Construction Noise Impact Assessment

Waterloo to Surry Hills Cable Project

VMS AUSTRALIA

Report Number 22017.1

Ausgrid Pty Ltd

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Quality Management

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22017.1	R1R0	4 August 2022	Sam Demasi	Yang Lui	Mark Blake
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VMS Australia Pty Ltd does not accept any liability or responsibility to any party with respect to the information and opinions contained in this report.

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1 Introduction

1.1 Background

The 132kV underground cables between Ausgrid's substations in Allen Street, Waterloo and Anne Street, Surry Hills are approximately 45 years old and nearing the end of their serviceable life.

Ausgrid is planning to install new underground cables. The project is known as the Waterloo to Surry Hills Cable Project and the extent of the works are shown in **Figure 1**.

The cables will be installed along the streets and will involve the digging of trenches to lay conduits, backfilling and temporary resurfacing, cable feeding and then final restoration of impacted areas.

1.2 Objective of this Report

Ausgrid is the determining authority for these works and will be preparing a review of environmental factors (REF) to assess the potential for environmental impacts associated with the project.

VMS Australia Pty Ltd (VMS) has been engaged by Ausgrid to prepare a construction noise impact statement CNIS for the Waterloo to Surry Hills Cable Project. We have been advised by Ausgrid that whilst still in draft, geotechnical site testing has thus far not encountered rock or concrete and as such the need for vibration intensive works are not necessary.

In preparing this report, reference has been made to the following main documents:

- NSW Environment Protection Authority (EPA) guideline documents:
    - Interim Construction Noise Guideline (ICNG).
    - Draft Construction Noise Guideline (DCNG).
    - Noise Policy for Industry (NPfI).
- Environmental Handbook for Construction and Maintenance (NS174C), prepared by Ausgrid.
- Waterloo South - Noise and Vibration Assessment (610.17084-R10, Version No: V2.0, dated 24 March 2020), prepared by SLR Consulting Australia Pty Ltd (SLR).

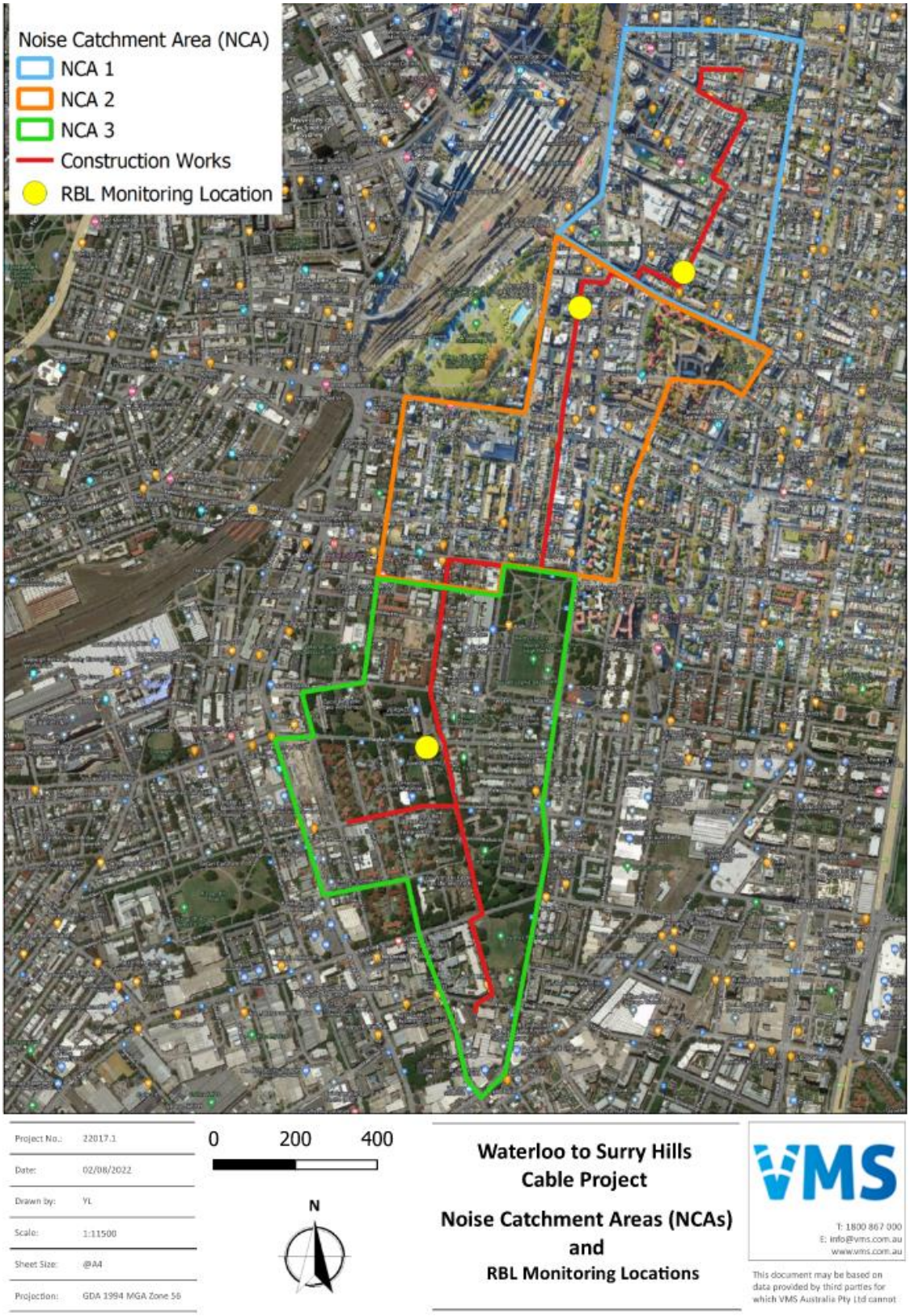
In considering the above, the main objectives of this report are to:

- Identify Noise Catchment Areas (NCAs) and potential sensitive receivers.
- Establish appropriate construction Noise Management Levels (NMLs) derived from Rating Background Levels (RBLs).
- Ensure all mitigation measures, where determined to be reasonable and feasible measures are implemented so that noise impacts are minimised and appropriately managed.

1.3 Acoustic Terminology

This report uses specialist acoustic terminology. An explanation of common terms is provided in **Appendix A**.

Figure 1 Extent of Works, NCAs and RBL Monitoring Locations



Source: Extent of Works provided by Ausgrid. NCAs and RBL Monitoring Locations by VMS.

2 General Identification of Sensitive Receivers

As can be seen from **Figure 1**, the project extends from the suburb of Waterloo to the south, Redfern, Strawberry Hills and then Surry Hills. Following a review of the extent of the project and in discussion with Ausgrid, the project has been divided into three NCAs.

Using Street view imagery and site inspections during logger installations, the typically most common sensitive receiver type has been identified within each of the three NCAs. A more detailed land use survey may form part of the REF, however regarding noise impacts, residential receivers are typically the most sensitive receiver types expected along this route as shown below:

- NCA 1 mostly consists of residential and in particular 2 storey terraces and some multilevel residential apartment buildings.
- NCA 2 mostly consists of residential and in particular 2 to 3 storey terraces and some multilevel residential apartment buildings. There are also many commercial premises within this NCA, usually ground level of a 3 storey or more building.
- NCA 3 mostly consists of residential and in particular 2 to 3 storey terraces and multilevel residential apartment buildings. There are also commercial premises within this NCA, usually ground level of a multilevel residential building. Active recreational areas have also been identified.

Depending on the final location of the trench, the closest works to a residential receiver would be as close as 5m, however the majority would be 10 to 15m from works. In many situations, there would be receivers looking down onto the works.

3 Existing Acoustic Environment

Consistent with EPA, long-term background noise monitoring data is required so that RBLs can be determined for residential receivers, and construction NMLs derived.

A single logger location within each NCA has been selected in order to provide an RBL that can typically be used to describe the general background noise in each area.

In light of the construction works in the Waterloo area (NCA 3) at the time, noise logging was not considered appropriate given the influence on the RBL. As such, within NCA 3, data collected by SLR for Waterloo Estate was reviewed and considered appropriate. The SLR report was sourced by VMS following a literature review.

Table 1 provides a summary of the monitoring locations.

Table 1 Noise Logger Monitoring Locations

Monitoring Location	Monitoring Period	Representative NCA	Equipment Used[1]
47 Waterloo St, Surry Hills front terrace	5 to 18 April 2022[2]	NCA 1	BSWA 308
42 Buckingham St, Surry Hills front terrace	5 to 18 April 2022[2]	NCA 2	BSWA 308
200 Pitt St, Waterloo cnr of Raglan & Pitt Sts	8 to 15 June 2016[3]	NCA 3	Bruel & Kjaer 2250L

Note 1: Class 1 equipment used.

Note 2: Monitoring conducted by VMS.

Note 3: Monitoring conducted by SLR.

With reference to the NPfI, **Table 2** provides the derived RBLs with daily noise plots shown in **Appendix B** to **Appendix D**.

Table 2 Summary of RBLs

Monitoring Location	Day[1]	Evening[1]	Night[1]	Night Shoulder[1]
47 Waterloo St, Surry Hills front terrace	51	51	47	48[2]
42 Buckingham St, Surry Hills front terrace	47	46	43	44[2]
200 Pitt St, Waterloo cnr of Raglan & Pitt Sts	47	43	37	41[3]

Note 1: As per NPfI, Day is defined as 7am to 6pm, Monday to Saturday and begins 8am on Sundays and Public Holidays. Evening is defined as 6pm to 10pm. Night is 10pm to 7am Monday to Saturday and ends 8am on Sundays and Public Holidays. The night shoulder is typically considered the period when night begins (10pm) to midnight. EPA recognises that in some areas this period can still have elevated background levels and the use of the night RBL for this period is unnecessarily conservative.

Note 2: Derived as per NPfI.

Note 3: Estimated from Daily Plots contained in SLR report.

All time periods are shown however the aim is to conduct the vast majority of the works during standard construction hours. Depending on third party approvals such as a Road Occupancy Licence (ROL), works at up to six road crossings may require some works during the night period.

4 Construction Airborne Noise Management Levels

Criteria for noise from construction (including demolition) works are prescribed by the NSW Environment Protection Authority's (EPA) *Interim Construction Noise Guideline (ICNG)* with further guidance sought from the *Draft Construction Noise Guideline (DCNG)*. Both Guidelines present a methodology for determining numerical criteria or Noise Management Levels (NMLs) for the impacts of construction noise on residences and other land uses according to the scale of the project being considered.

Construction noise is typically considered to be continuous or semi-continuous in nature and will sometime include short-term, high impact noise events. With regards to noise from trenching, a simple scenario of a truck idling would be considered continuous, whereas a scenario where an excavator is filling a truck would be considered semi-continuous. These scenarios are assessed over a 15 minute period as per the ICNG and DCNG. Both of these scenarios would include short-term high impact events (up to a few seconds at a time) including a truck pneumatic air release or a bucket striking the side of a truck.

4.1 Continuous and Semi-Continuous Noise

Describe scenarios etc and For this project, construction noise impacts are possible to the residential receivers, nearby commercial receivers, and the adjoining passive recreational areas. Considering both EPA Guidelines, **Table 3** provides a summary of NMLs for residential receivers, whereas **Table 4** provides a summary for other sensitive receivers.

Table 3 Noise Management Levels for Construction Works - Residential Receivers

Period of Noise Exposure	$L_{Aeq(15minute)}$ Construction NML
Approved Hours[1]	Noise affected[2] RBL + 10 dBA
	Highly Noise affected[3] 75 dBA
Outside Approved Hours	Noise affected[2] RBL + 5 dBA
	Highly Noise affected[3,4] 65 dBA

Note 1: Standard Construction hours are typically Monday to Friday 7am to 6pm, Monday to Friday and 8am to 1pm on Saturdays. No work is permitted on Sunday or Public Holidays.

Note 2: The noise affected level represents the point above which there may be some community reaction to noise.

Note 3: The highly noise affected level represents the point above which there may be strong community reaction to noise.

Note 4: NML from DCNG anticipated to be released shortly as a Final. This approach is being used and incorporated for the construction of current Metro Rail projects.

Based on the above, project specific construction NMLs are provided in **Table 5** for residential receivers.

Table 4 Noise Management Levels for Construction Works - Other Receivers

Receiver Type	Period of Noise Exposure	$L_{Aeq(15minute)}$ Construction NML
Commercial, office, retail outlets	When in Operation	70 dBA
Active Recreational Areas	When in Operation	65 dBA

The EPA NMLs are applied externally at a location just inside the boundary of a receiver considered to be sensitive to noise.

4.2 Sleep Disturbance

There is a risk that short-term, high impact events from construction activities could disturb the sleep of nearby residences. Typically, the EPA considers that sleep disturbance should be assessed if more than two consecutive nights of work occur in an area and impact the same receivers. In the opinion of VMS, given that the highly noise affected level corresponds to the typical awakening level of L_{AFmax} ,an upper maximum external noise level above 70dBA should be avoided where possible. This is a nominal 5dB above the highly noise affected level of $L_{Aeq\ (15min)}$ 65dBA and is on the basis that the typical average maximum noise level from construction activities lies between 3 and 8dB above the $L_{Aeq\ (15min)}$ sound power level of construction plant.

An assessment has not been conducted given that the works are not expected to occur in front of any receiver for more than two consecutive nights.

Table 5 Project Specific Construction NMLs - Residential

Receiver Type	$L_{Aeq(15minute)}$ Construction Noise Management Level	
	Noise Affected Level	Highly Noise Affected Level
Standard Construction Hours (RBL day + 10dB)		
Residential (NCA 1)	61	75
Residential (NCA 2)	57	75
Residential (NCA 3)	57	75
Outside Standard Construction Hours - Day (RBL day + 5dB)		
Residential (NCA 1)	56	65
Residential (NCA 2)	52	65
Residential (NCA 3)	52	65
Outside Standard Construction Hours - Evening (RBL evening + 5dB)		
Residential (NCA 1)	56	65
Residential (NCA 2)	51	65
Residential (NCA 3)	48	65
Outside Standard Construction Hours - Night Shoulder (RBL night shoulder + 5dB)		
Residential (NCA 1)	53	65
Residential (NCA 2)	49	65
Residential (NCA 3)	46	65
Outside Standard Construction Hours - Night (RBL night + 5dB)		
Residential (NCA 1)	52	65
Residential (NCA 2)	48	65
Residential (NCA 3)	42	65

5 Description of Construction Activities

The works have been categorised by Ausgrid into the following activities:

- Saw Cutting.
- Trenching and Material Removing.
- Conduit Laying.
- Backfilling/Compacting/Road Restoration.
- Under bore Drilling (if required and only to cross Cleveland Street).

As previously mentioned in this report, the majority of the works will be focussed during the standard construction hours. The following locations may require works outside of these standard hours:

- McEvoy Street,
- Redfern Street,
- Cleveland Street,
- Elizabeth Street,
- Foveaux Street, and
- Albion Street.

It is critical to note that works at the above locations will involve crossing Transport for NSW (TfNSW) roads and as such will be subject to third-party approvals such as Road Occupancy Licences (ROL).

When corresponding with TfNSW, Ausgrid will attempt, where possible and feasible to schedule noisy works, such as saw cutting during the weekend days, with the remainder of the works conducted at night.

Considering the construction activities presented, the following worst-case construction scenarios have been identified considering noise impacts as per **Table 6**.

Table 6 Typical Worst-Case Scenarios

Scenario	Description of Activity and Main Plant Working Together
Saw Cutting	Saw cutting using a demolition saw or similar.
Trenching	14 tonne excavator using a bucket to load material onto a truck. Truck would start, move slowly and then stop, engine off. Vac Truck will be used for at least 15 minutes as required.
Compaction	The use of an 8 tonne vibratory roller OR two vibratory plate compactors would be used after backfilling.
Underbore Drilling	A small to medium drill rig would be used together with a small filtration pump and Vac Truck used for at least 15 minutes as required.

Note: Up to 2 daymakers allowed for in each scenario in case works occur during the night periods.

6 Worst Case Noise Levels and Highly Impacted Noise Contours

6.1 Plant Sound Power Data

Following a review of the plant proposed by Ausgrid, **Table 7** confirms the typical L_{Aeq} sound power level assuming relatively continuous operation over a 15 minute period. All noise data collected must be guided by relevant Australian or International Standards.

Table 7 Sound Power Levels

Plant Item and Activity	Sound Power Level (L_{Aeq})
14 tonne excavator using a bucket to load material onto a truck	102[1]
Daymaker (diesel)	90[1]
Truck moving slowly (<10km/hr)	102[2]
Truck idling	98[2]
Concrete saw	123[1,3]
Vac Truck (up to medium)	109[4]
8 tonne vibratory roller	109[4]
Plate Compactors	106[1]
Drill Rig (up to medium)	105[1]

Note 1: Data from VMS database of measurements.

Note 2: Data from *Inter noise 2009 – Sound power level of trucks at low speeds*.

Note 3: Consistent with EPA, a 5dB penalty has been allowed for given the nature of the noise.

Note 4: Data from TfNSW.

6.2 Modelling Assumptions

The following modelling assumptions have been made:

- Nominally 1.5m wide trench with nominally 10 to 20m of trenching to occur each shift (nominally 8hrs).
- For each Scenario all plant is located at the centre of the trench and at a height of 1.5m except saw cutting activity with a height of 0.5m.
- In the event that noise blankets (or similar) are to be used, it has been assumed that the work zone can be contained in an approximate width of 5m (2.5m either side of the centre of the trench) and that noise blankets are installed on temporary mesh fencing to a height of 2.1m.
- For each Scenario all plant is operating simultaneously with the exception that the truck is assumed to be operating for less than 1 minute in any 15 minute period.
- All buildings are 6m in height (for shielding) and residential receivers (if present) are at a height of 1.5 and 4.5m. This is based on the most common terrace arrangement along this route.
- Hard ground and first reflections have been assumed.

6.3 Worst-Case Predicted Noise Levels

It is critical to note that the works immediately in front of a receiver will be worst-case but only for a short period of time and will be dependent on the progression rate and frontage of the receiver.

To illustrate a worst-case range of noise levels, a detailed prediction has been modelled for horizontal distances between the works and receiver of 5m, 10m and 15m. Receiver heights of 1.5m and 4.5m are considered to represent the ground and first floor receivers, and both with and without the use of a 2.1m high noise barrier is considered and summarised in **Table 8**.

Table 8 Range of Predicted Noise Levels

Scenario	Distance (source to receiver) - m		
	5m	10m	15m
No Barrier/Barrier (2.1m)			
Saw Cutting	101/89	95/84	92/81
Trenching or Compaction	87/79	81/74	78/71

It can be seen that the predicted noise levels within 15m of receivers, even if a barrier is provided, are approaching levels considered by residential receivers as highly noise affected.

The modelling also shown that the noise behind the first row of buildings reduces by at least 15dB.

6.4 Highly Impacted Noise Contours

Appendix E is better used to provide the community with a typical (not worst-case) extent of the highly noise affected "boundary" any point in time whilst works are occurring along the route. These contours are at a height of 4.5m to represent a first storey.

7 Assessment

The noise modelling confirms the following initial assessment:

- Saw cutting cannot meet the highly noise affected levels of 75dBA unless a 2.1m high barrier is used and the distance between the source and receiver is at least 15m.
- Trenching or compaction works cannot meet the highly noise affected levels of 75dBA and 65dBA for the majority of the first row of buildings along the route.
- All work activities can meet highly noise affected out of hours level of 65dBA when assessed at the second row of buildings, provided that the first row of buildings is at least two storey in height.

As can be seen (and expected), feasible and reasonable measures must be considered in order to manage the noise impacts of these works.

8 Discussion of Feasible and Reasonable Measures

In the first instance all standard mitigation measures that will reduce the noise shall be considered following an assessment of feasibility and reasonableness. Once this process has been completed and the noise levels impacts remain high, then additional measures are to be considered with the aim of further managing the residual impacts.

8.1 Standard Mitigation Measures

Feasible and reasonable mitigation measures that are recommended to be considered for these works are provided in **Table 9** to **Table 12**. The mitigation measures are typically divided into four categories; Administration; Source Mitigation; Path Mitigation and Receiver Mitigation.

Table 9 Standard Mitigation Measures - Administration

Item	Mitigation Measure	Details	Feasibility	Reasonableness	Project Implementation
5.1	Complaints Management	Ensure the community can register complaints and enquires.	Yes.	Yes.	To be considered and discussed with Ausgrid and include 24hr community information line, dedicated email and website as well as post as a minimum
5.2	Inductions	All contractors and sub-contractors shall be site inducted.	Yes.	Yes.	To be considered and discussed with Ausgrid. Induction must include aspects of noise such as location of sensitive receivers and mitigation
5.3	Construction Outside Standard Hours and Respite	Consider limiting noisy works to 10pm or midnight or providing respite days/periods.	Yes.	Yes.	To be considered for concrete cutting, potentially weekend days subject to ROL.
5.4	Scheduling of Works during Different Periods	Carry out any noisy works during the day or other least sensitive time periods.	Yes.	Yes.	To be considered for concrete cutting, potentially weekend days subject to ROL.
5.5	Community Engagement	Notify and engage with the community.	Yes.	Yes.	Will form part of the REF and Community Engagement Strategy developed in conjunction with the contractor.

5.7	CEMP	Mitigation to be included in Contractor's CEMP together with scope for consideration of additional or alternate mitigation.	Yes.	Yes.	To be considered and discussed with Ausgrid.

Table 10 Standard Mitigation Measures - Source

Item	Mitigation Measure	Details	Feasibility	Reasonableness	Project Implementation
6.1	Equipment Selection	Select quiet, modern and well maintained plant.	Yes.	Yes. Potential 3 to 8dB benefit.	To be considered and discussed with contractor.
6.2	Process	Well trained contractor to ensure spoil is place and not dropped into truck and shaking the bucket. Truck to be switched off.	Yes.	Yes. Potential 3 to 8dB benefit. Will reduce short term high level events.	To be considered as part of site induction and work method statement.
6.3	Silencers	Air parking brake must be silenced. Engine mufflers where necessary.	Yes.	Yes. Potential 2 to 5dB benefit. Will reduce short term high level events.	To be considered and discussed with contractor.
6.4	Reversing alarms to be non-tonal	Ensure all plant is fitted with quiet, non-tonal alarms.	Yes.	Yes. Will reduce short term high level events.	To be considered and discussed with contractor.
6.5	Noise Audits	Attended noise measurements.	Yes.	Yes. Will be able to verify near field noise levels.	To be considered and discussed with contractor.

Table 11 Standard Mitigation Measures - Path

Item	Mitigation Measure	Details	Feasibility	Reasonableness	Project Implementation
7.1	Shielding	Install Temporary Solid Barrier around works.	Yes, site to be configured to ensure enough space, especially at night.	Yes (but limited situations). Will provide reduction to ground and some to first floor but marginal to no reduction to those above 2 storey.	To be considered and discussed with contractor for night works.

Table 12 Standard Mitigation Measures - Receiver

Item	Mitigation Measure	Details	Feasibility	Reasonableness	Project Implementation
8.1	Closing Windows and Doors	Notification to close windows and doors during noisy works and in particular at night.	Yes	Yes, could provide an additional reduction of 10dB from outdoors to indoors	To be considered and discussed with Ausgrid.
8.2	Upgrading Windows and Doors	Discuss the option with each residential receiver to upgrade existing windows and doors	No. Not practical given the time and high number of receivers	No. Given the cost to supply and the cost to implement. Project delays	No

Note: Should only be considered after mitigation at the source and path have been exhausted or subject to consultation with affected receiver.

8.2 Additional Management Measures

Other strategies to further mange the impacts may include:

- Additional discussions directly with impacted receivers.
- Continued informing of the community of works and hours.
- Vehicle paths to be one way. This will allow reversing alarms to be disabled provided that this approach is deemed safe and accounted for in the Contractor's safe work method statement.
- Rebating road plates (during standard work hours or evening periods) to ensure flush installation. This will minimise high noise level as a result of public vehicle pass-bys over road plates.

9 Conclusions

Ausgrid is planning to undertake works associated with the replacement of aging cabling for the Waterloo to Surry Hills Cable Project and have engaged VMS Australia Pty Ltd to prepare a construction noise impact statement to form part of the review of environmental factors assessment.

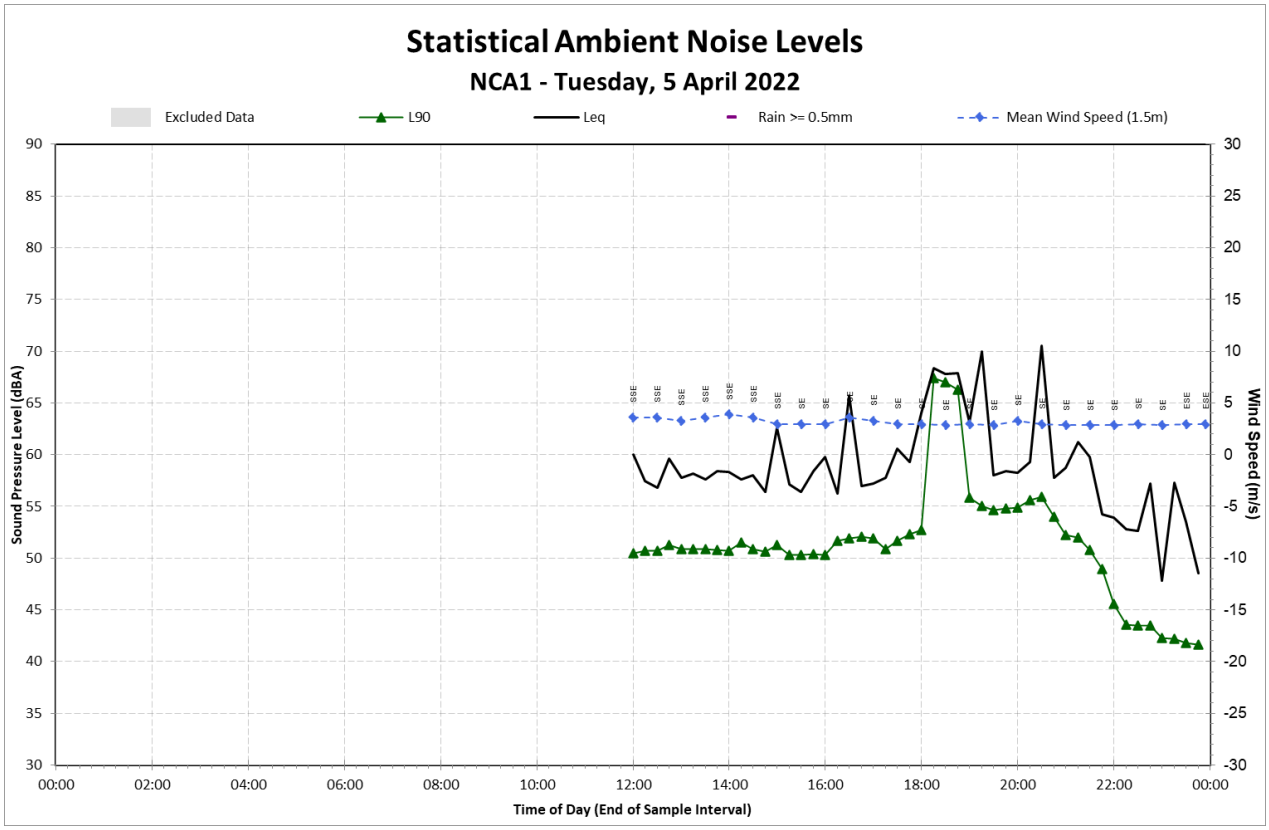
The assessment concludes the following:

- Vibration impacts are, if occurring, are likely to be acceptable given there are no vibration intensive works proposed.
- Sleep disturbance is unlikely to be a major concern and is likely to be addressed with the mitigation proposed if the works are deemed to be highly noise intrusive. Furthermore, it is not expected that such works would continue more than two consecutive nights.
- Saw cutting cannot meet the highly noise affected levels of 75dBA unless a 2.1m high barrier is used and the distance between the source and receiver is at least 15m.
- Trenching or compaction works cannot meet the highly noise affected levels of 75dBA and 65dBA for the majority of the first row of buildings along the route.
- All work activities can meet highly noise affected out of hours level of 65dBA when assessed at the second row of buildings, provided that the first row of buildings is at least two storey in height.

All feasible and reasonable measures (refer Section 8) are considered and implemented as required.

Terminology Relating to Noise and Vibration

Sound Pressure	Sound, or sound pressure, is a fluctuation in air pressure over the static ambient pressure.
Sound Power	Sound Power is the rate at which sound energy is emitted, reflected, transmitted, or received, per unit time. Unlike sound pressure, sound power is neither room-dependent nor distance-dependent.
Sound Pressure Level (SPL)	The sound level is the sound pressure relative to a standard reference pressure of 20µPa ($20x10^{-6}$ Pascals) on a decibel scale.
Sound Power Level (SWL)	The Sound Power Level is the sound power relative to a standard reference pressure of 1pW ($20x10^{-12}$ Watts) on a decibel scale. The SWL of a simple point source may be used to calculate the SPL at a given distance (r) using the following formula: $SPL = SWL - 10 \times Log_{10}(4 \times \pi \times r^2)$ Note that the above formula is only valid for sound propagation in the free-field (see below).
Decibel (dB)	A scale for comparing the ratios of two quantities, including sound pressure and sound power. The difference in level between two sounds s1 and s2 is given by 20 log10 (s1 / s2). The decibel can also be used to measure absolute quantities by specifying a reference value that fixes one point on the scale. For sound pressure, the reference value is 20µPa.
A-weighting, dBA	The unit of sound level, weighted according to the A-scale, which takes into account the increased sensitivity of the human ear at some frequencies.
Noise Level Indices	Noise levels usually fluctuate over time, so it is often necessary to consider an average or statistical noise level. This can be done in several ways, so a number of different noise indices have been defined, according to how the averaging or statistics are carried out.
Leq,T	A noise level index called the equivalent continuous noise level over the time period T. This is the level of a notional steady sound that would contain the same amount of sound energy as the actual, possibly fluctuating, sound that was recorded.
Lmax,T	A noise level index defined as the maximum noise level during the period T. Lmax is sometimes used for the assessment of occasional loud noises, which may have little effect on the overall Leq noise level but will still affect the noise environment. Unless described otherwise, it is measured using the 'fast' sound level meter response.
L90,T	A noise level index. The noise level exceeded for 90% of the time over the period T. L90 can be considered to be the "average minimum" noise level and is often used to describe the background noise.
L10,T	A noise level index. The noise level exceeded for 10% of the time over the period T. L10 can be considered to be the "average maximum" noise level. Generally used to describe road traffic noise.
Free-Field	Far from the presence of sound reflecting objects (except the ground), usually taken to mean at least 3.5m
Fast/Slow Time Weighting	Averaging times used in sound level meters.
Octave Band	A range of frequencies whose upper limit is twice the frequency of the lower limit.
DnT,w	The single number quantity that characterises airborne sound insulation between rooms over a range of frequencies.
Rw	Single number quantity that characterises the airborne sound insulating properties of a material or building element over a range of frequencies.
Reverberation	The persistence of sound in a space after a sound source has been stopped.
PPV	The particles of a medium are displaced from their random motion in the presence of a vibration wave. The greatest instantaneous velocity of a particle during this displacement is called the Peak Particle Velocity (PPV) and is typically measured in the units of mm/s.
Hertz, Hz	The unit of Frequency (or Pitch) of a sound or vibration. One hertz equals one cycle per second. 1 kHz = 1000 Hz, 2 kHz = 2000 Hz, etc.
Acceleration	Acceleration is defined as the rate of change of Velocity of a particle over a period of time and is typically measured in the units of m/sec^2.
Vibration Dose, VDV	When assessing intermittent vibration, it is necessary to use the vibration dose value (VDV), a cumulative measurement of the vibration level received over an 8-hour or 16-hour period. The VDV formulae uses the RMS Acceleration raised to the fourth power and is known as the Root-mean-quad method. This technique ensures the VDV is more sensitive to the peaks in the acceleration levels. VDVs are typically measured in the units of $m/s^{1.75}$.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Excluded Data
L90
Leq
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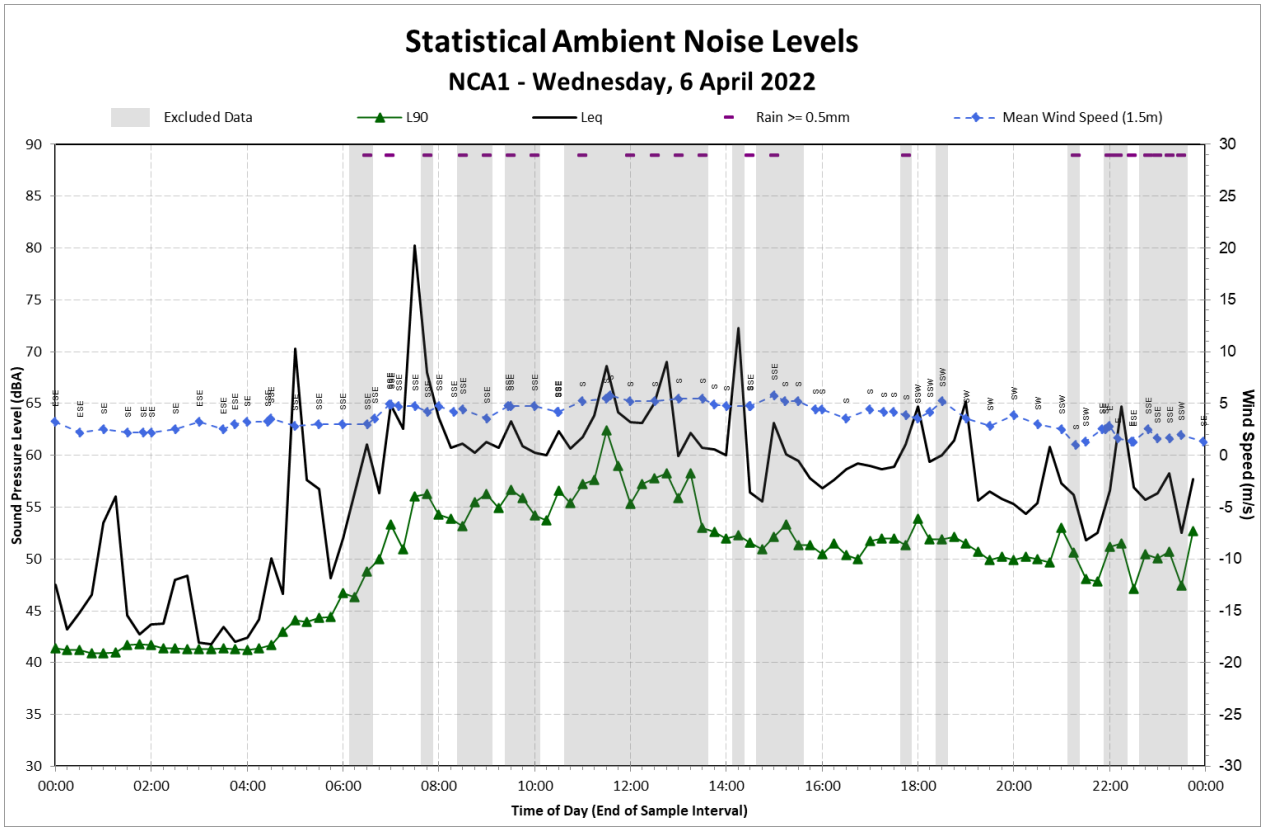
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)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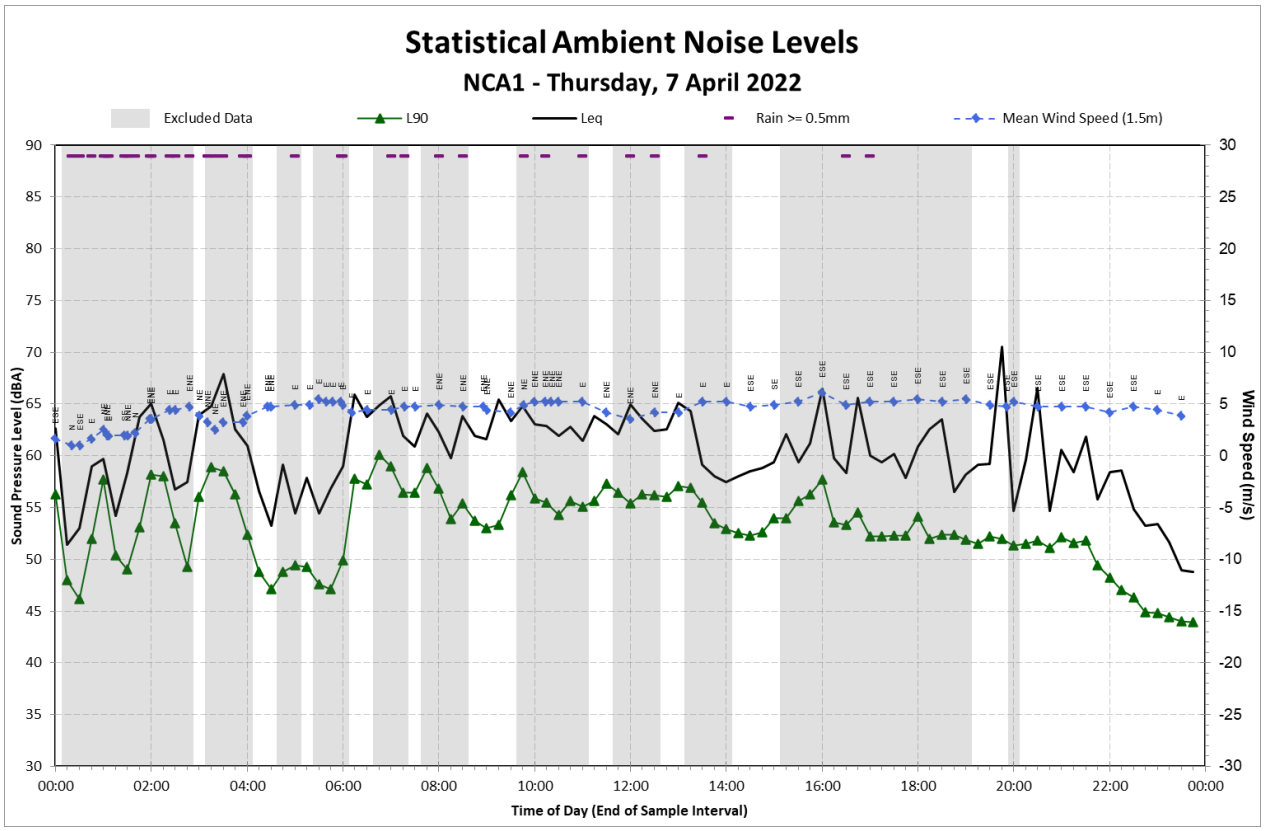
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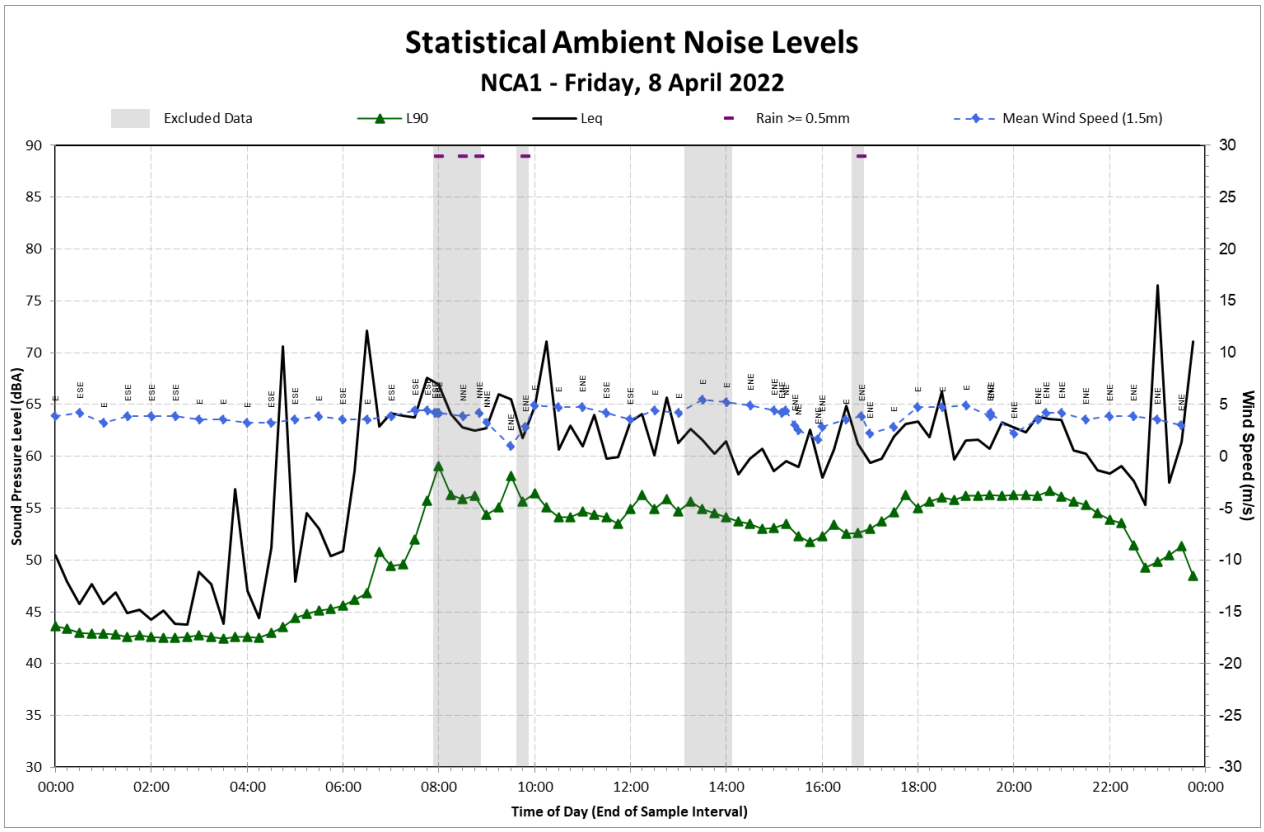
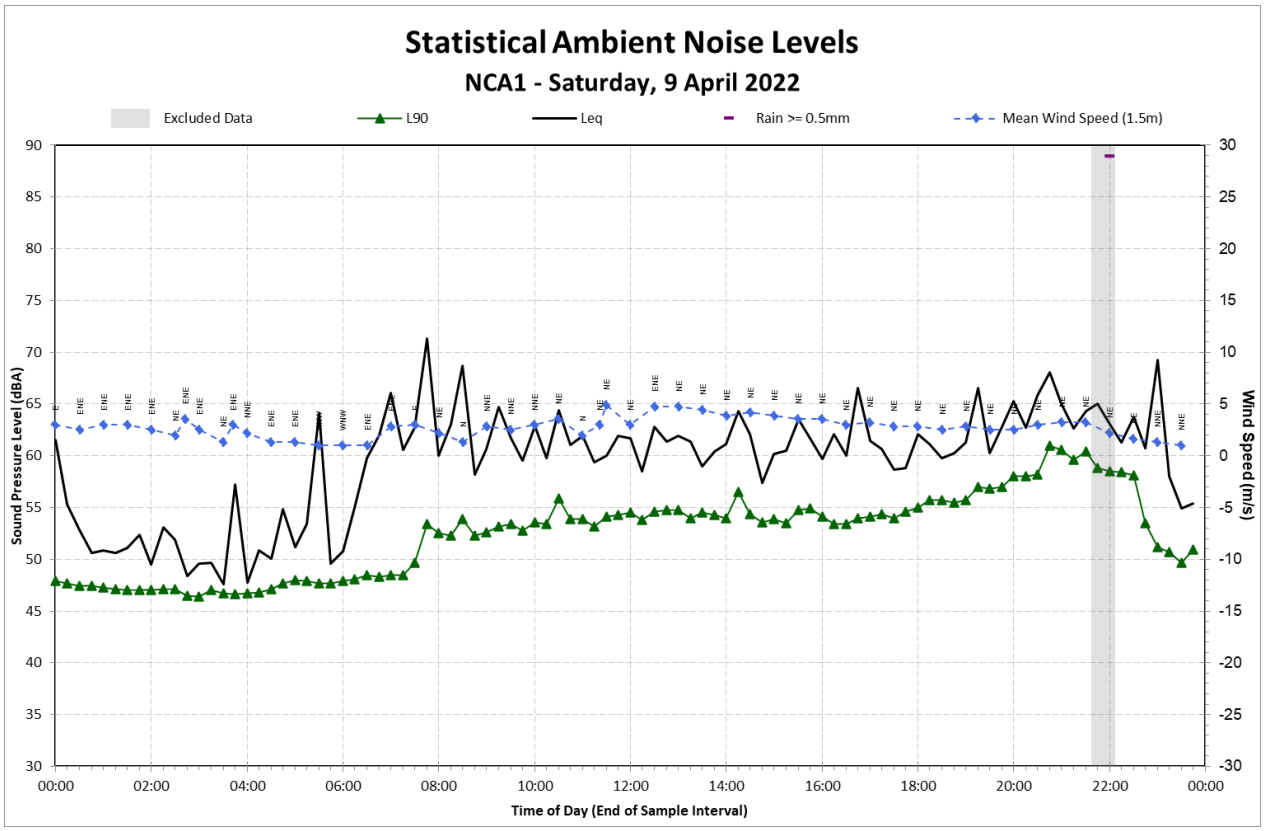
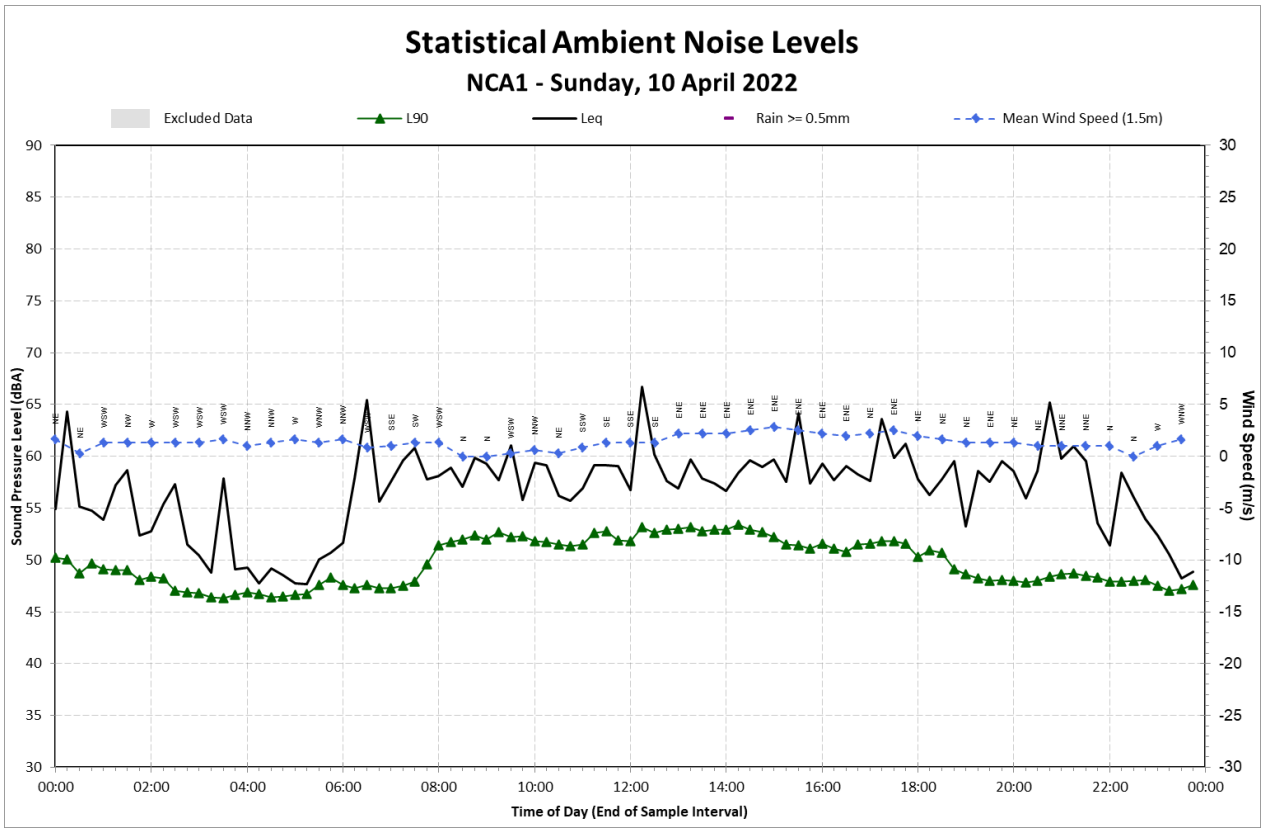
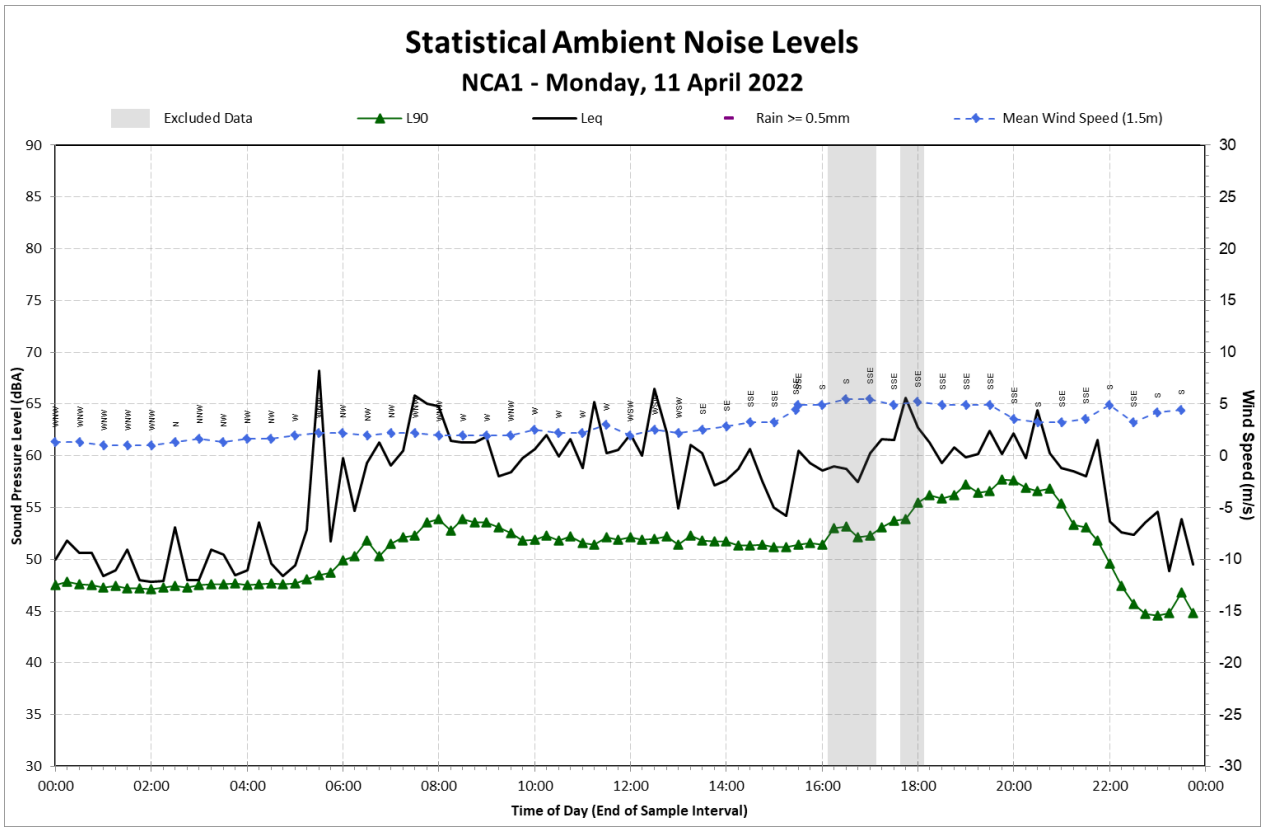
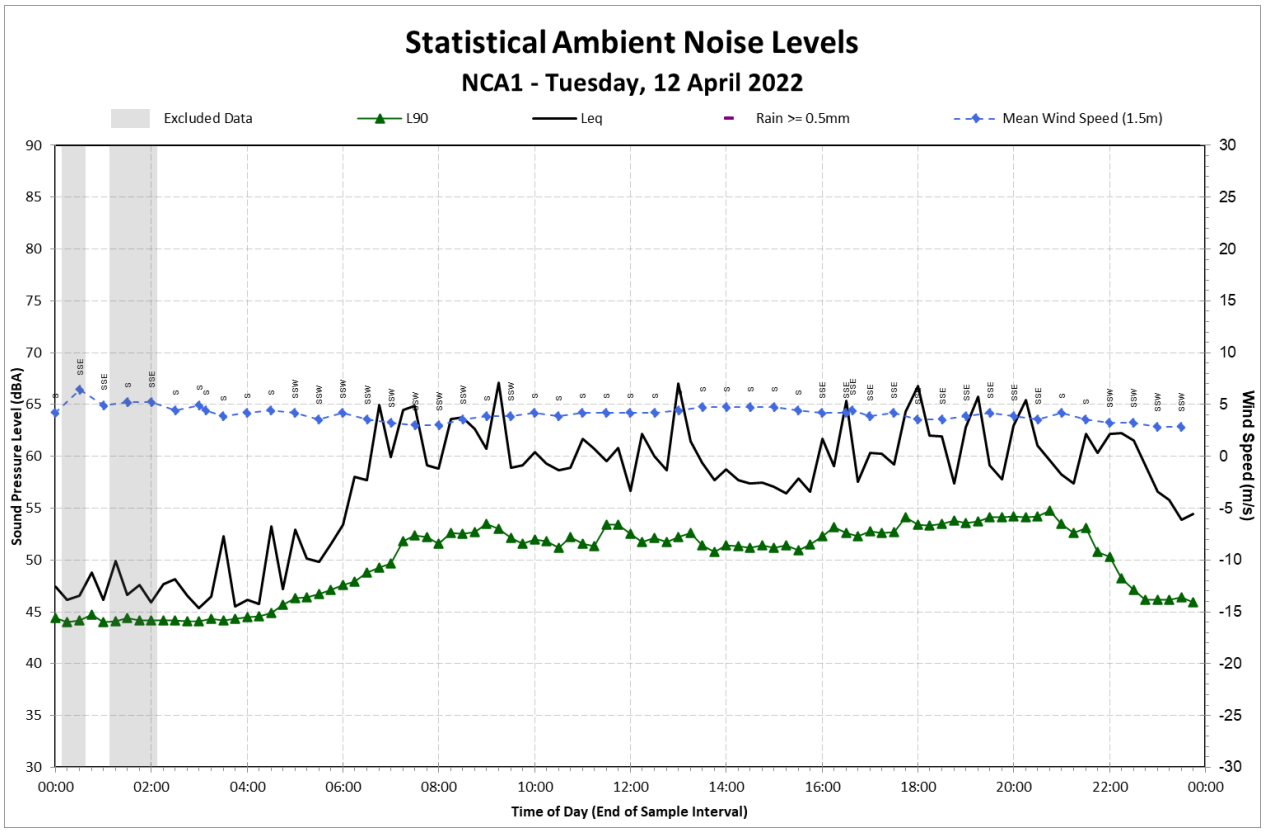
Wind Speed (m/s)
Time of Day (End of Sample Interval)

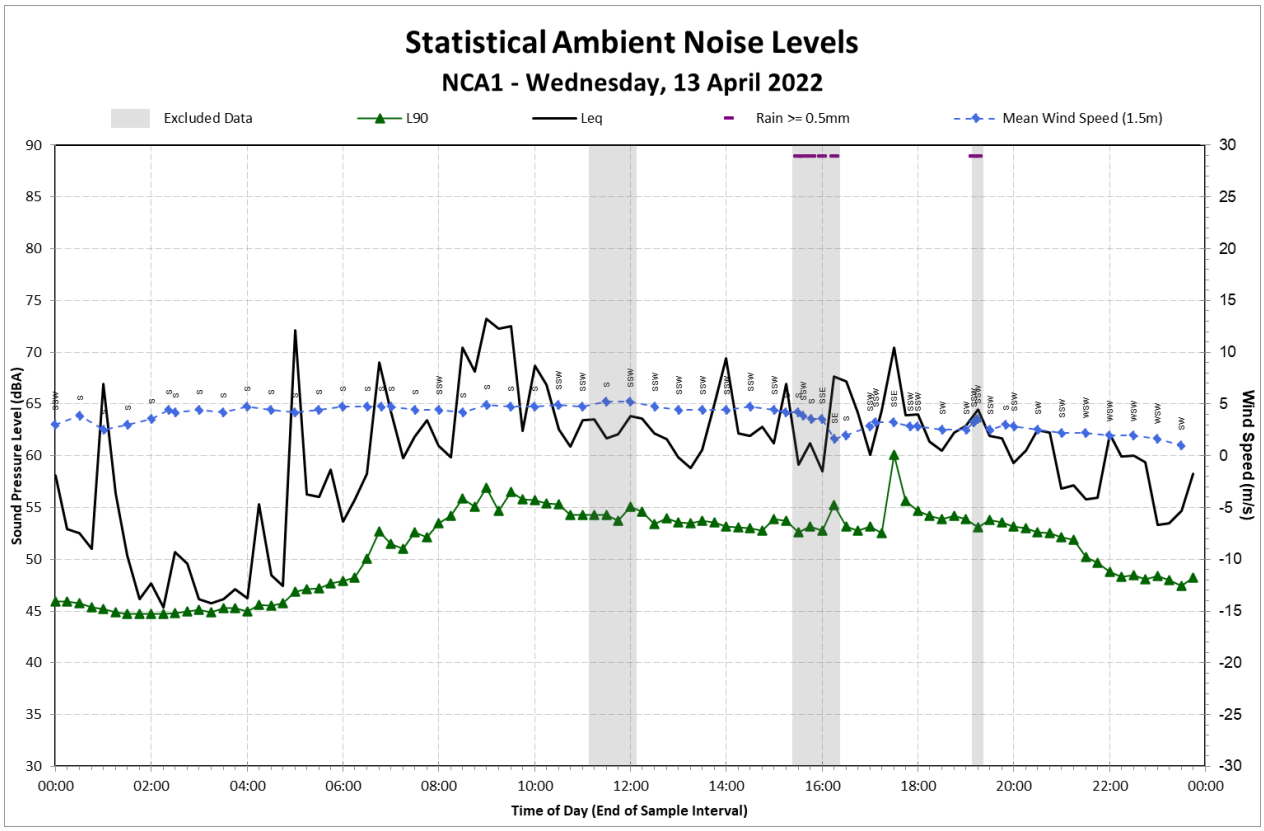

Statistical Ambient Noise Levels
NCA1 - Friday, 8 April 2022
Excluded Data
L90
Leq
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

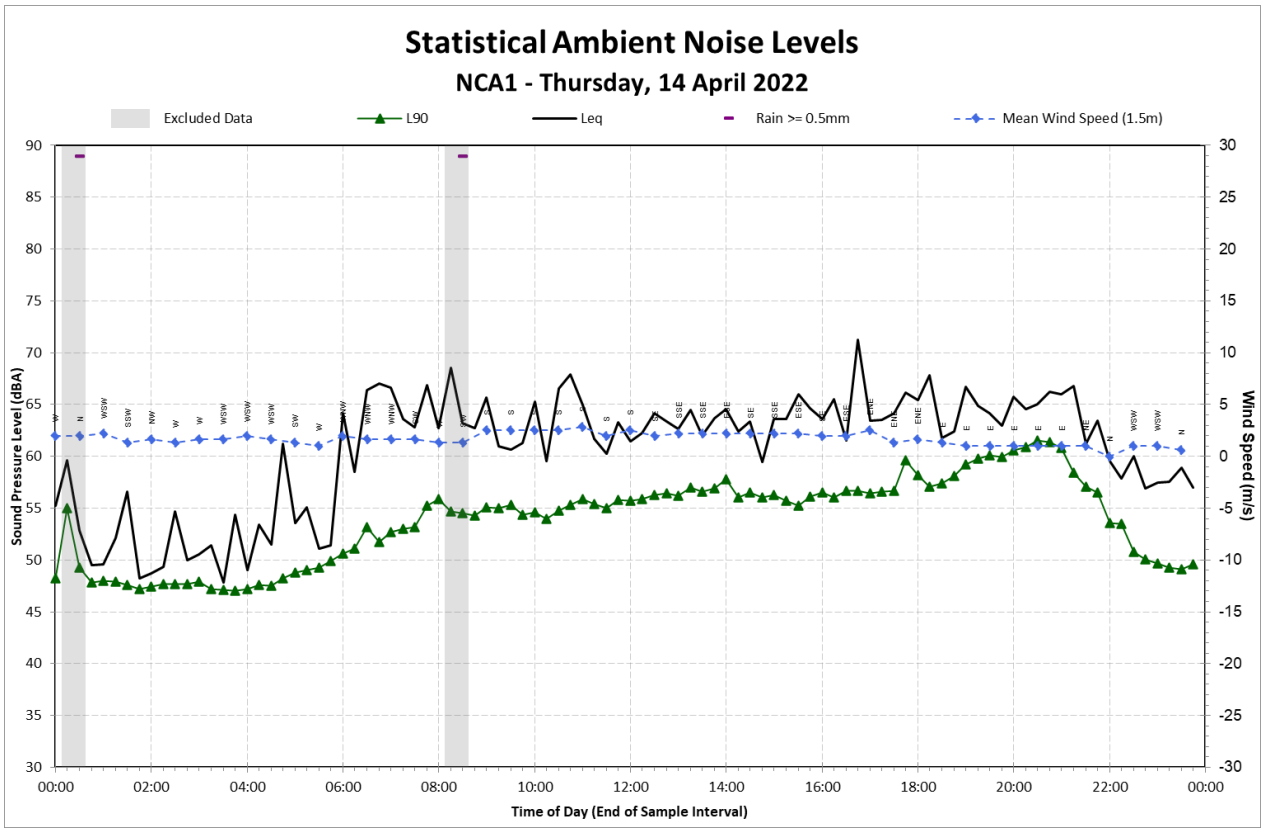

Statistical Ambient Noise Levels
NCA1 - Saturday, 9 April 2022
Excluded Data
L90
Leq
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

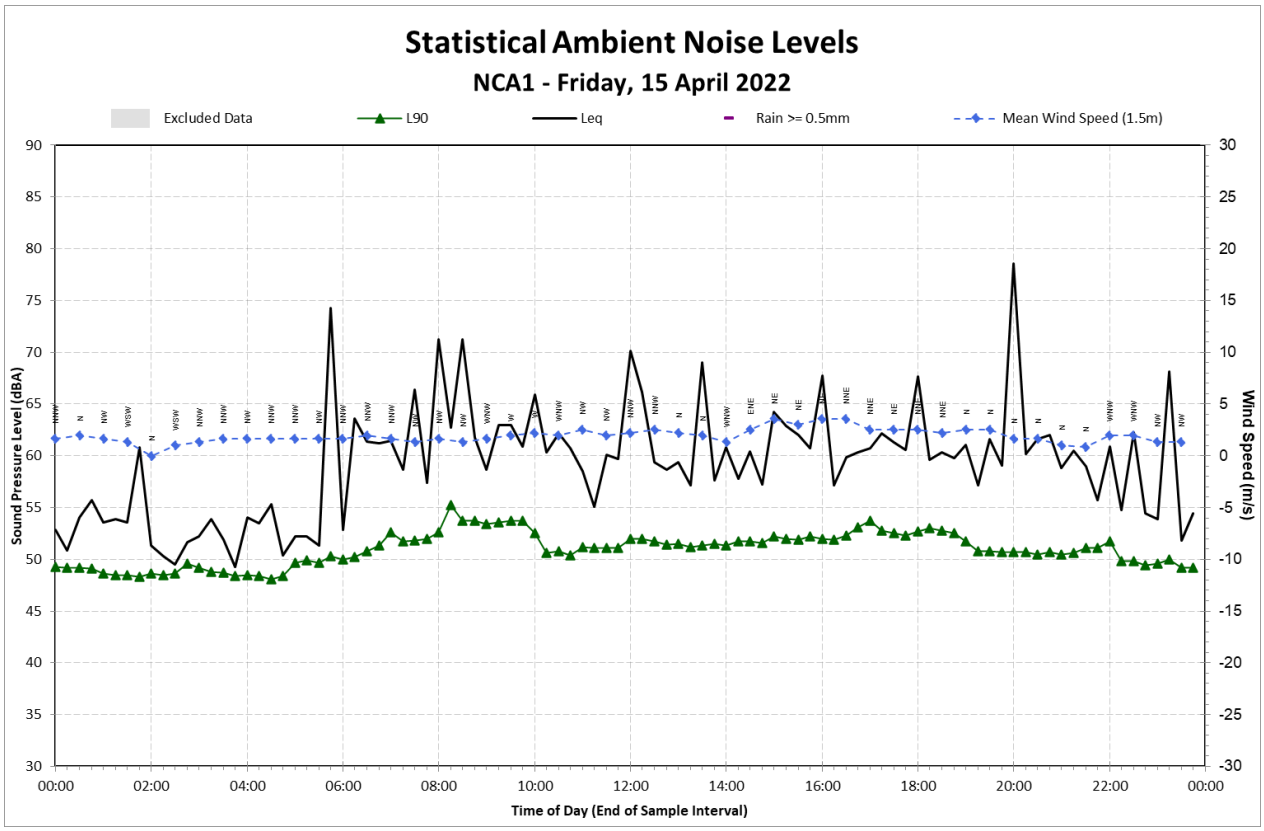

Statistical Ambient Noise Levels
NCA1 - Sunday, 10 April 2022
Excluded Data
L90
Leq
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

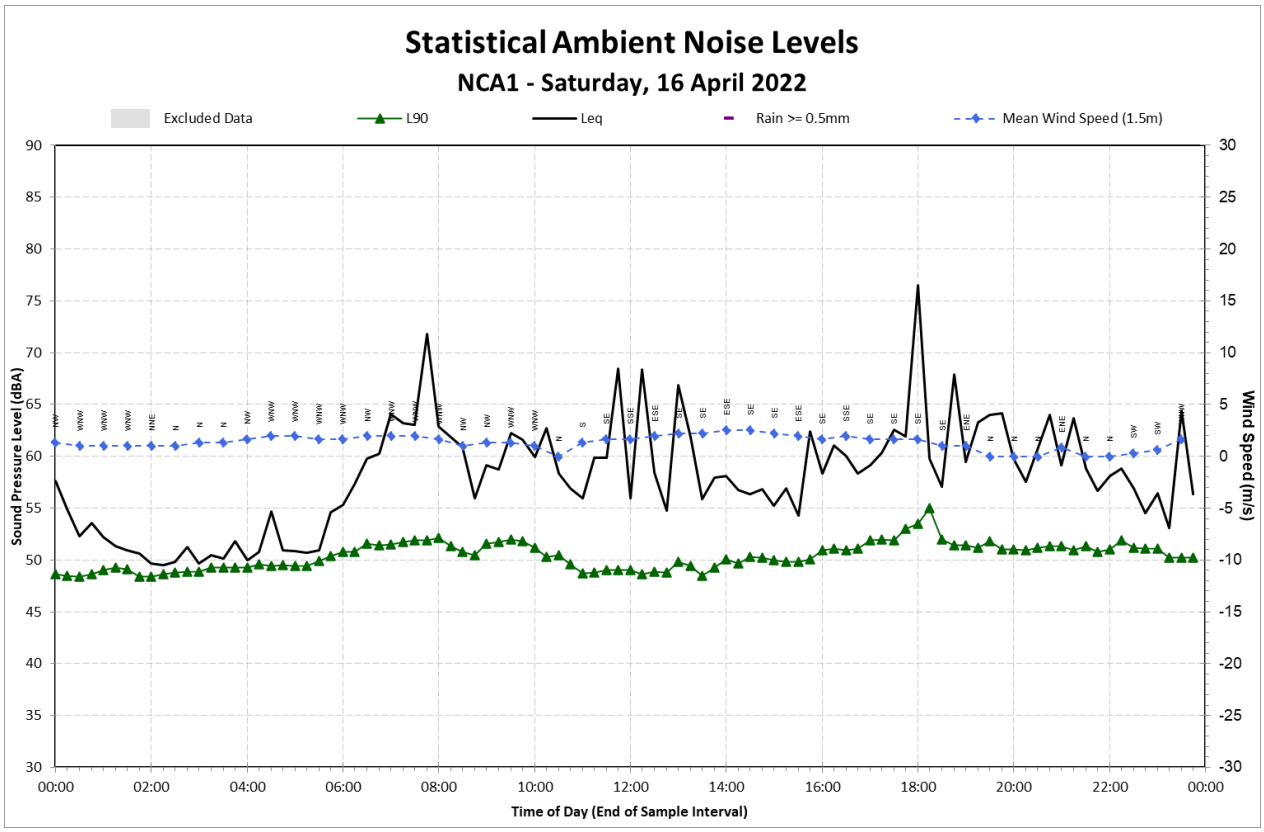

Statistical Ambient Noise Levels
NCA1 - Monday, 11 April 2022
Excluded Data
L90
Leq
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

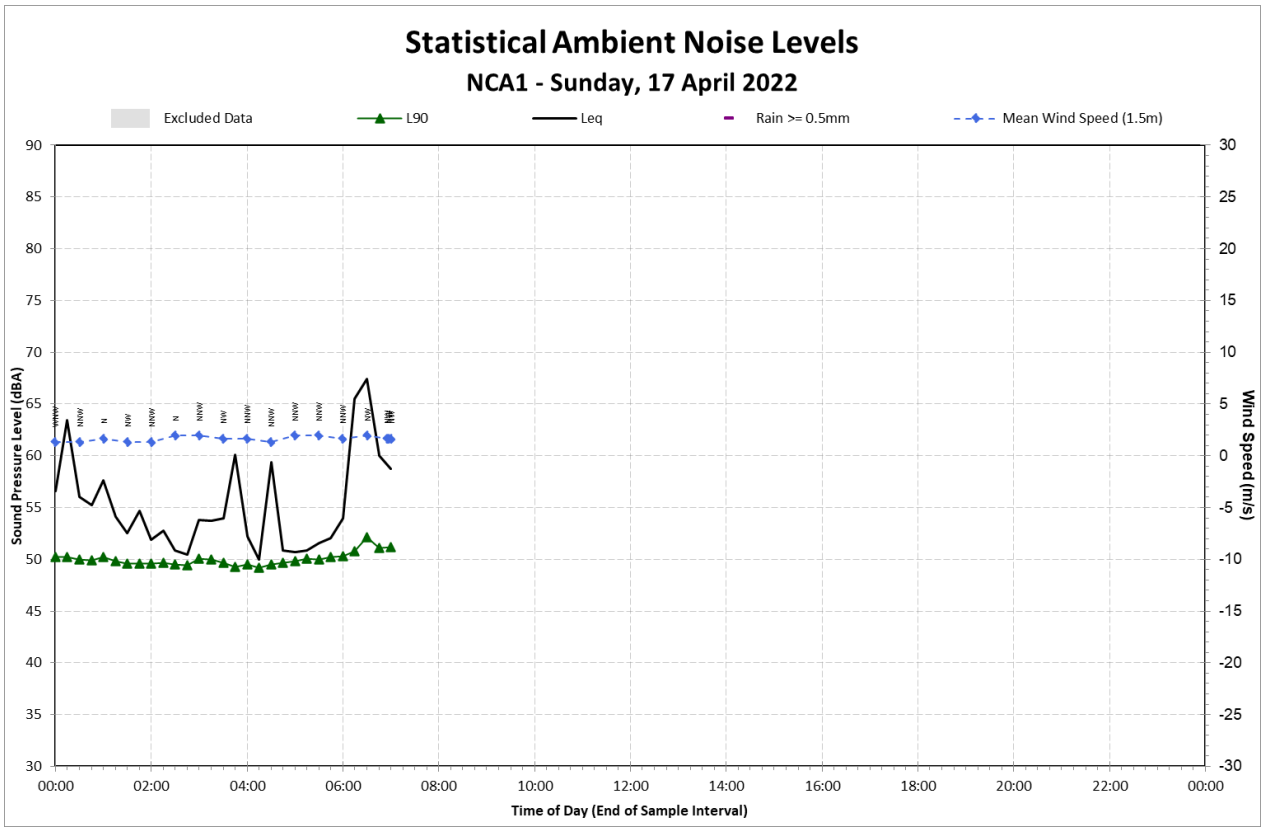

Statistical Ambient Noise Levels
NCA1 - Tuesday, 12 April 2022
Excluded Data
L90
Leq
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

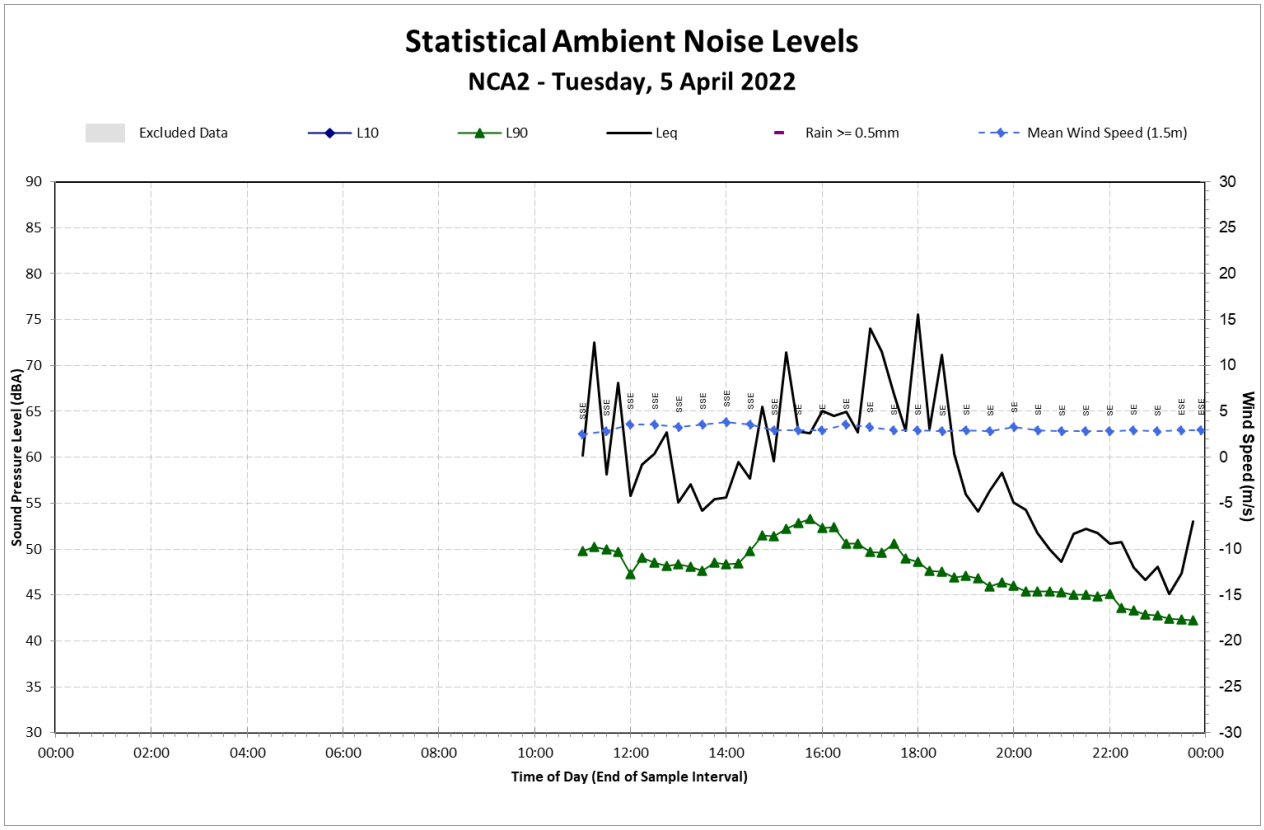

Statistical Ambient Noise Levels
NCA1 - Wednesday, 13 April 2022
Excluded Data
L90
Leq
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

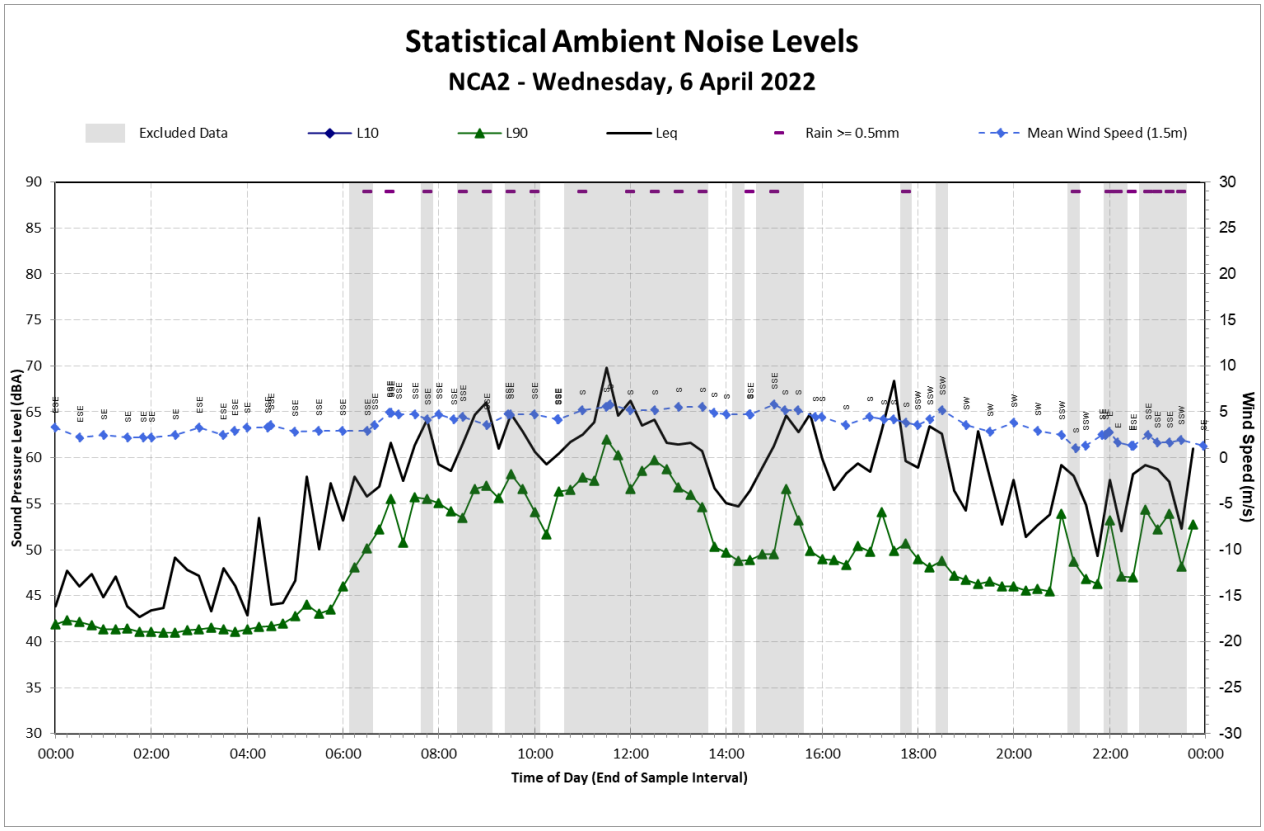

Statistical Ambient Noise Levels
NCA1 - Thursday, 14 April 2022
Excluded Data
L90
Leq
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

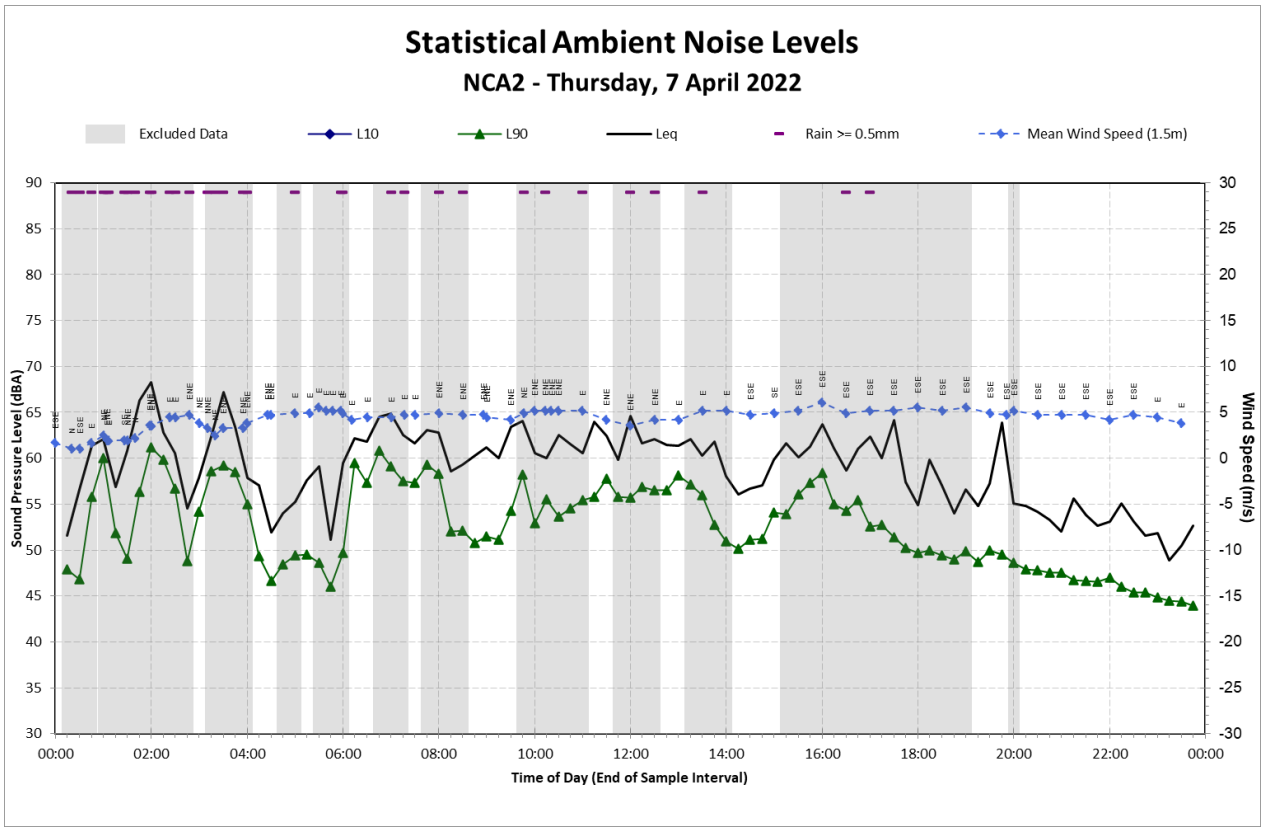

Statistical Ambient Noise Levels
NCA1 - Friday, 15 April 2022
Excluded Data
L90
Leq
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

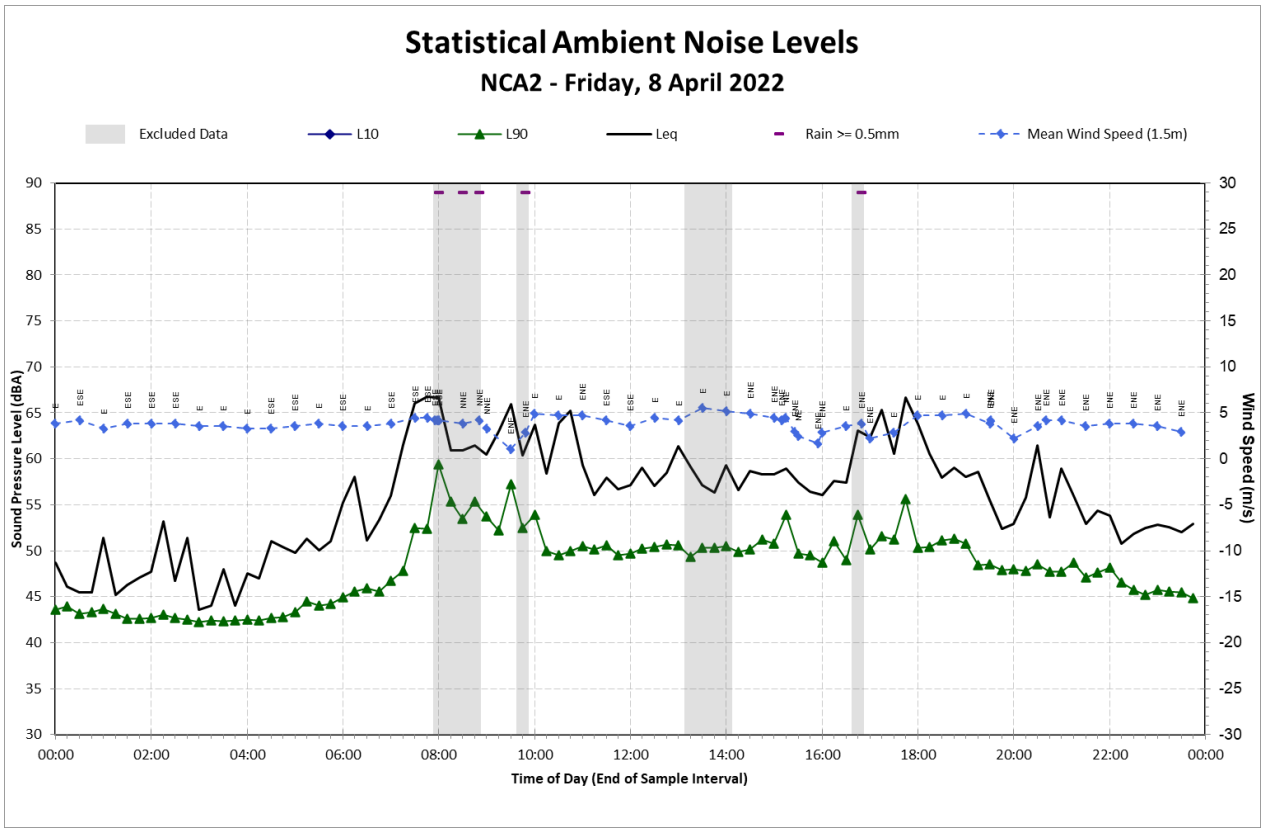

Statistical Ambient Noise Levels
NCA1 - Saturday, 16 April 2022
Excluded Data
L90
Leq
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

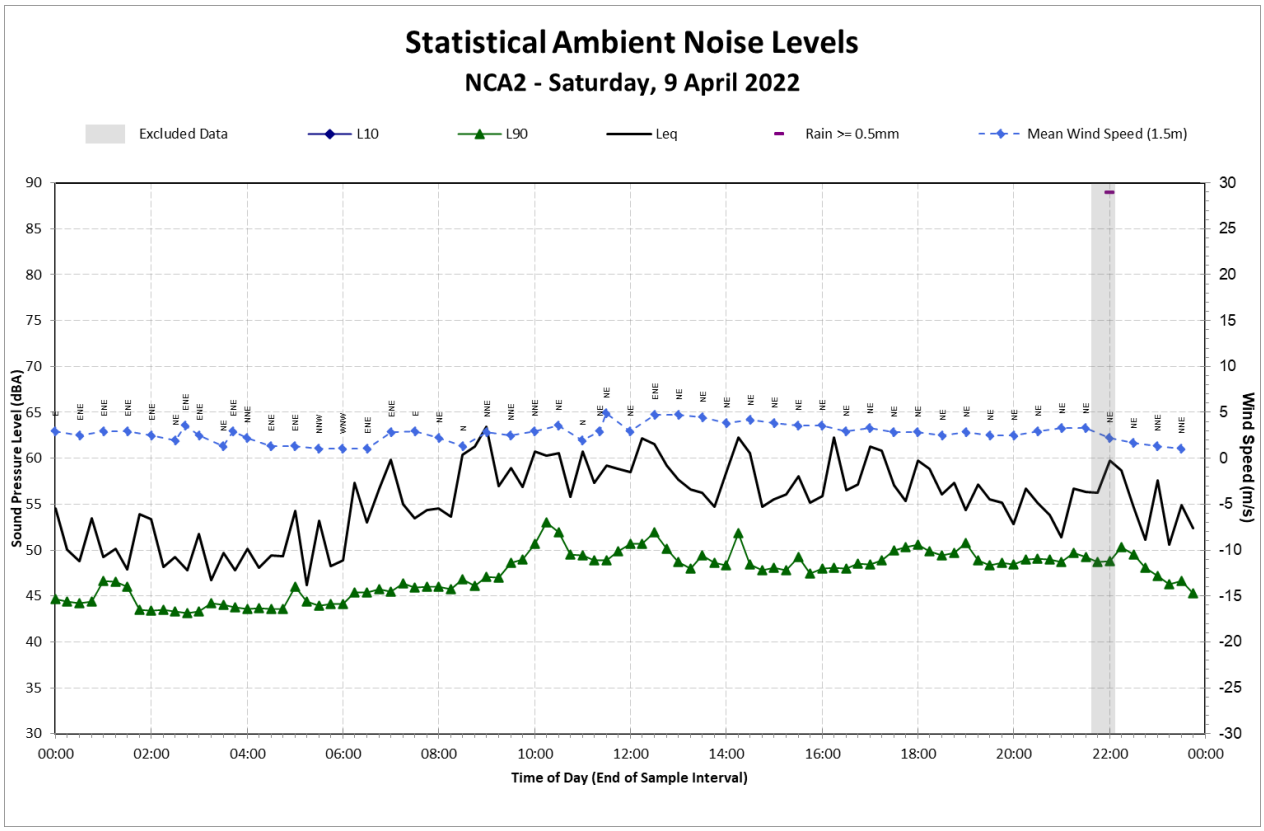

Statistical Ambient Noise Levels
NCA1 - Sunday, 17 April 2022
Excluded Data
L90
Leq
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)
90
85
80
75
70
65
60
55
50
45
40
35
30
30
25
20
15
10
5
0
-5
-10
-15
-20
-25
-30
00:00
02:00
04:00
06:00
08:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
00:00

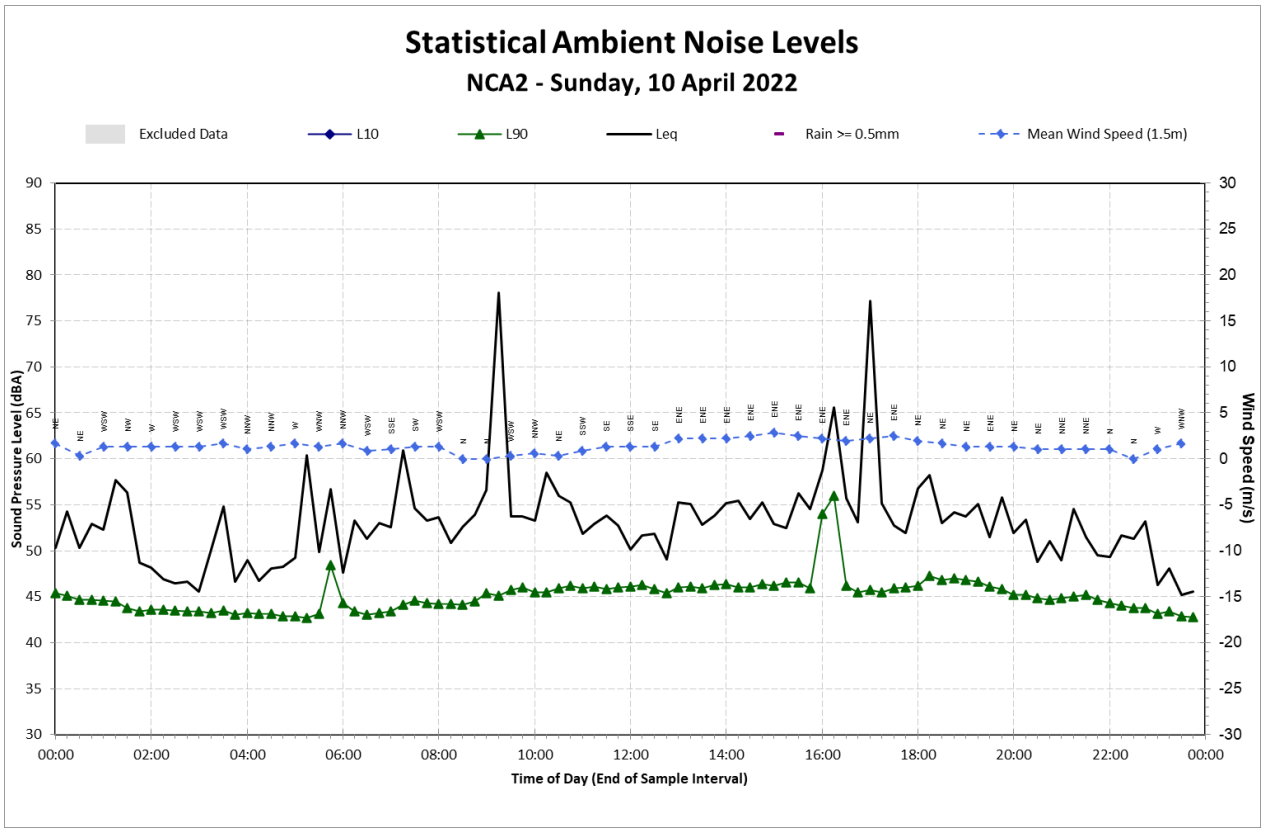

Statistical Ambient Noise Levels
NCA2 - Tuesday, 5 April 2022
Excluded Data
L10
L90
Leq
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

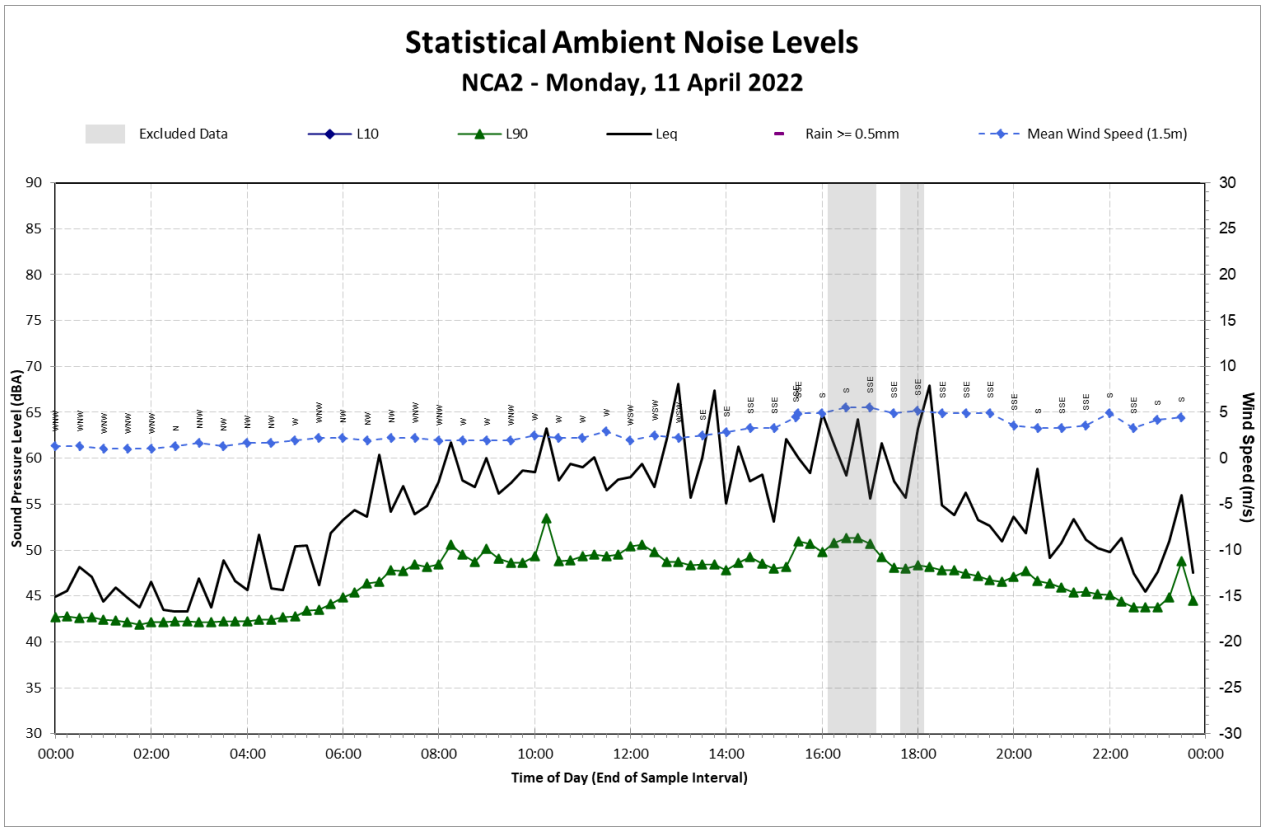

Statistical Ambient Noise Levels
NCA2 - Wednesday, 6 April 2022
Excluded Data
L10
L90
Leq
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

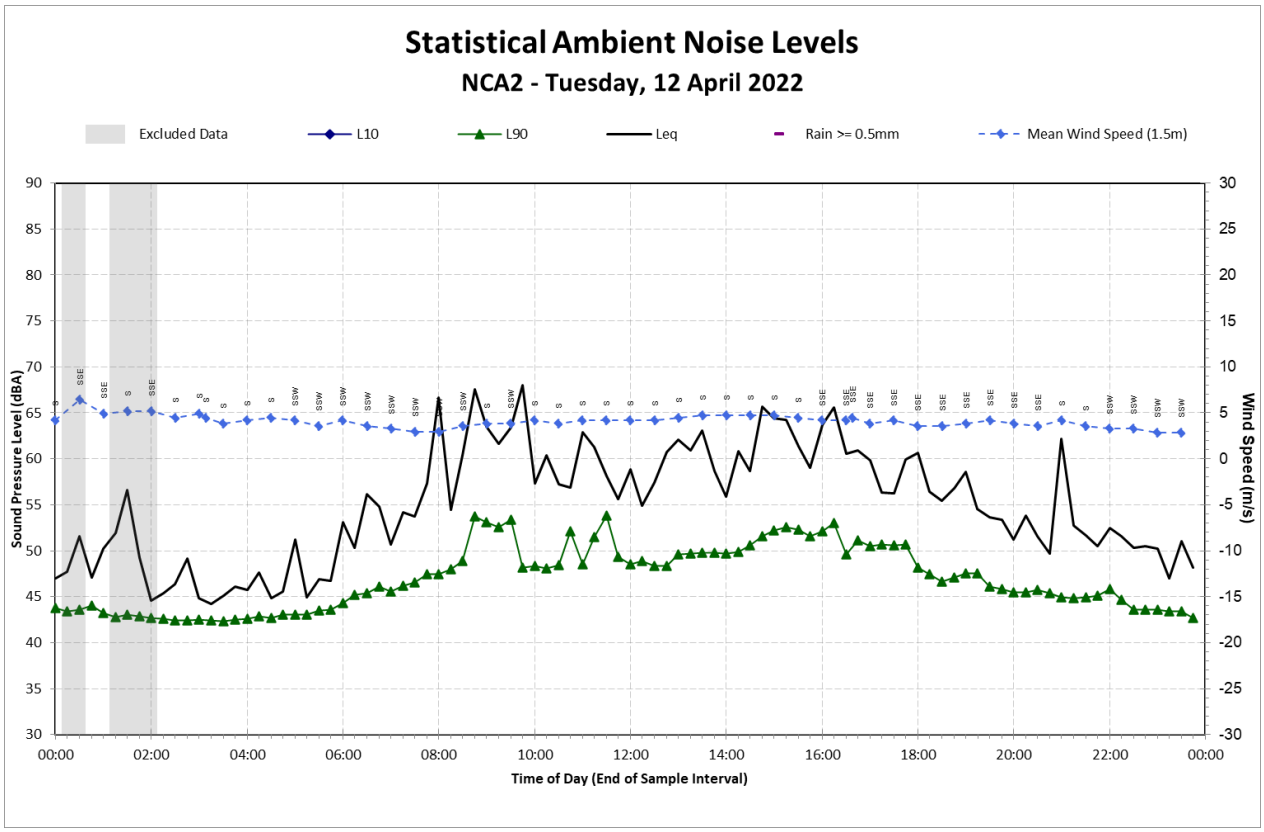

Statistical Ambient Noise Levels
NCA2 - Thursday, 7 April 2022
Excluded Data
L10
L90
Leq
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

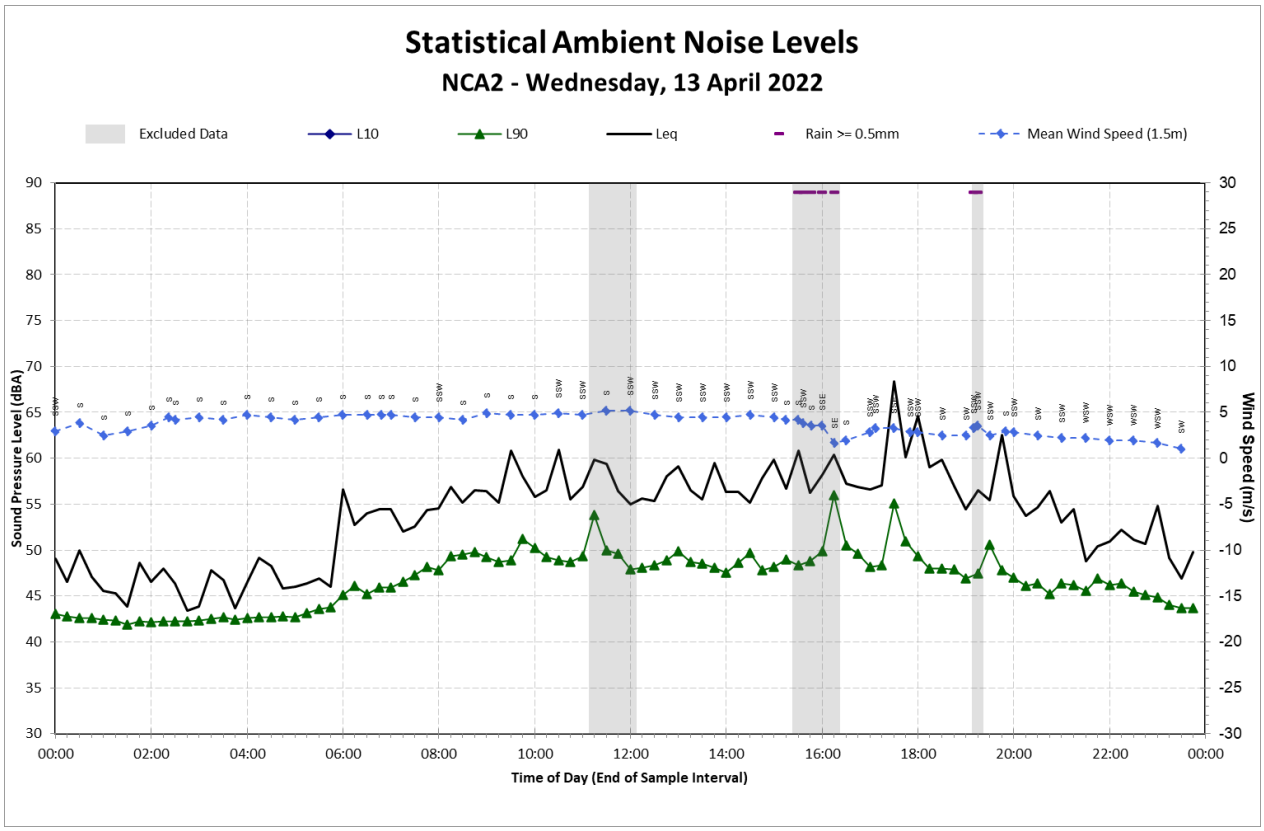

Statistical Ambient Noise Levels
NCA2 - Friday, 8 April 2022
Excluded Data
L10
L90
Leq
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

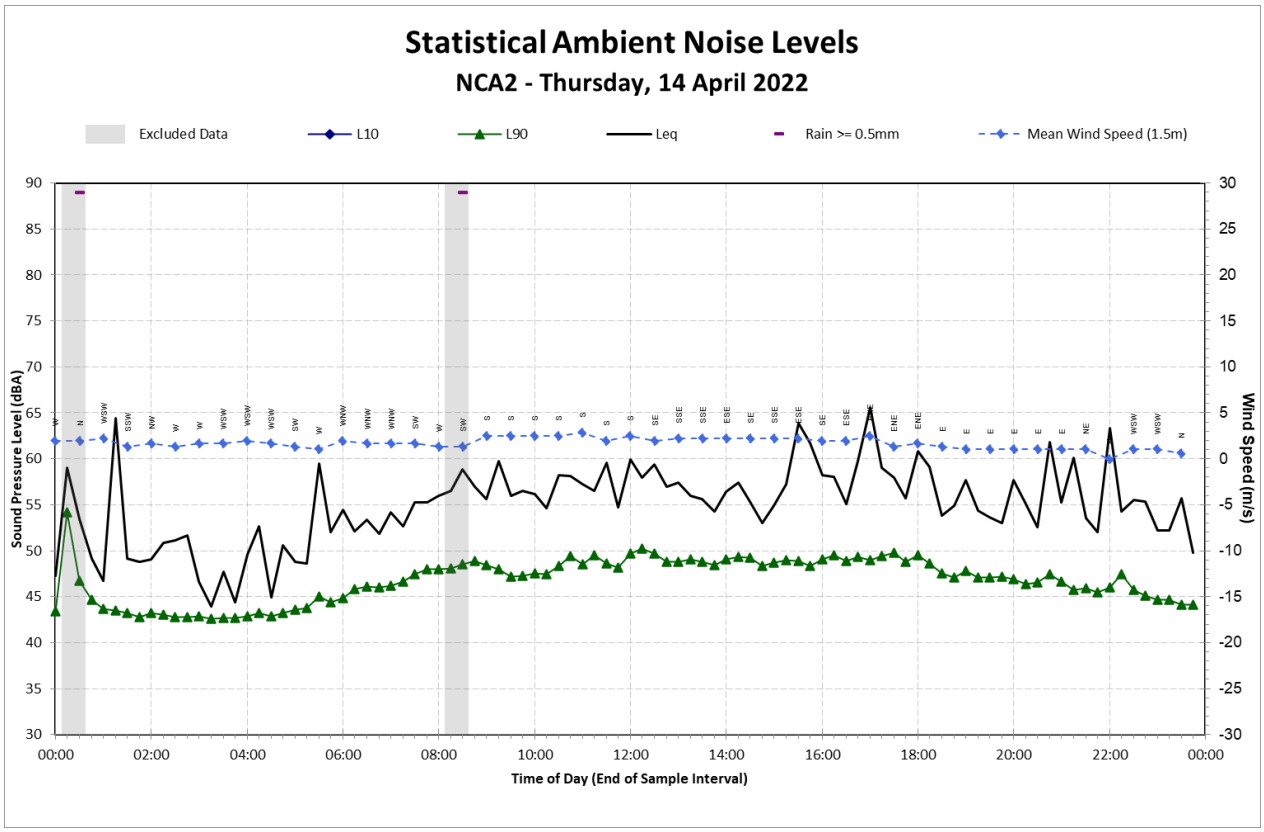

Statistical Ambient Noise Levels
NCA2 - Saturday, 9 April 2022
Excluded Data
L10
L90
Leq
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

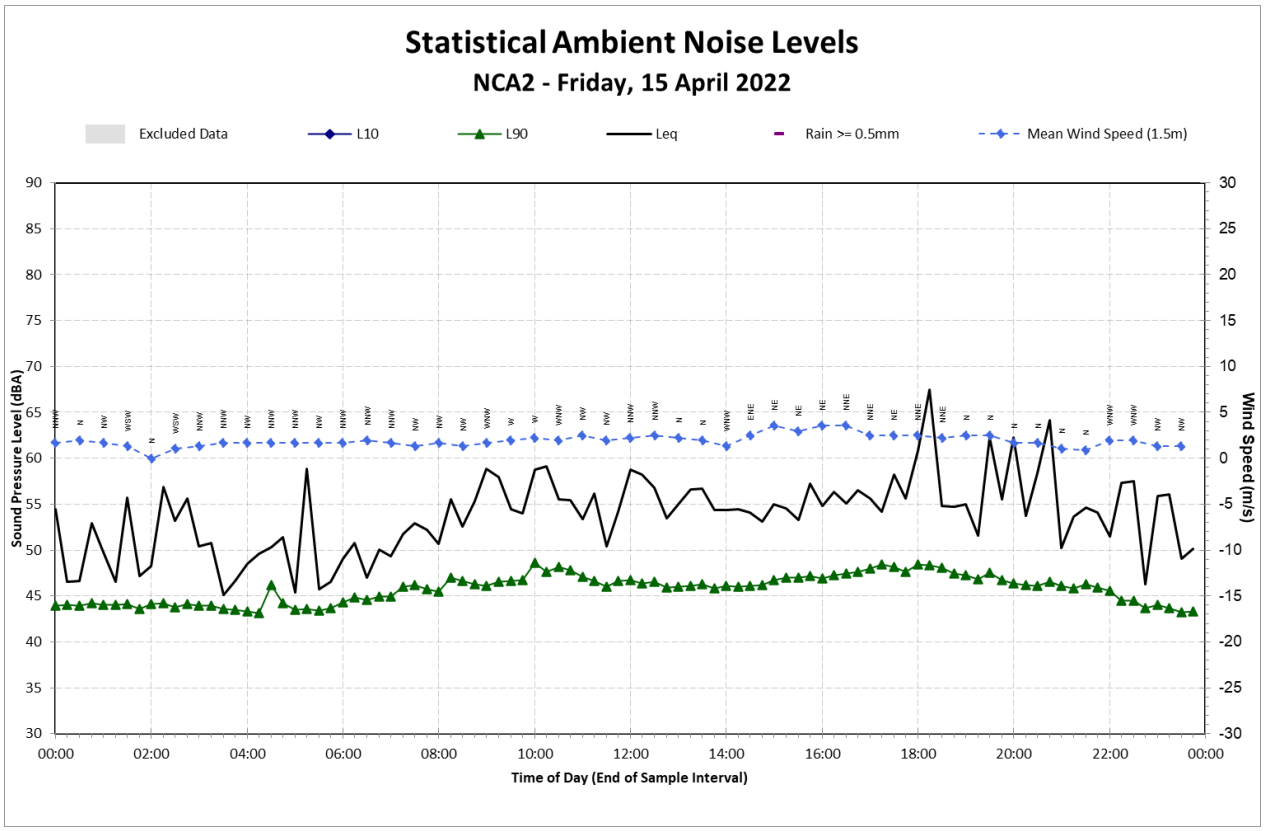

Statistical Ambient Noise Levels
NCA2 - Sunday, 10 April 2022
Excluded Data
L10
L90
Leq
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

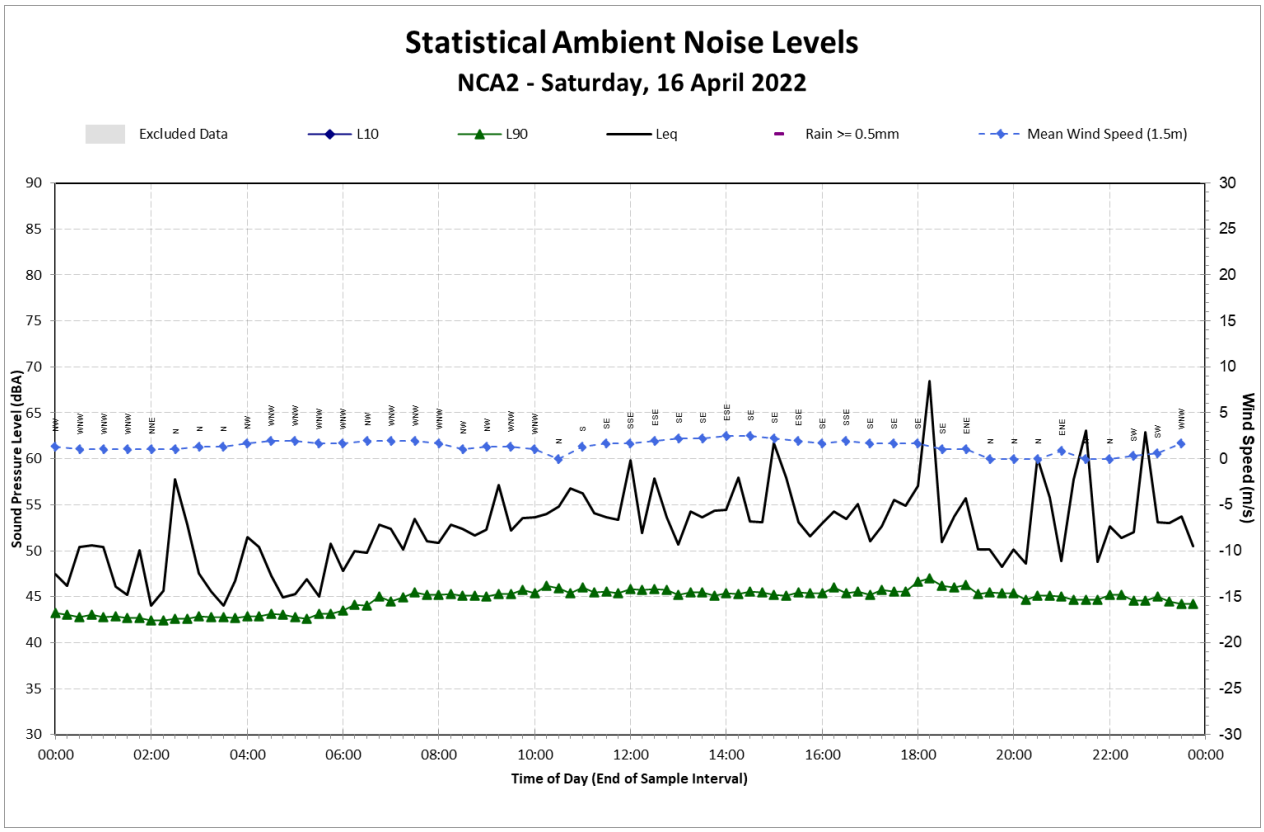

Statistical Ambient Noise Levels
NCA2 - Monday, 11 April 2022
Excluded Data
L10
L90
Leq
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

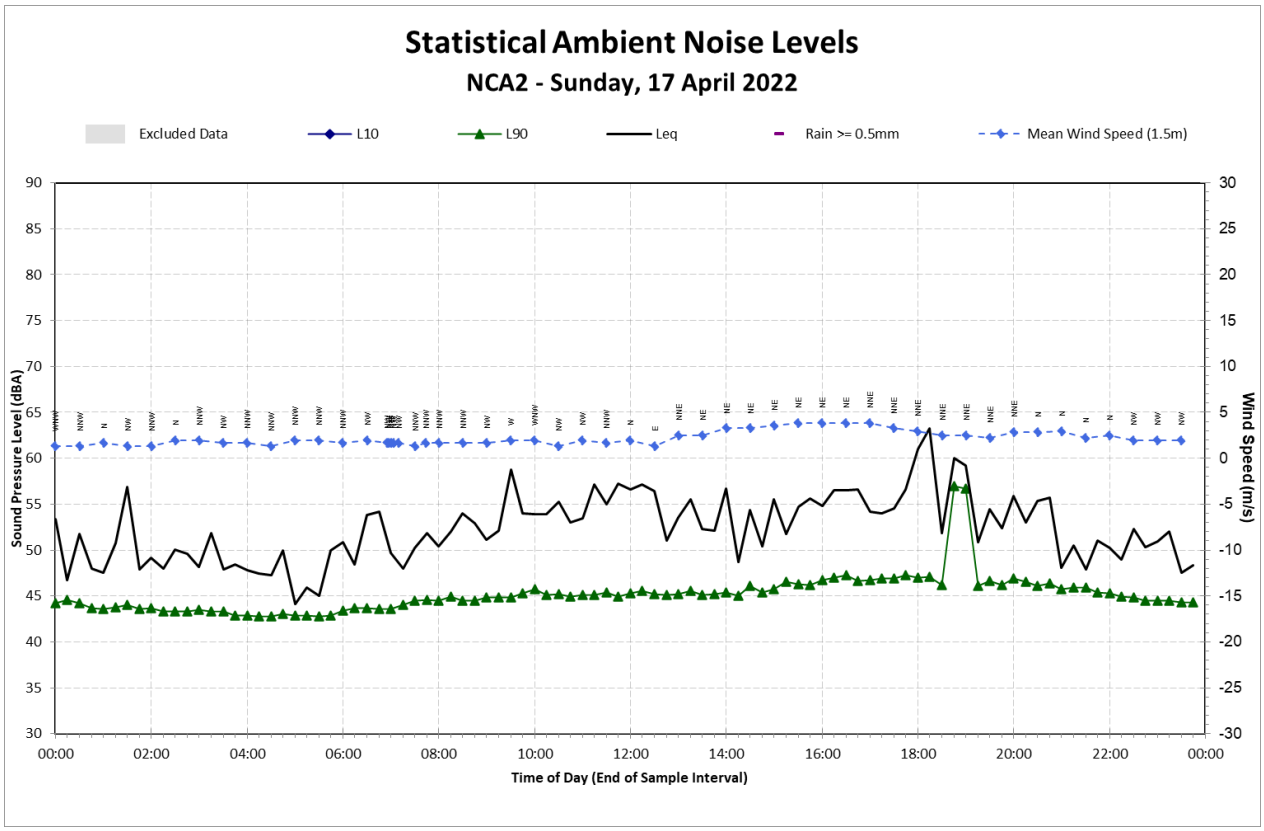

Statistical Ambient Noise Levels
NCA2 - Tuesday, 12 April 2022
Excluded Data
L10
L90
Leq
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

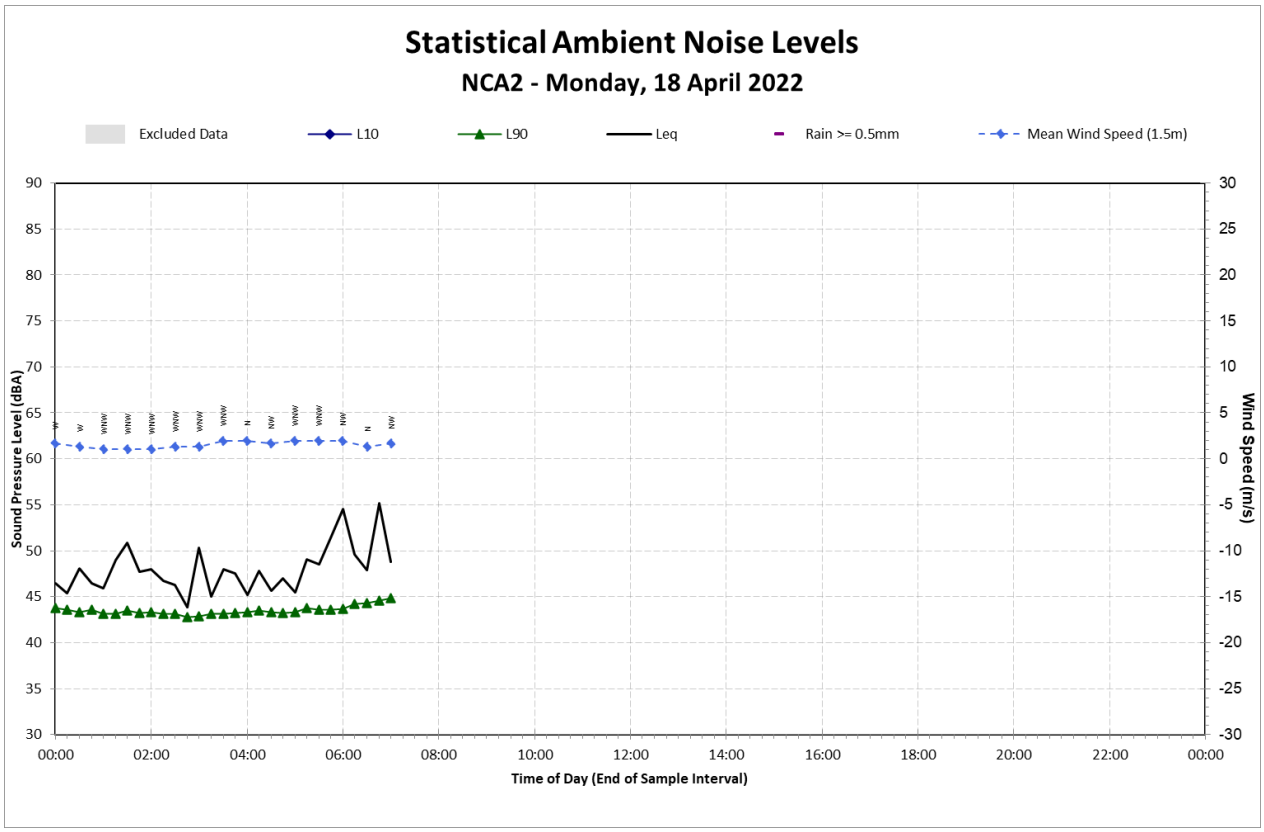

Statistical Ambient Noise Levels
NCA2 - Wednesday, 13 April 2022
Excluded Data
L10
L90
Leq
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)


Statistical Ambient Noise Levels
NCA2 - Thursday, 14 April 2022
Excluded Data
L10
L90
Leq
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)


Statistical Ambient Noise Levels
NCA2 - Friday, 15 April 2022
Excluded Data
L10
L90
Leq
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)


Statistical Ambient Noise Levels
NCA2 - Saturday, 16 April 2022
Excluded Data
L10
L90
Leq
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

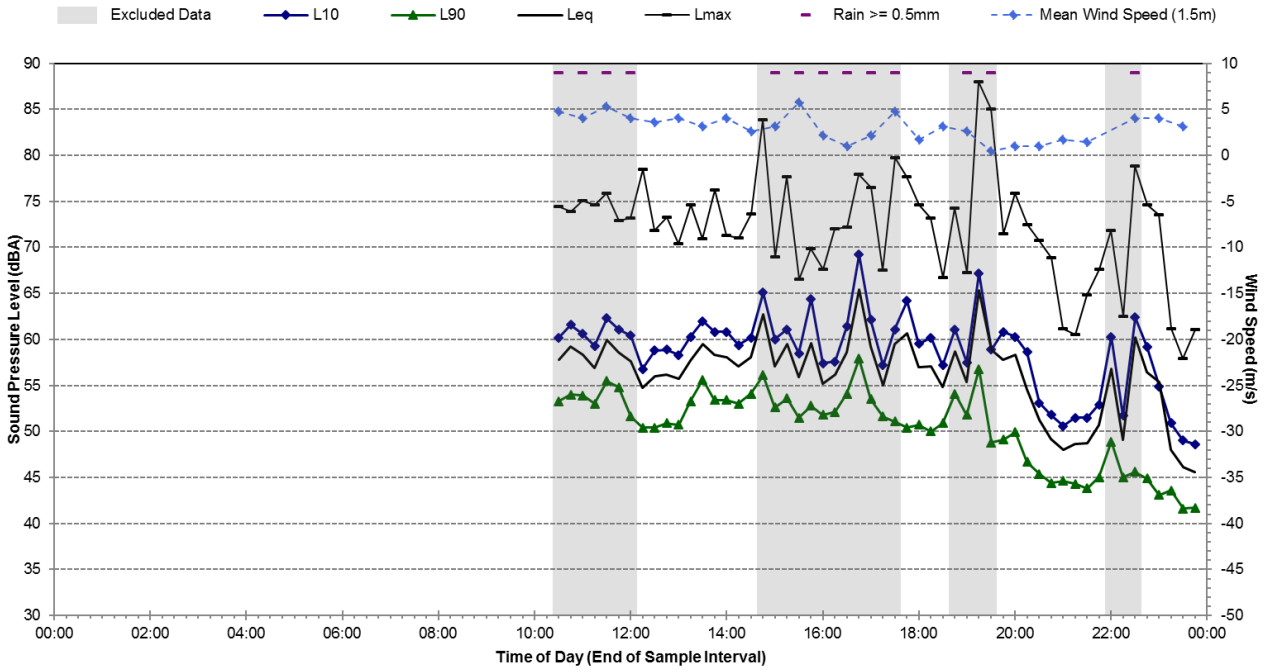

Statistical Ambient Noise Levels
NCA2 - Sunday, 17 April 2022
Excluded Data
L10
L90
Leq
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)


Statistical Ambient Noise Levels
NCA2 - Monday, 18 April 2022
Excluded Data
L10
L90
Leq
Rain >= 0.5mm
Mean Wind Speed (1.5m)
Sound Pressure Level (dBA)
Wind Speed (m/s)
Time of Day (End of Sample Interval)

In light of the current construction works in the Waterloo area (NCA3), noise logging was not considered appropriate given the influence on RBL. Therefore, background noise levels for NCA 3 are adopted from previous measurements conducted by SLR for Waterloo Estate. Graphical data for the logging period is extracted from SLR's report 'Noise and Vibration Assessment – Waterloo Estate (South) – Land Housing Corporation' and is presented as Appendix D.

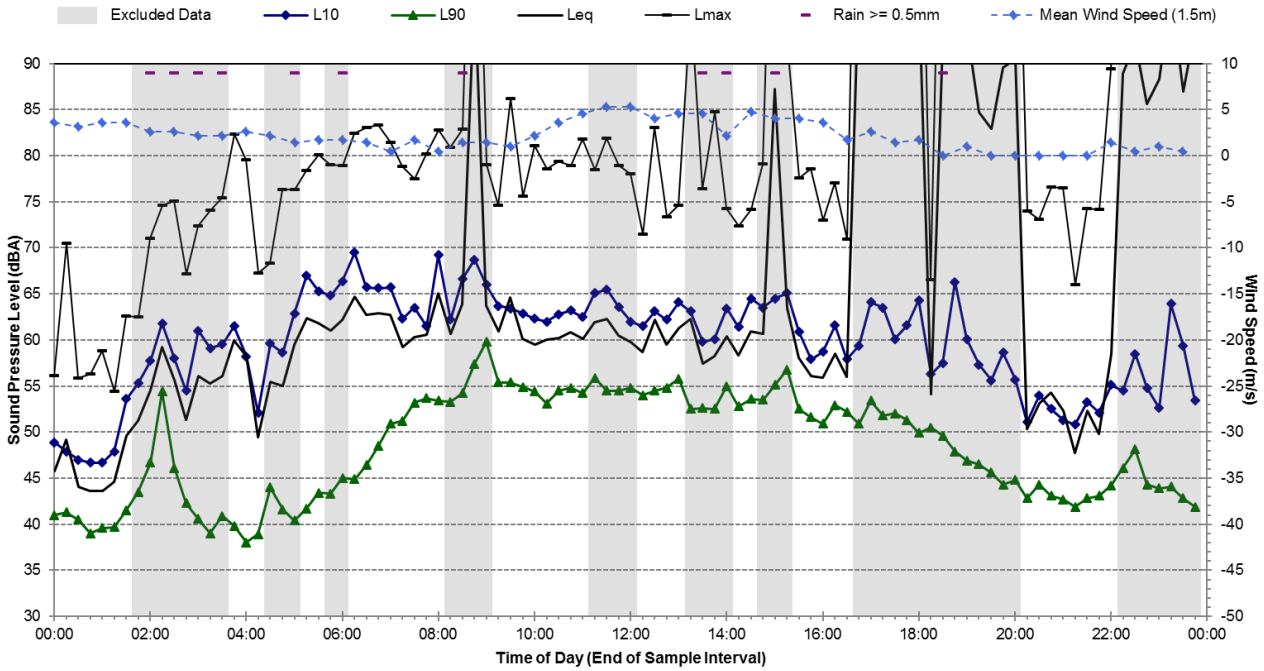
Statistical Ambient Noise Levels

L3 - 200 Pitt Street, Waterloo - Wednesday, 7 June 2017



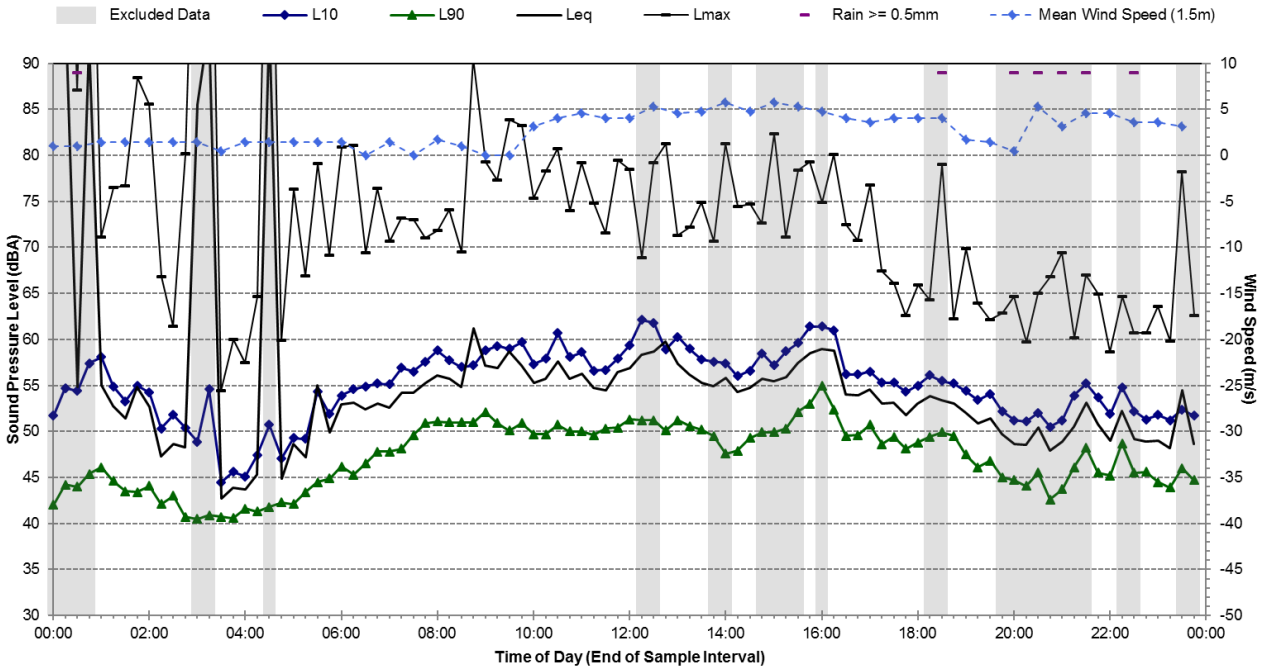
Statistical Ambient Noise Levels

L3 - 200 Pitt Street, Waterloo - Thursday, 8 June 2017



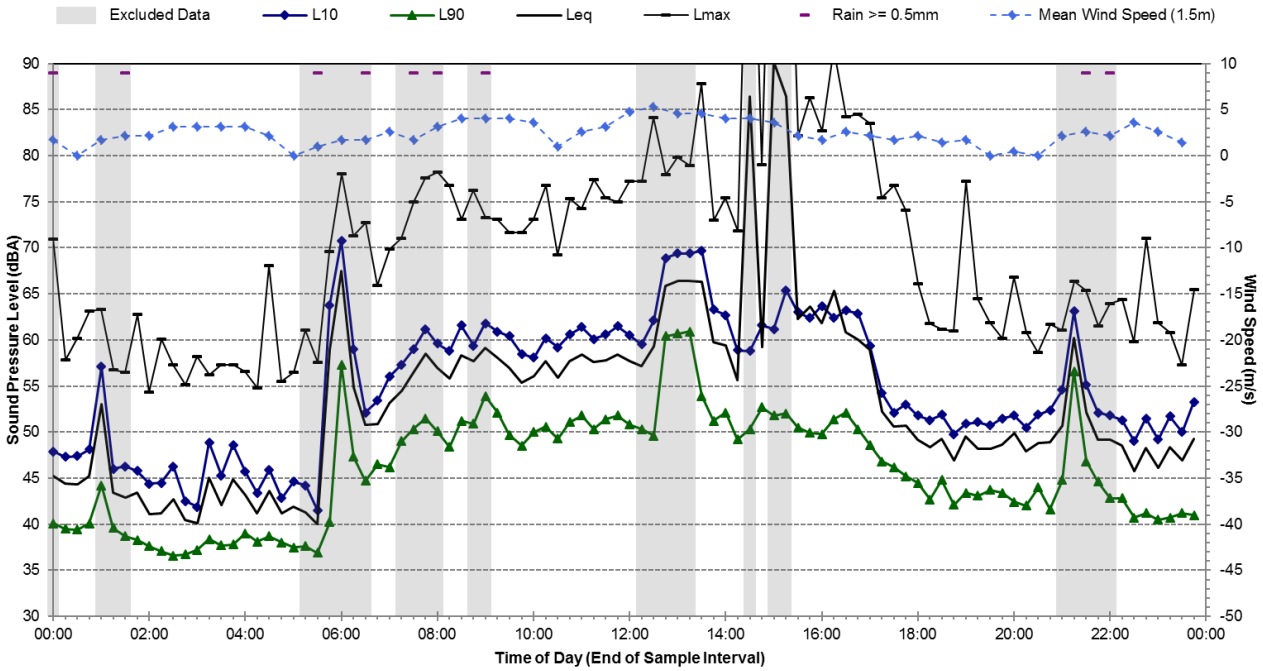
Statistical Ambient Noise Levels

L3 - 200 Pitt Street, Waterloo - Friday, 9 June 2017



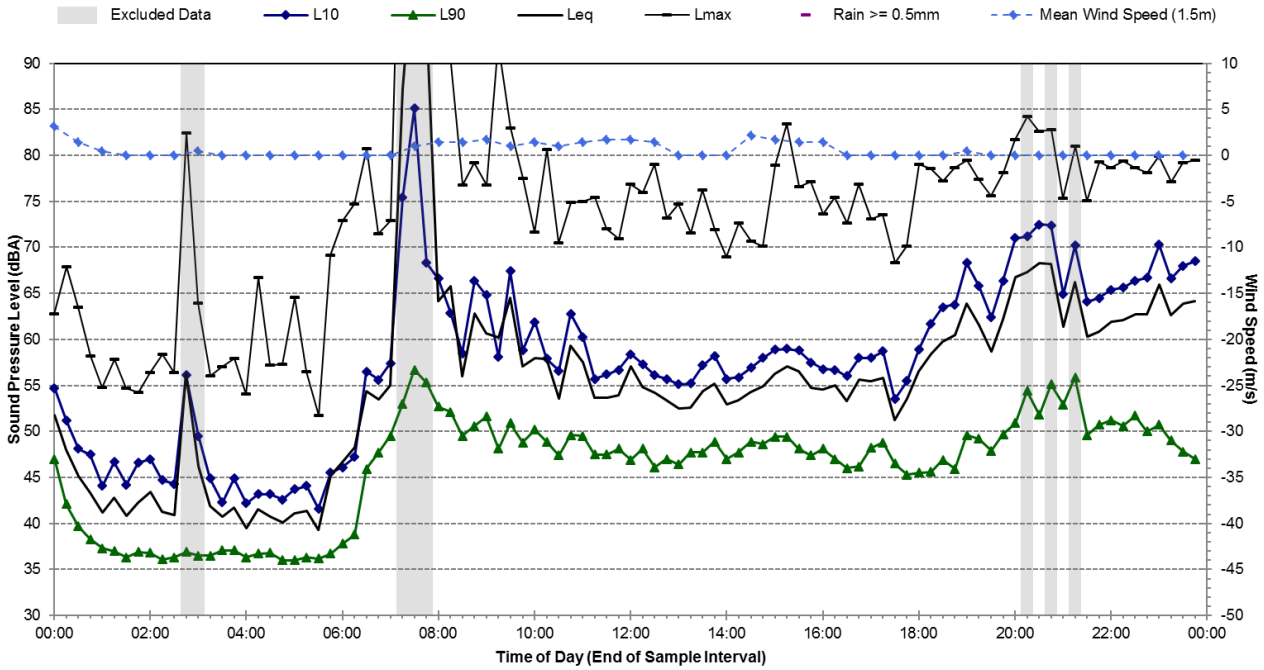
Statistical Ambient Noise Levels

L3 - 200 Pitt Street, Waterloo - Saturday, 10 June 2017



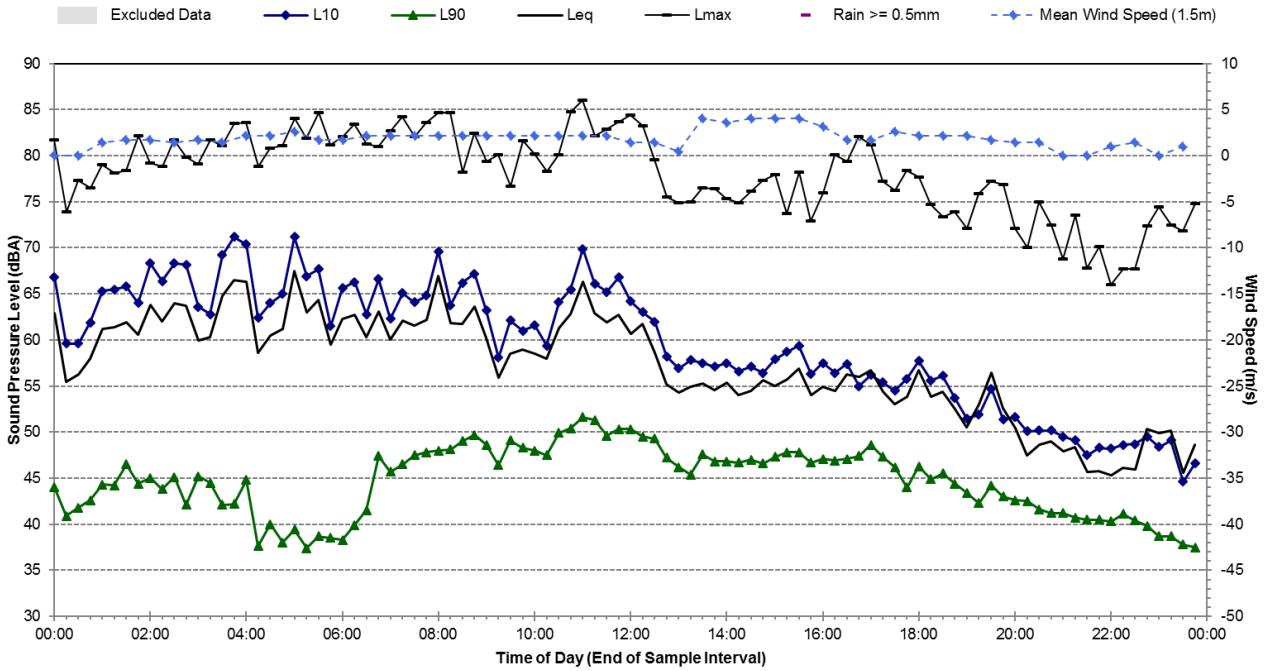
Statistical Ambient Noise Levels

L3 - 200 Pitt Street, Waterloo - Sunday, 11 June 2017



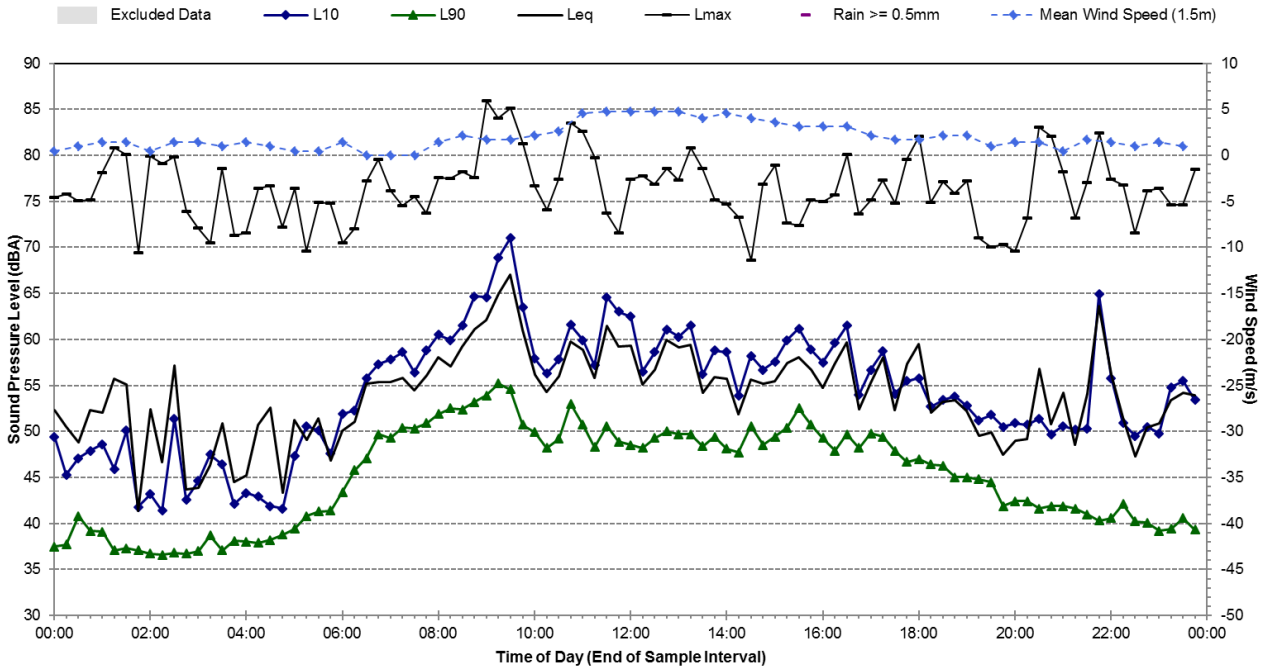
Statistical Ambient Noise Levels

L3 - 200 Pitt Street, Waterloo - Monday, 12 June 2017



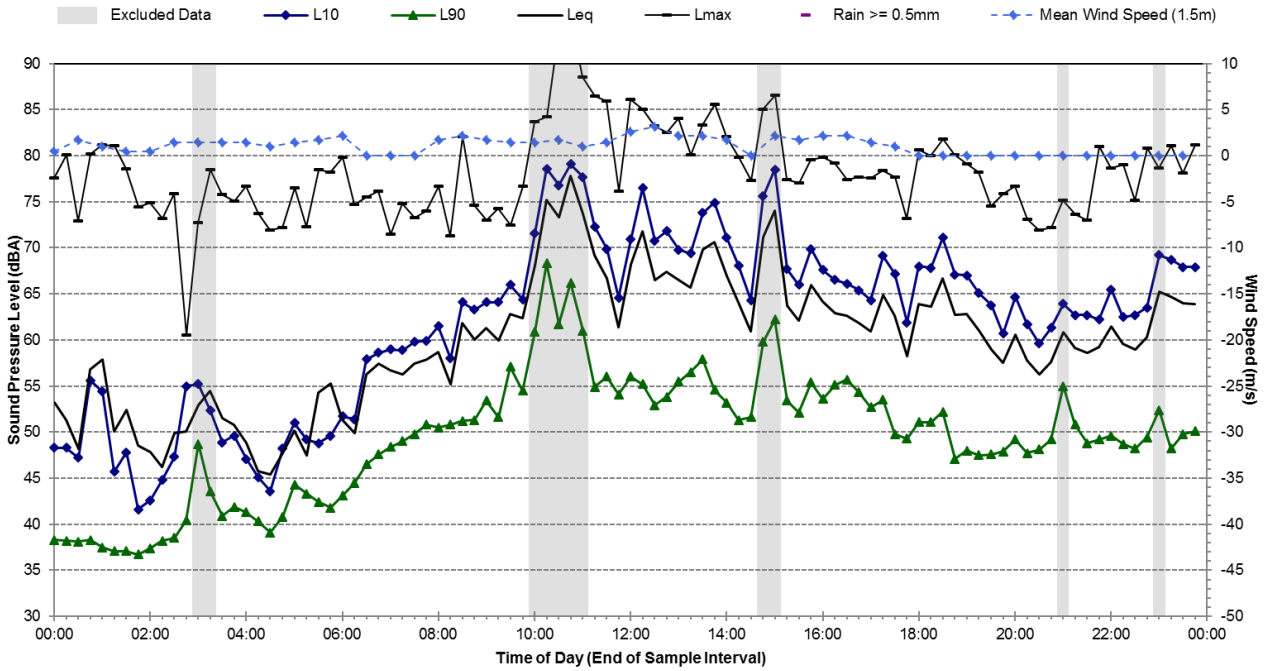
Statistical Ambient Noise Levels

L3 - 200 Pitt Street, Waterloo - Tuesday, 13 June 2017



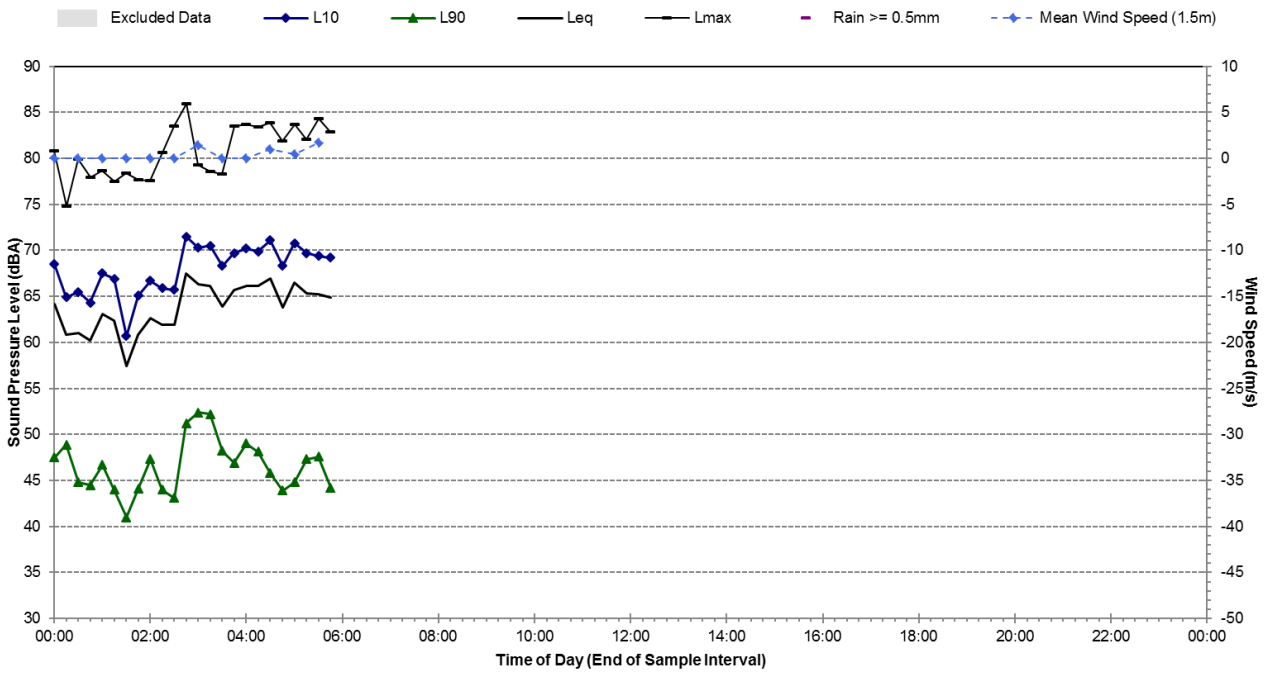
Statistical Ambient Noise Levels

L3 - 200 Pitt Street, Waterloo - Wednesday, 14 June 2017



Statistical Ambient Noise Levels

L3 - 200 Pitt Street, Waterloo - Thursday, 15 June 2017



Noise contours are presented for the worst-case scenarios to show the extent of the highly noise affected areas.

Project No.:	22017.1
Date:	13/07/2022
Drawn by:	YL
Scale:	1:2766
Sheet Size:	@A4
Projection:	GDA 1994 MGA Zone 56

0 60 120

N

Waterloo to Surry Hills Cable Project

Noise Contours

Pitt Street

Worst-case Scenario 2 (Backfilling/Compacting)

VMS

T: 1800 867 000
E: info@vms.com.au
www.vms.com.au

Project No.:	22017.1
Date:	13/07/2022
Drawn by:	YL
Scale:	1:2766
Sheet Size:	@A4
Projection:	GDA 1994 MGA Zone 56

0 60 120

N

Waterloo to Surry Hills Cable Project
Noise Contours
Pitt Street
Worst-case Scenario 2 (Backfilling/Compacting)

VMS
T: 1800 867 000
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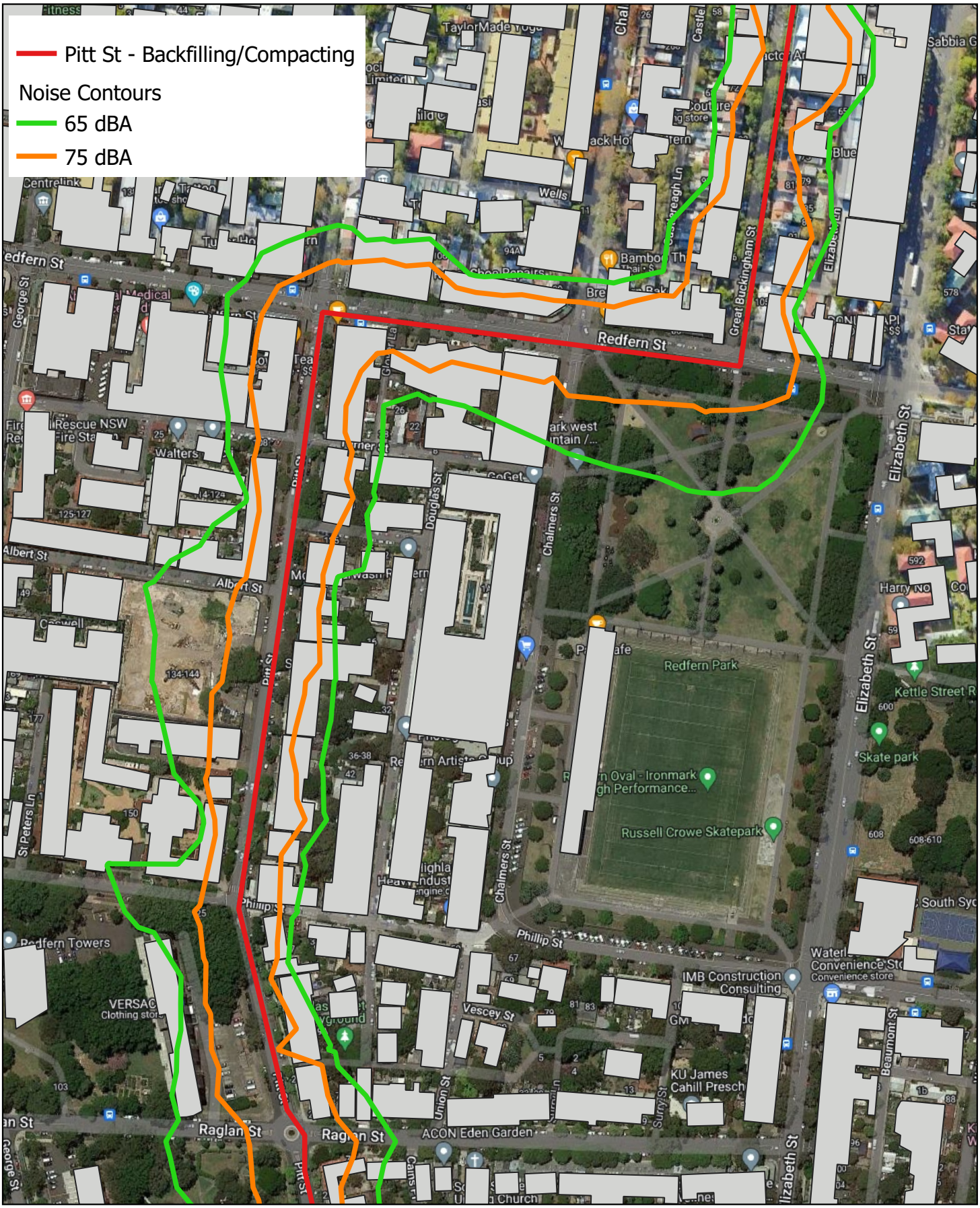

Project No.:	22017.1
Date:	13/07/2022
Drawn by:	YL
Scale:	1:2766
Sheet Size:	@A4
Projection:	GDA 1994 MGA Zone 56

0 60 120

N

Waterloo to Surry Hills Cable Project

Noise Contours

Pitt Street

Worst-case Scenario 2 (Backfilling/Compacting)

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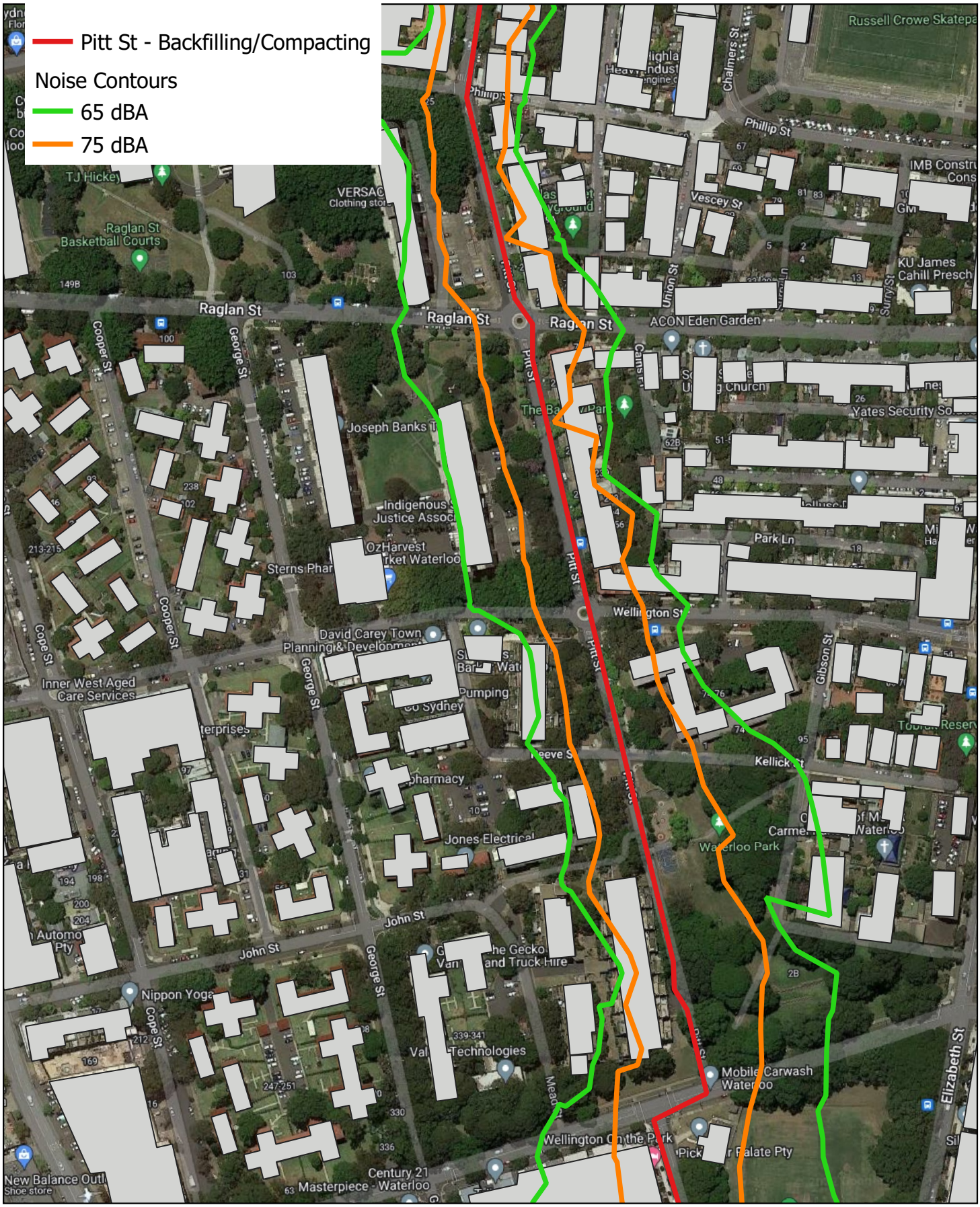

Project No.:	22017.1
Date:	13/07/2022
Drawn by:	YL
Scale:	1:2766
Sheet Size:	@A4
Projection:	GDA 1994 MGA Zone 56

0 60 120

N

Waterloo to Surry Hills Cable Project
Noise Contours
Pitt Street
Worst-case Scenario 2 (Backfilling/Compacting)

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Project No.:	22017.1
Date:	13/07/2022
Drawn by:	YL
Scale:	1:2766
Sheet Size:	@A4
Projection:	GDA 1994 MGA Zone 56

0 60 120

N

Waterloo to Surry Hills Cable Project
Noise Contours
Pitt Street
Worst-case Scenario 2 (Backfilling/Compacting)

VMS

T: 1800 867 000
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www.vms.com.au

Project No.:	22017.1
Date:	13/07/2022
Drawn by:	YL
Scale:	1:2766
Sheet Size:	@A4
Projection:	GDA 1994 MGA Zone 56

0 60 120

N

Waterloo to Surry Hills Cable Project

Noise Contours

Pitt Street

Worst-case Scenario 1 (Saw Cutting)

T: 1800 867 000
E: info@vms.com.au
www.vms.com.au

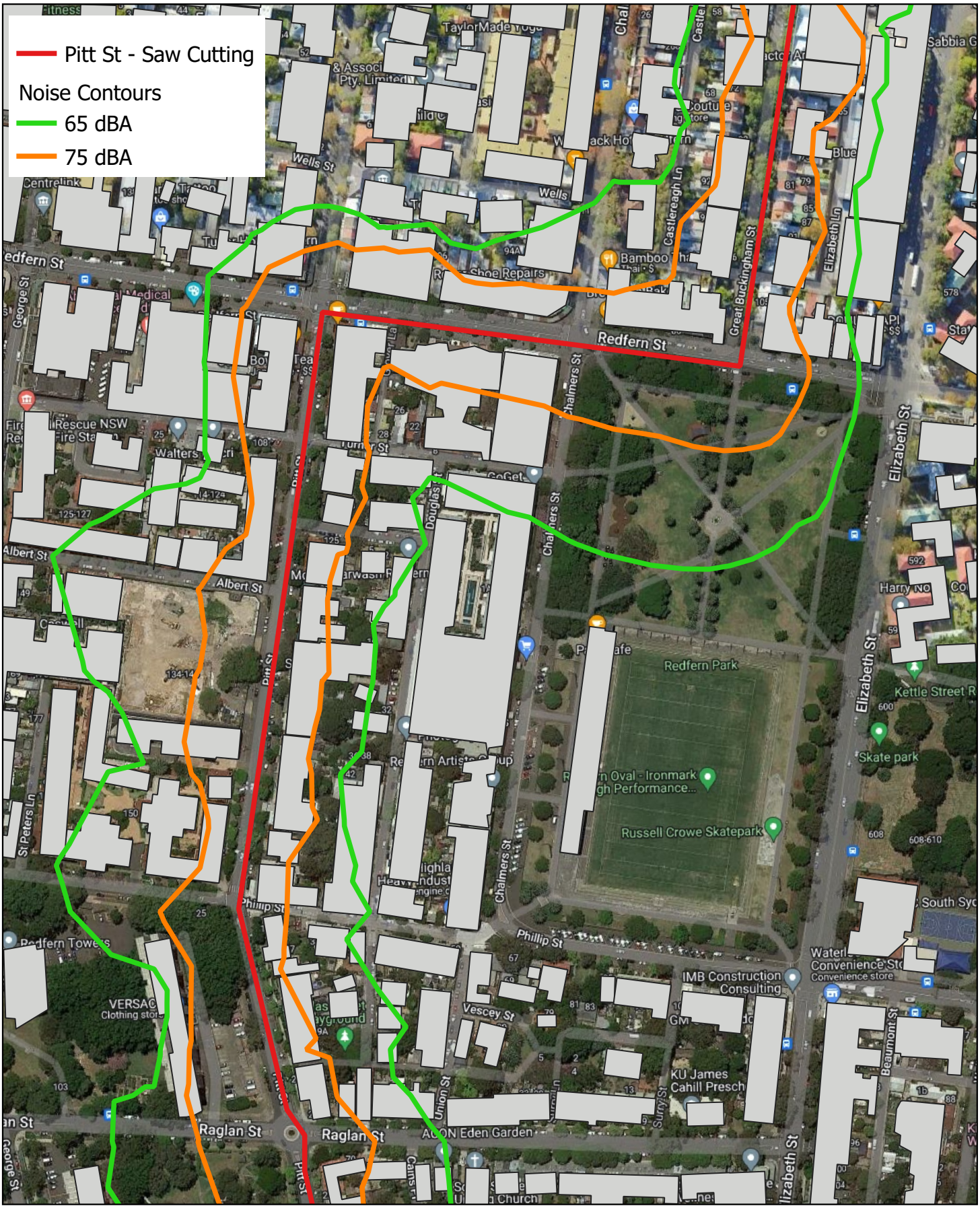
Project No.:	22017.1
Date:	13/07/2022
Drawn by:	YL
Scale:	1:2766
Sheet Size:	@A4
Projection:	GDA 1994 MGA Zone 56

0 60 120

N

Waterloo to Surry Hills Cable Project
Noise Contours
Pitt Street
Worst-case Scenario 1 (Saw Cutting)

VMS
T: 1800 867 000
E: info@vms.com.au
www.vms.com.au



Project No.:	22017.1
Date:	13/07/2022
Drawn by:	YL
Scale:	1:2766
Sheet Size:	@A4
Projection:	GDA 1994 MGA Zone 56

0 60 120

N

Waterloo to Surry Hills Cable Project

Noise Contours

Pitt Street

Worst-case Scenario 1 (Saw Cutting)

VMS

T: 1800 867 000
E: info@vms.com.au
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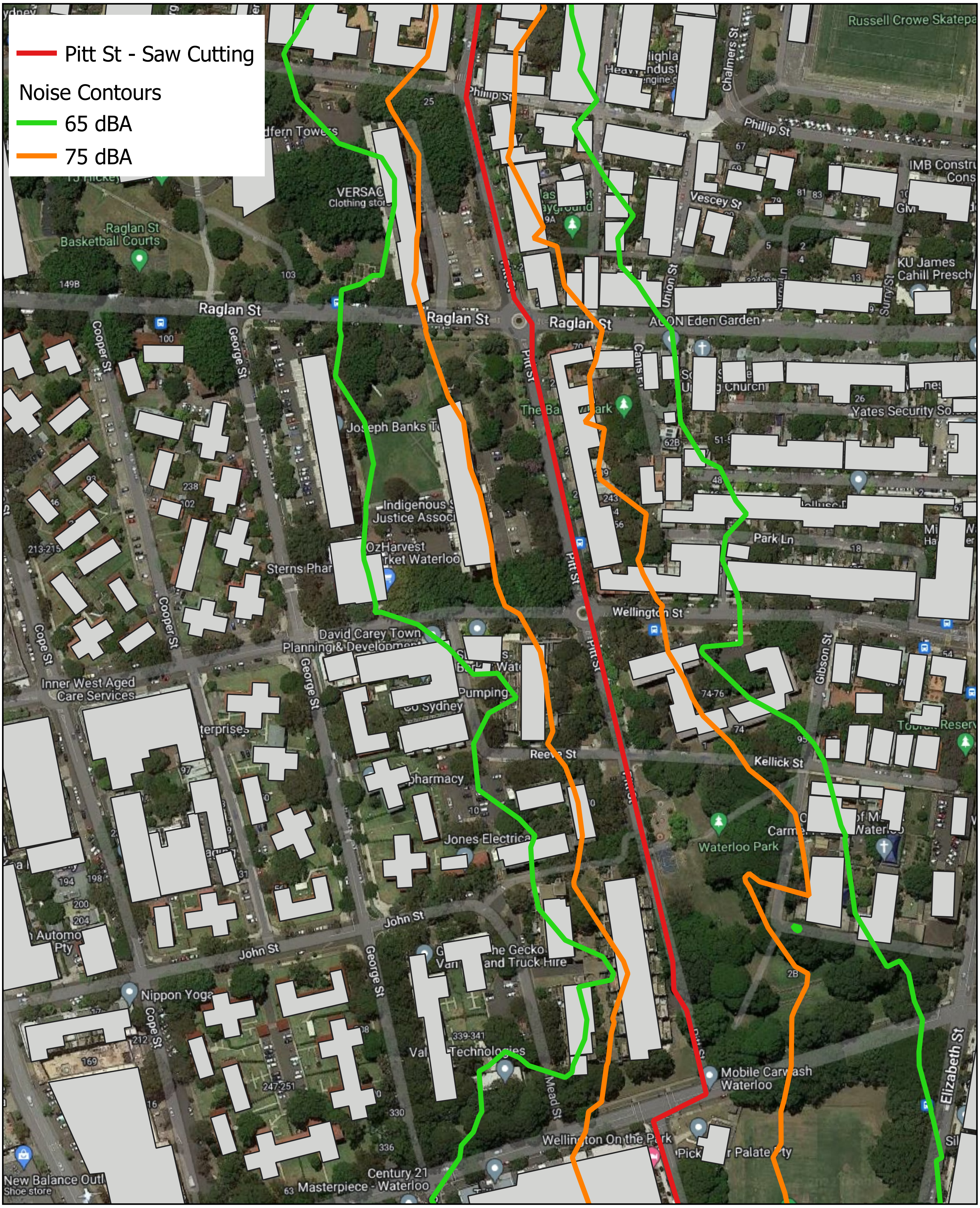

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N

Waterloo to Surry Hills Cable Project
Noise Contours
Pitt Street
Worst-case Scenario 1 (Saw Cutting)

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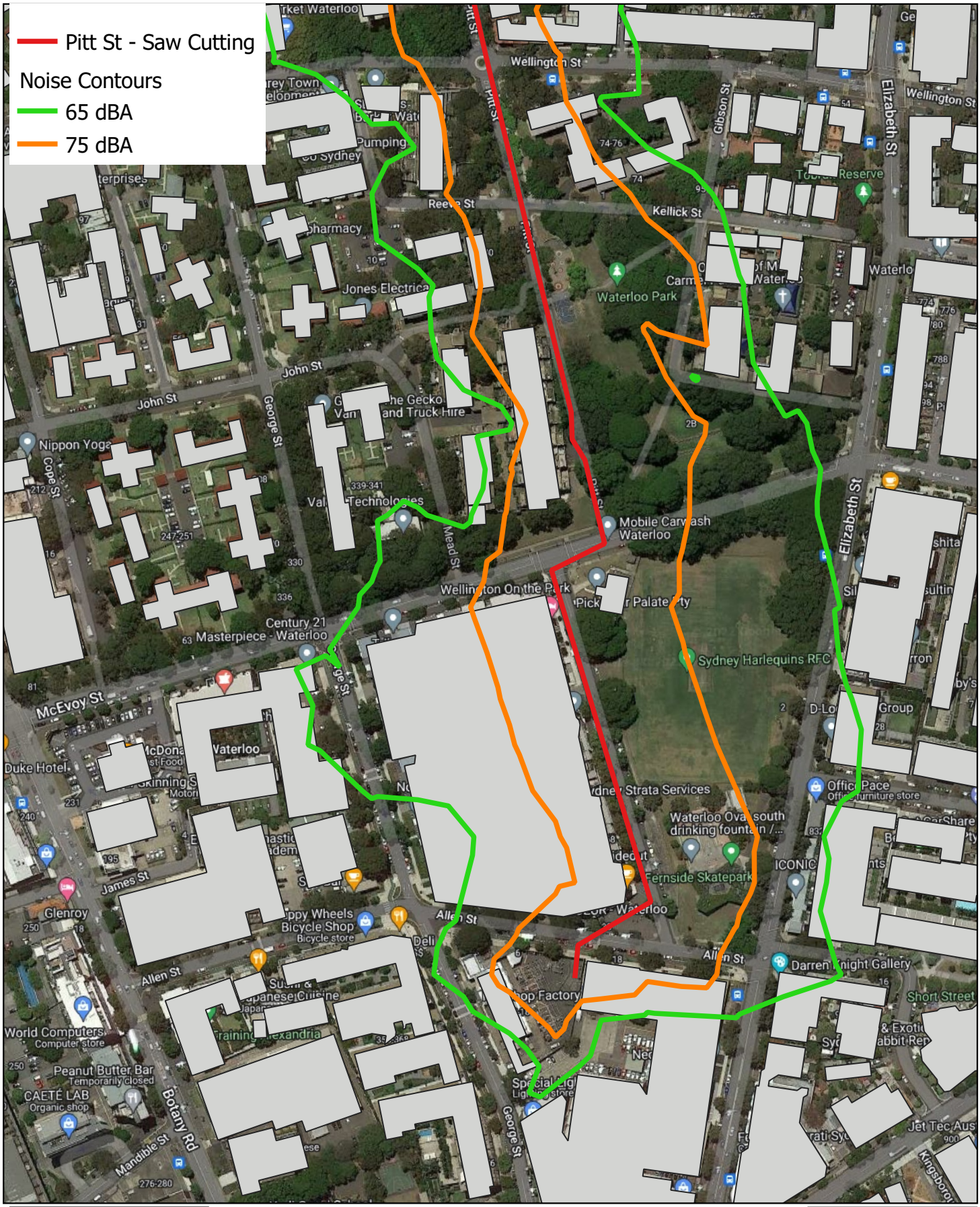

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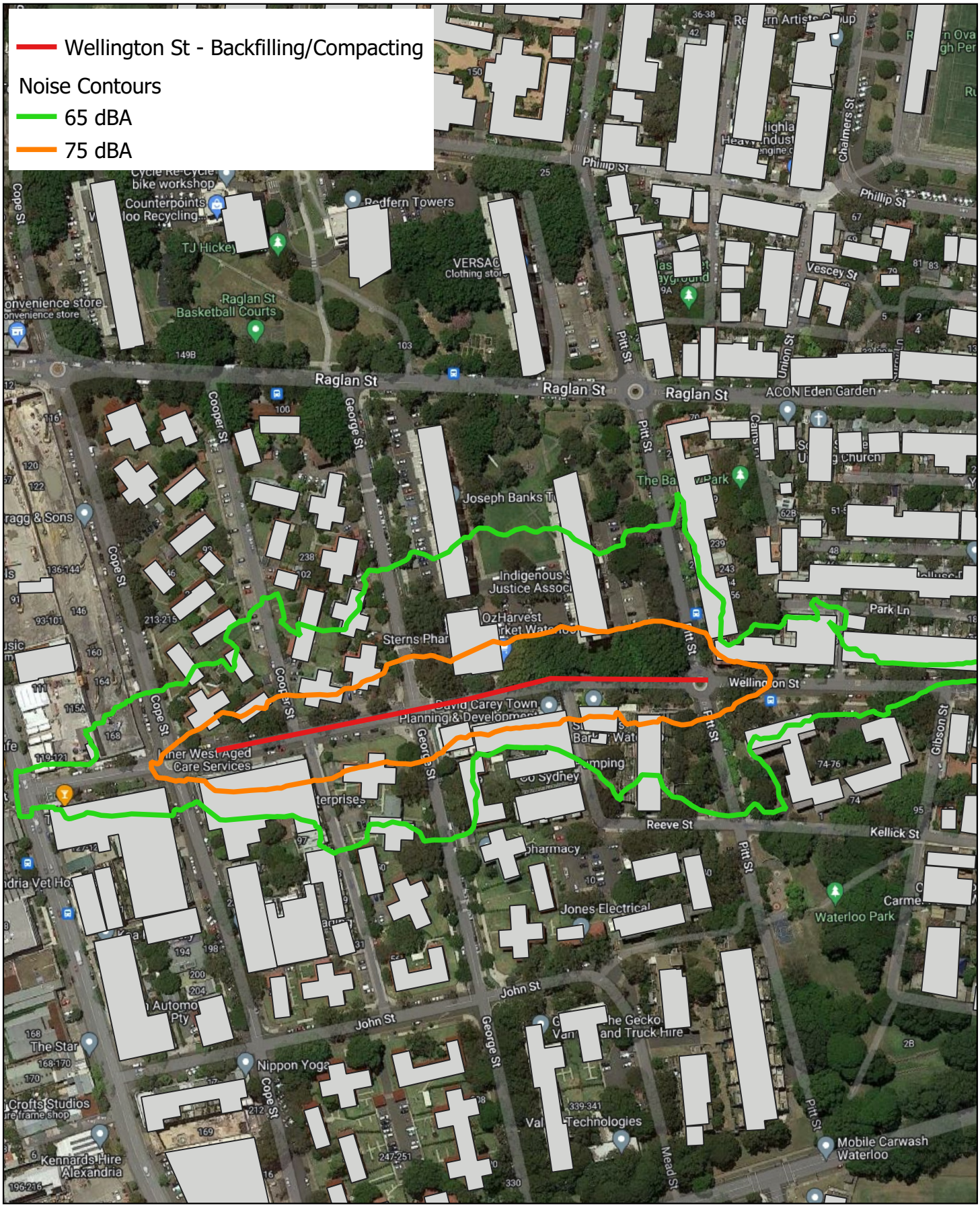

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0 60 120

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Waterloo to Surry Hills Cable Project

Noise Contours Wellington Street

Worst-case Scenario 2 (Backfilling/Compacting)

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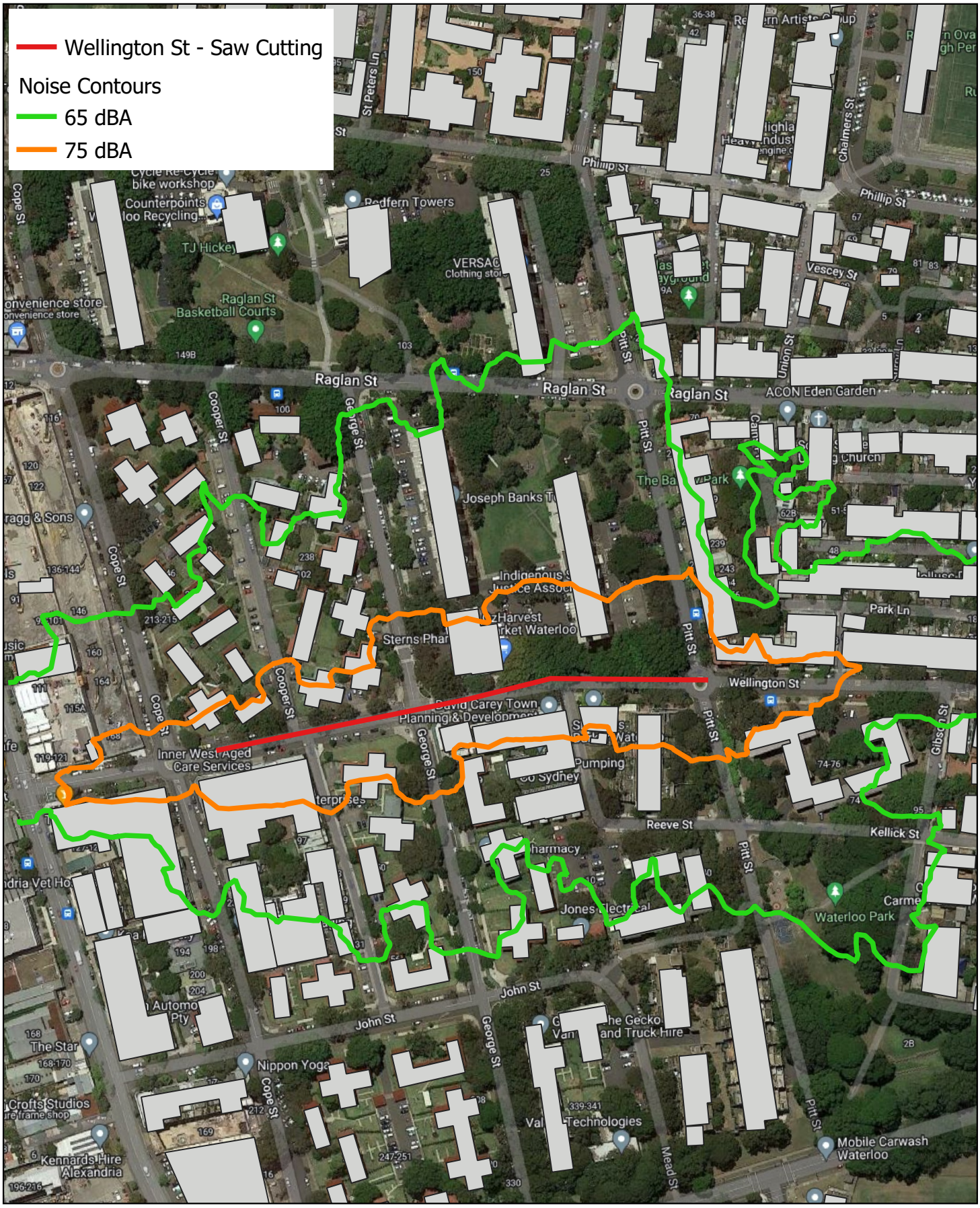

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0 60 120

N

Waterloo to Surry Hills Cable Project

Noise Contours Wellington St

Worst-case Scenario 1 (Saw cutting)

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Project No.:	22017.1
Date:	13/07/2022
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Scale:	1:1681
Sheet Size:	@A4
Projection:	GDA 1994 MGA Zone 56

0 40 80

N

Waterloo to Surry Hills Cable Project

Noise Contours

Buckingham Street

Worst-case Scenario 3 (HDD)

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