Apr 2022	<b>28.9</b>	39.3
<b>Limits (µgm<sup>-3</sup>)</b>		25 <sup>a</sup> 37.5 <sup>b</sup>	50 <sup>b</sup>

Notes:

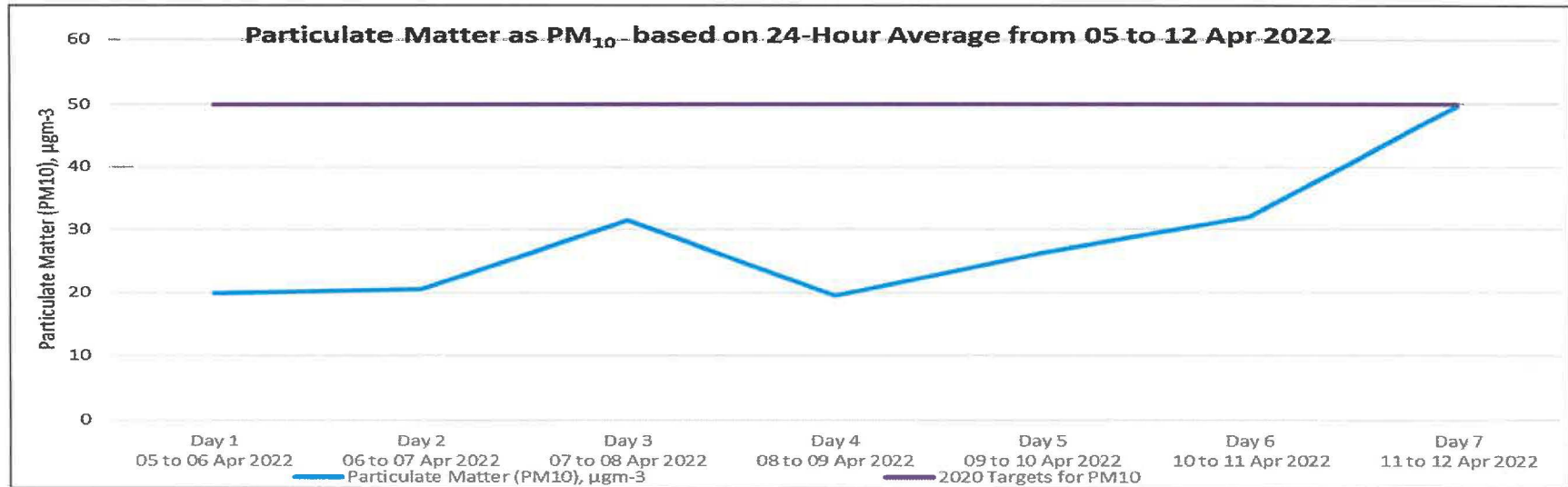
<sup>a</sup> Denotes as per client request, the results are compared to the limits stipulated by Singapore Ambient Air Quality Long Term Targets

<sup>b</sup> Denotes results are compared to the limits stipulated by Singapore Ambient Air Quality Targets by 2020. **BOLD** denote results exceedance to Singapore Ambient Air Quality Long Term Targets





**Figure 4.2: 24-Hour Average for PM<sub>2.5</sub> at AQ02 from 05 Apr to 12 Apr 2022**



**Figure 4.3: 24-Hour Average for PM<sub>10</sub> at AQ02 from 05 Apr to 12 Apr 2022**





**Table 4.3: Concentration of Dust Deposition for AQ02**

<b>Location (Period of Monitoring)</b>	<b>Dust Deposition, gm<sup>-2</sup>.mth<sup>-1</sup></b>
<b>AQ02</b> Entrance of Star Sin Trading along 12 Sungei Kadut Drive (05 Apr to 12 Apr 2022)	16.2



## 7.0 Conclusion

The PM<sub>2.5</sub> and PM<sub>10</sub> monitoring results are summarized in Table 4.1. The monitoring results for PM<sub>2.5</sub> are in compliance to both Singapore Ambient Air Quality Long Term Targets for 2020 and Singapore Ambient Air Quality Long Term Targets except Day 7 which exceeded the Singapore Ambient Air Quality Long Term Targets. The PM<sub>2.5</sub> concentrations ranges from 7.82 to 28.9 µg<sup>m</sup><sup>-3</sup>.

For PM<sub>10</sub>, the monitoring results are in compliance to both Singapore Ambient Air Quality Long Term Targets for 2020 and Singapore Ambient Air Quality Long Term Targets for all 7 days. The PM<sub>10</sub> results ranges from 15.3 to 39.3 µg<sup>m</sup><sup>-3</sup>.

Currently, there is no established limit for Dust Deposition as summarized in Table 4.3.

It should be noted that the Ambient Air Monitoring project was carried out to the best of our knowledge and ability as well as responsibility towards the code of practice in the performance and reliability of our business to be accurate, precise and representative at the date/time and locations sampled so as to achieve a satisfactory baseline study.



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**APPENDIX 9.1 BASELINE AIRBORNE NOISE SURVEY REPORTS**

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Co Reg No: 198403076R

Our Ref: SG2110917-002

Date: 20 December 2021

**NOISE MONITORING REPORT  
(BASED ON CONTROL OF NOISE AT CONSTRUCTION SITES REGULATIONS)**

**PROJECT |**

**For**

**ENVIRONMENTAL RESOURCES MANAGEMENT (S) PTE LTD  
120 ROBINSON ROAD #10-01  
SINGAPORE 068913**

**Edmundo Il Dio Casapao**  
Environmental Engineer

**Tan Teong Huat**  
Asst. General Manager (ENV)

The results reported herein have been performed in accordance with the terms of accreditation under the Singapore Accreditation Council and comply with the requirements specified in ISO/IEC 17025. This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted, unless the sampling was conducted by ALS. The laboratory declares that the test results relate only to the items tested. This report may not be reproduced except with prior written approval from the testing laboratory and shall not be used for advertising purposes.

## EXECUTIVE SUMMARY

ALS Technichem (S) Pte Ltd has carried out noise monitoring for Project. The monitoring was conducted at one (1) location through the request of Environmental Resources Management (S) Pte Ltd. It was conducted on 02 to 09 November 2021.

The objective of this monitoring is to generate a baseline airborne noise measurement to represent the potential Noise Sensitive Receptors (NSRs). The monitoring results were compared to the limits as stipulated in the National Environment Agency's (NEA) "the Maximum Permissible Noise Levels for Construction Work commenced on or after 1st October 2007, i.e. Second Schedule of the Environmental Protection and Management (Control of Noise at Construction Sites) Regulations, 2011 Revised Ed.

Based on Tables 4 to 11 of this report, the results obtained comply to the National Environmental Agency "the Maximum Permissible Noise Levels for Construction Work commenced on or after 1st October 2007, i.e. Second Schedule of the Environmental Protection and Management (Control of Noise at Construction Sites) Regulations, 2011 Revised Ed. except on certain days and time periods as summarized in the table below.

Currently, there is no limit available for equivalent continuous noise level over a period of 1 hour for this category.

Below summarizes the period of the monitoring results compared to Control of Noise at Construction Sites Regulations "(c) Buildings (other than those in paragraphs (a) and (b)":

Category of Noise Regulated Period	Period	N01
Reckoned as an equivalent continuous noise level over a period of 12 hours in decibels (A)	7am-7pm	No Exceedances
	7pm-7am	No Exceedances
Reckoned as an equivalent continuous noise level over a period of 5 minutes) in decibels (A)	7am-7pm	No Exceedances
	7pm-10pm	Day 7 exceedance
	10pm-7am	Day 1, Day 5, & Day 7 exceedance
Reckoned as an equivalent continuous noise level over a period of one hour) in decibels (A)	7am-7pm	No Available Limit
	7pm-10pm	
	10pm-7am	



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## LIST OF ABBREVIATIONS

dB(A)	Decibel A
Leq	Equivalent sound pressure level
Lmax	Maximum sound pressure levels recorded for a measurement period
Lmin	Minimum sound pressure levels recorded for a measurement period
NEA	National Environment Agency





## 1.0 INTRODUCTION

ALS TECHNICHEM (S) PTE LTD (hereafter as “ALS”) has conducted noise monitoring at three (3) selected locations for Project . The monitoring was conducted at the request of Environmental Resources Management (S) Pte Ltd (hereafter as “ERM”). The monitoring on first 2 locations were conducted from 26 October to 02 November 2021 while the monitoring on the third location was conducted on 02 to 09 November 2021.

### 1.1 Objectives

The objective of the monitoring is to generate a baseline airborne noise data to represent the potential Noise Sensitive Receptors (NSRs). The monitoring results were compared to the limits stipulated in the National Environment Agency’s (NEA) Environmental Protection and Management Act – Environmental Protection and Management (Control of Noise at Construction Sites) Regulations, 2011 Revised Ed.

### 1.2 Scope of Work

The scope of works for the noise monitoring included:

1. Preparation of Noise Monitoring Plan;

- a. One (1) Noise Monitoring Station, as dictated by ERM, was set-up. It is identified as N01 located within NSRCC Kranji Sanctuary Golf Course

The equivalent noise level ( $L_{Aeq}$ ) over a period of 24 hours period on a 5 minutes interval are determined from the monitoring station and the results are compared to below regulatory limits:

- Two specified periods according to the Part I, Second Schedule, Maximum Permissible Noise Levels For Construction Work Commenced On or After 1<sup>st</sup> October 2007, National Environment Agency’s (NEA) Environmental Protection & Management Act – Environmental Protection & Management (Control of Noise at Construction Sites) Regulations, 2011 Revised Ed.
  - Three specified periods according to the Part II, Second Schedule, Maximum Permissible Noise Levels For Construction Work Commenced On or After 1<sup>st</sup> October 2007, National Environment Agency’s (NEA) Environmental Protection & Management Act – Environmental Protection & Management (Control of Noise at Construction Sites) Regulations, 2011 Revised Ed.
  - Three specified periods according to the Part III, Second Schedule, Maximum Permissible Noise Levels For Construction Work Commenced On or After 1<sup>st</sup> October 2007, National Environment Agency’s (NEA) Environmental Protection & Management Act – Environmental Protection & Management (Control of Noise at Construction Sites) Regulations, 2011 Revised Ed.
2. Assessing the noise level against the adopted standards; and
3. Providing a report outlining the findings and results of the study.



### 1.2.1 Monitoring Requirement

Noise is measured in decibel (dB) with reference to the frequency of noise, 'A' weighting was selected for this entire monitoring.

Tables 1 and 2 lists the maximum permitted noise level of specified period based on type of affected buildings as per Second Schedule of National Environment Agency's (NEA) Environmental Protection & Management Act – Environmental Protection & Management (Control of Noise at Construction Sites) Regulations, 2011 Revised Ed.

**Table 1: Maximum permitted noise level for construction work commenced after 1<sup>st</sup> October 2007**

PART I			
Type of affected Buildings	*Maximum permitted noise level in decibels (A)		
	7am – 7pm	7pm – 7am	
Hospital, Schools, Institutions of higher learning, homes for the aged sick etc.	60	50	
Residential buildings located less than 150m from the construction site where the noise is being emitted	75	-	
Buildings (other than above)	75	65	
*reckoned as an equivalent continuous noise level over a period of 12 hours			
PART II			
	7am – 7pm	7pm – 10pm	10pm – 7am
Hospital, Schools, Institutions of higher learning, homes for the aged sick etc.	-	-	-
Residential buildings located less than 150m from the construction site where the noise is being emitted	-	65	55
Buildings (other than above)	-	-	-
*reckoned as an equivalent continuous noise level over a period of 1 hour			
PART III			
	7am – 7pm	7pm – 10pm	10pm – 7am
Hospital, Schools, Institutions of higher learning, homes for the aged sick etc.	75	55	55
Residential buildings located less than 150m from the construction site where the noise is being emitted:-			
(i) on Monday to Saturday	90	70	55
(ii) on Sundays & Public Holiday	75	55	55
Buildings (other than above)	90	70	70
*reckoned as an equivalent continuous noise level over a period of 5 minutes			



## **2.0 SAMPLING AND FIELD MONITORING**

ALS has performed all the required sampling for noise level monitoring at the selected location through the directive of ERM.

### **2.1 Sampling Equipment**

A portable SVAN 971 Class 1 Sound Level Meter was used to measure noise levels on the selected points. This instrument complies with the standard as specified in the International Electrotechnical Commission i.e. Class 1: IEC 61672-1:2013. The Sound Level Meters were also calibrated before and after the noise survey, using a field calibrator (Quest Sound Calibrator, QC-10).



## 2.2 Sampling Locations

Figure 1 illustrates the noise monitoring location as indicated by (★).



Figure 1: Noise Monitoring Location

## 2.3 Detail of Noise Monitoring Point

One (1) noise monitoring point, dictated by ERM, has been selected and identified as N01. During the noise measurement, a range of possible noise sources at the monitoring location that may contribute to the overall ambient noise levels was noted. The detail of the monitoring point and identified noise sources near to the monitoring points are listed in Table 2.

**Table 2: Identified noise sources near to the monitoring points**

Monitoring Point	Date		Time (hr)		Noise Sources: Vehicular Traffic Volume in Tables 3 and 4
	Start	Stop	Start	Stop	
N01	02 Nov 2021	09 Nov 2021	1500	1455	Activities at the golf course including players and golf car movement, pump boat, insects and birds, animal sounds and aircrafts passing

## 3.0 SAMPLING METHODOLOGY

The measuring instruments fitted with windshield shall be installed in such a way so that the measurements are not affected by external factors (draft, vibration, wind, magnetic field, etc). Measurement shall be carried out at around 1.2-1.5m from the ground or working level.

The equivalent continuous noise level ( $L_{Aeq}$ ) was measured by using the sound level meter for 5 minutes interval datalog over 24 hours sampling period at the selected monitoring point. Table 4 summarized the sound level meter set up in this study. To determine the noise level on specified period, the recorded noise data was then analyzed by using *Supervisor* Software.

**Table 3: Summary of sound level meter setting**

Parameter	Setting
Response Fast	Response Fast
Frequency weighting for RMS	A
Measurement range	30 – 120 dB
Exchange Rate (Q)	3



### **3.1 Calibration of Sound Level Meter**

All sound level meters were calibrated by an accredited laboratory under ISO/IEC 17025 standard. The certificates of field equipment's calibrations were attached in Appendix A. Sound level meter used for ambient noise survey shall have its calibration certified by an authorized calibration laboratory within one year of the actual measurement sessions.

### **4.0 LOCATION INDEX / SAMPLING SCHEDULE / TEST RESULTS**

Location index, sampling schedule and their respective test results obtained were tabulated and reflected our findings on the tables and figures below.

On the other hand, the sampling location is illustrated in Figure 1 of Page 9.



#### 4.1 Noise Monitoring Results for N01 - within NSRCC Kranji Sanctuary Golf Course

**Table 4: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 12 hours at N01**

Monitoring ID	Monitoring Location	Monitoring Period	Noise levels Leq in dB (A)	
			7am – 7pm	7pm – 7am
N01	within NSRCC Kranji Sanctuary Golf Course	Day 1 (02 to 03 Nov 2021)	61.3	56.1
		Day 2 (03 to 04 Nov 2021)	56.5	45.3
		Day 3 (04 to 05 Nov 2021)	66.2	48.1
		Day 4 (05 to 06 Nov 2021)	59.0	48.4
		Day 5 (06 to 07 Nov 2021)	58.0	56.1
		Day 6 (07 to 08 Nov 2021)	65.5	47.2
		Day 7 (08 to 09 Nov 2021)	66.5	60.5
<b>Control of Noise at Construction Sites for “(c) Buildings (other than those in paragraphs (a) and (b))”</b>			75	65

Remarks: Maximum Permissible Noise Level (reckoned as equivalent continuous noise level over a period of 12 hours)



**Table 5: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 5 minutes at N01 (Day 1)**

Day		Day 1																							
Date		02 November 2021										03 November 2021													
	Time (HR)	3PM	4PM	5PM	6PM	7PM	8PM	9PM	10PM	11PM	12AM	1AM	2AM	3AM	4AM	5AM	6AM	7AM	8AM	9AM	10AM	11AM	12PM	1PM	2PM
LEQ 5mins	0	57.9	58.0	49.4	45.5	46.9	46.8	51.7	46.6	45.6	44.2	45.3	43.4	42.7	43.5	41.0	41.7	44.5	63.0	61.9	51.3	58.1	44.4	58.0	53.9
	5	57.3	60.1	48.0	44.8	47.8	47.2	53.4	46.6	45.8	43.7	44.9	43.0	41.9	40.9	40.8	44.7	51.2	45.8	53.2	62.6	65.3	48.1	53.8	52.8
	10	56.5	64.8	48.0	44.7	47.3	46.6	53.5	46.7	45.0	43.8	44.8	43.6	40.8	40.8	40.5	44.3	47.5	46.1	61.6	42.6	63.3	42.0	54.8	52.4
	15	57.7	67.1	48.4	44.8	48.1	47.2	53.9	46.5	45.3	44.0	44.7	43.1	41.2	39.9	41.0	44.7	46.9	45.6	53.2	44.5	54.4	42.0	56.9	51.4
	20	55.7	65.2	47.5	47.2	46.8	47.4	53.9	46.4	44.7	44.0	45.1	43.0	41.3	40.1	41.0	61.4	47.4	48.1	52.1	49.3	52.9	44.3	52.0	51.5
	25	59.3	62.8	48.9	48.4	46.3	47.3	53.8	45.2	44.5	45.2	44.9	44.1	41.0	39.8	41.1	77.0	44.7	47.0	50.1	41.9	50.0	46.7	51.8	50.9
	30	51.1	63.9	56.5	51.8	46.5	52.2	54.2	45.5	44.6	44.7	44.7	43.7	41.1	39.2	40.8	47.5	45.9	44.6	49.9	42.8	53.5	63.0	49.9	50.9
	35	51.4	61.4	47.8	52.8	46.9	52.9	54.0	45.2	44.4	46.0	44.4	43.6	41.0	39.9	43.2	43.9	45.9	44.1	81.2	42.8	50.7	48.3	50.7	50.8
	40	52.5	55.7	45.8	52.6	46.0	49.5	53.9	44.8	43.7	44.6	43.7	43.3	41.5	40.0	41.2	44.6	47.9	43.5	63.7	63.4	47.4	47.8	57.7	50.8
	45	52.9	54.2	47.8	50.8	46.4	47.8	49.8	44.7	43.7	44.5	43.9	41.9	41.6	40.1	41.7	48.4	45.0	60.9	50.1	43.1	46.9	52.8	55.2	48.2
	50	58.0	52.6	48.3	48.3	46.6	52.0	46.6	45.4	43.9	45.1	43.9	42.2	41.2	40.2	42.1	53.7	44.9	62.2	52.7	44.9	48.8	47.1	51.5	48.7
55	58.0	52.1	53.4	48.3	46.5	53.2	47.1	45.6	44.1	45.7	44.3	42.1	40.8	41.0	42.1	45.5	62.8	56.4	47.3	51.3	52.0	47.0	50.3	49.6	
Maximum permitted noise level (reckoned as equivalent continuous noise level over 5 minutes) in decibels (A)		90	90	90	90	70	70	70	70	70	70	70	70	70	70	70	90	90	90	90	90	90	90	90	

**Remarks:**

Limits specified are based Environmental Protection and Management (Control of Noise at Construction Sites) Regulations "(c) Buildings (other than those in paragraphs (a) and (b))"

Red filled denotes exceeded the limit.





**Table 6: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 5 minutes at N01 (Day 2)**

Day		Day 2																							
Date		03 November 2021										04 November 2021													
	Time (HR)	3PM	4PM	5PM	6PM	7PM	8PM	9PM	10PM	11PM	12AM	1AM	2AM	3AM	4AM	5AM	6AM	7AM	8AM	9AM	10AM	11AM	12PM	1PM	2PM
LEQ 5mins	0	53.5	52.7	56.7	42.8	44.0	48.8	45.3	45.2	44.2	51.7	43.8	42.4	41.9	41.7	41.0	39.8	46.9	43.2	41.9	41.7	38.9	44.8	46.9	37.7
	5	49.7	49.0	45.5	43.1	44.5	45.6	45.4	44.7	44.2	45.9	43.1	43.8	44.3	42.4	41.4	40.3	50.8	49.2	44.3	40.7	44.4	39.8	41.9	36.7
	10	50.2	56.7	44.8	44.1	44.4	45.3	45.2	44.7	43.9	47.3	43.4	41.9	42.5	42.0	41.3	40.5	77.6	43.0	42.8	46.1	40.6	45.2	41.6	38.5
	15	46.3	56.0	48.0	44.3	44.0	45.9	45.4	44.5	43.8	50.2	43.6	41.8	39.8	40.7	40.8	40.6	48.6	42.2	58.4	42.5	39.6	38.1	37.8	37.9
	20	43.9	51.4	45.2	42.9	44.0	45.7	45.5	43.9	43.7	48.1	43.8	44.2	41.9	40.8	40.9	42.2	45.1	42.7	42.1	47.2	39.2	39.3	37.7	40.0
	25	43.2	45.8	45.4	43.5	44.0	45.3	45.3	43.7	43.9	45.0	44.0	42.0	43.2	41.1	41.1	42.7	46.6	42.7	42.6	38.9	39.7	44.8	42.8	40.1
	30	41.5	47.0	45.4	43.3	43.7	45.4	52.7	43.8	43.7	44.4	44.1	42.2	42.3	41.7	41.4	42.8	45.5	44.3	43.8	40.6	40.5	41.0	41.7	43.9
	35	42.2	47.0	44.7	44.7	43.8	45.3	56.8	43.3	44.1	44.6	43.2	41.4	41.4	42.0	40.9	43.9	45.7	45.4	43.4	40.1	43.6	38.2	54.6	43.1
	40	44.5	45.9	43.3	43.6	43.9	45.5	55.7	44.3	44.2	45.3	42.3	41.3	40.8	41.7	40.9	48.6	42.9	42.1	45.7	39.9	39.4	37.9	58.0	47.5
	45	44.9	44.5	43.5	43.9	44.9	45.2	45.3	44.2	44.2	44.9	43.7	41.5	40.1	41.9	40.6	51.5	50.6	42.3	42.4	40.0	50.3	38.0	54.0	46.5
	50	48.0	46.3	43.2	42.9	44.8	45.1	45.3	44.1	43.8	44.8	42.9	41.6	45.3	41.4	41.0	47.4	45.9	42.9	40.2	39.1	38.0	40.5	42.9	46.0
55	48.0	45.1	44.8	43.8	44.7	45.0	47.4	44.2	46.7	43.8	42.2	42.2	47.6	40.8	40.3	46.5	43.3	47.6	47.0	39.2	44.9	37.5	39.0	43.2	
Maximum permitted noise level (reckoned as equivalent continuous noise level over 5 minutes) in decibels (A)		90	90	90	90	70	70	70	70	70	70	70	70	70	70	70	70	90	90	90	90	90	90	90	90

**Remarks:**

Limits specified are based Environmental Protection and Management (Control of Noise at Construction Sites) Regulations “(c) Buildings (other than those in paragraphs (a) and (b))”:



**Table 7: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 5 minutes at N01 (Day 3)**

Day		Day 3																							
Date		04 November 2021										05 November 2021													
	Time (HR)	3PM	4PM	5PM	6PM	7PM	8PM	9PM	10PM	11PM	12AM	1AM	2AM	3AM	4AM	5AM	6AM	7AM	8AM	9AM	10AM	11AM	12PM	1PM	2PM
LEQ 5mins	0	48.6	60.2	51.4	43.9	43.0	53.4	54.0	52.9	45.6	43.9	43.2	44.7	42.2	42.8	42.2	42.1	48.1	50.2	51.0	42.8	56.6	41.9	40.2	61.3
	5	46.3	58.9	51.4	44.5	43.0	54.8	54.1	46.8	45.4	43.8	43.2	43.5	41.8	42.6	40.5	43.4	60.7	44.3	52.2	42.9	54.4	42.6	38.4	55.1
	10	53.6	58.2	50.4	44.4	45.3	54.5	54.1	46.6	45.5	42.8	43.7	43.0	41.5	43.1	41.3	46.5	78.1	44.6	57.3	40.9	50.6	45.9	47.3	59.2
	15	49.8	56.9	49.0	75.3	44.1	54.1	54.1	47.2	46.6	43.0	42.6	43.1	41.9	41.4	40.7	45.9	50.3	43.8	53.6	41.6	59.4	40.2	54.9	57.6
	20	60.8	56.9	50.4	46.8	45.0	54.3	53.6	46.5	45.8	43.1	43.1	46.1	42.0	41.3	39.7	46.8	47.7	45.2	52.4	41.1	60.3	38.5	52.5	65.7
	25	86.0	52.8	47.0	44.4	45.0	54.7	48.8	46.2	45.6	43.8	44.0	43.0	42.1	40.8	41.8	46.2	48.5	44.2	53.2	43.2	41.8	39.1	54.3	55.3
	30	72.1	54.7	45.2	44.7	45.0	54.5	48.1	47.2	45.2	44.0	45.8	42.7	44.5	41.3	43.7	48.4	56.8	45.8	54.4	41.4	42.8	41.8	53.3	51.8
	35	65.6	53.6	46.2	43.3	45.1	54.5	53.5	45.8	45.1	45.1	43.0	42.3	42.5	40.5	41.9	46.2	54.7	56.2	60.3	49.4	44.1	40.4	60.0	61.4
	40	66.5	51.5	47.6	44.4	45.3	54.5	53.6	47.0	44.9	43.7	46.2	41.5	41.2	41.2	40.7	47.6	45.6	44.4	59.4	42.5	43.5	43.2	62.4	73.5
	45	64.2	51.3	46.3	44.2	44.8	54.6	53.3	46.1	45.9	44.0	47.2	41.6	41.7	41.4	40.8	47.6	46.2	47.5	56.0	51.6	39.5	44.9	62.5	69.6
	50	62.2	51.2	46.4	44.4	44.7	54.6	53.5	46.1	44.0	43.8	43.2	41.6	41.9	42.1	41.8	48.8	57.7	46.1	56.7	58.2	40.6	40.3	62.3	65.9
	55	61.3	50.8	44.6	44.4	44.9	54.4	53.4	46.0	43.6	43.9	43.4	41.8	41.8	41.5	41.5	46.0	53.2	48.2	52.3	55.8	40.8	40.2	66.4	62.8
Maximum permitted noise level (reckoned as equivalent continuous noise level over 5 minutes) in decibels (A)		90	90	90	90	70	70	70	70	70	70	70	70	70	70	70	90	90	90	90	90	90	90	90	

Remarks:

Limits specified are based Environmental Protection and Management (Control of Noise at Construction Sites) Regulations "(c) Buildings (other than those in paragraphs (a) and (b))":



**Table 8: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 5 minutes at N01 (Day 4)**

Day		Day 4																							
Date		05 November 2021										06 November 2021													
	Time (HR)	3PM	4PM	5PM	6PM	7PM	8PM	9PM	10PM	11PM	12AM	1AM	2AM	3AM	4AM	5AM	6AM	7AM	8AM	9AM	10AM	11AM	12PM	1PM	2PM
LEQ 5mins	0	72.7	52.8	48.1	50.8	44.2	45.0	53.5	53.3	46.1	49.8	46.0	45.5	41.2	41.9	40.0	41.4	78.7	52.0	50.8	42.3	47.5	42.1	37.5	41.0
	5	70.1	52.0	49.3	51.7	47.3	48.2	53.6	53.3	46.4	51.7	44.4	44.8	41.1	42.1	40.7	43.5	49.4	44.8	50.5	43.7	43.5	43.4	38.7	43.8
	10	64.8	49.1	53.8	50.8	45.5	53.6	53.6	52.8	46.3	43.6	44.0	44.1	40.9	40.3	41.4	43.9	50.9	45.1	43.7	46.2	42.6	43.1	40.7	40.7
	15	57.2	50.6	52.8	49.5	45.6	53.9	53.9	52.6	46.3	43.3	44.9	44.7	43.6	40.3	41.3	47.3	51.0	44.8	44.6	43.2	43.4	41.0	40.1	43.4
	20	50.1	49.3	52.7	49.4	44.9	53.6	54.1	46.9	45.9	43.6	44.3	44.5	43.4	41.5	41.4	48.0	46.0	45.0	43.6	44.2	42.6	39.8	38.9	40.1
	25	50.4	49.3	53.3	47.0	44.8	53.3	54.2	46.6	46.1	43.7	43.3	44.1	41.4	40.3	40.0	52.2	44.7	44.8	43.6	45.3	41.2	42.3	38.8	42.0
	30	47.1	48.2	52.2	46.3	44.8	53.4	53.9	45.7	46.1	44.0	43.2	44.4	40.8	41.5	40.6	51.4	44.5	44.6	47.0	43.7	45.8	39.0	41.1	40.6
	35	47.1	48.5	51.8	45.0	44.4	53.4	53.6	45.7	46.0	43.7	43.9	44.0	40.8	41.8	40.4	50.8	48.3	45.5	49.3	43.9	45.5	40.5	38.9	39.4
	40	46.3	51.0	52.3	45.3	44.7	53.4	53.6	46.2	46.1	44.1	42.8	43.9	41.3	41.4	42.6	44.4	54.5	55.5	44.9	42.8	39.8	42.1	42.3	38.8
	45	47.9	49.4	52.5	44.7	44.8	53.8	53.5	47.7	45.8	45.1	42.3	43.5	44.5	40.5	41.1	47.9	56.1	46.4	51.7	42.1	39.3	41.1	43.2	41.6
	50	51.4	48.9	51.4	44.0	44.5	53.4	53.2	45.5	46.8	45.5	42.6	41.5	41.0	39.5	41.8	44.1	43.9	42.7	43.6	43.2	40.3	43.5	41.0	40.5
55	48.9	51.9	50.2	44.5	44.4	53.5	53.3	46.1	46.7	46.1	43.2	41.5	41.9	40.0	41.4	57.1	51.3	56.3	43.3	43.1	40.1	41.2	49.8	40.4	
<b>Maximum permitted noise level (reckoned as equivalent continuous noise level over 5 minutes) in decibels (A)</b>		90	90	90	90	70	70	70	70	70	70	70	70	70	70	70	70	90	90	90	90	90	90	90	90

**Remarks:**

Limits specified are based Environmental Protection and Management (Control of Noise at Construction Sites) Regulations "(c) Buildings (other than those in paragraphs (a) and (b))":



**Table 9: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 5 minutes at N01 (Day 5)**

Day		Day 5																							
Date		06 November 2021												07 November 2021											
	Time (HR)	3PM	4PM	5PM	6PM	7PM	8PM	9PM	10PM	11PM	12AM	1AM	2AM	3AM	4AM	5AM	6AM	7AM	8AM	9AM	10AM	11AM	12PM	1PM	2PM
LEQ 5mins	0	40.1	42.0	46.2	42.3	45.6	49.5	47.1	46.2	46.5	45.1	45.1	46.0	45.4	45.4	45.5	52.4	75.8	45.0	44.1	51.1	40.1	53.7	44.6	42.8
	5	41.7	60.0	39.9	41.0	43.4	46.7	45.7	46.4	46.4	45.6	44.6	45.6	44.4	46.2	46.6	52.5	49.7	44.4	45.7	41.3	44.8	72.1	54.6	42.5
	10	40.2	43.0	40.1	43.8	42.9	57.6	48.0	46.2	46.1	45.4	44.3	44.9	44.1	45.7	50.6	52.4	49.8	44.5	51.0	42.6	41.5	70.4	48.8	43.2
	15	42.7	39.3	43.1	44.4	49.0	52.4	45.4	46.6	46.5	45.1	45.0	45.4	45.6	44.2	52.0	52.7	48.6	53.0	48.1	45.0	44.7	65.0	48.2	43.7
	20	42.3	41.3	40.4	40.5	45.6	47.2	45.7	46.6	46.5	45.4	45.0	45.0	45.0	44.9	51.7	52.7	55.8	45.9	41.9	46.8	43.3	66.3	52.5	42.2
	25	38.8	42.5	42.6	41.9	44.9	49.2	46.0	46.3	46.1	44.0	45.2	45.2	44.0	43.6	52.1	52.9	46.5	44.1	43.2	63.0	41.5	65.4	51.1	41.7
	30	40.3	41.8	49.0	42.1	44.8	52.9	51.7	46.4	46.2	44.0	44.7	45.7	45.0	44.0	52.1	52.6	46.4	41.8	55.7	47.1	45.7	64.0	49.0	42.3
	35	40.2	42.0	41.4	41.5	44.3	48.9	46.7	46.9	45.8	43.9	45.9	46.0	46.3	43.7	47.1	52.4	45.6	43.2	53.2	60.1	40.8	61.4	47.2	42.7
	40	43.4	42.8	42.6	45.1	44.7	46.0	46.5	47.3	46.3	43.9	45.7	45.3	46.3	46.7	46.9	52.7	46.0	44.6	43.4	49.0	46.3	56.4	44.4	42.6
	45	42.8	41.0	42.4	47.4	44.9	52.9	45.9	46.3	46.3	43.8	44.6	45.6	44.6	47.6	52.4	69.2	47.7	43.3	42.2	43.7	41.2	47.1	44.0	42.1
	50	39.7	45.3	42.2	49.2	44.9	45.9	45.8	46.1	46.2	44.4	44.6	45.1	45.4	49.4	52.7	76.0	47.1	42.5	50.3	49.4	41.2	44.5	43.7	43.6
55	39.8	45.7	40.8	43.8	44.9	51.3	47.2	46.4	45.5	45.3	44.9	45.0	45.2	49.5	52.0	61.3	43.0	42.6	41.7	41.8	40.7	44.1	42.9	46.0	
Maximum permitted noise level (reckoned as equivalent continuous noise level over 5 minutes) in decibels (A)		90	90	90	90	70	70	70	70	70	70	70	70	70	70	70	70	90	90	90	90	90	90	90	90

Remarks:

Limits specified are based Environmental Protection and Management (Control of Noise at Construction Sites) Regulations “(c) Buildings (other than those in paragraphs (a) and (b)”

Red filled denotes exceeded the limit.



**Table 10: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 5 minutes at N01 (Day 6)**

Day		Day 6																							
Date		07 November 2021										08 November 2021													
	Time (HR)	3PM	4PM	5PM	6PM	7PM	8PM	9PM	10PM	11PM	12AM	1AM	2AM	3AM	4AM	5AM	6AM	7AM	8AM	9AM	10AM	11AM	12PM	1PM	2PM
LEQ 5mins	0	43.4	43.0	42.8	41.7	42.7	45.0	45.8	48.1	45.6	47.6	44.0	44.1	43.6	43.2	48.0	48.7	49.9	45.2	49.0	48.7	48.2	46.0	44.4	47.0
	5	51.7	43.1	41.7	41.1	44.2	44.5	45.6	45.6	45.7	47.1	44.1	44.7	42.0	43.4	47.6	48.9	48.0	49.8	44.7	48.3	61.4	46.5	44.0	47.0
	10	47.3	43.4	41.9	43.3	45.1	44.5	45.5	45.0	45.5	46.4	44.7	44.6	42.5	44.1	46.7	50.2	77.1	43.1	46.4	75.9	47.1	49.6	46.2	48.0
	15	41.1	43.3	43.6	44.2	42.7	44.1	45.0	45.6	45.5	45.8	44.1	44.4	42.4	45.4	48.7	58.2	51.8	42.7	51.4	74.9	44.7	45.5	45.1	45.5
	20	41.4	43.1	42.8	43.3	43.5	45.2	45.5	45.8	45.9	44.7	43.6	44.5	42.8	46.7	46.4	56.7	47.1	42.6	49.5	48.2	44.8	47.0	79.5	62.3
	25	41.3	42.6	42.5	44.0	42.9	48.8	45.7	45.5	46.0	44.4	42.6	44.9	42.8	46.6	46.9	54.5	45.4	47.3	45.1	48.5	46.1	47.0	79.7	45.8
	30	44.3	41.8	43.2	44.5	43.4	45.9	45.1	46.4	47.5	43.7	42.5	44.5	42.3	46.9	46.8	50.1	45.3	43.3	48.3	45.9	76.3	46.6	45.8	45.1
	35	44.0	41.5	43.0	43.8	45.0	45.7	45.2	45.5	47.3	43.9	43.3	44.1	41.9	47.3	46.8	53.3	43.7	55.7	47.5	48.7	74.5	46.4	45.1	53.2
	40	46.6	42.4	41.5	44.5	45.4	45.8	45.2	46.7	47.2	44.2	43.8	44.0	42.3	47.9	46.9	57.4	44.7	48.5	48.7	46.9	46.7	48.8	44.9	46.9
	45	44.6	44.6	41.2	44.8	48.2	45.5	45.0	46.4	46.2	44.5	44.4	44.6	42.5	48.1	46.3	49.7	45.2	49.8	46.8	47.2	45.8	47.0	58.6	46.4
	50	45.3	43.1	41.5	45.6	46.2	46.0	44.8	47.3	47.4	44.3	44.5	44.4	42.3	48.1	46.3	51.6	45.1	46.1	79.9	47.5	45.4	43.9	45.2	45.3
55	46.4	43.9	41.0	44.6	45.1	45.8	47.5	46.5	47.1	43.8	44.6	44.6	42.5	47.8	46.3	51.6	46.6	49.1	47.6	44.5	45.3	45.2	44.3	73.6	
Maximum permitted noise level (reckoned as equivalent continuous noise level over 5 minutes) in decibels (A)		90	90	90	90	70	70	70	70	70	70	70	70	70	70	70	70	90	90	90	90	90	90	90	

Remarks:

Limits specified are based Environmental Protection and Management (Control of Noise at Construction Sites) Regulations “(c) Buildings (other than those in paragraphs (a) and (b))”:



**Table 11: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 5 minutes at N01 (Day 7)**

Day		Day 7																							
Date		08 November 2021										09 November 2021													
	Time (HR)	3PM	4PM	5PM	6PM	7PM	8PM	9PM	10PM	11PM	12AM	1AM	2AM	3AM	4AM	5AM	6AM	7AM	8AM	9AM	10AM	11AM	12PM	1PM	2PM
LEQ 5mins	0	71.3	45.6	43.5	72.4	45.7	45.9	47.0	45.2	46.5	43.2	42.8	41.9	46.8	42.7	42.0	45.5	54.1	46.2	41.6	48.2	46.2	52.5	42.4	41.1
	5	69.3	46.5	48.6	45.3	45.3	45.5	47.1	44.5	46.5	42.7	42.8	41.8	44.3	42.9	42.0	45.9	50.9	46.0	43.2	47.5	57.7	46.5	42.8	42.6
	10	80.0	54.9	46.4	47.0	45.3	46.6	47.3	44.6	47.1	42.7	42.6	42.9	43.8	43.5	41.6	78.4	49.3	45.8	48.7	74.3	44.6	68.2	44.0	44.1
	15	78.4	80.8	45.0	50.2	46.3	46.7	47.1	44.7	46.0	43.7	43.7	42.8	43.0	44.1	40.8	64.4	48.2	54.9	43.4	78.0	44.0	42.9	43.5	53.0
	20	49.2	65.6	44.7	49.3	46.3	47.5	47.2	44.3	45.3	43.3	43.7	42.4	43.1	44.1	41.4	53.9	51.8	46.0	44.3	46.5	48.6	48.9	42.1	71.2
	25	65.4	49.5	46.4	52.8	45.7	46.9	46.8	45.0	45.5	43.7	45.7	42.3	42.6	43.7	42.5	45.5	51.6	44.9	46.6	45.7	44.2	40.7	44.7	67.6
	30	48.0	46.0	43.8	46.4	45.7	47.3	46.8	47.2	44.0	43.5	43.5	42.4	43.1	43.4	42.6	46.5	47.7	44.6	47.1	46.5	43.4	41.8	42.2	68.7
	35	60.3	43.6	44.5	46.3	71.3	47.1	46.7	47.8	44.6	43.5	44.4	42.3	43.4	43.9	44.4	47.1	50.1	43.9	46.9	46.1	46.1	53.8	40.4	67.6
	40	46.7	45.3	44.2	45.7	78.6	46.7	44.5	46.9	44.5	43.8	43.0	43.1	43.4	43.2	42.2	48.3	46.3	45.9	47.3	46.1	77.1	40.6	45.3	64.9
	45	44.0	80.4	43.7	46.7	45.7	47.1	44.8	45.9	44.6	43.2	43.1	44.1	42.7	43.3	41.8	50.7	50.6	46.3	55.5	47.8	45.2	44.9	42.3	62.7
	50	43.9	53.5	45.1	45.5	51.2	46.6	45.3	46.3	44.9	43.6	44.1	44.8	42.5	42.8	42.7	46.0	46.8	44.8	57.8	45.6	45.3	41.9	42.2	59.6
55	46.7	45.6	60.3	45.2	45.5	47.4	44.8	46.4	44.1	44.0	42.9	45.6	42.6	44.3	43.8	48.9	46.4	42.0	62.7	45.3	42.9	46.9	42.4	58.2	
Maximum permitted noise level (reckoned as equivalent continuous noise level over 5 minutes) in decibels (A)		90	90	90	90	70	70	70	70	70	70	70	70	70	70	70	90	90	90	90	90	90	90	90	

**Remarks:**

Limits specified are based Environmental Protection and Management (Control of Noise at Construction Sites) Regulations “(c) Buildings (other than those in paragraphs (a) and (b))”

Red filled denotes exceeded the limit.



**Table 12: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at N01**

Duration (hr)	Day 1 (02 to 03 Nov 2021)	
	Noise levels Leq in dB (A)	“(c) Buildings (other than those in paragraphs (a) and (b))”
0700 – 0800	53.1	NA
0800 – 0900	56.7	
0900 – 1000	70.7	
1000 – 1100	55.8	
1100 – 1200	57.9	
1200 – 1300	53.4	
1300 – 1400	54.5	
1400 – 1500	51.3	
1500 – 1600	56.4	
1600 – 1700	62.2	
1700 – 1800	50.4	
1800 – 1900	49.3	
1900 – 2000	46.9	NA
2000 – 2100	49.9	
2100 – 2200	52.8	
2200 – 2300	45.8	NA
2300 – 0000	44.7	
0000 – 0100	44.7	
0100 – 0200	44.6	
0200 – 0300	43.1	
0300 – 0400	41.4	
0400 – 0500	40.6	
0500 – 0600	41.4	
0600 – 0700	66.4	

Remark: NA denote Not Available

\* Limits specified are based Environmental Protection and Management (Control of Noise at Construction Sites) Regulations.

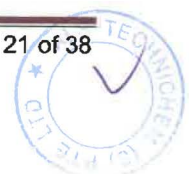


**Table 13: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at N01**

Duration (hr)	Day 2 (03 to 04 Nov 2021)	
	Noise levels Leq in dB (A)	“(c) Buildings (other than those in paragraphs (a) and (b))”
0700 – 0800	66.8	NA
0800 – 0900	44.6	
0900 – 1000	49.0	
1000 – 1100	42.3	
1100 – 1200	43.3	
1200 – 1300	41.4	
1300 – 1400	50.4	
1400 – 1500	43.2	
1500 – 1600	47.8	
1600 – 1700	51.1	
1700 – 1800	48.3	
1800 – 1900	43.6	
1900 – 2000	44.2	NA
2000 – 2100	45.8	
2100 – 2200	50.6	
2200 – 2300	44.2	NA
2300 – 0000	44.3	
0000 – 0100	47.1	
0100 – 0200	43.4	
0200 – 0300	42.3	
0300 – 0400	43.2	
0400 – 0500	41.6	
0500 – 0600	41.0	
0600 – 0700	45.6	

Remark: NA denote Not Available

\* Limits specified are based Environmental Protection and Management (Control of Noise at Construction Sites) Regulations.



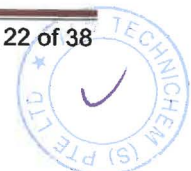


**Table 14: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at N01**

Duration (hr)	Day 3 (04 to 05 Nov 2021)	
	Noise levels Leq in dB (A)	“(c) Buildings (other than those in paragraphs (a) and (b))”
0700 – 0800	67.5	NA
0800 – 0900	48.7	
0900 – 1000	55.9	
1000 – 1100	50.7	
1100 – 1200	53.8	
1200 – 1300	42.2	
1300 – 1400	59.8	
1400 – 1500	65.8	
1500 – 1600	75.5	
1600 – 1700	55.9	
1700 – 1800	48.6	
1800 – 1900	64.6	
1900 – 2000	44.6	NA
2000 – 2100	54.4	
2100 – 2200	53.2	
2200 – 2300	47.6	NA
2300 – 0000	45.3	
0000 – 0100	43.8	
0100 – 0200	44.3	
0200 – 0300	43.1	
0300 – 0400	42.2	
0400 – 0500	41.7	
0500 – 0600	41.5	
0600 – 0700	46.6	

Remark: NA denote Not Available

\* Limits specified are based Environmental Protection and Management (Control of Noise at Construction Sites) Regulations.



**Table 15: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at N01**

Duration (hr)	Day 4 (05 to 06 Nov 2021)	
	Noise levels Leq in dB (A)	“(c) Buildings (other than those in paragraphs (a) and (b))”
0700 – 0800	67.9	NA
0800 – 0900	50.1	
0900 – 1000	47.6	
1000 – 1100	43.8	
1100 – 1200	43.4	
1200 – 1300	41.8	
1300 – 1400	42.6	
1400 – 1500	41.3	
1500 – 1600	64.4	
1600 – 1700	50.3	
1700 – 1800	52.0	
1800 – 1900	48.3	
1900 – 2000	45.1	NA
2000 – 2100	52.9	
2100 – 2200	53.7	
2200 – 2300	49.8	NA
2300 – 0000	46.2	
0000 – 0100	46.3	
0100 – 0200	43.9	
0200 – 0300	44.0	
0300 – 0400	42.0	
0400 – 0500	41.0	
0500 – 0600	41.1	
0600 – 0700	50.1	

Remark: NA denote Not Available

\* Limits specified are based Environmental Protection and Management (Control of Noise at Construction Sites) Regulations.



**Table 16: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at N01**

Duration (hr)	Day 5 (06 to 07 Nov 2021)	
	Noise levels Leq in dB (A)	“(c) Buildings (other than those in paragraphs (a) and (b))”
0700 – 0800	65.1	NA
0800 – 0900	46.0	
0900 – 1000	49.3	
1000 – 1100	54.6	
1100 – 1200	43.2	
1200 – 1300	65.5	
1300 – 1400	49.2	
1400 – 1500	43.1	
1500 – 1600	41.2	
1600 – 1700	50.0	
1700 – 1800	43.5	
1800 – 1900	44.4	
1900 – 2000	45.3	NA
2000 – 2100	51.5	
2100 – 2200	47.2	
2200 – 2300	46.5	NA
2300 – 0000	46.2	
0000 – 0100	44.7	
0100 – 0200	45.0	
0200 – 0300	45.4	
0300 – 0400	45.2	
0400 – 0500	46.4	
0500 – 0600	50.8	
0600 – 0700	66.3	

Remark: NA denote Not Available

\* Limits specified are based Environmental Protection and Management (Control of Noise at Construction Sites) Regulations.



**Table 17: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at N01**

Duration (hr)	Day 6 (07 to 08 Nov 2021)	
	Noise levels Leq in dB (A)	“(c) Buildings (other than those in paragraphs (a) and (b))”
0700 – 0800	66.4	NA
0800 – 0900	48.8	
0900 – 1000	69.2	
1000 – 1100	67.7	
1100 – 1200	67.8	
1200 – 1300	46.9	
1300 – 1400	71.9	
1400 – 1500	63.3	
1500 – 1600	45.9	
1600 – 1700	43.1	
1700 – 1800	42.3	
1800 – 1900	43.9	
1900 – 2000	44.8	NA
2000 – 2100	45.7	
2100 – 2200	45.5	
2200 – 2300	46.3	NA
2300 – 0000	46.5	
0000 – 0100	45.2	
0100 – 0200	43.9	
0200 – 0300	44.4	
0300 – 0400	42.5	
0400 – 0500	46.6	
0500 – 0600	47.0	
0600 – 0700	53.8	

Remark: NA denote Not Available

\* Limits specified are based Environmental Protection and Management (Control of Noise at Construction Sites) Regulations.



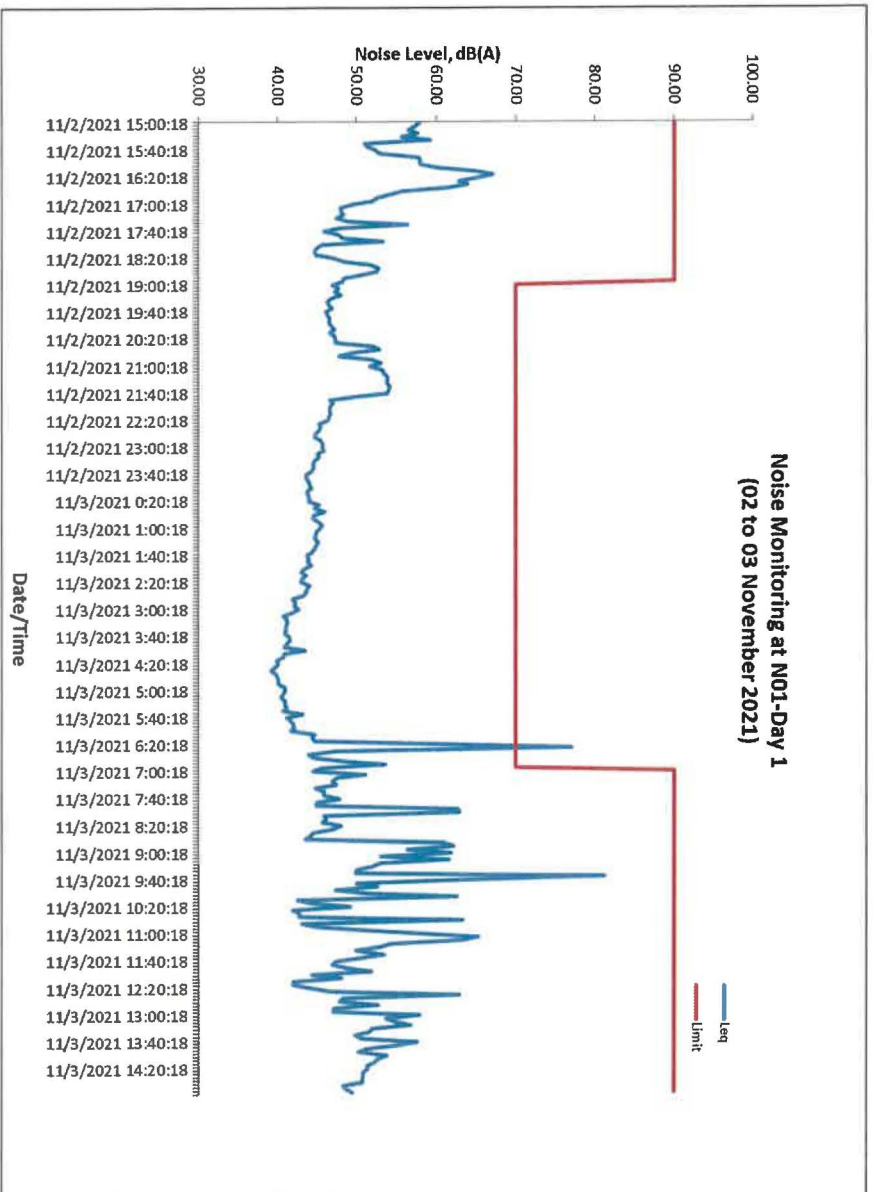
**Table 18: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at N01**

Duration (hr)	Day 7 (08 to 09 Nov 2021)	
	Noise levels Leq in dB (A)	“(c) Buildings (other than those in paragraphs (a) and (b))”
0700 – 0800	50.1	NA
0800 – 0900	47.5	
0900 – 1000	54.2	
1000 – 1100	68.7	
1100 – 1200	66.3	
1200 – 1300	57.8	
1300 – 1400	43.1	
1400 – 1500	65.1	
1500 – 1600	72.1	
1600 – 1700	72.9	
1700 – 1800	50.8	
1800 – 1900	61.8	
1900 – 2000	68.5	NA
2000 – 2100	46.8	
2100 – 2200	46.4	
2200 – 2300	45.9	NA
2300 – 0000	45.4	
0000 – 0100	43.4	
0100 – 0200	43.6	
0200 – 0300	43.2	
0300 – 0400	43.6	
0400 – 0500	43.5	
0500 – 0600	42.4	
0600 – 0700	67.9	

Remark: NA denote Not Available

\* Limits specified are based Environmental Protection and Management (Control of Noise at Construction Sites) Regulations.

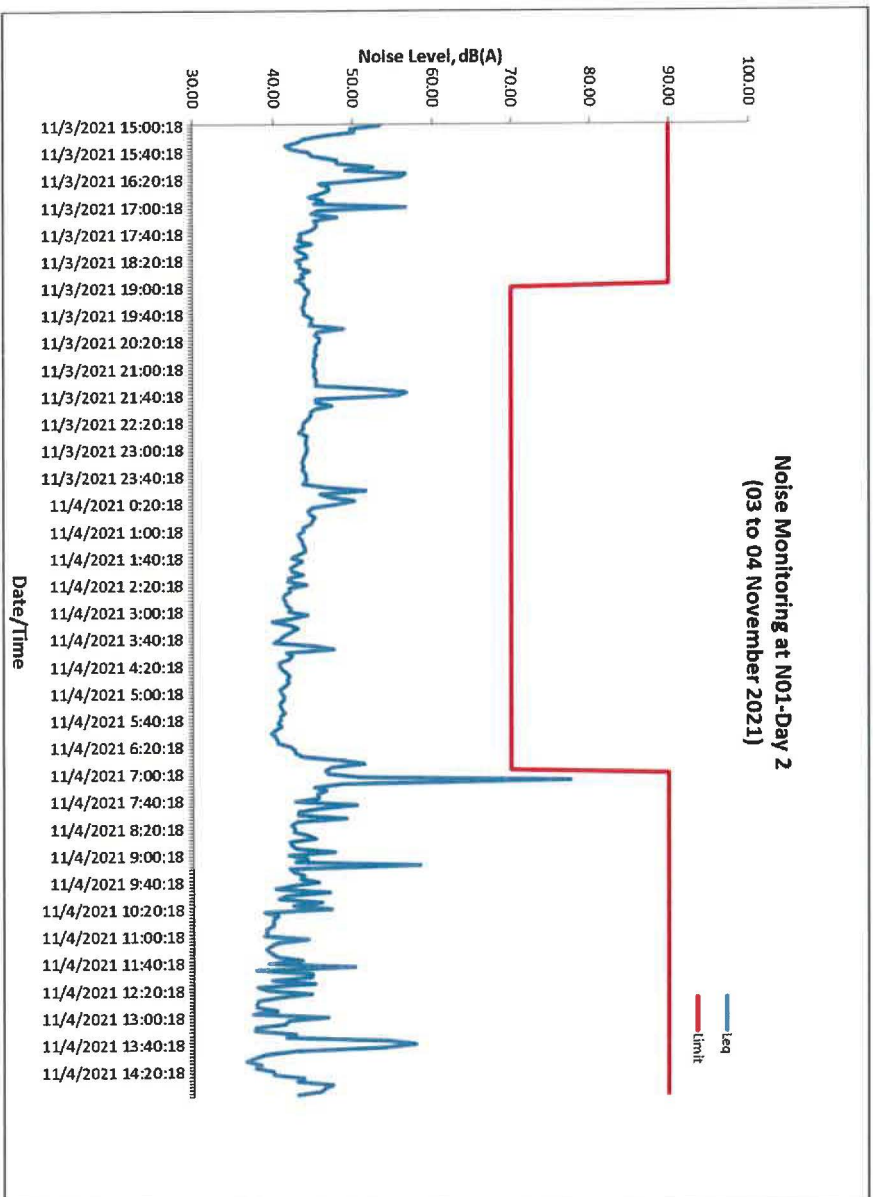


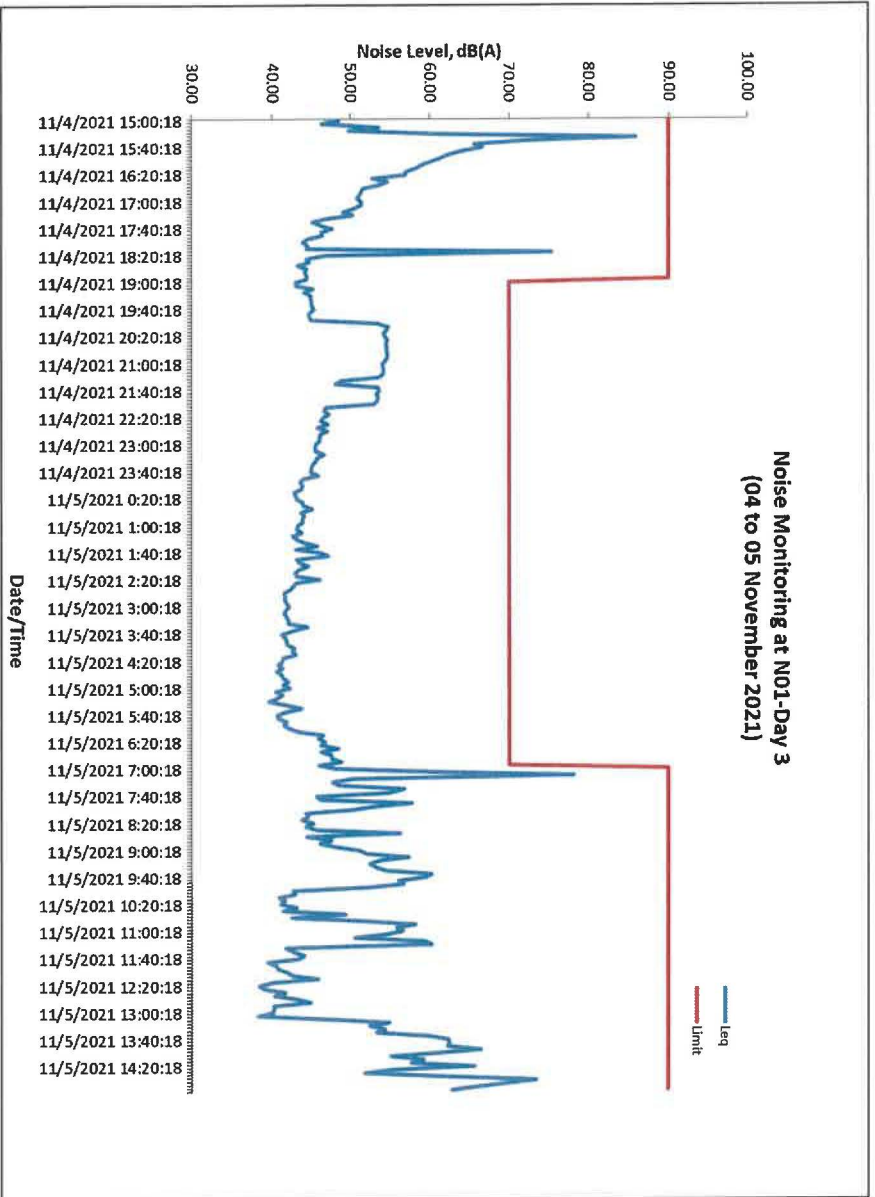


**Figure 16: Noise level measured at Point N01 (Day 1) reckoned as an equivalent continuous noise level over a period of 5 minutes**



Figure 17: Noise level measured at Point N01 (Day 2) reckoned as an equivalent continuous noise level over a period of 5 minutes

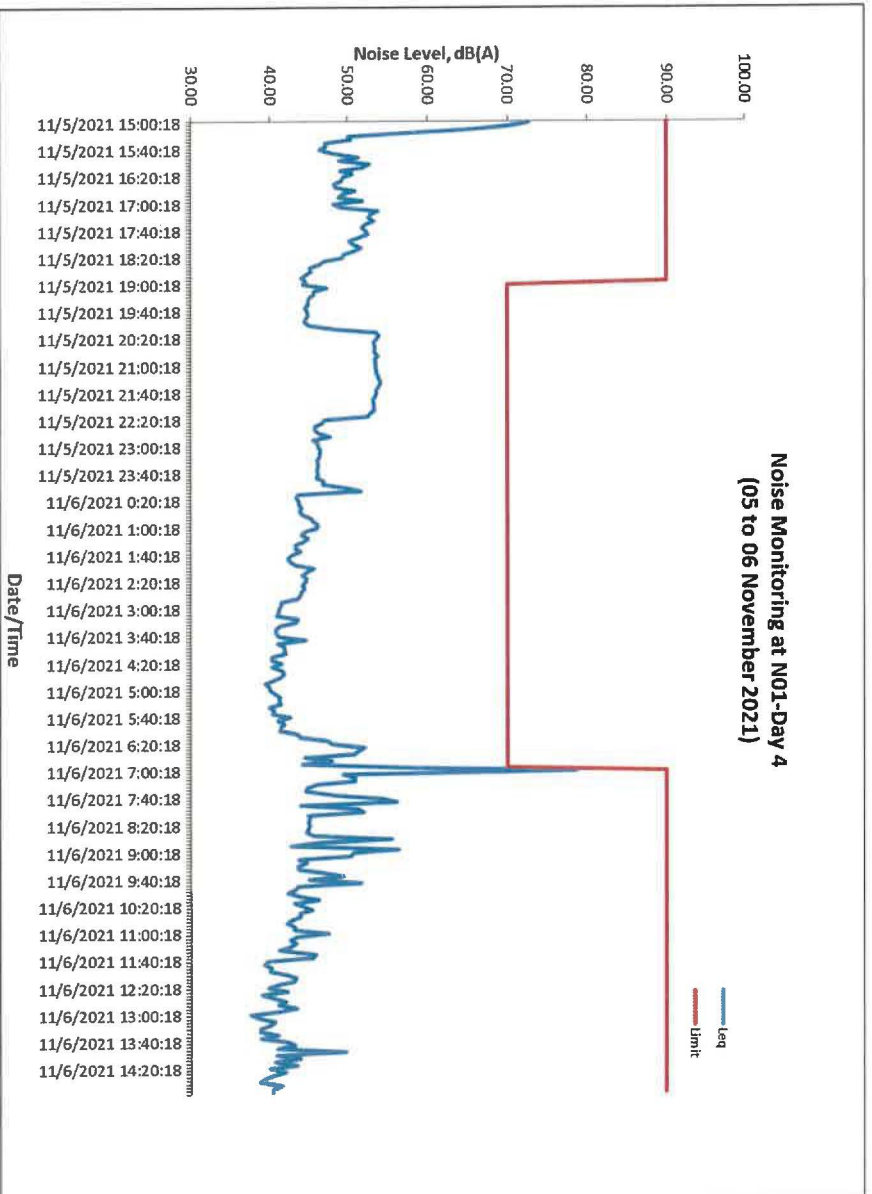




**Figure 18: Noise level measured at Point N01 (Day 3) reckoned as an equivalent continuous noise level over a period of 5 minutes**

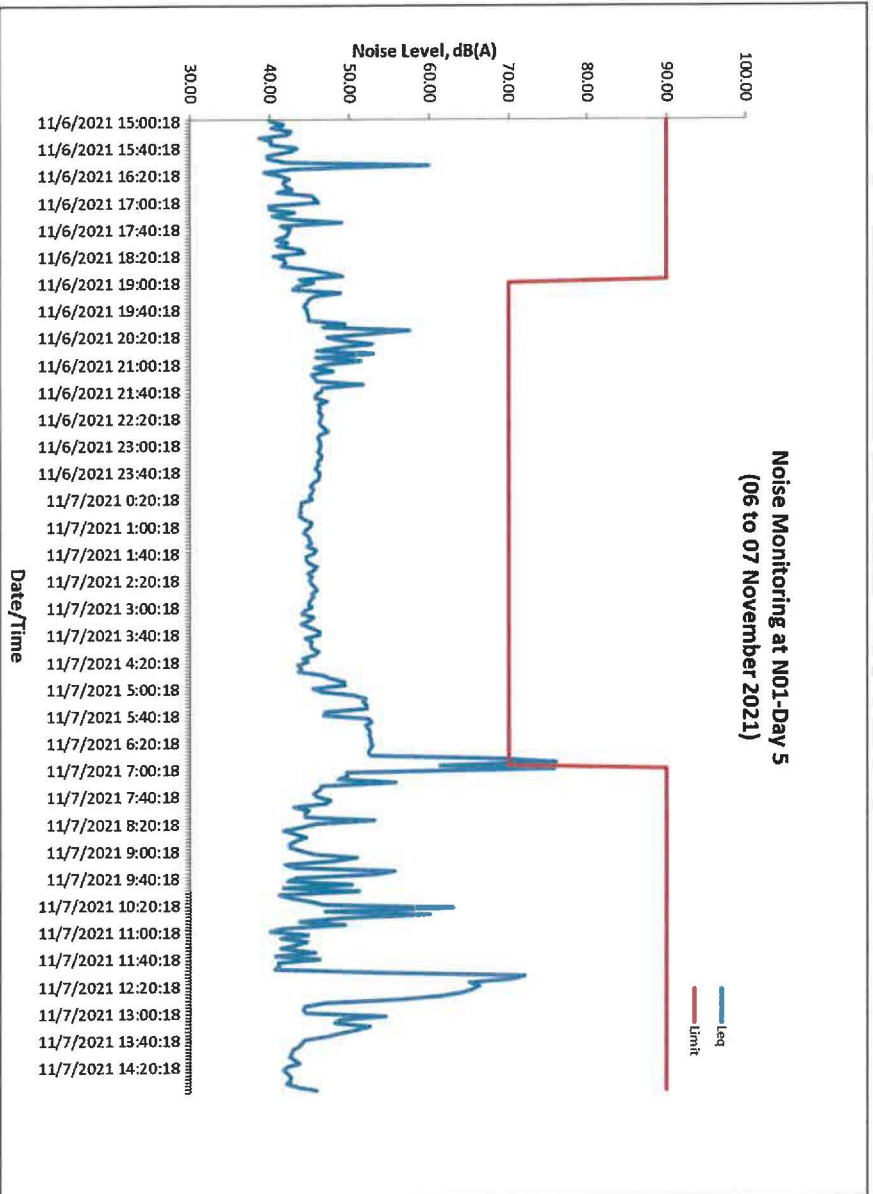






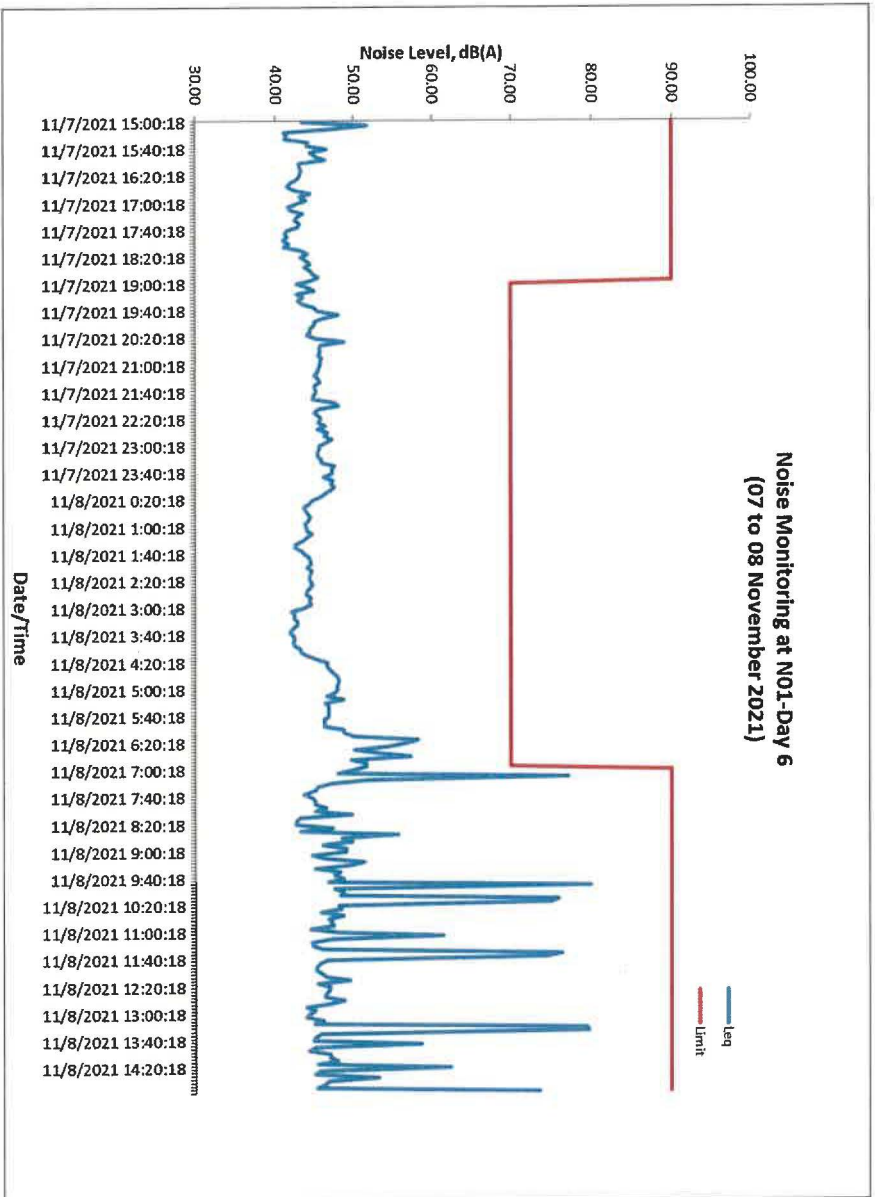
**Figure 19: Noise level measured at Point N01 (Day 4) reckoned as an equivalent continuous noise level over a period of 5 minutes**





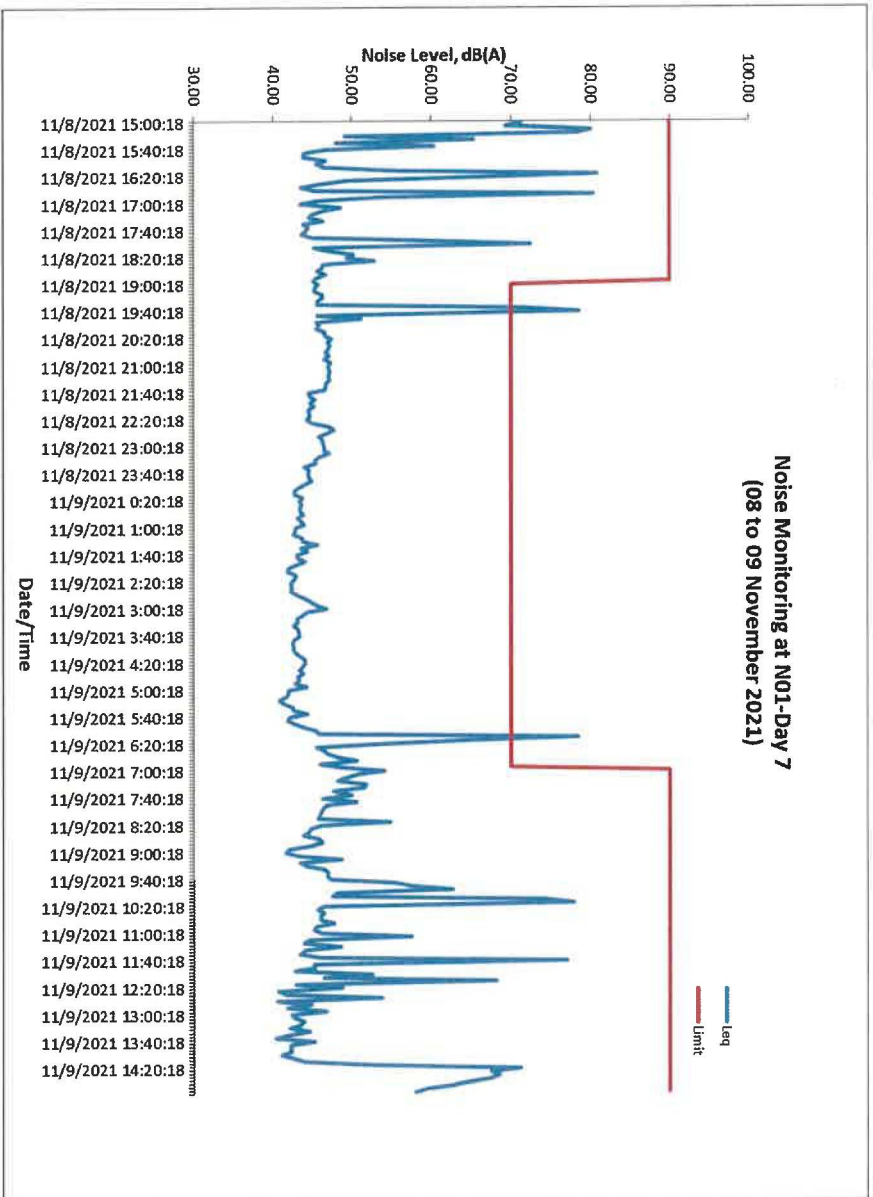
**Figure 20: Noise level measured at Point N01 (Day 5) reckoned as an equivalent continuous noise level over a period of 5 minutes**





**Figure 21: Noise level measured at Point N01 (Day 6) reckoned as an equivalent continuous noise level over a period of 5 minutes**





**Figure 22: Noise level measured at Point N01 (Day 7) reckoned as an equivalent continuous noise level over a period of 5 minutes**



## 5.0 EVALUATION AND DISCUSSION

The results obtained for N01 comply to the National Environmental Agency "the Maximum Permissible Noise Levels for Construction Work commenced on or after 1st October 2007, i.e. Second Schedule of the Environmental Protection and Management (Control of Noise at Construction Sites) Regulations, 2011 Revised Ed. except on certain days and time period as summarized in the table below

Currently, there is no limit available for equivalent continuous noise level over a period of 1 hour for this category.

Table 19 below summarizes the period of the monitoring results compared to Control of Noise at Construction Sites Regulations "(c) Buildings (other than those in paragraphs (a) and (b))":

**Table 19 Results Compared to Limits for Control of Noise at Construction Sites**

Category of Noise Regulated Period	Period	N01
Reckoned as an equivalent continuous noise level over a period of 12 hours in decibels (A)	7am-7pm	No exceedance
	7pm-7am	No exceedance
Reckoned as an equivalent continuous noise level over a period of 5 minutes) in decibels (A)	7am-7pm	No exceedance
	7pm-10pm	Day 7 exceedance
	10pm-7am	Day 1, Day 5, & Day 7 exceedance
Reckoned as an equivalent continuous noise level over a period of one hour) in decibels (A)	7am-7pm	No exceedance
	7pm-10pm	
	10pm-7am	

It should be noted that the Noise Monitoring project was carried out to the best of our knowledge and ability as well as responsibility towards the code of practice in the performance and reliability of our business to be accurate, precise and representative at the date/time and locations sampled so as to achieve a satisfactory baseline study.

## 6.0 REFERENCES

**National Environment Agency's (NEA) Environmental Protection & Management Act – Environmental Protection & Management (Control of Noise at Construction Sites) Regulations, 2011 Revised Ed.**

**Svantek SVAN 971 Sound Level Meter User Manual**



## Appendix A Calibration Certificates



### Calibration Certificate

Calibration Number: 210500411143

<b>Customer Name</b> :	ALS Technichem (Singapore) Pte Ltd	<b>Job Reference No:</b>	21050041
<b>Customer Address</b> :	121 Genting Lane, #04-01 ALS Building Singapore 349572	<b>Certificate Issue Date:</b>	12/05/2021
<b>Manufacturer</b> :	3M	<b>Calibration Date:</b>	10/05/2021
<b>Item Description</b> :	Acoustic Calibrator	<b>Test Conditions:</b>	
<b>Model Number</b> :	QC-10	Ambient Temperature:	23 °C
<b>Serial Number</b> :	Q1110298	Relative Humidity:	55 %R.H.
<b>Sub-Assemblies S/N</b> :	N.A.	Pressure:	101.3 kPa

This certificate provides traceability of measurement to the International System of Units (SI).  
Absolute Laboratories Pte. Ltd. certifies that the above product listed was calibrated in compliance with a quality management system using the applicable and approved Absolute Laboratories Pte. Ltd. calibration procedures as specified.

The reported expanded uncertainty is based on the standard uncertainty multiplied by a factor  $k = 2$  (degrees of freedom =  $\infty$ ), which corresponds to a level of confidence of approximately 95%.

**Calibration Method:**

The instrument was calibrated following AL calibration procedure WI-44-Rev-2

Calibration Equipment(s) Used			
Apparatus	Serial Number	Cal Due Date	Certificate Number
Microphone Calibration System	3049731/ 3175486	14/04/2022	CDK2102707
Digital Multimeter	MY57225429	26/03/2022	1-14220896244-1
THD Multimeter	0975704	22/07/2021	1-12902338207-1

Ambient Condition Range:  
Temperature: (20-26)°C, Humidity: (25-70)%RH, Pressure: (80-105)kPa

Calibration By :   
Tiong Bang Xiang  
Calibration Officer

Reviewed/Approved By :   
Rodrigo Manansala  
Approving Officer

This calibration document shall not be reproduced except in full, without written approval of Absolute Laboratories Pte. Ltd.  
Absolute Laboratories Pte. Ltd. is an affiliated company of Absolute Instrument Systems (Pte.) Ltd.

WI-44-CR-1-Rev-1

Absolute Laboratories Pte. Ltd.  
11 Kallang Place #06-02 Singapore 339155  
Tel: 65 6296 8012 Fax: 65 6296 3242





## Calibration Certificate

Calibration Number: 211001612512

**Customer Name** : Absolute Instrument Systems (Pte.) Ltd. **Job Reference No:** 21100161  
**Customer Address** : 11 Kallang Place **Certificate Issue Date:** 19/10/2021  
#06-03  
Singapore 339155  
**Manufacturer** : Svantek **Calibration Date:** 19/10/2021  
**Item Description** : Sound Level Meter Class I **Test Conditions:**  
**Model Number** : SVAN 971 **Ambient Temperature:** 24 °C  
**Serial Number** : 80327 **Relative Humidity:** 51 %R.H.  
**Sub-Assemblies S/N** : SV18 71566/ 7052E 76553 **Pressure:** 101.2 kPa

This certificate provides traceability of measurement to the International System of Units (SI).  
Absolute Laboratories Pte. Ltd. certifies that the above product listed was calibrated in compliance with  
a quality management system using the applicable and approved Absolute Laboratories Pte. Ltd.  
calibration procedures as specified.

The reported expanded uncertainty is based on the standard uncertainty multiplied by a  
factor  $k = 2$  (degrees of freedom =  $\infty$ ), which corresponds to a level of confidence of approximately 95%.

### Calibration Method:

The instrument was calibrated following AL calibration procedure WI- 63-Rev-0

Calibration Equipment(s) Used			
Apparatus	Serial Number	Cal Due Date	Certificate Number
Sound Source	KZF070009	20/05/2022	210501021186
Digital Multimeter	MY57230283	22/09/2022	1-15340546294-1
Arbitrary Function Generator	C015037	24/04/2022	SST/SA/R/2021D/1522

Ambient Condition Range:  
Temperature: (20-26)°C , Humidity: (25-70)%RH, Pressure: (80-105)kPa

Calibration By :

  
Ang Siang Cheaw  
Calibration Officer

Reviewed/Approved By :

  
Rodrigo Manansala  
Approving Officer

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1 of 2





## Calibration Certificate

Calibration Number: 210301050647

**Customer Name** : Absolute Instrument Systems (Pte.) Ltd. **Job Reference No:** 21030105  
**Customer Address** : 11 Kallang Place, #06-03 **Certificate Issue Date:** 15/03/2021  
Singapore 339155  
**Manufacturer** : Svantek **Calibration Date:** 15/03/2021  
**Item Description** : Sound Level Meter Class I **Test Conditions:**  
**Model Number** : SVAN 971 **Ambient Temperature:** 23 °C  
**Serial Number** : 80329 **Relative Humidity:** 60 %R.H.  
**Sub-Assemblies S/N** : SV18 71563/ 7052E 70110 **Pressure:** 101.3 kPa

This certificate provides traceability of measurement to the International System of Units (SI).  
Absolute Laboratories Pte. Ltd. certifies that the above product listed was calibrated in compliance with  
a quality management system using the applicable and approved Absolute Laboratories Pte. Ltd.  
calibration procedures as specified.

The reported expanded uncertainty is based on the standard uncertainty multiplied by a  
factor  $k = 2$  (degrees of freedom =  $\infty$ ), which corresponds to a level of confidence of approximately 95%.

### Calibration Method:

The instrument was calibrated following AL calibration procedure WI- 63-Rev-0

Calibration Equipment(s) Used			
Apparatus	Serial Number	Cal Due Date	Certificate Number
Calibrator	QOG060008	12/09/2021	891941 QOG060008
Sound Source	KZF070009	23/03/2021	200302710676
Digital Multimeter	MYS7230283	21/09/2021	1-13212653810-1
Arbitrary Function Generator	C012134	22/06/2021	RL002174

Ambient Condition Range:  
Temperature: (20-26)°C, Humidity: (25-70)%RH, Pressure: (80-105)kPa

Calibration By :

  
Ang Siong Cheaw  
Calibration Officer

Reviewed/Approved By :

  
Rodrigo Manansala  
Approving Officer

This calibration document shall not be reproduced except in full, without written approval of Absolute Laboratories Pte. Ltd.  
Absolute Laboratories Pte. Ltd. is an affiliated company of Absolute Instrument Systems (Pte.) Ltd.

WI-63-CR-2-Rev-0

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11 Kallang Place #06-02 Singapore 339155  
Tel: 65 6296 8012 Fax: 65 6296 3242

1 of 2





**Appendix B Photos of the Noise Monitoring Set-up**



**N01**

ALS Technichem (Singapore) Pte. Ltd.  
121 Genting Lane #04-01,  
ALS Building, Singapore 349572  
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UEN No.: 198403076R



Our Ref: SG2203633-002

Date: 18 May 2022

**NOISE MONITORING REPORT  
(BASED ON CONTROL OF NOISE AT CONSTRUCTION SITES REGULATIONS)**

**PROJECT**

**For**

**ENVIRONMENTAL RESOURCES MANAGEMENT (S) PTE LTD  
120 ROBINSON ROAD #10-01  
SINGAPORE 068913**



---

**Yong Li Sheng**  
Field Engineer



---

**Tan Teong Huat**  
Asst. General Manager (ENV)

The results reported herein have been performed in accordance with the terms of accreditation under the Singapore Accreditation Council and comply with the requirements specified in ISO/IEC 17025. This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted, unless the sampling was conducted by ALS. The laboratory declares that the test results relate only to the items tested. This report may not be reproduced except with prior written approval from the testing laboratory and shall not be used for advertising purposes.

## EXECUTIVE SUMMARY

ALS Technichem (S) Pte Ltd has carried out noise monitoring for Project. The monitoring was conducted at two (2) locations through the request of Environmental Resources Management (S) Pte Ltd. The monitoring on the 2 locations were conducted from 28 March to 04 April 2022.

The objective of this monitoring is to generate a baseline airborne noise measurement to represent the potential Noise Sensitive Receptors (NSRs). The monitoring results were compared to the limits as stipulated in the National Environment Agency's (NEA) "the Maximum Permissible Noise Levels for Construction Work commenced on or after 1st October 2007, i.e. Second Schedule of the Environmental Protection and Management (Control of Noise at Construction Sites) Regulations, 2011 Revised Ed.

Based on Tables 5 to 36 of this report, the results obtained for both monitoring locations comply to the National Environmental Agency "the Maximum Permissible Noise Levels for Construction Work commenced on or after 1st October 2007, i.e. Second Schedule of the Environmental Protection and Management (Control of Noise at Construction Sites) Regulations, 2011 Revised Ed. except on certain days and time period as summarized in the table below.

Currently, there is no limit available for equivalent continuous noise level over a period of 1 hour for this category.

Below summarizes the period of the monitoring results compared to Control of Noise at Construction Sites Regulations "(c) Buildings (other than those in paragraphs (a) and (b))":

Category of Noise Regulated Period	Period	N02	N03
Reckoned as an equivalent continuous noise level over a period of 12 hours in decibels (A)	7am-7pm	No Exceedances	No Exceedances
	7pm-7am	Day 1 until Day 6 exceedance	No Exceedances
Reckoned as an equivalent continuous noise level over a period of 5 minutes) in decibels (A)	7am-7pm	No Exceedances	No Exceedances
	7pm-10pm	Day 1 until Day 6 exceedance	Day 1 until Day 6 exceedance
	10pm-7am	Day 1 until Day 6 exceedance	Day 1 until Day 6 exceedance
Reckoned as an equivalent continuous noise level over a period of one hour) in decibels (A)	7am-7pm	No Available Limit	
	7pm-10pm		
	10pm-7am		



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## LIST OF ABBREVIATIONS

dB(A)	Decibel A
Leq	Equivalent sound pressure level
Lmax	Maximum sound pressure levels recorded for a measurement period
Lmin	Minimum sound pressure levels recorded for a measurement period
NEA	National Environment Agency



## 1.0 INTRODUCTION

ALS TECHNICHEM (S) PTE LTD (hereafter as “ALS”) has conducted noise monitoring at two (2) selected locations for Project. The monitoring was conducted at the request of Environmental Resources Management (S) Pte Ltd (hereafter as “ERM”). The monitoring on the 2 locations were conducted from 28 March to 04 April 2022.

### 1.1 Objectives

The objective of the monitoring is to generate a baseline airborne noise measurement to represent the potential Noise Sensitive Receptors (NSRs). The monitoring results were compared to the limits stipulated in the National Environment Agency’s (NEA) Environmental Protection and Management Act – Environmental Protection and Management (Control of Noise at Construction Sites) Regulations, 2011 Revised Ed.

### 1.2 Scope of Work

The scope of works for the noise monitoring included:

1. Preparation of Noise Monitoring Plan;
2. Two (2) Noise Monitoring Stations, as dictated by ERM, were set-up. The monitoring stations are identified as follows:
  - a. N02 – Entrance of Team Alliance along 12 Sungei Kadut Drive
  - b. N03 – Along the Forest Strip at Wyn Construction site

The equivalent noise level ( $L_{Aeq}$ ) over a period of 24 hours period on a 5 minutes interval are determined from the three monitoring stations and the results were compared to below regulatory limits:

- Two specified periods according to the Part I, Second Schedule, Maximum Permissible Noise Levels For Construction Work Commenced On or After 1<sup>st</sup> October 2007, National Environment Agency’s (NEA) Environmental Protection & Management Act – Environmental Protection & Management (Control of Noise at Construction Sites) Regulations, 2011 Revised Ed.
  - Three specified periods according to the Part II, Second Schedule, Maximum Permissible Noise Levels For Construction Work Commenced On or After 1<sup>st</sup> October 2007, National Environment Agency’s (NEA) Environmental Protection & Management Act – Environmental Protection & Management (Control of Noise at Construction Sites) Regulations, 2011 Revised Ed.
  - Three specified periods according to the Part III, Second Schedule, Maximum Permissible Noise Levels For Construction Work Commenced On or After 1<sup>st</sup> October 2007, National Environment Agency’s (NEA) Environmental Protection & Management Act – Environmental Protection & Management (Control of Noise at Construction Sites) Regulations, 2011 Revised Ed.
3. Assessing the noise level against the adopted standards; and
  4. Providing a report outlining the findings and results of the study.





## 1.2.1 Monitoring Requirement

Noise is measured in decibel (dB) with reference to the frequency of noise, 'A' weighting was selected for this entire monitoring.

Tables 1 and 2 lists the maximum permitted noise level of specified period based on type of affected buildings as per Second Schedule of National Environment Agency's (NEA) Environmental Protection & Management Act – Environmental Protection & Management (Control of Noise at Construction Sites) Regulations, 2011 Revised Ed.

**Table 1: Maximum permitted noise level for construction work commenced after 1<sup>st</sup> October 2007**

<b>PART I</b>			
<b>Type of affected Buildings</b>	<b>*Maximum permitted noise level in decibels (A)</b>		
	<b>7am – 7pm</b>	<b>7pm – 7am</b>	
Hospital, Schools, Institutions of higher learning, homes for the aged sick etc.	60	50	
Residential buildings located less than 150m from the construction site where the noise is being emitted	75	-	
Buildings (other than above)	75	65	
*reckoned as an equivalent continuous noise level over a period of 12 hours			
<b>PART II</b>			
	<b>7am – 7pm</b>	<b>7pm – 10pm</b>	<b>10pm – 7am</b>
Hospital, Schools, Institutions of higher learning, homes for the aged sick etc.	-	-	-
Residential buildings located less than 150m from the construction site where the noise is being emitted	-	65	55
Buildings (other than above)	-	-	-
*reckoned as an equivalent continuous noise level over a period of 1 hour			
<b>PART III</b>			
	<b>7am – 7pm</b>	<b>7pm – 10pm</b>	<b>10pm – 7am</b>
Hospital, Schools, Institutions of higher learning, homes for the aged sick etc.	75	55	55
Residential buildings located less than 150m from the construction site where the noise is being emitted:-			
(i) on Monday to Saturday	90	70	55
(ii) on Sundays & Public Holiday	75	55	55
Buildings (other than above)	90	70	70
*reckoned as an equivalent continuous noise level over a period of 5 minutes			



## **2.0 SAMPLING AND FIELD MONITORING**

ALS has performed all the required sampling for noise level monitoring at selected locations through the directive of ERM.

### **2.1 Sampling Equipment**

A portable SVAN 971 Class 1 Sound Level Meter was used to measure noise levels on the selected points. This instrument complies with the standard as specified in the International Electrotechnical Commission i.e. Class 1: IEC 61672-1:2013. The Sound Level Meters were also calibrated before and after the noise survey, using a field calibrator (Quest Sound Calibrator, QC-10).



## 2.2 Sampling Locations

Figure 1 illustrates the 2 noise monitoring locations. The (★) indicates noise monitoring location.

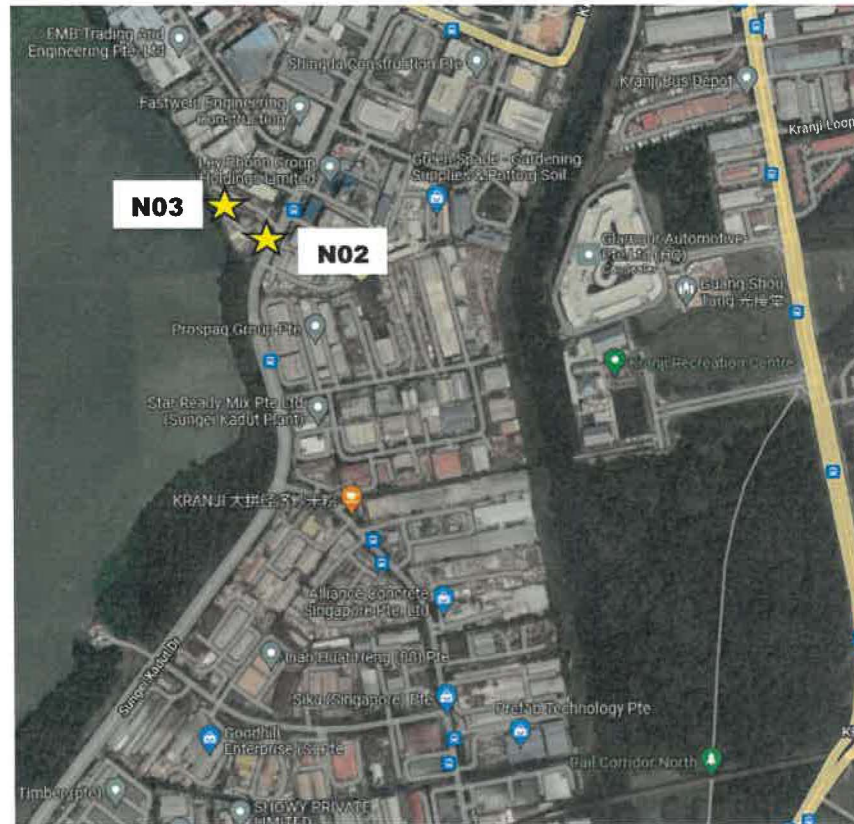


Figure 1: Noise Monitoring Locations

## 2.3 Detail of Noise Monitoring Point

A total of two (2) noise monitoring points has been selected and are identified as N02, and N03. The monitoring points were dictated by ERM. During the noise measurement, it was noted a range of possible noise sources at the respective monitoring points that may contribute to the overall ambient noise levels. The detail of the monitoring points and identified noise sources near to the monitoring points are listed in Table 2.

Table 3 list the number of vehicles/motorbikes during the short-term noise measurement, which traveled along the respective areas. The monitoring was conducted on weekdays during daytime period only.

**Table 2: Identified possible noise sources near to the monitoring points**

Monitoring Point	Date		Time (hr)		Possible Noise Sources:
	Start	Stop	Start	Stop	
N02	28 Mar 2022	04 Apr 2022	1200	1155	Grass cutting activities, aircraft passing, rain and thunder, heavy vehicles
N03	28 Mar 2022	04 Apr 2022	1200	1155	Rain and thunder, aircraft passing, mosquito repellent fogging operation

**Table 3: Vehicular Traffic volume for weekdays**

Location	Date and Time	Noise levels in dB (A)			Weekday Count		
		Lmin	Leq	Lmax	Light Vehicles	Heavy Vehicles	Motorbikes
N02	28 Mar 2022 1010H to 1025H	53.9	74.1	85.4	89	150	7

Remarks:

- Traffic volume was noted based on 15 minutes duration;
- The heavy vehicles included trucks, vans, lorries and buses (involved in business).
- The light vehicles include family car, four-wheel car and small vehicle which are non-commercial.



### 3.0 SAMPLING METHODOLOGY

The measuring instruments fitted with windshield shall be installed in such a way so that the measurements are not affected by external factors (draft, vibration, wind, magnetic field, etc). Measurement shall be carried out at around 1.2-1.5m from the ground or working level.

The equivalent continuous noise level ( $L_{Aeq}$ ) was measured by using the sound level meter for 5 minutes interval data log over 24 hours sampling period at the selected monitoring point. Table 4 summarized the sound level meter set up in this study. To determine the noise level on specified period, the recorded noise data was then analyzed by using *Supervisor Software*.

**Table 4: Summary of sound level meter setting**

Parameter	Setting
Response Fast	Response Fast
Frequency weighting for RMS	A
Measurement range	30 – 120 dB
Exchange Rate (Q)	3

### 3.1 Calibration of Sound Level Meter

All sound level meters were calibrated by an accredited laboratory under ISO/IEC 17025 standard. The certificates of field equipment's calibrations were attached in Appendix A. Sound level meter used for ambient noise survey shall have its calibration certified by an authorized calibration laboratory within one year of the actual measurement sessions.



#### 4.0 LOCATION INDEX / SAMPLING SCHEDULE / TEST RESULTS

Location index, sampling schedule and their respective test results obtained were tabulated and reflected our findings on the tables and figures below. Please refer to the following tables and figures for the monitoring results:

<b>Location</b>	<b>Tables</b>	<b>Figures</b>
N02	5 to 14	2 to 8
N03	15 to 24	9 to 15

On the other hand, the sampling locations are illustrated in Figure 1 of Page 10.



#### 4.1 Noise Monitoring Results for N02, Entrance of Team Alliance along 12 Sungei Kadut Drive

**Table 5: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 12 hours at N02**

Monitoring ID	Monitoring Location	Monitoring Period	Noise levels Leq in dB (A)	
			7am – 7pm	7pm – 7am
N02	Entrance of Team Alliance along 12 Sungei Kadut Drive	Day 1 (28 to 29 Mar 2022)	73.2	<b>67.1</b>
		Day 2 (29 to 30 Mar 2022)	74.0	<b>67.1</b>
		Day 3 (30 to 31 Mar 2022)	73.6	<b>66.8</b>
		Day 4 (31 Mar to 01 Apr 2022)	73.4	<b>66.9</b>
		Day 5 (01 to 02 Apr 2022)	73.1	<b>68.0</b>
		Day 6 (02 to 03 Apr 2022)	71.9	<b>68.0</b>
		Day 7 (03 to 04 Apr 2022)	72.8	64.9
<b>Control of Noise at Construction Sites for “(c) Buildings (other than those in paragraphs (a) and (b))”</b>			75	65

Remarks: Maximum Permissible Noise Level (reckoned as equivalent continuous noise level over a period of 12 hours)

**Bold** denotes exceeded limits



**Table 6: Range of noise level reckoned as an equivalent continuous noise level over a period of 5 minutes at N02**

Monitoring ID	Monitoring Location	Monitoring Period	Noise levels Leq in dB (A)					
			7am – 7pm		7pm – 10pm		10pm – 7am	
			Min	Max	Min	Max	Min	Max
N02	Entrance of Team Alliance along 12 Sungei Kadut Drive	Day 1 (28 to 29 Mar 2022)	70.3	78.3	65.0	<b>77.1</b>	53.6	<b>71.9</b>
		Day 2 (29 to 30 Mar 2022)	70.5	86.0	67.0	<b>72.8</b>	53.4	<b>72.2</b>
		Day 3 (30 to 31 Mar 2022)	70.3	87.3	66.6	<b>73.5</b>	53.9	<b>72.0</b>
		Day 4 (31 Mar to 01 Apr 2022)	70.3	77.6	67.4	<b>73.2</b>	53.9	<b>72.2</b>
		Day 5 (01 to 02 Apr 2022)	67.3	77.8	67.9	<b>78.9</b>	53.9	<b>71.2</b>
		Day 6 (02 to 03 Apr 2022)	63.7	75.1	68.9	<b>73.7</b>	56.7	<b>70.9</b>
		Day 7 (03 to 04 Apr 2022)	66.1	83.5	64.6	<b>70.0</b>	51.3	<b>67.5</b>
<b>Control of Noise at Construction Sites for “(c) Buildings (other than those in paragraphs (a) and (b))”</b>			90		70		70	

Remarks: Maximum Permissible Noise Level (reckoned as equivalent continuous noise level over a period of 5 minutes)

**Bold** denotes exceeded limits





**Table 7: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 5 minutes at N02 (Day 1)**

Day		Day 1																							
Date		28 March 2022											29 March 2022												
	Time (HR)	12PM	1PM	2PM	3PM	4PM	5PM	6PM	7PM	8PM	9PM	10PM	11PM	12AM	1AM	2AM	3AM	4AM	5AM	6AM	7AM	8AM	9AM	10AM	11AM
LEQ 5mins	0	73.2	72.6	72.1	73.3	71.9	74.2	73.4	73.6	71.1	69.7	67.3	66.0	57.6	61.2	57.4	61.6	56.3	64.7	67.1	72.6	72.0	71.8	72.4	71.4
	5	73.3	73.7	77.3	73.5	73.2	74.7	72.9	77.1	68.6	69.9	65.2	63.5	60.5	61.8	58.8	60.7	61.2	65.2	67.1	72.2	72.9	73.2	73.6	71.4
	10	72.5	72.6	72.6	72.8	78.3	73.7	73.4	70.9	69.2	68.5	67.9	64.8	63.4	58.6	61.6	61.8	58.7	66.1	68.0	70.7	73.1	72.2	72.1	72.1
	15	72.6	72.7	72.1	73.2	77.0	73.7	74.0	72.6	69.8	69.8	66.6	64.1	57.8	57.3	60.8	57.5	59.6	64.3	67.6	72.0	73.9	73.8	72.8	72.0
	20	72.6	72.8	72.2	73.1	76.8	74.0	73.1	75.7	68.3	66.5	67.0	66.0	61.3	57.0	62.4	60.6	61.4	65.9	67.5	72.3	72.8	72.6	73.4	72.1
	25	71.8	74.6	76.3	72.5	76.6	71.6	72.3	73.1	70.3	67.9	65.9	64.8	60.9	57.6	57.5	57.4	63.4	64.8	68.3	71.3	73.2	71.3	71.3	72.7
	30	72.8	74.1	72.6	72.8	76.2	73.5	72.5	72.6	69.5	69.0	66.3	60.8	59.3	58.7	57.4	62.5	57.6	63.2	68.4	73.1	73.0	73.0	72.3	73.5
	35	71.1	72.9	72.7	73.3	76.5	72.6	72.5	71.4	68.4	68.1	65.3	59.4	64.9	56.5	61.2	64.7	62.4	64.8	68.8	71.8	73.0	72.3	73.2	73.2
	40	71.8	73.5	73.0	72.5	75.5	72.6	71.2	73.9	68.9	65.0	65.9	64.7	61.2	62.3	53.6	61.7	64.9	67.5	69.6	72.3	71.9	72.8	72.9	72.4
	45	72.6	72.6	71.9	71.5	75.5	71.3	72.1	74.7	69.2	67.4	63.6	62.9	61.5	60.6	62.6	54.8	61.8	65.8	71.4	74.1	72.5	71.5	72.7	72.8
	50	71.9	74.1	72.8	72.0	75.3	72.7	71.9	71.2	66.6	65.5	65.1	56.7	60.2	61.3	62.6	61.1	60.7	67.7	71.9	72.6	73.9	73.3	73.1	71.3
	55	71.8	73.3	71.4	71.9	75.2	71.8	70.3	69.5	67.5	66.8	63.9	56.8	59.8	58.2	60.4	60.4	66.8	67.4	71.8	72.9	71.1	72.9	71.8	72.3
Maximum permitted noise level (reckoned as equivalent continuous noise level over 5 minutes) in decibels (A)		90	90	90	90	90	90	90	70	70	70	70	70	70	70	70	70	70	70	90	90	90	90	90	

Remarks:

Limits specified are based Environmental Protection and Management (Control of Noise at Construction Sites) Regulations "(c) Buildings (other than those in paragraphs (a) and (b))"

Red filled denotes exceeded the limit.



**Table 8: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 5 minutes at N02 (Day 2)**

Day		Day 2																							
Date		29 March 2022												30 March 2022											
	Time (HR)	12PM	1PM	2PM	3PM	4PM	5PM	6PM	7PM	8PM	9PM	10PM	11PM	12AM	1AM	2AM	3AM	4AM	5AM	6AM	7AM	8AM	9AM	10AM	11AM
LEQ 5mins	0	72.2	71.4	72.9	70.9	72.8	77.1	73.0	72.0	71.5	69.2	67.9	63.6	59.5	62.6	63.0	58.2	57.6	63.9	66.5	72.1	73.0	74.0	72.1	72.7
	5	72.8	72.2	72.7	72.9	71.5	74.5	71.4	72.7	72.4	70.0	68.7	63.0	65.9	65.0	59.8	60.1	60.0	61.0	65.6	71.4	72.7	73.4	73.3	74.5
	10	72.2	71.4	71.8	74.8	72.0	73.7	72.4	72.8	67.2	69.1	69.3	65.7	61.7	59.8	60.0	62.2	59.2	62.8	68.4	72.4	73.4	73.0	71.8	72.3
	15	72.6	72.3	72.1	71.5	76.0	74.3	73.0	71.9	71.5	69.6	67.2	65.8	63.5	60.6	58.6	59.4	62.0	62.0	67.4	73.5	72.4	73.7	72.4	72.6
	20	71.7	71.2	72.0	72.4	85.1	74.3	72.0	71.9	71.9	70.5	68.8	63.1	66.1	62.9	60.7	56.1	65.6	64.7	69.1	71.2	72.9	73.0	71.6	74.4
	25	71.2	70.9	72.3	70.5	86.0	73.4	72.0	70.7	69.0	70.4	66.9	64.1	62.6	62.6	61.3	57.5	65.0	63.2	69.0	72.1	73.8	72.6	72.4	72.8
	30	71.8	70.9	72.2	72.6	81.7	74.2	73.2	72.5	71.8	69.1	66.1	62.4	59.1	60.1	62.3	61.7	61.9	67.5	69.7	73.5	72.9	71.5	72.2	73.0
	35	71.6	73.3	72.6	71.2	76.6	73.9	72.2	72.2	69.2	67.0	65.7	62.3	63.7	62.3	59.0	58.3	58.6	63.4	67.1	71.5	73.4	71.9	72.4	72.9
	40	71.6	72.0	71.5	72.6	75.4	73.1	71.4	72.3	69.3	69.2	66.0	60.3	56.8	63.5	53.4	59.9	62.8	65.3	70.0	72.8	73.1	72.0	73.4	72.4
	45	71.4	73.0	72.1	70.8	77.9	72.0	72.4	71.7	71.0	67.6	65.6	62.9	61.8	59.8	58.9	57.2	66.2	66.5	70.8	72.8	72.9	72.4	74.1	72.6
	50	71.3	71.9	72.4	72.0	76.6	73.0	71.4	70.8	68.4	67.2	64.3	64.4	60.7	59.2	56.2	60.5	64.7	67.6	72.2	72.5	74.5	72.7	72.2	72.7
	55	71.2	72.3	72.2	71.2	75.3	72.0	71.4	71.3	70.8	68.2	66.0	64.7	63.2	63.5	60.5	61.0	65.2	65.7	71.8	73.2	74.2	73.3	72.7	73.3
Maximum permitted noise level (reckoned as equivalent continuous noise level over 5 minutes) in decibels (A)		90	90	90	90	90	90	90	70	70	70	70	70	70	70	70	70	70	70	90	90	90	90	90	

**Remarks:**

Limits specified are based Environmental Protection and Management (Control of Noise at Construction Sites) Regulations "(c) Buildings (other than those in paragraphs (a) and (b))"

Red filled denotes exceeded the limit.



**Table 9: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 5 minutes at N02 (Day 3)**

Day		Day 3																							
Date		30 March 2022											31 March 2022												
	Time (HR)	12PM	1PM	2PM	3PM	4PM	5PM	6PM	7PM	8PM	9PM	10PM	11PM	12AM	1AM	2AM	3AM	4AM	5AM	6AM	7AM	8AM	9AM	10AM	11AM
LEQ 5mins	0	72.0	73.1	72.1	73.0	71.7	72.2	72.9	71.9	71.4	68.5	67.7	63.5	59.6	59.0	59.0	62.0	57.8	64.5	68.6	71.7	73.6	73.3	72.0	72.6
	5	72.3	71.8	73.3	71.3	71.6	72.4	72.4	70.5	70.6	69.6	68.3	63.5	66.8	59.6	58.8	61.4	60.4	65.2	67.3	71.8	73.4	71.8	72.2	74.4
	10	72.6	72.8	72.0	72.5	73.1	71.7	71.7	71.5	68.9	69.5	66.6	65.8	60.2	62.8	53.9	60.5	62.9	61.4	67.0	71.4	74.6	72.8	72.3	72.9
	15	71.9	72.2	73.3	73.3	72.1	74.5	73.1	73.5	69.3	69.8	66.9	66.7	59.3	61.0	62.0	62.1	57.1	64.2	69.3	72.3	73.6	73.6	72.1	73.4
	20	70.3	72.6	72.3	71.2	73.3	72.1	71.1	72.0	70.4	67.8	67.6	63.1	55.8	61.2	61.6	55.5	63.7	63.8	68.1	72.2	73.4	72.3	72.0	72.0
	25	71.7	72.2	72.5	71.2	70.9	72.7	72.6	71.1	70.1	69.9	67.7	65.8	63.9	58.1	62.4	61.2	60.2	62.8	68.7	72.6	73.5	73.3	72.6	72.8
	30	72.0	72.3	71.4	87.3	72.1	73.3	73.1	71.2	71.2	68.3	66.5	62.2	63.0	63.7	62.8	61.5	61.6	66.1	69.0	72.7	74.0	72.4	73.2	73.5
	35	71.3	72.1	72.7	83.4	70.9	72.2	72.3	71.5	69.2	69.0	65.6	62.2	62.1	60.2	59.8	56.2	60.1	62.5	68.6	73.3	72.3	71.2	71.1	73.5
	40	72.2	72.0	72.6	72.8	73.1	72.5	71.4	71.3	69.2	66.6	64.5	65.2	60.5	65.6	63.3	58.9	63.7	66.5	69.5	73.2	72.6	72.0	72.7	72.5
	45	72.6	71.9	70.5	71.1	73.0	72.6	72.3	72.4	67.3	68.5	64.5	64.4	57.2	61.6	60.5	59.8	63.1	65.0	69.9	73.3	73.8	72.2	71.1	72.3
	50	72.3	71.9	74.2	72.2	71.1	72.1	71.7	71.1	70.0	67.5	65.6	63.9	59.1	62.0	63.0	60.5	63.4	66.9	70.6	73.5	72.6	72.6	74.8	72.4
55	71.6	73.6	73.3	72.1	72.8	70.6	71.5	71.1	67.4	68.0	66.1	66.0	54.3	64.2	57.9	54.8	65.3	68.2	72.0	73.7	73.9	73.9	71.8	73.1	
Maximum permitted noise level (reckoned as equivalent continuous noise level over 5 minutes) in decibels (A)		90	90	90	90	90	90	90	70	70	70	70	70	70	70	70	70	70	70	90	90	90	90	90	

**Remarks:**

Limits specified are based Environmental Protection and Management (Control of Noise at Construction Sites) Regulations "(c) Buildings (other than those in paragraphs (a) and (b))":

Red filled denotes exceeded the limit.



**Table 10: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 5 minutes at N02 (Day 4)**

Day		Day 4																							
Date		31 March 2022											01 April 2022												
	Time (HR)	12PM	1PM	2PM	3PM	4PM	5PM	6PM	7PM	8PM	9PM	10PM	11PM	12AM	1AM	2AM	3AM	4AM	5AM	6AM	7AM	8AM	9AM	10AM	11AM
LEQ 5mins	0	72.6	77.3	73.2	71.5	72.6	72.9	72.3	72.5	70.3	69.4	69.4	65.1	61.2	62.7	60.7	61.3	59.2	59.2	66.2	72.7	72.7	71.7	72.1	73.1
	5	71.8	77.6	72.9	74.2	72.6	72.9	72.5	72.8	71.6	69.4	66.7	66.0	63.3	61.2	57.1	63.0	63.7	64.2	67.3	71.9	72.9	72.9	73.0	72.6
	10	72.4	76.5	73.1	73.6	73.0	73.6	72.1	73.2	69.8	69.1	68.0	62.6	63.5	58.7	62.3	62.4	55.7	62.1	69.1	71.6	74.5	73.3	70.9	71.5
	15	71.1	76.9	74.1	73.3	73.4	73.0	72.5	72.0	69.8	71.3	67.1	63.7	62.1	60.5	61.6	61.9	60.1	65.1	68.4	71.9	74.0	72.6	72.3	73.2
	20	72.8	75.0	74.1	74.4	73.5	73.8	72.1	71.4	69.2	68.7	67.7	63.7	59.3	63.4	59.7	63.0	63.0	62.1	68.6	72.8	73.0	73.4	71.6	72.3
	25	72.1	76.1	75.2	74.1	72.5	73.2	70.3	71.2	70.9	68.0	67.8	63.6	64.3	59.5	58.6	59.1	66.6	64.8	68.0	72.9	73.9	72.6	72.5	73.9
	30	70.9	75.6	74.9	73.1	72.7	72.6	72.7	71.7	68.7	68.5	68.5	64.1	63.7	61.7	58.1	55.3	60.8	67.4	68.5	73.4	73.1	73.0	72.1	72.4
	35	72.2	74.0	73.7	73.4	71.7	72.8	72.0	70.6	68.7	69.5	64.4	65.5	65.2	60.9	62.6	60.4	61.7	65.3	69.6	73.1	72.6	72.8	73.6	73.1
	40	71.6	74.9	74.3	72.3	73.0	72.5	71.0	71.0	69.8	69.1	64.8	62.0	60.2	63.1	55.8	60.6	62.9	66.2	71.0	72.7	71.4	77.0	73.0	73.2
	45	73.5	73.1	74.0	73.0	73.1	72.4	72.3	71.0	68.4	68.0	66.6	60.3	61.3	57.8	61.8	61.5	59.3	64.5	69.4	73.4	72.9	76.1	71.9	72.4
	50	74.8	73.6	73.2	73.8	72.2	72.9	72.3	70.4	68.4	68.0	65.9	63.3	63.6	53.9	63.0	62.1	65.3	67.9	71.7	73.1	73.1	72.7	76.5	72.4
	55	76.7	75.8	72.8	73.1	73.8	73.2	72.3	71.0	67.4	67.5	65.8	65.1	61.8	61.2	59.8	59.9	63.8	66.6	72.2	73.4	72.4	72.1	74.0	73.7
Maximum permitted noise level (reckoned as equivalent continuous noise level over 5 minutes) in decibels (A)		90	90	90	90	90	90	90	70	70	70	70	70	70	70	70	70	70	70	90	90	90	90	90	

Remarks:

Limits specified are based Environmental Protection and Management (Control of Noise at Construction Sites) Regulations “(c) Buildings (other than those in paragraphs (a) and (b))”:

Red filled denotes exceeded the limit.



**Table 11: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 5 minutes at N02 (Day 5)**

Day		Day 5																							
Date		01 April 2022												02 April 2022											
	Time (HR)	12PM	1PM	2PM	3PM	4PM	5PM	6PM	7PM	8PM	9PM	10PM	11PM	12AM	1AM	2AM	3AM	4AM	5AM	6AM	7AM	8AM	9AM	10AM	11AM
LEQ 5mins	0	72.8	72.2	72.7	72.4	72.6	73.6	74.3	72.5	72.4	70.3	68.3	66.4	64.8	60.2	61.6	64.3	60.1	58.8	65.8	67.4	72.3	73.8	74.0	73.3
	5	71.7	71.5	72.4	76.6	72.2	76.2	73.6	72.9	70.9	70.4	68.9	68.1	63.0	60.2	61.4	61.9	58.8	61.2	60.0	68.4	72.4	73.3	73.6	74.1
	10	71.6	72.8	71.8	71.5	77.8	72.3	74.4	72.8	78.9	69.9	71.2	67.2	66.5	61.4	55.9	61.1	64.4	53.9	63.7	67.3	72.0	73.6	72.7	73.6
	15	73.3	71.5	72.5	72.4	75.2	73.5	73.8	71.3	78.2	69.1	68.9	67.9	64.6	64.5	61.7	64.2	60.9	63.5	67.3	68.8	72.8	73.5	72.4	73.0
	20	72.0	72.2	72.1	72.4	73.7	72.2	74.0	73.7	70.5	69.1	70.5	67.2	64.9	65.1	56.4	62.3	59.6	63.5	63.5	67.5	72.6	73.6	72.4	73.3
	25	72.2	72.3	72.4	72.0	74.8	73.8	74.2	72.5	71.2	68.5	66.8	67.3	65.3	63.6	57.7	65.2	63.0	62.2	62.9	69.4	73.4	74.4	71.7	72.9
	30	71.8	72.0	72.8	71.3	73.6	74.0	72.7	72.3	70.7	69.2	68.4	67.6	59.1	65.7	56.2	61.4	64.8	63.5	64.4	68.9	73.2	74.2	74.5	73.4
	35	72.4	72.6	72.0	71.9	73.6	73.7	74.1	71.4	70.9	68.8	68.4	67.1	62.4	60.0	54.1	65.2	63.3	64.0	66.4	70.6	73.5	73.3	72.9	73.5
	40	72.2	76.3	72.8	72.7	74.4	74.4	71.9	73.7	71.4	69.0	69.6	66.5	60.9	60.0	57.1	56.0	63.6	61.1	66.7	69.6	73.5	75.1	73.1	73.7
	45	71.7	74.6	71.9	71.6	73.5	74.6	72.7	72.5	70.7	67.9	68.3	65.3	59.0	64.7	58.8	57.3	62.1	63.1	66.0	71.9	72.7	74.4	73.2	71.9
	50	71.4	72.0	72.3	71.4	73.3	74.5	71.9	72.0	70.9	70.1	67.0	64.0	64.5	60.6	57.1	63.0	59.5	64.4	67.4	70.4	74.1	74.9	73.6	72.1
	55	71.5	74.0	71.8	72.8	72.7	73.7	72.8	71.9	71.5	68.1	67.6	67.7	64.9	59.0	60.8	62.7	61.3	66.8	68.1	70.7	74.1	74.4	74.7	73.2
Maximum permitted noise level (reckoned as equivalent continuous noise level over 5 minutes) in decibels (A)		90	90	90	90	90	90	90	70	70	70	70	70	70	70	70	70	70	70	90	90	90	90	90	

**Remarks:**

Limits specified are based Environmental Protection and Management (Control of Noise at Construction Sites) Regulations “(c) Buildings (other than those in paragraphs (a) and (b))”:

Red filled denotes exceeded the limit.



**Table 12: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 5 minutes at N02 (Day 6)**

Day		Day 6																							
Date		02 April 2022											03 April 2022												
	Time (HR)	12PM	1PM	2PM	3PM	4PM	5PM	6PM	7PM	8PM	9PM	10PM	11PM	12AM	1AM	2AM	3AM	4AM	5AM	6AM	7AM	8AM	9AM	10AM	11AM
LEQ 5mins	0	72.2	72.3	72.6	72.2	73.1	72.3	73.6	73.5	72.3	71.2	69.6	66.4	63.2	64.8	62.1	61.1	63.8	63.1	65.9	63.7	69.7	68.9	68.6	67.1
	5	73.6	71.8	72.3	72.5	71.4	72.6	74.8	73.1	73.7	70.6	70.1	67.6	66.1	64.1	65.4	65.3	62.6	59.5	61.7	65.0	68.7	70.4	69.9	66.4
	10	73.1	73.0	73.0	73.3	74.0	73.2	72.5	72.6	71.9	70.8	69.7	67.5	65.1	59.9	60.5	64.0	64.4	61.2	65.1	68.3	66.5	70.1	68.2	70.4
	15	74.3	73.8	73.3	74.6	72.6	71.6	72.9	73.2	72.6	72.1	68.5	68.6	65.1	66.4	58.4	62.0	61.1	61.7	65.1	66.0	68.5	69.5	69.0	68.8
	20	73.6	71.9	73.0	71.9	73.3	73.0	71.4	73.2	73.1	69.5	68.1	68.2	65.5	63.4	62.5	62.6	64.7	59.2	61.2	65.9	68.6	70.6	68.1	68.3
	25	73.5	73.4	72.5	72.9	74.1	74.4	73.5	72.1	71.4	70.4	69.4	67.4	65.9	62.4	68.0	63.6	58.2	63.4	63.6	64.4	69.4	69.2	69.6	69.1
	30	73.2	75.1	72.4	73.0	73.1	72.7	72.2	71.9	72.2	70.3	70.3	67.1	65.4	65.4	58.2	61.4	62.7	63.5	64.0	66.4	68.7	69.6	68.1	69.4
	35	73.9	73.4	73.6	72.6	72.5	74.0	72.5	72.0	71.5	70.3	69.5	67.2	63.1	61.1	65.4	65.4	56.7	61.6	60.2	66.7	69.9	69.2	70.8	69.7
	40	73.1	74.4	71.9	73.5	74.8	73.5	74.8	72.7	71.9	68.9	70.9	67.6	67.3	62.6	64.1	61.4	63.8	61.4	65.5	68.7	70.5	71.7	69.8	70.3
	45	73.3	74.2	72.0	73.2	71.4	73.8	72.5	73.1	72.3	70.6	67.4	67.1	63.8	59.8	63.6	65.0	64.0	62.4	63.5	66.8	70.7	69.3	70.2	69.5
	50	73.9	73.7	73.3	73.0	72.6	73.5	73.4	72.5	72.4	69.2	67.2	66.5	60.2	63.5	62.5	63.4	64.2	62.2	63.6	67.2	69.2	69.2	69.8	70.5
	55	73.8	73.8	73.5	72.6	73.1	72.7	72.5	72.1	69.6	69.2	67.5	67.6	64.8	59.4	58.4	62.2	63.5	61.2	65.4	66.4	70.0	67.3	68.7	70.4
Maximum permitted noise level (reckoned as equivalent continuous noise level over 5 minutes) in decibels (A)		90	90	90	90	90	90	90	70	70	70	70	70	70	70	70	70	70	70	70	90	90	90	90	90

Remarks:

Limits specified are based Environmental Protection and Management (Control of Noise at Construction Sites) Regulations "(c) Buildings (other than those in paragraphs (a) and (b))":

Red filled denotes exceeded the limit.



**Table 13: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 5 minutes at N02 (Day 7)**

Day		Day 7																							
Date		03 April 2022											04 April 2022												
	Time (HR)	12PM	1PM	2PM	3PM	4PM	5PM	6PM	7PM	8PM	9PM	10PM	11PM	12AM	1AM	2AM	3AM	4AM	5AM	6AM	7AM	8AM	9AM	10AM	11AM
LEQ 5mins	0	69.5	70.3	73.5	74.5	70.8	69.9	71.0	69.2	68.6	66.3	66.9	66.1	63.0	62.3	52.1	60.8	55.4	63.8	66.6	67.7	72.5	73.7	72.5	73.1
	5	70.7	69.4	71.9	76.7	70.0	69.5	71.5	69.2	65.7	65.6	65.1	65.8	64.9	60.8	57.1	62.0	60.8	59.1	63.7	67.6	72.9	74.1	74.0	72.8
	10	70.1	70.2	83.5	77.4	70.1	71.1	70.0	69.8	68.9	66.5	66.9	67.3	62.0	60.9	58.2	57.7	58.3	53.8	66.2	66.1	72.3	73.3	75.1	72.9
	15	68.2	68.5	74.9	76.8	69.0	68.5	70.2	69.1	68.1	66.0	66.3	63.8	60.5	60.5	57.8	60.8	58.0	57.2	60.7	69.2	73.5	74.1	73.6	73.7
	20	68.6	70.5	70.8	74.9	69.9	70.6	70.1	69.8	65.9	67.8	62.8	63.0	63.2	61.2	59.4	60.8	58.2	59.7	60.2	69.4	72.5	73.9	73.1	73.4
	25	67.6	68.9	73.1	72.9	69.3	69.7	69.3	70.0	68.1	66.9	66.2	66.5	65.0	62.5	64.7	65.4	51.3	61.6	66.2	68.9	73.7	81.5	74.2	72.4
	30	69.0	69.4	69.4	71.5	69.9	70.5	70.4	69.2	67.5	66.2	65.9	64.9	64.3	62.3	60.5	62.2	55.6	61.2	65.0	69.6	73.3	74.4	73.8	74.7
	35	69.9	68.5	71.8	72.0	68.3	68.6	67.8	69.9	67.3	66.5	65.5	64.5	64.0	58.2	63.3	59.4	60.5	59.5	65.9	70.2	73.5	77.8	74.7	74.1
	40	69.7	67.0	70.7	71.6	71.2	70.2	68.9	69.5	67.4	66.2	67.5	65.6	63.2	61.3	59.1	60.9	61.2	62.9	66.4	70.8	76.9	78.6	73.5	73.7
	45	71.3	69.0	70.7	71.1	69.6	71.0	68.9	68.2	65.4	67.3	63.6	62.3	64.8	63.4	59.4	51.9	59.3	62.4	65.0	70.1	74.0	74.5	73.9	75.1
	50	69.9	69.1	73.8	70.3	71.0	70.8	70.0	67.6	67.7	65.4	65.5	67.4	63.3	59.2	62.5	62.4	56.2	66.7	67.3	70.5	74.1	73.8	73.4	74.6
55	71.1	70.1	71.5	70.0	70.6	70.6	69.5	67.8	67.3	64.6	64.7	63.4	61.4	59.8	60.2	59.4	58.6	65.0	67.2	71.5	74.2	74.7	74.7	73.2	
<b>Maximum permitted noise level (reckoned as equivalent continuous noise level over 5 minutes) in decibels (A)</b>		90	90	90	90	90	90	90	70	70	70	70	70	70	70	70	70	70	70	70	90	90	90	90	90

**Remarks:**

Limits specified are based Environmental Protection and Management (Control of Noise at Construction Sites) Regulations “(c) Buildings (other than those in paragraphs (a) and (b))”:



**Table 14: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at N02**

Duration (hr)	Day 1 (28 to 29 Mar 2022)	
	Noise levels Leq in dB (A)	“(c) Buildings (other than those in paragraphs (a) and (b))”
0700 – 0800	72.4	NA
0800 – 0900	72.8	
0900 – 1000	72.6	
1000 – 1100	72.7	
1100 – 1200	72.3	
1200 – 1300	72.4	
1300 – 1400	73.3	
1400 – 1500	73.5	
1500 – 1600	72.7	
1600 – 1700	75.9	
1700 – 1800	73.2	
1800 – 1900	72.6	
1900 – 2000	73.5	
2000 – 2100	69.1	
2100 – 2200	68.1	
2200 – 2300	66.0	NA
2300 – 0000	63.5	
0000 – 0100	61.2	
0100 – 0200	59.7	
0200 – 0300	60.4	
0300 – 0400	61.0	
0400 – 0500	62.2	
0500 – 0600	65.8	
0600 – 0700	69.3	

Remark: NA denote Not Available

\* Limits specified are based Environmental Protection and Management (Control of Noise at Construction Sites) Regulations.





**Table 15: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at N02**

Duration (hr)	Day 2 (29 to 30 Mar 2022)	
	Noise levels Leq in dB (A)	“(c) Buildings (other than those in paragraphs (a) and (b))”
0700 – 0800	72.5	NA
0800 – 0900	73.3	
0900 – 1000	72.8	
1000 – 1100	72.6	
1100 – 1200	73.1	
1200 – 1300	71.8	
1300 – 1400	72.0	
1400 – 1500	72.2	
1500 – 1600	72.1	
1600 – 1700	79.9	
1700 – 1800	74.0	
1800 – 1900	72.2	
1900 – 2000	71.9	NA
2000 – 2100	70.6	
2100 – 2200	69.0	
2200 – 2300	67.1	NA
2300 – 0000	63.8	
0000 – 0100	62.8	
0100 – 0200	62.2	
0200 – 0300	60.1	
0300 – 0400	59.7	
0400 – 0500	63.3	
0500 – 0600	64.9	
0600 – 0700	69.4	

Remark: NA denote Not Available

\* Limits specified are based Environmental Protection and Management (Control of Noise at Construction Sites) Regulations.



**Table 16: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at N02**

Duration (hr)	Day 3 (30 to 31 Mar 2022)	
	Noise levels Leq in dB (A)	“(c) Buildings (other than those in paragraphs (a) and (b))”
0700 – 0800	72.7	NA
0800 – 0900	73.5	
0900 – 1000	72.7	
1000 – 1100	72.4	
1100 – 1200	73.0	
1200 – 1300	71.9	
1300 – 1400	72.4	
1400 – 1500	72.6	
1500 – 1600	78.8	
1600 – 1700	72.2	
1700 – 1800	72.5	
1800 – 1900	72.2	
1900 – 2000	71.6	NA
2000 – 2100	69.7	
2100 – 2200	68.7	
2200 – 2300	66.6	NA
2300 – 0000	64.6	
0000 – 0100	61.5	
0100 – 0200	62.1	
0200 – 0300	61.1	
0300 – 0400	60.1	
0400 – 0500	62.2	
0500 – 0600	65.2	
0600 – 0700	69.3	

Remark: NA denote Not Available

\* Limits specified are based Environmental Protection and Management (Control of Noise at Construction Sites) Regulations.



**Table 17: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at N02**

Duration (hr)	Day 4 (31 Mar to 01 Apr 2022)	
	Noise levels Leq in dB (A)	“(c) Buildings (other than those in paragraphs (a) and (b))”
0700 – 0800	72.8	NA
0800 – 0900	73.1	
0900 – 1000	73.7	
1000 – 1100	73.0	
1100 – 1200	72.9	
1200 – 1300	73.0	
1300 – 1400	75.7	
1400 – 1500	73.9	
1500 – 1600	73.4	
1600 – 1700	72.9	
1700 – 1800	73.0	
1800 – 1900	72.1	
1900 – 2000	71.6	NA
2000 – 2100	69.5	
2100 – 2200	69.0	
2200 – 2300	67.1	NA
2300 – 0000	64.0	
0000 – 0100	62.8	
0100 – 0200	61.0	
0200 – 0300	60.6	
0300 – 0400	61.3	
0400 – 0500	62.7	
0500 – 0600	65.2	
0600 – 0700	69.5	

Remark: NA denote Not Available

\* Limits specified are based Environmental Protection and Management (Control of Noise at Construction Sites) Regulations.



**Table 18: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at N02**

Duration (hr)	Day 5 (01 to 02 Apr 2022)	
	Noise levels Leq in dB (A)	“(c) Buildings (other than those in paragraphs (a) and (b))”
0700 – 0800	69.5	NA
0800 – 0900	73.1	
0900 – 1000	74.1	
1000 – 1100	73.3	
1100 – 1200	73.2	
1200 – 1300	72.1	
1300 – 1400	73.1	
1400 – 1500	72.3	
1500 – 1600	72.7	
1600 – 1700	74.2	
1700 – 1800	74.0	
1800 – 1900	73.4	
1900 – 2000	72.5	NA
2000 – 2100	73.6	
2100 – 2200	69.3	
2200 – 2300	68.8	NA
2300 – 0000	67.0	
0000 – 0100	63.9	
0100 – 0200	62.7	
0200 – 0300	58.9	
0300 – 0400	62.8	
0400 – 0500	62.2	
0500 – 0600	63.0	
0600 – 0700	65.7	

Remark: NA denote Not Available

\* Limits specified are based Environmental Protection and Management (Control of Noise at Construction Sites) Regulations.



**Table 19: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at N02**

Duration (hr)	Day 6 (02 to 03 Apr 2022)	
	Noise levels Leq in dB (A)	“(c) Buildings (other than those in paragraphs (a) and (b))”
0700 – 0800	66.5	NA
0800 – 0900	69.3	
0900 – 1000	69.7	
1000 – 1100	69.3	
1100 – 1200	69.3	
1200 – 1300	73.5	
1300 – 1400	73.5	
1400 – 1500	72.8	
1500 – 1600	73.0	
1600 – 1700	73.1	
1700 – 1800	73.2	
1800 – 1900	73.2	
1900 – 2000	72.7	NA
2000 – 2100	72.2	
2100 – 2200	70.4	
2200 – 2300	69.2	NA
2300 – 0000	67.4	
0000 – 0100	64.9	
0100 – 0200	63.3	
0200 – 0300	63.4	
0300 – 0400	63.4	
0400 – 0500	63.0	
0500 – 0600	61.9	
0600 – 0700	64.1	

Remark: NA denote Not Available

\* Limits specified are based Environmental Protection and Management (Control of Noise at Construction Sites) Regulations.



**Table 20: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at N02**

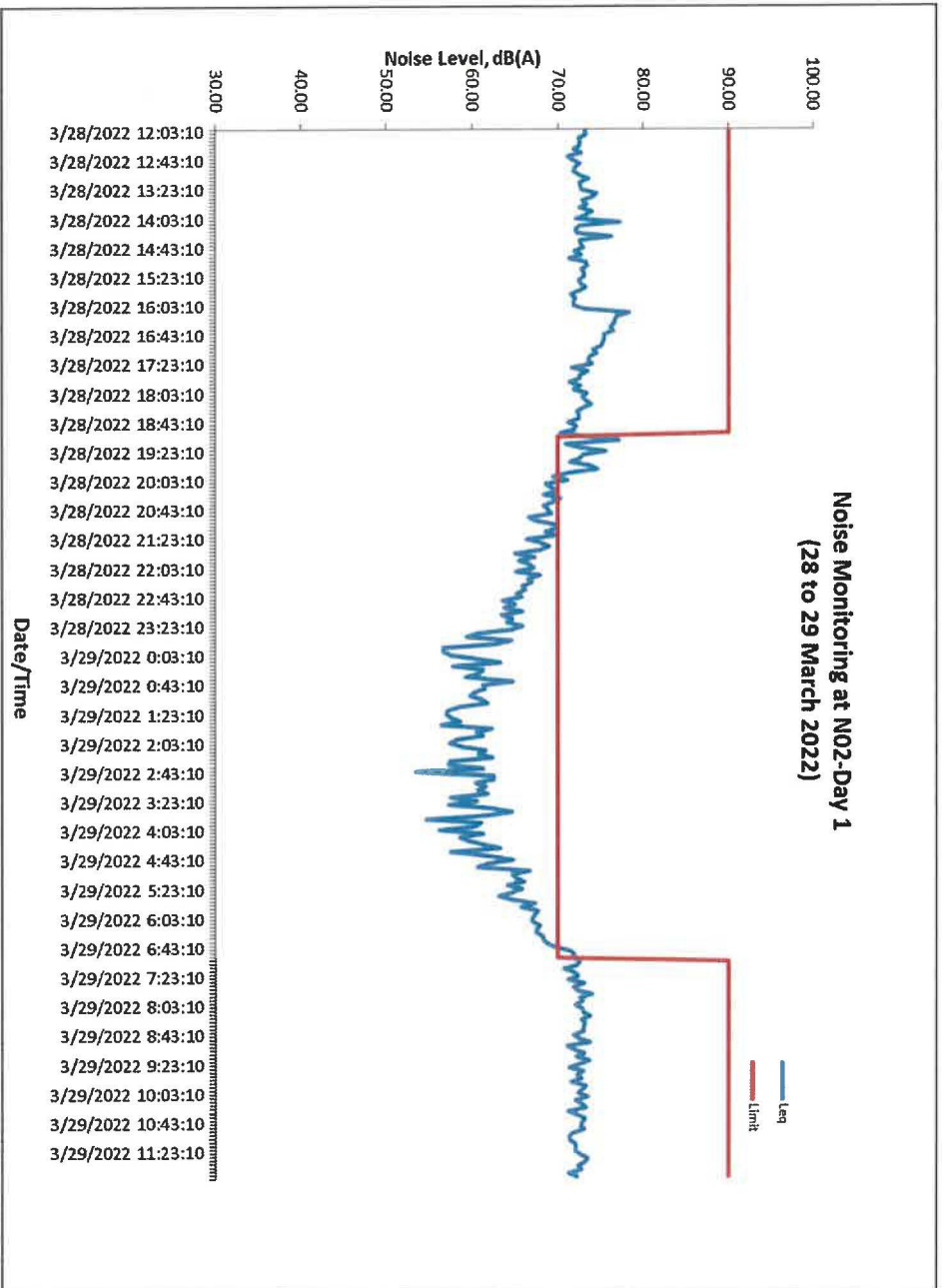
Duration (hr)	Day 7 (03 to 04 Apr 2022)	
	Noise levels Leq in dB (A)	“(c) Buildings (other than those in paragraphs (a) and (b))”
0700 – 0800	69.5	NA
0800 – 0900	73.8	
0900 – 1000	76.2	
1000 – 1100	73.9	
1100 – 1200	73.7	
1200 – 1300	69.8	
1300 – 1400	69.3	
1400 – 1500	75.3	
1500 – 1600	74.1	
1600 – 1700	70.0	
1700 – 1800	70.2	
1800 – 1900	69.9	
1900 – 2000	69.2	NA
2000 – 2100	67.5	
2100 – 2200	66.4	
2200 – 2300	65.8	NA
2300 – 0000	65.3	
0000 – 0100	63.5	
0100 – 0200	61.3	
0200 – 0300	60.5	
0300 – 0400	61.2	
0400 – 0500	58.5	
0500 – 0600	62.2	
0600 – 0700	65.5	

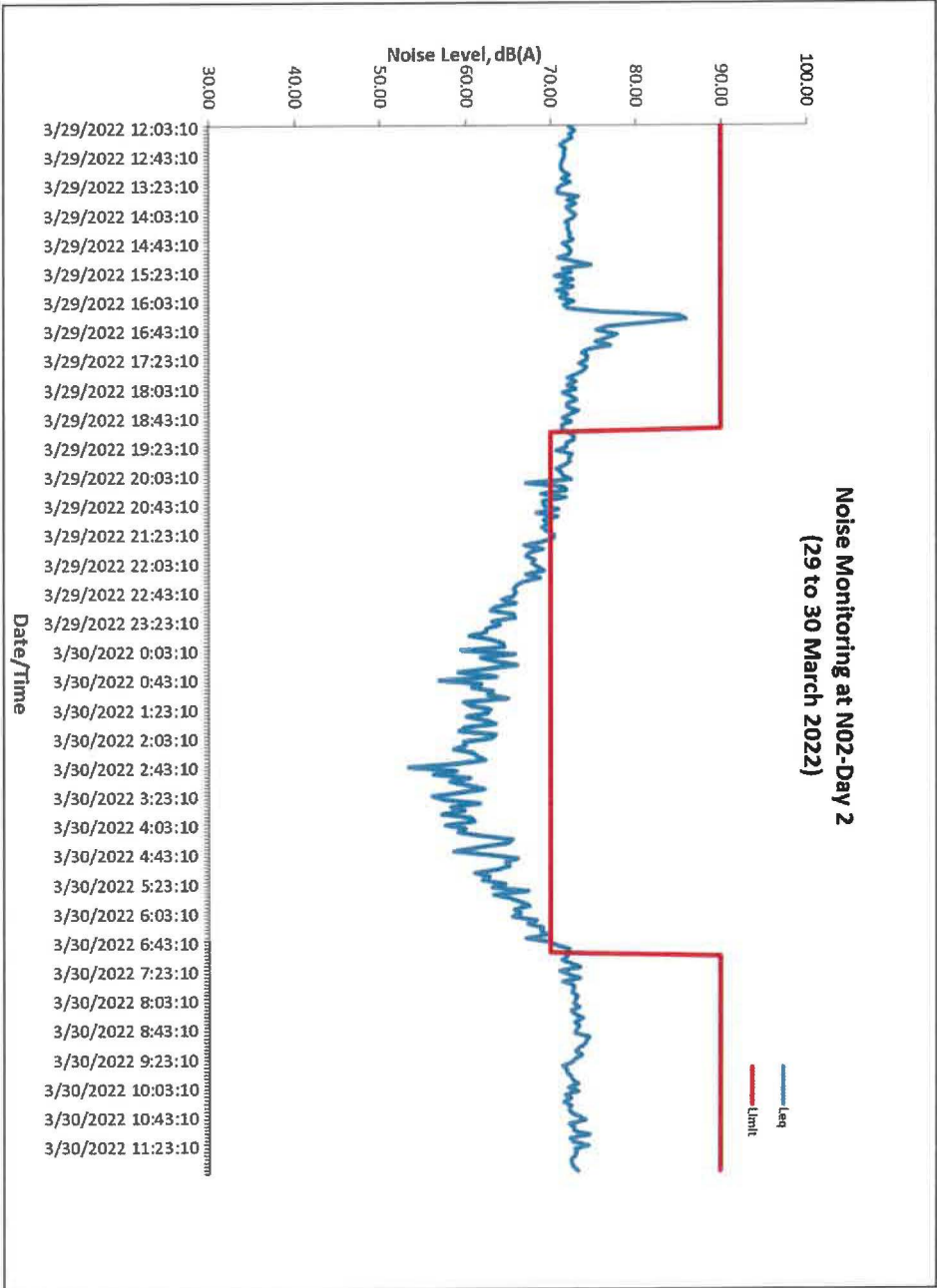
Remark: NA denote Not Available

\* Limits specified are based Environmental Protection and Management (Control of Noise at Construction Sites) Regulations.



Figure 2: Noise level measured at Point N02 (Day 1) reckoned as an equivalent continuous noise level over a period of 5 minutes

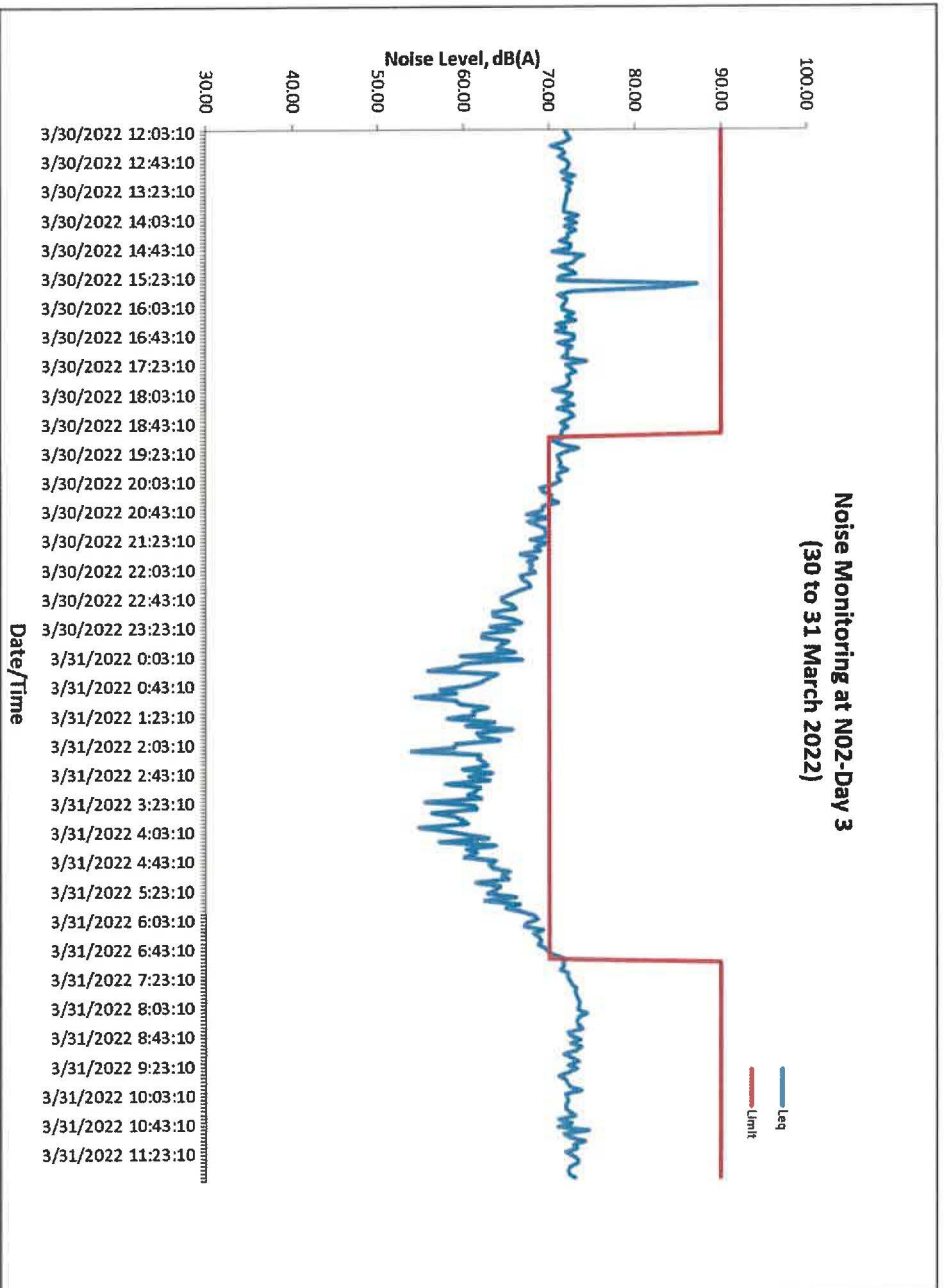




**Figure 3: Noise level measured at Point N02 (Day 2) reckoned as an equivalent continuous noise level over a period of 5 minutes**

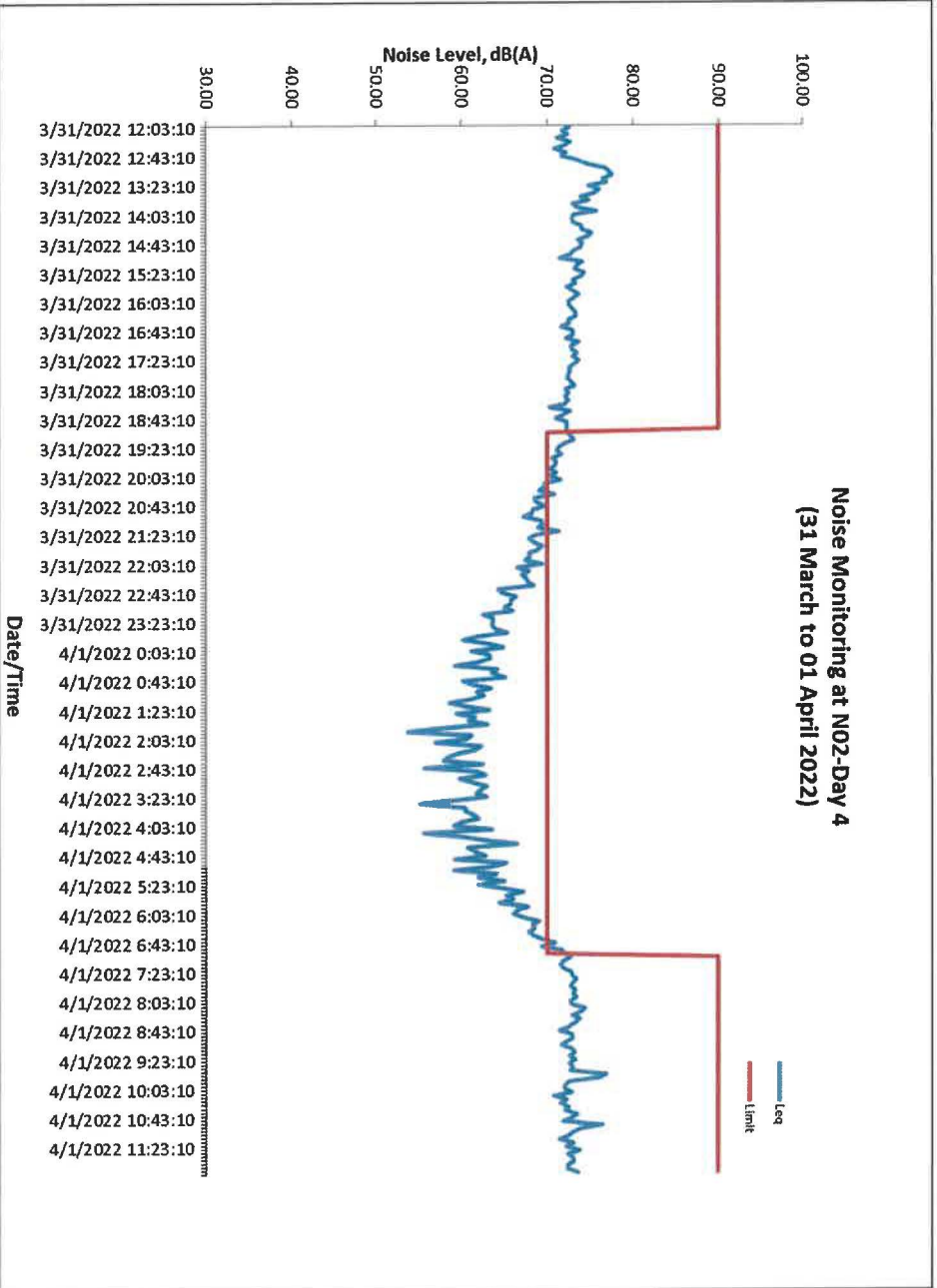






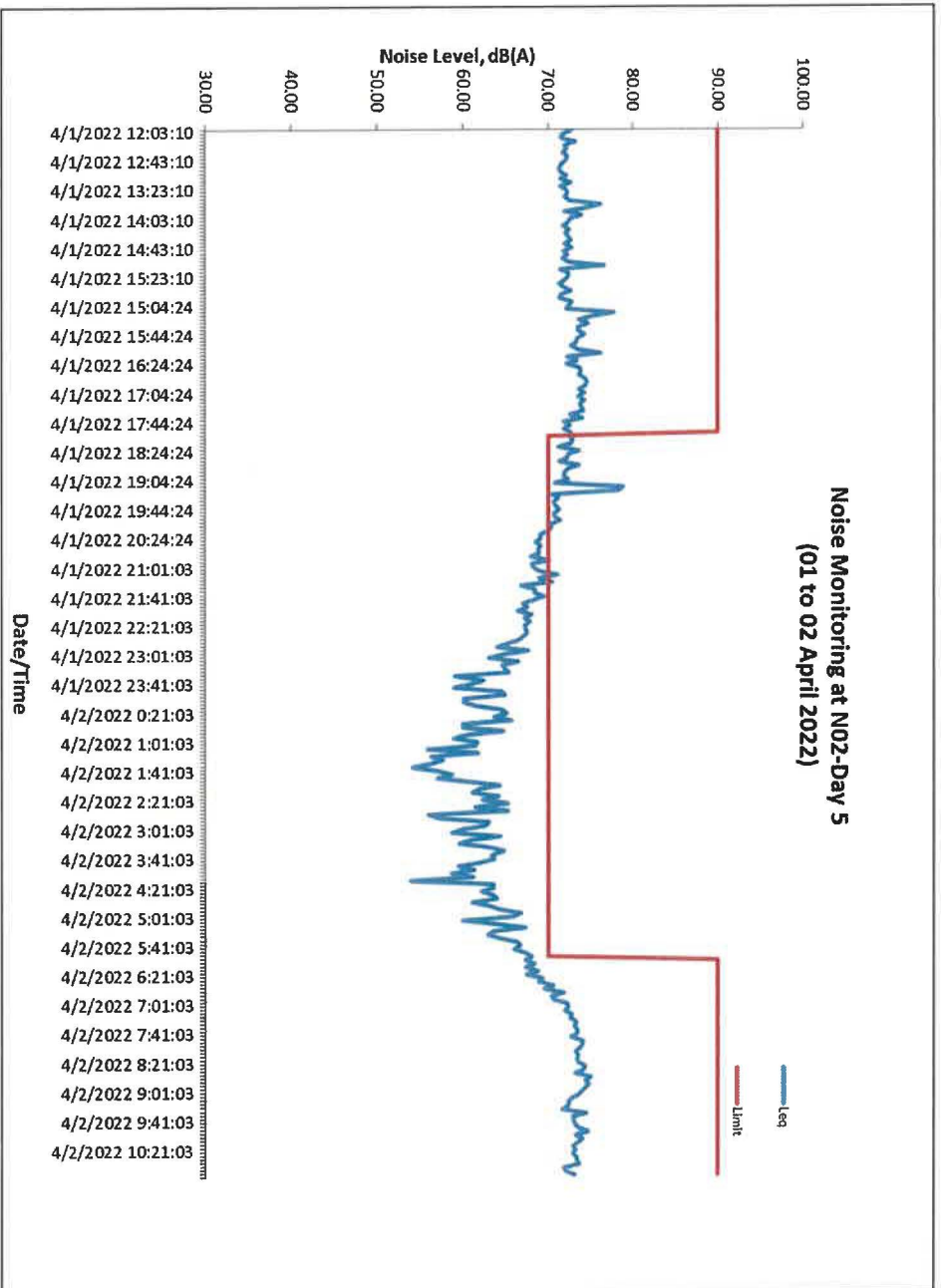
**Figure 4: Noise level measured at Point N02 (Day 3) reckoned as an equivalent continuous noise level over a period of 5 minutes**





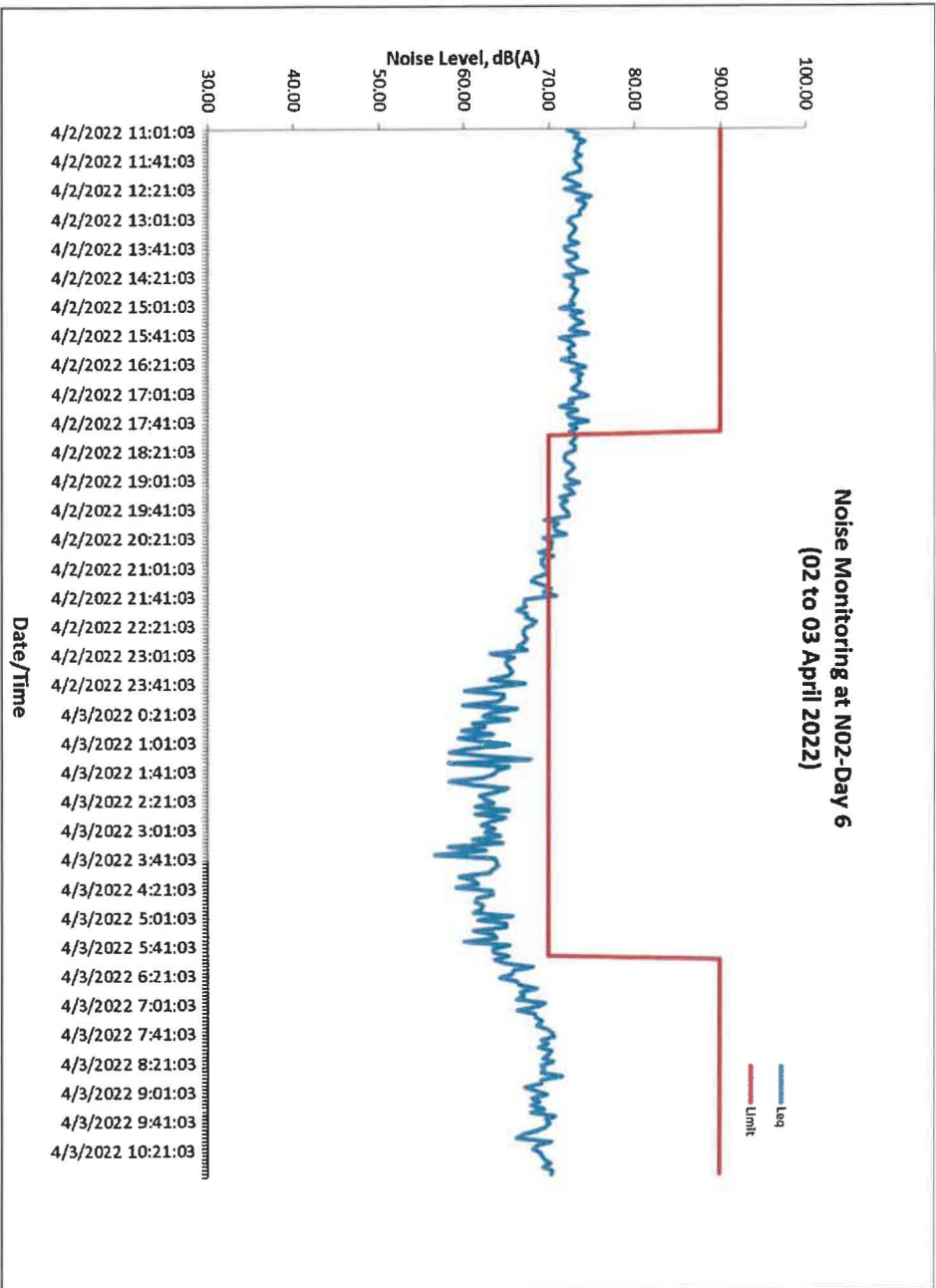
**Figure 5: Noise level measured at Point N02 (Day 4) reckoned as an equivalent continuous noise level over a period of 5 minutes**





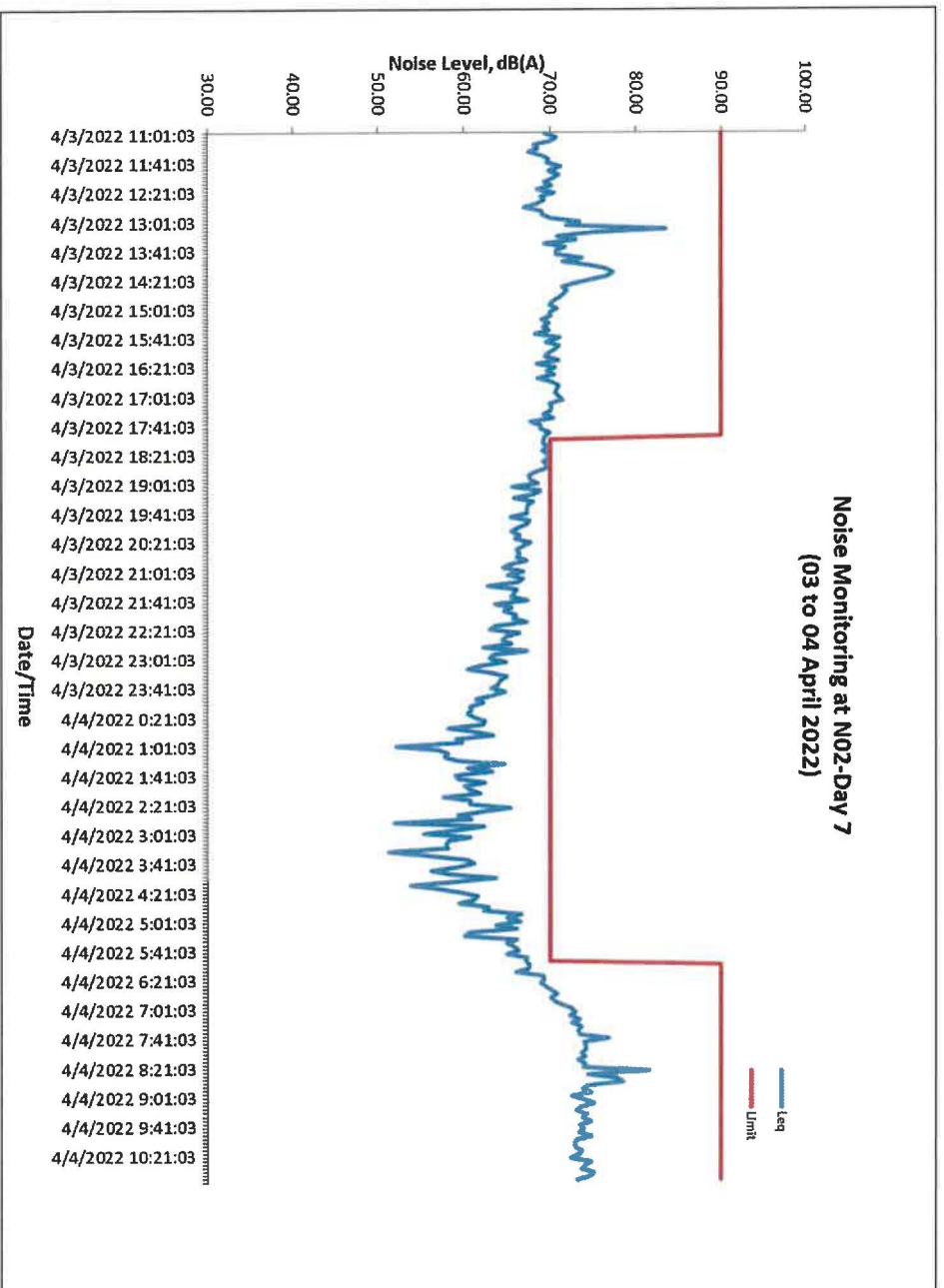
**Figure 6: Noise level measured at Point N02 (Day 5) reckoned as an equivalent continuous noise level over a period of 5 minutes**





**Figure 7: Noise level measured at Point N02 (Day 6) reckoned as an equivalent continuous noise level over a period of 5 minutes**





**Figure 8: Noise level measured at Point N02 (Day 7) reckoned as an equivalent continuous noise level over a period of 5 minutes**



#### 4.2 Noise Monitoring Results for N03, Along the Forest Strip at Wyn Construction site

**Table 21: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 12 hours at N03**

Monitoring ID	Monitoring Location	Monitoring Period	Noise levels Leq in dB (A)	
			7am – 7pm	7pm – 7am
N03	Along the Forest Strip at Wyn Construction site	Day 1 (28 to 29 Mar 2022)	65.5	61.1
		Day 2 (29 to 30 Mar 2022)	71.4	45.6
		Day 3 (30 to 31 Mar 2022)	66.1	44.7
		Day 4 (31 Mar to 01 Apr 2022)	65.9	52.1
		Day 5 (01 to 02 Apr 2022)	61.1	51.5
		Day 6 (02 to 03 Apr 2022)	56.6	44.9
		Day 7 (03 to 04 Apr 2022)	71.9	45.3
<b>Control of Noise at Construction Sites for “(c) Buildings (other than those in paragraphs (a) and (b))”</b>			75	65

Remarks: Maximum Permissible Noise Level (reckoned as equivalent continuous noise level over a period of 12 hours)



**Table 22: Range of noise level reckoned as an equivalent continuous noise level over a period of 5 minutes at N03**

Monitoring ID	Monitoring Location	Monitoring Period	Noise levels Leq in dB (A)					
			7am – 7pm		7pm – 10pm		10pm – 7am	
			Min	Max	Min	Max	Min	Max
N03	Along the Forest Strip at Wyn Construction site	Day 1 (28 to 29 Mar 2022)	42.1	82.4	38.5	<b>79.2</b>	33.1	63.7
		Day 2 (29 to 30 Mar 2022)	43.4	88.8	38.9	58.1	30.5	62.6
		Day 3 (30 to 31 Mar 2022)	42.5	84.2	38.9	51.3	32.7	59.6
		Day 4 (31 Mar to 01 Apr 2022)	41.2	83.9	38.5	57.3	34.7	64.4
		Day 5 (01 to 02 Apr 2022)	42.2	76.5	36.7	55.3	32.2	63.2
		Day 6 (02 to 03 Apr 2022)	40.0	71.3	37.6	54.5	33.1	62.7
		Day 7 (03 to 04 Apr 2022)	39.2	85.4	37.5	44.3	34.3	61.5
<b>Control of Noise at Construction Sites for “(c) Buildings (other than those in paragraphs (a) and (b))”</b>			90		70		70	

Remarks: Maximum Permissible Noise Level (reckoned as equivalent continuous noise level over a period of 5 minutes)

**Bold** denotes exceeded limits



**Table 23: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 5 minutes at N03 (Day 1)**

Day		Day 1																							
Date		28 March 2022												29 March 2022											
	Time (HR)	12PM	1PM	2PM	3PM	4PM	5PM	6PM	7PM	8PM	9PM	10PM	11PM	12AM	1AM	2AM	3AM	4AM	5AM	6AM	7AM	8AM	9AM	10AM	11AM
LEQ 5mins	0	46.0	51.5	62.3	57.6	64.3	58.4	58.1	79.2	50.6	63.4	38.0	38.0	35.6	35.5	34.9	35.0	35.0	34.8	36.2	45.7	52.7	51.4	50.4	54.0
	5	45.5	55.6	78.5	55.7	82.4	58.3	60.4	47.0	50.1	43.0	38.0	38.1	35.7	35.3	35.3	34.1	34.7	35.6	36.4	42.3	54.1	52.7	51.6	52.9
	10	44.7	57.3	64.4	53.2	78.2	61.9	55.6	47.1	52.0	41.3	38.6	38.0	36.4	35.3	36.2	37.2	34.3	35.3	36.4	46.6	56.7	52.7	50.7	51.9
	15	45.1	62.7	60.1	62.8	71.0	58.2	61.6	47.2	49.7	39.6	40.8	37.8	35.9	35.5	35.4	36.3	33.9	34.6	35.5	43.3	60.1	53.2	52.2	53.3
	20	44.0	71.1	53.8	57.2	70.3	57.7	60.0	76.4	46.5	45.0	38.7	39.8	35.0	35.4	35.6	34.3	34.1	34.7	35.6	42.1	59.5	51.4	52.0	52.0
	25	44.7	60.3	76.5	53.1	74.3	55.9	55.0	47.2	46.9	48.5	39.3	38.5	35.6	36.0	35.8	33.1	34.6	34.8	35.7	42.5	59.6	53.9	52.2	50.3
	30	44.6	61.2	58.0	56.8	70.8	55.5	58.0	48.9	45.8	51.4	38.9	38.9	35.8	35.1	35.7	34.2	34.2	34.9	59.4	47.7	57.7	54.5	55.9	53.3
	35	44.3	63.7	60.6	59.3	68.6	58.5	54.6	49.0	45.7	52.4	39.1	38.7	35.5	36.3	34.9	34.6	42.9	36.7	63.7	45.0	55.2	53.8	53.3	49.7
	40	44.3	62.3	56.1	60.6	67.6	54.8	49.2	75.8	47.4	47.1	38.4	45.5	35.7	36.3	35.1	33.3	34.3	36.0	55.8	42.8	58.3	53.1	53.9	48.7
	45	45.8	58.3	55.4	60.9	61.5	55.3	47.1	51.4	45.0	39.0	37.9	37.1	35.7	35.6	34.6	34.2	34.3	35.5	43.1	42.4	52.3	52.8	52.9	63.3
	50	52.2	61.0	53.4	62.9	56.6	55.2	46.6	51.7	41.2	38.5	38.7	36.0	35.7	35.6	35.6	35.4	35.8	35.8	40.9	47.8	54.8	53.2	56.8	46.5
55	49.8	66.5	56.1	64.8	63.9	58.1	49.4	53.2	43.8	38.7	40.9	35.6	35.3	35.2	37.6	35.6	35.5	35.9	48.9	59.0	54.9	51.7	54.6	45.3	
Maximum permitted noise level (reckoned as equivalent continuous noise level over 5 minutes) in decibels (A)		90	90	90	90	90	90	90	70	70	70	70	70	70	70	70	70	70	70	70	90	90	90	90	90

Remarks:

Limits specified are based Environmental Protection and Management (Control of Noise at Construction Sites) Regulations "(c) Buildings (other than those in paragraphs (a) and (b))"

Red filled denotes exceeded the limit.





**Table 24: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 5 minutes at N03 (Day 2)**

Day		Day 2																							
Date		29 March 2022												30 March 2022											
	Time (HR)	12PM	1PM	2PM	3PM	4PM	5PM	6PM	7PM	8PM	9PM	10PM	11PM	12AM	1AM	2AM	3AM	4AM	5AM	6AM	7AM	8AM	9AM	10AM	11AM
LEQ 5mins	0	45.3	53.4	50.7	51.5	58.6	58.4	56.8	47.1	45.8	39.5	38.5	35.4	41.0	35.6	32.5	30.5	36.0	34.7	36.5	43.9	54.0	64.9	46.8	55.5
	5	45.6	53.0	51.5	48.4	56.2	59.4	56.8	49.2	44.9	40.7	38.3	36.1	33.4	32.7	32.1	32.0	34.8	34.2	36.5	47.4	55.5	58.9	46.7	52.8
	10	45.1	54.2	54.7	48.8	69.9	55.9	56.1	48.6	43.8	42.1	38.7	35.7	32.9	31.0	34.9	33.0	35.0	35.0	37.0	47.2	52.8	63.8	52.1	51.4
	15	45.9	52.9	51.4	52.6	84.8	56.2	55.0	53.9	46.8	40.7	38.0	35.4	33.6	33.6	32.1	35.0	34.4	34.6	37.3	48.2	52.7	60.1	56.3	53.2
	20	46.7	54.6	52.5	54.9	88.8	56.9	64.6	58.1	45.8	44.6	36.2	35.1	33.5	34.1	34.5	35.6	35.1	35.6	37.8	45.6	53.4	52.8	56.1	51.6
	25	46.1	53.0	52.9	53.2	88.2	54.9	52.3	47.0	49.3	41.5	36.3	34.0	31.8	36.2	32.3	35.4	34.6	35.6	37.8	43.4	56.8	58.9	56.0	59.0
	30	45.2	53.5	52.4	59.8	81.2	56.9	55.1	47.3	52.0	44.4	37.5	33.7	35.5	34.7	32.9	35.8	33.5	36.4	43.9	43.4	54.6	57.1	53.4	60.8
	35	45.6	53.4	54.0	57.4	74.4	60.6	52.4	46.6	43.9	39.5	36.6	36.1	32.0	33.8	32.9	35.1	34.3	35.6	62.6	49.1	52.2	49.9	54.3	53.1
	40	45.8	56.3	57.2	58.0	75.5	58.9	58.9	45.0	42.6	39.4	36.1	33.3	31.6	33.3	35.1	35.4	34.3	36.1	55.1	47.3	52.9	52.6	53.6	60.8
	45	45.3	53.2	51.6	54.8	71.6	55.7	51.3	46.4	41.0	38.9	36.0	37.2	32.3	33.3	32.6	35.5	34.8	35.7	55.6	46.4	59.2	51.4	55.3	46.9
	50	44.6	50.5	52.7	55.8	63.8	55.1	50.6	49.0	40.3	39.1	36.7	33.4	31.2	32.8	33.4	35.8	35.1	36.4	53.8	49.6	54.8	54.0	50.6	45.0
55	49.6	57.4	49.2	56.1	58.1	55.8	49.6	44.3	41.4	39.0	36.7	34.2	34.9	33.3	32.6	35.4	34.2	37.3	46.6	49.5	54.0	49.9	53.0	45.7	
Maximum permitted noise level (reckoned as equivalent continuous noise level over 5 minutes) in decibels (A)		90	90	90	90	90	90	90	70	70	70	70	70	70	70	70	70	70	70	90	90	90	90	90	

**Remarks:**

Limits specified are based Environmental Protection and Management (Control of Noise at Construction Sites) Regulations “(c) Buildings (other than those in paragraphs (a) and (b))”



**Table 25: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 5 minutes at N03 (Day 3)**

Day		Day 3																							
Date		30 March 2022											31 March 2022												
	Time (HR)	12PM	1PM	2PM	3PM	4PM	5PM	6PM	7PM	8PM	9PM	10PM	11PM	12AM	1AM	2AM	3AM	4AM	5AM	6AM	7AM	8AM	9AM	10AM	11AM
LEQ 5mins	0	45.0	51.6	59.2	52.5	57.8	57.0	55.2	45.7	46.9	45.3	38.2	35.3	36.2	33.8	34.0	34.2	33.9	35.0	37.1	42.5	53.4	56.4	52.8	54.9
	5	62.1	53.7	84.2	51.4	59.1	55.6	58.0	45.1	46.7	48.3	38.2	35.4	35.4	33.9	33.4	33.6	35.3	34.8	36.9	44.5	58.4	56.4	50.9	51.8
	10	45.7	57.2	84.0	52.0	59.5	57.0	56.9	46.5	45.8	46.9	38.5	36.5	34.3	35.0	34.1	32.7	33.4	34.4	37.9	57.6	56.9	58.9	55.8	52.7
	15	44.6	55.3	54.3	53.4	57.5	59.5	57.8	46.8	46.3	50.0	37.9	35.5	33.8	34.3	35.8	33.1	33.3	37.7	36.5	47.8	59.5	59.8	59.2	53.4
	20	44.4	54.7	56.1	55.5	57.8	60.3	57.7	45.9	46.7	50.7	38.7	35.3	34.6	34.2	33.5	32.9	34.4	35.0	37.5	47.2	60.7	60.9	62.6	52.0
	25	46.1	55.9	57.3	52.8	56.4	58.2	55.5	47.4	45.0	47.5	38.1	34.4	34.5	35.1	34.3	33.4	34.9	35.8	39.2	44.6	60.5	60.2	60.0	56.6
	30	44.4	52.7	53.1	54.5	55.9	56.7	55.3	48.5	45.1	48.6	38.1	34.7	34.4	34.5	33.6	33.7	34.6	36.3	39.9	46.0	60.0	58.3	59.2	57.6
	35	44.5	52.4	55.7	57.2	53.9	56.8	56.3	51.3	45.9	47.9	36.1	34.3	34.2	34.4	33.7	34.1	52.2	35.9	56.3	46.7	58.5	60.9	60.3	57.5
	40	44.8	54.2	53.4	55.9	54.3	54.6	50.8	49.7	45.5	42.5	35.6	38.7	33.7	35.7	34.2	33.7	56.0	36.4	59.6	51.0	58.9	58.6	59.1	59.6
	45	44.5	63.9	52.7	55.7	57.1	56.3	48.5	50.3	46.9	39.1	35.4	39.1	34.3	34.4	34.6	34.2	32.9	35.7	43.4	47.7	59.7	58.7	57.6	56.0
	50	45.2	59.6	52.6	57.5	57.0	57.5	46.8	46.2	48.2	40.4	34.7	35.9	33.9	34.5	34.0	33.7	34.2	37.3	44.5	46.1	59.7	63.6	58.0	50.1
55	49.9	60.6	50.5	57.2	56.5	56.2	45.6	47.6	45.1	38.9	38.9	34.8	33.6	34.1	34.1	34.8	34.8	37.2	44.6	50.1	60.1	53.1	54.2	48.6	
Maximum permitted noise level (reckoned as equivalent continuous noise level over 5 minutes) in decibels (A)		90	90	90	90	90	90	90	70	70	70	70	70	70	70	70	70	70	70	70	90	90	90	90	90

Remarks:

Limits specified are based Environmental Protection and Management (Control of Noise at Construction Sites) Regulations "(c) Buildings (other than those in paragraphs (a) and (b))":



**Table 26: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 5 minutes at N03 (Day 4)**

Day		Day 4																							
Date		31 March 2022											01 April 2022												
	Time (HR)	12PM	1PM	2PM	3PM	4PM	5PM	6PM	7PM	8PM	9PM	10PM	11PM	12AM	1AM	2AM	3AM	4AM	5AM	6AM	7AM	8AM	9AM	10AM	11AM
LEQ 5mins	0	46.1	74.2	61.6	50.4	56.8	60.4	55.6	46.3	46.2	47.6	39.5	37.2	36.8	38.7	62.1	36.2	36.3	36.0	37.4	43.5	58.5	59.7	51.7	58.2
	5	47.5	74.1	60.9	51.4	54.9	58.0	52.7	48.4	45.2	45.3	38.9	38.4	38.4	37.9	62.3	35.6	35.9	36.6	38.1	41.2	61.2	59.6	50.6	57.2
	10	47.8	70.5	64.3	56.2	55.8	56.9	53.3	48.4	45.3	45.8	39.5	37.6	37.0	37.0	62.1	35.6	35.9	37.4	38.2	48.3	58.3	60.4	54.4	56.9
	15	45.1	65.8	63.4	56.8	58.7	56.0	57.1	47.5	49.5	48.0	39.6	36.7	37.7	37.2	61.8	36.1	36.0	38.1	39.4	44.8	54.9	57.8	57.4	56.7
	20	45.7	63.0	60.5	57.6	58.3	60.8	56.6	46.6	48.9	46.9	40.5	38.0	38.0	37.1	58.8	35.7	36.4	38.1	39.7	44.6	60.6	57.4	55.8	54.5
	25	45.9	61.3	60.9	59.4	57.7	62.1	56.4	45.4	48.7	46.4	40.9	36.7	38.3	37.4	34.7	35.4	36.1	37.9	44.9	43.3	58.2	57.0	58.1	56.4
	30	52.4	58.6	60.2	58.9	53.8	59.3	56.2	46.7	51.0	45.3	41.4	36.9	38.0	37.9	34.8	35.2	36.3	39.8	56.6	46.8	58.5	58.9	57.2	57.0
	35	53.5	59.8	57.7	57.6	57.7	59.3	55.7	48.7	50.9	46.8	40.0	36.8	38.1	37.7	35.4	35.7	37.3	37.7	63.0	47.1	60.1	75.5	57.2	56.1
	40	61.7	60.6	65.7	57.0	56.6	60.8	51.7	57.3	49.2	42.1	40.4	38.0	38.3	63.1	35.1	36.0	38.1	37.5	55.4	46.0	58.8	59.0	54.6	52.0
	45	68.3	63.2	56.4	56.1	57.2	54.5	47.2	46.9	51.4	40.2	38.9	36.6	37.5	63.0	35.9	35.8	37.4	37.2	62.0	46.3	56.1	76.5	53.7	48.2
	50	83.9	63.7	56.4	59.1	57.4	58.1	45.6	45.5	48.5	38.5	37.7	37.7	37.7	64.4	35.3	35.9	37.9	38.2	44.2	51.5	55.8	54.4	76.9	51.7
55	75.3	59.9	50.0	55.5	56.9	54.8	45.6	45.6	49.0	39.7	38.5	37.6	38.5	63.0	34.7	36.3	36.8	38.1	47.1	50.5	56.9	52.1	58.5	48.5	
Maximum permitted noise level (reckoned as equivalent continuous noise level over 5 minutes) in decibels (A)		90	90	90	90	90	90	90	70	70	70	70	70	70	70	70	70	70	70	70	90	90	90	90	90

Remarks:

Limits specified are based Environmental Protection and Management (Control of Noise at Construction Sites) Regulations "(c) Buildings (other than those in paragraphs (a) and (b))":

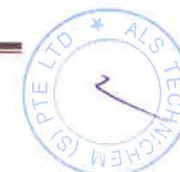


**Table 27: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 5 minutes at N03 (Day 5)**

Day		Day 5																							
Date		01 April 2022												02 April 2022											
	Time (HR)	12PM	1PM	2PM	3PM	4PM	5PM	6PM	7PM	8PM	9PM	10PM	11PM	12AM	1AM	2AM	3AM	4AM	5AM	6AM	7AM	8AM	9AM	10AM	11AM
LEQ 5mins	0	50.4	49.3	55.6	75.2	73.1	56.2	58.6	49.8	50.7	47.7	37.1	35.6	35.2	34.2	32.4	34.1	33.0	34.6	36.6	48.3	48.9	57.5	51.5	60.7
	5	52.3	53.1	56.8	49.7	57.4	57.2	59.9	48.4	49.7	49.3	37.2	35.9	34.8	33.6	33.1	33.9	62.0	35.0	36.6	42.4	52.3	58.3	49.5	55.1
	10	50.1	58.3	57.8	52.0	57.3	57.7	62.4	50.3	49.9	48.1	38.4	35.9	34.9	33.2	32.3	34.1	62.8	34.6	36.4	51.0	51.5	59.6	52.7	53.6
	15	46.5	57.6	59.8	54.4	56.4	59.7	58.6	52.9	47.3	45.1	38.8	35.7	35.2	33.5	33.1	34.2	63.2	34.5	36.0	50.6	53.0	57.6	60.5	55.0
	20	44.7	58.3	59.2	55.4	56.0	60.0	60.6	55.3	51.7	50.2	39.6	35.2	34.9	33.7	34.0	36.2	62.5	35.0	36.0	46.3	60.9	57.4	58.4	51.9
	25	44.4	57.1	60.1	55.1	57.5	57.3	60.6	52.6	50.5	49.2	38.7	34.4	35.2	33.7	33.3	34.9	62.6	35.1	37.5	45.9	56.7	56.8	60.7	51.8
	30	44.7	57.7	57.2	55.4	57.7	59.4	58.9	49.5	50.4	43.1	37.6	34.8	34.7	33.0	33.1	34.1	62.7	35.4	58.8	49.2	58.6	57.2	56.8	54.0
	35	44.9	57.2	54.2	55.7	57.8	58.5	55.0	48.2	47.5	45.8	36.4	34.7	34.4	32.7	32.9	33.5	62.9	35.3	62.8	42.2	56.2	56.7	59.5	57.1
	40	45.1	76.5	55.5	55.1	55.6	58.4	50.4	48.4	50.0	37.7	36.3	34.7	33.9	32.2	37.3	34.3	51.9	36.4	58.9	48.2	55.2	56.1	59.2	49.7
	45	45.3	71.3	55.0	67.5	54.4	58.6	49.7	50.5	47.5	37.8	36.7	35.2	34.1	32.2	38.2	34.0	41.2	36.4	42.2	52.8	58.9	56.3	55.3	48.4
	50	45.6	56.9	55.1	55.2	56.7	58.9	47.6	48.5	48.8	38.4	36.0	34.7	34.3	33.0	38.3	33.3	57.5	35.7	46.4	50.4	57.8	55.5	58.4	46.0
	55	49.3	54.5	49.1	68.8	55.8	59.4	49.2	48.2	45.4	36.7	36.6	34.5	33.9	32.7	36.4	34.1	34.3	36.8	43.7	47.8	58.9	53.7	58.3	48.9
Maximum permitted noise level (reckoned as equivalent continuous noise level over 5 minutes) in decibels (A)		90	90	90	90	90	90	90	70	70	70	70	70	70	70	70	70	70	70	70	90	90	90	90	90

**Remarks:**

Limits specified are based Environmental Protection and Management (Control of Noise at Construction Sites) Regulations "(c) Buildings (other than those in paragraphs (a) and (b))":



**Table 28: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 5 minutes at N03 (Day 6)**

Day		Day 6																							
Date		02 April 2022											03 April 2022												
	Time (HR)	12PM	1PM	2PM	3PM	4PM	5PM	6PM	7PM	8PM	9PM	10PM	11PM	12AM	1AM	2AM	3AM	4AM	5AM	6AM	7AM	8AM	9AM	10AM	11AM
LEQ 5mins	0	46.7	49.1	58.4	46.5	56.7	57.6	53.7	45.2	48.7	39.1	37.7	38.7	36.3	33.8	36.9	34.1	34.6	34.3	37.2	46.4	50.5	49.9	46.7	51.0
	5	45.2	51.8	54.8	48.2	57.7	60.0	51.9	50.1	48.4	38.4	38.1	37.3	36.2	34.3	35.6	35.0	34.6	36.3	35.6	43.8	50.4	51.3	46.5	50.8
	10	44.1	53.6	55.7	53.1	56.0	59.1	54.0	50.7	46.3	38.7	37.5	37.9	36.0	34.3	34.8	35.0	33.6	33.8	36.9	43.2	50.6	51.3	51.5	49.9
	15	44.2	53.9	54.8	59.7	58.5	57.7	50.6	50.0	47.2	39.2	37.4	37.1	36.1	35.0	34.3	35.2	34.8	34.0	35.3	46.0	51.5	48.0	48.2	48.5
	20	45.3	54.9	57.8	58.6	59.6	57.1	54.4	54.5	39.3	39.5	37.0	36.8	35.8	34.5	34.8	34.9	34.6	35.0	36.5	42.4	49.6	50.7	48.4	50.9
	25	45.1	56.6	57.9	59.3	57.4	57.1	57.3	48.6	38.5	39.2	38.2	36.6	35.4	34.7	34.1	34.0	33.5	34.5	36.4	40.0	49.7	52.0	49.2	57.0
	30	45.0	54.8	58.8	54.4	57.6	57.8	54.4	49.2	38.1	39.3	37.7	36.8	34.8	35.2	33.3	34.9	33.4	34.7	37.2	42.5	51.8	50.9	51.1	49.0
	35	45.2	57.0	58.1	55.4	71.0	56.0	54.3	50.5	40.5	39.5	37.8	37.2	34.3	35.5	34.2	34.8	33.1	34.2	38.3	42.4	50.8	50.0	48.9	49.9
	40	45.9	55.6	59.1	58.0	71.3	56.4	52.4	50.4	39.6	39.6	37.1	37.1	35.1	33.7	35.1	42.4	33.3	39.9	62.7	44.7	53.3	47.7	50.0	50.8
	45	44.8	55.9	55.6	58.5	59.3	57.6	50.3	45.9	38.9	38.9	38.2	36.6	33.9	33.8	35.1	39.3	34.5	35.3	56.9	43.7	50.4	50.8	50.0	47.8
	50	48.5	55.6	54.2	57.6	57.6	58.4	46.4	48.4	38.5	38.2	37.3	37.0	33.4	34.2	34.7	33.9	33.6	34.6	45.2	43.6	51.7	49.3	49.5	49.7
55	47.5	54.5	46.7	57.4	65.2	55.4	45.9	47.9	38.7	37.6	40.0	36.3	34.3	35.9	34.3	34.1	33.7	34.8	47.8	51.8	49.4	48.1	50.0	47.1	
Maximum permitted noise level (reckoned as equivalent continuous noise level over 5 minutes) in decibels (A)		90	90	90	90	90	90	90	70	70	70	70	70	70	70	70	70	70	70	90	90	90	90	90	

**Remarks:**

Limits specified are based Environmental Protection and Management (Control of Noise at Construction Sites) Regulations “(c) Buildings (other than those in paragraphs (a) and (b))”:



**Table 29: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 5 minutes at N03 (Day 7)**

Day		Day 7																							
Date		03 April 2022											04 April 2022												
	Time (HR)	12PM	1PM	2PM	3PM	4PM	5PM	6PM	7PM	8PM	9PM	10PM	11PM	12AM	1AM	2AM	3AM	4AM	5AM	6AM	7AM	8AM	9AM	10AM	11AM
LEQ 5mins	0	48.4	84.7	85.3	48.0	48.1	50.7	41.1	39.9	39.9	38.6	38.0	37.7	36.1	35.8	36.0	34.7	35.3	36.8	38.5	42.8	52.7	54.7	48.0	57.7
	5	46.2	79.1	84.5	49.7	47.3	52.6	41.5	38.6	39.2	38.6	37.1	37.2	35.8	35.6	34.8	35.3	36.3	36.2	38.2	41.8	54.7	53.7	49.2	54.4
	10	46.6	71.2	80.9	59.2	47.2	48.8	39.2	39.7	38.3	38.4	36.1	36.4	35.6	35.2	34.9	34.4	36.1	36.6	38.5	41.3	53.9	53.2	52.2	56.3
	15	44.8	66.3	74.3	62.1	47.5	48.6	43.4	44.3	38.8	38.7	37.3	36.5	37.4	36.3	35.7	35.9	37.6	37.3	39.4	45.6	79.3	57.3	53.6	53.9
	20	47.4	63.2	71.2	62.4	48.1	47.2	42.6	40.0	40.1	38.8	37.2	36.6	36.1	35.5	35.4	34.6	36.3	37.2	39.2	44.7	54.1	54.4	62.0	59.2
	25	49.5	65.5	65.8	61.8	48.5	47.1	44.4	38.5	39.8	38.3	36.4	36.7	35.1	36.8	35.4	34.3	35.1	36.9	40.7	45.0	74.4	66.8	53.9	56.4
	30	53.7	66.5	64.3	62.1	47.8	45.0	40.6	40.4	40.7	38.5	37.2	36.2	36.0	37.2	35.3	34.4	35.3	37.8	61.0	48.4	59.3	59.8	55.1	53.4
	35	49.2	75.8	54.9	59.2	46.7	45.1	42.3	38.5	38.3	38.2	36.6	39.8	36.1	36.5	36.0	35.1	34.7	37.7	61.1	45.2	75.0	61.2	56.8	54.5
	40	53.1	85.4	51.5	53.0	51.2	48.5	43.8	38.6	38.6	38.0	36.2	38.1	35.2	36.4	36.2	34.6	36.0	38.0	61.5	45.4	57.6	55.4	60.9	56.9
	45	62.8	79.7	49.8	48.6	54.6	40.6	42.9	37.9	38.9	38.4	37.2	36.1	34.8	35.0	36.0	34.9	36.2	38.6	47.5	47.0	58.2	56.4	57.7	51.1
	50	56.1	80.9	48.9	47.8	54.1	42.1	41.6	38.6	38.3	37.8	35.8	36.1	34.9	35.2	35.1	35.1	36.8	39.0	48.3	46.7	55.5	54.7	54.7	49.6
	55	69.4	84.2	50.0	47.7	47.2	41.6	39.9	38.7	38.9	37.5	35.9	35.7	35.2	35.1	34.8	34.8	37.1	38.6	47.4	48.1	55.3	55.0	58.8	52.2
Maximum permitted noise level (reckoned as equivalent continuous noise level over 5 minutes) in decibels (A)		90	90	90	90	90	90	90	70	70	70	70	70	70	70	70	70	70	70	70	90	90	90	90	90

**Remarks:**

Limits specified are based Environmental Protection and Management (Control of Noise at Construction Sites) Regulations “(c) Buildings (other than those in paragraphs (a) and (b))”:



**Table 30: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at N03**

Duration (hr)	Day 1 (28 to 29 Mar 2022)	
	Noise levels Leq in dB (A)	“(c) Buildings (other than those in paragraphs (a) and (b))”
0700 – 0800	49.7	NA
0800 – 0900	57.1	
0900 – 1000	53.0	
1000 – 1100	53.5	
1100 – 1200	54.8	
1200 – 1300	46.8	
1300 – 1400	63.8	
1400 – 1500	70.2	
1500 – 1600	60.2	
1600 – 1700	74.3	
1700 – 1800	57.8	
1800 – 1900	57.0	
1900 – 2000	71.7	NA
2000 – 2100	48.0	
2100 – 2200	53.5	
2200 – 2300	39.1	NA
2300 – 0000	39.4	
0000 – 0100	35.7	
0100 – 0200	35.6	
0200 – 0300	35.6	
0300 – 0400	34.9	
0400 – 0500	36.3	
0500 – 0600	35.4	
0600 – 0700	54.9	

Remark: NA denote Not Available

\* Limits specified are based Environmental Protection and Management (Control of Noise at Construction Sites) Regulations.



**Table 31: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at N03**

Duration (hr)	Day 2 (29 to 30 Mar 2022)	
	Noise levels Leq in dB (A)	“(c) Buildings (other than those in paragraphs (a) and (b))”
0700 – 0800	47.2	NA
0800 – 0900	54.9	
0900 – 1000	59.0	
1000 – 1100	53.8	
1100 – 1200	55.8	
1200 – 1300	46.1	
1300 – 1400	54.1	
1400 – 1500	53.1	
1500 – 1600	55.4	
1600 – 1700	82.1	
1700 – 1800	57.4	
1800 – 1900	57.2	
1900 – 2000	50.8	NA
2000 – 2100	46.2	
2100 – 2200	41.2	
2200 – 2300	37.2	NA
2300 – 0000	35.1	
0000 – 0100	34.7	
0100 – 0200	33.9	
0200 – 0300	33.3	
0300 – 0400	34.8	
0400 – 0500	34.7	
0500 – 0600	35.7	
0600 – 0700	53.7	

Remark: NA denote Not Available

\* Limits specified are based Environmental Protection and Management (Control of Noise at Construction Sites) Regulations.





**Table 32: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at N03**

Duration (hr)	Day 3 (30 to 31 Mar 2022)	
	Noise levels Leq in dB (A)	“(c) Buildings (other than those in paragraphs (a) and (b))”
0700 – 0800	49.9	NA
0800 – 0900	59.2	
0900 – 1000	59.5	
1000 – 1100	58.5	
1100 – 1200	55.3	
1200 – 1300	52.3	
1300 – 1400	57.7	
1400 – 1500	76.3	
1500 – 1600	55.1	
1600 – 1700	57.2	
1700 – 1800	57.4	
1800 – 1900	55.3	
1900 – 2000	48.0	NA
2000 – 2100	46.3	
2100 – 2200	47.0	
2200 – 2300	37.6	NA
2300 – 0000	36.1	
0000 – 0100	34.5	
0100 – 0200	34.5	
0200 – 0300	34.1	
0300 – 0400	33.7	
0400 – 0500	46.9	
0500 – 0600	36.1	
0600 – 0700	50.9	

Remark: NA denote Not Available

\* Limits specified are based Environmental Protection and Management (Control of Noise at Construction Sites) Regulations.



**Table 33: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at N03**

Duration (hr)	Day 4 (31 Mar to 01 Apr 2022)	
	Noise levels Leq in dB (A)	“(c) Buildings (other than those in paragraphs (a) and (b))”
0700 – 0800	47.1	NA
0800 – 0900	58.5	
0900 – 1000	68.6	
1000 – 1100	66.5	
1100 – 1200	55.4	
1200 – 1300	73.8	
1300 – 1400	68.2	
1400 – 1500	61.3	
1500 – 1600	57.0	
1600 – 1700	57.0	
1700 – 1800	59.0	
1800 – 1900	54.3	
1900 – 2000	49.6	NA
2000 – 2100	49.1	
2100 – 2200	45.3	
2200 – 2300	39.8	NA
2300 – 0000	37.4	
0000 – 0100	37.9	
0100 – 0200	58.7	
0200 – 0300	57.8	
0300 – 0400	35.8	
0400 – 0500	36.8	
0500 – 0600	37.8	
0600 – 0700	55.8	

Remark: NA denote Not Available

\* Limits specified are based Environmental Protection and Management (Control of Noise at Construction Sites) Regulations.



**Table 34: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at N03**

Duration (hr)	Day 5 (01 to 02 Apr 2022)	
	Noise levels Leq in dB (A)	“(c) Buildings (other than those in paragraphs (a) and (b))”
0700 – 0800	48.9	NA
0800 – 0900	56.9	
0900 – 1000	57.1	
1000 – 1100	57.8	
1100 – 1200	54.5	
1200 – 1300	47.9	
1300 – 1400	67.2	
1400 – 1500	57.1	
1500 – 1600	66.1	
1600 – 1700	63.3	
1700 – 1800	58.6	
1800 – 1900	58.2	
1900 – 2000	50.9	NA
2000 – 2100	49.5	
2100 – 2200	46.3	
2200 – 2300	37.6	NA
2300 – 0000	35.1	
0000 – 0100	34.6	
0100 – 0200	33.2	
0200 – 0300	35.2	
0300 – 0400	34.3	
0400 – 0500	60.6	
0500 – 0600	35.5	
0600 – 0700	54.7	

Remark: NA denote Not Available

\* Limits specified are based Environmental Protection and Management (Control of Noise at Construction Sites) Regulations.



**Table 35: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at N03**

Duration (hr)	Day 6 (02 Oct to 03 Apr 2022)	
	Noise levels Leq in dB (A)	“(c) Buildings (other than those in paragraphs (a) and (b))”
0700 – 0800	45.4	NA
0800 – 0900	51.0	
0900 – 1000	50.2	
1000 – 1100	49.4	
1100 – 1200	51.1	
1200 – 1300	45.8	
1300 – 1400	54.9	
1400 – 1500	56.8	
1500 – 1600	56.9	
1600 – 1700	64.7	
1700 – 1800	57.7	
1800 – 1900	53.2	
1900 – 2000	49.9	NA
2000 – 2100	44.0	
2100 – 2200	39.0	
2200 – 2300	37.9	NA
2300 – 0000	37.2	
0000 – 0100	35.2	
0100 – 0200	34.6	
0200 – 0300	34.9	
0300 – 0400	36.6	
0400 – 0500	34.0	
0500 – 0600	35.5	
0600 – 0700	53.1	

Remark: NA denote Not Available

\* Limits specified are based Environmental Protection and Management (Control of Noise at Construction Sites) Regulations.



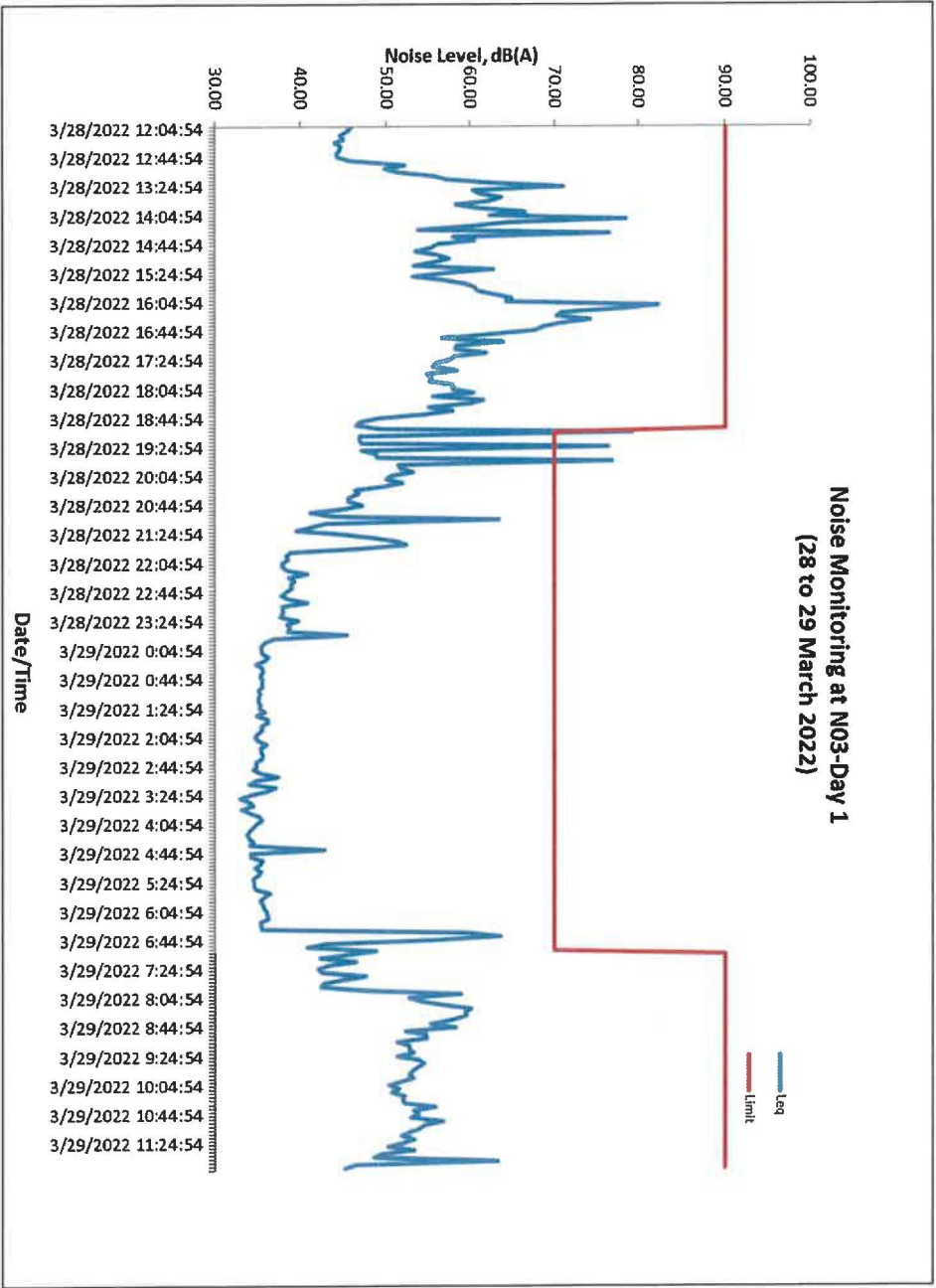
**Table 36: Summary of results for noise level reckoned as an equivalent continuous noise level over a period of 1 hour at N03**

Duration (hr)	Day 7 (03 to 04 Apr 2022)	
	Noise levels Leq in dB (A)	“(c) Buildings (other than those in paragraphs (a) and (b))”
0700 – 0800	45.7	NA
0800 – 0900	70.9	
0900 – 1000	59.2	
1000 – 1100	57.0	
1100 – 1200	55.4	
1200 – 1300	60.0	
1300 – 1400	80.2	
1400 – 1500	78.2	
1500 – 1600	58.6	
1600 – 1700	50.0	
1700 – 1800	47.8	
1800 – 1900	42.2	
1900 – 2000	39.9	NA
2000 – 2100	39.2	
2100 – 2200	38.3	
2200 – 2300	36.8	NA
2300 – 0000	37.1	
0000 – 0100	35.7	
0100 – 0200	35.9	
0200 – 0300	35.5	
0300 – 0400	34.9	
0400 – 0500	36.1	
0500 – 0600	37.6	
0600 – 0700	55.4	

Remark: NA denote Not Available

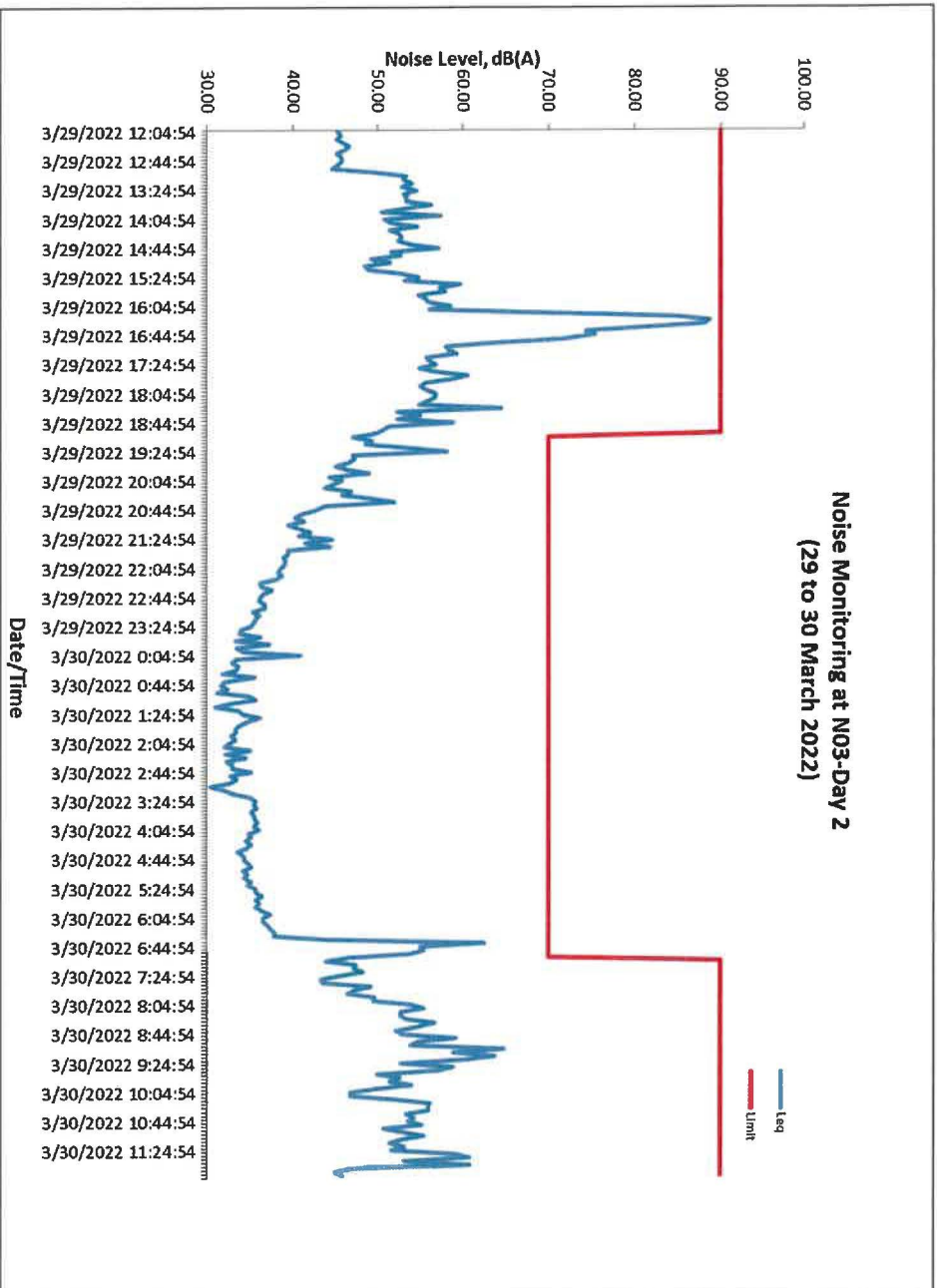
\* Limits specified are based Environmental Protection and Management (Control of Noise at Construction Sites) Regulations.





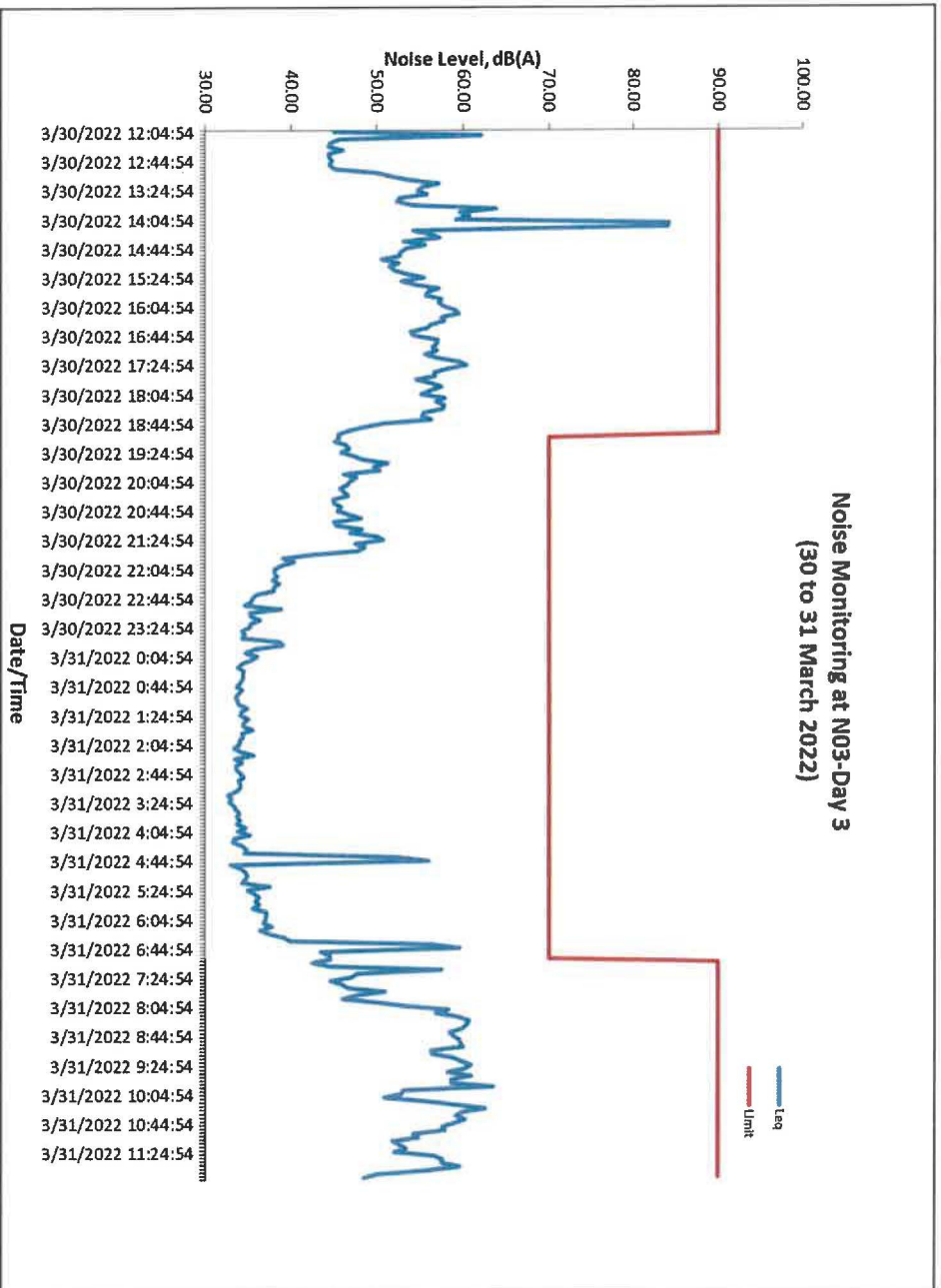
**Figure 9: Noise level measured at Point N03 (Day 1) reckoned as an equivalent continuous noise level over a period of 5 minutes**





**Figure 10: Noise level measured at Point N03 (Day 2) reckoned as an equivalent continuous noise level over a period of 5 minutes**

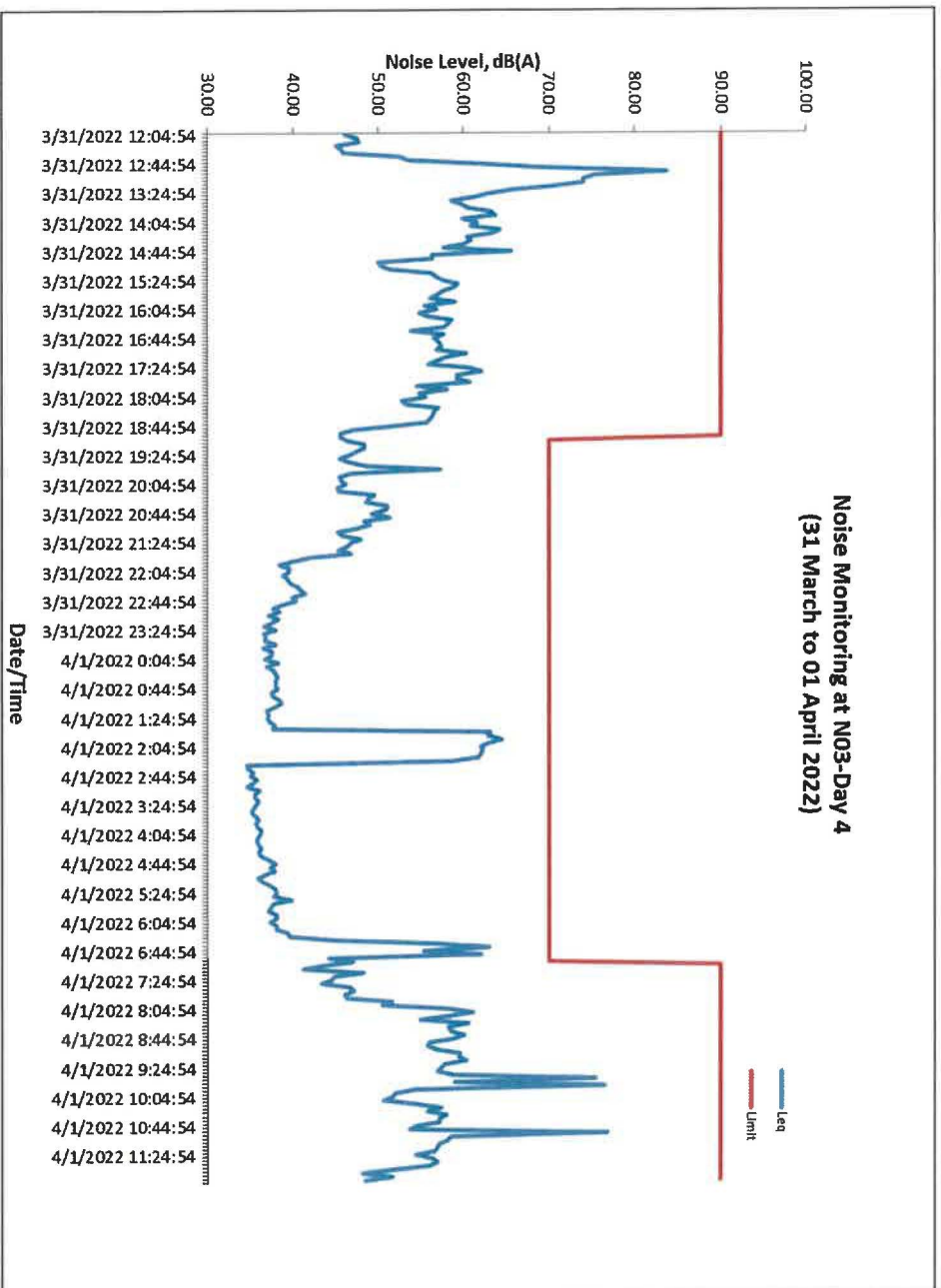




**Figure 11 : Noise level measured at Point N03 (Day 3) reckoned as an equivalent continuous noise level over a period of 5 minutes**

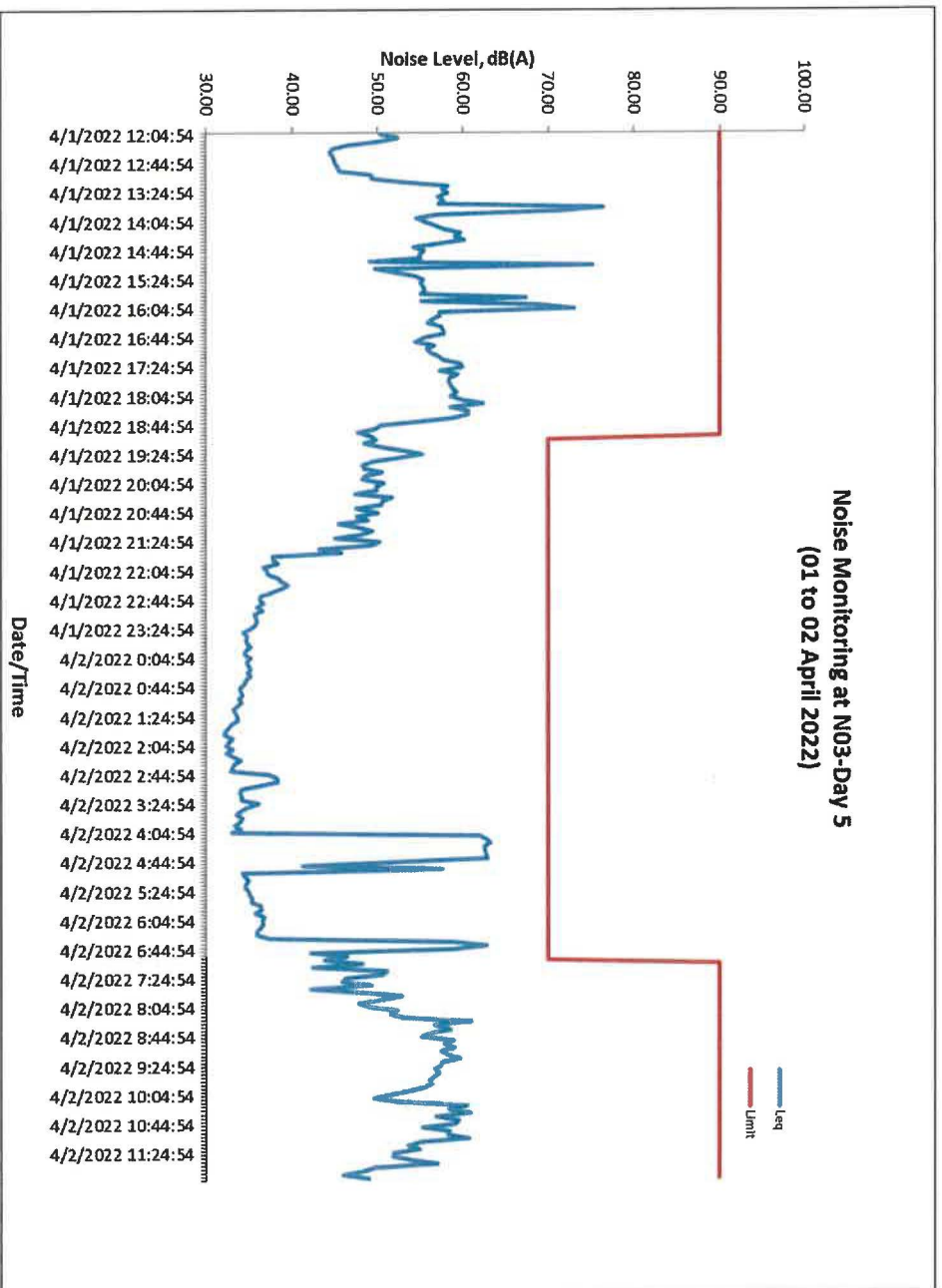






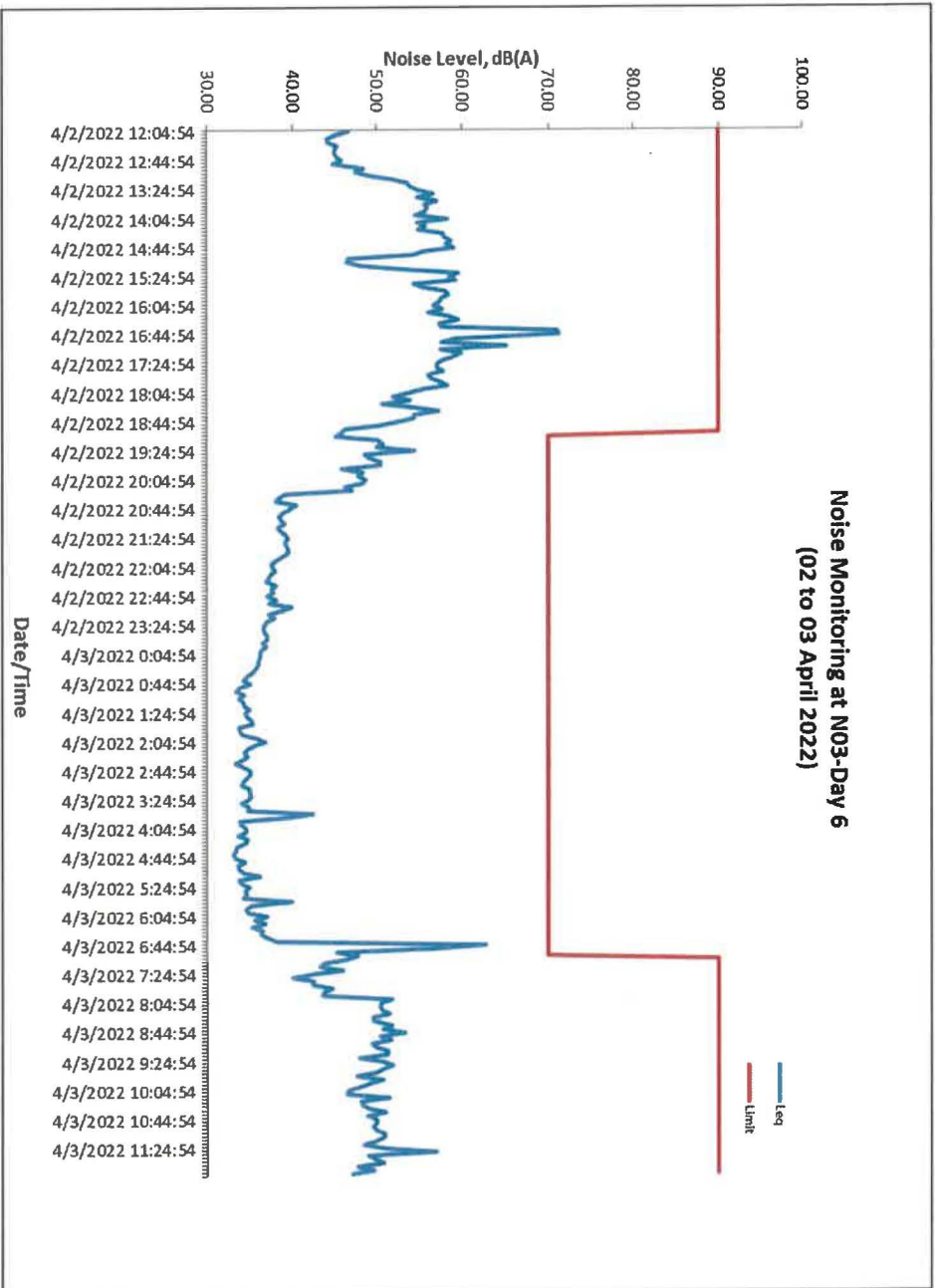
**Figure 12: Noise level measured at Point N03 (Day 4) reckoned as an equivalent continuous noise level over a period of 5 minutes**





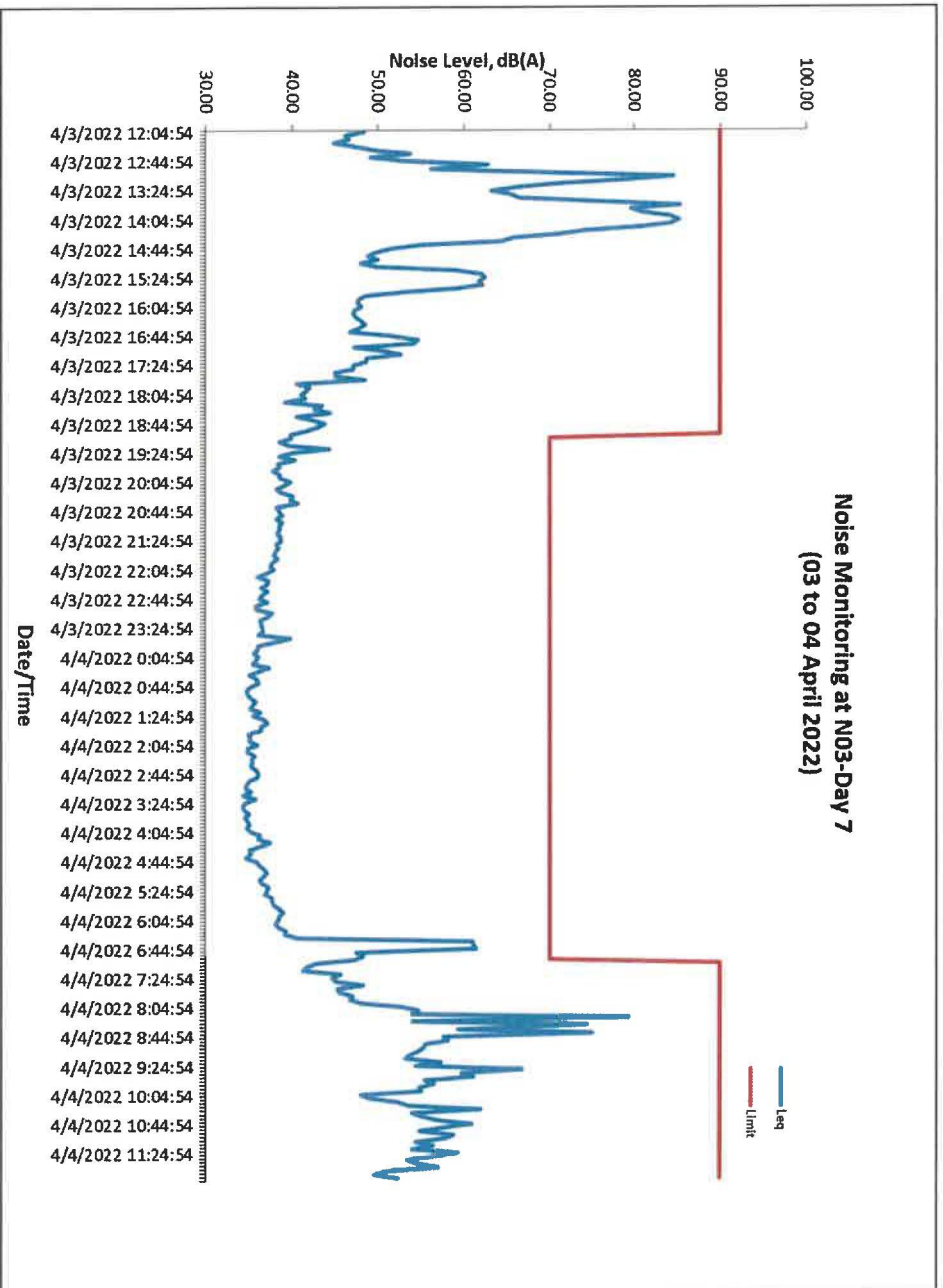
**Figure 13: Noise level measured at Point N03 (Day 5) reckoned as an equivalent continuous noise level over a period of 5 minutes**





**Figure 14: Noise level measured at Point N03 (Day 6) reckoned as an equivalent continuous noise level over a period of 5 minutes**





**Figure 15: Noise level measured at Point N03 (Day 7) reckoned as an equivalent continuous noise level over a period of 5 minutes**



## 5.0 EVALUATION AND DISCUSSION

The results obtained for all three (3) monitoring locations, N02, N03 and N06 are in compliance to the National Environmental Agency "the Maximum Permissible Noise Levels for Construction Work commenced on or after 1st October 2007, i.e. Second Schedule of the Environmental Protection and Management (Control of Noise at Construction Sites) Regulations, 2011 Revised Ed. except on certain days and time period as summarized in the table below

Currently, there is no limit available for equivalent continuous noise level over a period of 1 hour for this category.

Tables 37 Below summarizes the period of the monitoring results compared to Control of Noise at Construction Sites Regulations "(c) Buildings (other than those in paragraphs (a) and (b))":

**Table 37: Results Compared to Limits for Control of Noise at Construction Sites**

Category of Noise Regulated Period	Period	N02	N03
Reckoned as an equivalent continuous noise level over a period of 12 hours in decibels (A)	7am-7pm	No Exceedances	No Exceedances
	7pm-7am	Day 1 until Day 6 exceedance	No Exceedances
Reckoned as an equivalent continuous noise level over a period of 5 minutes) in decibels (A)	7am-7pm	No Exceedances	
	7pm-10pm	Day 1 until Day 6 exceedance	Day 1 exceedance
	10pm-7am	Day 1 until Day 6 exceedance	No Exceedances
Reckoned as an equivalent continuous noise level over a period of one hour) in decibels (A)	7am-7pm	No Available Limit	
	7pm-10pm		
	10pm-7am		

It should be noted that the Noise Monitoring project was carried out to the best of our knowledge and ability as well as responsibility towards the code of practice in the performance and reliability of our business to be accurate, precise and representative at the date/time and locations sampled so as to achieve a satisfactory baseline study.

## 6.0 REFERENCES

**National Environment Agency's (NEA) Environmental Protection & Management Act – Environmental Protection & Management (Control of Noise at Construction Sites) Regulations, 2011 Revised Ed.**

**Svantek SVAN 971 Sound Level Meter User Manual**



## Appendix A Calibration Certificates



### Calibration Certificate

Calibration Number: 220201170438

<b>Customer Name</b>	: Absolute Instrument Systems (Pte.) Ltd.	<b>Job Reference No:</b>	22020117
<b>Customer Address</b>	: 11 Kallang Place, #06-03 Singapore 339155	<b>Certificate Issue Date:</b>	16/02/2022
<b>Manufacturer</b>	: Svantek	<b>Calibration Date:</b>	16/02/2022
<b>Item Description</b>	: Octave Band Filter	<b>Test Conditions:</b>	
<b>Model Number</b>	: SVAN 971 (1/1 & 1/3 Octave Band Filter)	<b>Ambient Temperature:</b>	23.4 °C
<b>Serial Number</b>	: 55465	<b>Relative Humidity:</b>	62 %R.H.
<b>Sub-Assemblies S/N</b>	: SV18 57139/ 7052E 63284	<b>Pressure:</b>	100.3 kPa

This certificate provides traceability of measurement to the International System of Units (SI). Absolute Laboratories Pte. Ltd. certifies that the above product listed was calibrated in compliance with a quality management system using the applicable and approved Absolute Laboratories Pte. Ltd. calibration procedures as specified.

The reported expanded uncertainty is based on the standard uncertainty multiplied by a factor  $k = 2$  (degrees of freedom =  $\infty$ ), which corresponds to a level of confidence of approximately 95%.

**Calibration Method:**

The instrument was calibrated following AL calibration procedure WI- 19-Rev-1

Calibration Equipment(s) Used			
Apparatus	Serial Number	Cal Due Date	Certificate Number
Arbitrary Function Generator	C015037	24/04/2022	SST/SA/R/2021D/1522

**Ambient Condition Range:**

Temperature: (20-26)°C , Humidity: (25-70)%RH, Pressure: (80-105)kPa

**Calibration By :**

  
Han Chun Keong  
Calibration Officer

**Reviewed/ Approved By :**

  
Rodrigo Manansala  
Approving Officer

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Absolute Laboratories Pte. Ltd. is an affiliated company of Absolute Instrument Systems (Pte.) Ltd.

WI-19-CR-1-Rev-0

Absolute Laboratories Pte. Ltd.  
11 Kallang Place #06-02 Singapore 339155  
Tel: 65 6296 8012 Fax: 65 6296 3242

1 of 3





## Calibration Certificate

Calibration Number: 210501891269

**Customer Name** : Absolute Instrument Systems (Pte.) Ltd. **Job Reference No:** 21050189  
**Customer Address** : 11 Kallang Place, #06-03 **Certificate Issue Date:** 03/06/2021  
Singapore 339155  
**Manufacturer** : Svantek **Calibration Date:** 03/06/2021  
**Item Description** : Octave Band Filter **Test Conditions:**  
**Model Number** : SVAN 971 (1/1 & 1/3 Octave Band Filter) **Ambient Temperature:** 24 °C  
**Serial Number** : 56909 **Relative Humidity:** 55 %R.H.  
**Sub-Assemblies S/N** : SV18 78802/ 7052E 80156 **Pressure:** 101.5 kPa

This certificate provides traceability of measurement to the International System of Units (SI).  
Absolute Laboratories Pte. Ltd. certifies that the above product listed was calibrated in compliance with  
a quality management system using the applicable and approved Absolute Laboratories Pte. Ltd.  
calibration procedures as specified.

The reported expanded uncertainty is based on the standard uncertainty multiplied by a  
factor  $k = 2$  (degrees of freedom =  $\infty$ ), which corresponds to a level of confidence of approximately 95%.


### Calibration Method:

The instrument was calibrated following AL calibration procedure WI- 19-Rev-1

Calibration Equipment(s) Used			
Apparatus	Serial Number	Cal Due Date	Certificate Number
Arbitrary Function Generator	C012134	22/06/2021	RL002174

Ambient Condition Range:  
Temperature: (20-26)°C , Humidity: (25-70)%RH, Pressure: (80-105)kPa

Calibration By :

  
Tiong Bang Xiang  
Calibration Officer

Reviewed/Approved By :

  
Rodrigo Manansala  
Approving Officer

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Tel: 65 6296 8012 Fax: 65 6296 3242

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ATS ENV 3456

### Calibration Certificate

Calibration Number: 210700291590

**Customer Name** : ALS Technichem (Singapore) Pte Ltd  
**Customer Address** : 121 Genting Lane,  
 #04-01 ALS Building  
 Singapore 349572  
**Manufacturer** : Quest Technologies  
**Item Description** : Sound Level Meter Class I  
**Model Number** : SP-DL-1  
**Serial Number** : BLK030008  
**Sub-Assemblies S/N** : 4936 2819034

**Job Reference No:** 21070029  
**Certificate Issue Date:** 15/07/2021  
**Calibration Date:** 06/07/2021  
**Test Conditions:**  
**Ambient Temperature:** 24 °C  
**Relative Humidity:** 57 %R.H.  
**Pressure:** 101.3 kPa

This certificate provides traceability of measurement to the International System of Units (SI). Absolute Laboratories Pte. Ltd. certifies that the above product listed was calibrated in compliance with a quality management system using the applicable and approved Absolute Laboratories Pte. Ltd. calibration procedures as specified.

The reported expanded uncertainty is based on the standard uncertainty multiplied by a factor  $k = 2$  (degrees of freedom =  $\infty$ ), which corresponds to a level of confidence of approximately 95%.

**Calibration Method:**

The instrument was calibrated following AL calibration procedure WI- 23-Rev-1

Calibration Equipment(s) Used			
Apparatus	Serial Number	Cal Due Date	Certificate Number
Digital Multimeter	MY57230283	21/09/2021	1-13212653810-1
Sound Source	KZF070009	20/05/2022	210501021186
Callibrator	QOG060008	12/09/2021	891941 QOG060008
Arbitrary Function Generator	C015037	24/04/2022	SST/SA/R/2021D/1522

Ambient Condition Range:  
 Temperature: (20-26)°C , Humidity: (25-70)%RH, Pressure: (80-105)kPa

Calibration By :   
 Ang Siong Cheaw  
 Calibration Officer

Reviewed/Approved By :   
 Rodrigo Mariansala  
 Approving Officer

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WI-23-CR-1-Rev-1

Absolute Laboratories Pte. Ltd.  
 11 Kallang Place #06-02 Singapore 339155  
 Tel: 65 6296 8012 Fax: 65 6296 3242

1 of 3



14 Jul 2021





## Appendix B Photos of the Noise Monitoring Set-up



**N02**





**N03**



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## **APPENDIX 9.2 AIRBORNE NOISE MODELLING RESULTS**

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**Table 1: Impact Significance for Unmitigated Scenario during Construction at the Proposed Temporary Staging/ Launching Area and Integrated Project Substation (with O&M Facility)**

ID	Receptors	Applicable Criteria, dB(A)					Predicted Noise Levels, dB(A)					Exceedance of Criteria, dB(A)				
		Leq,5min			Leq,12hr		Leq,5min			Leq,12hr		Leq,5min			Leq,12hr	
		D	E	N	D	N	D	E	N	D	N	D	E	N	D	N
NSR1	Star Sin Trading Pte Ltd	90	70	70	75	65	85	85	85	85	85	-5	15	15	10	20
NSR2	Ley Choon Group Holding	90	70	70	75	65	73	73	73	73	73	-17	3	3	-2	8
NSR3	Eng Hua Furniture Manufacturing Pte Ltd	90	70	70	75	65	76	76	76	76	76	-14	6	6	1	11
NSR4	Eng Seng Cement Products Pte Ltd	90	70	70	75	65	76	76	76	76	76	-14	6	6	1	11
<b>Impact Significance, considering construction duration will be greater than 1 month exposure</b>											<b>Negligible Impact Significance:</b> Considering Negligible impact magnitude [0 – 2 dB(A) exceedance]			<b>Minor Impact Significance:</b> Considering Small impact magnitude [3 – 5 dB(A) exceedance]		
											<b>Moderate Impact Significance:</b> Considering Medium impact magnitude [6 - 9 dB(A) exceedance]			<b>Major Impact Significance:</b> Considering Large impact magnitude [10 dB(A) or greater exceedance]		
<p>Notes:</p> <p>(a) In the case of Leq,5min criteria, Day is defined as 7 am – 7 pm; Evening is defined as 7 pm – 10 pm; and Night is defined as 10 pm – 7 am, according to the Environmental Protection and Management (Control of Noise At Construction Sites) Regulations.</p> <p>(b) In the case of Leq,12hr criteria, Day is defined as 7 am – 7 pm; Night is defined as 7 pm – 7 am, according to the Environmental Protection and Management (Control of Noise At Construction Sites) Regulations.</p> <p>(c) Only impacts to the nearest noise sensitive receptors have been assessed. Further details are provided in <i>Section 9.5.1</i>.</p>																

**Table 2: Impact Significance for Mitigated Scenario during Construction at the Proposed Temporary Staging/ Launching Area and Integrated Project Substation (with O&M Facility)**

ID	Receptors	Applicable Criteria, dB(A)					Predicted Noise Levels, dB(A)					Exceedance of Criteria, dB(A)				
		Leq,5min			Leq,12hr		Leq,5min			Leq,12hr		Leq,5min			Leq,12hr	
		D	E	N	D	N	D	E	N	D	N	D	E	N	D	N
NSR1	Star Sin Trading Pte Ltd	90	70	70	75	65	70	70	70	70	70	-20	0	0	-5	5
NSR2	Ley Choon Group Holding	90	70	70	75	65	66	66	66	66	66	-24	-4	-4	-9	1
NSR3	Eng Hua Furniture Manufacturing Pte Ltd	90	70	70	75	65	68	68	68	68	68	-22	-2	-2	-7	3
NSR4	Eng Seng Cement Products Pte Ltd	90	70	70	75	65	68	68	68	68	68	-22	-2	-2	-7	3
<b>Impact Significance, considering construction duration will be greater than 1 month exposure</b>											<b>Negligible Impact Significance:</b> Considering Negligible impact magnitude [0 – 2 dB(A) exceedance]			<b>Minor Impact Significance:</b> Considering Small impact magnitude [3 – 5 dB(A) exceedance]		
											<b>Moderate Impact Significance:</b> Considering Medium impact magnitude [6 - 9 dB(A) exceedance]			<b>Major Impact Significance:</b> Considering Large impact magnitude [10 dB(A) or greater exceedance]		
<p>Notes:</p> <p>(a) The results above are for the mitigated scenario where temporary 4 meter-high noise barriers will be installed along the northern, eastern and southern boundaries.</p> <p>(b) In the case of Leq,5min criteria, Day is defined as 7 am – 7 pm; Evening is defined as 7 pm – 10 pm; and Night is defined as 10 pm – 7 am, according to the Environmental Protection and Management (Control of Noise At Construction Sites) Regulations.</p> <p>(c) In the case of Leq,12hr criteria, Day is defined as 7 am – 7 pm; Night is defined as 7 pm – 7 am, according to the Environmental Protection and Management (Control of Noise At Construction Sites) Regulations.</p> <p>(d) Only impacts to the nearest noise sensitive receptors have been assessed. Further details are provided in <i>Section 9.5.1</i>.</p>																

**Table 3: Impact Significance for Unmitigated Scenario during Construction in Reservoir**

ID	Receptors	Applicable Criteria, dB(A)					Predicted Noise Levels, dB(A)					Exceedance of Criteria, dB(A)				
		Leq,5min			Leq,12hr		Leq,5min			Leq,12hr		Leq,5min			Leq,12hr	
		D	E	N	D	N	D	E	N	D	N	D	E	N	D	N
NSR5	NSRCC Kranji Sanctuary Golf Course	90	70	70	75	65	70	70	70	70	70	-20	0	0	-5	5
NSR6	FMB Trading and Engineering Pte Ltd	90	70	70	75	65	69	69	69	69	69	-21	-1	-1	-6	4
<b>Impact Significance, considering construction duration will be greater than 1 month exposure</b>											<b>Negligible Impact Significance:</b> Considering Negligible impact magnitude [0 – 2 dB(A) exceedance]			<b>Minor Impact Significance:</b> Considering Small impact magnitude [3 – 5 dB(A)exceedance]		
											<b>Moderate Impact Significance:</b> Considering Medium impact magnitude [6 - 9 dB(A) exceedance]			<b>Major Impact Significance:</b> Considering Large impact magnitude [10 dB(A) or greater exceedance]		
<p>Notes:</p> <p>(a) In the case of Leq,5min criteria, Day is defined as 7 am – 7 pm; Evening is defined as 7 pm – 10 pm; and Night is defined as 10 pm – 7 am, according to the Environmental Protection and Management (Control of Noise At Construction Sites) Regulations.</p> <p>(b) In the case of Leq,12hr criteria, Day is defined as 7 am – 7 pm; Night is defined as 7 pm – 7 am, according to the Environmental Protection and Management (Control of Noise At Construction Sites) Regulations.</p> <p>(c) Only impacts to the nearest noise sensitive receptors have been assessed. Further details are provided in <i>Section 9.5.1</i>.</p>																

**Table 4: Impact Significance for Unmitigated Scenario during Operation of Intergrated Project Substation (with O&M Facility)**

Boundary of Intergrated Project Substation (and O&M Facility)	Applicable Criteria, dB(A)			Predicted Noise Levels, dB(A)			Exceedance of Criteria, dB(A)			
	Leq,5min			Leq,5min			Leq,5min			
	D	E	N	D	E	N	D	E	N	
North	75	70	65	45	45	45	-30	-25	-20	
South	75	70	65	26	26	26	-49	-44	-39	
East	75	70	65	54	54	54	-21	-16	-11	
West	75	70	65	23	23	23	-52	-47	-42	
Note: (a) In the case of Leq,5min criteria, Day is defined as 7 am – 7 pm; Evening is defined as 7 pm – 11 pm; and Night is defined as 11 pm – 7 am, according to the Environmental Protection and Management (Boundary Noise Limits for Factory Premises) Regulations.							<b>Negligible Impact Significance:</b> Considering Negligible impact magnitude [at or < 0 dB(A) exceedance]		<b>Minor Impact Significance:</b> Considering Small impact magnitude [up to 3 dB(A) exceedance]	
							<b>Moderate Impact Significance:</b> Considering Medium impact magnitude [between 3 - 10 dB(A) exceedance]		<b>Major Impact Significance:</b> Considering Large impact magnitude [>10 dB(A) or greater exceedance]	

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**APPENDIX 10.1 STAGING/ LAUNCHING AREA AND INTEGRATED  
PROJECT SUBSTATION – PHOTOLOG & HISTORICAL  
MAPS**

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## APPENDIX 10.1: PROPOSED TEMPORARY STAGING/ LAUNCHING AREA & INTEGRATED PROJECT SUBSTATION – PHOTOLOG & HISTORICAL MAPS

Table 1: Proposed Temporary Staging/ Launching Area and Integrated Project Substation Worksite – Photolog of Surroundings



Northern Portion (as of 14 April 2022)	
Star Sin Trading Pte Ltd (10 Sungei Kadut Drive)	Fastweld Engineering Construction Pte Ltd (2 Kranji Link)
	
Northeastern Portion (as of 14 April 2022)	
Ley Choon Group (3 Sungei Kadut Drive)	Eng Seng Cement Products Pte Ltd (7 Sungei Kadut Drive)
	

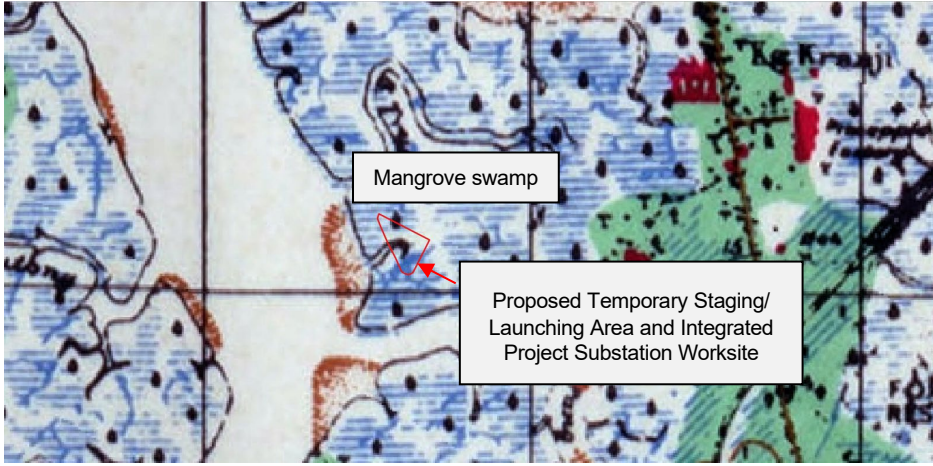


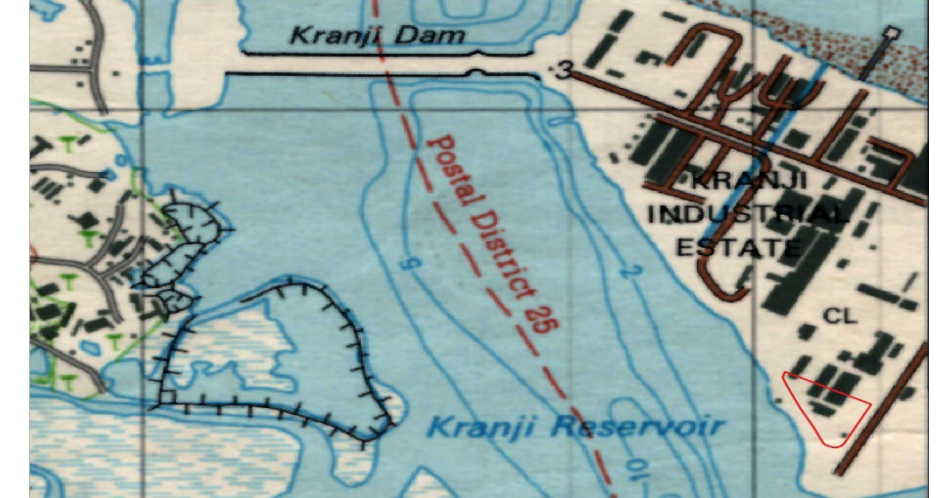
Eastern Portion (as of 14 April 2022)	12A Sungei Kadut Drive (as of 14 April 2022)
Eng Hua Furniture Manufacturing Pte Ltd (5 Sungei Kadut Drive)	View of 12A Site Entrance (Google Street View, image capture March 2021) <sup>1</sup>
 <p>Sungei Kadut Drive</p>	
12A Sungei Kadut Drive (as of 14 April 2022)	
View of 12A Site Entrance	View of 12A Site Entrance
	

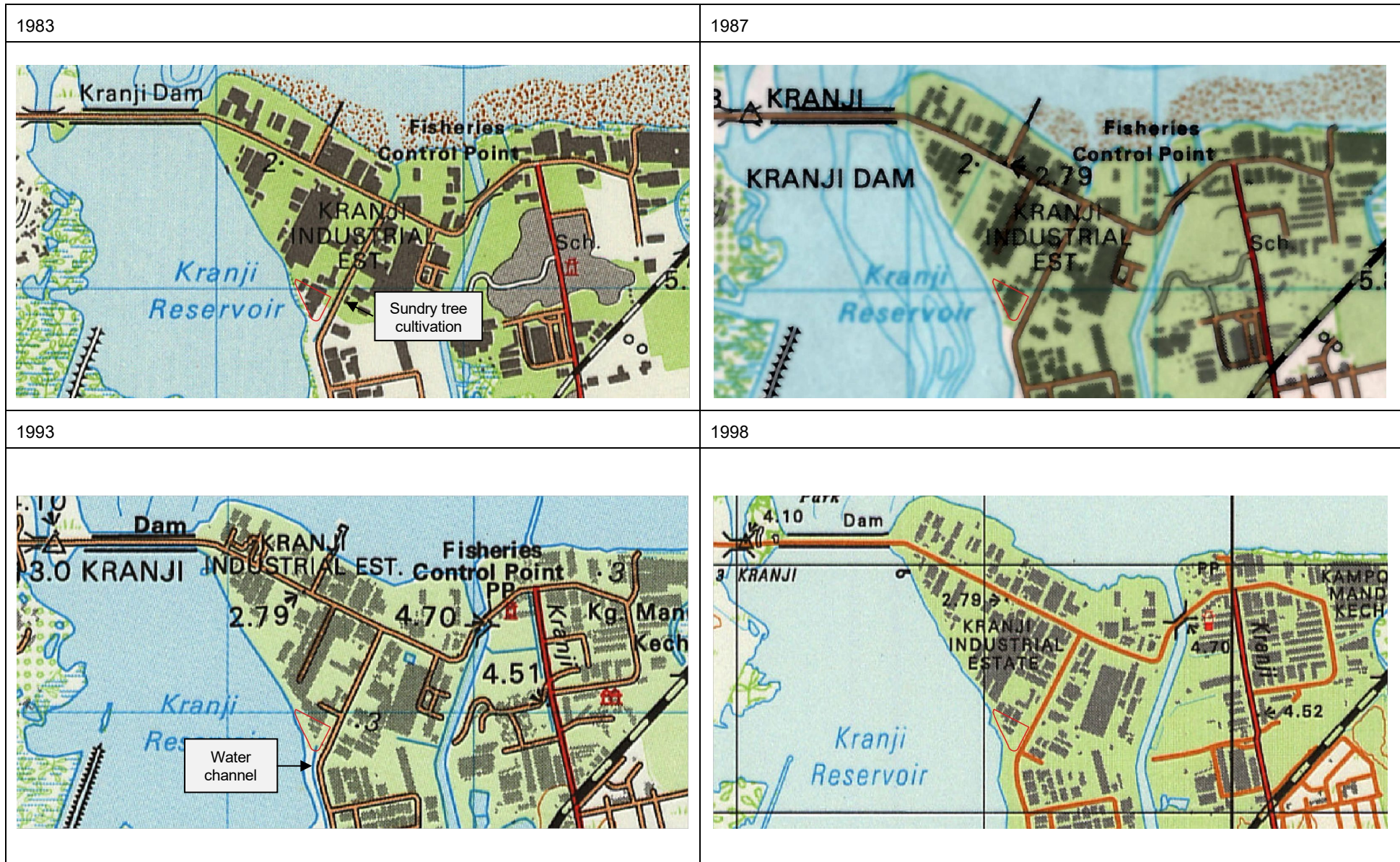
<sup>1</sup> Google Maps (2021). [View of 12 Sungei Kadut Drive, Singapore] [Street Map]. Available from [https://www.google.com/maps/@1.4312174,103.7471633,3a,90y,295.53h,91.75t/data=!3m6!1e1!3m4!1skxEajBqhiqyQO9KJj7T5\\_A!2e0!7i16384!8i8192](https://www.google.com/maps/@1.4312174,103.7471633,3a,90y,295.53h,91.75t/data=!3m6!1e1!3m4!1skxEajBqhiqyQO9KJj7T5_A!2e0!7i16384!8i8192) (assessed on 10 November 2023)

View towards the South from 12A Site Entrance (towards 12B Site Entrance)	View towards the North from 12A Site Entrance (away from 12B Site Entrance)
	
<b>12B Sungei Kadut Drive (as of 14 April 2022)</b>	
View of 12B Site Entrance (Google Street View, image capture March 2021)	View of 12B Site Entrance
	

View towards the North from 12B Site Entrance (towards 12A Site Entrance)	View towards South from 12B Site Entrance (away from 12A Site Entrance)
	
<b>12A &amp; 12B Sungei Kadut Drive (as of 13 September 2022)</b>	
View towards West from 12A Site Entrance	
	

Table 2: Proposed Temporary Staging/ Launching Area and Integrated Project Substation Site – Historical Maps and Aerial Images

1943	1969
 <p>Mangrove swamp</p> <p>Proposed Temporary Staging/ Launching Area and Integrated Project Substation Worksite</p>	 <p>Point</p> <p>S. Lotoh</p> <p>S. Trusmi</p> <p>Mud</p> <p>Bund</p> <p>475</p> <p>Kg. Kranji</p> <p>M. Cem.</p>
1974	1975
 <p>Fisheries Control Point</p> <p>Kg. Kranji</p> <p>CL</p> <p>3.</p> <p>S. Kranji</p>	 <p>Kranji Dam</p> <p>Postal District 25</p> <p>Kranji Reservoir</p> <p>KRANJI INDUSTRIAL ESTATE</p> <p>CL</p>



2002



2005



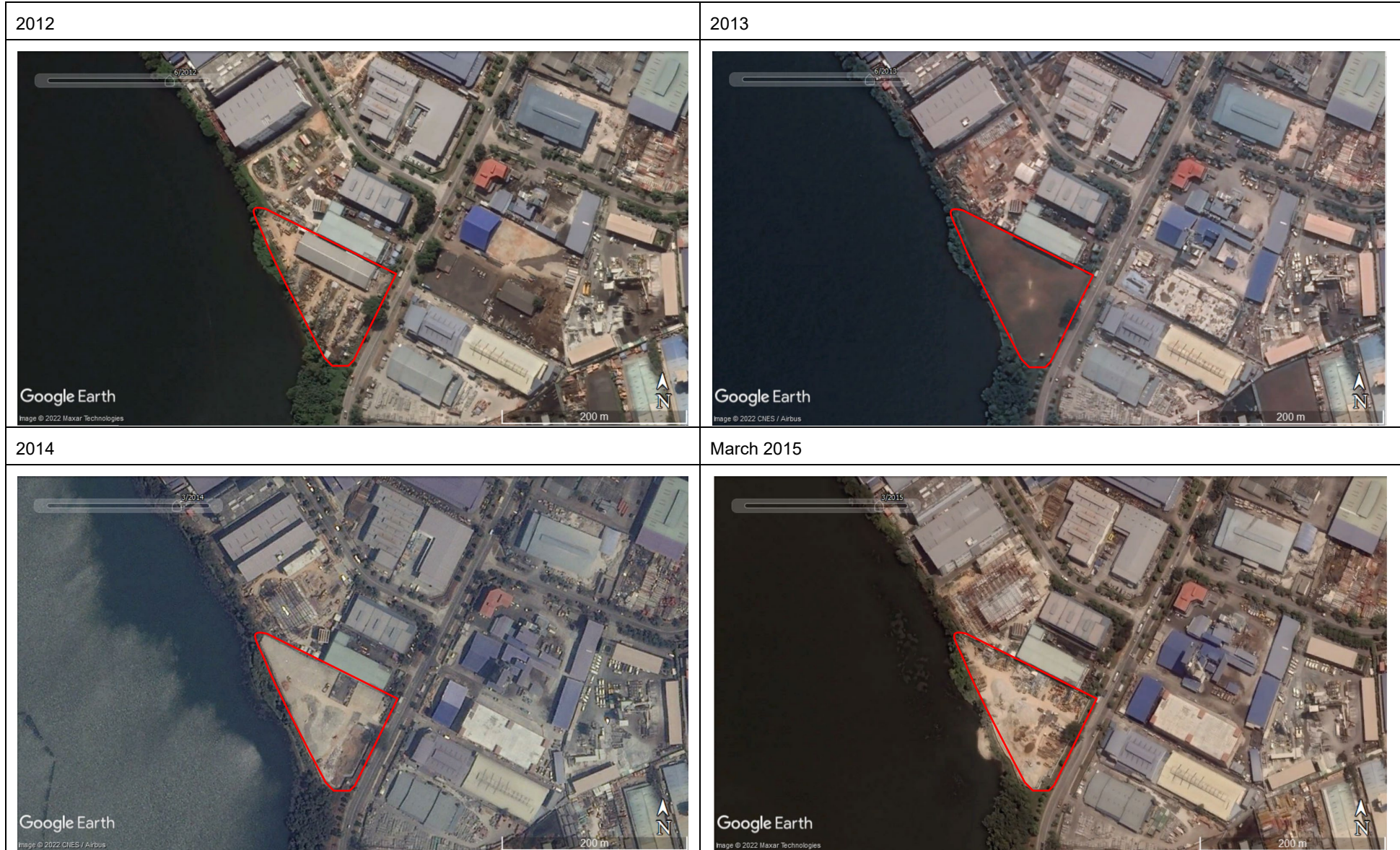
2008

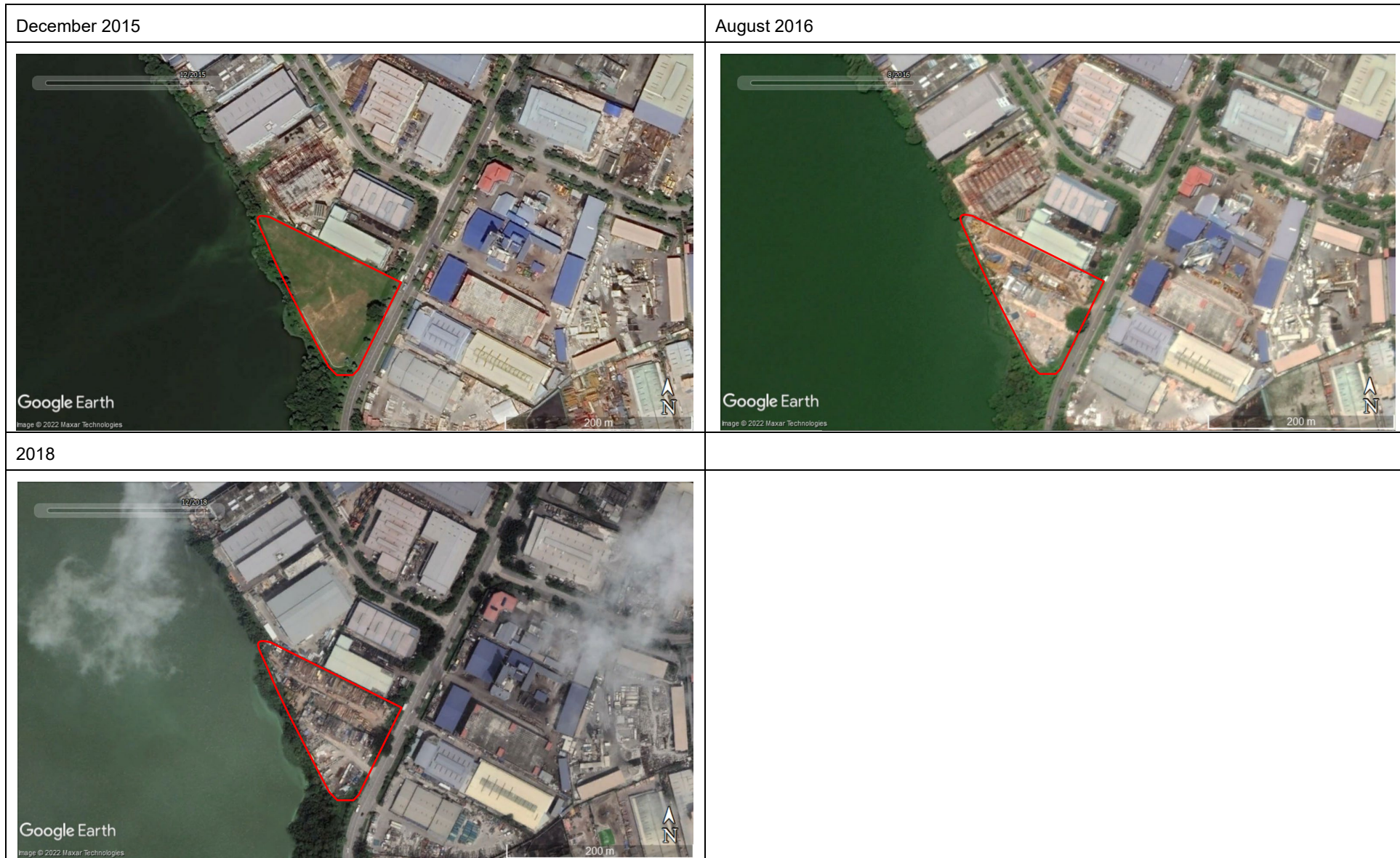


2010









Site Layout as of 14 April 2022 (basis of Phase I ESA)

**Legend**

- 1** Diesel oil stains around diesel drums storage and generator on open ground and bottom of boundary slope
- 2** Diesel stain on open ground
- 3** Unknown staining around oil/lubricant drums storage area
- 4** Unknown staining around hydraulic hoses laydown area
- 5** Significant diesel staining around aboveground diesel storage tank



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## **APPENDIX 11.1 VECTOR SENSITIVE RECEPTORS**

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## APPENDIX 11.1: VECTOR SENSITIVE RECEPTORS

S/N	Nearest Worksite	Receptor	Type of Receptor
1	Proposed Temporary Staging / Launching Area and integrated Project Substation	Quek & Quek Civil Engineering Pte. Ltd.	Industrial
2	Proposed Temporary Staging / Launching Area and integrated Project Substation	Daiya Engineering & Construction Pte. Ltd.	Industrial
3	Proposed Temporary Staging / Launching Area and integrated Project Substation	ZAP Piling Pte. Ltd.	Industrial
4	Proposed Temporary Staging / Launching Area and integrated Project Substation	Kranji Reservoir Park A	Park
5	Proposed Temporary Staging / Launching Area and integrated Project Substation	Future Kranji Reservoir Eastern Park	Park
6	Proposed Temporary Staging / Launching Area and integrated Project Substation	Rangoon Investment Pte. Ltd.	Industrial
7	Proposed Temporary Staging / Launching Area and integrated Project Substation	Wee Hur Construction Pte. Ltd.	Industrial
8	Proposed Temporary Staging / Launching Area and integrated Project Substation	Chng Woodworking	Industrial
9	Proposed Temporary Staging / Launching Area and integrated Project Substation	Siong Kee Piling Construction Pte. Ltd.	Industrial
10	Proposed Temporary Staging / Launching Area and integrated Project Substation	China Jingye Engineering Corporation Limited (MCC)	Industrial
11	Proposed Temporary Staging / Launching Area and integrated Project Substation	Union Heng Forklifts Services Pte. Ltd.	Industrial
12	Proposed Temporary Staging / Launching Area and integrated Project Substation	Topmast Engineering Pte. Ltd.	Industrial
13	Proposed Temporary Staging / Launching Area and integrated Project Substation	Or Kim Peow Contractors Pte. Ltd.	Industrial
14	Proposed Temporary Staging / Launching Area and integrated Project Substation	KGA Pte. Ltd.	Industrial
15	Proposed Temporary Staging / Launching Area and integrated Project Substation	Hua Khian Co. Pte. Ltd.	Industrial
16	Proposed Temporary Staging / Launching Area and integrated Project Substation	J Lim Piling Pte. Ltd.	Industrial
17	Proposed Temporary Staging / Launching Area and integrated Project Substation	KTS Pte. Ltd.	Industrial

S/N	Nearest Worksite	Receptor	Type of Receptor
18	Proposed Temporary Staging / Launching Area and integrated Project Substation	Sin Joo Lee Timber Pte. Ltd.	Industrial
19	Proposed Temporary Staging / Launching Area and integrated Project Substation	FMB Trading & Engineering Pte. Ltd.	Industrial
20	Proposed Temporary Staging / Launching Area and integrated Project Substation	EDZ Interior Pte. Ltd.	Industrial
21	Proposed Temporary Staging / Launching Area and integrated Project Substation	New Century Recycling	Industrial
22	Proposed Temporary Staging / Launching Area and integrated Project Substation	HSS Eating House	Eatery
23	Proposed Temporary Staging / Launching Area and integrated Project Substation	ZAP Piling Pte. Ltd.	Industrial
24	Proposed Temporary Staging / Launching Area and integrated Project Substation	Co-Top Marketing Pte. Ltd.	Industrial
25	Proposed Temporary Staging / Launching Area and integrated Project Substation	Ah Boon Civil Engineering & Building Contractor Pte. Ltd.	Industrial
26	Proposed Temporary Staging / Launching Area and integrated Project Substation	Vivo PPVC Centre	Industrial
27	Proposed Temporary Staging / Launching Area and integrated Project Substation	Thiam Aik Manufacturing Pte. Ltd.	Industrial
28	Proposed Temporary Staging / Launching Area and integrated Project Substation	Hock Eek Seng Machinery Pte. Ltd.	Industrial
29	Proposed Temporary Staging / Launching Area and integrated Project Substation	Koh Civil Engineering Pte. Ltd.	Industrial
30	Proposed Temporary Staging / Launching Area and integrated Project Substation	Fastweld Engineering Construction Pte. Ltd.	Industrial
31	Proposed Temporary Staging / Launching Area and integrated Project Substation	Hock Chuan Hong Corporation	Industrial
32	Proposed Temporary Staging / Launching Area and integrated Project Substation	Leading Bio-Energy Pte. Ltd.	Industrial
33	Proposed Temporary Staging / Launching Area and integrated Project Substation	Star Sin Trading Pte. Ltd.	Industrial
34	Proposed Temporary Staging / Launching Area and integrated Project Substation	Ley Choon Group Holdings	Industrial
35	Proposed Temporary Staging / Launching Area and integrated Project Substation	Samwoh Corporation Pte. Ltd.	Industrial

S/N	Nearest Worksite	Receptor	Type of Receptor
36	Proposed Temporary Staging / Launching Area and integrated Project Substation	Samwoh Eco-Green Park	Industrial
37	Proposed Temporary Staging / Launching Area and integrated Project Substation	Kiat Lee Landscape & Building Pte. Ltd.	Industrial
38	Proposed Temporary Staging / Launching Area and integrated Project Substation	Eng Hua Furniture Manufacturing Pte. Ltd.	Industrial
39	Proposed Temporary Staging / Launching Area and integrated Project Substation	Eng Seng Cement Products Pte. Ltd.	Industrial
40	Proposed Temporary Staging / Launching Area and integrated Project Substation	Wason Pte. Ltd.	Industrial
41	Proposed Temporary Staging / Launching Area and integrated Project Substation	Prospaq Group Pte. Ltd.	Industrial
42	Proposed Temporary Staging / Launching Area and integrated Project Substation	PERI Asia Pte. Ltd.	Industrial
43	Proposed Temporary Staging / Launching Area and integrated Project Substation	Teng Lee Green Pack Pte. Ltd.	Industrial
44	Proposed Temporary Staging / Launching Area and integrated Project Substation	Star Ready-Mix Pte. Ltd.	Industrial
45	Proposed Temporary Staging / Launching Area and integrated Project Substation	EcoWise Holdings Ltd.	Industrial
46	Proposed Temporary Staging / Launching Area and integrated Project Substation	Practical Furniture Pte. Ltd.	Industrial
47	Proposed Temporary Staging / Launching Area and integrated Project Substation	Gim Chuan Heng & Co.	Industrial
48	Proposed Temporary Staging / Launching Area and integrated Project Substation	HEC Electrical & Construction Pte. Ltd.	Industrial
49	Proposed Temporary Staging / Launching Area and integrated Project Substation	Hup Heng Engineering Works Pte. Ltd.	Industrial
50	Proposed Temporary Staging / Launching Area and integrated Project Substation	Shanghai Kah Yin Woodworking	Industrial
51	Proposed Temporary Staging / Launching Area and integrated Project Substation	Top Plastercell Pte. Ltd.	Industrial
52	Proposed Temporary Staging / Launching Area and integrated Project Substation	76 Sungei Kadut Street 1	Industrial
53	Proposed Temporary Staging / Launching Area and integrated Project Substation	3S Solid Surface Pte. Ltd.	Industrial

S/N	Nearest Worksite	Receptor	Type of Receptor
54	Proposed Temporary Staging / Launching Area and integrated Project Substation	Future Kranji Reservoir Eastern Park	Park



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**APPENDIX 12.1 ENVIRONMENTAL IMPACT REGISTER**

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APPENDIX 12.1: ENVIRONMENTAL IMPACT REGISTER

Table 1: Environmental Impact Register (Construction)

SURFACE WATER QUALITY (SECTION 6)					
S/N	Impact	Impact Magnitude Description	Pre-Mitigation Impact Significance	Mitigation Measures and Monitoring	Residual (with mitigation) Impact Significance
C1	Site runoff and wastewater from geotechnical/ site investigation on land (at the proposed temporary Staging/ Launching Area and the integrated Project Substation site)	<ul style="list-style-type: none"> <li><b>Nature:</b> Degradation of surface water quality is considered <b>negative</b>.</li> <li><b>Type:</b> <b>Indirect</b> change in surface water quality is expected from site runoff and other wastewater from geotechnical/ site investigation on land.</li> <li><b>Duration:</b> Changes in surface water quality from site runoff and other wastewater from geotechnical/ site investigation on land are relatively <b>short-term</b> (12 to 16 weeks) for surface water quality. Such changes are temporary and surface water quality is expected to return to baseline after completion of the active works.</li> <li><b>Extent:</b> Impacts are <b>localised</b> within the work areas and the immediate surroundings.</li> <li><b>Scale:</b> Body of water and/ or drains within less than 100 m could be affected by increased suspended solids, oil and grease or other contaminants.</li> <li><b>Frequency:</b> Geotechnical/ site investigation on land will happen <b>daily/ intermittently</b> during the specified period of construction phase.</li> </ul> <p>Geotechnical/ site investigation at the proposed temporary Staging/ Launching Area and integrated Project Substation will likely be conducted based on typical in-situ methods such as the standard penetration test (SPT) per ASTM D1586, or the cone penetration test (CPT) per ASTM D3441. The approaches will comply with the relevant Singapore standards and will not result in notable deterioration of surface water quality from site runoff or discharge of wastewater. As an embedded control, an ECM Plan would be prepared to control potential risk of soil erosion from geotechnical/ site investigations on land. All discharge from the ECM system should be well within the statutory limits.</p> <p>Impact magnitude is expected to be <b>Negligible</b> for the receiving water of the Kranji Reservoir and Sungei Pang Sua, where impacts are expected to be well within existing baseline/ statutory limits, as geotechnical/ site investigation will only occur at small area(s) and be well controlled by embedded control measures.</p>	<p>Impact Magnitude: <b>Negligible</b></p> <p>Receptor Sensitivity: <b>Low</b> (Sungei Pang Sua) <b>to High</b> (Kranji Reservoir/ tributaries/ PUB intakes)</p> <p>Impact Significance: <b>Negligible</b></p>	<ul style="list-style-type: none"> <li>Detailed design and construction methodology of land-based geotechnical/ site investigation to optimise/ minimise extent and number of borehole locations, where feasible.</li> </ul>	<p>Impact Magnitude: <b>Negligible</b></p> <p>Impact Significance: <b>Negligible</b></p>
C2	Site runoff, wastewater, and sediment disturbance from preparation of the proposed temporary Staging/ Launching Area	<ul style="list-style-type: none"> <li><b>Nature:</b> Degradation of surface water quality is considered <b>negative</b>.</li> <li><b>Type:</b> <b>Indirect</b> change in surface water quality is expected from site runoff and other wastewater from preparation of the proposed temporary Staging/ Launching Area including ramp into the Kranji Reservoir.</li> <li><b>Duration:</b> Changes in surface water quality from site runoff and other wastewater from preparation of the proposed temporary Staging/ Launching Area are relatively <b>short-term</b> (8 to 12 weeks) for surface water quality. Such changes are temporary and surface water quality is expected to return to baseline after completion of the active works.</li> <li><b>Extent:</b> Impacts are <b>localised</b> within the work area and the immediate surroundings.</li> <li><b>Scale:</b> Body of water and/ or drains within less than 100 m could be affected by increased suspended solids, oil and grease or other contaminants.</li> </ul>	<p>Impact Magnitude: <b>Negligible to Small</b></p> <p>Receptor Sensitivity: <b>Low</b> (Sungei Pang Sua) <b>to High</b> (Kranji Reservoir/ tributaries/ PUB intakes)</p> <p>Impact Significance: <b>Negligible to Moderate</b></p>	<ul style="list-style-type: none"> <li>Detailed design and construction methodology of land-based site preparations (including launching ramp) to optimise/ minimise extent of sediment disturbance, where feasible.</li> </ul>	<p>Impact Magnitude: <b>Negligible</b></p> <p>Impact Significance: <b>Negligible</b></p>

SURFACE WATER QUALITY (SECTION 6)					
S/N	Impact	Impact Magnitude Description	Pre-Mitigation Impact Significance	Mitigation Measures and Monitoring	Residual (with mitigation) Impact Significance
		<ul style="list-style-type: none"> <li><b>Frequency:</b> Preparation of the proposed temporary Staging/ Launching Area will happen <b>daily/ intermittently</b> during the specified period of construction phase.</li> </ul> <p>The proposed temporary Staging/ Launching Area was previously an industrial yard (now vacated grassland). Minor grading and levelling works may be needed. Clearing of vegetation would be needed only along the 150 m shoreline section to allow installation of launching ramp and for works near the shoreline. As an embedded control, an ECM Plan will be prepared to control potential risk of soil erosion from works at the launching area. All discharge from the ECM system should be well within the statutory limits and thus the associated impact magnitude is considered <i>Negligible</i>.</p> <p>The launching ramp typically consists of wooden planks fixed on top of metal frame installed at the shoreline. Minor piling works may be required for the installation of metal frame and localised disturbance to the reservoir bed sediment underneath the ramp would be expected. Level of localised disturbance from such installation works is expected to be within ambient levels and thus the associated impact magnitude is considered <i>Small</i>.</p> <p>Impact magnitude is expected to be <b>Negligible to Small</b> for the receiving water of the Kranji Reservoir and Sungei Pang Sua, where impacts are expected to be within existing baseline/ statutory limits, as the required work will be well controlled by embedded control measures and only minor sediment disturbance is expected from launching ramp installation.</p>			
C3	Site runoff and wastewater from land-based assembly of the FPV system	<ul style="list-style-type: none"> <li><b>Nature:</b> Degradation of surface water quality is considered <b>negative</b>.</li> <li><b>Type:</b> The assembly process would be conducted on land and no wastewater will be generated from the assembly process. Water quality impacts from site runoff during this process would be <b>indirect</b>. Wastewater from workforce would also be <b>indirect</b>.</li> <li><b>Duration:</b> The work period for assembly of the FPV system is around 52 to 70 weeks, which is considered relatively <b>long-term</b> for surface water quality. Such changes are temporary and surface water quality is expected to return to baseline after completion of the active works.</li> <li><b>Extent:</b> Impacts are <b>localised</b> within the work area and the immediate surroundings.</li> <li><b>Scale:</b> Body of water and/ or drains within less than 100 m could be affected by increased suspended solids, oil and grease or other contaminants.</li> <li><b>Frequency:</b> The assembly of the FPV system will happen <b>daily</b> during the specified period of construction phase.</li> </ul> <p>Assembly of the FPV system typically follows the manufacturer's installation manual. It includes connecting the rows of floats to form a floating platform, mounting PV panels on the floating platform, connecting cables, inverters, connection lines, etc. No wastewater will be generated from the assembly process. Sufficient chemical toilets (or equivalent) will be provided on site in accordance with the EPHA to serve the assembly workers for the FPV and no direct discharge of sanitary sewage from the site (including to the Kranji Reservoir) would be allowed. All discharge from the site drainage should be well within the statutory limits. Impact magnitude is expected to be <b>Negligible</b> for the receiving water of Kranji Reservoir and Sungei Pang Sua, where impacts are expected to be well within existing baseline/ statutory limits, given the lack of discharge sources and embedded controls.</p>	<p>Impact Magnitude: <b>Negligible</b></p> <p>Receptor Sensitivity: <b>Low</b> (Sungei Pang Sua) <b>to High</b> (Kranji Reservoir/ tributaries/ PUB intakes)</p> <p>Impact Significance: <b>Negligible</b></p>	No mitigation measures are required as embedded controls are considered to be adequate to manage impact significance to be <b>Negligible</b> .	N/A (To refer to Pre-Mitigation Impact Significance Column)

SURFACE WATER QUALITY (SECTION 6)					
S/N	Impact	Impact Magnitude Description	Pre-Mitigation Impact Significance	Mitigation Measures and Monitoring	Residual (with mitigation) Impact Significance
C4	Sediment disturbance from geotechnical/ site investigation in reservoir	<ul style="list-style-type: none"> <li><b>Nature:</b> Degradation of surface water quality is considered <b>negative</b>.</li> <li><b>Type:</b> In-reservoir geotechnical/ site investigation could result in disturbance to reservoir bed sediments, resulting in <b>direct</b> change in surface water quality.</li> <li><b>Duration:</b> Changes in surface water quality from disturbance to reservoir bed sediment from in-reservoir geotechnical/ site investigation are relatively <b>short-term</b> (12 to 16 weeks) for surface water quality. Such changes are temporary and elevated turbidity will subside relatively quickly and return to baseline after completion of the active works. Release of pore water will result in temporary elevation of ambient levels of nutrients and contaminants, which will be diluted in the surrounding water, the change is considered temporary.</li> <li><b>Extent:</b> Impacts are <b>localised</b> around the active site of geotechnical/ site investigation. Note that geotechnical/ site investigations will be conducted in phases across the reservoir. This means affected area would be localised at any one time.</li> <li><b>Scale:</b> Elevated levels of suspended solids as well as other changes in surface water quality would likely be limited to less than 100 m from the work front and return towards baseline beyond this (in view of its potential sediment disturbance being far less than the potential piling/ anchoring work, whose impact was estimated to return to baseline levels at a distance of around 100 m from sediment disturbance source, according to the evaluation in <i>Appendix E of Appendix 6.1</i>).</li> <li><b>Frequency:</b> Geotechnical/ site investigation will happen <b>daily/ intermittently</b> during the specified period of construction phase.</li> </ul> <p>These geotechnical/ site investigations will be performed from over-water equipment or structures such as floating platforms or spud barges. The anchoring of these floating platforms or spud barges would likely involve concrete anchors sunk to the reservoir bed, which may result in temporary localised elevation of sediment. The methods for subsurface investigations vary based on the expected geology to be encountered but it is likely that over-water investigations will be performed using a shell and auger percussion rig with a winch, small diesel engine or generator, and tripod (similar to those used for Tengeh FPV construction). The retrieval of sediment samples will also result in temporary and localised elevation of sediment in the water column. Level of localised disturbance from such site investigation works is expected to be within ambient levels.</p> <p>Impact magnitude is expected to be <b>Small</b> for the receiving water of the Kranji Reservoir, where impacts are expected to be within existing baseline/ statutory limits, given the small scale of work, embedded controls, minor disturbance to sediment and relatively low tendency for release of sediment-bound contaminants as indicated in the baseline survey results.</p>	<p>Impact Magnitude: <b>Small</b></p> <p>Receptor Sensitivity: <b>High</b> (Kranji Reservoir/ tributaries/ PUB intakes)</p> <p>Impact Significance: <b>Moderate</b></p>	<ul style="list-style-type: none"> <li>Detailed design and construction methodology (e.g. phasing) of reservoir-based geotechnical/ site investigation to optimise/ minimise extent and number of borehole locations and minimise sediment disturbance, where feasible.</li> </ul> <p>Monitoring and adaptive management measures (see <i>Section 4.7.1</i> for further details on adaptive management approaches) including:</p> <ul style="list-style-type: none"> <li>Agree construction phase surface water quality threshold criteria with PUB prior to works commencement, including action and limit levels.</li> <li>Establish construction phase surface water quality monitoring programme in agreement with PUB prior to works commencement, to inform the Developer/ Owner on any potential deterioration of surface water quality from the works. Online water quality systems, pre-agreed with PUB, should be deployed in the reservoir pre- and during construction (and throughout operation) prior to works being carried out in the reservoir. <ul style="list-style-type: none"> <li>Surface water quality monitoring parameters to include: Temperature (°C), pH, EC (µS/cm) (conductivity), Turbidity (NTU), Secchi Depth, Dissolved oxygen (DO), Metals and metalloids (including Aluminium, Arsenic, Copper, Iron, Lead, Manganese), Major ions (including chloride), grease and oil, PAR, Chlorophyll-a (fluorescence-based spectrophotometer) and nutrients (TP, TN, TOC, DOC, nitrate (as N), phosphate and ammonia (as N)), 2-MIB, Geosmin, Microcystin-LR, and Total Suspended Solids (TSS).</li> <li>Pre-construction sediment quality monitoring parameters to include: nutrients, contaminants/ metals and hydrocarbons.</li> </ul> </li> <li>In case surface water quality monitoring results indicate notable change in surface water quality in reservoir as a result of project works, agree with PUB on adoption of further mitigation measures, such as silt curtains around the two reservoir water intakes and/ or geotechnical/ site investigation worksites, propose alternate construction methodologies, or to cease works temporarily.</li> </ul>	<p>Impact Magnitude: <b>Negligible</b></p> <p>Impact Significance: <b>Negligible</b></p>
C5	Sediment disturbance from deployment of anchors/ ballasted foundations/ piles and mooring lines	<ul style="list-style-type: none"> <li><b>Nature:</b> Degradation of surface water quality is considered <b>negative</b>.</li> <li><b>Type:</b> Deployment of anchors/ ballasted foundations/ piles and mooring lines will disturb reservoir bed sediment, resulting in elevated turbidity. Compression of reservoir bed sediment could squeeze out pore water, which contains nutrients and contaminants. Both of these are considered <b>direct</b> impacts. Indirect impacts may occur to the Johor Straits when tidal gates are opened.</li> </ul>	<p>Impact Magnitude: <b>Medium</b></p> <p>Receptor Sensitivity: <b>Medium</b> (Johor Strait) <b>to High</b> (Kranji Reservoir/</p>	<ul style="list-style-type: none"> <li>Detailed design and construction methodology of reservoir-based piles/ anchors/ ballasted foundations to optimise/ minimise extent and number and minimise sediment disturbance, where feasible.</li> <li>Conduct lowering of anchors/ piles/ weights in controlled manner to reservoir bed to minimise sediment disturbance and the use of divers to assist with the underwater works (if necessary).</li> </ul> <p>Monitoring and adaptive management measures including:</p>	<p>Impact Magnitude: <b>Small</b></p> <p>Impact Significance: <b>Moderate</b></p>

SURFACE WATER QUALITY (SECTION 6)					
S/N	Impact	Impact Magnitude Description	Pre-Mitigation Impact Significance	Mitigation Measures and Monitoring	Residual (with mitigation) Impact Significance
		<ul style="list-style-type: none"> <li><b>Duration:</b> Depending on the final design of anchoring to be adopted, the installation of piles/ anchors/ ballasted foundations could take up to 52 to 70 weeks, which is considered relatively <b>long-term</b> for surface water quality. Such changes are temporary and elevated turbidity will subside relatively quickly and return to baseline after completion of the active works. Release of pore water will result in temporary elevation of ambient levels of nutrients and contaminants, which will be diluted in the surrounding water, thus the change is considered temporary.</li> <li><b>Extent:</b> Impacts are <b>localised</b> around the active site(s) of deployment. Note that deployment of anchors/ ballasted foundation, piles and mooring lines will be conducted in phases across the reservoir. This means affected area would be localised at any one time. Sediment plume from construction works around the tidal gate when it is opened could spread into the Johor Straits and has wider extent of impact.</li> <li><b>Scale:</b> Elevated levels of suspended solids as well as other changes in surface water quality would likely be limited to less than 100 m from the work front and return towards baseline beyond this (see the evaluation in <i>Appendix E of Appendix 6.1</i>).</li> <li><b>Frequency:</b> Deployment of anchors/ ballasted foundations/ piles and mooring lines will happen <b>daily/ intermittently</b> during the specified period of construction phase.</li> </ul> <p>It is anticipated that no dredging and excavation of reservoir sediment will be required for anchoring. The deployment of anchors/ ballasted foundations/ piles for FPV and PCUs and the O&amp;M berthing facility is expected to result in temporary and localised disturbance of reservoir bed sediment. The disturbance to sediment could result in release of pore water and sediment-bound contaminants. Further details on the anchoring and mooring options under consideration are provided in <i>Appendix 2.1</i>, including work rates and workstation assumptions.</p> <p>Detailed analysis on the potential change in surface water quality associated with the piling/ anchoring is provided under <i>Appendix E</i> of the Water Quality Modelling Technical Appendix (<i>Appendix 6.1</i>). The potential conservative scenario in term of disturbance to reservoir bed sediment and associated change in surface water quality was identified between the anchoring options and the potential level of change in surface water quality was estimated. The main conservative assumptions adopted in <i>Appendix E of Appendix 6.1</i> include (1) conservative estimation (i.e. overestimation) of pile diameter (actual: up to 600 mm; assessed: up to 900 mm) and anchor block dimension (actual: 1 m x 2 m; assessed: 2 m x 2 m) as well as conservative selection of sediment source for assessment (solid pile assessed, which results in more sediment loss than cylindrical pile or anchor block options). It is estimated that the elevation of suspended solids would likely be at the level of 5.3 mg/L at 100 m from the active works area and would be even lower at further distances. For release of sediment-bound nitrogen and phosphorus, it is estimated that the released total nitrogen and total phosphorus from the piling works would be below 0.25% and 0.03% of the catchment load respectively. Similar analysis conducted for sediment-bound contaminants including arsenic, cadmium and lead also indicated the potential release of these contaminants would be negligible (<i>Table E-8 of Appendix E of Appendix 6.1</i> refers) and is not considered to be a major cause of concern in terms of surface water quality. Impact magnitude on the Kranji Reservoir is expected to be <b>Medium</b>.</p> <p>Release of suspended sediments, nutrients and contaminants to the Johor Straits may occur during tidal gate opening. Given the tidal gate is only opened during rain events in the</p>	<p>tributaries/ PUB intakes)</p> <p>Impact Significance: <b>Major</b></p>	<ul style="list-style-type: none"> <li>Agree construction phase surface water quality threshold criteria with PUB prior to works commencement, including action and limit levels.</li> <li>Establish construction phase surface water quality monitoring programme in agreement with PUB prior to works commencement, to inform the Developer/ Owner on any potential deterioration of surface water quality from the works (see item C4 above). Online water quality systems, pre-agreed with PUB, should be deployed in the reservoir pre-construction prior to works being carried out in the reservoir.</li> <li>At the beginning of anchoring operations, work fronts should preferably be chosen at locations sufficiently far away from the water intakes to minimise potential impact from sediment disturbance. Surface water quality monitoring should be regularly reviewed (e.g. when work front moves) to inform work rate adjustments, for example, according to the distance of the work fronts to the water intakes for treatment plant (such as, where work front is closer to water intake, monitoring may indicate the Developer/ Owner should consider a reduced work rate). Work rate should start low and be allowed to ramp up for successive days showing no notable deterioration of surface water quality contributed by project works.</li> <li>Any notable deterioration of surface water quality observed should be investigated. Investigation should determine whether or not the observed deterioration can be attributed to the construction work. If affirmative, work procedures should be reviewed and further mitigation identified, e.g. work rate could be reduced or silt curtains used. The Developer/ Owner should liaise with PUB closely on active work front locations, agreed work rates, monitoring results and frequency, and investigation findings and seek agreement on management action(s) to be conducted. Where observations are not attributable to the Project, the Developer/ Owner will liaise with relevant Government Agencies responsible for managing the identified effect for their action.</li> <li>In case surface water quality monitoring results indicate notable change in surface water quality in reservoir as a result of project works, agree with PUB on adoption of further mitigation measures, such as silt curtains around the two reservoir water intakes and/ or piling/ anchoring worksites, propose alternate construction methodologies, or to cease works temporarily.</li> </ul>	

SURFACE WATER QUALITY (SECTION 6)					
S/N	Impact	Impact Magnitude Description	Pre-Mitigation Impact Significance	Mitigation Measures and Monitoring	Residual (with mitigation) Impact Significance
		<p>catchment area (i.e. upstream of the reservoir) or to manage reservoir water levels (i.e. when there is notable inflows), impacts (if any) will only be limited to such time periods. It should be highlighted that with the combined effect of limited extent of impact within the reservoirs, embedded controls, as well as sedimentation/ dilution/ assimilation within the reservoir itself, any change in surface water quality as a result of works under this Project would be limited to the immediate proximity from the tidal gate. Also, since Standard Operating Procedures will be agreed and applied (e.g. works stoppage prior to tidal gate opening); sufficient mixing and dilution will have occurred with sediments, nutrients and contaminants being relatively small compared to the existing baseline of the reservoir outflows from the tidal gate. Impact magnitude on the Johor Straits is expected to be <i>Negligible</i>. Given the distance from the Project to the international boundary (over 1.1km from the tidal gate), it is considered that no cross-border impacts are anticipated from this Project.</p> <p>The installation of mooring lines is not expected to result in notable disturbance to reservoir bed sediment or other changes in surface water quality.</p> <p>Overall, conservatively, impact magnitude is expected to be <b>Medium</b> for the receiving water of the Kranji Reservoir, where impacts are expected to occasionally exceed existing baseline/ statutory limits over short timeframes at the works areas with embedded controls.</p>			
C6	<b>Sediment disturbance from launching, towing and installation of FPV and ancillary equipment at designed locations</b>	<ul style="list-style-type: none"> <li>■ <b>Nature:</b> Degradation of surface water quality is considered <b>negative</b>.</li> <li>■ <b>Type:</b> Installation of FPV and ancillary equipment involves launching of assembled equipment from the proposed temporary Staging/ Launching Area, towing them to designated locations and then securing them in place. These works may disturb reservoir bed sediment <b>directly or indirectly</b>.</li> <li>■ <b>Duration:</b> Launching of FPV from the proposed Staging/ Launching Area into the reservoir and towing FPV into designated locations, connecting FPV to piles/ anchors/ ballasted foundations via mooring lines, and installation of water-based ancillary equipment (e.g. PCUs/ inverters) etc., could take 52 to 70 weeks, which is considered to be relatively <b>long-term</b> for surface water quality. Such changes are temporary and elevated turbidity will subside relatively quickly and return to baseline after completion of the active works.</li> <li>■ <b>Extent:</b> Impacts are <b>localised</b> around the active site of the launching area and mooring locations as well as the active travel routes for work boats.</li> <li>■ <b>Scale:</b> Elevated levels of suspended solids as well as other changes in surface water quality would likely be limited to less than 100 m from the work front and return towards baseline beyond this (in view of its potential sediment disturbance being far less than the potential piling/ anchoring work, whose impact was estimated to return to baseline levels at a distance of around 100 m from sediment disturbance source, according to the evaluation in <i>Appendix E of Appendix 6.1</i>).</li> <li>■ <b>Frequency:</b> Installation will happen <b>daily/ intermittently</b> during the specified period of construction phase.</li> </ul> <p>The launching of assembled FPV and ancillary equipment from launching ramp or via land-based crane lifting will not result in notable disturbance to reservoir bed sediment. However, work boats moving within shallow areas or close to banks at high speed, or heavily laden barges, could disturb reservoir bed sediment or erode soil from the banks. Disturbed sediment</p>	<p>Impact Magnitude: <b>Negligible to Small</b></p> <p>Receptor Sensitivity: <b>High</b> (Kranji Reservoir/ tributaries/ PUB intakes)</p> <p>Impact Significance: <b>Negligible to Moderate</b></p>	<ul style="list-style-type: none"> <li>■ Detailed design and construction methodology of launching/ towing and installation of FPVs and ancillary equipment to minimise sediment disturbance, where feasible.</li> <li>■ Design of vessel operation procedures to account for the relatively shallow water off the launching ramp and shorelines to avoid the work boats/ barges from getting into the shallow depths and running their engines at full throttle. Account for heavy loads activity procedures/ navigation routes. Ensure boat operators are familiar with water depths across the reservoir.</li> <li>■ Vessels required for transportation of crew and/ or materials/ equipment should account for the additional load when considering navigation routes to ensure sufficient reservoir bed clearance.</li> </ul> <p>Monitoring and adaptive management measures including:</p> <ul style="list-style-type: none"> <li>■ Agree construction phase surface water quality threshold criteria with PUB prior to works commencement, including action and limit levels.</li> <li>■ Establish construction phase surface water quality monitoring programme in agreement with PUB prior to works commencement, to inform the Developer/ Owner on any potential deterioration of surface water quality from the works (see item C4 above).</li> <li>■ In case surface water quality monitoring results indicate notable change in surface water quality in reservoir as a result of project works, agree with PUB on adoption of further mitigation measures, such as silt curtains around the two reservoir water intakes, propose alternate construction methodologies, or to cease works temporarily.</li> </ul>	<p>Impact Magnitude: <b>Negligible</b></p> <p>Impact Significance: <b>Negligible</b></p>

SURFACE WATER QUALITY (SECTION 6)					
S/N	Impact	Impact Magnitude Description	Pre-Mitigation Impact Significance	Mitigation Measures and Monitoring	Residual (with mitigation) Impact Significance
		<p>and eroded soil would result in localised increases in turbidity. Such increased turbidity will settle relatively quickly after the disturbance subsides and any potential release of sediment-bound contaminants would be limited. The more exposed reservoir bank at the proposed temporary Staging/ Launching Area would be covered by the installed launching ramp, and thus be shielded from wake from work boats, thus limiting the potential erosion. The resulting elevation in surface water quality is likely to be within ambient levels and thus considered to be of <i>Small</i> impact magnitude.</p> <p>After launching, the FPV and ancillary equipment will be towed and the equipment will be secured at designed locations by connecting the mooring lines between the floating elements with the installed piles/ anchors/ ballasted foundations. Any potential disturbed sediment is expected to be minimal and will settle relatively quickly around the work area. The resulting elevation in surface water quality is likely to be well within ambient levels and thus considered to be of <i>Negligible</i> impact magnitude.</p> <p>Overall, impact magnitude is expected to be <b>Negligible</b> to <b>Small</b> for the receiving water of the Kranji Reservoir, where impacts are expected to be within existing baseline/ statutory limits, considering the minimal disturbance to reservoir bed sediment and banks with embedded controls.</p>			
C7	<b>Sediment disturbance from installation of connector cables (between FPV islands and to shore)</b>	<ul style="list-style-type: none"> <li>■ <b>Nature:</b> Degradation of surface water quality is considered <b>negative</b>.</li> <li>■ <b>Type:</b> Laying of cable on reservoir bed could result in disturbance of reservoir bed sediment, resulting in a <b>direct</b> change in surface water quality.</li> <li>■ <b>Duration:</b> Installation of connector cables could take 24 to 32 weeks, which is considered to be relatively <b>short-term</b> for surface water quality. Such changes are temporary and elevated turbidity will subside relatively quickly and return to baseline after completion of the active works. Release of pore water will result in temporary elevation of ambient levels of nutrients and contaminants, which will be diluted and disperse in the surrounding water, the change is considered temporary.</li> <li>■ <b>Extent:</b> Impacts are expected to be <b>localised</b> along the connector cables between FPV islands and the landing location at the shore at the proposed temporary Staging/ Launching Area and integrated Project Substation site.</li> <li>■ <b>Scale:</b> Elevated levels of suspended solids as well as other changes in surface water quality would likely be limited to less than 100 m from the work front and return towards baseline beyond this (in view of its potential sediment disturbance being far less than the potential piling/ anchoring work, whose impact was estimated to return to baseline levels at a distance of around 100 m from sediment disturbance source, according to the evaluation in <i>Appendix E of Appendix 6.1</i>).</li> <li>■ <b>Frequency:</b> Connector cable installation will happen <b>daily/ intermittently</b> during the specified period of construction phase.</li> </ul> <p>Connector cables laid on the surface of the reservoir bed would result in minor sediment disturbance. The corresponding elevation of suspended solids is expected to be within ambient level.</p>	<p>Impact Magnitude: <b>Small</b></p> <p>Receptor Sensitivity: <b>High</b> (Kranji Reservoir/ tributaries/ PUB intakes)</p> <p>Impact Significance: <b>Moderate</b></p>	<ul style="list-style-type: none"> <li>■ Detailed design and construction methodology of reservoir-based connector cables to optimise/ minimise length and minimise sediment disturbance, where feasible.</li> <li>■ Conduct lowering of cables in controlled manner to reservoir bed to minimise sediment disturbance and the use of divers to assist with the underwater works (if necessary).</li> </ul> <p>Monitoring and adaptive management measures including:</p> <ul style="list-style-type: none"> <li>■ Agree construction phase surface water quality threshold criteria with PUB prior to works commencement, including action and limit levels.</li> <li>■ Establish construction phase surface water quality monitoring programme in agreement with PUB prior to works commencement, to inform the Developer/ Owner on any potential deterioration of surface water quality from the works (see item C4 above).</li> <li>■ In case surface water quality monitoring results indicate notable change in surface water quality in reservoir as a result of project works, agree with PUB on adoption of further mitigation measures, such as silt curtains around the two reservoir water intakes, propose alternate construction methodologies, or to cease works temporarily.</li> </ul>	<p>Impact Magnitude: <b>Negligible</b></p> <p>Impact Significance: <b>Negligible</b></p>

SURFACE WATER QUALITY (SECTION 6)					
S/N	Impact	Impact Magnitude Description	Pre-Mitigation Impact Significance	Mitigation Measures and Monitoring	Residual (with mitigation) Impact Significance
		Impact magnitude is expected to be <b>Small</b> , where impacts are expected to be within existing baseline/ statutory limits, given the small scale of work and minor disturbance to sediment with embedded controls.			
C8	Degradation/ change of surface water quality from trimming of aquatic vegetation	<ul style="list-style-type: none"> <li><b>Nature:</b> Degradation of surface water quality is considered <b>negative</b>.</li> <li><b>Type:</b> Trimming of aquatic vegetation in the top 1m of the water column<sup>1</sup>, will not result in significant disturbance to reservoir bed sediment. For the trimming of aquatic vegetation, conservatively, if the cut waste vegetation is not collected and allowed to decompose in the water column, this will result in <b>indirect</b> changes in surface water quality.</li> <li><b>Duration:</b> Trimming of aquatic vegetation would be carried out in phases before works activities in different areas of the reservoir commence (due to rapid regeneration of the aquatic vegetation) throughout the in-reservoir construction period (approximately 104 weeks), which is considered to be relatively <b>long-term</b> for surface water quality. If any trimmings of aquatic vegetation are left in-reservoir they would likely settle into the sediment and decay slowly. The effect of decomposition of these cut vegetation would diminish over time but could linger beyond the construction period. A detailed literature review on rate of decomposition of aquatic plant material is provided in <i>Appendix D of Appendix 6.1</i>. On average, about 40%, 20% and 16% of total phosphorus, total nitrogen and total carbon could be released in the first 30 days respectively. For the effect of reduced photosynthesis from reduced vegetation resulting from trimming and FPV shading, the effect on dissolved oxygen (DO) levels as well as the change in pH buffering capacity will be permanent throughout the Project operational phase (see also Table 6-13).</li> <li><b>Extent:</b> Conservatively, vegetation trimming works could cover the entirety of the Reservoir Project Site within the Kranji Reservoir, to be carried out in phases. Impacts would be <b>localised</b> within the work areas of the current work phase and the immediate surroundings judging by the lack of notable change in surface water quality from existing ongoing regular (daily) aquatic vegetation removal works by PUB.</li> <li><b>Scale:</b> Conservatively, the effect of the release of nutrients and depletion of dissolved oxygen associated with the decomposition of trimmed vegetation left in-reservoir would likely be limited to less than 100 m from the work front given the small vegetation amounts and the lack of notable change in surface water quality from existing regular aquatic vegetation removal works.</li> <li><b>Frequency:</b> Trimming of aquatic vegetation will happen <b>intermittently</b> during the specified period of construction phase.</li> </ul> <p>Detailed estimation on the nutrient content in the aquatic vegetation in the Kranji Reservoir is provided in <i>Appendix D of Appendix 6.1</i>. It is estimated that in the very unlikely conservative scenario of having all the aquatic vegetation within the Reservoir Project Site (i.e. all</p>	<p>Impact Magnitude: <b>Small to Medium</b></p> <p>Receptor Sensitivity: <b>High</b> (Kranji Reservoir/ tributaries/ PUB intakes)</p> <p>Impact Significance: <b>Moderate to Major</b></p>	<ul style="list-style-type: none"> <li>Detailed design and construction methodology of reservoir-based works to manage aquatic vegetation management/ trimming, as appropriate in consultation with PUB.</li> <li>Detailed design and construction methodology and schedule to review the analysis conducted under <i>Appendix D and E of Appendix 6.1</i> to update estimation of potential surface water quality impact. Should changes (if any) be considered to be greater, or more impactful, than those assumed in this assessment, the impact assessments should be reviewed, and adaptive management measures implemented to ensure impacts are smaller than or equal to the impact significances assessed herein.</li> <li>Establish an Aquatic Vegetation/ Invasive Species Management Plan (includes removal of aquatic vegetation). This plan should be prepared and submitted to PUB for agreement prior to commencement of the removal works for construction.</li> <li>All aquatic vegetation trimmings, where required, to be collected and removed from the water column immediately for disposal offsite by a licenced contractor, thus further limiting surface water quality impacts from decomposition (far below the conservative estimation provided in <i>Appendix D of Appendix 6.1</i>).</li> </ul> <p>Monitoring and adaptive management measures including:</p> <ul style="list-style-type: none"> <li>Agree construction phase surface water quality threshold criteria with PUB prior to works commencement, including action and limit levels.</li> <li>Establish construction phase surface water quality monitoring programme in agreement with PUB prior to works commencement, to inform the Developer/ Owner on any potential deterioration of surface water quality from the works (see item C4 above).</li> <li>Any notable deterioration of surface water quality observed should be investigated. Investigation should determine whether or not the observed deterioration can be attributed to the construction work. If affirmative, work procedures should be reviewed and further mitigation identified or to cease works temporarily. The Developer/ Owner should liaise with PUB closely on aquatic vegetation management/ trimming, monitoring results and investigation findings and seek agreement on management action(s) to be conducted. Where observations are not attributable to the Project, the Developer/ Owner will liaise with relevant Government Agencies responsible for managing the identified effect for their action.</li> </ul>	<p>Impact Magnitude: <b>Negligible to Small</b></p> <p>Impact Significance: <b>Negligible to Moderate</b></p>

<sup>1</sup> Trimming of aquatic vegetation in the top 1m of the water column was determined to be sufficient for construction activities related to deployment of the in-reservoir Project components (e.g. vessel movements). This trimming depth has been determined to be achievable based on discussion with PUB and inputs from PUB's existing aquatic vegetation management contractors.



SURFACE WATER QUALITY (SECTION 6)					
S/N	Impact	Impact Magnitude Description	Pre-Mitigation Impact Significance	Mitigation Measures and Monitoring	Residual (with mitigation) Impact Significance
		<p>vegetation in the water column) cut off at the same time (unlikely), and start decomposing and releasing nutrients immediately (unlikely), the addition of total phosphorus, total nitrogen and total carbon in the 1<sup>st</sup> month will be approximately 11%, 9%, and 5% of the existing fluxes into the reservoir (catchment loadings, mineralisation, and atmospheric deposition).</p> <p>A realistic (yet still highly conservative) scenario is assessed here, of the aquatic vegetation in the top 1m of the water column being trimmed all at once (unlikely) and starting to decompose and releasing nutrients immediately (unlikely). In this case, the addition of total phosphorus, total nitrogen and total carbon in the 1<sup>st</sup> month will be approximately 3%, 3%, and 2% of the existing fluxes into the reservoir (catchment loadings, mineralisation, and atmospheric deposition) respectively. Note: that the assessed scenario is very conservative to account for uncertainties on vegetation decomposition rates, vegetation volumes etc, and thus is expected to over-estimate the potential flux. Given the actual trimming works is expected to be conducted in phases and be localised over a period of time, the potential flux would therefore be even lower. As the associated change in surface water quality is expected to be small and be within ambient levels, the impact magnitude is considered to be <i>Small</i>.</p> <p>Aquatic plants regulate the pH in the water column by taking up pH affecting constituents such as dissolved carbon dioxide, ammonia as well as cations (such as calcium). The trimming of aquatic vegetation would reduce photosynthesis and stop the uptake of carbon dioxide, nutrients and ions, which would result in a reduction of DO levels and change the pH buffering capacity. Since, conservatively, the aquatic vegetation will not be allowed to re-establish after clearance, the potential change identified would remain through the period of project construction and operation. In view of the lasting change in surface water quality, the impact is considered of <i>Medium</i> magnitude.</p> <p>It should be noted that while existing ongoing removal of aquatic vegetation is regularly conducted (daily) in Kranji Reservoir by PUB without notable adverse surface water quality impacts being recorded, the Project would remove a larger area of aquatic vegetation over a shorter time period.</p> <p>Overall, impact magnitude is expected to be <i>Small to Medium</i> for the receiving water of the Kranji Reservoir, where conservatively impacts are expected to be potential lasting change which is not expected to exceed existing baseline/ statutory limits with embedded controls.</p>			
C9	Site runoff and wastewater from construction of integrated Project Substation and land-based connector cable in the proposed temporary Staging/ Launching Area (adjacent to reservoir)	<ul style="list-style-type: none"> <li><b>Nature:</b> Degradation of surface water quality is considered <b>negative</b>.</li> <li><b>Type:</b> <b>Indirect</b> change in surface water quality is expected from site runoff and other wastewater from installation of the integrated Project Substation.</li> <li><b>Duration:</b> Changes in surface water quality from site runoff and other wastewater from installation of the integrated Project Substation are relatively <b>long-term</b> (44 to 64 weeks) for surface water quality. Such changes are temporary and surface water quality is expected to return to baseline after completion of the active works.</li> <li><b>Extent:</b> Impacts are <b>localised</b> within the work area and the immediate surroundings.</li> <li><b>Scale:</b> Body of water and/ or drains within less than 100 m could be affected by increased suspended solids, oil and grease or other contaminants.</li> <li><b>Frequency:</b> Construction of integrated Project Substation will happen <b>daily</b> during the specified period of construction phase.</li> </ul>	<p>Impact Magnitude: <b>Negligible</b></p> <p>Receptor Sensitivity: <b>Low</b> (Sungei Pang Sua) <b>to High</b> (Kranji Reservoir/ tributaries/ PUB intakes)</p> <p>Impact Significance: <b>Negligible</b></p>	<ul style="list-style-type: none"> <li>Detailed design and construction methodology of land-based buildings/ equipment to minimise runoff and wastewater, where feasible.</li> </ul>	<p>Impact Magnitude: <b>Negligible</b></p> <p>Impact Significance: <b>Negligible</b></p>

SURFACE WATER QUALITY (SECTION 6)					
S/N	Impact	Impact Magnitude Description	Pre-Mitigation Impact Significance	Mitigation Measures and Monitoring	Residual (with mitigation) Impact Significance
		<p>Construction of the integrated Project Substation involves foundation works, excavation works for basement, installation of underground conduits/ trenches for utilities, installation of steel structures, major electrical equipment, prefabricated building structures, ancillary buildings and O&amp;M systems, as well as pulling and termination of cables. Note that the connector cables from the FPVs would be landing at the shoreline of the same site and thus require a short section of cable burial from the shore to the integrated Project Substation. Potential surface water quality issues include site runoff as well as control of wastewater from the construction. As an embedded control, an ECM Plan would be prepared to control potential risk of soil erosion from works for the integrated Project Substation and land-based connector cable. All discharge from the ECM system should be well within the statutory limits.</p> <p>Impact magnitude is expected to be <b>Negligible</b> for the receiving water of the Kranji Reservoir and Sungei Pang Sua, where impacts are expected to be well within existing baseline/ statutory limits, given construction of the integrated Project Substation and cable connection will be well controlled by embedded measures.</p>			
C10	<p><b>Sediment disturbance from construction of O&amp;M berthing facility</b> (location subject to approval from agencies)</p>	<ul style="list-style-type: none"> <li>■ <b>Nature:</b> Degradation of surface water quality is considered <b>negative</b>.</li> <li>■ <b>Type:</b> In-reservoir construction of O&amp;M berthing facility could result in <b>direct</b> changes of surface water quality.</li> <li>■ <b>Duration:</b> Changes in surface water quality from disturbance to reservoir bed sediment from in-reservoir installation of O&amp;M berthing facility are relatively <b>short-term</b> (4 to 6 weeks) for surface water quality. Such changes are temporary and elevated turbidity will subside relatively quickly and return to baseline after completion of the active works. Release of pore water will result in temporary elevation of ambient levels of nutrients and contaminants, which will be diluted in the surrounding water, the change is considered temporary.</li> <li>■ <b>Extent:</b> Impacts are <b>localised</b> within the work area and the immediate surroundings.</li> <li>■ <b>Scale:</b> Elevated levels of suspended solids as well as other changes in surface water quality would likely be limited to less than 100 m from the work front and return towards baseline beyond this (in view of its potential sediment disturbance being far less than the potential piling/ anchoring work, whose impact was estimated to return to baseline levels at a distance of around 100 m from sediment disturbance source, according to the evaluation in <i>Appendix E of Appendix 6.1</i>).</li> <li>■ <b>Frequency:</b> Installation of O&amp;M berthing facility will happen <b>daily/ intermittently</b> during the specified period of construction phase</li> </ul> <p>Installation of O&amp;M work boat berthing facility will involve piling (&lt;10 no.) near the shoreline. The level of impact to reservoir bed sediment is expected to be similar or less than that of the initial works at the proposed temporary Staging/ Launching Area for ramp installation (see item C2 above). Level of localised disturbance from such installation works is expected to be within ambient levels.</p> <p>Impact magnitude is expected to be <b>Small</b> for the receiving water of the Kranji Reservoir, where impacts are expected to be within existing baseline/ statutory limits, given only minor sediment disturbance is expected from O&amp;M berthing facility installation with embedded controls.</p>	<p>Impact Magnitude: <b>Small</b></p> <p>Receptor Sensitivity: <b>High</b> (Kranji Reservoir/ tributaries/ PUB intakes)</p> <p>Impact Significance: <b>Moderate</b></p>	<ul style="list-style-type: none"> <li>■ Detailed design and construction methodology of reservoir-based O&amp;M berthing facility to minimise sediment disturbance, where feasible.</li> </ul> <p>Monitoring and adaptive management measures including:</p> <ul style="list-style-type: none"> <li>■ Agree construction phase surface water quality threshold criteria with PUB prior to works commencement, including action and limit levels.</li> <li>■ Establish construction phase surface water quality monitoring programme in agreement with PUB prior to works commencement, to inform the Developer/ Owner on any potential deterioration of surface water quality from the works (see item C4 above).</li> <li>■ In case surface water quality monitoring results indicate notable change in surface water quality in reservoir as a result of project works, agree with PUB on adoption of further mitigation measures, such as silt curtain around the two reservoir water intakes and/ or piling/ anchoring worksites, propose alternate construction methodologies, or to cease works temporarily.</li> </ul>	<p>Impact Magnitude: <b>Negligible</b></p> <p>Impact Significance: <b>Negligible</b></p>

BIODIVERSITY (SECTION 7)					
S/N	Impact	Impact Magnitude Description	Pre Mitigation Impact Significance	Mitigation Measures and Monitoring	Residual (with mitigation) Impact Significance
AQUATIC BIODIVERSITY					
C1	Benthic habitat/ fauna loss/ disturbance	<ul style="list-style-type: none"> <li><b>Nature:</b> Benthic habitat and fauna loss or degradation is considered <b>negative</b> for aquatic biodiversity.</li> <li><b>Type: Direct</b> loss in active worksites at geotechnical/ site investigation, anchoring and connector cable routing locations. Potential indirect disturbance during shallow workboat/ barge activities outside direct Project footprint.</li> <li><b>Duration:</b> Depending on the final design, these activities are to take place over approximately 104 weeks, which is considered relatively <b>long term</b> for biodiversity, and could be reversible upon removal of the Project.</li> <li><b>Extent: Localised</b> around the active worksite(s) of deployment.</li> <li><b>Scale:</b> Areas affected by geotechnical/ site investigations, laying anchors/ ballasted foundations/ piles and laying of connector cables (estimated to be approximately 2-2.5 ha, conservatively assuming up to 5,000 anchors at 2 (L)m x 2(W)m, see <i>Appendix 2.1</i>), and shallow work boat/ barge working areas.</li> <li><b>Frequency:</b> Deployments and activities will happen <b>daily/ intermittently</b> during the specified period of construction phase.</li> <li><b>Sensitive Receptor(s):</b> Aquatic habitat (Medium, including benthic), Aquatic plants (Low).</li> </ul> <p>Within the direct Project footprint (e.g. anchors/ ballasted foundations/ piles and connector cables) benthic habitat and vegetation will be lost.</p> <p>Per the Surface Water Quality impact assessment (<i>Section 6</i>), sediment suspension around works areas are anticipated to be limited within less than 100 m of work front, i.e. re-settlement will occur within this area disturbing benthic habitats. Surface water quality embedded controls will be established.</p> <p>Benthic habitats comprise mostly silty, slightly sandy substrates. The benthic fauna is biodiversity-poor and of low value, dominated by filtering collectors that forage fine particulate organic matter, and are expected to be tolerant to sedimentation and the existing lentic and eutrophic environment. Disturbance processes resulting in the removal and recolonisation of macroinvertebrates was observed during the sampling (e.g. site BC05 following rain events in March – May 2021). Rapid recolonisation was observed following disturbance.</p> <p>In areas outside of the Project footprint the benthic habitat/ benthos is expected to recover naturally and relatively quickly (within weeks) with no substantial change to the viability or function of the habitat or the benthic community overall.</p> <p>Impact magnitude is expected to be <b>Negligible</b> to <b>Small</b> for the aquatic biodiversity, where impacts are expected to (i) only affect a small area with no loss of habitat viability/ function, and/or (ii) not cause substantial change in species population or other species dependent on it, with embedded controls for surface water quality; given the low value benthic fauna, ability to recolonise and the relatively small area of directly lost benthic habitat.</p>	<p>Impact Magnitude: <b>Small</b></p> <p>Receptor Sensitivity: <b>Medium</b></p> <p>Impact Significance: <b>Minor</b></p>	<p>Mitigation measures presented in the Surface Water Quality <i>Section 6</i> will be applied. In addition to:</p> <ul style="list-style-type: none"> <li>Detailed design and construction methodology of reservoir-based geotechnical/ site investigations, FPV layout, anchoring method and connector cables to optimise/ minimise footprint, where feasible.</li> </ul>	<p>Impact Magnitude: <b>Negligible</b></p> <p>Impact Significance: <b>Negligible</b></p>
C2	Elevation of suspended sediments within the reservoir	<ul style="list-style-type: none"> <li><b>Nature:</b> Elevation of suspended sediments within the reservoir is considered <b>negative</b> for aquatic biodiversity.</li> <li><b>Type: Indirect</b> adjacent to active worksites (e.g. geotechnical/ site investigation, anchoring and connector cable routing locations).</li> <li><b>Duration:</b> Depending on the final design, these activities are to take place over approximately 104 weeks, which is considered relatively <b>long term</b> for aquatic biodiversity. Elevated turbidity from works will subside relatively quickly and the change is temporary.</li> <li><b>Extent: Localised</b> around the active worksite(s) of deployment. Note that deployment of geotechnical/ site investigations, anchors/ ballasted foundation, piles and mooring lines</li> </ul>	<p>Impact Magnitude: <b>Small</b></p> <p>Receptor Sensitivity: <b>Medium</b></p> <p>Impact Significance:</p>	<p>Mitigation measures presented in the Surface Water Quality <i>Section 6</i> will be applied to inform need for adaptive management (see <i>Section 4.7.1</i> for further details on adaptive management approaches).</p>	<p>Impact Magnitude: <b>Negligible</b></p> <p>Impact Significance: <b>Negligible</b></p>

BIODIVERSITY (SECTION 7)					
S/N	Impact	Impact Magnitude Description	Pre Mitigation Impact Significance	Mitigation Measures and Monitoring	Residual (with mitigation) Impact Significance
		<p>will be conducted in phases across the reservoir. This means affected area would be localised at any one time.</p> <ul style="list-style-type: none"> <li>■ <b>Scale:</b> Elevated levels of suspended solids would likely be limited to less than 100 m from the work front (per <i>Section 6</i>) and return towards baseline beyond this.</li> <li>■ <b>Frequency:</b> Deployments and activities will happen <b>daily/ intermittently</b> during the specified period of construction phase.</li> <li>■ <b>Sensitive Receptor(s):</b> Aquatic habitats (Medium), Fish (Medium), Aquatic plants (Low).</li> </ul> <p>The in-reservoir work activities are expected to result in temporary and localised disturbance of reservoir bed sediment. Per the Surface Water Quality impact assessment (<i>Section 6</i>), it is estimated that the elevation of suspended solids would likely be at the level of 5.3 mg/L at 100 m from the active works area and would be even lower at further distances. Surface water quality embedded controls will be established.</p> <p>Any increased load of suspended sediments could reduce light penetration and the depth of photosynthetic activity by phytoplankton and submerged macrophytes. In addition, it could increase heat absorption and consequently reduce dissolved oxygen concentrations. This would negatively affect zooplankton and fish. The increased turbidity also could reduce predation pressure of fish on zooplankton, and perhaps increase grazing pressure on phytoplankton.</p> <p>The tolerance of each organism to the concentration of suspended sediment will vary between taxa (macrophyte, phytoplankton, zooplankton and fish) and their different life stages (larva, juvenile and adult).</p> <p>Fish have been shown to experience sub-lethal stress from suspended sediments rather than mortality because they are able to relocate to more suitable habitat (Kjelland, M. et al 2015).</p> <p>Total suspended solid (TSS) levels were recorded at or around 10mg/L throughout this EIA baseline. The fish and other fauna within the reservoir are adapted to conditions typical of high suspended sediment and turbidity. The recommended safe limit of TSS is 30mg/l for controlled watercourses as per NEA. Griffiths and Watson (1978) showed that the tolerance for TSS for macroinvertebrates was between 10 – 15 mg/L, and Nicholls et al. 2003 showed increased mortality at TSS levels &gt;300 mg/L for some macroinvertebrates.</p> <p>Impact magnitude is expected to conservatively be <b>Small</b> for the aquatic biodiversity, where impacts are expected to (i) only affect a small area with no loss of habitat viability/ function, and/or (ii) not cause substantial change in species population or other species dependent on it, with embedded controls for surface water quality; given the current baseline and tolerances of aquatic flora and fauna to suspended sediments</p>	Minor		
C3	Elevation of pollutants and/or nutrients within the reservoir	<ul style="list-style-type: none"> <li>■ <b>Nature:</b> Elevation of pollutants and/ or nutrients within the reservoir is considered <b>negative</b> for aquatic biodiversity.</li> <li>■ <b>Type:</b> <b>Indirect</b> adjacent to active worksites (e.g. at geotechnical/ site investigation, anchoring and connector cable routing locations).</li> <li>■ <b>Duration:</b> Depending on the final design, these activities are to take place over approximately 104 weeks, which is considered relatively long term for aquatic biodiversity. Release of porewater will result in temporary elevation of ambient levels of nutrients and contaminants, which will be diluted in the surrounding water, the change is considered temporary.</li> <li>■ <b>Extent:</b> <b>Localised</b> around the active worksite(s) of deployment. Note that deployment of geotechnical/ site investigations, anchors/ ballasted foundation, piles and mooring lines will be conducted in phases across the reservoir. This means affected area would be localised at any one time.</li> </ul>	<p>Impact Magnitude: <b>Medium</b></p> <p>Receptor Sensitivity: <b>Medium</b></p> <p>Impact Significance: <b>Moderate</b></p>	<p>Mitigation measures presented in the Surface Water Quality <i>Section 6</i> will be applied to inform need for adaptive management.</p> <p>Monitoring and adaptive management measures including:</p> <ul style="list-style-type: none"> <li>■ Establish construction phase biodiversity monitoring programme in agreement with relevant Government authorities prior to works commencement, to inform the Developer/ Owner on any potential disturbance to biodiversity from the works.</li> <li>■ Biodiversity monitoring to include: plankton (zooplankton and phytoplankton), fish biomass and size.</li> </ul>	<p>Impact Magnitude: <b>Small</b></p> <p>Impact Significance: <b>Minor</b></p>

BIODIVERSITY (SECTION 7)					
S/N	Impact	Impact Magnitude Description	Pre Mitigation Impact Significance	Mitigation Measures and Monitoring	Residual (with mitigation) Impact Significance
		<ul style="list-style-type: none"> <li>■ <b>Scale:</b> Changes in surface water quality would likely be limited to less than 100 m from the work front (per <i>Section 6</i>) and return towards baseline beyond this.</li> <li>■ <b>Frequency:</b> Deployments and activities will happen <b>daily/ intermittently</b> during the specified period of construction phase.</li> <li>■ <b>Sensitive Receptor(s):</b> Aquatic habitats (Medium), Fish (Medium), Aquatic plants (Low).</li> </ul> <p>The in-reservoir work activities are expected to result in temporary and localised disturbance of reservoir bed sediment. Per the Surface Water Quality impact assessment (<i>Section 6</i>), it is estimated that for release of sediment-bound nitrogen and phosphorus that the released total nitrogen and total phosphorus from the piling works would be below 0.25% and 0.03% of the catchment load, respectively. For sediment-bound contaminants including arsenic, cadmium and lead, analysis indicated the potential release of these contaminants would be negligible. Surface water quality embedded controls will be established.</p> <p>The increased pollutant concentrations in the water could affect fish survival.</p> <p>Should there be a pulse of phosphorus into the water, this may trigger a change in the phytoplankton community (as observed following storm events during the baseline). Potentially, in a conservative case, a phytoplankton bloom could possibly occur if warmer meteorological conditions prevail at the same time. However, it is understood blooms have not occurred during the construction of other FPVs on Singapore reservoirs (Yang et al., 2022).</p> <p>The impact magnitude is expected to conservatively be <b>Medium</b> for the aquatic biodiversity, where impacts are expected to (i) affect part of the habitat but not threaten long-term habitat viability/ function, and/or (ii) cause a substantial change in abundance and/or the reduction in distribution of a population over one or more generations but does not threaten the long-term viability / function of that population, or any population dependent on it, with embedded controls for surface water quality; and given the potential affect on fish survival and implications of phosphorus on phytoplankton,</p>			
C4	Changes due to trimming of aquatic vegetation	<ul style="list-style-type: none"> <li>■ <b>Nature:</b> Trimming and decomposition of aquatic vegetation could lead to <b>negative</b> impacts for aquatic biodiversity.</li> <li>■ <b>Type:</b> Trimming of aquatic vegetation in the top 1m of the water column would <b>directly</b> impact aquatic plants. Trimming and decomposition (assuming conservative case of waste vegetation not being collected and being allowed to decompose in the water column), would <b>indirectly</b> impact aquatic habitat and both aquatic and terrestrial species.</li> <li>■ <b>Duration:</b> Trimming of aquatic vegetation would be carried out in phases before works activities in different areas of the reservoir commence (due to rapid regeneration of the aquatic vegetation) throughout the in-reservoir construction period (approximately 104 weeks), which is considered to be relatively <b>long-term</b> for aquatic biodiversity. If any trimmings of aquatic vegetation are left in-reservoir they would likely settle into the sediment and decay slowly. The effect of decomposition of these cut vegetation would diminish over time but could linger beyond the construction period. The effect of vegetation trimming and FPV shading will be permanent throughout the Project operational phase.</li> <li>■ <b>Extent:</b> Conservatively, vegetation trimming works could cover the entirety of the Reservoir Project Site within the Kranji Reservoir, to be carried out in phases. Direct impacts would be <b>localised</b> within the work areas of the current work phase and the immediate surroundings, whereas indirect impacts may extend across the reservoir.</li> <li>■ <b>Scale:</b> Conservatively, the effect of the release of nutrients and depletion of dissolved oxygen associated with the decomposition of trimmed vegetation left in-reservoir would likely be limited to less than 100 m from the work front given the small vegetation amounts and the lack of notable change in surface water quality from existing regular aquatic vegetation removal works.</li> </ul>	Impact Magnitude: <b>Small</b>  Receptor Sensitivity: <b>Medium</b>  Impact Significance: <b>Minor</b>	<p>Mitigation measures presented in the Surface Water Quality <i>Section 6</i> will be applied to inform need for adaptive management. In addition to:</p> <ul style="list-style-type: none"> <li>■ Detailed design and construction methodology of reservoir-based works to manage aquatic vegetation trimming, as appropriate in consultation with PUB.</li> </ul> <p>Monitoring and adaptive management measures including:</p> <ul style="list-style-type: none"> <li>■ Establish construction phase biodiversity monitoring programme in agreement with relevant Government authorities prior to works commencement, to inform the Developer/ Owner on any potential deterioration of biodiversity from the works. <ul style="list-style-type: none"> <li>- Biodiversity monitoring to include: fish biomass and size.</li> </ul> </li> <li>■ Should monitoring show a decline in fish biomass, the Developer/ Owner to consider opportunities, in consultation with relevant Government authorities, for additional nature based solutions, e.g. for fish habitat enhancement in the retained habitats areas within the reservoir, for example: <ul style="list-style-type: none"> <li>- Patches of floating vegetation to be retained, where feasible, in the Reservoir Project Site, subject to the FPV system's and PUB's reservoir operational requirements.</li> <li>- If the fish population is observed to be significantly affected despite above adaptive measures then consider other adaptive management which may include, for example, potential layout changes, removal of FPV panels, etc where appropriately agreed between responsible agencies and the Developer/ Owner.</li> </ul> </li> </ul>	Impact Magnitude: <b>Negligible</b>  Impact Significance: <b>Negligible</b>

BIODIVERSITY (SECTION 7)					
S/N	Impact	Impact Magnitude Description	Pre Mitigation Impact Significance	Mitigation Measures and Monitoring	Residual (with mitigation) Impact Significance
		<ul style="list-style-type: none"> <li>■ <b>Frequency:</b> Trimming of aquatic vegetation will happen <b>intermittently</b> during the specified period of construction phase.</li> <li>■ <b>Sensitive Receptor(s):</b> Aquatic habitat (Medium, also considering secondary values for supporting terrestrial species), Aquatic plants (Low), Fish (Medium).</li> </ul> <p>It should be noted that existing removal of aquatic vegetation is regularly conducted (daily) in Kranji Reservoir by PUB without notable adverse surface water quality impacts being recorded. Such regular operations results in controlling the spread of aquatic (floating) vegetation coverage which typically serves as additional habitats for the wildlife. It is noted PUB indicate that they have not observed fauna using the vegetation as nesting grounds.</p> <p>Removal of aquatic (floating) vegetation will increase/ maintain light penetration into the reservoir temporarily prior to FPV deployment. This will benefit phytoplankton growth and submerged macrophytes growing below trimming depth.</p> <p>Aquatic vegetation removal may restrict the additional provision of habitat complexity (increased homogeneity) and shelter used by fish and zooplankton. The Asian arowana (introduced globally EN) spends the day hiding and forages at night. The species is practicing mouthbrooding and is therefore not relying on vegetation for reproduction (Scott &amp; Fuller, 1976).</p> <p>Fringing aquatic vegetation along the shoreline (within the minimum 25 m setback areas) will continue to provide habitat for sheltering.</p> <p>Given most of the aquatic vegetation is non-native and/ or invasive, its trimming may potentially have an overall <i>Positive</i> impact for biodiversity.</p> <p>For the conservative case of the trimmings of aquatic vegetation in the top 1m of the water column being left to decompose in the reservoir, the trimmed cuttings would sink to the reservoir bed and enrich the benthos with nutrients. Bacteria will decompose the cuttings and increase in abundance, which will likely reduce oxygen concentrations and pH. The lower pH is likely to result in the release of Phosphorus from benthic sediment, making it available to algal growth. This internal loading process could possibly reduce dissolved oxygen and result in an algal bloom and/or fish deaths. Per the Surface Water Quality impact assessment (<i>Section 6</i>), were the top 1m of all the aquatic vegetation within the Reservoir Project Site to be cut off at the same time (unlikely), and start decomposing and releasing nutrients immediately (unlikely), the addition of total phosphorus, total nitrogen and total carbon in the 1<sup>st</sup> month will be approximately 3%, 3% and 2% of the existing fluxes into the reservoir (catchment loadings, mineralisation, and atmospheric deposition). These nutrient inputs are less than the variation in monthly fluxes for the catchment runoff. Daily release will be very small and limited to local areas.</p> <p>Overall, impact magnitude is expected to be <b>Small</b> for the aquatic and terrestrial biodiversity, where impacts are expected to (i) only affect a small area with no loss of habitat viability/ function, and/or (ii) not cause substantial change in species population or other species dependent on it, with embedded controls for surface water quality; and given the existing regular (daily) removal of aquatic vegetation, species of concern (Asian arowana), very small changes in nutrients from the conservative vegetation decomposition, and potential positive removal of non-native/ invasive species.</p>			

BIODIVERSITY (SECTION 7)					
S/N	Impact	Impact Magnitude Description	Pre Mitigation Impact Significance	Mitigation Measures and Monitoring	Residual (with mitigation) Impact Significance
C5	Disturbance to aquatic fauna (piling, boat movements)	<ul style="list-style-type: none"> <li><b>Nature:</b> Disturbance to aquatic fauna is considered <b>negative</b> for aquatic biodiversity.</li> <li><b>Type:</b> Both <b>direct</b> within active worksites, and <b>indirect</b> impacts within the reservoir are expected to aquatic fauna.</li> <li><b>Duration:</b> In-reservoir activities will be carried out throughout the in-reservoir construction period (approximately 104 weeks), whereas depending on the anchoring approach, the installation of piles/ anchors/ ballasted foundations could take up to 70 weeks, both of which are considered to be relatively <b>long-term</b> for aquatic biodiversity. The change is considered temporary.</li> <li><b>Extent:</b> Direct impacts are <b>localised</b> within the active worksite(s) and the immediate surroundings. Note that activities will be conducted in phases across the reservoir. This means affected area would be localised at any one time. Whereas indirect impacts may extend across the reservoir.</li> <li><b>Scale:</b> Areas affected by active worksites in Reservoir Project Site, and wider reservoir.</li> <li><b>Frequency:</b> Activities will happen <b>daily/ intermittently</b> during the specified period of construction phase.</li> <li><b>Sensitive Receptor(s):</b> Aquatic habitat (Medium).</li> </ul> <p>See also item C7 below on terrestrial fauna disturbance from piling.</p> <p>Construction works will include geotechnical/ site investigations, piling (conservatively assuming up to 4 simultaneous driven piles at the same location in the western portion of the reservoir, and 2 simultaneous driven piles at the same location in the eastern portion of the reservoir) and up to 8 working boats installing FPV and other in-reservoir infrastructure.</p> <p>Underwater noise and vibration might deter fish from important feeding and reproduction areas, interrupt critical activities or cause stress-induced reduction in growth and reproductive output. However, there is a lack of data regarding these behavioural responses of increased noise in fish (Slabbekoom et al. 2010). It is assumed, that construction works in the reservoir would temporarily displace fish to the south of the reservoir, or to other areas in the reservoir away from active work fronts or designated, regularly used vessel routes.</p> <p>Overall, impact magnitude is expected to be <b>Medium</b> for the aquatic biodiversity, where impacts are expected to (i) affect part of the habitat but not threaten long-term habitat viability/ function, and/or (ii) cause a substantial change in abundance and/ or the reduction in distribution of a population over one or more generations but does not threaten the long-term viability/ function of that population, or any population dependent on it, with embedded controls for surface water quality; and given the small worksites and ability of aquatic fauna to temporarily move to non-affected areas of the reservoir and embedded controls.</p>	<p>Impact Magnitude: <b>Medium</b></p> <p>Receptor Sensitivity: <b>Medium</b></p> <p>Impact Significance: <b>Moderate</b></p>	<p>Mitigation measures presented in the Surface Water Quality <i>Section 6</i> will be applied to inform need for adaptive management.</p> <p>Monitoring and adaptive management measures including:</p> <ul style="list-style-type: none"> <li>Establish construction phase biodiversity monitoring programme in agreement with relevant Government authorities prior to works commencement, to inform the Developer/ Owner on any potential deterioration of biodiversity from the works. <ul style="list-style-type: none"> <li>Biodiversity monitoring to include: plankton (zooplankton and phytoplankton), fish biomass and size.</li> </ul> </li> </ul> <p>Also see mitigation measures presented in item C7 below on terrestrial fauna disturbance from piling.</p>	<p>Impact Magnitude: <b>Small</b></p> <p>Impact Significance: <b>Minor</b></p>
TERRESTRIAL BIODIVERSITY					
C6	Terrestrial habitat clearing/ fragmentation	<ul style="list-style-type: none"> <li><b>Nature:</b> Terrestrial habitat clearing/ fragmentation is considered <b>negative</b> for terrestrial biodiversity.</li> <li><b>Type:</b> <b>Direct</b> loss along approximately 150m strip of shoreline habitat at the proposed temporary Staging/ Launching Area and integrated Project Substation worksite.</li> <li><b>Duration:</b> Vegetation clearance to be over 2 to 4 weeks, relatively short term for terrestrial biodiversity. The gap/ fragmentation of habitat will remain throughout the construction period (approximately 3 years), which is considered to be relatively <b>long-term</b> for terrestrial biodiversity. Change is considered temporary based on embedded controls (e.g. re-planting/ landscaping). Future land use planning for this eastern shoreline is designated as a Park.</li> <li><b>Extent:</b> <b>Localised</b> at the approximate 150 m at the proposed temporary Staging/ Launching Area worksite and surrounding habitats.</li> </ul>	<p>Impact Magnitude: <b>Small</b></p> <p>Receptor Sensitivity: <b>High</b></p> <p>Impact Significance: <b>Moderate</b></p>	<ul style="list-style-type: none"> <li>Detailed design and construction methodology of the proposed temporary Staging/ Launching Area and integrated Project Substation worksite to optimise/ minimise footprint and vegetation clearance, where feasible.</li> <li>Avoid felling trees and clearing vegetation during the peak bird breeding season (March to July).</li> <li>Pre-felling fauna inspection by qualified Biodiversity Specialist should be conducted before felling any trees or removing any vegetation.</li> <li>Re-plant shoreline vegetation as early as possible in the construction schedule: <ul style="list-style-type: none"> <li>Plant keystone flora such as fig trees. They provide important food source for avian fauna and small mammals. It is recommended that only native plant species are planted.</li> </ul> </li> </ul>	<p>Impact Magnitude: <b>Negligible</b></p> <p>Impact Significance: <b>Negligible</b></p>

BIODIVERSITY (SECTION 7)					
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		<ul style="list-style-type: none"> <li>■ <b>Scale:</b> Clearance of vegetation along the approximately 150m shoreline (conservatively estimated to be less than 1 ha).</li> <li>■ <b>Frequency:</b> <b>Direct</b> vegetation clearance will be one-off. Fragmented habitat will remain throughout construction.</li> <li>■ <b>Sensitive Receptor(s):</b> Terrestrial habitats at clearance area (Low), Terrestrial habitats to south of clearance area (Sungei Kadut forest, High), Terrestrial plants (High), Invertebrates (High), Birds including black-crowned night heron (High), Reptiles (Medium), Otter (High), Bats (Medium).</li> </ul> <p>The proposed temporary Staging/ Launching Area and integrated Project Substation will take place on already-disturbed, cleared land within Sungei Kadut Industrial Estate.</p> <p>The vegetation in the shoreline of this worksite and further north is largely dominated by tall grasses with scattered trees. No semi-natural or natural terrestrial habitats of high value will be cleared for the waterfront access for the proposed temporary Staging/ Launching Area (including launching ramp), and connector cable launching point and O&amp;M Berthing Facility (location subject to approval from agencies). These areas to be cleared have negligible biodiversity value. The shoreline is to be re-planted after construction.</p> <p>To the south of the worksite is the Sungei Kadut forest (High sensitivity), and black-crowned night herons (nationally EN, High sensitivity) temporary roosts have been identified in the shoreline habitat to the north. The area to be cleared does not represent good quality habitat for connectivity, and the habitat to the north is considered of low value. No other species of conservation concern have been identified in the area to be cleared. Embedded controls apply the Urban Design Guidelines and greening/ planting for the final integrated Project Substation. With the future land use of the shoreline (to the north and south) designated as a Park, some future modification of these habitats is anticipated.</p> <p>Impact magnitude is expected to conservatively be <b>Small</b> for the terrestrial biodiversity, where impacts are expected to (i) only affect a small area with no loss of habitat viability/ function, and/ or (ii) not cause substantial change in species population or other species dependent on it, with embedded controls; given the status of the current surrounding habitats and species identified in the baseline, and future land use designation.</p>		<ul style="list-style-type: none"> <li>- It is recommended to select a diversity of flowering and fruiting plants species so that the area will be flowering and fruiting throughout the year to provide food and improve ecological processes.</li> <li>- Consult with NParks on the land-based worksite re-planting/ landscaping scheme considering the future land use of the shoreline as Park.</li> <li>■ Ensure there are no works outside of the in-reservoir and land-based worksites.</li> </ul> <p>Also see mitigation measures presented in item C7 below on terrestrial fauna disturbance.</p>	
C7	Disturbance to terrestrial fauna (piling in reservoir)	<ul style="list-style-type: none"> <li>■ <b>Nature:</b> Disturbance to terrestrial fauna from piling in reservoir is considered <b>negative</b>.</li> <li>■ <b>Type:</b> <b>Indirect</b> impacts within the reservoir are expected to terrestrial fauna.</li> <li>■ <b>Duration:</b> Depending on the final design of anchoring to be adopted, the installation of in-reservoir piles could take up to 56 weeks (see <i>Appendix 2.1</i>), which is considered to be relatively <b>long-term</b> for terrestrial biodiversity. Works activities are considered temporary.</li> <li>■ <b>Extent:</b> <b>Localised</b> around the active worksite(s) and the immediate surroundings.</li> <li>■ <b>Scale:</b> Within the Reservoir Project Site.</li> <li>■ <b>Frequency:</b> Activities will happen <b>daily/ intermittently</b> during the specified period of construction phase.</li> <li>■ <b>Sensitive Receptor(s):</b> Protected Areas and Designated Sites (High), Birds (High), Smooth-coated Otter (High).</li> </ul> <p>Construction works will include daytime geotechnical/ site investigations, piling (conservatively assuming up to 4 simultaneous driven piles at the same location in the western portion of the reservoir, and 2 simultaneous driven piles at the same location in the eastern portion of the reservoir) and up to 8 working boats installing FPV and other in-reservoir infrastructure.</p> <p>A minimum 25 m shoreline setback is established on the western shoreline (under the unmitigated maximum FPV layout). Typically in-reservoir infrastructure is over 50m from the</p>	<p>Impact Magnitude: <b>Negligible to Small</b></p> <p>Receptor Sensitivity: <b>Medium to High</b></p> <p>Impact Significance: <b>Minor to Moderate</b></p>	<p><u>In-reservoir Piling</u></p> <ul style="list-style-type: none"> <li>■ Detailed design and construction methodology of reservoir-based piles to optimise/ minimise extent and number of piles, simultaneous piling workstations (e.g. in-reservoir piling activities could be controlled according to works phasing, intensity, distance between piling workstations, distance from the shoreline, etc.), etc where feasible, with due consideration of this C7 and <i>Appendix 7.7</i>.</li> <li>- Minimise use of driven piling. Use low-noise piling methods instead, e.g. vibratory piling or bored/drilling piling. If driven piles is selected, apply noise mitigation measures, e.g. ramp up piling gradually, install enclosed shrouds around the piling equipment etc. Based on ERM's existing database, the noise level reduction for enclosed shrouds is predicted to be up to 9 dB(A).</li> <li>■ A setback of distance of 50 m from FPV panels to western shoreline of Kranji Reservoir, where relatively higher bird foraging was observed, will be established as a biodiversity mitigation, as suggested by stakeholders, to give greater confidence in the ability of the mitigated biodiversity FPV layout to reduce impacts on biodiversity associated with disturbance and displacement along the western shoreline. With the 50 m western shoreline setback to the FPV layout and pile enclosed shrouding (see <i>Appendix 7.7, Tables 1B to 6B</i>):</li> <li>- The noise level for 4 <u>mitigated</u> (enclosed shrouded), simultaneous adjacent piling workstations would be 66 dB(A) (i.e. &lt;70 dB(A)) at Kranji Marshes and</li> </ul>	<p>Impact Magnitude: <b>Negligible to Small (retained on precautionary basis)</b></p> <p>Impact Significance: <b>Minor to Moderate (retained on precautionary basis)</b></p>



BIODIVERSITY (SECTION 7)					
S/N	Impact	Impact Magnitude Description	Pre Mitigation Impact Significance	Mitigation Measures and Monitoring	Residual (with mitigation) Impact Significance
		<p>eastern shoreline, due to PUB reservoir operations requirements for a 50 m north-south vessel corridor at prescribed water depths.</p> <p>The driven piling activities (conservatively assessed as the more impactful installation method) will be carried out in phases across the reservoir in daytime throughout the construction period, hence active worksites will be restricted to very small areas.</p> <p>The anticipated airborne noise and vibration levels from piling activities have been evaluated in <i>Section 9, Airborne Noise &amp; Vibration</i>, based on human receptor thresholds. These thresholds are not directly applicable to fauna, since some species have sensory receptors which have perception ranges and sensitivities that are above and/ or below the ranges of human perception and sensitivity (Fraser et al. 2000). Accordingly, additional assessment is provided below. An assessment matrix for disturbance by piling noise for sensitive terrestrial fauna receptors can also be found in <i>Appendix 7.6</i>. An assessment of noise propagation from piling on the reservoir (based on conservative assumptions) has been carried out, see <i>Appendix 7.7</i>.</p> <p>The main receptors to in-reservoir driven piling include:</p> <ul style="list-style-type: none"> <li>■ SBWR, Mandai Mangroves and Mudflats, Kranji Marshes and Gemala Nature Area.</li> <li>■ High value species nesting or roosting, i.e. black-crowned night heron (nationally EN), grey headed fish eagle (nationally VU), straw-headed bulbul (globally CR), and White-bellied sea eagle (nationally LC).</li> <li>■ Other forest birds (globally and nationally EN and VU) in Sungei Kadut Forest.</li> <li>■ Wetland birds foraging around the reservoir edges (nationally EN and VU), including little tern (nationally EN), herons and egrets.</li> <li>■ Smooth-coated otter (nationally EN).</li> </ul> <p>The Cutts et al. 2009 study entitled “<i>Construction and Waterfowl: Defining Sensitivity, Response, Impacts and Guidance</i>” (by the Institute of Estuarine and Coastal Studies, University of Hull, UK) found moderate to high disturbance effects on foraging waterbirds for irregular piling noise &gt; 70 dB(A) and low to moderate effects for regular piling noise &lt; 70 dB(A) with birds habituating to effects over time. Birds were found to react differently in different situations and at different times of the year.</p> <p>In addition, per <i>Section 9 (Airborne Noise &amp; Vibration), Table 9-13</i> background noise monitoring considered representative of the western shoreline of the reservoir, i.e. at NSRCC Kranji Sanctuary Golf Course, identified daytime (7am – 7pm) levels to be 62 dB(A). On the eastern shoreline, background noise monitoring (<i>Section 9, Table 9-11</i>) indicated average noise levels adjacent to the shoreline forest strip at the proposed temporary Staging/ Launching Area to be approximately 64 dB(A) (ranging from 57-72 LAeq, 12 hours; and 38-89 LAeq, 5 mins) in the daytime (7am – 7pm).</p> <p>On a precautionary basis, the following assessment considers the background noise monitoring levels of 62 (western shoreline) - 64 (eastern shoreline) dB(A) along with the identified 70 dB(A) noise threshold by Cutts et al. 2009.</p> <p>In the western portion of the reservoir, modelled noise levels (see <i>Appendix 7.7, Table 1A</i>) predict sound levels to be &lt;70 dB(A) at a distance of approximately 90 m from the conservative piling works scenario (i.e. 4 piling workstations carrying out piling simultaneously at the same location). In other words, disturbance to waterbirds would likely be caused within 90 m of 4 unmitigated, simultaneous adjacent piling operations. To achieve levels of &lt;62</p>		<p>Gemala Nature Area boundary. To achieve noise levels of 62 dB(A) at Kranji Marshes and Gemala Nature Area boundary, the 4 <u>mitigated</u> (enclosed shrouded), simultaneous adjacent piling workstations would need to be 80 m away from the boundaries of these areas.</p> <ul style="list-style-type: none"> <li>- The noise level for 3 <u>mitigated</u> (enclosed shrouded) simultaneous adjacent piling workstations would be &lt;70dB(A) at 30 m away, and &lt;62 dB(A) at 75 m away, from the boundaries of these areas.</li> <li>- The noise level for 2 <u>mitigated</u> (enclosed shrouded) simultaneous adjacent piling workstations would be &lt;70dB(A) at 25 m away, and &lt;62 dB(A) at 60 m away, from the boundaries of these areas, i.e. given the 50 m mitigated biodiversity western setback to FPV layout and 20 m Kranji bund width to the Kranji Marshes boundary (total 70 m), 2 mitigated (enclosed shrouded), simultaneous adjacent piling workstations achieves the 70 dB(A) and 62 dB(A) guideline and baseline thresholds for the Kranji Marshes.</li> <li>- The noise level for 1 <u>mitigated</u> (enclosed shrouded) piling workstation would be &lt;62 dB(A) at 40 m away from the boundaries of these areas, i.e. given the 50 m mitigated biodiversity western setback to FPV layout 1 mitigated (enclosed shrouded) piling workstation achieves the 62 dB(A) baseline thresholds for the Gemala Nature Area.</li> </ul> <ul style="list-style-type: none"> <li>■ On the eastern shoreline, to achieve noise levels of &lt;70 dB(A) and &lt;64 dB(A) the 2 <u>mitigated</u> (enclosed shrouded), simultaneous adjacent piling workstations would need to be 25 m and 45 m away, respectively, i.e. given the eastern 50 m PUB north-south vessel corridor, 2 mitigated (enclosed shrouded), simultaneous adjacent piling workstations achieves the 70 dB(A) and 64 dB(A) guideline and baseline thresholds.</li> <li>■ Apply mitigation related to vessel navigation (see Surface Water Quality, <i>Section 6</i>), e.g. regular traffic routes should be established for routine works. Offset from shoreline as well as corridors between FPV islands allow safe navigation access, this will minimise the risk of disturbing bird shoreline foraging areas.</li> </ul> <p><u>General</u></p> <ul style="list-style-type: none"> <li>■ Regulate contractor movements and activities to areas only within the construction and operational footprint (i.e. in the Reservoir Project Site), and prohibiting access to other areas without prior agreement of the Site’s Environmental Manager (e.g. retained terrestrial and aquatic habitats and parts of the setback zone around the reservoir edges not required for access).</li> <li>■ Establish a Wildlife Incident Response Plan and Reporting (including for birds, bats, snakes, crocodiles etc.) to be enacted when a trapped/ injured/ dead/ dangerous animal is encountered around or within the worksite.</li> <li>■ Conduct regular inspections to ensure compliance and identify impacts to adjacent biodiversity areas, fauna entrapments etc.</li> <li>■ Train site personnel on biodiversity awareness and actions to take when encountering wildlife.</li> <li>■ Erosion control blankets should be removed after construction to avoid trapping fossorial fauna.</li> </ul> <ul style="list-style-type: none"> <li>■ Monitoring and adaptive management measures including:</li> <li>■ Establish construction phase noise monitoring programme in agreement with relevant Government authorities prior to works commencement, to inform the Developer/ Owner on any potential impact of noise from the works, e.g. in the vicinity of Kranji Marshes, the black-crowned night heron roosts, and the proposed temporary Staging/ Launching Area and the integrated Project Substation worksite.</li> </ul>	

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		<p>dB(A), a distance of 225 m is required from 4 unmitigated, simultaneous adjacent piling operations.</p> <p><u>SBWR and Mandai Mangroves and Mudflats</u></p> <p>SBWR and Mandai Mangroves and Mudflats are more than 225m from the Reservoir Project Site works area. Therefore, the impact magnitude is expected to be <i>Negligible</i> at these Protected Areas, where impacts are expected to be within normal range of natural variation for the habitat, or population of the species, including migratory birds resting at SBWR.</p> <p><u>Kranji Marshes (570,000 m<sup>2</sup>)</u></p> <p>The nearest potential piling location to the Kranji Marshes is east of the Kranji bund. It is noted that Kranji Marshes' nearest boundary to the Reservoir Project Site is on the western side of Kranji bund. The Kranji bund is on average (based on satellite analysis) 20 m wide. A minimum setback of 25 m from the reservoir shoreline to the Reservoir Project Site is also established as an embedded control. Therefore, it is assumed that piling will be at least 45m (i.e. 20 m + 25 m) from the Kranji Marsh boundary at its nearest.</p> <p>Assuming 4 unmitigated, simultaneous adjacent piles took place at the nearest point to the Kranji Marshes boundary (i.e. 45 m away), then noise levels would be 76 dB(A) (see <i>Appendix 7.7, Table 1A</i>). An estimated maximum area of around 5,550 m<sup>2</sup> within Kranji Marshes would be affected by noise over 70 dB(A), and an area of around 60,780 m<sup>2</sup> would be affected by noise over 62 dB(A). Given the total area of Kranji Marshes is 570,000 m<sup>2</sup>, the conservative impact area from 4 unmitigated simultaneous adjacent piling workstations 25 m from the reservoir shoreline would equal &lt;1% (70dB(A)) and &lt;11% (62 dB(A)) of the total Kranji Marshes area and the impact magnitude is expected to be <i>Negligible to Small</i>, given the ability of affected fauna to move away from noise disturbance into other areas of the Protected Area, where impacts are expected to be within normal range of natural variation for the habitat, or population of the species with embedded controls.</p> <p>To achieve noise levels of &lt;70 dB(A) and &lt;62 dB(A) at Kranji Marshes boundary for 4 unmitigated, simultaneous adjacent piles, the 4 piling workstations would need to be 90 m and 225 m away, respectively, from the boundary of Kranji Marshes (see <i>Appendix 7.7, Table 1A</i>).</p> <p>Assuming, for example, 1 unmitigated piling workstation was 25m setback from the western shoreline (i.e. 45 m from Kranji Marshes boundary at its nearest), then noise levels would be 70 dB(A) at the nearest edge of Kranji Marshes and 62 dB(A) would be achieved at a distance of 115 m (see <i>Appendix 7.7, Table 4A</i>). A maximum area of around 90 m<sup>2</sup> (0.02%) of Kranji Marshes would be affected by noise over 70 dB(A), and an area of 11,500m<sup>2</sup> (2%) would be affected for noise over 62 dB(A) in this scenario.</p> <p><u>Gemala Nature Area (201,000 m<sup>2</sup>)</u></p> <p>The nearest distance between the Reservoir Project Site and the Gemala Nature Area is approximately 40 m. If 4 unmitigated, simultaneous piles took place at a distance of 40 m, the noise level at the boundary of the Gemala Nature Area would be 77 dB(A) (see <i>Appendix 7.7, Table 1A</i>). An area of approximately 4,500 m<sup>2</sup> would be affected by noise over 70 dB(A), and an area of around 44,700m<sup>2</sup> would be affected by noise over 62 dB(A). Given the total area of Gemala Nature Area is approximately 201,000 m<sup>2</sup>, the impact would equal 2.2% (70dB(A)) and 22% (62 dB(A)) of the area. In order to achieve noise levels of &lt;70 dB(A) and &lt;62 dB(A) unmitigated, simultaneous adjacent piles, the 4 piling workstations would need to be 90 m and</p>		<ul style="list-style-type: none"> <li>■ Establish construction phase biodiversity monitoring programme in agreement with relevant Government authorities prior to works commencement, to inform the Developer/ Owner on any potential disturbance to biodiversity from the works.                             <ul style="list-style-type: none"> <li>- Biodiversity monitoring to include: focal/ waterbird species and smooth-coated otters.</li> </ul> </li> </ul> <p>Although the mitigation proposed is likely to reduce the noise level to less than the 70 dB(A) and 62dB(A) (western shoreline) and 64dB(A) (eastern shoreline) as discussed, the residual impact magnitude and significance has been retained at pre-mitigation levels on a precautionary basis subject to Developer/ Owner selection of detailed construction approaches (e.g. location of piling, phasing, number of simultaneous piles etc) and related mitigation measures described above. Establishment of monitoring, datasets and analysis (see <i>Section 12</i> EMMP) are to validate post-mitigation impact significance, and further support management of this impact and determination of deteriorating trends (if any).</p>	


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		<p>225 m away, respectively, from the boundary of the Gemala Nature Area (see <i>Appendix 7.7, Table 1A</i>).</p> <p>Assuming, for example, 1 unmitigated piling took place at a distance of 45 m (see <i>Appendix 7.7, Table 4A</i>) from the Gemala Nature Area boundary, only approximately 89 m<sup>2</sup> of Gemala Nature Area would be affected by over 70 dB(A), which equals 0.04% its total area, and an area of 8,800 m<sup>2</sup> (4.4%) would be affected for noise over 62 dB(A) in this scenario.</p> <p>The impact magnitude is expected to be <i>Negligible to Small</i> for the Gemala Nature Area, given the areas affected by over 70 dB(A) and over 62 dB(A) are relatively small compared to their total areas, and the ability of affected fauna to move away from noise disturbance into other areas of the Protected Area, where impacts are expected to be within the normal range of natural variation for the habitat, or population of the species with embedded controls.</p> <p><u>Bird Foraging at western and southern area of the reservoir</u> (herons, egrets and little tern)</p> <p>The western shoreline and southern area of the reservoir (south of the Reservoir Project Site) are where most bird foraging was recorded, in particular by herons, egrets and little tern. Noise levels in locations where these nationally EN and VU wetland birds are foraging will likely cause disturbance, for example, should 4 unmitigated, simultaneous adjacent piling workstations be located within 90 m to 225 m from the western shoreline or the southern boundary of the Reservoir Project Site. However, as the noise source will be temporary and shift with the construction phasing, and these birds are highly mobile, it is expected that the birds would relocate to avoid noise should they need to, and indeed may habituate to it over the course of the works across the Reservoir Project Site. Given this and the likely scale of the species' home range, that extends to areas outside Kranji Reservoir, any displacement would be localised and not affect the conservation status species, for example the little tern. Overall, the impact magnitude is expected to be <i>Negligible</i> overall for foraging birds, where impacts are expected to be within normal range of natural variation for the habitat, or population of the species, given embedded controls, the species' home range and availability of habitat.</p> <p><u>High Value Birds roosting and foraging on the Eastern edge of the reservoir</u> (black-crowned night heron, straw-headed bulbul, grey-headed fish eagle)</p> <p>A number of high value species were recorded on the eastern edge of the reservoir. Assuming works took place at least 50 m from the majority of the shoreline on the east of the reservoir (due to PUB's 50m requirement for a north-south vessel corridor) by 2 unmitigated, simultaneous adjacent piles then noise levels at the eastern shoreline and the black-crowned night heron roost (see <i>Appendix 7.6 and 7.7, Table 5A</i>) would be 72 dB(A); a distance of 130 m would be required to achieve 64 dB(A) on the eastern shoreline in this scenario.</p> <p>Assuming, for example, 1 unmitigated piling took place at a 50 m from the eastern shoreline then noise levels would be 69 dB(A), and 64 dB(A) would be achieved at a distance of 90 m in this scenario (see <i>Appendix 7.7, Table 6A</i>).</p> <p>The impact magnitude is expected to be <i>Small</i> for the black-crowned night heron roost and any other birds foraging at the eastern shoreline (see <i>Appendix 7.6</i>), where impacts are expected to (i) only affect a small area with no loss of habitat viability/ function, and/or (ii) not cause substantial change in species population or other species dependent on it, with embedded controls, the species' home range and availability of habitat.</p>			

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		<p>For the straw-headed bulbul and the other species of conservation concern within Sungei Kadut Forest adjacent to the eastern shoreline (see <i>Appendix 7.6</i>), the conclusion of impact magnitudes of <i>Small</i> is drawn for the same reasons (see above paragraph), based on 2 unmitigated simultaneous adjacent piling workstations.</p> <p>A grey-headed fish eagle nest was recorded at Sungei Kadut Forest. The tolerance levels of eagles have been shown to be higher than waterbirds: nesting bald eagles (<i>Haliaeetus leucocephalus</i>) in Canada have been shown to be resistant to noise disturbance as loud as 94 dB(A) (Diamond Head Consulting Ltd, 2017). Further considering habituation from existing background noise levels from Sungei Kadut Industrial Estate (maximum approximately 62.6 dB(A)<sup>2</sup>) and the shielding vegetation in Sungei Kadut Forest (vegetation was found to reduce noise levels for road traffic on average by 9 - 11 dB according to Ow &amp; Ghosh 2017), the impact magnitude is expected to be <i>Negligible</i> for the nesting grey-headed fish eagle at the eastern shoreline, where impacts are expected to be within normal range of natural variation for the habitat, or population of the species, given embedded controls, the species' home range and availability of habitat.</p> <p><u>White-belled sea eagle</u></p> <p>Assuming 4 unmitigated simultaneous piles on the western/ northern shore, noise levels at the two white-belled sea-eagle nests at SBWR, or the BBC transmission towers used by this species for perching, would be well below 94 dB(A) and even below 70 dB(A) at the nests given the separation distance to the nearest piling workstations. The impact magnitude is expected to be <i>Negligible</i> for the nesting/ perching white-bellied sea-eagle, where impacts are expected to be within normal range of natural variation for the habitat, or population of the species, given embedded controls, the species' home range and availability of habitat.</p> <p><u>Smooth-coated otter</u></p> <p>The smooth-coated otter is known to be resilient in Singapore to the presence of human activity and even to use human-made structures. However, having a secure and undisturbed holt for resting also was found to be a main factor for the species (Khoo &amp; Sivasothi 2018). For its close relative, the Eurasian otter (<i>Lutra lutra</i>), a distance of 150 m to holts with breeding females is recommended to avoid disturbance and the abandonment of territory (NRA 2008<sup>3</sup>). The 20 month baseline surveys did not identify any holts of smooth-coated otter along the reservoir shoreline. The impact magnitude is expected to be <i>Negligible</i> for smooth-coated otter during reservoir piling works with disturbance to foraging otters only, where impacts are expected to be within normal ranges of natural variation for habitats and populations of the species, with embedded controls and habituation to human activity and availability of other foraging habitat.</p> <p><u>Vibration</u></p> <p>Vibration caused by piling activities in the water might disrupt sensory communication between animals, interfering with mating, hunting and predator-evasion success. The effect of vibration from construction works will differ for different fauna types. Fauna that are ground-dwelling, nesting and/ or utilise vibration for environmental sensing and communication are</p>			

<sup>2</sup> Short term (15 min) noise monitoring in the northern portion of Sungei Kadut forest indicated night-time noise levels of up to 62.9 dB(A).

<sup>3</sup> National Roads Authority (2008): Guidelines for the treatment of otters prior to the construction of national road schemes. Environmental series on construction impacts. Submitted by Dr. Chris Small, Ecological Solutions, Wicklow, Ireland. (<https://cieem.net/resource/guidelines-for-the-treatment-of-otters-prior-to-the-construction-of-national-road-schemes/>)

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		<p>more susceptible to vibration impacts, compared to other fauna types such as those in flight that are less exposed to vibration. There are no available studies establishing thresholds for wildlife tolerance to vibration. However, vibration exposure caused by the Project's in-reservoir construction will be transient and shift with construction phasing. Therefore, the impact magnitude is expected to be <i>Negligible</i> for vibration to terrestrial fauna during piling, where impacts are expected to be within normal ranges of natural variation for habitats and populations of the species, with embedded controls.</p> <p>Overall, the impact magnitude is expected to conservatively be <b>Negligible to Small</b> for the daytime in-reservoir piling on terrestrial fauna, where impacts are expected to (i) only affect a small area with no loss of habitat viability/ function, and/ or (ii) not cause substantial change in species population or other species dependent on it, with embedded controls, the species' home range and availability of habitat.</p> <p>See item C9 below on potential impacts to terrestrial fauna from night lighting on land.</p>			
C8	<b>Disturbance to terrestrial fauna (land-based worksite)</b>	<ul style="list-style-type: none"> <li>■ <b>Nature:</b> Disturbance to terrestrial fauna from land-based worksite is considered <b>negative</b>.</li> <li>■ <b>Type:</b> <b>Indirect</b> impacts from land-based worksite are expected to terrestrial fauna.</li> <li>■ <b>Duration:</b> Impact will remain throughout the construction period (approximately 3 years), which is considered to be relatively <b>long-term</b> for terrestrial biodiversity. Works activities are considered temporary.</li> <li>■ <b>Extent:</b> <b>Localised</b> around the land-based worksite and the immediate surroundings.</li> <li>■ <b>Scale:</b> Within the proposed temporary Staging/ Launching Area worksite.</li> <li>■ <b>Frequency:</b> Activities will happen <b>daily/ intermittently</b> during the specified period of construction phase.</li> <li>■ <b>Sensitive Receptor(s):</b> Birds (High), Smooth-coated Otter (High), Long-tailed macaque (Medium).</li> </ul> <p>The proposed temporary Staging/ Launching Area and integrated Project Substation worksite could potentially lead to disturbance by day- and night-time works of the nearby black-crowned night heron temporary roosting areas at the eastern bank of the reservoir and other birds of conservation concern within Sungei Kadut Forest. Unmitigated noise levels are expected to be at approximately 75 dB(A) at the black-crowned night heron roosting site to the south of the worksite (see <i>Figure 7-21</i>). Baseline studies found this roost to be only temporary and used by a maximum of 3 individuals at one time. It is noted that location of such roosting sites are regularly shifting. Conservatively, the impact magnitude is expected to be <i>Small</i>, where impacts are expected to (i) only affect a small area with no loss of habitat viability/ function, and/or (ii) not cause substantial change in species population or other species dependent on it, with embedded controls; given the status of the current surrounding habitats and species identified in the baseline, and future land use designation.</p> <p>The main black-crowned night heron roost, where 16 individuals were recorded, is &gt;250 m to the north of the worksite. Unmitigated noise levels are expected to be 69 dB(A) at this location. A grey-headed fish eagle nest was found on the eastern shore &gt;500 m south of the worksite. Overall, because noise levels at both locations are &lt;70 dB(A), impact magnitude is expected to be <i>Negligible</i>, where impacts are expected to be within normal ranges of natural variation for habitats and populations of the species, with embedded controls and separation distances from the worksite.</p>	<p>Impact Magnitude: <b>Negligible to Small</b></p> <p>Receptor Sensitivity: <b>Medium to High</b></p> <p>Impact Significance: <b>Minor to Moderate</b></p>	<p>Mitigation measures presented in the Airborne Noise and Vibration <i>Section 9</i> will be applied, including:</p> <ul style="list-style-type: none"> <li>■ Install 4 m noise barrier around north, east and south boundaries of proposed temporary Staging/ Launching Area and integrated Project Substation worksite. This will reduce noise levels to approximately 74 dB(A) at the location of the temporary black-crowned night heron roost to the south of the worksite (see <i>Figure 7-21</i>).</li> </ul> <p>Monitoring and adaptive management measures including:</p>	<p>Impact Magnitude: <b>Negligible</b></p> <p>Impact Significance: <b>Negligible</b></p>

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		<p>The 20 month baseline surveys did not identify any holts of smooth-coated otter along the reservoir shoreline, including the land-based worksite. Therefore, no disturbance by land-based construction is expected to occur.</p> <p>The long-tailed macaque is considered widespread in Singapore. The species is common in urban areas and adapted to human presence. No individuals were found at or near the planned land-based worksite during the baseline surveys. No disturbance by land-based construction is expected to occur.</p> <p>Impact magnitude for smooth-coated otter and long-tailed macaque is expected to be <b>Negligible</b>, where impacts are expected to be within normal ranges of natural variation for habitats and populations of the species.</p> <p>Overall, the impact magnitude is expected to be <b>Negligible to Small</b> for the disturbance from land-based construction on terrestrial fauna, where impacts are expected to (i) only affect a small area with no loss of habitat viability/ function, and/ or (ii) not cause substantial change in species population or other species dependent on it, with embedded controls, the species' home range and availability of habitat.</p> <p>See item C9 below on potential impacts to terrestrial fauna from night lighting on land.</p>		<ul style="list-style-type: none"> <li>Establish construction phase noise monitoring programme in agreement with relevant Government authorities prior to works commencement, to inform the Developer/ Owner on any potential impact of noise to biodiversity from the works, e.g. in the vicinity of the black-crowned night heron roosts near the proposed temporary Staging/ Launching Area and the integrated Project Substation worksite.</li> </ul>  <p><b>Figure 7-21: Noise levels at land-based worksite with mitigation</b></p> <p><u>General</u></p> <ul style="list-style-type: none"> <li>Refer to general mitigation identified under item C7 above.</li> </ul>	
C9	Disturbance to terrestrial fauna (in-reservoir piling and land-based worksite night lighting)	<ul style="list-style-type: none"> <li><b>Nature:</b> Disturbance to terrestrial fauna from in-reservoir piling and land-based worksite night lighting is considered <b>negative</b>.</li> <li><b>Type:</b> <b>Indirect</b> impacts within the reservoir and on land are expected to terrestrial fauna.</li> <li><b>Duration:</b> Depending on the final design of anchoring to be adopted, the installation of in-reservoir piles could take up to 56 weeks (see <i>Appendix 2.1</i>). Land-based worksite impacts will remain throughout the construction period (approximately 3 years). Both durations are considered to be relatively <b>long-term</b> for terrestrial biodiversity. Works activities are considered temporary.</li> <li><b>Extent:</b> <b>Localised</b> around the active worksite(s) and the immediate surroundings.</li> <li><b>Scale:</b> Within the Reservoir Project Site and the proposed temporary Staging/ Launching Area worksite.</li> <li><b>Frequency:</b> Activities will happen <b>daily/ intermittently</b> during the specified period of construction phase.</li> <li><b>Sensitive Receptor(s):</b> Protected Areas and Designated Sites (High), Birds (High), Smooth-coated Otter (High), long-tailed macaque (Medium).</li> </ul>	<p>Impact Magnitude: <b>Small</b></p> <p>Receptor Sensitivity: <b>Medium to High</b></p> <p>Impact Significance: <b>Moderate</b></p>	<ul style="list-style-type: none"> <li>Use minimal number of luminaires, at low positions in relation to the ground, directed and shielded to provide the least amount of spill to adjacent habitats. Baffles, hoods, or louvres can be used to reduce light spill and direct it to only where it is needed.</li> <li>Set up dark buffers, illuminance limits, and zonation.</li> <li>Limit the duration of lighting, e.g. where peak nocturnal fauna activity is avoided, where possible.</li> <li>Lights with reduced or filtered blue, violet and ultra-violet wavelengths should be used. As a general rule, only lights with little or no short wavelength (400–500 nm) violet or blue light should be used to avoid unintended effects.</li> <li>Where wildlife is sensitive to longer wavelength light (e.g. some bird species), consideration should be given to wavelength selection on a case by case basis. Where possible, warm colour temperature light sources to be employed preferably at &lt;2,700 Kelvin.</li> </ul> <p><u>General</u></p>	<p>Impact Magnitude: <b>Negligible</b></p> <p>Impact Significance: <b>Negligible</b></p>

BIODIVERSITY (SECTION 7)					
S/N	Impact	Impact Magnitude Description	Pre Mitigation Impact Significance	Mitigation Measures and Monitoring	Residual (with mitigation) Impact Significance
		<p>See also item C5 above on aquatic fauna disturbance.</p> <p>Whilst in-reservoir works are to be in daylight hours only (due to health and safety), conservatively it is assumed some form of security and/ or navigation lighting may be required on the construction barges/ piling workstations etc within the reservoir. In addition, conservatively, potential 24 hour works and/ or security lighting is assumed for the land-based construction worksite.</p> <p>Illumination of working areas might result in avoidance by light-intolerant species or attraction to such areas by light-tolerant species, altering natural competition dynamics. It might also alter the circadian rhythms of wildlife and disorient and disrupt orientation in nocturnal animals.</p> <p>Use of directional lighting at night to avoid lighting directed at, and minimise light spill, to Kranji Marshes and Sungei Kadut Forest and reservoir edges, wherever possible, to minimise disturbance effects for light sensitive species.</p> <p>Conservatively, the smooth-coated otter is the main terrestrial fauna considered to be mainly nocturnal. It is known to be resilient in Singapore to the presence of human activity and even to use human-made structures. However, having a secure and undisturbed holt for resting was also found to be a main factor for the resilience of the species (Khoo &amp; Sivasothi 2018). For its close relative, the Eurasian otter (<i>Lutra lutra</i>), a distance of 150 m to holts with breeding females is recommended to avoid disturbance and the abandonment of territory (NRA 2008). The 20 month baseline surveys did not identify any holts of smooth-coated otter along the reservoir. The impact magnitude is expected to be <i>Negligible</i> for smooth-coated otter, where impacts are expected to be within normal ranges of natural variation for habitats and populations of the species, with embedded controls and habituation to human activity, disturbance to foraging otters only, and availability of other foraging habitat.</p> <p>Night-time works might be carried out on land-based worksites, which is adjacent to the existing artificially lit Sungei Kadut Industrial Estate. The impact magnitude is expected to be <i>Small</i> for terrestrial fauna (such as long-tailed macaque) at the proposed temporary Staging / Launching Area worksite at night, where impacts are expected to (i) only affect a small area with no loss of habitat viability/ function, and/or (ii) not cause substantial change in species population or other species dependent on it, with embedded controls; given the status of the current surrounding habitats and species identified in the baseline, and future land use designation.</p> <p>The black-crowned night heron's foraging opportunities may benefit from night-time lighting if there is an increase in prey availability/ visibility at night.</p> <p>Overall, impact magnitude is expected to be <i>Small</i> for the terrestrial fauna related to night lighting on land, where impacts are expected to (i) only affect a small area with no loss of habitat viability/ function, and/or (ii) not cause substantial change in species population or other species dependent on it, given embedded controls, the species' home range and availability of habitat and roosts.</p>		<ul style="list-style-type: none"> <li>Refer to general mitigation identified under item C7 above.</li> </ul>	
C10	Disturbance to terrestrial fauna (boat movements)	<ul style="list-style-type: none"> <li><b>Nature:</b> Disturbance to terrestrial fauna from boat movements and use of helicopters is considered <b>negative</b>.</li> <li><b>Type:</b> <b>Indirect</b> impacts within the reservoir and on land are expected to terrestrial fauna.</li> <li><b>Duration:</b> Boat movement impacts will remain throughout the construction period (approximately 3 years), which is considered to be relatively long-term for terrestrial</li> </ul>	Impact Magnitude: <b>Small</b> Receptor Sensitivity:	<b>Boat Movements</b> <ul style="list-style-type: none"> <li>Apply mitigation related to vessel navigation (see Surface Water Quality, <i>Section 6</i>), e.g. regular traffic routes should be established for routine works. Offset from shoreline as well as corridors between FPV islands allow safe navigation access, this will minimise the risk of disturbing bird shoreline foraging areas.</li> </ul>	Impact Magnitude: <b>Negligible</b> Impact Significance:

BIODIVERSITY (SECTION 7)					
S/N	Impact	Impact Magnitude Description	Pre Mitigation Impact Significance	Mitigation Measures and Monitoring	Residual (with mitigation) Impact Significance
	and use of helicopters)	<p>biodiversity. Use of helicopters will be short term. Works activities are considered temporary.</p> <ul style="list-style-type: none"> <li>■ <b>Extent: Localised</b> around the active worksite(s) and the immediate surroundings, for boats; and broader Kranji Reservoir area for helicopters.</li> <li>■ <b>Scale:</b> Within the Reservoir Project Site.</li> <li>■ <b>Frequency:</b> Activities will happen <b>daily</b> (work boats)/ <b>intermittently</b> (helicopters) during the specified period of construction phase.</li> <li>■ <b>Sensitive Receptor(s):</b> Protected Areas and Designated Sites (High), Birds (High), Smooth-coated Otter (High), long-tailed macaque (Medium).</li> </ul> <p><u>Boat Movements</u></p> <p>Currently there are various boat/ barge (including excavator equipment etc) movements throughout the reservoir on a daily basis from PUB's operational management. Boat/ barge movements are likely to generate activity which are avoided by wetland and waterbirds. Disturbance effects during nesting and migrating periods are likely to have relatively greater impact. Smooth-coated otters and long-tailed macaques are expected to keep away from working areas and, being adapted to coexisting with human activities, are not expected to be impacted.</p> <p>Cutts et al. (2009) found, that in order to minimise disturbance to waterbirds by boat movements, speeds should be kept to &lt;25 km/h (&lt;13.5 knots) and a minimum distance of 100 m should separate boats from colonies. However, the Project's embedded controls include limiting vessel speeds to &lt;5 knots (PUB requirement); and the flight initiation survey conducted for this Project found 25 m to be the maximum average flight distance for disturbed birds. With a generally &gt;50 m works boundary from the eastern reservoir edge (due to PUB's 50 m vessel corridor) and an unmitigated 25 m set back from the western edge to the in-reservoir FPV infrastructure, boats are therefore unlikely to completely disturb birds using foraging habitats around the reservoir edges and in protected areas (SBWR, Mandai Mangroves and Mudflats, Gemala Nature area).</p> <p>Overall, the impact magnitude is expected to be <b>Small</b> for the terrestrial fauna related to boat movements, where impacts are expected to (i) only affect a small area with no loss of habitat viability/ function, and/or (ii) not cause substantial change in species population or other species dependent on it, given embedded controls, the species' home range and availability of habitat and habituation to existing boat operations by PUB in-reservoir.</p> <p><u>Helicopters</u></p> <p>Helicopters may be used to hoist the PCU's (between 18 to 36 no.) into their positions in the east of the reservoir. These activities will create noise and movement. However, helicopters will only occasionally be deployed for transportation of large equipment into the reservoir, and for short periods of time (&lt; 1 hour) each time. It is noted that due to the proximity of the military air base, military jet noise is common over the reservoir. The noise impacts from helicopter use are not expected to significantly trigger displacement of wildlife from grey-headed fish eagle nest and/or black-crowned night heron roosts, or Protected Areas over a long period of time. The impact magnitude is expected to be <b>Small</b> for the terrestrial fauna related to helicopters, where impacts are expected to (i) only affect a small area with no loss of habitat viability/ function, and/or (ii) not cause substantial change in species population or other species dependent on it, given embedded controls, and the availability of habitat and to move away from impact area.</p>	<p><b>Medium to High</b></p> <p>Impact Significance:</p> <p><b>Moderate</b></p>	<p><u>Helicopters</u></p> <ul style="list-style-type: none"> <li>■ No fly zone for helicopters within 100 m of grey-headed fish eagle nest and/ or black-crowned night heron roosts, or Protected Areas. This distance is based on Grubb et al. (2007) guideline for helicopter effects on golden eagles (<i>Aquila chrysaetos</i>) in Utah, USA and is considered appropriate to apply to this Project.</li> </ul> <p><u>General</u></p> <ul style="list-style-type: none"> <li>■ Refer to general mitigation identified under item C7 above.</li> </ul> <p>Mitigation measures presented in the Airborne Noise and Vibration Section 9 will be applied.</p>	<p><b>Negligible</b></p>



BIODIVERSITY (SECTION 7)					
S/N	Impact	Impact Magnitude Description	Pre Mitigation Impact Significance	Mitigation Measures and Monitoring	Residual (with mitigation) Impact Significance
C1 1	Generation of dust from land-based worksite	<ul style="list-style-type: none"> <li><b>Nature:</b> Increased dust pollution is considered to be <b>Negative</b>.</li> <li><b>Type:</b> <b>Direct</b> and <b>indirect</b> impacts to terrestrial flora and fauna</li> <li><b>Duration:</b> This worksite will be active throughout construction (3 years) which is considered relatively <b>long-term</b> and is reversible upon removal of the Project.</li> <li><b>Extent:</b> Impacts are <b>localised</b> within the Project area land-based worksite and the immediate surroundings.</li> <li><b>Scale:</b> Per air quality guidelines, receptors within 350 m may be affected (see <i>Section 8</i>).</li> <li><b>Frequency:</b> Activities will happen <b>daily/ intermittently</b> during the specified period of construction phase with most dust emissions likely in the initial few months related to land clearance, site levelling and site establishment for the proposed temporary Staging / Launching Area, and then for the integrated Project Substation construction period.</li> <li><b>Sensitive receptor(s):</b> Terrestrial plants (Medium-High), Terrestrial Habitats (High).</li> </ul> <p>See Air Quality (<i>Section 8</i>) to assessment related to human receptors.</p> <p>During land clearance, excavation or backfill activities, track out of soil may occur when heavy duty vehicles leave the construction sites with dusty material which may then spill onto the road, and/or when heavy duty vehicles transfer dust and dirt onto the road having travelled over muddy ground on site. It is assumed that at the peak there will be approximately 4 to 5 trucks moving in and out the land-based worksite per day. This worksite is adjacent to Sungei Kadut Forest. Good practice embedded control measures discussed in Air Quality <i>Section 8</i> will be implemented.</p> <p>Considering the permanent building volume is approximately 25,000 m<sup>3</sup>, earthwork material is anticipated to be only 3,500 tonnes, the existing industrial nature of the nearby Sungei Kadut Estate, and embedded controls, it is anticipated that there will be limited dusty activities during FPV assembly activities after initial proposed temporary Staging/ Launching Area establishment.</p> <p>Dust deposition might impact terrestrial plants of conservation concern that were detected in Sungei Kadut Forest adjacent to the land-based worksite, negatively. Also, the Sungei Kadut Forest as terrestrial habitat, that supports these plant species, might be impacted.</p> <p>Impact magnitude is expected to be <b>Small</b> for terrestrial plants/ habitats, where impacts are expected to (i) only affect a small area with no loss of habitat viability/ function, and/or (ii) not cause substantial change in species population or other species dependent on it, given embedded controls.</p>	<p>Impact Magnitude: <b>Small</b></p> <p>Receptor Sensitivity: <b>Medium to High</b></p> <p>Impact Significance: <b>Moderate</b></p>	Mitigation measures presented in the Air Quality <i>Section 8</i> will be applied.	<p>Impact Magnitude: <b>Negligible</b></p> <p>Impact Significance: <b>Negligible</b></p>
AQUATIC AND/OR TERRESTRIAL BIODIVERSITY					
C1 2	Introduction and spread of invasive alien species	<ul style="list-style-type: none"> <li><b>Nature:</b> Introduction and spread of invasive alien species is considered <b>negative</b> for both aquatic and terrestrial biodiversity.</li> <li><b>Type:</b> Introduction will have a <b>direct</b> impact on aquatic and terrestrial biodiversity.</li> <li><b>Duration:</b> Throughout the construction period (approximately 3 years), which is considered to be relatively <b>long-term</b> for aquatic and terrestrial biodiversity.</li> <li><b>Extent:</b> <b>Localised</b> around the worksite(s) and the immediate surroundings, and Kranji Reservoir.</li> <li><b>Scale:</b> Potentially localised patches across the reservoir and surrounding terrestrial habitats.</li> <li><b>Frequency:</b> <b>Intermittently</b> during the specified period of construction phase.</li> <li><b>Sensitive Receptor(s):</b> Aquatic habitat (Medium), Surrounding terrestrial habitats (Low to High, for Sungei Kadut Forest).</li> </ul>	<p>Impact Magnitude: <b>Negligible</b></p> <p>Receptor Sensitivity: <b>Medium to High</b></p> <p>Impact Significance: <b>Negligible</b></p>	<p>No mitigation measures are required as embedded controls are considered to be adequate to manage impact significance to be <b>Negligible</b>. However, it is noted that mitigation measures presented in the Surface Water Quality <i>Section 6</i> will be applied, for example:</p> <ul style="list-style-type: none"> <li>Establish an Aquatic Vegetation/ Invasive Species Management Plan (includes removal of aquatic vegetation). This plan should be prepared and submitted to PUB for agreement prior to commencement of the removal works for construction.</li> </ul>	N/A (refer to Pre-Mitigation Impact Significance Column)

BIODIVERSITY (SECTION 7)					
S/N	Impact	Impact Magnitude Description	Pre Mitigation Impact Significance	Mitigation Measures and Monitoring	Residual (with mitigation) Impact Significance
		<p>The site has an existing significant issue with invasive non-native species. Regular management of aquatic vegetation within the Kranji Reservoir is already undertaken by PUB. Additional aquatic vegetation trimming and management, and therefore also increased management of invasive plant species, is expected to occur during construction period within the Reservoir Project Site. Therefore, the project might overall exert a positive impact regarding invasive species. Toxic blooming species of phytoplankton already occur in the reservoir. No invasive species have been identified on the land-based worksite.</p> <p>The impact magnitude is expected to be <b>Negligible</b> for invasive species, where impacts are expected to be within normal ranges of natural variation for habitats and populations of the species, given embedded controls and the existing baseline.</p>			
PROTECTED AREAS (SBNR NETWORK)					
C1 3	Release of suspended sediments, pollutants or nutrients outside of the reservoir into the Johor Straits, e.g. to SBWR or Mandai Mudflats, due to FPV construction	<ul style="list-style-type: none"> <li>■ <b>Nature:</b> Release of suspended sediments, pollutants or nutrients into the Johor Straits is considered <b>negative</b> for aquatic biodiversity.</li> <li>■ <b>Type:</b> <b>Indirect</b> impacts to the Johor Straits when tidal gates are opened.</li> <li>■ <b>Duration:</b> Depending on the final design, these activities are to take place over approximately 104 weeks, which is considered relatively <b>long-term</b> for aquatic biodiversity. Release of pore water will result in temporary elevation of ambient levels of nutrients and contaminants, which will be diluted in the surrounding water, of which the change is considered temporary.</li> <li>■ <b>Extent:</b> Impacts of tidal gate opening are to the Johor Straits, with potential <b>regional extent</b>.</li> <li>■ <b>Scale:</b> Elevated levels of suspended solids as well as other changes in surface water quality would likely be limited to less than 100 m from the work front and return towards baseline beyond this.</li> <li>■ <b>Frequency:</b> Deployments and activities will happen <b>daily/ intermittently</b> during the specified period of construction phase.</li> <li>■ <b>Sensitive Receptor(s):</b> SBWR and Mandai Mangrove and Mudflats (Protected Areas) (High)</li> </ul> <p>Per the Surface Water Quality impact assessment (<i>Section 6</i>), it is expected that sediments, nutrients and contaminant outflows from the tidal gate are relatively small compared to the existing baseline of the reservoir outflows.</p> <p>In the context of the littoral environment north of the Kranji tidal gate, adjacent to SBWR and Mandai Mangrove and Mudflats (high value sensitive receptors) in the Johor Straits, any sediment plume would likely be relatively small compared to the natural sediment load influx naturally in this environment. No coral reefs are located nearby which could be affected.</p> <p>Impact magnitude is expected to conservatively be <b>Small</b> for the release of suspended sediments, pollutants or nutrients into the Johor Straits, where impacts are expected to (i) only affect a small area with no loss of habitat viability/ function, and/or (ii) not cause substantial change in species population or other species dependent on it, given embedded controls for surface water quality given the current baseline and tolerances of aquatic flora and fauna to suspended sediments.</p>	<p>Impact Magnitude: <b>Negligible</b></p> <p>Receptor Sensitivity: <b>High</b></p> <p>Impact Significance: <b>Negligible</b></p>	No mitigation measures are required as embedded controls are considered to be adequate to manage impact significance to be <b>Negligible</b> .	N/A (refer to Pre-Mitigation Impact Significance Column)
C1 4	Loss/ degradation of integrity of Protected Areas	<ul style="list-style-type: none"> <li>■ <b>Nature:</b> Loss/ degradation of integrity of Protected Areas is considered <b>negative</b>.</li> <li>■ <b>Type:</b> <b>Indirect</b> impacts given the Protected Areas are outside the Project Site(s).</li> <li>■ <b>Duration:</b> Throughout the construction period (approximately 3 years), which is considered to be relatively <b>long-term</b> for aquatic and terrestrial biodiversity.</li> </ul>	Impact Magnitude: <b>Negligible to Small</b>	All of the mitigation measures described above/ below to control the impacts in relation to works in and around the reservoir for aquatic and terrestrial biodiversity will also avoid and minimise their impact magnitude on the Protected Areas.	Impact Magnitude: <b>Negligible</b>

BIODIVERSITY (SECTION 7)					
S/N	Impact	Impact Magnitude Description	Pre Mitigation Impact Significance	Mitigation Measures and Monitoring	Residual (with mitigation) Impact Significance
		<ul style="list-style-type: none"> <li>■ <b>Extent:</b> Impacts to Protected Areas surrounding the Project Site(s), potential regional extent.</li> <li>■ <b>Scale:</b> Within SBNP Network.</li> <li>■ <b>Frequency: Infrequent</b> during the specified period of construction phase.</li> <li>■ <b>Sensitive Receptor(s):</b> Protected areas (High) outside the Project Site(s).</li> </ul> <p>Although the conservation objectives for the Protected Areas within the SBNP Network are not publicly available, the integrity of these Areas likely depends on the maintenance of the following:</p> <ul style="list-style-type: none"> <li>■ The extent and distribution of wetland habitats of the designating features.</li> <li>■ The structure and function of those wetland habitats of the designating features.</li> <li>■ The supporting processes on which the habitats of the designating features rely.</li> <li>■ The population of each designating feature.</li> <li>■ The distribution of designating features within the Protected Areas.</li> </ul> <p>The designating features for each site within the SBNP Network are listed above in Table 7-6.</p> <p>Of the impacts addressed in this table, only the following could potentially affect the integrity of the Protected Areas:</p> <ul style="list-style-type: none"> <li>■ Disturbance from noise emissions from daytime in-reservoir piling could disturb migratory birds (present September to March). The disturbance of migratory birds could be significant at the national population level given the importance of the Protected Areas to these species – with reference to item C7 above, this has been assessed to have an impact magnitude of <i>Negligible</i> for the SBWR and Mandai Mangroves and Mudflats, and <i>Negligible</i> to <i>Small</i> for the Gemala Nature Area and Kranji Marshes.</li> <li>■ Helicopter noise – with reference to item C10 above, this has been assessed to have an impact magnitude of <i>Small</i>.</li> <li>■ Introduction/ spread of invasive species – with reference to item C12 above, this has been assessed to have an impact magnitude of <i>Negligible</i>.</li> <li>■ Release of suspended sediments, pollutants or nutrients outside of the reservoir, in particular SBWR and Mandai Mangroves and Mudflats to the north – with reference to item C13 above, this has been assessed to have an impact magnitude of <i>Negligible</i>.</li> <li>■ Unplanned events from fire/ explosion or spills – with reference to item U1 below, this has been assessed to have an impact magnitude of <i>Negligible</i> (land-based) to <i>Small</i> (in-reservoir).</li> </ul> <p>In all cases above, expected impact magnitudes for Protected Areas would not cause a (i) loss of habitat viability/ function, and/or (ii) substantial change in species population or other species dependent on it, with embedded controls.</p>	<p>Receptor Sensitivity: <b>High</b></p> <p>Impact Significance: <b>Minor to Moderate</b></p>	<p>Taking these into account, no significant impacts are expected on the integrity of the Protected Areas.</p>	<p>Impact Significance: <b>Negligible</b></p>

AIR QUALITY (SECTION 8)					
S/N	Impact	Impact Magnitude Description	Pre-Mitigation Impact Significance	Mitigation Measures and Monitoring	Residual (with mitigation) Impact Significance
C1	Generation of dust from land-based construction at the proposed temporary Staging/ Launching Areas and integrated Project Substation worksite	<ul style="list-style-type: none"> <li><b>Nature:</b> Increased dust pollution is considered <b>negative</b>.</li> <li><b>Type:</b> <b>Direct and indirect</b> impact to receptors near to land-based worksite.</li> <li><b>Duration:</b> The worksite will be active throughout construction (3 years) which is considered relatively <b>long term</b> for air quality, and is reversible upon completion of the construction.</li> <li><b>Extent:</b> Impacts are <b>localised</b> within the land-based worksite and the immediate surroundings.</li> <li><b>Scale:</b> Per Guidelines, receptors within 350 m may be affected.</li> <li><b>Frequency:</b> Activities will happen <b>daily/ intermittently</b> during the specified period of construction phase, with most dust emissions likely in the initial few months related to land clearance, site levelling and site establishment for the proposed temporary Staging/ Launching Area, and then for the integrated Project Substation construction period.</li> </ul> <p>The following approximate areas and material volumes are assumed for this assessment, and are subject to detailed design:</p> <ul style="list-style-type: none"> <li>Worksite area: 11,000 m<sup>2</sup> (1.1 ha) occupied by the proposed temporary Staging / Launching area, within which 4,400 m<sup>2</sup> (0.44 ha) is allocated for permanent integrated Project Substation area</li> <li>Building area: approximately 3,160 m<sup>2</sup> for permanent integrated Project Substation (with O&amp;M facility)</li> <li>Building volume: approximately 23,520 m<sup>3</sup> (including 3.5 m cable chamber basement)</li> <li>Site levelling: Minor grading, limited to smoothing of soil</li> <li>Waste volume: 1,800 m<sup>3</sup></li> <li>Excavation/ backfill: 10,000 m<sup>3</sup> (3,500 tonnes)</li> </ul> <p>During land clearance, excavation or backfill activities, track out of soil may occur when heavy duty vehicles leave the construction sites with dusty material which may then spill onto the road, and/or when heavy duty vehicles transfer dust and dirt onto the road having travelled over muddy ground on site. It is assumed that at the peak there will be approximately 4 to 5 trucks moving in and out the proposed temporary Staging/ Launching Area and integrated Project Substation worksite per day. It is noted this worksite is adjacent to Sungei Kadut Forest - see <i>Section 7</i> (Biodiversity) regarding assessment of potential dust impacts to this ecological receptor.</p> <p>Typical good practice embedded control measures discussed in <i>Section 8.6.1.2</i> above will be implemented.</p> <p>Impact magnitude is expected to be <b>Small</b> for dust, when considering (i) the permanent building volume is under 25,000m<sup>3</sup>, (ii) earthwork material moved is &lt; 20,000 tonnes (only 3,500 tonnes), (iii) the existing industrial nature of the nearby Sungei Kadut Industrial Estate, (iv) the limited dusty activities during FPV assembly activities after initial proposed temporary Staging/ Launching Area establishment, as well as (v) the embedded controls.</p>	<p>Impact Magnitude: <b>Small</b></p> <p>Receptor Sensitivity: <b>Medium</b></p> <p>Impact Significance: <b>Minor</b></p>	<ul style="list-style-type: none"> <li>Detailed design and construction methodology and scheduling to minimise extent and duration of dusty activities, where feasible.</li> </ul> <p>No significant (above minor) residual impacts are anticipated related to air quality, as such specific air quality monitoring is not considered necessary. However, it is recommended to conduct regular environmental site inspections, i.e. on a weekly basis, see the <i>Section 12</i> (EMMP).</p>	<p>Impact Magnitude: <b>Negligible</b></p> <p>Impact Significance: <b>Negligible</b></p>

AIRBORNE NOISE AND VIBRATION (SECTION 9)					
S/N	Impact	Impact Magnitude Description	Pre-Mitigation Impact Significance	Mitigation Measures and Monitoring	Residual (with mitigation) Impact Significance
C1	Generation of noise during the land-based construction at the proposed temporary Staging/ Launching Area and integrated Project Substation (with O&M facility) worksite	<ul style="list-style-type: none"> <li><b>Nature:</b> Increased airborne noise levels are considered <b>negative</b>.</li> <li><b>Type:</b> <b>Direct</b> impact to human noise sensitive receptors near to land-based worksite.</li> <li><b>Duration:</b> The worksite will be active throughout construction (3 years) which is considered relatively <b>long-term</b> for airborne noise (greater than 1-month exposure), and is reversible upon completion of the construction.</li> <li><b>Extent:</b> Impacts are <b>localised</b> within the land-based worksite and the immediate surroundings.</li> <li><b>Scale:</b> Nearest human receptors are industrial premises located immediately adjacent to the land-based worksite.</li> <li><b>Frequency:</b> Activities will happen <b>daily/ intermittently</b> during the specified period of construction phase.</li> </ul> <p>Unmitigated noise levels predicted at the nearest off-site noise sensitive human receptors surrounding the proposed temporary Staging/ Launching Area and integrated Project Substation (with O&amp;M facility) worksite against the applicable criteria limits, as well as noise exceedances, corresponding impact magnitude and significance are provided in <i>Appendix 9.2 (Table 1)</i>. The results are also illustrated in Figure 9-3 below.</p> <p>The nearest affected NSRs are Eng Hua Furniture Manufacturing (NSR 3), Eng Seng Cement Products Pte Ltd (NSR 4), Ley Choon Group Holding (NSR 2) and Star Sin Trading Pte Ltd (NSR 1).</p> <p>For <math>L_{Aeq,5mins}</math> results:</p> <ul style="list-style-type: none"> <li>Impact magnitude during the daytime period (7am – 7pm) would be <b>Negligible</b> (0 – 2 dB(A) exceedance) at NSRs 1 to 4;</li> <li>Impact magnitude during the evening (7pm – 10pm) ranges from <b>Small to Large</b> (3 – &gt;10 dB(A) exceedance) at NSRs 1 to 4; and</li> <li>Impact magnitude during the night (10pm – 7am) ranges from <b>Small to Large</b> (3 – &gt;10 dB(A) exceedance) at NSRs 1 to 4.</li> </ul> <p>For <math>L_{Aeq,12hours}</math> results:</p> <ul style="list-style-type: none"> <li>Impact magnitude during the daytime period (7am-7pm) ranges from <b>Negligible to Large</b> (0 – &gt;10 dB(A) exceedance) at NSRs 1 to 4; and</li> <li>Impact magnitude during the night (7pm – 7am) ranges from <b>Medium to Large</b> (6 - &gt;10 dB(A) exceedance) at NSRs 1 to 4.</li> </ul> <p>Overall, taking into account that the duration of the construction for the proposed temporary Staging/ Launching Area and integrated Project Substation is greater than 1 month, the impact significance for all the nearest human NSRs (1 – 4) ranges from <b>Negligible to Major</b> for <math>L_{Aeq,5mins}</math> and <math>L_{Aeq,12hours}</math> for all periods – day, evening and night, see <i>Appendix 9.2 (Table 1)</i>.</p>	<p>Impact Magnitude: <b>Negligible to Large</b></p> <p>Receptor Sensitivity: The impact magnitude criteria have already taken into account the receptor sensitivities.</p> <p>Impact Significance: <b>Negligible to Major</b></p>	<p>Recommended mitigation measures include:</p> <ul style="list-style-type: none"> <li>Installation of temporary 4 meter-high noise barrier along the northern, eastern and southern boundaries (see illustration in Figure 9-4 below) throughout the construction phase;</li> <li>The temporary noise barriers shall have a minimum surface density of 20kg/m<sup>2</sup> or a minimum sound transmission loss of 20 dB, e.g. steel with a 22-gauge with thickness of 0.79 mm, surface density of 6.1 kg/m<sup>2</sup> and sound transmission loss of 20 dB. Additionally, there shall be no gaps at the bottom of the noise barriers or in between the panels, as far as reasonably practicable. Any gaps must be sealed with rubber gasketing to minimise noise propagation to the nearest off-site receptors;</li> <li>If required, access ways along the barriers should be minimised as much as possible as well;</li> <li>Such materials and principals described above shall be applied to the worksite access gates, which should remain closed as far as reasonably practicable throughout the construction period; and</li> <li>Detailed design and construction methodology and scheduling to minimise extent and duration of noisy activities (e.g. reduce continuously operating equipment and simultaneous equipment operation etc), where feasible.</li> </ul> <p>With the abovementioned noise barriers, the mitigated predicted noise levels at NSRs 1 to 4 (impact magnitude and significance) would be reduced. See <i>Appendix 9.2 (Table 2)</i> and Figure 9-4 below for further details.</p> <p>No significant (above minor) residual impacts are anticipated related to airborne noise, however, it is recommended to conduct noise monitoring during construction to verify the impacts assessed herein, see <i>Section 12 (EMMP)</i>.</p>	<p>Impact Magnitude: <b>Negligible to Small</b></p> <p>Impact Significance: <b>Negligible to Minor</b></p>
C2	Generation of piling noise at Reservoir Project Site	<ul style="list-style-type: none"> <li><b>Nature:</b> Increased airborne noise levels are considered <b>negative</b>.</li> <li><b>Type:</b> <b>Direct</b> impact to human noise sensitive receptors near to reservoir worksite.</li> <li><b>Duration:</b> Depending on the final design of anchoring to be adopted, the installation of in-reservoir (driven) piles could take up to 56 weeks (see <i>Appendix 2.1</i>), which is considered to be relatively <b>long-term</b> for airborne noise (greater than 1-month exposure) and is reversible upon completion of the construction.</li> <li><b>Extent:</b> Impacts are <b>localised</b> within the reservoir worksite and the immediate surroundings.</li> </ul>	<p>Impact Magnitude: <b>Negligible to Small</b></p> <p>Receptor Sensitivity: The impact magnitude criteria have already taken</p>	<p>Mitigation measures presented in the <i>Section 7 (Biodiversity)</i> related to minimising in-reservoir piling noise to biodiversity will be applied, therefore also reducing the impacts for human receptors.</p> <p>No significant (above minor) residual impacts are anticipated related to airborne noise, however, it is recommended to conduct noise monitoring</p>	<p>Impact Magnitude: <b>Negligible</b></p> <p>Impact Significance: <b>Negligible</b></p>

AIRBORNE NOISE AND VIBRATION (SECTION 9)					
S/N	Impact	Impact Magnitude Description	Pre-Mitigation Impact Significance	Mitigation Measures and Monitoring	Residual (with mitigation) Impact Significance
		<ul style="list-style-type: none"> <li><b>Scale:</b> Nearest human receptors are industrial premises and sports and recreation areas that are located in the vicinity of the piling activity at the FPV footprint.</li> <li><b>Frequency:</b> Activities will happen <b>daily/ intermittently</b> during the specified period of construction phase.</li> </ul> <p>The main activity contributing to high sound power levels (SWL) of 114 dB(A) in the reservoir is conservatively assumed to be the driven piling option for the FPV and PCU anchoring systems.</p> <p>As a conservative case: in the western portion of the reservoir, 4 piles will be driven simultaneously at the same location, resulting in a cumulative sound power level (SWL) of 120 dB(A); in the eastern portion of the reservoir, 2 piles will be driven simultaneously at the same location, resulting in a cumulative SWL of 117 dB(A).</p> <p>Unmitigated noise levels predicted at the nearest off-site noise sensitive human receptors to the FPV layout on the west and east portion of the reservoir against the applicable criteria limits, as well as noise exceedances, corresponding impact magnitude and significance are provided in <i>Appendix 9.2 (Table 3)</i>. The results are also presented illustrated in Figure 9-5 below.</p> <p>The nearest affected NSRs are NRSCC Kranji Sanctuary Golf Course (NSR 5) from the western shoreline of the reservoir, and FMB Trading and Engineering Ptd Ltd (NSR 6) from the eastern shoreline of the reservoir.</p> <p>For <math>L_{Aeq,5mins}</math> results:</p> <ul style="list-style-type: none"> <li>Impact magnitude during the daytime period (7am – 7pm), evening (7pm – 10pm) and night (10pm – 7am) would be <b>Negligible</b> (0 – 2 dB(A) exceedance) at NSRs 5 and 6.</li> </ul> <p>For <math>L_{Aeq,12hours}</math> results:</p> <ul style="list-style-type: none"> <li>Impact magnitude during the daytime period (7am – 7pm) results show the impact magnitude would be <b>Negligible</b> at NSRs 5 and 6; and</li> <li>Impact magnitude during the night (7pm – 7am) would be <b>Small</b> (3 – 5 dB(A) exceedance) at NSRs 5 and 6.</li> </ul> <p>Overall, taking into account that the duration of the construction for the driven piling activities in the Reservoir Project Site is greater than 1 month, the impact significance for the nearest human NSRs (5 - 6) along both the western and eastern shorelines ranges from <b>Negligible to Minor</b> for <math>L_{Aeq,5mins}</math> and <math>L_{Aeq,12hours}</math> for all periods – day, evening and night, see <i>Appendix 9.2 (Table 3)</i>.</p>	<p>into account the receptor sensitivities.</p> <p>Impact Significance: <b>Negligible to Minor</b></p>	<p>during construction to verify the impacts assessed herein, see <i>Section 12 (EMMP)</i>.</p>	
C3	Generation of vibration during the land-based construction at the proposed temporary Staging/ Launching Area and integrated Project Substation (with O&M facility) worksite	<ul style="list-style-type: none"> <li><b>Nature:</b> Increased vibration levels are considered <b>negative</b>.</li> <li><b>Type:</b> <b>Direct</b> impact to human vibration sensitive receptors near to land-based worksite.</li> <li><b>Duration:</b> The rotary piling activity at the worksite is anticipated to be 6 - 8 weeks. Whilst this is greater than 1-month exposure, this is considered relatively <b>short to long-term</b> for vibration, and is reversible upon completion of the construction.</li> <li><b>Extent:</b> Impacts are <b>localised</b> within the land-based worksite and the immediate surroundings.</li> <li><b>Scale:</b> Nearest receptors are industrial premises located immediately adjacent to the land-based worksite.</li> <li><b>Frequency:</b> Activities will happen <b>daily/intermittently</b> during the specified period of construction phase.</li> </ul> <p>At the proposed temporary Staging/ Launching Area and integrated Project Substation (with O&amp;M facility) worksite, the main vibration source will be the rotary bored piling activity for concrete foundation work for the integrated Project Substation (with O&amp;M Facility).</p>	<p>Impact Magnitude: <b>Medium</b> at 2m distance.</p> <p>Receptor Sensitivity: The impact magnitude criteria have already taken into account the receptor sensitivities.</p> <p>Impact Significance: <b>Moderate</b></p>	<p>It is calculated that rotary piling activities at a distance of 4 m from the nearest human VSR will result in a small (0.14 mm/s – 1 mm/s) impact magnitude (and thus <b>minor</b> significance).</p> <ul style="list-style-type: none"> <li>Detailed design and construction methodology and scheduling to minimise extent, duration and distance (for example, minimum 4 m) to VSRs of vibration activities, where feasible.</li> </ul>	<p>Impact Magnitude: <b>Small</b></p> <p>Impact Significance: <b>Minor</b></p>

AIRBORNE NOISE AND VIBRATION (SECTION 9)					
S/N	Impact	Impact Magnitude Description	Pre-Mitigation Impact Significance	Mitigation Measures and Monitoring	Residual (with mitigation) Impact Significance
		<p>The vibration magnitude at the nearest receptor was predicted using empirical equations developed for vibratory piling, as presented in <i>British Standard 5228-2:2009+A1:2014</i>, Table D.6 (C106). Data obtained for Rotary Bored Piling (Augering) gave rise to 0.54 mm/s (Peak Particle Velocity – PPV)<sup>2</sup> at a 5 m distance from the sources. Vibration level propagation was calculated using the empirical equations as stated in the <i>British Standard 5228-2:2009+A1:2014</i>, Table E.1.</p> <p>A conservative scenario was selected to estimate the vibration levels at 2 m distance from the nearest human vibration sensitive receptors at the worksite (i.e. Star Sin Trading Pte Ltd, VSR 1, see Figure 9-2). The estimated level of vibration would be approximately 1.9 mm/s. Hence, a <b>Medium</b> (1 mm/s – 10 mm/s) impact magnitude is anticipated.</p> <p>Overall, taking into account that the duration of the construction for the rotary piling activities in the proposed temporary Staging/Launching Area and integrated Project Substation site is greater than 1 month, the impact significance for the nearest human VSR 1 is <b>Moderate</b>.</p>			
C4	Generation of vibration at Reservoir Project Site	<ul style="list-style-type: none"> <li>■ <b>Nature:</b> Increased vibration levels are considered <b>Negative</b>.</li> <li>■ <b>Type:</b> Vibration sensitive receptors are <b>directly</b> impacted by increased vibration levels.</li> <li>■ <b>Duration:</b> Depending on the final design of anchoring to be adopted, the installation of in-reservoir (driven) piles could take up to 56 weeks (see <i>Appendix 2.1</i>), which is considered to be relatively <b>long-term</b> for airborne noise (greater than 1-month exposure), and is reversible upon completion of the construction.</li> <li>■ <b>Extent:</b> Impacts are <b>localised</b> within the reservoir worksite and the immediate surroundings.</li> <li>■ <b>Scale:</b> Nearest human receptors are industrial premises and sports and recreation areas that are located in the vicinity of the piling activity at the FPV footprint.</li> <li>■ <b>Frequency:</b> Activities will happen <b>daily/ intermittently</b> during the specified period of construction phase.</li> </ul> <p>At the Reservoir Project Site, the main vibration source is conservatively assumed to be the driven piling option for the FPV and PCU anchoring system.</p> <p>Data obtained from <i>British Standard 5228-2:2009+A1:2014</i>, Table D.2 (C24) for Driven Cast-in-place Piling (Drop hammer) gave rise to 6.1 mm/s (PPV) at a 8.5 m distance from the source. Vibration level propagation was calculated using the empirical equations as stated in the <i>British Standard 5228-2:2009+A1:2014</i>, Table E.1.</p> <p>A conservative scenario was selected to estimate the vibration levels at 100 meter distance from the nearest human vibration sensitive receptors to the FPV layout on the west and east portion of the reservoir, i.e. NRSCC Kranji Sanctuary Golf Course (NSR 5) from the western shoreline of the reservoir, and FMB Trading and Engineering Ptd Ltd (NSR 6) from the eastern shoreline of the reservoir (see Figure 9-2). The estimated level of vibration would be approximately 0.5 mm/s. Hence, a <b>Small</b> (0.14 mm/s – 1 mm/s) impact magnitude is anticipated.</p> <p>Overall, taking into account that the duration of the construction for the driven piling activities in the Reservoir Project Site is greater than 1 month, the impact significance for the nearest human VSRs (5 - 6) along both the western and eastern shorelines is <b>Minor</b>.</p>	<p>Impact Magnitude: <b>Small</b></p> <p>Receptor Sensitivity: The impact magnitude criteria has already taken into account the receptor sensitivities.</p> <p>Impact Significance: <b>Minor</b></p>	No mitigation measures are required as embedded controls are considered to be adequate to manage impact significance to be <b>Minor</b> .	N/A. (refer to Pre-Mitigation Impact Significance Column)

<sup>2</sup> The vibration levels obtained from Code of Practice for Noise and Vibration control on Construction and Open Sites: BS 5228-2:2009+A1:2014 are measured outside of buildings. Note 3 in Table 9-8 also refers to a transfer function (which relates to conversion of an external level to an internal level) which needs to be applied if only external measurements are available. In this case no transfer function has been applied which is likely to be a conservative case for most buildings.

VECTOR (SECTION 11)					
S/N	Impact	Impact Magnitude Description	Pre-Mitigation Impact Significance	Mitigation Measures and Monitoring	Residual (with mitigation) Impact Significance
C1	Increase in Vector Populations (Mosquitoes and Rats) at proposed temporary Staging/ Launching Area and integrated Project Substation	<ul style="list-style-type: none"> <li><b>Nature:</b> Increased vector populations of mosquitoes/ rats or transmission of diseases is considered <b>negative</b>.</li> <li><b>Type: Direct</b> impact on human receptors due to the transmission of vector-borne diseases.</li> <li><b>Duration:</b> The worksite will be active throughout construction (3 years) which is considered relatively <b>long term</b> for vector impacts, and is reversible upon completion of the construction.</li> <li><b>Extent:</b> Impacts are <b>localised</b> within the land-based worksite and the immediate surroundings.</li> <li><b>Scale:</b> For Mosquitoes, 400 m from worksite as per the flying range of an <i>Aedes</i> mosquito capable of transmitting diseases; and for Rats, 100 m from worksite as per the foraging distance of rats from their nests.</li> <li><b>Frequency: Intermittent</b> over approximately 3 years of construction.</li> </ul> <p>Worksite activities could lead to increased formation of stagnant pools following rainfall events. These stagnant pools of water would be breeding grounds for <i>Aedes</i> mosquitoes. Receptor sensitivity for mosquitoes is considered High, as majority of the spaces within a 400 m radius of the worksite consist of industrial workplaces occupied for long hours.</p> <p>As there are no known potential hotspots for rats due to no presence of food centres or food consumption areas nearby, receptor sensitivity for rats is considered Low. However, it is notable that the temporary storage or improper disposal of organic wastes such as food from workers within the construction site may result in an increase in the population of vectors such as rats.</p> <p>With embedded controls, the impact magnitude is expected to be <b>Small</b> for vectors, where there may be occasional incidences of vector breeding conditions that can be controlled easily before the transmission of vector-borne diseases.</p>	<p>Impact Magnitude: <b>Small</b></p> <p>Receptor Sensitivity: <b>Low</b> (from rats) to <b>High</b> (from mosquitoes)</p> <p>Impact Significance: <b>Negligible</b> (rats) <b>Moderate</b> (mosquitoes)</p>	<ul style="list-style-type: none"> <li>Detailed design and construction methodology and scheduling to minimise potential for vector proliferation, where feasible.</li> <li>Informing stakeholders (i.e. neighbours) of construction activities, controls in place and schedule prior to the start of the Project construction activities.</li> <li>Setting up a grievance mechanism to ensure that any complaints from stakeholders with regards to vector (mosquito) breeding / pest infestation due to the Project, are identified and promptly addressed.</li> <li>Visual inspection of excavation sites, pits, worksites, internal and perimeter drainages, ECM collection basin(s), waste collection areas etc for still water/ rat population.</li> <li>To implement preventive measures by removing sources of stagnant water.</li> <li>Ensure regular food waste collection by licensed collector.</li> </ul> <p>Embedded controls and above mitigation measures should be applied to in-reservoir worksites as well.</p> <p>No significant (above minor) residual impacts are anticipated related to vectors, as such specific vector monitoring is not considered necessary. However, it is recommended to conduct regular environmental site inspections, i.e. on a weekly basis, (for land-based and in-reservoir worksites) see the EMMP Section 12.</p>	<p>Impact Magnitude: <b>Negligible</b></p> <p>Impact Significance: <b>Negligible</b></p>



Table 2: Environmental Impact Register (Operation)

SURFACE WAER QUALITY (SECTION 6)					
S/N	Impact	Impact Magnitude Description	Pre-Mitigation Impact Significance	Mitigation Measures and Monitoring	Residual (with mitigation) Impact Significance
O1	Change of hydrodynamics and surface water quality from the presence of FPV in reservoir	<ul style="list-style-type: none"> <li><b>Nature:</b> Predicted change in surface water quality within model results are mixed, <b>positive</b> (improvement) for certain parameters and <b>negative</b> (deterioration) for other parameters.</li> <li><b>Type:</b> The presence of FPV will alter light penetration, wind drag, heat exchange and other physical parameters that <b>indirectly</b> affect the surface water quality in the reservoir.</li> <li><b>Duration:</b> Impacts are <b>permanent</b> throughout the Project operational phase. Its effect on surface water quality is reversible should the Project's FPV be removed.</li> <li><b>Extent:</b> Impacts are limited <b>locally</b> within the reservoir only.</li> <li><b>Scale:</b> The change in surface water quality is expected at locations covered by Project's FPV islands (including FPV, walkways and perimeter floats) and PCUs.</li> <li><b>Frequency:</b> Impact may happen <b>daily/ intermittently</b> during the operational phase.</li> </ul> <p>A detailed water quality modelling exercise was conducted to assess the potential change in surface water quality associated with the presence of FPV in the Kranji Reservoir. Methodology, scenarios and findings of the modelling exercise is provided in <i>Appendix 6.1</i>. Modelling results indicated:</p> <ul style="list-style-type: none"> <li>The change in median temperature (average of whole reservoir) difference with presence of FPV (change in temperature = FPV minus Non-FPV) was not more than 0.3°C (PUB's guideline for this Project) in all assessment years, including base case in 2019 and climate change assessment years of 2030, 2040, 2050. Change in water temperature could affect a host of physiochemical (e.g. DO saturation) and biological processes (e.g. respiration, nitrification) in the reservoir.</li> <li>Total nitrogen (TN), Total Organic Carbon (TOC) and Chlorophyll-a reduce (i.e. improve) when compared to the Non-FPV simulation results under all assessment years (year 2019 as well as 2030, 2040 and 2050), which resulted in reduced time of non-compliance by at least 30% for all three parameters. These indicate lower algal activities in the reservoir.</li> <li>Total phosphorous (TP) concentration increases under the FPV scenarios for all assessment years. Note that TP level always exceeds, and is generally well above, the surface water quality guideline criteria of 0.06 mg/L in the baseline scenario (Non-FPV) as well as in the observed data, and thus the change in predicted TP levels is not expected to result in an increase in time of exceedance in surface water quality criterion for TP.</li> <li>Decrease in DO level is predicted in the reservoir with FPV (assuming the 5 current aerators are retained within the reservoir) but the median DO levels were within water quality guideline values (not below 3 mg/L, PUB's guideline for this Project) for more than 97% of time (i.e. more than 354 days in a year)<sup>4</sup> under the FPV scenarios in all assessment years (year 2019 as well as 2030, 2040 and 2050). Extent of locations with DO non-compliance is predicted to be highly localised. Percentage time with reservoir average DO level below 3 mg/L under Non-FPV scenarios for all assessment years ranges from 0.0% to 1.1%, and under FPV scenarios range from 0.3% to 1.4%. The reduction in DO level could affect a host of chemical (e.g. reduction/ oxidation) and biological processes (e.g. respiration, denitrification) in the reservoir.</li> </ul> <p>Note that the modelling conducted was based on a conservative larger FPV layout (122 ha, see <i>Section 6.6.2.3</i>), and did not take into account the breaking up of the large FPV islands with 30-40m corridors (which will be incorporated into the final FPV layout design to accommodate operational and SCDF requirements for safe and viable operations, and firefighting access). A reduced FPV layout, and presence of such additional corridors within the large FPV islands will also improve gaseous/ heat exchange, increase light penetration,</p>	<p>Impact Magnitude: <b>Medium</b></p> <p>Receptor Sensitivity: <b>High</b> (Kranji Reservoir/ tributaries/ PUB intakes)</p> <p>Impact Significance: <b>Major</b></p>	<ul style="list-style-type: none"> <li>Detailed design of FPV layout to optimise/minimise FPV island footprint, where feasible.</li> <li>Establish an Aquatic Vegetation/ Invasive Species Management Plan (includes removal of aquatic vegetation). This plan should be prepared and submitted to PUB for agreement prior to commencement of the operations.</li> <li>All aquatic vegetation trimmings, where required, to be collected and removed from the water column immediately for disposal offsite by a licenced contractor.</li> </ul> <p>Monitoring and adaptive management measures including:</p> <ul style="list-style-type: none"> <li>Conduct updated model runs (e.g. hydrodynamic and water quality) and hydraulic studies based on the final FPV layout. Review water quality impact assessment based on the findings of the updated model runs. Should changes (if any) be considered to be greater, or more impactful, than those assumed in this assessment, the impact assessments should be reviewed, and adaptive management measures implemented to ensure impacts are smaller than or equal to the impact significances assessed herein.</li> <li>Agree operational phase surface water quality threshold criteria with PUB, including action and limit levels.</li> <li>Online water quality monitoring systems installed pre-construction should be maintained and remain within the reservoir during operation (including decommissioning). Establish operation phase surface water quality monitoring programme in agreement with PUB prior to operation, to inform the adaptive management of any potential deterioration of surface water quality attributable to the Project, and provide analysis of long term changes and trends. Operation phase surface water quality monitoring programme is to continue for the entire operation period (including decommissioning). <ul style="list-style-type: none"> <li>Surface water quality monitoring parameters to include: Temperature (°C), pH, EC (µS/cm) (conductivity), Turbidity (NTU), Secchi Depth, Dissolved oxygen (DO), Metals and metalloids (including Aluminium, Arsenic, Copper, Iron, Lead, Manganese), Major ions (including chloride), grease and oil, PAR, Chlorophyll-a (fluorescence-based spectrophotometer) and Nutrients (TP, TN, TOC, DOC, nitrate (as N), phosphate and ammonia (as N)), 2-MIB, Geosmin, Microcystin-LR, and Total Suspended Solids (TSS).</li> </ul> </li> <li>Any notable deterioration of surface water quality observed should be investigated. Investigation should determine whether or not the observed deterioration can be attributed to the operation of the Project. If affirmative, the cause of adverse surface water quality events should be reviewed and targeted adaptive mitigation implemented. The Developer/ Owner should liaise with PUB closely on monitoring results and investigation findings and seek agreement on management action(s), which may include provision of artificial aeration, potential layout changes, removal of the FPV etc where appropriately agreed between responsible agencies and the Developer/ Owner. Where observations are not attributable to the Project, the Developer/ Owner will liaise with relevant Government Agencies responsible for managing the identified effect for their action.</li> </ul>	<p>Impact Magnitude: <b>Small</b></p> <p>Impact Significance: <b>Moderate</b></p>

<sup>4</sup>The use of median DO levels and the derivation of the 97% value are explained in *Appendix 6.1 Section 5.5.2* under 'Daily whole-reservoir averages' subsection.

SURFACE WAER QUALITY (SECTION 6)					
S/N	Impact	Impact Magnitude Description	Pre-Mitigation Impact Significance	Mitigation Measures and Monitoring	Residual (with mitigation) Impact Significance
		<p>all or which partially counteracts the effect of the presence of the FPV. This means the conservative modelled changes in hydrodynamic and surface water quality is anticipated to be greater than that ultimately proposed by this EIA for approval (112 ha). Overall, based on the conservative modelling, the change in surface water quality due to the presence of FPV would result in increased occasion of exceedance for some of surface water quality parameters (while improvement in others), and thus is considered to be of <i>Medium</i> impact magnitude.</p> <p>The presence of FPV will reduce sunlight entering the water column, thus limiting the regrowth of aquatic vegetation, assessed in Table 6-10 item C8 above (see also <i>Appendix D of Appendix 6.1</i>). Certain aquatic vegetation species that do not receive sufficient sunlight could die off partially or entirely, releasing some of their captured carbon, nitrogen and phosphorus through decomposition. As stated under the assessment under item C8, quantitative analysis of a very unlikely conservative scenario of having all the aquatic vegetation within the Reservoir Project Site (i.e. all vegetation in the water column) start decomposing at the same time and releasing nutrients immediately, the addition of total phosphorus, total nitrogen and total carbon in the 1<sup>st</sup> month will be approximately 11%, 9%, and 5% of the existing fluxes into the reservoir (catchment loadings, mineralisation, and atmospheric deposition) respectively. Therefore, the potential release of nutrients from dying of aquatic vegetation due to FPV shading is expected to have small impact on the reservoir surface water quality. Given this effect would be cumulative to the effect of presence of FPV assessed in the previous paragraph, the overall impact magnitude is considered to be <i>Medium</i>.</p> <p>The Floating Solar Handbook for Practitioners (World Bank Group, ESMAP and SERIS, 2019) refers to the potential for reduced evaporation from FPV projects depending on the system design such as the configuration of FPV panels. Various internationally published studies in tropical/ sub-tropical regions (Melvin and Xiang, 2015; Rosa-Clot et al., 2017; Gonzalez Sanchez et al., 2021; Mamatha &amp; Kulkarni, 2021; Farrar et al., 2022) have estimated evaporation rates related to FPV projects via various means. Depending on the coverage and configuration of FPV panels, a number of these studies indicate evaporation rates below FPV panels could reduce by 40–80% compared to non-FPV areas (Farfan et al., 2018; Gonzalez Sanchez et al., 2021; Farrar et al., 2022). For this Project, the potential for reduced evaporation will be reviewed/ studied as the Project progresses where appropriate, subject to further discussions between PUB and the Developer/ Owner on requirements and monitoring approaches.</p> <p>Overall, the impact magnitude is expected to be <i>Medium</i> for the receiving water of the Kranji Reservoir, where impacts are expected to be over the long term, however only occasionally exceedances of existing baseline/ statutory or guideline limits over short timeframes are expected with embedded controls, with positive changes in nutrients and chlorophyll-a levels.</p>			
O2	Wastewater and sediment disturbance from the O&M of FPV facilities (including cleaning of PV panels) in reservoir	<ul style="list-style-type: none"> <li>■ <b>Nature:</b> Degradation of surface water quality is considered <b>negative</b>.</li> <li>■ <b>Type:</b> O&amp;M requires regular access to the FPV site. Boat access could result in minor disturbance of reservoir bed sediment at shallow areas, which is considered to be a <b>direct</b> impact. Wash water from cleaning of FPV with reservoir water would also result in <b>direct</b> impacts.</li> <li>■ <b>Duration:</b> Though impacts are short-term and temporary, they will be <b>permanent</b> throughout the Project operational phase.</li> <li>■ <b>Extent:</b> Impacts are <b>localised</b> at shallow areas (particularly around the O&amp;M berthing facility). Impacts from wash water from cleaning of FPV would also be localised at the location where cleaning is necessary, where cleaning may be required throughout the FPV covered area.</li> <li>■ <b>Scale:</b> Body of water within less than 100 m could be affected by increased suspended solids, oil and grease or other contaminants.</li> <li>■ <b>Frequency:</b> Impact may happen <b>daily/ intermittently</b> during the operational phase.</li> </ul>	<p>Impact Magnitude: <b>Negligible to Small</b></p> <p>Receptor Sensitivity: <b>High</b> (Kranji Reservoir/ tributaries/ PUB intakes)</p> <p>Impact Significance: <b>Negligible to Moderate</b></p>	<ul style="list-style-type: none"> <li>■ As item O1 above.</li> <li>■ Design of the vessel operation procedures to account for the relatively shallow water to avoid the work boats etc from getting into the shallow depths and running their engines at full throttle. Account for heavy loads activity procedures/ navigation routes. Ensure boat operators are familiar with water depths across the reservoir.</li> </ul>	<p>Impact Magnitude: <b>Negligible</b></p> <p>Impact Significance: <b>Negligible</b></p>

SURFACE WATER QUALITY (SECTION 6)					
S/N	Impact	Impact Magnitude Description	Pre-Mitigation Impact Significance	Mitigation Measures and Monitoring	Residual (with mitigation) Impact Significance
		<p>Work boats moving within shallow area or close to banks could disturb reservoir bed sediment or erode soil from the bank. Disturbed sediment and eroded soil would result in localised increase in turbidity. Such increased turbidity will settle quickly after the disturbance subsides. Embedded measures regarding vessel speed limits would minimise disturbance to the reservoir bed sediment or to the bank. The resulting elevation of suspended solids is expected to be within ambient levels/ statutory limits and thus the impact magnitude is considered to be <i>Small</i>.</p> <p>Other maintenance works include checking of main and secondary floats buoyancy, tightness of connections, physical appearance, as well as checking of harness, moorings, shackles and or concrete blocks for the anchoring, which will not result in change in surface water quality. Some targeted cleaning (water only) would be needed to clean up bird droppings as required. No detergent or soap would be allowed. Water (pressurised if needed) drawn from the reservoir directly would be used. Therefore, the impact magnitude is considered to be <i>Negligible</i>.</p> <p>Impact magnitude is expected to be <b>Negligible</b> to <b>Small</b> for the receiving water of the Kranji Reservoir, where impacts are expected to be within existing baseline/ statutory or guideline limits, given the localised impact.</p>			

BIODIVERSITY (SECTION 7)					
S/N	Impact	Impact Magnitude Description	Pre-Mitigation Impact Significance	Mitigation Measures and Monitoring	Residual (with mitigation) Impact Significance
<b>AQUATIC BIODIVERSITY</b>					
O 1	Changes to the planktonic and/ or benthic communities	<ul style="list-style-type: none"> <li><b>Nature:</b> Changes to the planktonic and/ or benthic communities is considered <b>negative</b> for aquatic biodiversity.</li> <li><b>Type:</b> <b>Indirect</b> impacts which may extend across the reservoir.</li> <li><b>Duration:</b> Impacts are <b>long-term</b> throughout the Project operational phase. Its effect on aquatic biodiversity is reversible should the Project's FPV be removed.</li> <li><b>Extent:</b> Impacts are limited <b>locally</b> within the reservoir only.</li> <li><b>Scale:</b> <b>Indirect</b> changes may extend throughout the reservoir.</li> <li><b>Frequency:</b> The change will be <b>continuous</b> throughout the Project operational phase.</li> <li><b>Sensitive Receptor(s):</b> Aquatic habitats (planktonic and benthic) (Medium), Fish (Medium).</li> </ul> <p>A 40% reduction in solar radiation below the FPV panels is assumed (see <i>Appendix 6.1</i>). The total Kranji Reservoir surface area is 522 ha. Within the Reservoir Project Site of 201 ha, the unmitigated maximum FPV layout is assumed to occupy 113 ha (including areas for intra-island spacing between FPV islands required for maintenance vessel and firefighting access). As such the unmitigated maximum FPV layout coverage (i.e. 113 ha) is up to 21.6% of the total Kranji Reservoir surface area.</p> <p>This would reduce solar radiation entering the reservoir which would otherwise be available to primary producers (phytoplankton and submerged macrophytes). Scientific literature indicates that surface covers (FPVs, ice, cloth etc.) reduce solar irradiance and photosynthesis by a factor between 50%-88% depending on the waterbody type (Exley, 2021).</p> <p>Surface Water Quality modelling results show a decline in predicted chlorophyll-a values, that can be seen as a proxy for phytoplankton biomass, of 7-8 µg/L when FPVs are present compared to a non-FPV scenarios (see <i>Appendix 6.1</i>).</p> <p>The panels would also reduce heat absorption in the water column and shield the surface from wind, resulting in a reduction in the degree of mixing and mixing depth (see Table 7-16).</p> <p>Following the trimming of aquatic macrophyte vegetation within the top 1 m of the water column during the construction phase, nutrient availability will increase for phytoplankton and submerged macrophyte production due to decreased competition. However, in the absence of sufficient sunlight with the FPV panels deployed the phytoplankton and macrophytes would not utilise all available nutrients.</p> <p>It is anticipated that benthic macroinvertebrate diversity in shallow areas would also reduce from an observed medium level to mirror the</p>	<p>Impact Magnitude: <b>Medium</b></p> <p>Receptor Sensitivity: <b>Medium</b></p> <p>Impact Significance: <b>Moderate</b></p>	<p>Mitigation measures presented in the Surface Water Quality <i>Section 6</i> will be applied, including DO, Chlorophyll-a, Total Nitrogen, Total Phosphorus, Ammonia (as N), etc. monitoring, to verify impacts and inform the need for adaptive management. In addition to:</p> <ul style="list-style-type: none"> <li>Detailed design of FPV layout to optimise/ minimise FPV island footprint, where feasible.</li> </ul> <p>Monitoring and adaptive management measures including:</p> <ul style="list-style-type: none"> <li>Establish operation phase biodiversity monitoring programme in agreement with relevant Government authorities prior to works commencement, to inform the Developer/ Owner on any potential disturbance to biodiversity from the works. <ul style="list-style-type: none"> <li>Biodiversity monitoring to include: plankton (zooplankton and phytoplankton)</li> </ul> </li> <li>Any notable deterioration of biodiversity observed should be investigated. Investigation should determine whether or not the observed deterioration can be attributed to the operation of the Project. If affirmative, the cause of adverse biodiversity events should be reviewed and targeted mitigation applied. The Developer/ Owner should liaise with NParks closely on monitoring results and investigation findings and seek agreement on management action(s), which may include potential layout changes, removal of the FPV etc, where appropriately agreed between responsible agencies and the Developer/ Owner. Where observations are not attributable to the Project, the Developer/ Owner will liaise with relevant Government Agencies responsible for managing the identified effect for their action.</li> </ul> <p>Although mitigation is proposed through detailed design development the residual impact magnitude and significance has been retained at pre-mitigation levels on a precautionary basis due to the (1) limited baseline data available, and (2) uncertainty of long term effects on plankton community. Establishment of extensive long-term monitoring, datasets and analysis (see <i>Section 12</i>) are to validate residual (post-mitigation) impact significance, and further support management of this impact and determination of deteriorating trends (if any).</p>	<p>Impact Magnitude: <b>Medium (retained on precautionary basis)</b></p> <p>Impact Significance: <b>Moderate (retained on precautionary basis)</b></p>

BIODIVERSITY (SECTION 7)					
S/N	Impact	Impact Magnitude Description	Pre-Mitigation Impact Significance	Mitigation Measures and Monitoring	Residual (with mitigation) Impact Significance
		<p>low levels of biodiversity found in existing deeper areas of the reservoir, where light levels are reduced.</p> <p>It is not expected light levels will be reduced to the extent that primary production is precluded all together. There may be a shift in the phytoplankton community to taxa better adapted to lower light intensities beneath the panels, as is likely to currently occur beneath floating mats of aquatic vegetation (water hyacinth). It is likely phytoplankton distribution will change but their relative abundances or distributions would not change.</p> <p>The FPV islands will increase the amount of edge habitat across the reservoir surface and provide stable (not moving) shelter and foraging opportunities for zooplankton.</p> <p>Conservatively, should there be a die-off in phytoplankton, submerged macrophytes and benthic macroinvertebrates would increase bacterial decomposition activity in the benthos and lower the pH and dissolved oxygen concentration.</p> <p>Potentially anoxic conditions may promote phosphate and ammonium release from the sediments due to a reduced photosynthesis/ respiration ratio. High Total Phosphorus and low Total Nitrogen/ Total Phosphorus ratios can lead to cyanobacteria blooms.</p> <p>Within the setback zones around the reservoir edge, oxygen levels would likely remain unchanged (due to exchange across the reservoir surface).</p> <p>Connector cables laid on the reservoir bed are not expected to impact aquatic communities significantly due to their electric isolation and the comparatively small area they occupy. They might provide additional habitat structures for the aquatic communities.</p> <p>Taken together, these impacts could affect a significant proportion of aquatic habitats within the Reservoir Project Site. However, Yang et al. (2022) found for the Tengge reservoir FPV system, that processes away from the immediate area of FPV panels appear to be largely unaffected.</p> <p>Overall, the impact magnitude is expected to be <b>Medium</b> for the aquatic biodiversity, where impacts are expected to (i) affect part of the habitat but not threaten long-term habitat viability/ function, and/or (ii) cause a substantial change in abundance and/or the reduction in distribution of a population over one or more generations but does not threaten the long-term viability/ function of that population, or any population dependent on it, with embedded controls (e.g. optimising angle FPV panels to allow for some light to penetrate the water surface and reduce shading) for surface water quality and biodiversity; and</p>			

BIODIVERSITY (SECTION 7)					
S/N	Impact	Impact Magnitude Description	Pre-Mitigation Impact Significance	Mitigation Measures and Monitoring	Residual (with mitigation) Impact Significance
		considering that conservatively less than 21.6% of the total Kranji Reservoir area will be covered.			
O2	Changes to the fish community	<ul style="list-style-type: none"> <li><b>Nature:</b> Changes to the fish community is considered <b>negative</b> for aquatic biodiversity.</li> <li><b>Type:</b> <b>Indirect</b> impacts which may extend across the reservoir.</li> <li><b>Duration:</b> Impacts are <b>long-term</b> throughout the Project operational phase. Its effect on aquatic biodiversity is reversible should the Project's FPV be removed.</li> <li><b>Extent:</b> Impacts are limited <b>locally</b> within the reservoir only.</li> <li><b>Scale:</b> Indirect changes may extend throughout the reservoir.</li> <li><b>Frequency:</b> The change will be <b>continuous</b> throughout the Project operational phase.</li> <li><b>Sensitive Receptor(s):</b> Fish (Medium).</li> </ul> <p>The drivers of the biomass and distribution of fish in reservoirs are light, temperature, the distribution of macrophytes and plankton (zooplankton and phytoplankton), and shelter for spawning or avoiding predation. Dissolved oxygen is also a limiting factor affecting the fish community.</p> <p>Following the changes described above for the planktonic and benthic communities, the fish community could be altered in terms of the biomass and distribution of species. However, all fish species recorded are generalists and none are strict planktivorous (feed on plankton). So, despite any changes to plankton community, the overall biomass and size of the fish population is unlikely to change. This includes the introduced but globally EN Asian arowana.</p> <p>Installation of the FPVs could potentially reduce eutrophication and improve conditions for native species. The FPV panels will increase surface edge habitat and might provide new stable (not moving) shelter and nursery grounds. Anchoring might serve as additional habitat structures for fish and macroinvertebrates.</p> <p>Overall, impact magnitude is expected to be <b>Small</b> for the fish community, where impacts are expected to (i) only affect a small area with no loss of habitat viability/ function, and/ or (ii) not cause substantial change in species population or other species dependent on it, with embedded controls for surface water quality and biodiversity including no development of area south of the Reservoir Project Site where fish biomass is highest.</p>	<p>Impact Magnitude: <b>Small</b></p> <p>Receptor Sensitivity: <b>Medium</b> (introduced globally EN Asian arowana)</p> <p>Impact Significance: <b>Minor</b></p>	<p>Mitigation measures presented in the Surface Water Quality <i>Section 6</i> will be applied to inform need for adaptive management. In addition to:</p> <ul style="list-style-type: none"> <li>Detailed design of FPV layout to optimise/ minimise FPV island footprint, where feasible.</li> </ul> <p>Monitoring and adaptive management measures including:</p> <ul style="list-style-type: none"> <li>Establish operation phase biodiversity monitoring programme in agreement with relevant Government authorities prior to works commencement, to inform the Developer/ Owner on any potential deterioration of biodiversity from the works. <ul style="list-style-type: none"> <li>Biodiversity monitoring to include: fish biomass and size.</li> </ul> </li> <li>Should monitoring show a decline in fish biomass, the Developer/ Owner to consider opportunities, in consultation with relevant Government authorities, for additional nature based solutions, e.g. for fish habitat enhancement in the retained habitats areas within the reservoir, for example: <ul style="list-style-type: none"> <li>Patches of floating vegetation to be retained, where feasible, in the Reservoir Project Site, subject to FPV system and PUB's reservoir operational requirements.</li> <li>If the fish population is observed to be significantly affected despite above adaptive measures then consider other adaptive management which may include, for example, potential layout changes, removal of FPV panels etc, where appropriately agreed between responsible agencies and the Developer/ Owner.</li> </ul> </li> </ul>	<p>Impact Magnitude: <b>Negligible</b></p> <p>Impact Significance: <b>Negligible</b></p>
TERRESTRIAL BIODIVERSITY					
O3	Reduced foraging opportunities on reservoir surface for	<ul style="list-style-type: none"> <li><b>Nature:</b> Reduced foraging opportunities on reservoir surface is considered <b>negative</b> for terrestrial fauna. Additional resting areas on, and increased surface edge habitat and aquatic nursery grounds under, FPV within the reservoir are considered positive for terrestrial fauna foraging.</li> </ul>	<p>Impact Magnitude: <b>Small</b></p> <p>Receptor Sensitivity: <b>High</b></p>	<p>Mitigation measures presented in item O1 and O2 above on plankton, benthic and fish communities, including monitoring, will be applied to inform need for adaptive management. In addition to:</p> <ul style="list-style-type: none"> <li>Detailed design of FPV layout to optimise/ minimise FPV island footprint, where feasible.</li> <li>A mitigated biodiversity FPV layout is recommended under this EIA for approval: <ul style="list-style-type: none"> <li>(i) Reduce the FPV layout footprint in the observed higher bird foraging area within the Reservoir Project Site, in the central west edge (near VP3, adjacent to Kranji Marshes) (see Figure 7-15).</li> </ul> </li> </ul>	<p>Impact Magnitude: <b>Small (retained on precautionary basis)</b></p>

BIODIVERSITY (SECTION 7)					
S/N	Impact	Impact Magnitude Description	Pre-Mitigation Impact Significance	Mitigation Measures and Monitoring	Residual (with mitigation) Impact Significance
	terrestrial fauna	<ul style="list-style-type: none"> <li><b>Type:</b> Direct impacts from permanent Project in-reservoir footprint (e.g. FPV islands, PCUs). Indirect impacts which may extend across the reservoir.</li> <li><b>Duration:</b> Impacts are long-term throughout the Project operational phase. Its effect on terrestrial fauna is reversible should the Project's FPV be removed.</li> <li><b>Extent:</b> Impacts are limited locally within the reservoir only.</li> <li><b>Scale:</b> Direct impacts within permanent Project in-reservoir footprint. Indirect changes may extend throughout the reservoir.</li> <li><b>Frequency:</b> The change will be continuous throughout the Project operational phase.</li> <li><b>Sensitive Receptor(s):</b> Birds (Low to High), Reptiles (Low to Medium), Smooth-coated otter (Medium), Bats (Medium).</li> </ul> <p>See also item O1 and O2 above on aquatic biodiversity.</p> <p>The unmitigated maximum FPV layout includes a 25 m setback from the western reservoir shoreline to the FPV panels, corridors between large FPV islands, and PUB vessel corridors (50m wide) for reservoir operations, which can be used for fauna passage and foraging. The setback of the FPV infrastructure from the eastern shoreline is at least 50 m to allow for the required PUB vessel corridors (at a prescribed depth). In addition, as described in Section 7.7.2.2, the large FPV islands presented will be further broken down with 30-40m "intra-island corridors" in the final design by the Developer/ Owner to allow for Operation and Maintenance (O&amp;M) and emergency vessel access. The unmitigated maximum FPV layout, the subject of this biodiversity impact assessment, within the Reservoir Project Site (201 ha) is shown Figure 7-22 and Figure 7-24. The unmitigated maximum FPV layout is assumed to occupy 113 ha, up to 21.6% of the total Kranji Reservoir surface area (522 ha). This means 409 ha or 78.3% of the Kranji Reservoir surface area will remain unoccupied by the Project's permanent in-reservoir structures under the unmitigated maximum FPV layout scenario. It is considered that the vessel corridors, and the intra-island corridors between the FPV islands will still provide access to the observed higher bird foraging habitat areas and allow in-reservoir fauna movements.</p> <p>The majority of feeding by bird species (e.g. herons, Rallidae) is concentrated along the shoreline edge of the reservoir and south of the Reservoir Project Site (avoided by the Project, as these areas are outside the Reservoir Project Site boundary) and on patches of floating vegetation. As indicated in Section 7.5.2.10, very low levels of foraging were recorded for all species in the Vantage Point (VP) survey area of Kranji Reservoir (35.4 foraging events per hour, equivalent to 0.1 foraging events per hectare per hour<sup>5</sup>). Further analysis indicates the majority of these foraging events were attributable to little tern (national</p>	Impact Significance: Moderate	<ul style="list-style-type: none"> <li>(ii) Establish a setback distance of 50 m from the FPV panels to the western shoreline of Kranji Reservoir, where relatively higher bird foraging was observed, as suggested by stakeholders, to give greater confidence in the ability of the mitigated biodiversity FPV layout to reduce impacts on biodiversity associated with disturbance and displacement along the western shoreline.</li> <li>Based on bird baseline survey data analysis using foraging activity per 50x50m cell, a mitigated biodiversity FPV layout has been proposed, and is presented as the FPV layout in the EIA's Project Description for approval (Section 2, Figure 2-3).</li> <li>The mitigated biodiversity FPV layout footprint will occupy approximately 112 ha or 21.5% of the total Kranji Reservoir surface area. This means 410 ha or 78.5% of the total Kranji Reservoir surface will remain unoccupied by the Project's permanent structures.</li> <li>The (i) targeting of areas of higher foraging activity to adjust the mitigated layout, and (ii) increasing of the western shoreline setback to the FPV panels to 50 m; allows an overall 2 ha reduction in FPV cover to achieve an improvement of 31% fewer foraging events lost compared to the unmitigated maximum FPV layout; and 16% more observed foraging areas gained compared to the unmitigated maximum FPV layout.</li> <li>See Figure 7-24 comparing the unmitigated maximum FPV and mitigated biodiversity FPV layouts, Table 0-4 comparing the observed baseline foraging events against the mitigated biodiversity FPV layout, and figure 7-25 and figure 7-26 indicating the FPV layouts against foraging events per hour for all species.</li> </ul> <p>Monitoring and adaptive management measures include:</p> <ul style="list-style-type: none"> <li>Establish operation phase biodiversity monitoring programme in agreement with relevant Government authorities prior to operation, to inform the Developer/ Owner on any potential disturbance to biodiversity from the works. <ul style="list-style-type: none"> <li>Biodiversity monitoring to include: focal-/ waterbird species and smooth-coated otters.</li> </ul> </li> <li>Any notable deterioration of biodiversity observed should be investigated. Investigation should determine whether or not the observed deterioration can be attributed to the operation of the Project. If affirmative, the cause of adverse biodiversity events should be reviewed and targeted mitigation developed. The Developer/ Owner should liaise with NParks closely on monitoring results and investigation findings and seek agreement on management action(s), which may include potential layout changes, removal of the FPV etc, where appropriately agreed between responsible agencies and the Developer/ Owner. Where observations are not attributable to the Project, the Developer/ Owner will liaise with relevant Government Agencies responsible for managing the identified effect for their action.</li> </ul>	Impact Significance: Moderate (retained on precautionary basis)

<sup>5</sup> The total number of foraging events recorded from each VP was mapped to a 50m x 50m cell and divided by the hours of observation at the VP to generate a map of foraging activity per hour.

**BIODIVERSITY (SECTION 7)**

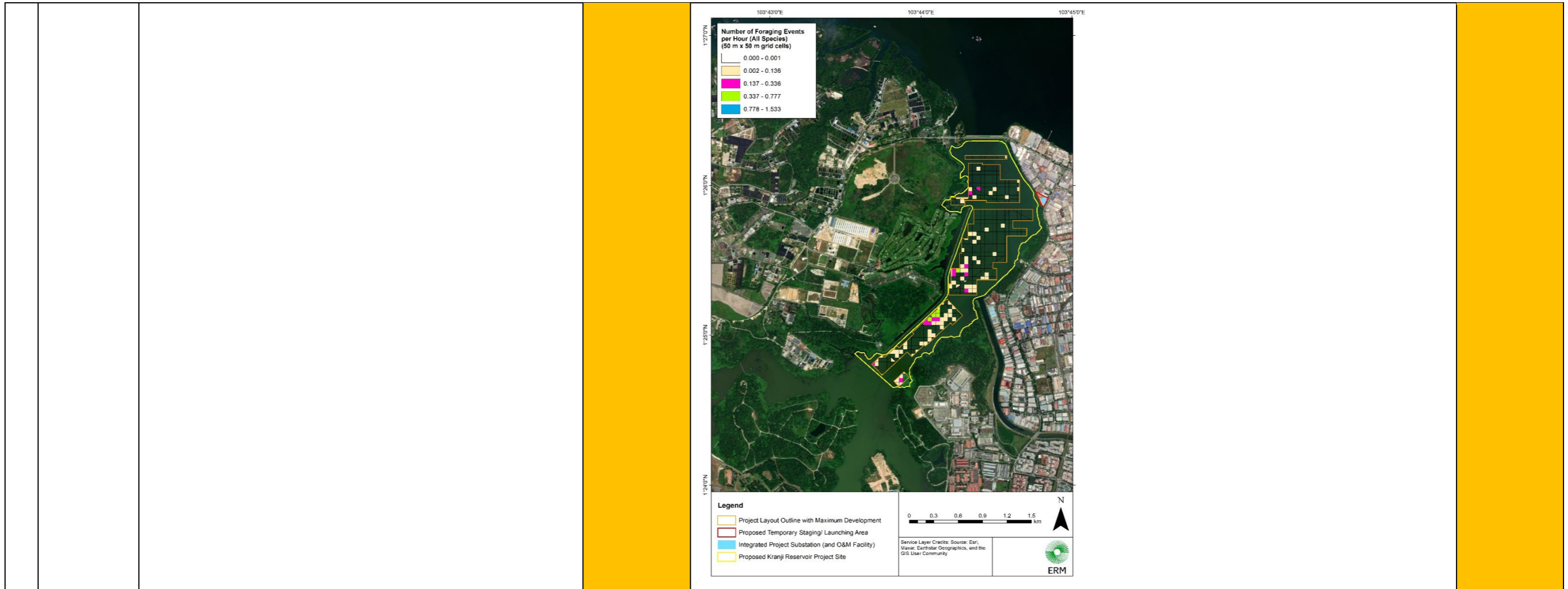
S/N	Impact	Impact Magnitude Description	Pre-Mitigation Impact Significance	Mitigation Measures and Monitoring	Residual (with mitigation) Impact Significance												
		<p>EN) (22.9 foraging events per hour). Low foraging activity was recorded for white-bellied sea eagle, grey-headed fish eagle, purple heron, other ardeids and other terns in the VP survey area. Hence, given their relative numbers, foraging analysis focuses on little terns.</p> <p>For little terns, records indicate the unmitigated maximum FPV layout coverage (113 ha) may result in 6.6 fewer foraging events per hour (7.8 fewer foraging events per hour for all species). The unmitigated maximum FPV layout covers an area of 15 ha observed to be used by little terns for foraging (i.e. 15 ha of foraging area will be lost due to the FPV coverage across the VP survey area).</p> <p><b>Table 7-19: Comparison of Observed Foraging Events in VP Survey Area against Unmitigated Maximum FPV Layout (see Figure 7-26)</b></p> <table border="1"> <thead> <tr> <th></th> <th>Foraging events per hour in VP study area: <u>without FPV</u></th> <th>Foraging events per hour in VP study area: if <u>unmitigated maximum FPV layout</u></th> <th>Difference: without FPV vs unmitigated maximum FPV layout</th> </tr> </thead> <tbody> <tr> <td>All species</td> <td>35.4</td> <td>27.6</td> <td>- 7.8</td> </tr> <tr> <td>Little Tern</td> <td>22.9</td> <td>16.3</td> <td>- 6.6</td> </tr> </tbody> </table> <p>The foraging range of the little terns is reported to range from 4 km for breeding birds (Parsons et al 2015) to 9-11 km (Thaxter et al. 2012). Given the absence of breeding little tern in the data recorded, their foraging habitat is expected to extend outside of the reservoir. Thus, the lost foraging habitat due to the unmitigated maximum FPV layout is considered to represent only a small fraction of the total foraging grounds of this species. The likelihood that little terns would not be able to compensate for this very small loss of foraging events by increasing feeding in areas unaffected by the FPV layout is extremely low. Furthermore, fish populations will continue to be able to sustain little terns (S/N O2 above). The impact magnitude is expected to be <i>Small</i> for the foraging by little terns, where impacts are expected to (i) only affect a small area with no loss of habitat viability/ function, and/ or (ii) not cause substantial change in species population or other species dependent on it, with embedded controls for biodiversity. Noting the area south of the Reservoir Project Site is where fish biomass is highest, and little terns foraging was recorded to be concentrated, remains unaffected.</p> <p>Similarly, for other bird species, the home ranges of these species extend to foraging habitat outside of the reservoir, and fish populations will continue to be able to sustain these birds populations. Furthermore,</p>		Foraging events per hour in VP study area: <u>without FPV</u>	Foraging events per hour in VP study area: if <u>unmitigated maximum FPV layout</u>	Difference: without FPV vs unmitigated maximum FPV layout	All species	35.4	27.6	- 7.8	Little Tern	22.9	16.3	- 6.6			
	Foraging events per hour in VP study area: <u>without FPV</u>	Foraging events per hour in VP study area: if <u>unmitigated maximum FPV layout</u>	Difference: without FPV vs unmitigated maximum FPV layout														
All species	35.4	27.6	- 7.8														
Little Tern	22.9	16.3	- 6.6														
		<p><b>Table 7-20: Comparison of Observed Foraging Events in VP Survey Area against Mitigated FPV Layout (see Figure 7-26)</b></p> <table border="1"> <thead> <tr> <th></th> <th>Foraging events per hour in VP study area: <u>without FPV</u></th> <th>Foraging events per hour in VP study area: if <u>mitigated biodiversity FPV layout</u></th> <th>Difference: without FPV vs mitigated biodiversity FPV layout</th> </tr> </thead> <tbody> <tr> <td>All Species</td> <td>35.4</td> <td>30</td> <td>- 5.4</td> </tr> <tr> <td>Little Tern</td> <td>22.9</td> <td>18.4</td> <td>- 4.5</td> </tr> </tbody> </table>		Foraging events per hour in VP study area: <u>without FPV</u>	Foraging events per hour in VP study area: if <u>mitigated biodiversity FPV layout</u>	Difference: without FPV vs mitigated biodiversity FPV layout	All Species	35.4	30	- 5.4	Little Tern	22.9	18.4	- 4.5			
	Foraging events per hour in VP study area: <u>without FPV</u>	Foraging events per hour in VP study area: if <u>mitigated biodiversity FPV layout</u>	Difference: without FPV vs mitigated biodiversity FPV layout														
All Species	35.4	30	- 5.4														
Little Tern	22.9	18.4	- 4.5														

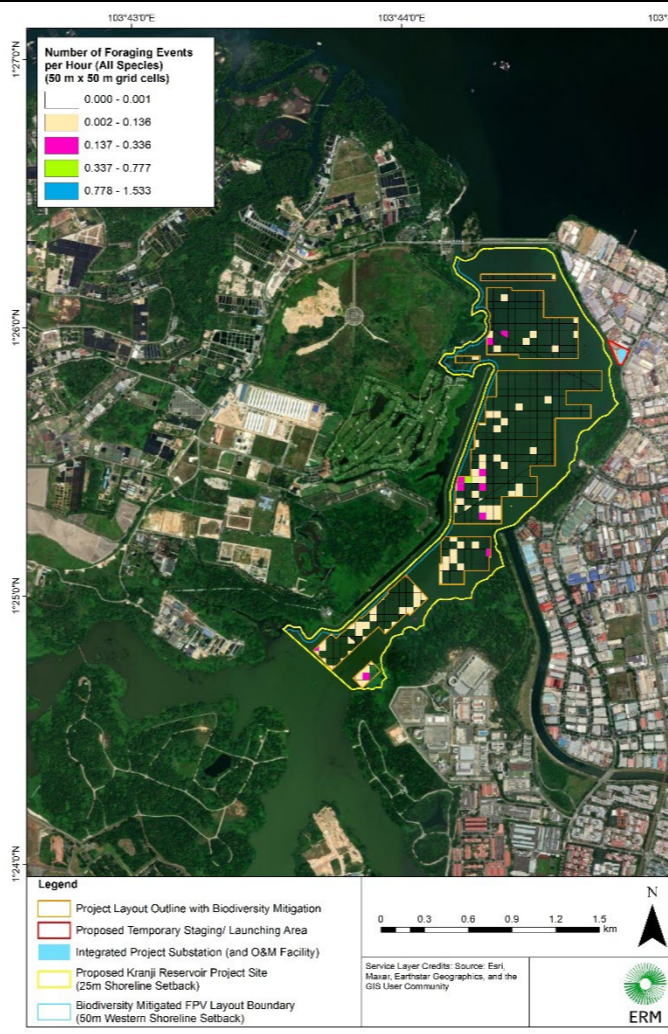


BIODIVERSITY (SECTION 7)					
S/N	Impact	Impact Magnitude Description	Pre-Mitigation Impact Significance	Mitigation Measures and Monitoring	Residual (with mitigation) Impact Significance
		<p>it should be noted, that the piscivorous (fish feeding) raptors are efficient and spend relatively little time foraging, especially in food rich areas. The impact magnitude is expected to be <i>Negligible</i> for these other birds, where impacts are expected to be within normal range of natural variation for the habitat, or population of the species with embedded controls.</p> <p>Baseline surveys indicate birds tolerate boats within 5 - 25m before initiating flight response, and that birds use existing infrastructure within the reservoir for roosting and feeding. Information from Tengeh reservoir also indicates rapid habituation of some species to FPV's<sup>6</sup>.</p> <p>Insectivorous bats were recorded foraging mainly on the reservoir edge. The unmitigated 25 m western setback to FPV panels, and various vessel corridors within (subject to final design) and between the large FPV islands and PUB vessel corridors (50 m) will also still be able to provide foraging habitat. Insect populations will continue to be able to sustain bat populations. The impact magnitude is expected to be <i>Small</i> for insectivorous bats, where impacts are expected to (i) only affect a small area with no loss of habitat viability/ function, and/or (ii) not cause substantial change in species population or other species dependent on it.</p> <p>Smooth-coated otters were recorded using the reservoir, particularly the banks. This species is expected to forage beyond Kranji Reservoir within nearby rivers to the south, mangroves and mudflats to the north, Kranji Marshes and storm drains. Fish populations will continue to be able to sustain the smooth-coated otter. The impact magnitude is expected to be <i>Small</i> for the foraging by the smooth-coated otter, where impacts are expected to (i) only affect a small area with no loss of habitat viability/ function, and/or (ii) not cause substantial change in species population or other species dependent on it, with embedded controls.</p> <p>Aquatic herpetofauna (reptiles), such as the Asian soft-shelled turtle, Malayan box terrapin and red-tailed pipe-snake are also adapted to disturbed waterbodies with poor surface water quality. These species are less mobile than birds and the individuals in the reservoir may not be able to relocate as easily as birds to find other foraging habitat. With embedded controls, the impact magnitude is expected to be <i>Small</i> for the foraging by reptiles, where impacts are expected to (i) only affect a small area with no loss of habitat viability/ function, and/or (ii) not cause substantial change in species population or other species dependent on it.</p> <p>Some incidental positive impact is possible by the FPVs providing stable (non-moving) shade and nursery habitats for fish and resting</p>			

<sup>6</sup> Meet the Wildlife of Sembcorp Tengeh Floating Solar Farm <https://www.youtube.com/watch?v=0jGWYTWHJeQ>

BIODIVERSITY (SECTION 7)					
S/N	Impact	Impact Magnitude Description	Pre-Mitigation Impact Significance	Mitigation Measures and Monitoring	Residual (with mitigation) Impact Significance
		<p>habitat for species such as birds, including little tern, herons and egrets, and non-flying (i.e. swimming) terrestrial fauna.</p> <p>Overall, conservatively the impact magnitude is expected to be <b>Small</b> for the foraging by the terrestrial fauna, where impacts are expected to (i) only affect a small area of the Kranji Reservoir with no loss of habitat viability/ function, and/ or (ii) not cause substantial change in species population or other species dependent on it, with embedded controls.</p>		<p><b>Figure 7-25: All Species Foraging Events per Hour in VP Survey Area overlaid on Mitigated Biodiversity FPV layout</b></p>	



BIODIVERSITY (SECTION 7)					
S/N	Impact	Impact Magnitude Description	Pre-Mitigation Impact Significance	Mitigation Measures and Monitoring	Residual (with mitigation) Impact Significance
				 <p>The map displays the Kranji Reservoir area with various project components overlaid. A legend identifies the Project Layout Outline with Biodiversity Mitigation (yellow), Proposed Temporary Staging/ Launching Area (red), Integrated Project Substation (and O&amp;M Facility) (blue), Proposed Kranji Reservoir Project Site (25m Shoreline Setback) (orange), Biodiversity Mitigated FPV Layout Boundary (50m Western Shoreline Setback) (light blue), and a scale bar (0 to 1.5 km). A color-coded legend for 'Number of Foraging Events per Hour (All Species) (50 m x 50 m grid cells)' is also present, with categories: 0.000 - 0.001 (white), 0.002 - 0.136 (yellow), 0.137 - 0.336 (orange), 0.337 - 0.777 (green), and 0.778 - 1.533 (blue). The map shows a high density of foraging events in the unmitigated layout (left) and a significantly reduced density in the mitigated layout (right).</p>	
				<p><b>Figure 7-26: All Species Foraging Events per Hour recorded within Unmitigated Maximum FPV Layout (left) and Mitigated Biodiversity FPV Layout (right)</b></p> <p>This “loss of foraging” analysis for the unmitigated and mitigated FPV layout scenarios is based on the conservative assumption birds will not compensate for the loss of foraging areas by changing their foraging behaviour, for example, by increasing: (i) the intensity of their foraging, (ii) the length of time foraging, or (iii) the area of foraging, to offset the effect of the FPV covering the reservoir surface. This is a highly precautionary approach. On the basis of the low number of foraging events lost to the FPV coverage and the high likelihood that birds could compensate; in addition to the mitigated FPV layout, and further open areas required for the 30-40m intra-island vessel corridors for O&amp;M and emergency vessel use (embedded control to be incorporated in final design); the magnitude of the impact on foraging could be reduced from small (pre-mitigation) to negligible (residual).</p> <p>However, despite the proposed mitigation and refinement of the FPV layout, the residual impact magnitude and significance has been retained at pre-mitigation levels on a precautionary basis due to the uncertainty of bird responses to the FPV panels. Establishment of extensive long-term monitoring, datasets, and analysis (see Section 12) are to validate residual (post-mitigation) impact significance, and further support management of this impact and determination of deteriorating trends</p>	

BIODIVERSITY (SECTION 7)					
S/N	Impact	Impact Magnitude Description	Pre-Mitigation Impact Significance	Mitigation Measures and Monitoring	Residual (with mitigation) Impact Significance
				(if any). The EMMP will also specify adaptive management measures in the event limits of acceptable change could be exceeded.	
O4	Bird and/ or bat collision with FPV panels	<ul style="list-style-type: none"> <li><b>Nature:</b> Bird and/ or bat collision with FPV panels is considered <b>negative</b>.</li> <li><b>Type:</b> <b>Direct</b> impact from collision with FPV panels.</li> <li><b>Duration:</b> Impacts are <b>long-term</b> throughout the Project operational phase. Its effect on terrestrial fauna is reversible should the Project's FPV be removed.</li> <li><b>Extent:</b> <b>Localised</b> to FPV layout footprint.</li> <li><b>Scale:</b> Specific to location of collision within the FPV layout footprint.</li> <li><b>Frequency:</b> <b>Incidental</b> during the operation phase.</li> <li><b>Sensitive Receptor(s):</b> Birds (Low to High), Bats (Low to Medium).</li> </ul> <p>There is little scientific evidence to suggest that birds mistake PV panels for waterbodies (IUCN, 2021). Literature of comparable studies with similar surrounding environments to Kranji Reservoir are not available.</p> <p>To date there is no scientific proof that bats are attracted to FPV panels for insects, or that they collide with them.</p> <p>A comprehensive review of the risks associated with solar power was undertaken by Natural England, the national government conservation body (<i>Evidence review of the impact of solar farms on birds, bats and general ecology (NER012) 2017</i>), concluded that the risks of solar panel collision was low but not impossible and strongly recommended further research. A number of influential bird NGO's including Audubon society, Birdlife International and organisations such as the IUCN are supportive of solar power but stress the need for post-construction monitoring to help quantify effects. Monitoring forms a significant part of the EMMP (see <i>Section 12</i>) in part to address this.</p> <p>Low angling of panels and use of anti-reflective materials will reduce collision likelihood. Collisions are less likely given the panels are part of an existing waterbody, rather than the situation identified by some studies reported in the IUCN guidance on solar and wind energy development (2019), where such PV arrays were placed in desert conditions, thereby potentially attracting birds. This putative creation of a lake effect (or mirage) for birds in desert settings is unlikely to occur for FPVs in existing waterbodies. It is also understood that no bird and bat collisions have been reported to date from other FPV testbeds and utility scale FPV installations in Singapore. Also noting that collision risks are generally avoided by the fact that bird and bat usage of the open areas of the Kranji Reservoir surface is low overall, with the exception of little tern. With embedded controls, however, for little tern bird and bat species, the effects of any collisions, should they occur, the impact magnitude is expected to be <b>Negligible</b>, where impacts are</p>	<p>Impact Magnitude: <b>Negligible</b></p> <p>Receptor Sensitivity: <b>High</b> (Birds, particularly little tern)</p> <p>Impact Significance: <b>Negligible</b></p>	<p>Mitigation measures presented in item O3 above on foraging by terrestrial fauna, including monitoring, will be applied to inform need for adaptive management. In addition to:</p> <ul style="list-style-type: none"> <li>Establish a Wildlife Incident Response Plan and Reporting (including for birds, bats, snakes, crocodiles etc) to be enacted when a trapped/ injured/ dead/ dangerous animal is encountered around or within the Project Site(s), e.g. during the regular monitoring or maintenance activities.</li> </ul>	<p>Impact Magnitude: <b>Negligible</b></p> <p>Impact Significance: <b>Negligible</b></p>

BIODIVERSITY (SECTION 7)					
S/N	Impact	Impact Magnitude Description	Pre-Mitigation Impact Significance	Mitigation Measures and Monitoring	Residual (with mitigation) Impact Significance
		expected to be within normal range of natural variation for the habitat, or population of the species.			
O5	Barrier effects/habitat fragmentation across reservoir surface and integrated Project Substation site	<ul style="list-style-type: none"> <li><b>Nature:</b> Barrier effects and habitat fragmentation across the reservoir surface and land-based integrated Project Substation site is considered <b>negative</b> for terrestrial fauna.</li> <li><b>Type:</b> <b>Indirect</b> impacts from FPV layout footprint and integrated Project Substation site.</li> <li><b>Duration:</b> Impacts are <b>long-term</b> throughout the Project operational phase. Its effect on terrestrial fauna in-reservoir is reversible should the Project's FPV be removed. For the integrated Project Substation site the future surrounding land use is designated as Park.</li> <li><b>Extent:</b> <b>Localised</b> to FPV layout footprint and integrated Project Substation site.</li> <li><b>Scale:</b> <b>Indirect</b> changes may extend throughout the Project Site(s).</li> <li><b>Frequency:</b> The change will be <b>continuous</b> throughout the Project operational phase.</li> <li><b>Sensitive Receptor(s):</b> Smooth-coated otter (High), Reptiles (Low to Medium).</li> </ul> <p>As terrestrial species, the mammals and herpetofauna (reptiles) recorded using the surface of the reservoir for foraging would be able to walk/ run over the FPVs. The fauna may also rest, or for herpetofauna bask, on the FPVs and the walkways and perimeter floats. The retained setback zone around the edge of the reservoir, also, corridors within/ between the large FPV islands, and PUB vessel corridors can still be used for passage and foraging. Wildlife will still be able to move around the FPVs without incurring significant additional energy expenditure or predation risk, etc.</p> <p>The 150 m shoreline adjacent to the integrated Project Substation will be re-planted to support continuity of habitat along the eastern shoreline. The future designated land use is Park. Minimal fragmentation is expected to terrestrial habitats for any fauna.</p> <p>There is no scientific evidence that flight paths of birds, including migratory birds, might be disrupted by increased light reflectance by solar panels. Since the FPV panels will be coated with anti-reflective materials to maximise light absorption and minimise glare as an embedded measure, no impact on the flight path of birds is expected.</p> <p>Overall, the impact magnitude is expected to be <b>Negligible</b> for the barrier effects/ fragmentation to terrestrial fauna, where impacts are expected to be within normal range of natural variation for the habitat, or population of the species with embedded controls.</p>	<p>Impact Magnitude: <b>Negligible</b></p> <p>Receptor Sensitivity: <b>High</b></p> <p>Impact Significance: <b>Negligible</b></p>	<ul style="list-style-type: none"> <li>Detailed design to determine whether operational fencing is required at locations around the Reservoir Project Site, due to operational safety and security concerns, the Developer/ Owner should, in consultation with relevant Government authorities, establish wildlife-friendly fencing, crossings, access into the fencing design.</li> </ul> <p>Monitoring and adaptive management measures include:</p> <ul style="list-style-type: none"> <li>Establish operation phase biodiversity monitoring programme in agreement with relevant Government authorities prior to operation, to inform the Developer/ Owner on any potential disturbance to biodiversity from the works.                             <ul style="list-style-type: none"> <li>Biodiversity monitoring to include: bird flight paths post-construction against pre-construction behaviour to identify if there are any significant changes in flight behaviour.</li> </ul> </li> </ul>	<p>Impact Magnitude: <b>Negligible</b></p> <p>Impact Significance: <b>Negligible</b></p>
AQUATIC AND/OR TERRESTRIAL BIODIVERSITY					

BIODIVERSITY (SECTION 7)					
S/N	Impact	Impact Magnitude Description	Pre-Mitigation Impact Significance	Mitigation Measures and Monitoring	Residual (with mitigation) Impact Significance
O6	Maintenance	<ul style="list-style-type: none"> <li><b>Nature:</b> Maintenance activities could be considered <b>negative</b> for aquatic and thus terrestrial fauna.</li> <li><b>Type:</b> <b>Direct</b> impact from use on in-reservoir infrastructure.</li> <li><b>Duration:</b> Impacts may occur <b>long-term</b> throughout the Project operational phase, however impacts would be temporary.</li> <li><b>Extent:</b> <b>Localised</b> to in-reservoir infrastructure footprint.</li> <li><b>Scale:</b> <b>Indirect</b> changes may extend throughout the Reservoir Project Site.</li> <li><b>Frequency:</b> Occasional during the operation phase.</li> <li><b>Sensitive Receptor(s):</b> Aquatic habitats (Medium, includes for secondary value to terrestrial fauna)</li> </ul> <p>See also Surface Water Quality <i>Section 6, Table 6-12</i>, item O2.</p> <p>Embedded controls include no detergent or soap allowed for FPV cleaning, where water (pressurised if needed) drawn from the reservoir directly is to be used.</p> <p>Overall, the impact magnitude is expected to be <b>Negligible</b> for maintenance impacts to terrestrial fauna, where impacts are expected to be expected to be within normal range of natural variation for the habitat, or population of the species with embedded controls.</p>	<p>Impact Magnitude: <b>Negligible</b></p> <p>Receptor Sensitivity: <b>Medium</b></p> <p>Impact Significance: <b>Negligible</b></p>	No mitigation measures are required as embedded controls are considered to be adequate to manage impact significance to be <b>Negligible</b> .	N/A (refer to Pre-Mitigation Impact Significance Column)
O7	Introduction and spread of invasive alien species	<ul style="list-style-type: none"> <li><b>Nature:</b> Introduction and spread of invasive alien species is considered <b>negative</b> for both aquatic and terrestrial biodiversity.</li> <li><b>Type:</b> Introduction will have a <b>direct</b> impact on aquatic and terrestrial biodiversity.</li> <li><b>Duration:</b> Impacts may occur <b>long-term</b> throughout the Project operational phase.</li> <li><b>Extent:</b> <b>Localised</b> around the Project site(s) and the immediate surroundings, and Kranji Reservoir.</li> <li><b>Scale:</b> Potentially localised patches across the reservoir and surrounding terrestrial habitats.</li> <li><b>Frequency:</b> <b>Intermittently</b> during the operational phase.</li> <li><b>Sensitive Receptor(s):</b> Aquatic habitat (Medium), Surrounding terrestrial habitats (Low to High)</li> </ul> <p>The site has an existing significant issue with invasive non-native species. Regular management of aquatic vegetation within the Kranji Reservoir is already undertaken by PUB. Additional aquatic vegetation trimming and management and therefore also increased management of invasive plant species is expected to occur during operation period within the Reservoir Project Site. Therefore, the project might overall exert a positive impact regarding invasive species. Toxic blooming species of phytoplankton already occur in the reservoir. No invasive species have been identified on the land-based worksite.</p> <p>The impact magnitude is expected to be <b>Negligible</b> for invasive species, where impacts are expected to be within normal ranges of natural variation for habitats and populations of the species, given embedded controls and the existing baseline.</p>	<p>Impact Magnitude: <b>Negligible</b></p> <p>Receptor Sensitivity: <b>Medium</b> (Aquatic - Kranji Reservoir) to <b>High</b> (Terrestrial, Sungei Kadut Forest)</p> <p>Impact Significance: <b>Negligible</b></p>	No mitigation measures are required as embedded controls are considered to be adequate to manage impact significance to be <b>Negligible</b> . However, mitigation measures presented in the Surface Water Quality ( <i>Section 6</i> ) will be applied, for example: <ul style="list-style-type: none"> <li>Establish an Aquatic Vegetation/ Invasive Species Management Plan (includes removal of aquatic vegetation). This plan should be prepared and submitted to PUB for agreement prior to commencement of the operations.</li> </ul>	N/A (refer to Pre-Mitigation Impact Significance Column)

BIODIVERSITY (SECTION 7)					
S/N	Impact	Impact Magnitude Description	Pre-Mitigation Impact Significance	Mitigation Measures and Monitoring	Residual (with mitigation) Impact Significance
<b>PROTECTED AREAS (SBNR NETWORK)</b>					
O8	Loss/ degradation of integrity of Protected Areas	<ul style="list-style-type: none"> <li><b>Nature:</b> Loss/ degradation of integrity of Protected Areas is considered <b>negative</b>.</li> <li><b>Type:</b> <b>Indirect</b> impacts given the Protected Areas are outside the Project Site(s).</li> <li><b>Duration:</b> Impacts may occur <b>long-term</b> throughout the Project operational phase.</li> <li><b>Extent:</b> Impacts to Protected Areas surrounding the Project Site(s), potential regional extent.</li> <li><b>Scale:</b> Within SBNP Network.</li> <li><b>Frequency:</b> <b>Infrequent</b> during the operational phase.</li> <li><b>Sensitive Receptor(s):</b> Protected areas (High) outside the Project Site(s).</li> </ul> <p>Although the conservation objectives for the Protected Areas within the SBNP Network are not publicly available, the integrity of these Areas likely depends on the maintenance of the following:</p> <ul style="list-style-type: none"> <li>The extent and distribution of wetland habitats of the designating features.</li> <li>The structure and function of those wetland habitats of the designating features.</li> <li>The supporting processes on which the habitats of the designating features rely.</li> <li>The population of each designating feature.</li> <li>The distribution of designating features within those Areas.</li> </ul> <p>The designating features for each site are listed above in Table 7-6.</p> <p>Of the impacts addressed in this table only the following could potentially affect the integrity of the Protected Areas:</p> <ul style="list-style-type: none"> <li>Maintenance – with reference to item O6 above, this has been assessed to have an impact magnitude of <i>Negligible</i>.</li> <li>Introduction/ spread of invasive species – with reference to item O7 above, this has been assessed to have an impact magnitude of <i>Negligible</i>.</li> <li>Unplanned events from fire/ explosion or spills – with reference to item U2 below, this has been assessed to have an impact magnitude of <i>Negligible</i> (land-based) to <i>Small</i> (in-reservoir).</li> </ul> <p>In all cases above, expected impact magnitudes for Protected Areas would not cause a (i) loss of habitat viability/ function, and/ or (ii) substantial change in species population or other species dependent on it, with embedded controls.</p>	<p>Impact Magnitude: <b>Negligible to Small</b></p> <p>Receptor Sensitivity: <b>High</b></p> <p>Impact Significance: <b>Minor to Moderate</b></p>	<p>All of the mitigation measures described above to control the impacts in relation to works in and around the reservoir will also generally avoid and minimise their magnitude on the Protected Areas.</p> <p>Taking these in account, no significant impacts are expected on the integrity of the Protected Areas.</p>	<p>Impact Magnitude: <b>Negligible</b></p> <p>Impact Significance: <b>Negligible</b></p>



AIRBORNE NOISE (SECTION 9)					
S/N	Impact	Impact Magnitude Description	Pre-Mitigation Impact Significance	Mitigation Measures and Monitoring	Residual (with mitigation) Impact Significance
O1	Generation of noise from operation of integrated Project Substation (with O&M Facility)	<ul style="list-style-type: none"> <li>■ <b>Nature:</b> Increased airborne noise levels are considered <b>negative</b>.</li> <li>■ <b>Type:</b> <b>Direct</b> impact to human noise sensitive receptors near to land-based worksite.</li> <li>■ <b>Duration:</b> Impacts are throughout the Project operational phase. Its effect on human noise sensitive receptors is <b>reversible</b> should the Project's integrated Project Substation be removed. For integrated Project Substation site the future sensitive adjacent land use is designated as future park.</li> <li>■ <b>Extent:</b> Impacts are <b>localised</b> within the integrated Project Substation (with O&amp;M facility) site and the immediate surroundings.</li> <li>■ <b>Scale:</b> Nearest human receptors are industrial premises located immediately adjacent north and east of the site, and future park to the immediate west.</li> <li>■ <b>Frequency:</b> <b>Continuous</b> throughout the Project operational phase (25 years).</li> </ul> <p>Unmitigated noise levels predicted at the nearest off-site noise sensitive human receptors surrounding the integrated Project Substation (with O&amp;M facility) site against the applicable criteria limits, as well as noise exceedances, corresponding impact magnitude and significance are provided in <i>Appendix 9.2 (Table 4)</i>. The results are also presented illustrated in <i>Figure 9-6</i> below. The embedded control of orientating the louvres to face the public roads to the east (instead of the future park to the west) is included in the operational noise modelling.</p> <p>Based on the regulations, noise levels at the boundary of the Project Site (north, south, east, west) are assessed (instead of at the nearest human sensitive receptors).</p> <p><math>L_{Aeq,5mins}</math> during the daytime period (7am – 7pm), evening (7pm – 11pm) and night (11pm – 7am) results show the impact magnitude would be <b>Negligible</b> (0 – 2 dB(A) exceedance) at all boundaries.</p> <p>Overall, the impact significance at the boundary of the integrated Project Substation (with O&amp;M facility) site is <b>Negligible</b> for <math>L_{Aeq,5mins}</math> for all periods – day, evening and night, see <i>Appendix 9.2 (Table 4)</i>.</p>	<p>Impact Magnitude: <b>Negligible</b></p> <p>Receptor Sensitivity: The impact magnitude criteria have already taken into account the receptor sensitivities.</p> <p>Impact Significance: <b>Negligible</b></p>	<p>No mitigation measures are required as embedded controls are considered to be adequate to manage impact significance to be <b>Negligible</b>.</p>	<p>N/A. (refer to Pre-Mitigation Impact Significance Column)</p>

Table 3: Environmental Impact Register (Unplanned Events – Construction and Operation)

SURFACE WATER QUALITY (SECTION 6)					
S/N	Impact	Impact Magnitude Description	Pre-Mitigation Impact Significance	Mitigation Measures and Monitoring	Residual (with mitigation) Impact Significance
U1	Degradation/ change of surface water quality from unplanned events of fire and explosion	<ul style="list-style-type: none"> <li><b>Nature:</b> Degradation of surface water quality is considered <b>negative</b>.</li> <li><b>Type:</b> In case of fire and explosion, combustible materials/ fuels/ debris/ firefighting water or chemical(s) may enter bodies of water <b>directly</b> (if fire/ explosion occurs on work boat(s)) or <b>indirectly</b> (if fire/ explosion occurs at FPV or on land and then contaminating materials are washed into surrounding waters). This assessment item covers the effect of fire and explosion, as well as the effect of firefighting water/ reagent. If spillage of other hazardous materials (fuel leakage) is involved, its impact is assessed under item U2 below.</li> <li><b>Duration:</b> Impacts are <b>short-term</b> and temporary, and surface water quality is expected to return to baseline after the event.</li> <li><b>Extent:</b> Impacts are <b>localised</b> at area around the fire/explosion, with potential to spread across reservoir if uncontrolled.</li> <li><b>Scale:</b> Scale of impact depends on location and nature of fire and explosion. Effect of land-based fire and explosion would likely be limited to the immediate vicinity. Effect of fire and explosion in the reservoir could affect waters within a few hundred meters.</li> <li><b>Frequency:</b> <b>Infrequent</b>, due to the unlikely event of fire and explosion with embedded controls.</li> <li><b>Likelihood:</b> <b>Unlikely</b>.</li> </ul> <p>Spacing between islands of FPV, setbacks from reservoir edges etc, will control/ slow down the spread of fire and the associated impact, and enable firefighting access. Design and construction of the FPV and integrated Project Substation will align with the Fire Safety Act and the SCDF's requirements as well as relevant Singapore and international standards (<i>Appendix 2.2, Embedded Controls</i>).</p> <p>A Spill Prevention and Emergency Response Plan detailing how fires/ explosions will be managed will be prepared and agreed with SCDF, including how spillage, leakage or accidents involving firefighting water and materials resulting from fire/ explosion management will be dealt with (see U2 below). Workers on site will be properly trained to operate vessels and machinery. The implementation of Emergency Response Plan would allow minimising the surface water quality impacts from any fire or explosion incident.</p> <p>Impact magnitude is expected to be <b>Negligible</b> for the receiving water of the Kranji Reservoir and Sungei Pang Sua from land-based events, and <b>Small</b> for the receiving water of the Kranji Reservoir for reservoir-based events, where impacts are expected to be within existing baseline/ statutory limits, given the short-term nature and embedded controls.</p>	<p>Impact Magnitude: <b>Negligible to Small</b></p> <p>Receptor Sensitivity: <b>Low</b> (Sungei Pang Sua) <b>to High</b> (Kranji Reservoir/ tributaries/ PUB intakes)</p> <p>Pre-Likelihood Significance: <b>Negligible</b> (land-based) <b>to Moderate</b> (in-reservoir)</p>	<p><u>Likelihood Evaluation</u></p> <p>Given the low vessel traffic and generally low travel speed, fire and explosion of work boats as a result of collision is unlikely.</p> <p>Other land-based machinery and vehicles should be well-maintained and should not have any elevated risk of fire and explosion.</p> <p><u>Mitigation</u></p> <p>The following measures would also be implemented to further mitigate the consequence of the unplanned event of fire and explosion:</p> <ul style="list-style-type: none"> <li>Contractor to conduct thorough quality checks and inspections of materials prior to installation to ensure there are no manufacturing defects.</li> <li>Proper material handling practices and inspections of installed materials should be done to ensure there are no defects during construction.</li> <li>Developer/ Owner to conduct a review of past FPV design failure modes and incorporate main findings into the newer designs.</li> <li>Where possible, drains/ body of water where fire and explosion occurs should be cut off from the Kranji Reservoir. Firefighting water will be contained within the ECM system and holding pond, where appropriate. Such water will be collected and be disposed by a licensed waste collector as soon as possible to ensure normal ECM/ holding pond operation can continue.</li> <li>Only non-toxic firefighting reagent (if needed) will be used for firefighting. This will minimise human health and ecological risk in case using of such reagent is needed and such reagent ends up in reservoir water. Developer/ Owner to agree with PUB on the proposed firefighting reagent to be used on site prior to usage.</li> <li>Train workers in implementation of Spill Prevention and Emergency Response Plan.</li> <li>Joint exercises/ drills for spillage and fire will be conducted by the Developer/ Owner with SCDF each year to ensure preparedness on spillage containment and clean up, as well as fire preventing and fighting among workers.</li> <li>In case of a fire and explosion in reservoir, a perimeter floating boom should be set up (where possible and safe) to allow containment of any floating debris from the event.</li> </ul> <p>Monitoring and adaptive management measures including:</p> <ul style="list-style-type: none"> <li>Establish construction phase surface water quality/ sediment quality monitoring programme in agreement with PUB prior to works commencement, to inform the Developer/ Owner on any potential deterioration of surface water quality from unplanned events. In addition to those parameters in C4 above: <ul style="list-style-type: none"> <li>Sediment quality monitoring parameters to include: Nutrients, contaminants/ metals and hydrocarbons.</li> </ul> </li> </ul>	<p>Pre-Likelihood Significance: <b>Negligible</b> (land-based) <b>to Moderate</b> (in-reservoir)</p> <p>Likelihood of Occurrence: <b>Unlikely</b></p> <p>Post-Likelihood Impact Significance: <b>Negligible</b> (land-based) <b>to Minor</b> (in-reservoir)</p>
U2	Degradation/ change of surface water quality from unplanned event of failure	<ul style="list-style-type: none"> <li><b>Nature:</b> Degradation of surface water quality is considered <b>negative</b>.</li> <li><b>Type:</b> Spillage can affect surface water quality of the receiving bodies of water <b>directly</b>, e.g. if spillage occurs during works within reservoir, such as fuel spillage from work boat. ECM failure/ spillage can <b>indirectly</b> affect surface water quality, e.g. ECM failure/ spillage on land may be washed into reservoir, or via groundwater.</li> </ul>	<p>Impact Magnitude: <b>Negligible to Small</b></p> <p>Receptor Sensitivity: <b>Low</b> (Sungei Pang</p>	<p><u>Likelihood Evaluation</u></p> <p>With the implementation of embedded control measures related to ECM management, accidental spillage/ leakage, notable change in surface water quality as a result of land-based spillage is unlikely.</p>	<p>Pre-Likelihood Significance: <b>Negligible</b> (land-based) <b>to Moderate</b> (in-reservoir)</p>

SURFACE WATER QUALITY (SECTION 6)					
S/N	Impact	Impact Magnitude Description	Pre-Mitigation Impact Significance	Mitigation Measures and Monitoring	Residual (with mitigation) Impact Significance
	of erosion control measures (ECM)/ environmental spill	<ul style="list-style-type: none"> <li><b>Duration:</b> Impacts are <b>short-term</b> and temporary, and surface water quality is expected to return to baseline after the event.</li> <li><b>Extent:</b> Spillage within the reservoir could <b>spread across the reservoir</b> if uncontrolled.</li> <li><b>Scale:</b> Scale of impact depends on location and nature of ECM failure/ environmental spill. Effect of land-based spill would likely be limited to the immediate vicinity. An ECM failure would likely be limited to the land-based Project Site and immediately adjacent launching area of the reservoir. An in-reservoir fuel spill/ leak at designated refuelling location would be limited within the containment (e.g. floating booms). A spillage in the middle of the reservoir could affect waters up to a few hundred meters.</li> <li><b>Frequency:</b> <b>Infrequent</b>, due to the unlikely event of ECM failure/ environmental spillage with embedded controls.</li> <li><b>Likelihood:</b> <b>Unlikely</b>.</li> </ul> <p>Sizing of the ECM will be for 1 in 5 years rainfall. Given outfall(s) for ECM would be located within the catchment of Sungei Pang Sua, a failure of ECM (e.g. failure of outlet discharge pump resulting in overflow of sedimentation basin or rupture due to accident or leakage or wear and tear of ECM discharge pipeline) would likely affect the Sungei Pang Sua instead of Kranji Reservoir, which has lower receptor sensitivity and does not serve as drinking water supply.</p> <p>Storage and use of chemicals and fuels are subjected to stringent control as stated under <i>Section 6.6.1.2</i>, therefore the risk for spillage on land is very low and is likely to be highly localised after taking into account the embedded control measures.</p> <p>For spillages in-reservoir, given the provision of spill clean-up kits at locations where fuel and chemicals would be stored or used, any spill is unlikely to spread beyond the initial location.</p> <p>In case of spill, for example, from vessel collision that is away from the berthing/ refuelling area and immediate containment is not possible, the typical amount of fuel spilled is expected to be limited because of the limited size of fuel tank (due to small vessel sizes) as well as the low possibility of fuel tank being completely compromised from collision at low navigation speed (&lt;5 knots). Also, evaporation is the dominant process contributing to the removal of spilled diesel from the water surface and can account for 60-80% loss if no spill response is mounted. As oil weathers (i.e. through evaporation of its lightest and most toxic fractions), its inherent toxicity also reduces. Overall, with the implementation of the Spill Prevention and Emergency Response Plan, small spill volumes as well as the tendency to evaporate means the overall impact would be limited and temporary.</p> <p>A Spill Prevention and Emergency Response Plan detailing how spillage, leakage or accidents involving hazardous materials will be dealt with will be prepared. The implementation of Spill Prevention and Emergency Response Plan would allow minimising the surface water quality impact from any accidental spillage or release.</p> <p>Impact magnitude is expected to be <b>Negligible</b> for the receiving water of the Kranji Reservoir and Sungei Pang Sua from land based events, and <b>Negligible to Small</b> for the receiving water of the Kranji Reservoir for reservoir based events, where impacts are expected to be within existing baseline/ statutory limits, given the short-term nature and embedded controls.</p>	<p>Sua) to High (Kranji Reservoir/ tributaries/ PUB intakes)</p> <p>Pre-Likelihood Significance: <b>Negligible (land-based) to Moderate (in-reservoir)</b></p>	<p>For spillage within the reservoir, one plausible scenario of spill is a result of accidental collision. A vessel to vessel collision is unlikely given limited traffic within the reservoir. Vessel to shore collision, vessel to FPV collision and vessel grounding are also unlikely given the use of navigation aids (embedded control measures) as well as the very low occurrence of severe weather conditions which hinder navigation (such as typhoons). Also, given only vessels of small size would and could be used in the reservoir and the slow speed these vessels will travel, the scale of potential spillage will be limited as well.</p> <p><u>Mitigation</u></p> <p>The following measures would also be implemented to further mitigate the consequence of the unplanned event of environmental spill:</p> <ul style="list-style-type: none"> <li>Preparation and implementation of vessel standard operating procedures.</li> <li>Chemicals and/ or hydrocarbons will be handled and stored in compliance with the Material Safety Data Sheet (MSDS).</li> <li>All chemical and/ or hydrocarbon wastes will be segregated into clearly marked containers prior to onshore disposal by a licensed waste management contractor, as per the relevant MSDSs. Secondary containment should also be provided for these chemicals.</li> <li>Daily inspection of boat and machinery to avoid fuel leakage.</li> <li>Practise due diligence in proper storage and handling of machinery to prevent leaching of oil or harmful materials.</li> <li>Regular maintenance of vehicles and equipment, proper training to operators to avoid fuel leakage or spillage into reservoir.</li> <li>Where possible, drains/ body of water where fire and explosion occurs should be cut off from the Kranji Reservoir. Firefighting water will be contained within the ECM system and holding pond, where appropriate. Such water will be collected and be disposed by a licensed waste collector as soon as possible to ensure normal ECM/ holding pond operation can continue.</li> <li>Work boats will be refuelled at specified locations following standard procedures. Refuelling location(s) should be equipped with spill control kits and measures, e.g. floating booms at the perimeter, clean up kits ready to use, etc. This means any spillage from refuelling would be contained and cleaned up properly.</li> <li>Provision of navigation aides and establishment of regular traffic routes would further reduce the risk of collision.</li> <li>Train workers in implementation of the Spill Prevention and Emergency Response Plan.</li> <li>Joint exercises/ drills for spillage and fire will be conducted by the Developer/ Owner with SCDF each year to ensure preparedness on spillage containment and clean up, as well as fire preventing and fighting among workers.</li> </ul> <p>Monitoring and adaptive management measures including:</p> <ul style="list-style-type: none"> <li>Establish construction phase surface water quality/ sediment quality monitoring programme in agreement with PUB prior to works commencement, to inform the Developer/ Owner on any potential deterioration of surface water quality from unplanned events. In addition to those parameters in C4 above: <ul style="list-style-type: none"> <li>Sediment quality monitoring parameters to include: Nutrients, contaminants/ metals and hydrocarbons.</li> </ul> </li> </ul>	<p>Likelihood of Occurrence: <b>Unlikely</b></p> <p>Post-Likelihood Impact Significance: <b>Negligible (land-based) to Minor (in-reservoir)</b></p>
U3	Degradation/ change of	<ul style="list-style-type: none"> <li><b>Nature:</b> Degradation of surface water quality is considered <b>negative</b>.</li> </ul>	Impact Magnitude:	<u>Likelihood Evaluation</u>	Pre-Likelihood Significance: <b>Negligible (land-</b>

SURFACE WATER QUALITY (SECTION 6)					
S/N	Impact	Impact Magnitude Description	Pre-Mitigation Impact Significance	Mitigation Measures and Monitoring	Residual (with mitigation) Impact Significance
	surface water quality from unplanned event of fire and explosion	<ul style="list-style-type: none"> <li><b>Type:</b> In case of fire and explosion, combustible materials/ fuels/ debris/ firefighting water or chemical(s) may enter bodies of water <b>directly</b> (if fire/ explosion occurs at FPV or on work boat(s)) or <b>indirectly</b> (if fire/ explosion occurs on land and then contaminating materials be washed into surrounding waters). This assessment item covers the effect of fire and explosion, as well as the effect of firefighting water/ reagent. If spillage of other hazardous materials (fuel leakage) is involved, its impact is assessed under item U4 below.</li> <li><b>Duration:</b> Impacts are <b>short-term</b> and temporary, and surface water quality is expected to return to baseline after the event.</li> <li><b>Extent:</b> Impacts are <b>localised</b> at area around the fire/ explosion.</li> <li><b>Scale:</b> Scale of impact depends on location and nature of fire and explosion. Effect of land-based fire and explosion would likely be limited to the immediate vicinity. Effect of fire and explosion in the reservoir could affect waters within a few hundred meters.</li> <li><b>Frequency:</b> Fire and explosion is <b>unlikely</b> to occur given the embedded controls.</li> <li><b>Likelihood:</b> <b>Unlikely</b>.</li> </ul> <p>Spacing between islands of FPV, setback from reservoir edges etc, will control/ slow down the spread of fire and the associated impact, and enable firefighting access. Design and operation of the FPV and integrated Project Substation will align with the Fire Safety Act and the SCDF's requirements as well as relevant Singapore and international standards. Electricity generation will be cut off remotely at the control room to facilitate firefighting.</p> <p>A Spill Prevention and Emergency Response Plan detailing how fires/ explosions will be managed will be prepared and agreed with SCDF, including how spillage, leakage or accidents involving firefighting water and materials resulting from fire/explosion management will be dealt with (see U4 below). Workers on site will be properly trained to operate vessels and machinery. The implementation of the Spill Prevention and Emergency Response Plan would allow minimising the surface water quality impacts from any fire or explosion incident.</p> <p>Impact magnitude is expected to be <b>Negligible</b> for the receiving water of the Kranji Reservoir and Sungei Pang Sua from land-based events, and <b>Small</b> for the receiving water of the Kranji Reservoir for reservoir based events, where impacts are expected to be within existing baseline/ statutory limits, given the short term nature and embedded controls.</p>	<p><b>Negligible to Small</b></p> <p>Receptor Sensitivity: <b>Low</b> (Sungei Pang Sua) <b>to High</b> (Kranji Reservoir/ tributaries/ PUB intakes)</p> <p>Pre-Likelihood Significance: <b>Negligible</b> (land-based) <b>to Moderate</b> (in-reservoir)</p>	<p>Design and operation of the FPV and integrated Project Substation will align with relevant Singapore and international standards. Overall, fire risk for the FPV system is unlikely.</p> <p>No fuel will be required for FPV or other parts that will be installed in the reservoir and therefore risk for major fire at these parts is unlikely as well.</p> <p>Given the low vessel traffic and generally low travel speed, fire and explosion of work boats as a result of collision is unlikely.</p> <p><u>Mitigation</u></p> <p>The following measures would also be implemented to further mitigate the consequence of the unplanned event of fire and explosion:</p> <ul style="list-style-type: none"> <li>Contractor to conduct thorough quality checks and inspections of materials prior to installation to ensure there are no manufacturing defects.</li> <li>Proper material handling practices and inspections of installed materials should be done to ensure there are no defects during construction.</li> <li>Developer/ Owner to conduct a review of past FPV design failure modes and incorporate main findings into the newer designs.</li> <li>Where possible, drains/ body of water where fire and explosion occurs should be cut off from the Kranji Reservoir. Firefighting water will be contained within the drainage system. Such water will be collected and be disposed by a licensed waste collector as soon as possible to ensure the drains are empty for normal operation.</li> <li>Only non-toxic firefighting reagent (if needed) will be used for firefighting with approval from agencies. This will minimise human health and ecological risk in case using of such reagent is needed and such reagent ends up in reservoir water. Developer/ Owner to agree with PUB on the proposed firefighting reagent to be used on site prior to usage.</li> <li>Train workers in implementation of Emergency Fire Response Plan.</li> <li>Do not use "PVStop" chemical spray as a fire retardant to render PV panels electrically safe. Instead, electricity generation will be cut off remotely at the Project's control room to facilitate firefighting.</li> <li>Train workers in implementation of the Spill Prevention and Emergency Response Plan.</li> <li>Joint exercises/ drills for spillage and fire will be conducted by the Developer/ Owner with SCDF each year to ensure preparedness on spillage containment and clean up, as well as fire preventing and fighting among site staff.</li> <li>In case of a fire and explosion in reservoir, a perimeter floating boom would be set up (where possible and safe) to allow containment of any floating debris from the event.</li> </ul> <p>Monitoring and adaptive management measures including:</p> <ul style="list-style-type: none"> <li>Establish operation phase surface water quality / sediment quality monitoring programme in agreement with PUB prior to operation, to inform the Developer/ Owner on any potential deterioration of surface water quality from unplanned events. In addition to those parameters in O1 above: <ul style="list-style-type: none"> <li>Sediment quality monitoring parameters to include: Nutrients, contaminants/ metals and hydrocarbons.</li> </ul> </li> </ul>	<p>based) <b>Moderate</b> (in-reservoir)</p> <p>Likelihood of Occurrence: <b>Unlikely</b></p> <p>Post-Likelihood Impact Significance: <b>Negligible</b> (land-based) <b>to Minor</b> (in-reservoir)</p>
U4	Degradation/change of	<ul style="list-style-type: none"> <li><b>Nature:</b> Degradation of surface water quality is considered <b>negative</b>.</li> </ul>	Impact Magnitude:	<u>Likelihood Evaluation</u>	Pre-Likelihood Significance: <b>Negligible</b> (land-

SURFACE WATER QUALITY (SECTION 6)					
S/N	Impact	Impact Magnitude Description	Pre-Mitigation Impact Significance	Mitigation Measures and Monitoring	Residual (with mitigation) Impact Significance
	surface water quality from unplanned event of environmental spill	<ul style="list-style-type: none"> <li><b>Type:</b> Spillage can affect surface water quality of the receiving bodies of water <b>directly</b>, e.g. if spillage occurs during works within reservoir, such as fuel spillage from work boat) or <b>indirectly</b> via spillage on land being washed into reservoir.</li> <li><b>Duration:</b> Impacts are <b>short-term</b> and temporary, and surface water quality is expected to return to baseline after the event.</li> <li><b>Extent:</b> Spillage within the reservoir could <b>spread across the reservoir</b> if uncontrolled.</li> <li><b>Scale:</b> Scale of impact depends on location and nature of environmental spill. Effect of land-based spill would likely be limited to the immediate vicinity. An in-reservoir fuel spill/ leak at designated refuelling location would be limited. A spillage in the middle of the reservoirs could affect waters up to a few hundred meters.</li> <li><b>Frequency:</b> Environmental spillage on land is <b>unlikely</b> to occur given the embedded controls. Environmental spillage in the reservoir would likely be a result of vessel collision and refuelling, which are both very unlikely given the limited traffic, speed limit and embedded controls.</li> <li><b>Likelihood: Unlikely.</b></li> </ul> <p>Storage and use of chemicals and fuels are subjected to stringent control as stated under <i>Section 6.2</i>, therefore the risk for spillage on land is very low and is likely to be highly localised after taking into account the embedded control measures.</p> <p>For spillages in-reservoir, given the provision of spill clean up kits at locations where fuel and chemicals would be stored or used, any spill is unlikely to spread beyond the initial location. In case of spill, for example, from vessel collision that is away from the berthing/refuelling area and immediate containment is not possible, the typical amount of fuel spilled is expected to be limited because of the limited size of fuel tank (due to small vessel sizes) as well as the low possibility of fuel tank being completely compromised from collision at low navigation speed. Also, evaporation is the dominant process contributing to the removal of spilled diesel from the water surface and can account for 60-80% loss if no spill response is mounted. As oil weathers (i.e. through evaporation of its lightest and most toxic fractions), its inherent toxicity also reduces. Overall, the implementation of the Spill Prevention and Emergency Response Plan, small spill volumes as well as the tendency to evaporate means the overall impact would be limited and temporary.</p> <p>A Spill Prevention and Emergency Response Plan detailing how spillage, leakage or accidents involving hazardous materials will be dealt with will be prepared. The implementation of a Spill Prevention and Emergency Response Plan would allow minimising the surface water quality impact from any accidental spillage or release.</p> <p>Impact magnitude is expected to be <b>Negligible</b> for the receiving water of the Kranji Reservoir and Sungei Pang Sua from land based events, and <b>Negligible to Small</b> for the receiving water of the Kranji Reservoir for reservoir based events, where impacts are expected to be within existing baseline/ statutory limits, given the short term nature and embedded controls.</p>	<p><b>Negligible to Small</b></p> <p>Receptor Sensitivity: <b>Low</b> (Sungei Pang Sua) to <b>High</b> (Kranji Reservoir/ tributaries/ PUB intakes)</p> <p>Pre-Likelihood Significance: <b>Negligible</b> (land-based) to <b>Moderate</b> (in-reservoir)</p>	<p>With the implementation of embedded control measures related to accidental spillage/ leakage, notable change in surface water quality as a result of land-based spillage is unlikely.</p> <p>For spillage within the reservoir, one plausible scenario of spill is a result of accidental collision. A vessel to vessel collision is unlikely given limited traffic within the reservoir. Vessel to shore collision, vessel to FPV collision and vessel grounding are also unlikely given the use of navigation aids (embedded control measures) as well as the very low occurrence of severe weather conditions which hinder navigation (such as typhoons). Also, given only vessels of small size would and could be used in the reservoir and the slow speed these vessels will travel, the scale of potential spillage will be limited as well.</p> <p><u>Mitigation</u></p> <p>The following measures would also be implemented to further mitigate the consequence of the unplanned event of environmental spill:</p> <ul style="list-style-type: none"> <li>Preparation and implementation of vessel standard operating procedures.</li> <li>Chemicals and/ or hydrocarbons will be handled and stored in compliance with the Material Safety Data Sheet (MSDS).</li> <li>All chemical and/ or hydrocarbon wastes will be segregated into clearly marked containers prior to onshore disposal by a licensed waste management contractor, as per the relevant MSDSs. Secondary containment should also be provided for these chemicals.</li> <li>Daily inspection of boat and machinery to avoid fuel leakage.</li> <li>Practise due diligence in proper storage and handling of machinery to prevent leaching of oil or harmful materials.</li> <li>Regular maintenance of vehicles and equipment, proper training to operators to avoid fuel leakage or spillage into reservoir.</li> <li>Work boats will be refuelled at specified locations following standard procedures. Refuelling location(s) should be equipped with spill control kits and measures, e.g. floating booms at the perimeter, clean up kits ready to use, etc. This means any spillage from refuelling would be contained and cleaned up properly.</li> <li>Provision of navigation aids and establishment of regular traffic routes would further reduce the risk of collision.</li> <li>Where possible, drains/ body of water where fire and explosion occurs should be cut off from the Kranji Reservoir. Firefighting water will be contained within the drainage system. Such water will be collected and be disposed by a licensed waste collector as soon as possible to ensure the drains are empty for normal operation.</li> <li>Spill Prevention and Emergency Response Plans to have inclusions for addressing wildlife and biodiversity concerns from events.</li> <li>Train workers in implementation of the Spill Prevention and Emergency Response Plan.</li> <li>Joint exercises/ drills for spillage and fire will be conducted by the Developer/ Owner with SCDF each year to ensure preparedness on spillage containment and clean up, as well as fire preventing and fighting among site staff.</li> </ul> <p>Monitoring and adaptive management measures including:</p> <ul style="list-style-type: none"> <li>Establish operation phase surface water quality / sediment quality monitoring programme in agreement with PUB prior to operation, to inform the Developer/ Owner on any potential deterioration of surface water quality from unplanned events. In addition to those parameters in O1 above:</li> </ul>	<p>based) to <b>Moderate</b> (in-reservoir)</p> <p>Likelihood of Occurrence: <b>Unlikely</b></p> <p>Post-Likelihood Impact Significance: <b>Negligible</b> (land-based) to <b>Minor</b> (in-reservoir)</p>

SURFACE WATER QUALITY (SECTION 6)					
S/N	Impact	Impact Magnitude Description	Pre-Mitigation Impact Significance	Mitigation Measures and Monitoring	Residual (with mitigation) Impact Significance
				- Sediment quality monitoring parameters to include: Nutrients, contaminants/metals and hydrocarbons.	
BIODIVERSITY (SECTION 7)					
S/N	Impact	Impact Magnitude Description	Pre Mitigation Impact Significance	Mitigation Measures and Monitoring	Residual (with mitigation) Impact Significance
U1	Habitat degradation from unplanned event of fire/ explosion and environmental spills	<ul style="list-style-type: none"> <li><b>Nature:</b> Habitat degradation from unplanned events is considered <b>negative</b> for aquatic and terrestrial biodiversity.</li> <li><b>Type:</b> Fire/ explosion or spills can <b>directly</b> or <b>indirectly</b> affect habitats and species, depending on the event location.</li> <li><b>Duration:</b> Impacts are short term and temporary, and biodiversity is expected to return to baseline in the <b>longer-term</b> after the event.</li> <li><b>Extent:</b> Impacts are <b>localised</b> at area around the fire/ explosion or spill, with potential to spread across further into surrounding habitats if uncontrolled.</li> <li><b>Scale:</b> Scale of impact depends on location and nature of the fire/ explosion or environmental spill. Effect of land-based event would likely be limited to the immediate vicinity and its immediate surroundings habitat. Per the Surface Water Quality impact assessment (<i>Section 6</i>), an in-reservoir event could affect habitat up to a few hundred meters.</li> <li><b>Frequency:</b> <b>Infrequent</b>, fire/ explosion and spill are unlikely to happen with embedded controls.</li> <li><b>Sensitive Receptor(s):</b> Protected areas (High), Aquatic habitats (Medium), Surrounding terrestrial habitats (Low to High), Aquatic plants (Low), Terrestrial Plants (Low to High), Fish (Low to Medium), Invertebrates (Low to High), Birds (Low to High), Reptiles (Low to Medium), Smooth-coated otter (High), Long-tailed macaque (Medium), Bats (Low to Medium).</li> <li><b>Likelihood:</b> Unlikely</li> </ul> <p>Spills and leaks may occur accidentally during maintenance works, for example, during fuelling of a boat engine or other maintenance equipment, as required. Any impact would be localised due to the small volume of any spill. Dilution effects in the reservoir are expected to be high. Embedded controls include establishing a Spill Prevention and Emergency Response Plan.</p> <p>Fire could spread to native vegetation. If the fire reached Sungei Kadut Forest this could be of large magnitude. Embedded controls include compliance with the Fire Safety Act and SCDF requirements, as well as establishing an Emergency Response Plan. Also, setting back the FPV's from shore prevents fires from spreading on terrestrial habitats; and spacing between FPV islands avoids fires spreading in the reservoir between FPV islands, and also enables firefighting access.</p> <p>In view of embedded controls implemented outlined in <i>Appendix 2.2</i> and Surface Water Quality impact assessment (<i>Section 6</i>) for land and in-reservoir fire/ explosion and spill events, the impact magnitude is expected to be <b>Negligible</b> for land-based events on terrestrial habitats and species, and to conservatively be <b>Small</b> for the aquatic habitat and species of Kranji Reservoir.</p>	<p>Impact Magnitude: <b>Negligible</b> (land-based) to <b>Small</b> (in-reservoir)</p> <p>Receptor Sensitivity: <b>High</b> (aquatic and terrestrial habitats, fauna and flora)</p> <p>Pre-Likelihood Significance: <b>Negligible</b> (land-based) to <b>Moderate</b> (in-reservoir)</p>	<p><u>Likelihood Evaluation</u></p> <p>See likelihood evaluation in <i>Section 6</i> (Surface Water Quality). In summary, a spillage on land is unlikely, and in-reservoir is unlikely; a fire/ explosion on land is unlikely, and in-reservoir is unlikely.</p> <p><u>Mitigation</u></p> <p>Mitigation measures presented in the Surface Water Quality <i>Section 6</i> will be applied. The following measures would also be implemented to further mitigate the consequence of the unplanned event of fire and explosion, and environmental spills to biodiversity:</p> <ul style="list-style-type: none"> <li>Spill Prevention and Emergency Response Plan to have inclusions for addressing wildlife and biodiversity concerns from events.</li> </ul>	<p>Pre-Likelihood Significance: <b>Negligible</b> (land-based) to <b>Moderate</b> (in-reservoir)</p> <p>Likelihood of Occurrence: <b>Unlikely</b></p> <p>Post-Likelihood Impact Significance: <b>Negligible</b> (land-based) to <b>Minor</b> (in-reservoir)</p>
U2	Habitat degradation from unplanned event of fire/	<ul style="list-style-type: none"> <li><b>Nature:</b> Habitat degradation from unplanned events is considered <b>negative</b> for aquatic and terrestrial biodiversity.</li> <li><b>Type:</b> Fire/ explosion or spills can <b>directly</b> or <b>indirectly</b> affect habitats and species, depending on the event location.</li> <li><b>Duration:</b> Impacts are <b>short term</b> and temporary, and biodiversity is expected to return to baseline in the <b>longer-term</b> after the event.</li> </ul>	<p>Impact Magnitude: <b>Negligible</b> (land-based) to <b>Small</b> (in-reservoir)</p> <p>Receptor Sensitivity: <b>High</b> (aquatic and</p>	<p><u>Likelihood Evaluation</u></p> <p>See likelihood evaluation in <i>Section 6</i> (Surface Water Quality). In summary, a spillage on land is unlikely, and in-reservoir is unlikely; a fire/ explosion on land is unlikely, and in-reservoir is unlikely.</p> <p><u>Mitigation</u></p>	<p>Pre-Likelihood Significance: <b>Negligible</b> (land-based) to <b>Moderate</b> (in-reservoir)</p>

BIODIVERSITY (SECTION 7)					
S/N	Impact	Impact Magnitude Description	Pre Mitigation Impact Significance	Mitigation Measures and Monitoring	Residual (with mitigation) Impact Significance
	explosion and environmental spills	<ul style="list-style-type: none"> <li><b>Extent:</b> Impacts are <b>localised</b> at area around the fire/ explosion or spill, with potential to spread across further into surrounding habitats if uncontrolled.</li> <li><b>Scale:</b> Scale of impact depends on location and nature of the fire/ explosion or environmental spill. Effect of land-based event would likely be limited to the immediate vicinity and its immediate surroundings habitat. Per the Surface Water Quality impact assessment (<i>Section 6</i>), an in-reservoir event could affect habitat up to a few hundred meters.</li> <li><b>Frequency:</b> Fire/ explosion and spill are unlikely to happen with embedded controls</li> <li><b>Sensitive Receptor(s):</b> Protected areas (High), Aquatic habitats (Medium), Surrounding terrestrial habitats (Low to High), Aquatic plants (Low), Terrestrial Plants (Low to High), Fish (Low to Medium), Invertebrates (Low to High), Birds (Low to High), Reptiles (Low to Medium), Smooth-coated otter (High), Long-tailed macaque (Medium), Bats (Low to Medium).</li> <li><b>Likelihood:</b> Unlikely.</li> </ul> <p>Spills and leaks may occur accidentally during maintenance works, for example during fuelling of a boat engine or other maintenance equipment, as required. Any impact would be localised due to the small volume of any spill. Dilution effects in the reservoir are expected to be high. Embedded controls include establishing a Spill Prevention and Emergency Response Plan.</p> <p>Fire could spread to native vegetation. If the fire reached Sungei Kadut Forest this could be of large magnitude. Embedded controls include compliance with the Fire Safety Act and SCDF requirements, as well as establishing an Emergency Response Plan. Also, setting back the FPV's from shore prevents fires from spreading on terrestrial habitats; and spacing between FPV islands avoids fires spreading in the reservoir between FPV islands, and also enables firefighting access.</p> <p>In view of embedded controls implemented outlined in <i>Appendix 2.2</i> and Surface Water Quality impact assessment (<i>Section 6</i>) for land and in-reservoir fire/ explosion and spill events the impact magnitude is expected to be <b>Negligible</b> for land-based events on terrestrial habitats and species, and to conservatively be <b>Small</b> for the aquatic habitat and species of Kranji Reservoir.</p>	terrestrial habitats, fauna and flora)  Pre-Likelihood Significance: <b>Negligible</b> (land-based) to <b>Moderate</b> (in-reservoir)	Mitigation measures presented in the Surface Water Quality <i>Section 6</i> will be applied. The following measures would also be implemented to further mitigate the consequence of the unplanned event of fire and explosion, and environmental spills to biodiversity:  Spill Prevention and Emergency Response Plan to have inclusions for addressing wildlife and biodiversity concerns from events.	Likelihood of Occurrence: <b>Unlikely</b>  Post-Likelihood Impact Significance: <b>Negligible</b> (land-based) to <b>Minor</b> (in-reservoir)

AIR QUALITY (SECTION 8)					
S/N	Impact	Impact Magnitude Description	Pre-Mitigation Impact Significance	Mitigation Measures and Monitoring	Residual (with mitigation) Impact Significance
U1	Release of ash or smoke from burning due to fire and explosion (unplanned event) during the construction and operational phase	<ul style="list-style-type: none"> <li>■ <b>Nature:</b> Ash and smoke in the air are considered to be <b>negative</b>.</li> <li>■ <b>Type:</b> <b>Indirect</b> impact to surrounding receptors.</li> <li>■ <b>Duration:</b> These impacts will be present temporarily for a <b>short period</b> of time during the unplanned event.</li> <li>■ <b>Extent:</b> Impacts could <b>spread into immediate surroundings</b> if uncontrolled.</li> <li>■ <b>Scale:</b> Scale of impact depends on location and nature of fire and explosion. Effect would likely be limited to the surrounding area of the fire.</li> <li>■ <b>Frequency:</b> <b>Infrequent</b>, due to the unlikely event of fire and explosion with embedded controls.</li> <li>■ <b>Likelihood:</b> <b>Unlikely</b>.</li> </ul> <p>Spacing between islands of FPV, setbacks from reservoir edge etc, will control/ slow down the spread of fire and the associated impact. Design, construction and operation of the FPV and integrated Project Substation will align with the Fire Safety Act and the SCDF's requirements as well as relevant Singapore and international standards.</p> <p>A Spill Prevention and Emergency Response Plan detailing how fires/ explosions will be managed will be prepared and agreed with SCDF for construction and operation, including response arrangements. Workers onsite will be properly trained to operate vessels and machinery. The implementation of the Spill Prevention and Emergency Response Plan would minimise the air quality impacts from any fire or explosion incident.</p> <p>Air quality impacts to surrounding receptors during construction and operational phases will depend on the (i) wind direction, and (ii) time taken to put out the fire. As indicated in <i>Section 8.4.2</i>, wind can be from the north/ northeast (smoke moving south/ southwest), or from south/ southeast (smoke moving north/ northwest) depending on the time of year. With embedded controls during construction and operation to minimise and limit the extent of fires, and SCDF response times, FPV island spacing, shut off systems, spacing around FPV islands providing firefighting access etc it is anticipated that fires will be under control and put out within a few hours or less. As such, the impact magnitude is expected to be <b>Negligible</b> during construction and operation.</p>	<p>Impact Magnitude: <b>Negligible</b></p> <p>Receptor Sensitivity: <b>Low</b> (Future Park) <b>to High</b> (dormitories east of the reservoir)</p> <p>Pre-Likelihood Significance: <b>Negligible</b></p>	<p><u>Likelihood Evaluation</u></p> <p>See likelihood evaluation in <i>Appendix 4.2</i>. In summary, a fire/ explosion on land and in-reservoir is unlikely during construction and operation.</p> <p><u>Mitigation</u></p> <p>The following measures would also be implemented to further mitigate the consequence of the unplanned event of fire and explosion:</p> <ul style="list-style-type: none"> <li>■ Train workers in implementation of the Spill Prevention and Emergency Response Plan.</li> <li>■ Joint exercises/ drills for spillage and fire will be conducted each year by the Developer/ Owner with SCDF to ensure preparedness fire preventing and fighting among site staff.</li> </ul>	<p>Pre-Likelihood Significance: <b>Negligible</b></p> <p>Likelihood of Occurrence: <b>Unlikely</b></p> <p>Post-Likelihood Impact Significance: <b>Negligible</b></p>



SOIL AND GROUNDWATER (Section 10)					
S/N	Impact	Impact Magnitude Description	Pre-Mitigation Impact Significance	Mitigation Measures and Monitoring	Residual (with mitigation) Impact Significance
U1	<p><b>Degradation/ change of soil and groundwater from unplanned event of environmental spill (including related to spills from responses to explosions and fire, and failure of ECM)</b></p> <p>(see also Section 6 for assessment related to Kranji Reservoir's Surface Water Quality)</p>	<ul style="list-style-type: none"> <li>■ <b>Nature:</b> Degradation of soil and groundwater quality is considered <b>negative</b>.</li> <li>■ <b>Type:</b> <b>Direct</b> impacts to soil and groundwater receptors from leaks and spills.</li> <li>■ <b>Duration:</b> These impacts will be present <b>temporarily</b> for a short period of time after the unplanned event.</li> <li>■ <b>Extent:</b> Impacts are <b>localised</b> within the land-based worksite and the immediate surroundings.</li> <li>■ <b>Scale:</b> Scale of impact depends on location and nature of spill/ leak. Effect of land-based spill/ leak would likely be limited to the immediate surroundings with embedded controls.</li> <li>■ <b>Frequency:</b> <b>Infrequent</b>, due to the unlikely event of environmental spillage (and fire and explosion and ECM failure) with embedded controls.</li> </ul> <p>Any outcomes of the Phase II ESA and related recommended remedial measures (e.g. removal or treatment of potential contamination sources), are considered to be embedded controls.</p> <p>Accidental spills or leakages of fuel, oil and lubricants may occur from the use of construction vehicles and equipment, fuel and chemical storage areas, improper management of construction waste, or other unplanned environmental spills (including related to spills from responses to explosions and fire, and failure of ECM). This will impact soil and groundwater quality if it enters the ground.</p> <p>Storage and use of chemicals and fuels during construction are subjected to stringent control as stated under <i>Section 10.2</i> therefore the risk for spillage on land is low and is likely to be highly localised after taking into account the embedded control measures, including those described in Surface Water Quality <i>Section 6.6.1.2</i>. A Spill Prevention and Emergency Response Plan detailing how spillage, leakage or accidents involving hazardous materials will be dealt with will be prepared. The implementation of Spill Prevention and Emergency Response Plan would minimise the soil and groundwater quality impact from any accidental spillage or release.</p> <p>Impact magnitude is expected to be <b>Small</b> at the proposed temporary Staging/ Launching Area and integrated Project Substation worksite, where impacts are expected to be (i) localised small-scale contamination to soil, and (ii) discharge to groundwater aquifer(s) may cause small but local changes in groundwater quality in the aquifer system, where these can be considered potential short-term localised effects on groundwater quality which is likely to return to equilibrium conditions within a short timeframe.</p>	<p>Impact Magnitude: <b>Small</b></p> <p>Receptor Sensitivity: <b>Low</b> (soil) <b>to High</b> (groundwater)</p> <p>Pre-Likelihood Significance: <b>Negligible</b> (soil) <b>to Moderate</b> (groundwater)</p>	<p><u>Likelihood Evaluation</u></p> <p>With the implementation of embedded controls, notable change in soil and groundwater quality as a result of land-based spillage is unlikely.</p> <p><u>Mitigation</u></p> <p>The following measures will also be implemented to further mitigate the consequence of the unplanned event of environmental spill:</p> <ul style="list-style-type: none"> <li>■ Chemicals and/ or hydrocarbons will be handled and stored in compliance with the Material Safety Data Sheet (MSDS).</li> <li>■ All chemical and/ or hydrocarbon wastes will be segregated into clearly marked containers prior to onshore disposal by a licensed waste management contractor, as per the relevant MSDSs. Secondary containment should also be provided for these chemicals.</li> <li>■ Daily inspection of machinery to avoid fuel leakage.</li> <li>■ Practise due diligence in proper storage and handling of machinery to prevent leaching of oil or harmful materials.</li> <li>■ Regular maintenance of vehicles and equipment, proper training to operators to avoid fuel leakage or spillage into reservoir.</li> <li>■ Train workers in implementation of the Spill Prevention and Emergency Response Plan.</li> <li>■ Joint exercises/ drills for spillage and fire will be conducted by the Developer/ Owner with SCDF each year to ensure preparedness on spillage containment and clean up, as well as fire preventing and fighting among site staff.</li> </ul> <p>No significant (above minor) residual impacts are anticipated related to soil and groundwater quality, as such specific soil and groundwater quality monitoring is not considered necessary. However, it is recommended to conduct regular environmental site inspections, i.e. on a weekly basis, see the <i>Section 12</i> (EMMP).</p>	<p>Pre-Likelihood Significance: <b>Negligible</b> (soil) <b>to Moderate</b> (groundwater)</p> <p>Likelihood of Occurrence: <b>Unlikely</b></p> <p>Post-Likelihood Impact Significance: <b>Negligible</b> (soil) <b>to Minor</b> (groundwater)</p>

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## APPENDIX 12.2 EXAMPLE BIODIVERSITY MANAGEMENT FORMS

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## APPENDIX 12.2: EXAMPLE BIODIVERSITY MANAGEMENT PROTOCOLS

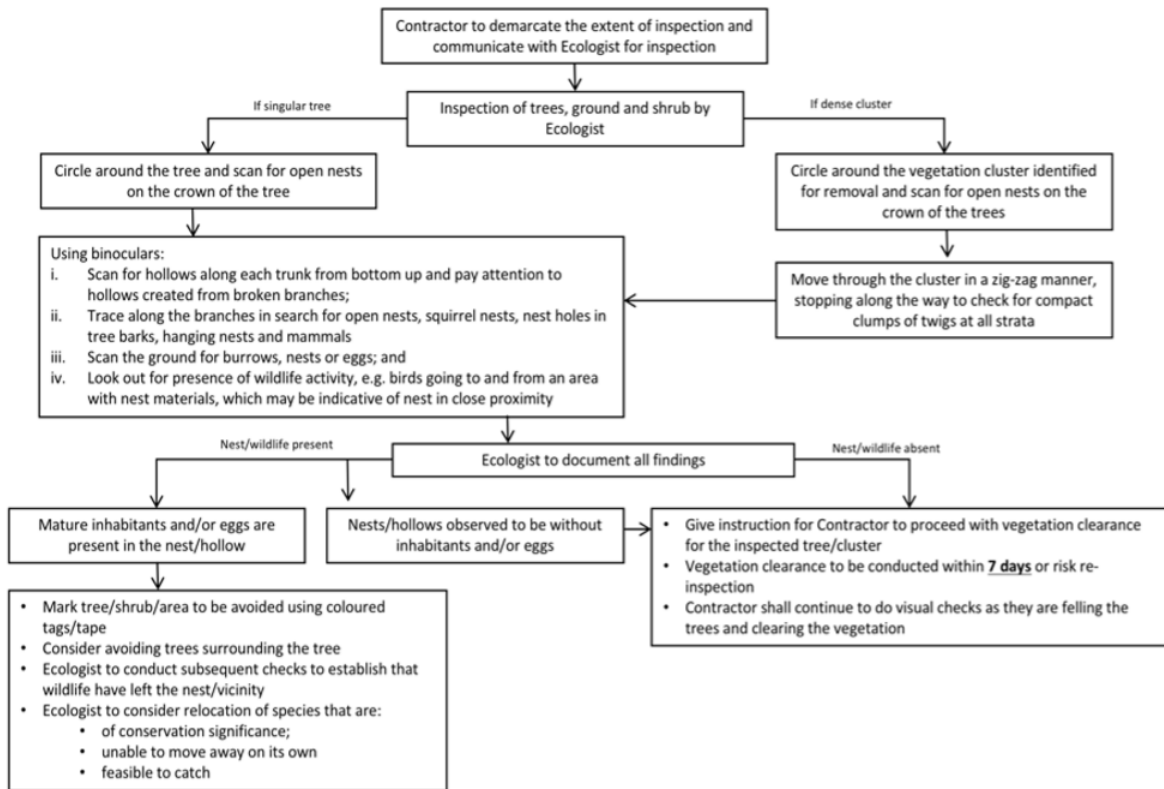


Figure 1: Pre-felling Inspection Protocol

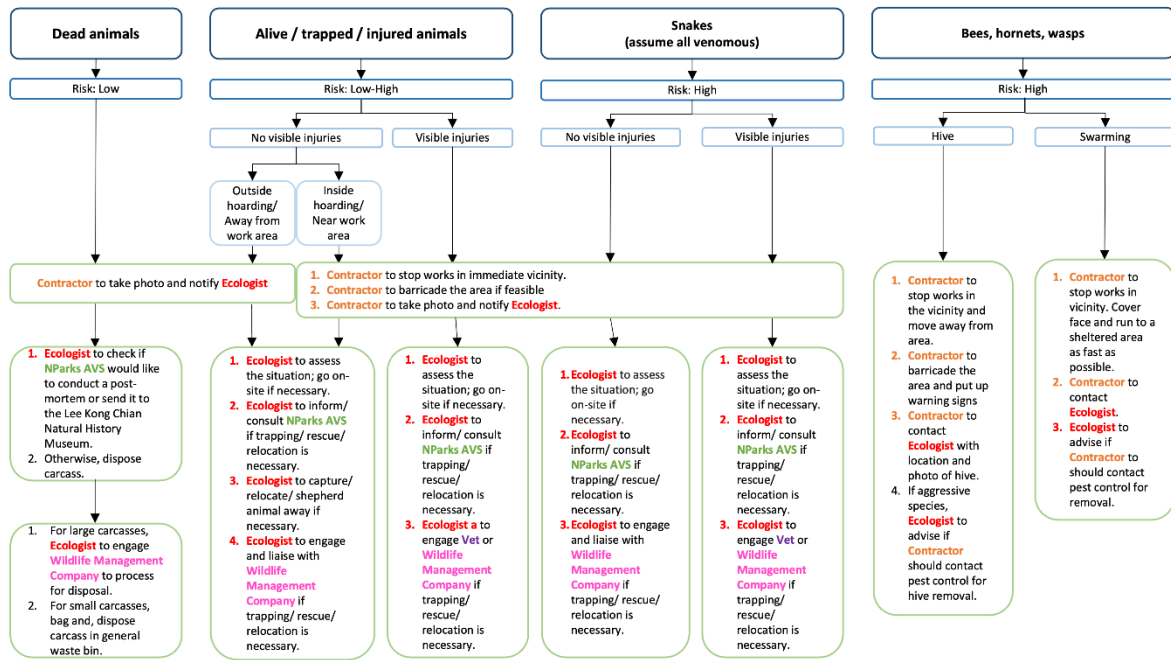


Figure 2: An Indicative Flowchart of the Fauna Response and Rescue Plan

**WILDLIFE INCIDENT FORM**

Date (YYYY/MM/DD):	Time:
Description of Location:	GPS Coordinates:
Wildlife Observed:	Condition of Animal (e.g., alive, injured, dead, etc.):  Animal Activity (e.g., moving, trapped, etc.):
Photographs Taken (Yes or No):	
Describe Incident (e.g., activities being carried out; what animal was doing; personnel involved):	
Actions Taken:	
Reported by:	Reported to:
_____	_____
Contact #:	Contact #:
_____	_____
Remarks:	

## PHOTOGRAPHS:


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