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Transport for New South Wales
ABN: 18 804 239 602

AECOM

Redfern Station Upgrade

Operational Noise Compliance Report

19-Mar-2024
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Client: Transport for New South Wales

ABN: 18 804 239 602

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Executive Summary

This Operational Noise Compliance Report (ONCR) provides an operational noise assessment for the post-construction period of the Redfern Station Upgrade – New Southern Concourse Project. Nearby noise-sensitive receivers were identified. Attended and unattended noise measurements were completed to characterise the operational noise emission from the Project. The measured noise levels were used to form an operational noise model to formulate this report.

Operational noise from Opal card readers, PA systems, mechanical plant, and the commuter carpark were considered as part of the modelling and assessment process. The assessment demonstrated that predicted noise levels as a result of the operation of the Project are generally compliant with relevant operational noise criteria presented in Section 2.0, with the exception of an exceedance of the L_{AFmax} sleep disturbance screening level at two assessment receivers.

In accordance with the *Noise Policy for Industry*, a detailed discussion of the nature of these sleep disturbance exceedances was provided. It was concluded that when considering recommended supporting policy, the *Road Noise Policy*, the resulting internal noise level at residential receivers would be unlikely to cause an awakening reaction. In addition, the frequency of these maximum noise level events is likely to be insignificant in nature when compared with other maximum noise events from noise monitoring data. As a result, no further noise mitigation is required.

1.0 Introduction

1.1 Background

On 8 October 2023, Transport for New South Wales (Transport) opened the Redfern Station Upgrade (RSU) – New Southern Concourse Project (the Project) as part of the Transport Access Program (TAP) - a NSW government initiative to provide a better experience for public transport customers by delivering accessible, modern, secure and integrated transport infrastructure across NSW.

The Project included construction of a new pedestrian concourse to the south of the Lawson Street concourse, providing both lift and stair access to Platforms 1 to 10. The new pedestrian concourse also provides a new connection across the rail corridor, between Little Eveleigh Street and Marian Street in the suburbs of Redfern and Eveleigh, respectively.

Transport has engaged AECOM Australia Pty Ltd to meet the Project's operational noise requirements, as required by the Project Environmental Impact Statement (EIS) (May 2020) and the Minister for Planning and Public Spaces Infrastructure Approval (SSI 10041) (December 2020). Specifically, the Minister's Conditions of approval (MCoA) require operational noise monitoring at representative sensitive receiver locations and for this monitoring to be documented in an Operational noise Compliance Report (ONCR). This report constitutes the ONCR.

A glossary of acoustic terminology is provided in Appendix A.

1.2 Minister's Conditions of Approval (SSI 10041)

Operational noise requirements are detailed in the Minister's Conditions of Approval (SSI 10041). The relevant Conditions (D29-31) are presented below with their compliance status.

Table 1 Compliance with MCoA

	Requirement	Document Reference	How addressed
D29	Where exceedances of the relevant project-specific operational noise level criteria are predicted at sensitive residential receivers, the Proponent must install at-source and/or at-property acoustic treatments to reduce noise impacts from the new Little Eveleigh Street car park at sensitive residential receivers. The noise mitigation measures must be implemented prior to the commencement of operation. The implemented noise mitigation measures must reduce noise so that the noise levels at impacted sensitive residential receivers meet the relevant project-specific operational noise level criteria (determined in accordance with the Noise Policy for Industry (EPA, 2017)) and the sleep disturbance screening criteria, unless otherwise approved by the Planning Secretary	Section 4.3	Noise levels were assessed prior to operation of the project. No mitigation measures were deemed required. Refer to Section 4.3 for operational noise validation.
D30	The Proponent must undertake operational noise monitoring at representative sensitive receiver locations within four (4) months of commencement of operation to confirm operational noise levels, including noise from the new car park at Little Eveleigh Street, Redfern. Noise monitoring must be undertaken during the day, evening and night-time periods.	Section 3	Monitoring was undertaken between 7 and 21 December 2023 and included selected receivers during day, evening and night-time periods.
D31	The results of the noise monitoring must be documented in an Operational Noise Compliance Report (ONCR). The report must:	This report	

	Requirement	Document Reference	How addressed
	(a) document the methodology, location and frequency of noise monitoring undertaken;	Section 3	Details of the methodology, location and frequency of noise monitoring have been provided.
	(b) confirm the operational noise criteria based on the Noise Policy for Industry (EPA, 2017);	Section 2	Operational noise criteria have been based on the Noise Policy for Industry
	(c) confirm the operational noise impacts at sensitive receivers and assess these against the operational noise criteria;	Section 4	Operational noise impacts at sensitive receivers have been discussed.
	(d) provide details of any complaints and enquiries received in relation to operational noise generated by the SSI between the date of commencement of operation and the date the report was prepared and how these complaints were responded to;	Section 4.5	Details of noise complaints have been provided.
	(e) review the effectiveness of the at-source and/or at-property acoustic treatments in reducing noise levels from the Little Eveleigh Street car park at nearby sensitive residential receivers to achieve the operational noise criteria; and	N/A	Noise levels were assessed prior to operation of the project. No mitigation measures were deemed required. Refer to Section 4.3 for operational noise validation.
	(f) where operational noise criteria are not met, identify additional measures that are to be implemented with the objective of meeting the criteria outlined in the Noise Policy for Industry (EPA, 2017), when these measures are to be implemented, the consultation to be undertaken with impacted sensitive receivers on the proposed measures, and how their effectiveness is to be measured and reported to the Planning Secretary.	N/A	No mitigation measures identified to be required (Section 5).
	The Proponent must implement the identified mitigation measures.	N/A	No mitigation measures identified to be required (Section 5).

1.3 Site description

Redfern Station is located within an urban environment, bordered by a mix of residential, commercial, and industrial properties. The station is directly surrounded by residential, commercial, and industrial receivers. The closest residential receivers are located approximately 10-20 metres away from the new Entrances on Little Eveleigh Street to the north and Marian Street to the south. These receivers are also located approximately 20 metres from the closest railway line running through Redfern Station.

Additional residential receivers directly adjoin the car park constructed as part of the Project on Little Eveleigh Street / Ivy Lane. The car park is adjacent to a rail operations and maintenance area for Sydney Trains, contractors and a parking area for Sydney Trains drivers.

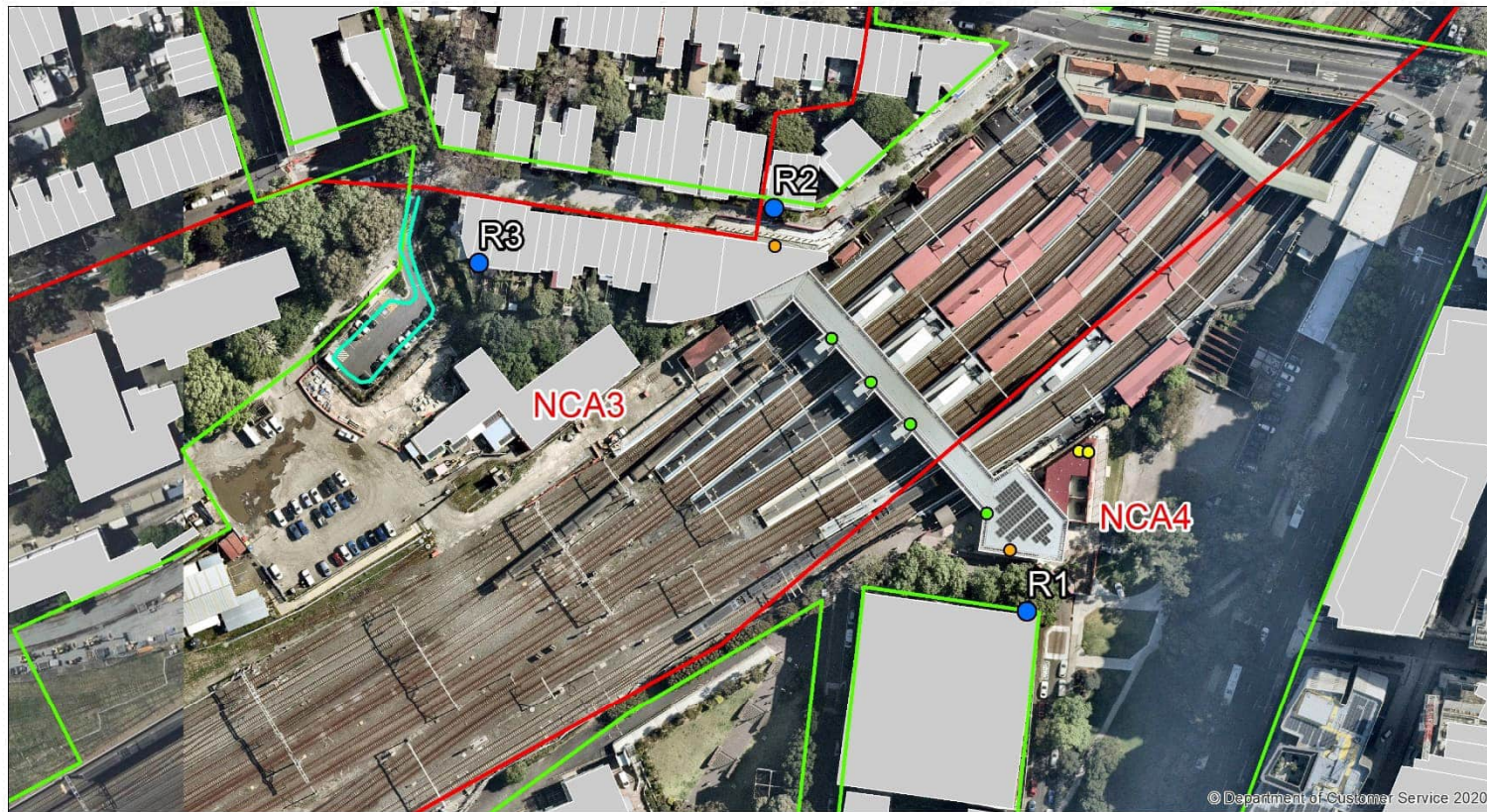
The station serves as a key transportation hub, catering to a diverse range of customers, including those heading to destinations such as Sydney University and Carriageworks by utilising Little Eveleigh Street.

A site visit was conducted on 13 November 2023 to determine sources of noise emission associated with the completed operational project. They were determined to be:

- Building services plant
- PA system speakers
- Opal card readers
- Car park operation (vehicle movements & car door slams).

As a result, these were the operational noise sources under consideration in this Report and are discussed in more detail in Section 4.2.

The Project area and surrounding environment are shown in Figure 1. Assessment receivers outlined in this figure are discussed further in Section 3.1.



Redfern Station Upgrade - Project Overview

- EIS Project Area
- NCAs
- Assessment Receivers
- Carpark Vehicle Movements
- PA Speakers
- Opal Readers
- Condenser Units



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Figure 1 Project overview and assessment receivers (refer Section 3.1)

1.4 Design development

Detailed design development and subsequent approvals resulted in a number of changes from the EIS design including:

- re-orientation of the LittleEveleigh Street offset carpark
- removal of the extension of Marian Street shared zone onto Cornwallis Street
- removal of the footpath upgrade on Gibbons Street.
- Safety initiatives on Lawson Street and Wilson Street (not commenced at time of monitoring), consisting of:
 - Zebra crossing and parking spaces on Lawson Street
 - One-way changes and loading zone on Little Eveleigh Street
 - Wilson Street lane closure.

2.0 Operational noise criteria

Applicable operational noise criteria are produced in the sections below. These criteria are also explicitly referenced in the MCoA in Section 1.2 and reproduced here where applicable.

2.1 Noise Policy for Industry

Project specific criteria were previously determined in accordance with the *Noise Policy for Industry* (EPA, 2017) and presented in the *Redfern Station Upgrade – New Southern Concourse Technical Report 4 – Noise and vibration* (Transport, 2020).

2.1.1 $L_{Aeq,15\text{ min}}$ noise level criteria

A summary of the project specific noise criteria for the relevant Noise Catchment Areas (NCAs) directly affected by fixed facility noise is presented in Table 2. These criteria apply to environmental noise emissions from any plant installed as part of the project. It should be noted that while criteria for all NCAs from the EIS are shown, only criteria for NCAs 3 & 4 are assessed in Section 4.0, as they apply to the most affected residential receivers located on Little Eveleigh Street and Marian Street, respectively. Due to their distance from the Project, compliance at NCAs 3 & 4 would also mean compliance within other NCAs.

For reference, the purpose of an NCA when undertaking a noise impact assessment is to group residential receivers that are considered to have a similar noise environment for the purposes of setting criteria.

Table 2 Summary of environmental noise emission criteria

Location	Time of day ¹	Project specific noise levels criteria $L_{Aeq,15\text{min}}$, dB(A)
NCA1	Day	47
	Evening	42
	Night	37
NCA2	Day	46
	Evening	43
	Night	38
NCA3 – Little Eveleigh Street residences	Day	58
	Evening	48
	Night	44
NCA4 – Marian Street residences	Day	58
	Evening	48
	Night	44
NCA5	Day	49
	Evening	43
	Night	38

Notes:

- In accordance with the *Noise Policy for Industry*, time of day is defined as follows:
 Day – the period from 7 am to 6 pm Monday to Saturday or 8 am to 6 pm on Sundays and public holidays.
 Evening – the period from 6 pm to 10 pm.
 Night – the remaining periods.

2.1.2 Maximum noise level criteria

A summary of the sleep disturbance criteria for the nearest noise-sensitive residential receivers are presented in Table 3.

Table 3 Night-time sleep disturbance screening levels

Location	Sleep disturbance screening levels, dB(A)	
	L _{Aeq,15min}	L _{AF,Max}
NCA 1 Residential receivers	40	52
NCA 2 Residential receivers	40	52
NCA 3 Residential receivers	44	54
NCA 4 Residential receivers	44	54
NCA 5 Residential receivers	42	52

2.2 Noise Guide for Local Government

Noise from the additional commuters using the station/shared zone does not fall under the *Noise Policy for Industry*. The *Redfern Station Upgrade – New Southern Concourse Technical Report 4 – Noise and vibration* presented a checklist of considerations to determine whether noise is offensive from the EPA's *Noise Guide for Local Government* (EPA, 2013):

1. Is the noise loud in an absolute sense? Is it loud relative to other noise in the area?
2. Does the noise include characteristics that make it particularly irritating?
3. Does the noise occur at times when people expect to enjoy peace and quiet?
4. Is the noise atypical for the area?
5. Does the noise occur often?
6. Are a number of people affected by the noise?

3.0 Noise monitoring

3.1 Assessment receivers

Residential receivers potentially affected by the operation of the Project are located around the site area in multiple locations.

For the assessment, noise levels were predicted and assessed at representative sensitive receivers. These locations were selected to represent locations most affected by various operational noise sources from the Project and are presented in Figure 1. The assessment receiver addresses are presented in Table 4.

Table 4 Receiver locations

Assessment receiver	Address	Usage
R1	The Watertower, 1-9 Marian Street, Redfern	Residential
R2	126 Little Eveleigh Street, Redfern	Residential
R3	155 Little Eveleigh Street, Redfern	Residential

Compliance with the relevant criteria at the receivers detailed in Table 4 would result in compliance with other residential and non-residential receivers located further away from the Project area.

3.2 Noise measurement methodology

Long-term unattended and short-term attended noise measurements were undertaken to capture noise emissions from the station since the opening of the Redfern Station Upgrade Project, between 7 and 21 December 2023, within four months of the commencement of operations of the concourse.

The acoustic instrumentation employed during unattended and attended noise measurements comply with the requirements of *AS IEC 61672.1-2019 Electroacoustics – Sound level meters Specifications* and were within their current National Association of Testing Authorities, Australia (NATA) certified in-calibration period (i.e. calibration in the last two years). Measurements were conducted in accordance with the EPA's *Approved Methods for Measurement and Analysis of Environmental Noise in NSW, 2022*.

3.2.1 Unattended noise measurements

Unattended measurements were made using a noise logger located outside of R1, directly across from the Marian Street entrance between 7 December and 21 December 2023. The purpose of the unattended measurements was predominantly to provide current environmental noise levels since the completion of the Project and identify operational noise emission relating to the Project. In addition, these measurements are also able to provide a high-level comparison of the background noise environment to noise monitoring conducted for the EIS. However, it should be noted that due to the different purposes of noise monitoring between the EIS and this ONCR, it is expected that there would be some differences in background noise levels between the two.

Table 5 presents the L_{Aeq} and L_{A90} noise levels for the day, evening and night-time periods, measured in accordance with the *Noise Policy for Industry*. The results for each day and the graphical noise logging results are presented in Appendix B.

Table 5 Unattended noise measurement results

Location	RBL L_{A90} dB(A)			Log Average L_{Aeq} dB(A)		
	Day ¹	Evening ¹	Night ¹	Day ¹	Evening ¹	Night ¹
R1 - The Watertower, 1-9 Marian Street, Redfern	47	45	41	67	70	56

Notes:

1. In accordance with the NPfI, time of day is defined as follows:

Day – the period from 7 am to 6 pm Monday to Saturday or 8 am to 6 pm on Sundays and public holidays.

Evening – the period from 6 pm to 10 pm.

Night – the remaining periods.

Noise monitoring affected by adverse weather conditions or extraneous noise events was excluded from the monitoring data. The *Noise Policy for Industry* advises that data may be affected where adverse weather, such as wind speeds higher than 5 m/s or rain, occurs. Weather data was acquired from the Bureau of Meteorology's Canterbury weather station (station number 94766) located around seven kilometres west of the Project. The logger measured noise levels over the sample period and then determined L_{A1} , L_{A10} , L_{A90} , and L_{Aeq} levels of the noise environment. The L_{A90} noise levels are the levels exceeded 90% of the measurement period. This is taken as the background level. The L_{Aeq} level is the equivalent continuous sound level and has the same sound energy over the sample period as the actual noise environment with fluctuating sound levels. The L_{Aeq} measurements assisted with determining the noise emission from the station, in addition to contribution from other potential noise sources in the vicinity.

For context, noise monitoring conducted at a similar location on Marian Street during the EIS phase is reproduced in Table 6 below.

Table 6 EIS noise monitoring results – Marian Street

Location	RBL L_{A90} dB(A)			Log Average L_{Aeq} dB(A)		
	Day	Evening	Night	Day	Evening	Night
Marian Street, Eveleigh (TfNSW land opposite 'The Watertower')	53	51	39	61	58	57

Comparison between the background noise levels recorded in the ONCR (this report) and those documented during the EIS reveals that daytime and evening background noise levels were generally higher than the ONCR levels, this discrepancy is likely to be because of differences in logger placement. During the EIS, the logger was situated on TfNSW vacant land which directly overlooked Redfern Station, where station-related noise, like departing trains and door-closing buzzers was. In contrast, the ONCR logger was positioned farther from the platforms and benefitted from some shielding due to the new Marian Street entrance.

However the ONCR night-time RBLs are 2 dB(A) higher than in the EIS. A change of 2 dB(A) is generally imperceptible to the average person, and therefore not considered a significant deviation from the EIS findings.

3.2.2 Attended noise measurements

A series of attended measurements were conducted at each representative receiver location outlined in Section 3.1 during the daytime and evening periods on 7 December 2023. These attended measurements were used to identify any operational noise sources occurring from the Project area. The measurements were conducted over a period of 15-minutes. It should be noted that daytime attended measurements at R3 were not undertaken as noise emissions related to car park movements during this time period was considered negligible compared with background, and therefore modelled noise levels from Section 4.2.4 were considered more appropriate to determine compliance. In addition, since unattended noise monitoring was conducted in Section 3.2.1 consisting of daytime, evening and night-time periods, night-time attended measurements were not conducted. Finally, it was assumed that noise emissions from the project would be higher during the evening than the night-time period and so would be easier to ascertain the contribution from the Project to overall noise levels during the attended measurement period.

The results of the attended monitoring are presented in Table 7.

Table 7 Attended noise measurements

Location	Date	Time	L _{Aeq}	L _{A90} , dB(A)	Notes
R1 – The Watertower, 1-9 Marian Street, Redfern	7/12/2023	10:18	60	55	Opal card readers audible, causes spike at 4 kHz. Road traffic on Gibbons Street audible, some construction noise further up Marian Street to east mainly reversing beepers at 50 dB(A). Some construction noise from Watertower roof, hand tools 65 dB(A). Helicopter 65 dB(A). Train brake squeal 56 dB(A). Bird noise in trees in garden bed 58 dB(A).
R2 – 126 Little Eveleigh Street, Redfern	7/12/2023	10:56	57	50	Bicycles clacking pass by 53-54 dB(A). Reverberant conversations in station 51-53 dB(A). Helicopter 67 dB(A). Lots of urban hum.
R1 – The Watertower, 1-9 Marian Street, Redfern	7/12/2023	19:07	52	46	Staff talking 50-52 dB(A). Traffic on Gibbons Street 52 dB(A). Pedestrian noise consistent. Car pass by 65 dB(A). Train leaving station 62 dB(A).
R2 – 126 Little Eveleigh Street, Redfern	7/12/2023	19:24	56	49	Sydney trains staff talking 56-57 dB(A), quite reverberant. Trains 55 dB(A). Whistle from platform 61 dB(A).
R3 – 155 Little Eveleigh Street, Redfern	7/12/2023	19:40	58	53	Talking by pedestrians 50 dB(A). Passenger train 52-53 dB(A). Light wind noise about 40 dB(A). Car leaving Sydney Trains carpark 57-66 dB(A) L _{AMax} .

4.0 Operational noise and vibration assessment

4.1 Methodology

Noise emissions resulting from mechanical services, PA systems and vehicle movements from the carpark were predicted at nearby receiver locations based upon attended noise measurements conducted on site. Scenarios for day, evening and night-time noise emissions were modelled to assess noise levels at nearby sensitive receiver locations and determine compliance with the relevant project noise trigger levels presented in Section 2.0. The predicted noise levels are presented in Section 4.3 below.

4.2 Modelling

Noise levels from the operation of the Project have been predicted at nearby noise-sensitive receivers using SoundPLAN 8.2 (industry standard) noise modelling software. The operational noise levels were predicted using an implementation of the ISO9613 algorithm in the SoundPLAN noise propagation software.

The modelling includes:

- existing ground topography
- buildings and structures
- all noise-producing items identified on site, modelled as point or line sources where appropriate
- all sources are modelled to assume a 'reasonable' worst case 15 minute period scenario
- ground absorption factor of 0.6.

Noise modelling in this assessment is assumed to represent a 'reasonable worst-case' scenario.

The noise model takes into account significant noise sources and locations, screening effects, receiver locations, ground topography and noise attenuation due to geometrical spreading, air absorption, and ground absorption.

All predicted noise levels are free-field and 1.5 m above ground level at the most-affected point within a residential property boundary within 30 m of the nearest facade.

4.2.1 Noise sources

This section discusses the sources of noise emission from the Project, including building services plant noise, PA system noise, Opal card readers, and carpark noise. These activities have been categorised into steady-state or quasi steady-state noise, which is typically continuous and consistent noise.

Below is a summary of all noise sources used in the model. Each source was measured in-situ during field work using attended noise measurements.

4.2.1.1 Building services plant

The new services building located to the southern extent of the site at the Marian Street entrance contains a number of operational equipment, including transformers and condenser units. During the site visit, it was noted that the transformers and all indoor equipment was completely inaudible from the facade of the building, and was therefore not included in modelling. Therefore, only the two outdoor condenser units were considered and are shown in Table 8 below. These units have been assumed to be running continuously throughout each assessment period.

Table 8 Building services plant - Sound power levels

Item	No off	Octave band centre frequency, Hz							Sound power level, dB(A)
		63	125	250	500	1k	2k	4k	
Condenser unit	2	83	92	81	79	72	66	61	80

4.2.2 PA system

The new concourse contains PA speakers at both the Marian Street and Little Eveleigh Street entrances, and throughout the concourse itself. Table 9 below summarises the measured sound power level of the PA system. Sydney Trains has confirmed that the PA system on the new concourse is only used in the event of disruptions or emergencies. One announcement could be made within a worst-case 15-minute period, for a duration of approximately 10 seconds.

Table 9 PA system - Sound power levels

Item	Octave band centre frequency, Hz							Sound power level, dB(A)
	63	125	250	500	1k	2k	4k	
PA speaker	79	85	88	89	85	74	76	89

Notes:

1. In accordance with the Noise Policy for Industry Fact Sheet C, a +5 dB(A) correction was applied to noise from the PA speakers during the night-time to account for intermittent noise
2. L_{AFmax} was calculated to be 89 dB(A) for the purposes of the sleep disturbance assessment

4.2.3 Opal card readers

The number of hourly tap on/tap off events was provided to AECOM by Transport for each entrance under consideration (Little Eveleigh Street and Marian Street).. Table 10 shows the averaged hourly data covering 8 October to 31 December 2023. The maximum number of hourly taps for each entrance are highlighted in bold for each day, evening and night-time period in accordance with the time of day outlined in the NPfI. These periods are represented by shading the relevant cells in the table below.

It is noted that due to security concerns, Transport were not able to provide data where very low numbers of tap on/tap off events occurred during the night-time period. For these cases, it was assumed 20 taps per hour as the worst-case. During some night-time periods there were no tap on/tap off events, so when averaged over the date range, the resultant average hourly data was less than 1 and not able to be used. Therefore, this data is shown as "Not used" and does not influence the maximum number of hourly taps.

Table 10 Opal card readers - Taps per hour (8/10/2023 - 31/12/2023)

Hour ¹	Taps per hour (8/10/2023 - 31/12/2023)	
	Little Eveleigh Street Entrance	Marian Street Entrance
0	129	194
1	38	60
2	Not used	Not used
3	Not used	Not used
4	64	150
5	127	218
6	59	371
7	177	865
8	422	1,777
9	256	1,068
10	203	472
11	226	393
12	217	433
13	209	449

Hour ¹	Taps per hour (8/10/2023 - 31/12/2023)	
	Little Eveleigh Street Entrance	Marian Street Entrance
14	206	587
15	252	847
16	319	1,378
17	374	1,767
18	230	867
19	147	428
20	103	320
21	101	308
22	177	276
23	160	240

Notes:

- In accordance with the NPfI, time of day is defined as follows:
 Day – the period from 7 am to 6 pm Monday to Saturday or 8 am to 6 pm on Sundays and public holidays.
 Evening – the period from 6 pm to 10 pm.
 Night – the remaining periods.

These maximum averaged hourly taps were divided by four to adjust noise emission from multiple uses of the readers for a 15-minute assessment period. This is summarised in Table 11 below.

Table 11 Opal card readers - Tap on/tap off events summary

Entrance	Period	Maximum taps per hour	Maximum taps per 15-minute period
Little Eveleigh Street	Day	422	106
	Evening	230	58
	Night	177	44
Marian Street	Day	1,777	444
	Evening	867	217
	Night	371	93

A summary of the measured sound power levels for Opal card readers is provided in Table 12 below for a single tap event lasting approximately 0.5 seconds.

Table 12 Opal card readers - Sound power levels

Item	Octave band centre frequency, Hz							Sound power level, dB(A)
	63	125	250	500	1k	2k	4k	
Opal card reader	71	69	65	60	59	59	63	67

Notes:

- In accordance with the NPfI Fact Sheet C, a +5 dB(A) correction was applied to noise from the Opal card readers to account for tonal noise
- L_{AFmax} was calculated to be 67 dB(A) for the purposes of the sleep disturbance assessment

4.2.4 Carpark

Table 13 below summarises car movements and car door slam SWLs used in the assessment. Measurements were taken in-situ at the carpark and cross-referenced with values noted in the document *Parking Area Noise* from the Bavarian State Office for the Environment, dated 2007.

Table 13 Carpark activities - Sound Power Levels

Activity	Sound Power Level, dB(A)
Car movement	90 dB(A) $L_{Aeq,15min}$
Car door slam	97 dB(A) L_{AMax}

Table 14 shows assumed vehicle movement numbers at the carpark based on information provided by Transport. Currently the carpark contains 20 spaces and it has been reported that most residents exit and enter once each per day during peak hours, with only a small percentage using the car park during the evening/night-time. It has been estimated that a worst-case would be three movements per space per day. Therefore 60 movements have been assumed. At the time of monitoring, the car park was used exclusively by residents and businesses of Little Eveleigh Street. When the shared zone is completed the car park will be converted to timed public parking with resident permit allowances, which offsets the street parking lost by conversion of Little Eveleigh Street into a shared zone. The 60 movements have been allocated into day, evening and night-time periods based on the number of Opal card tap on/tap off events on Little Eveleigh Street during each period.

Table 14 Carpark – Vehicle movements

Location	Number of vehicle movements per period		
	Day	Evening	Night
Carpark	30	17	13

For comparison, the design for the safety initiatives predicts up to 420 car movements per day, accessing Sydney Trains operational area and the new carpark collectively. It is expected that approximately 15% of these movements would be associated with the new carpark (63 movements). For information, and as a final check of the worst-case predicted carpark noise emissions, if it is conservatively assumed that 50% of the total car movements are associated with the new carpark (210 car movements per day), the overall predicted noise levels would be 5 dB(A) higher than predicted, and would still comply with the project-specific noise trigger levels.

4.3 Predicted operational noise levels

The predicted noise levels from the Project resulting from operational-related noise is shown in Section 4.3.1 and 4.3.2 below. Noise contours showing a graphical representation of these results are shown in Appendix C.

4.3.1 L_{Aeq} noise levels

Table 15 Predicted operational noise levels

Receiver	Period	Project specific noise levels criteria L_{Aeq} , dB(A) ¹	Predicted noise levels, L_{Aeq} , dB(A)	Exceedance, dB(A)
R1	Day	58	29	-
	Evening	48	28	-
	Night	44	29	-
R2	Day	58	35	-
	Evening	48	35	-
	Night	44	40	-
R3	Day	58	36	-
	Evening	48	36	-
	Night	44	30	-

Notes:

1. Project specific noise criteria from Table 2

Predicted operational noise levels for the daytime, evening and night-time periods are shown to be below the relevant project specific noise criteria at all assessment receivers. Therefore, operational L_{Aeq} noise levels are considered to be compliant, and no further consideration of noise mitigation is considered necessary.

4.3.2 Sleep disturbance

A sleep disturbance assessment was performed to assess the compliance from maximum noise level events on nearby sensitive receivers. Sources of maximum noise level events whilst completing noise measurements of site activities on 7 December 2023 included Opal card reader noise, PA system noise, and car boot slams from the carpark. The sound power levels used for these activities are shown in tables and footnotes throughout Section 4.2.1.

The predicted noise levels from maximum noise level events are shown in Table 16 below.

Table 16 Sleep disturbance predicted noise levels

Receiver	Sleep Disturbance screening levels, dB(A) ¹		Predicted noise level, dB(A)		Exceedance, dB(A)	
	$L_{Aeq,15min}$	L_{AFmax}	$L_{Aeq,15min}$	L_{AFmax}	$L_{Aeq,15min}$	L_{AFmax}
R1	44	54	29	55	-	1
R2	44	54	40	35	-	-
R3	44	54	23	61	-	7

Notes:

1. Sleep disturbance noise criteria from Table 3

The results show that the predicted noise levels are expected to exceed the L_{AFmax} sleep disturbance screening levels at receivers R1 and R3, by a magnitude of 1 dB(A) and 7 dB(A) respectively. At R1, the exceedance of 1 dB(A) is caused by operation of the PA speakers, whilst the exceedance at R3 of 7 dB(A) is caused by car door slams.

In accordance with the *Noise Policy for Industry*, where the sleep disturbance screening levels are exceeded, a detailed maximum noise level assessment should be undertaken. The detailed assessment should cover the maximum noise level, the extent to which the maximum noise level exceeds the rating background level, and the number of times this happens during the night-time period. The *Noise Policy for Industry* also notes some guidance on possible impact is contained within the EPA's *NSW Road Noise Policy (EPA, 2017)*.

The *Road Noise Policy* states that from research on sleep disturbance to date, it can be concluded that:

- maximum internal noise levels below 50-55 dB(A) are unlikely to awaken people from sleep
- one or two noise events per night, with maximum internal noise levels of 65-70 dB(A) are not likely to affect health and wellbeing significantly.

When considering the predicted noise levels at the worst-case assessment receiver, R3, an external noise level of 61 dB(A) results in an emergence of 22 dB(A) above the rating background level noted in Table 3. This noise level would result in internal noise levels of approximately 51 dB(A) (assuming a typical 10 dB(A) loss through an open window to allow for natural ventilation). As noted above, this internal noise level would be unlikely to awaken people from sleep.

Furthermore, when considering the number of night-time vehicle movements taken from Table 14, the number of car door slam events would be unlikely to exceed 1-2 events per hour.

To provide context to this, audio recordings from the noise monitoring on Marian Street were examined to determine night-time maximum events from train pass-bys. Results between 2am – 3am showed that train pass-by events occurred approximately 5-6 times per hour and were between 60-70 dB(A) in magnitude. Considering the similar setback distance from the railway line to both the noise logger and receiver R2, it can be considered that maximum noise level events occurring from car door slams are

generally quieter than existing train pass-by events and would likely occur more infrequently during the night-time. Therefore, this source of maximum noise events would not be considered significant.

Finally, it should be noted that the carpark would be used infrequently between 2:00 am and 5:00 am, when EIS noise monitoring demonstrated that background noise levels would be at their lowest and receivers are most noise-sensitive. Therefore, it is expected that sleep awakening events would similarly be infrequent. No further consideration of sleep disturbance impacts is considered necessary, and no further mitigation is required.

This conclusion is generally consistent with the findings outlined in the EIS, in addition to the carpark assessments undertaken in compliance with Condition D29.

4.4 Commuter noise

Since opening, Opal card reader data from Table 10 shows that during the period of 8 October to 31 December, a maximum number of 422 people tapped on/off at Little Eveleigh Street whilst 1,777 people tapped on/off at Marian Street per hour. This provides a rough estimate for the maximum number of commuters walking down Little Eveleigh Street and Marian Street per hour, however some commuters would also utilise the community walkway, where no use of the Opal Card is required.

This is compared with the EIS estimate, which said approximately 3,300 and 6,770 people would walk down Little Eveleigh Street and Marian Street respectively during a typical AM peak hour. It should be noted that no specific noise criteria would apply to this activity.

However, to provide context, the 'offensive noise' checklist from the *Noise Guide for Local Government* (Section 2.2) has been used to determine if nearby noise-sensitive receivers are likely to consider the noise the Project as 'offensive'. The following section details the checklist items and addresses them based on site observations, noise monitoring data and modelled noise levels.

Is the noise loud in an absolute sense? Is it loud relative to other noise in the area?

The noise generated by people walking through the shared zones to and from the new station entrances was not observed to be loud in an absolute sense (e.g. in the context of the overall existing noise environment) at nearby residential receivers. During site observations and measurements, urban hum from sources other than the Project were considered to be dominant. This was noted to be sources such as road traffic, unrelated construction activities, and rail noise. Noise from people walking along these roads was not considered loud relative to these ambient noise levels.

Does the noise include characteristics that make it particularly irritating? Is the noise atypical for the area?

The noise generated by people comprised footfall noise and conversations and would not be considered atypical for an urban area. It would not include any characteristics that typically irritate such as low frequency or tonal components.

Does the noise occur at times when people expect to enjoy peace and quiet? Does the noise occur often?

It is considered that local residential receivers would notice a difference in ambient noise levels due to the large number of commuters utilising the new station entrances and concourse. The noise levels from commuters are highest during commuter peak periods which coincide with the noisier parts of the day, and therefore have less of an effect on the overall noise level. The noise is likely to occur on most weekdays.

Based on the above considerations, noise associated with the use of the new station entrances and surrounding shared zones is unlikely to be considered 'offensive' as defined in Section 2.2, whilst acknowledging it would be noticeable to the closest residential receivers.

4.5 Noise complaints

To date, Transport has received a total of nine complaints from residents in relation to noise from the operation of the Project since it was completed.

The complaints raised by residents were similar in nature and were received via email, and phone. The complaints and enquiries generally related to Opal card reader noise, and PA system noise, particularly

regarding recurring 'No Smoking' announcements. One property also complained about increased foot traffic. There have been no complaints regarding noise from the use of the car park.

Transport contacted each person making the complaint or enquiry to discuss their concerns and answer questions. This response was made either by phone or email. Complainants were advised that 'No Smoking' announcements had been subsequently switched off, and were also made aware of future noise monitoring to investigate the issues raised in their complaints (this report).

5.0 Conclusion

An operational noise compliance assessment has been completed following construction of the Redfern Station Upgrade – New Southern Concourse (the Project).

Nearby noise-sensitive receivers were identified. Attended and unattended noise measurements were completed to characterise the operational noise emission from the Project. The measured noise levels were used to form an operational noise model to formulate this Operational Noise Compliance Report (ONCR).

Operational noise from Opal card readers, PA systems, mechanical plant, and the commuter carpark were considered as part of the modelling and assessment process. The assessment demonstrated that predicted noise levels resulting from the operation of the Project are generally compliant with relevant operational noise criteria presented in Section 2.0, with the exception of an exceedance of the L_{AFmax} sleep disturbance screening level at two assessment receivers.

In accordance with the *Noise Policy for Industry*, a detailed discussion of the nature of these sleep disturbance exceedances was provided. It was concluded that when considering the recommended supporting policy, the *Road Noise Policy*, the resulting internal noise level at residential receivers is unlikely to cause an awakening reaction. In addition, the frequency of these maximum noise level events is likely to be insignificant in nature when compared with other maximum noise events from noise monitoring data. As a result, no noise mitigation is required.

Appendix A

Glossary of acoustic
terminology

Appendix A Glossary of acoustic terminology

The following is a brief description of acoustic terminology used in this report.

Sound power level	The total sound emitted by a source																						
Sound pressure level	The amount of sound at a specified point																						
Decibel [dB]	The measurement unit of sound																						
A Weighted decibels [dB(A)]	The A weighting is a frequency filter applied to measured noise levels to represent how humans hear sounds. The A-weighting filter emphasises frequencies in the speech range (between 1kHz and 4 kHz) which the human ear is most sensitive to, and places less emphasis on low frequencies at which the human ear is not so sensitive. When an overall sound level is A-weighted it is expressed in units of dB(A).																						
Decibel scale	<p>The decibel scale is logarithmic in order to produce a better representation of the response of the human ear. A 3 dB increase in the sound pressure level corresponds to a doubling in the sound energy. A 10 dB increase in the sound pressure level corresponds to a perceived doubling in volume. Examples of decibel levels of common sounds are as follows:</p> <table> <tr> <td>0dB(A)</td> <td>Threshold of human hearing</td> </tr> <tr> <td>30dB(A)</td> <td>A quiet country park</td> </tr> <tr> <td>40dB(A)</td> <td>Whisper in a library</td> </tr> <tr> <td>50dB(A)</td> <td>Open office space</td> </tr> <tr> <td>70dB(A)</td> <td>Inside a car on a freeway</td> </tr> <tr> <td>80dB(A)</td> <td>Outboard motor</td> </tr> <tr> <td>90dB(A)</td> <td>Heavy truck pass-by</td> </tr> <tr> <td>100dB(A)</td> <td>Jackhammer/Subway train</td> </tr> <tr> <td>110 dB(A)</td> <td>Rock Concert</td> </tr> <tr> <td>115dB(A)</td> <td>Limit of sound permitted in industry</td> </tr> <tr> <td>120dB(A)</td> <td>747 take off at 250 metres</td> </tr> </table>	0dB(A)	Threshold of human hearing	30dB(A)	A quiet country park	40dB(A)	Whisper in a library	50dB(A)	Open office space	70dB(A)	Inside a car on a freeway	80dB(A)	Outboard motor	90dB(A)	Heavy truck pass-by	100dB(A)	Jackhammer/Subway train	110 dB(A)	Rock Concert	115dB(A)	Limit of sound permitted in industry	120dB(A)	747 take off at 250 metres
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70dB(A)	Inside a car on a freeway																						
80dB(A)	Outboard motor																						
90dB(A)	Heavy truck pass-by																						
100dB(A)	Jackhammer/Subway train																						
110 dB(A)	Rock Concert																						
115dB(A)	Limit of sound permitted in industry																						
120dB(A)	747 take off at 250 metres																						
Frequency [f]	The repetition rate of the cycle measured in Hertz (Hz). The frequency corresponds to the pitch of the sound. A high frequency corresponds to a high pitched sound and a low frequency to a low pitched sound.																						
Equivalent continuous sound level [Leq]	The constant sound level which, when occurring over the same period of time, would result in the receiver experiencing the same amount of sound energy.																						
L_{max}	The maximum sound pressure level measured over the measurement period																						
L_{min}	The minimum sound pressure level measured over the measurement period																						
L_{10}	The sound pressure level exceeded for 10% of the measurement period. For 10% of the measurement period it was louder than the L_{10} .																						

L ₉₀	The sound pressure level exceeded for 90% of the measurement period. For 90% of the measurement period it was louder than the L ₉₀ .
Ambient noise	The all-encompassing noise at a point composed of sound from all sources near and far.
Background noise	The underlying level of noise present in the ambient noise when extraneous noise (such as transient traffic and dogs barking) is removed. The L ₉₀ sound pressure level is used to quantify background noise.
Traffic noise	The total noise resulting from road traffic. The Leq sound pressure level is used to quantify traffic noise.
Day	The period from 0700 to 1800 h Monday to Saturday and 0800 to 1800 h Sundays and Public Holidays.
Evening	The period from 1800 to 2200 h Monday to Sunday and Public Holidays.
Night	The period from 2200 to 0700 h Monday to Saturday and 2200 to 0800 h Sundays and Public Holidays.
Assessment background level [ABL]	The overall background level for each day, evening and night period for each day of the noise monitoring.
Rating background level [RBL]	The overall background level for each day, evening and night period for the entire length of noise monitoring.

*Definitions of a number of terms have been adapted from Australian Standard AS1633:1985 "Acoustics – Glossary of terms and related symbols", the EPA's NSW *Noise Policy for Industry* and the EPA's NSW *Road Noise Policy*.

Appendix B

Unattended noise monitoring results

Noise Logger Report

11 Marian Street, Eveleigh

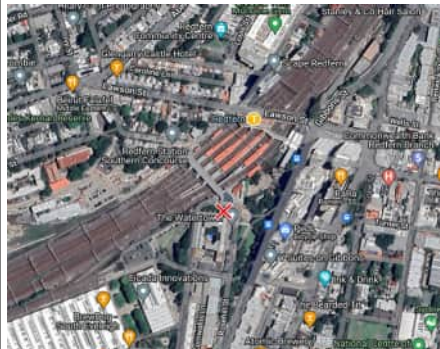



Item	Information
Logger Type	Matlab
Serial number	00164393
Address	11 Marian Street, Eveleigh
Location	Front Yard
Facade / Free Field	Free Field
Environment	Opal card readers clearly audible. Road traffic on Gibbons St audible, some construction noise further up Marian St. Reversing beepers about 50 dB. Some construction noise from water tower roof hand tools 65 dB . Helicopter 65 dB. Train brake squeal 56 dB. Bird noise in trees in garden bed 58 dB

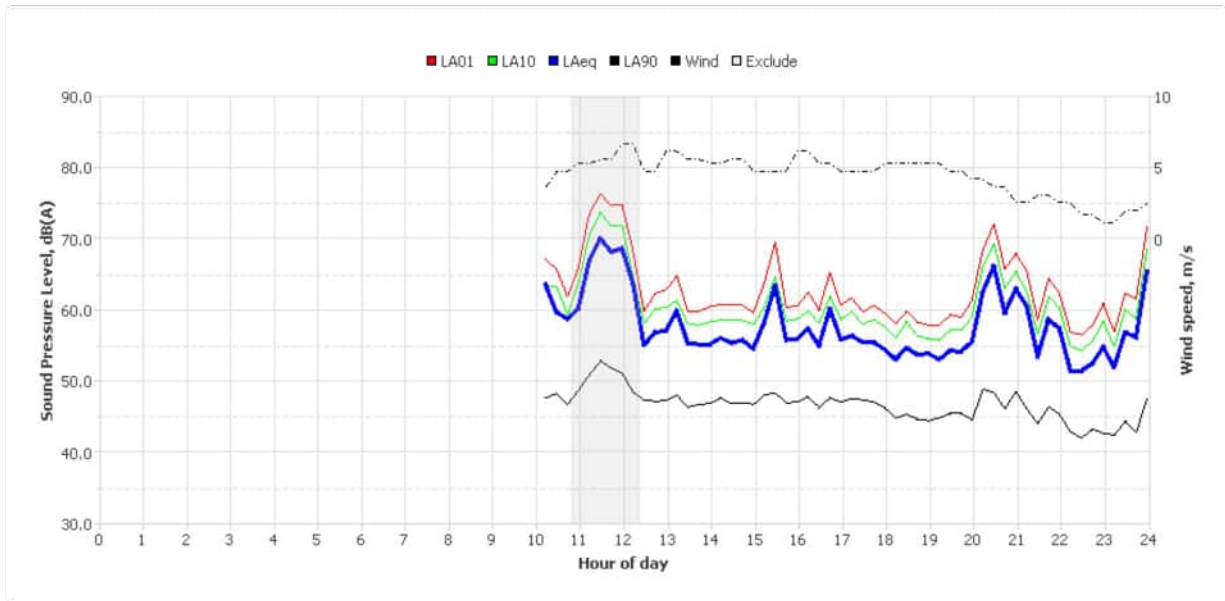
Measured noise levels

Logging Date	L _{Aeq,day} 7am-6pm	L _{Aeq,evening} 6pm-10pm	L _{Aeq,night} 10pm-7am	ABL Day 7am-6pm	ABL Eve 6pm-10pm	ABL Night 10pm-7am	L _{Aeq,15hr} 7am-10pm	L _{Aeq,9hr} 10pm-7am
Thu Dec 7 2023	58	59	58	-	44	-	58	58
Fri Dec 8 2023	76	81	62	47	-	39	77	62
Sat Dec 9 2023	67	60	56	46	-	-	67	56
Sun Dec 10 2023	54	52	51	43	43	-	53	51
Mon Dec 11 2023	56	53	52	46	42	36	55	52
Tue Dec 12 2023	66	64	57	46	45	37	66	57
Wed Dec 13 2023	72	62	54	-	-	-	70	54
Thu Dec 14 2023	61	60	55	-	-	-	61	55
Fri Dec 15 2023	59	59	56	-	53	44	59	56
Sat Dec 16 2023	59	58	55	51	-	44	58	55
Sun Dec 17 2023	58	57	55	-	50	43	57	55
Mon Dec 18 2023	61	58	55	54	51	41	60	55
Tue Dec 19 2023	60	59	54	54	-	-	60	54
Wed Dec 20 2023	-	58	58	-	-	-	58	58
Thu Dec 21 2023	-	-	53	-	-	-	-	53
Summary	67	70	56	47	45	41	68	56

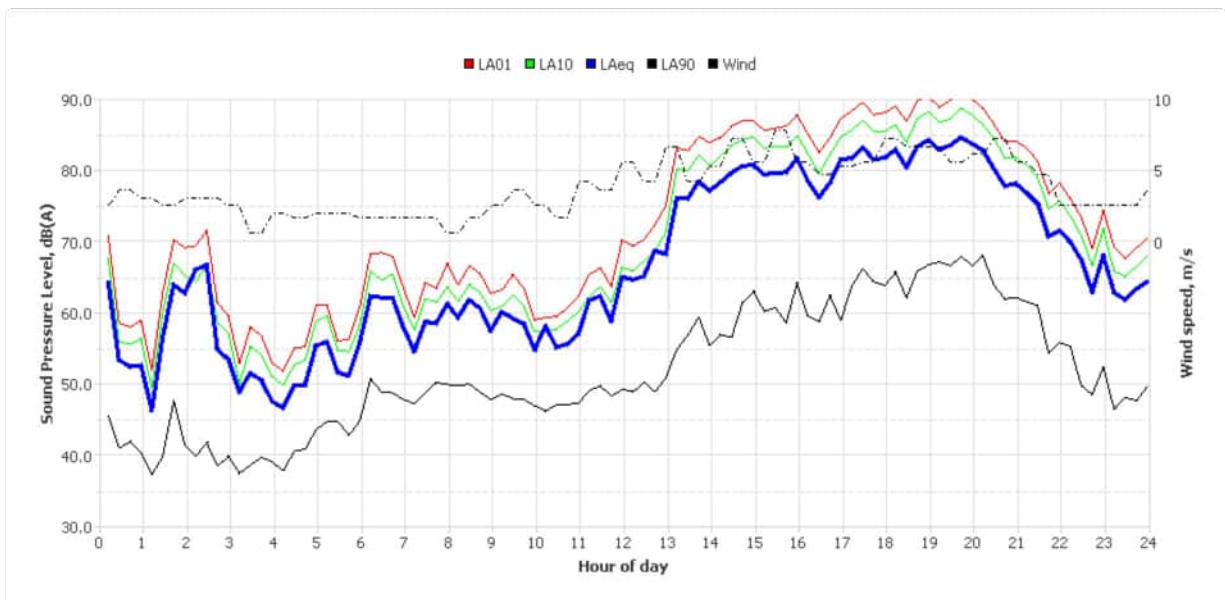
Note: Results denoted with '-' do not contain enough valid data for a value to be calculated. The data has been excluded either manually or automatically as a result of adverse weather conditions.

Logger Location	Logger Deployment Photo
 <p>11 Marian Street, Eveleigh</p>	

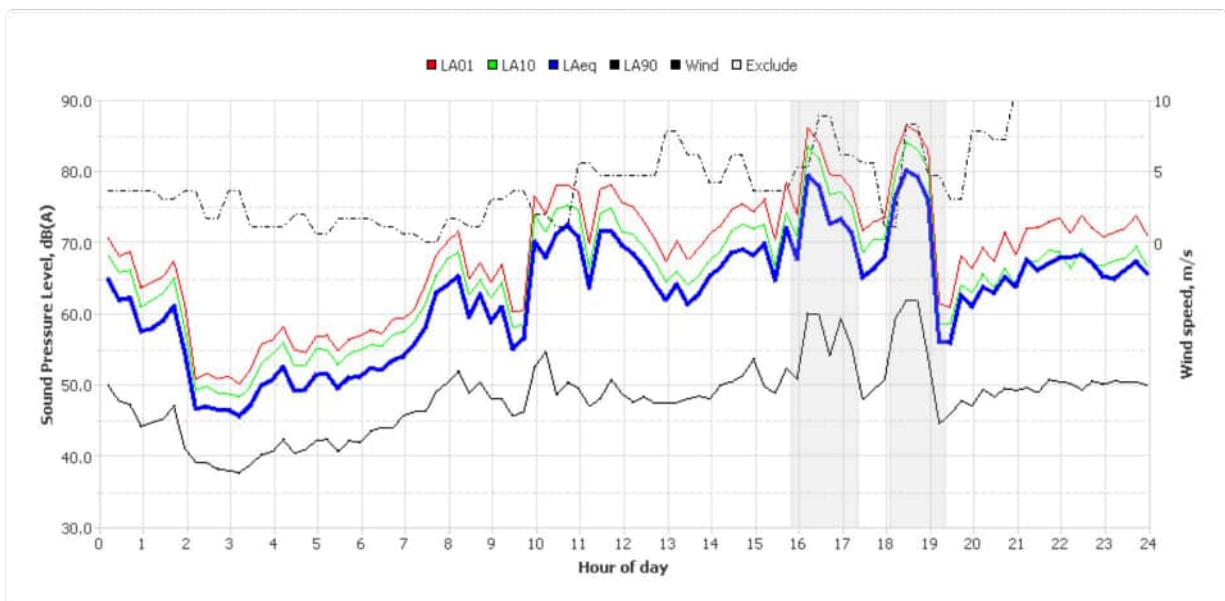
Thursday, 07 Dec 2023



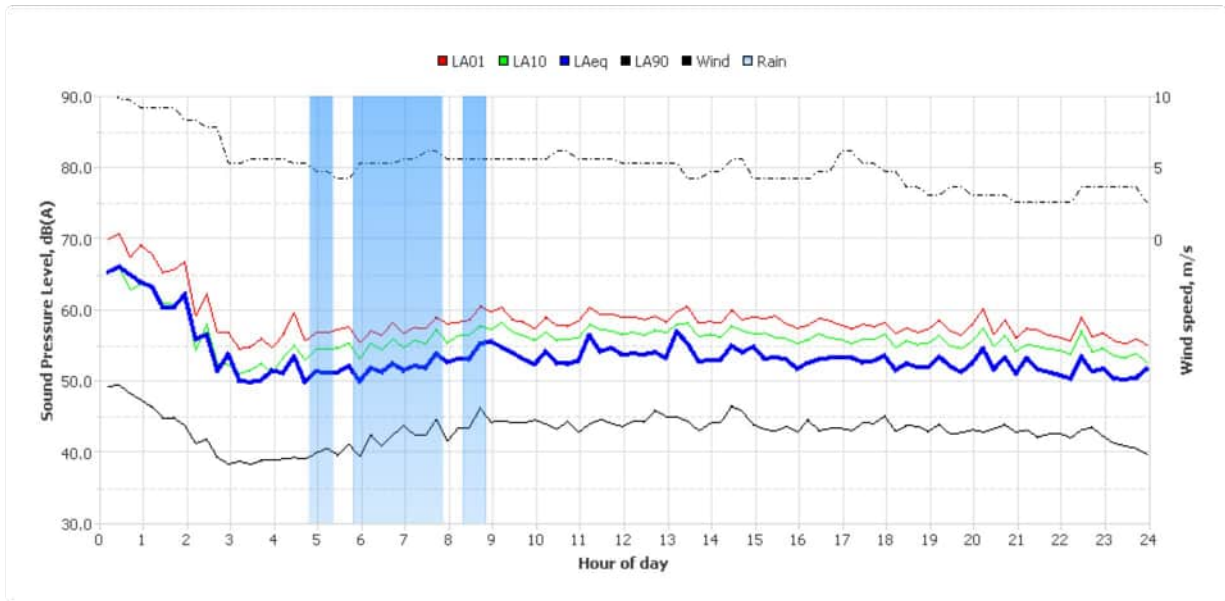
Friday, 08 Dec 2023



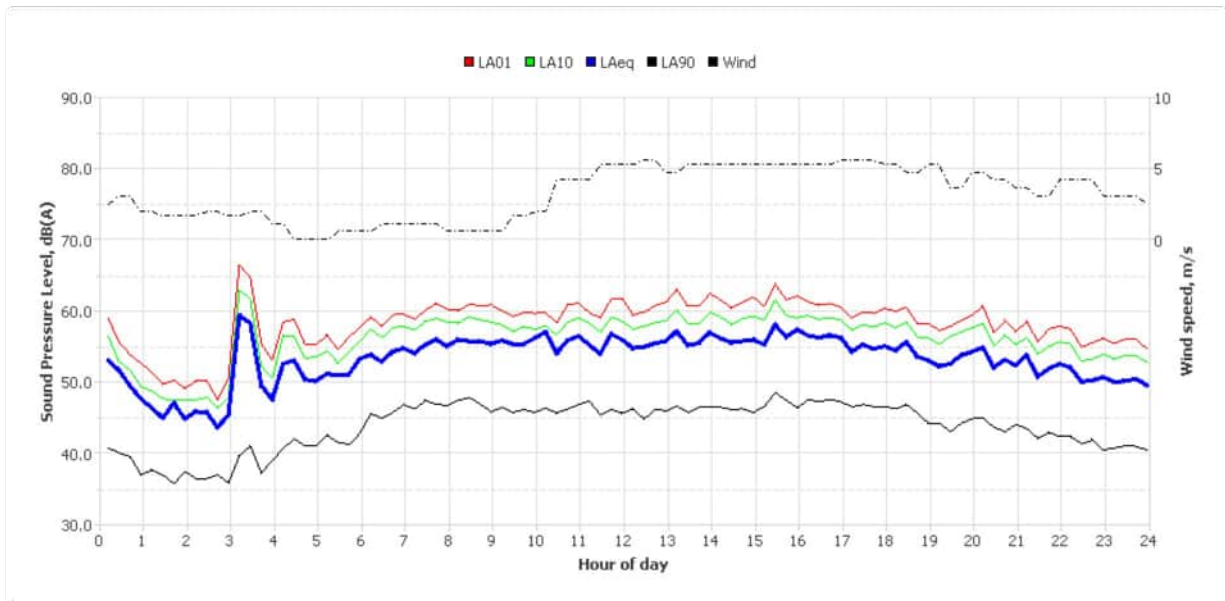
Saturday, 09 Dec 2023



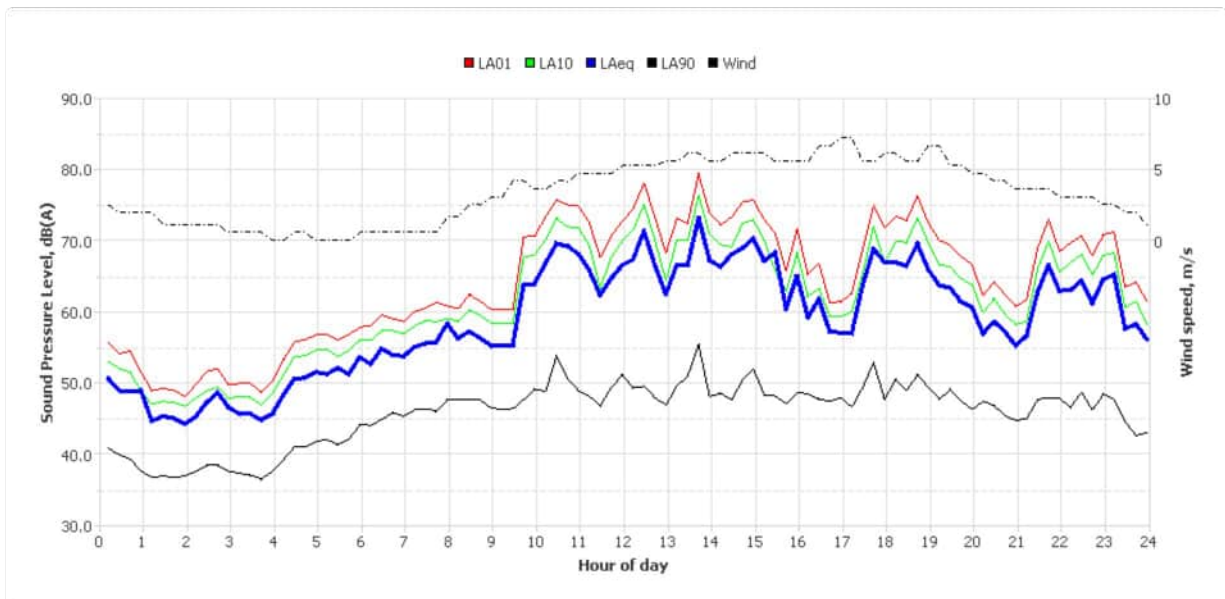
Sunday, 10 Dec 2023



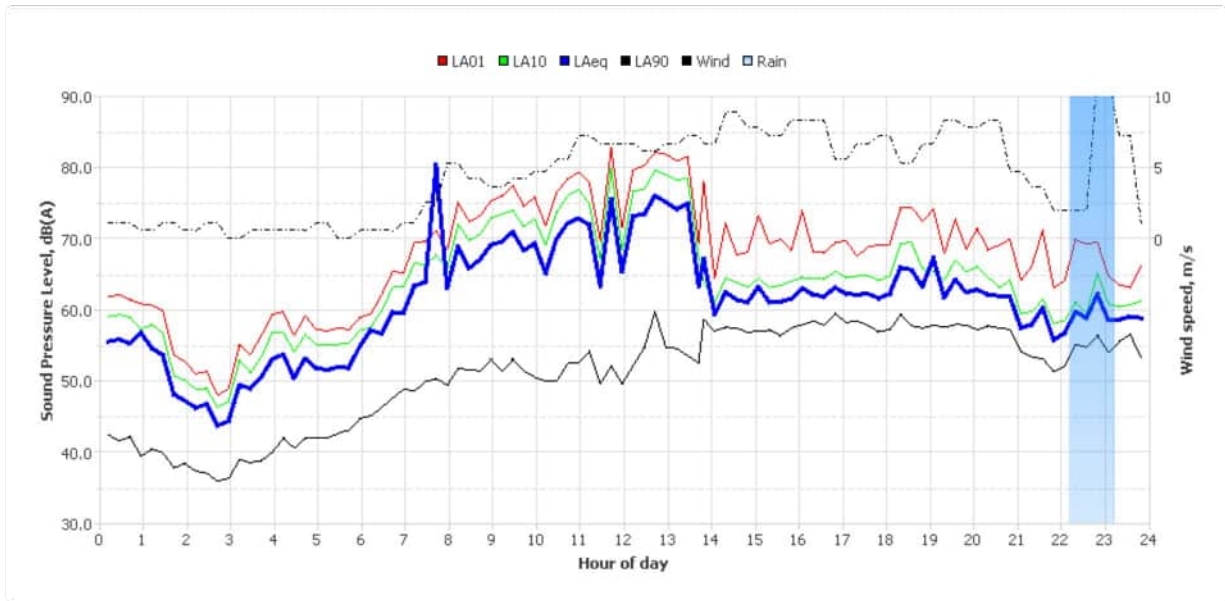
Monday, 11 Dec 2023



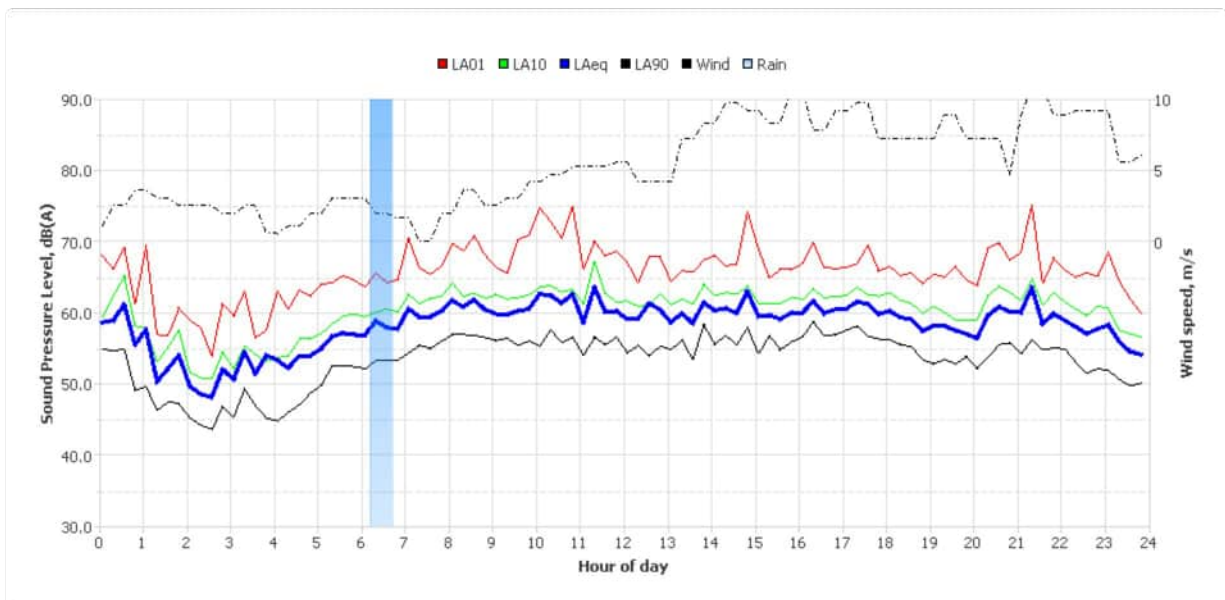
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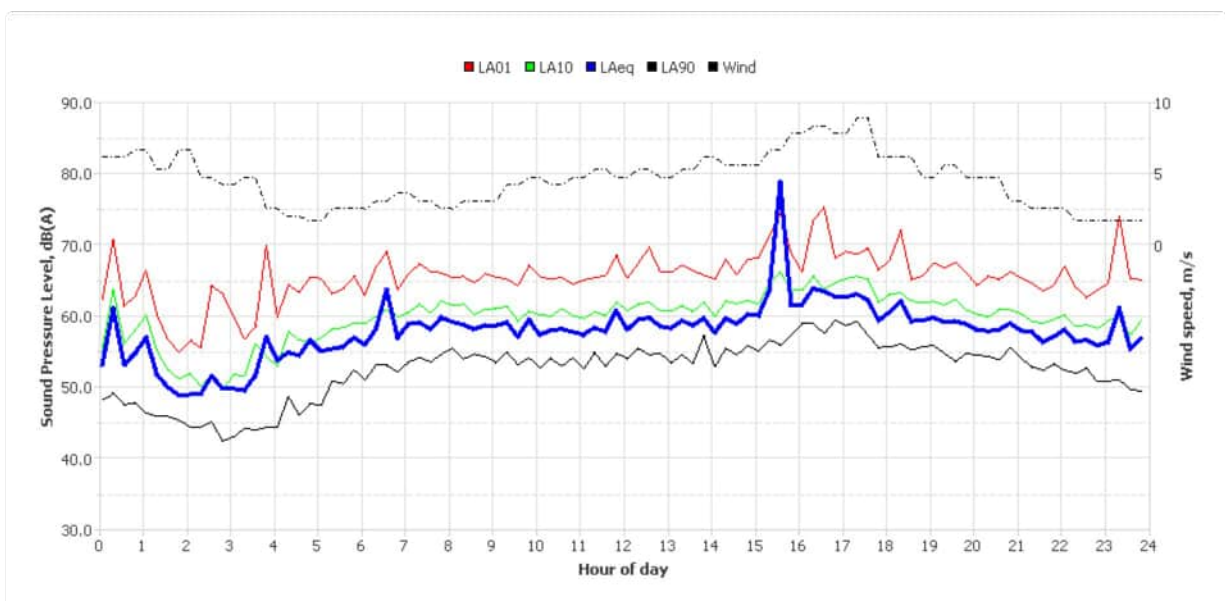
Wednesday, 13 Dec 2023



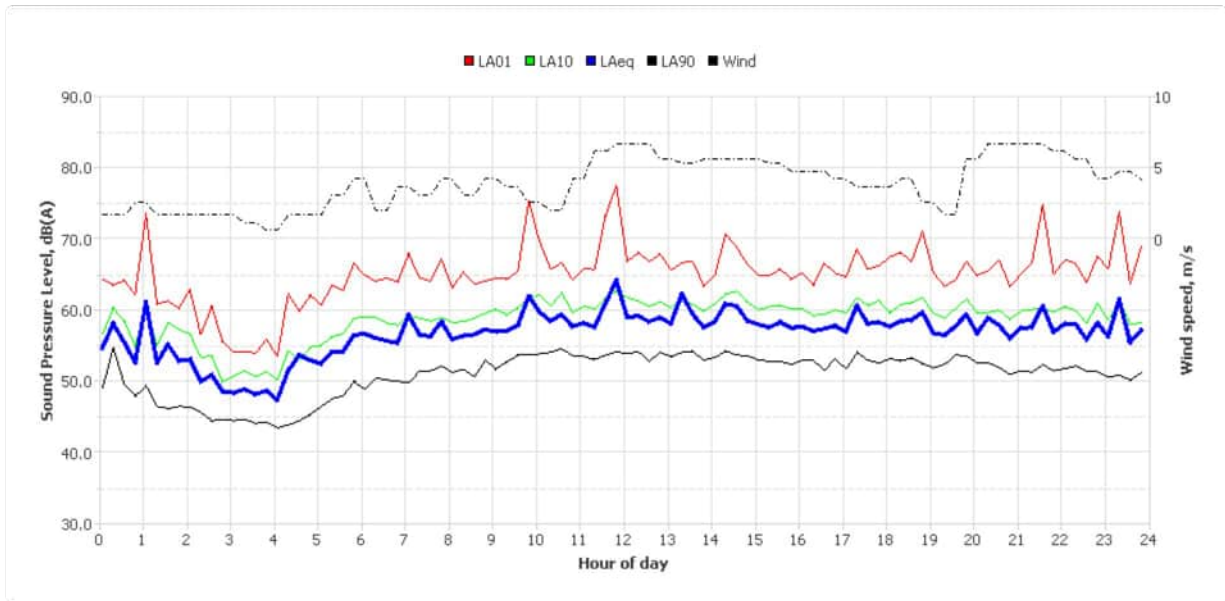
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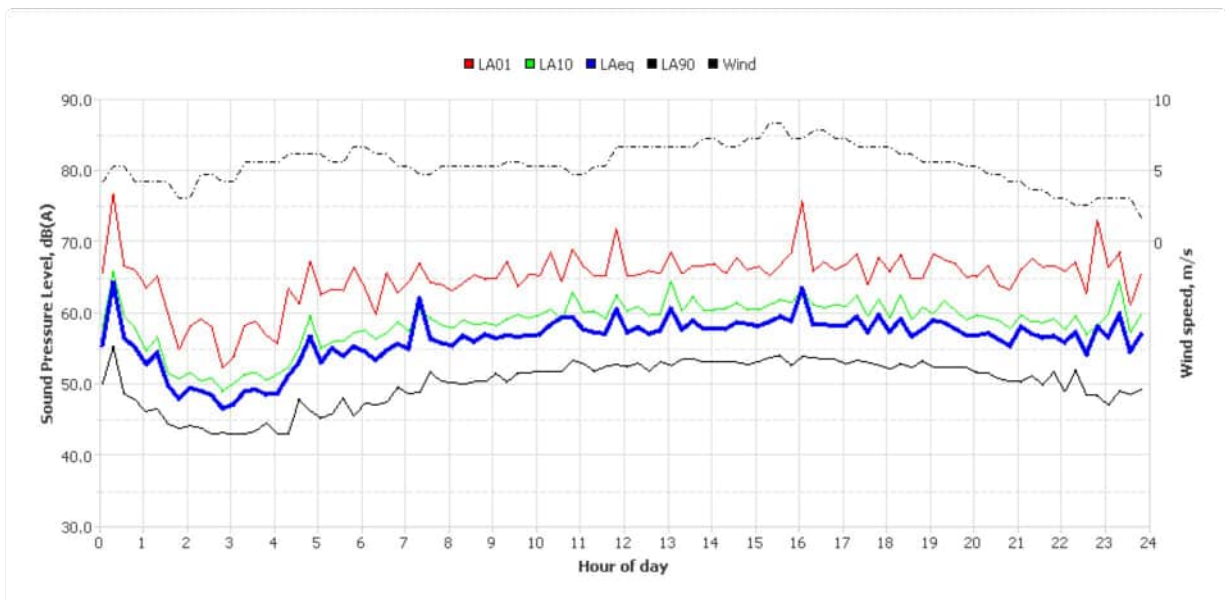
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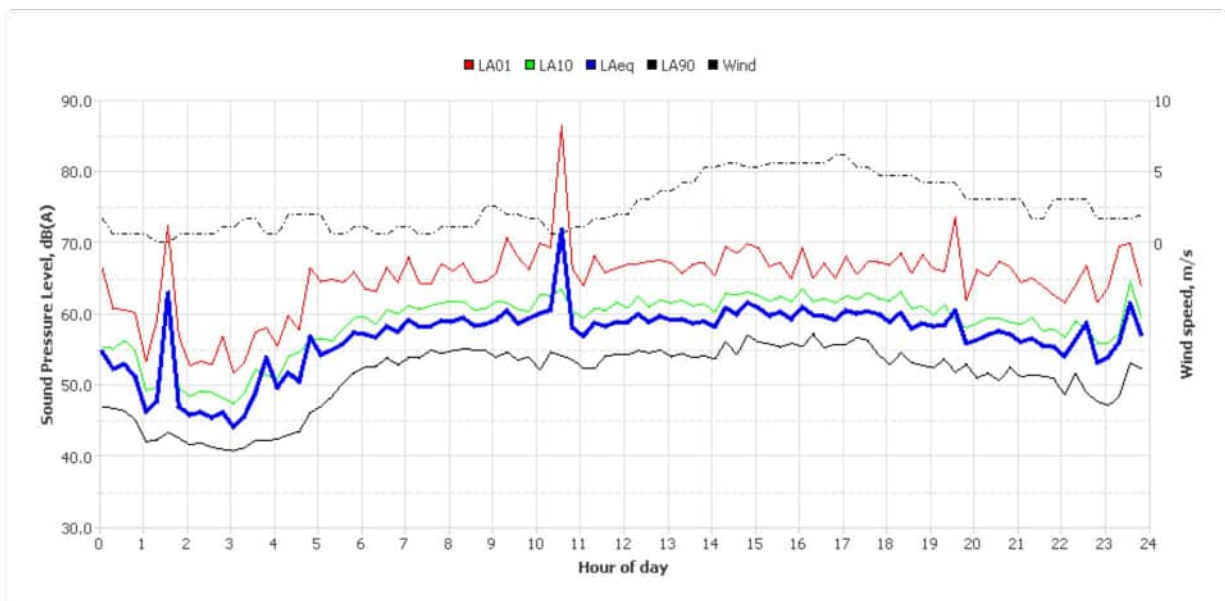
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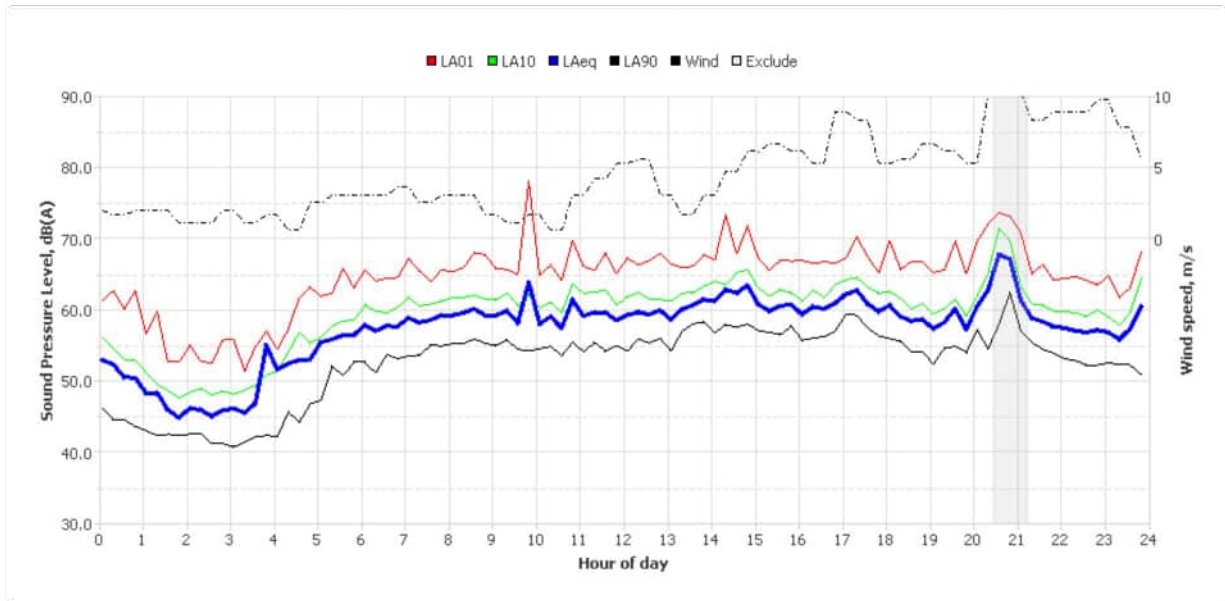
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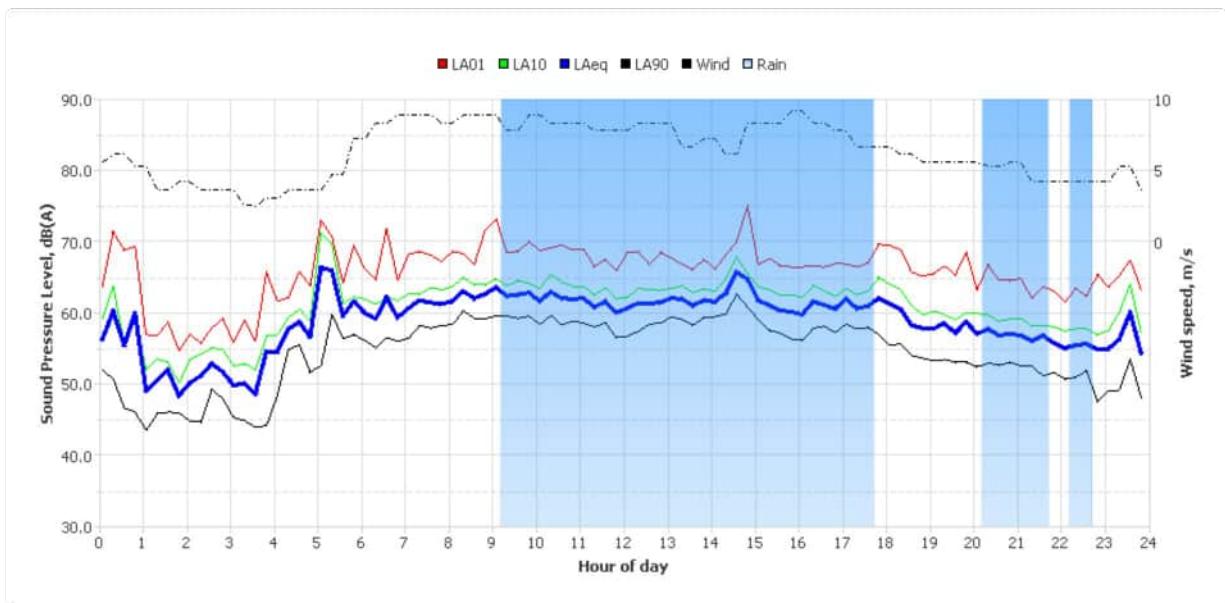
Monday, 18 Dec 2023



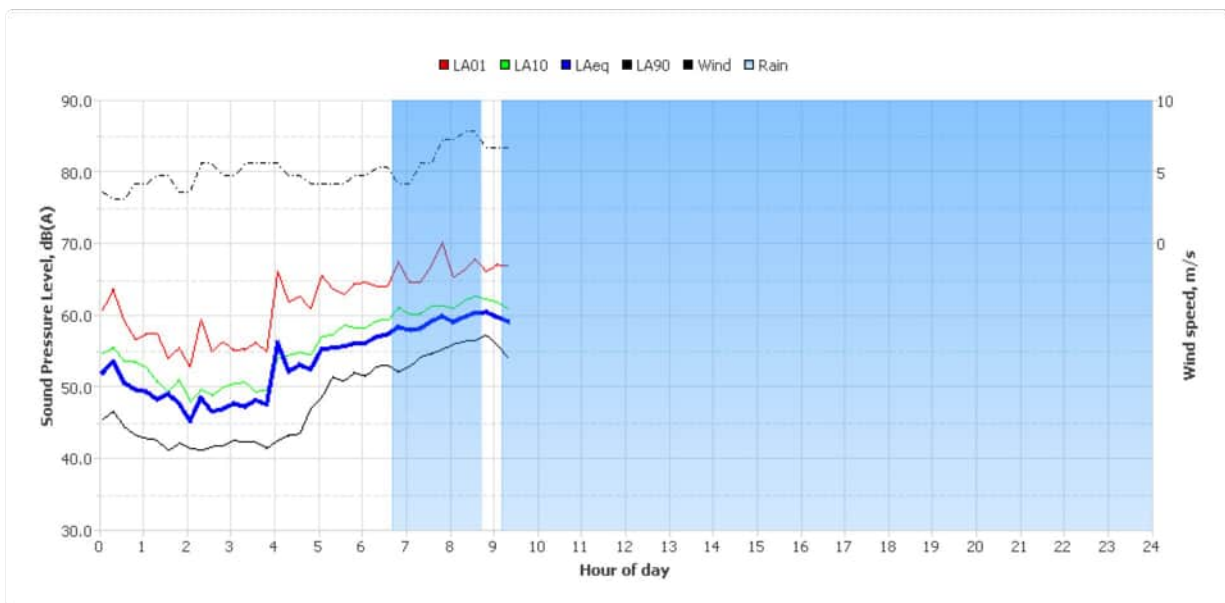
Tuesday, 19 Dec 2023



Wednesday, 20 Dec 2023

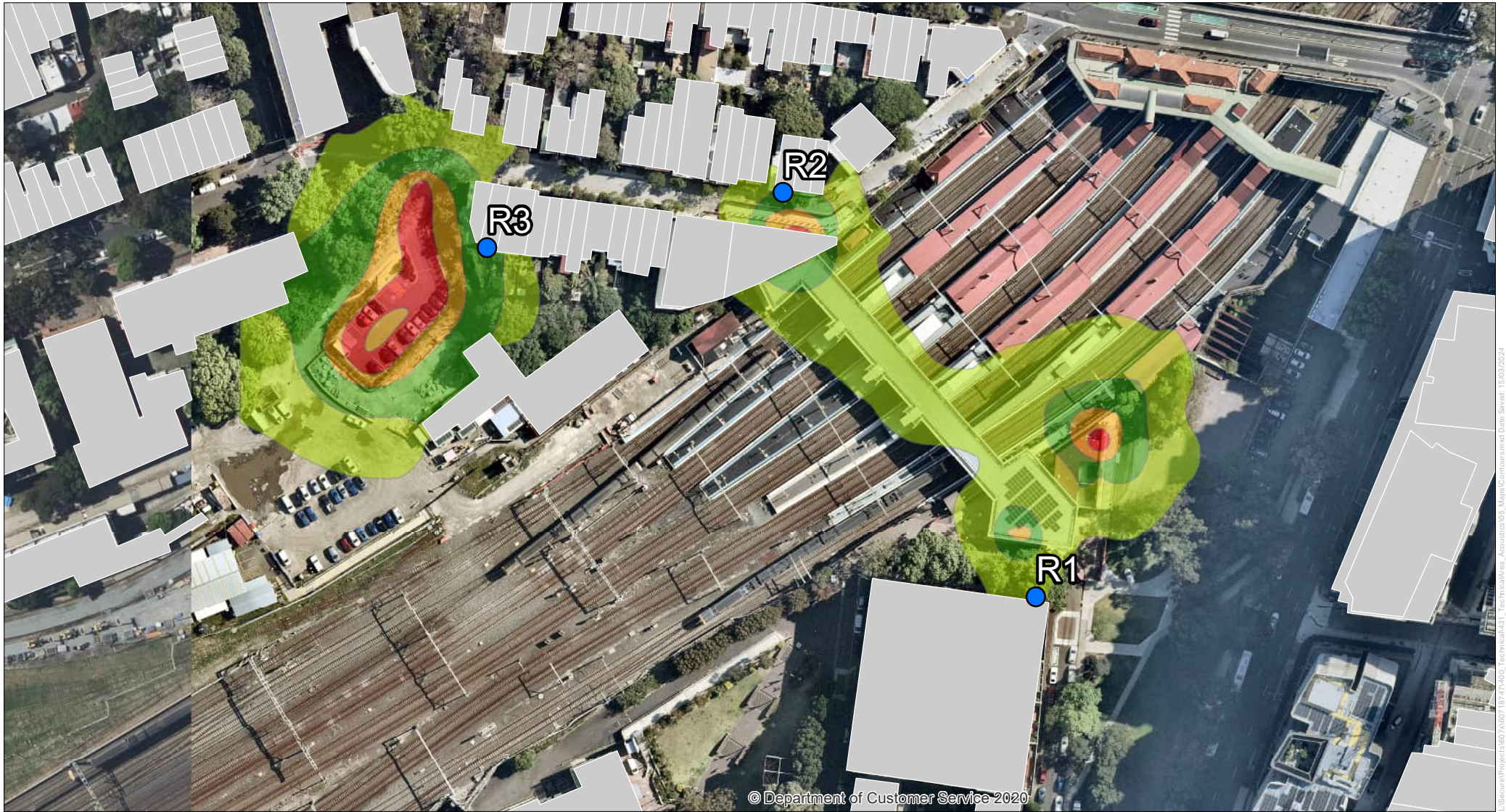


Thursday, 21 Dec 2023



Appendix C

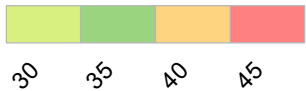
Operational noise contours



Redfern Station Upgrade - Noise Contours - $L_{Aeq,15min}$ - Day

● Assessment Receivers

$L_{Aeq,15min}, dB(A)$



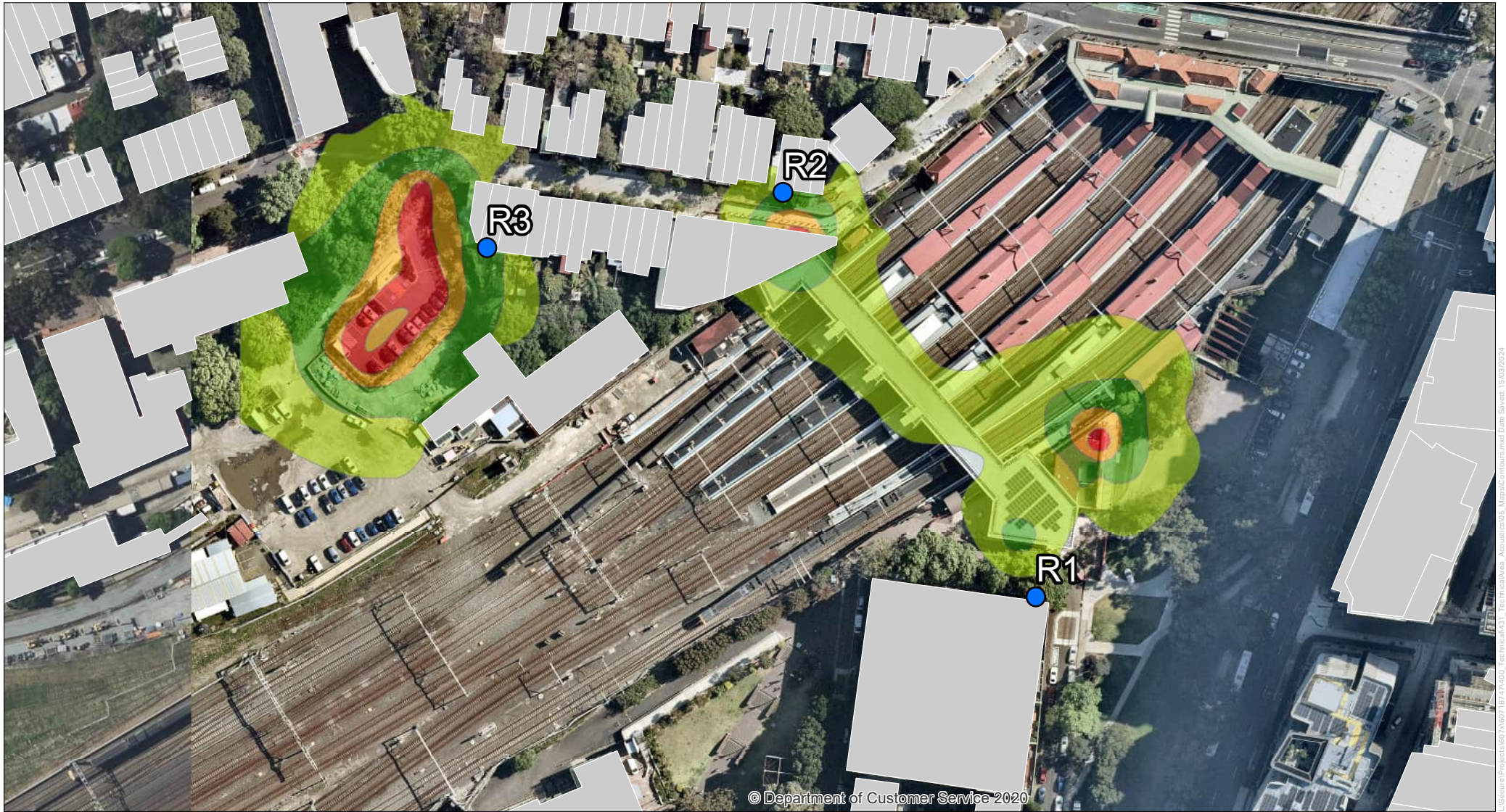
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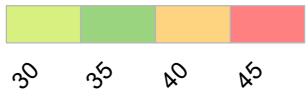
Source:



Redfern Station Upgrade - Noise Contours - $L_{Aeq,15min}$ - Evening

● Assessment Receivers

$L_{Aeq,15min}, dB(A)$



AECOM

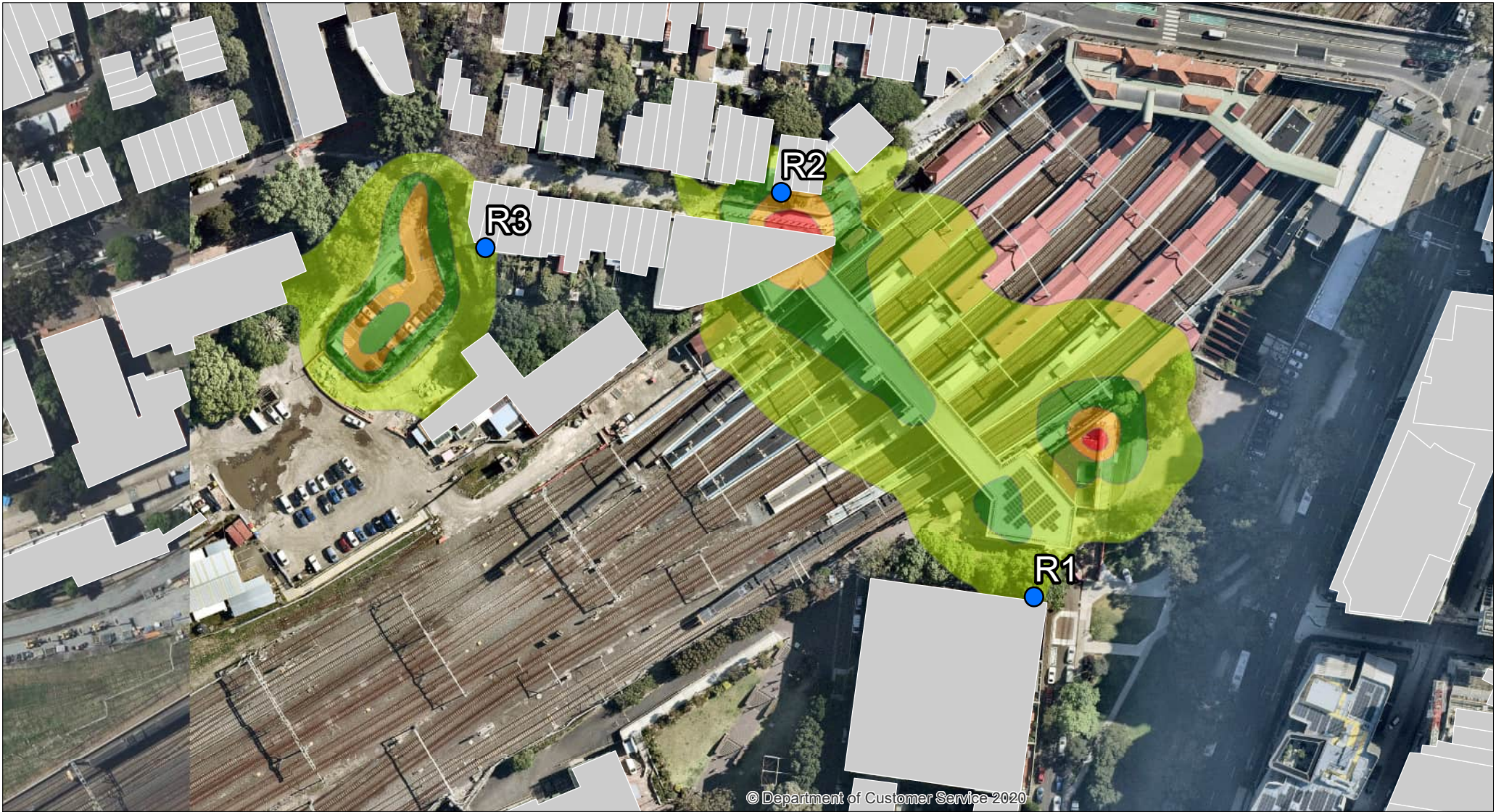
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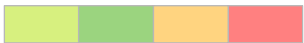
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Redfern Station Upgrade - Noise Contours - $L_{Aeq,15min}$ - Night

● Assessment Receivers

$L_{Aeq,15min}, dB(A)$



30 35 40 45



AECOM

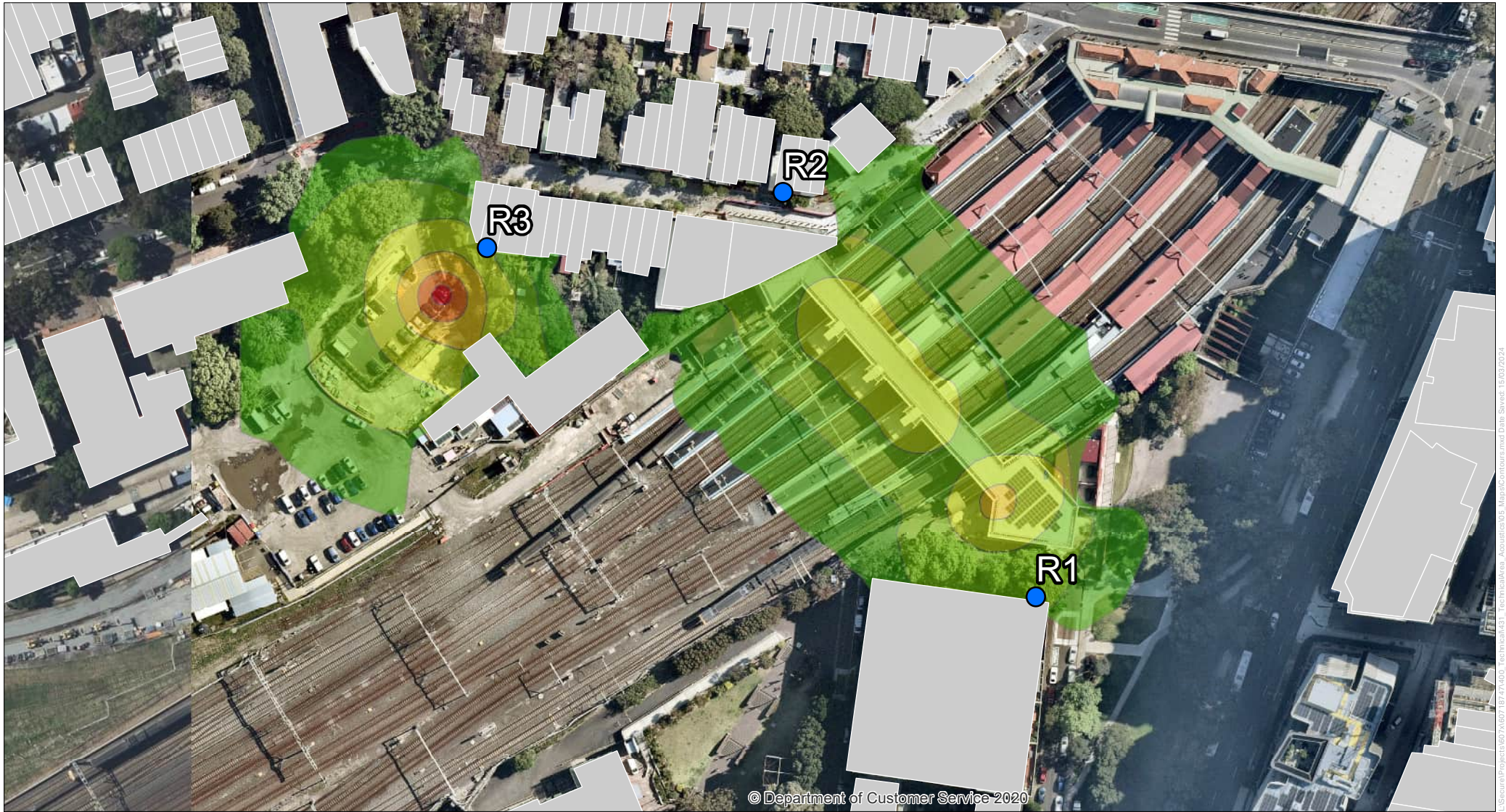
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Redfern Station Upgrade - Noise Contours - L_{Amax}

● Assessment Receivers

$L_{Amax}, dB(A)$



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