

Appendix E

NOISE IMPACT ASSESSMENT



**WALGETT SOLAR FARM – NOISE & VIBRATION IMPACT ASSESSMENT
– JANUARY 2017**

WALGETT SOLAR PTY LTD

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	Name	Position Title	Signature	Date
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Reviewer	David Arbuckle	General Manager		03.02.2017
Approver	Craig Beyers	Consulting Services Manager		03.02.2017

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1 INTRODUCTION

1.1 Scope of Assessment

The Assured Monitoring Group was appointed by Walgett Solar Pty Ltd to undertake a noise assessment for the proposed Walgett Solar Farm project. The project involves construction and operation of a 30 MW solar farm across three land parcels (Lot 49 DP 752271, Lot A DP 418888 and Lot 1 DP 822477).

The noise study has been undertaken to assess the potential impacts of the construction and operation of the proposed solar farm on nearby sensitive receptors in accordance with the following NSW policies and guidelines:

- NSW Environmental Protection Authority Industrial Noise Policy (EPA, 2000)
- NSW Assessing Vibration: a technical guideline (DEC, 2006);
- NSW Road Noise Policy (DECCW, 2011); and
- Interim Construction Noise Guideline (DECCW, 2009)

In accordance with the requirements of the above guidelines, computational modelling and first principle calculations have been undertaken to support the assessment of the potential for adverse amenity impacts as a result of the development.

1.2 This Report

This report summarises the methodology, results and conclusions of the noise and vibration impact assessment. A glossary of terms is presented in Appendix A to assist the reader.

2 PROPOSED DEVELOPMENT SITE

2.1 Development Site

The proposed development site is located approximately 5 km north of Walgett in northern New South Wales. Specifically, the proposed solar farm is to be constructed within the boundaries of three land parcels including:

- Lot 49 DP 752271;
- Lot A DP 418888;
- Lot 1 DP 822477.

Figure 1 presents the location of the site.

The area surrounding the proposed development includes a range of agricultural and rural uses with the Walgett Wheat siding and Lightning Ridge Pistol Club located approximately 2.5 km to the east and south-east of the subject site respectively.

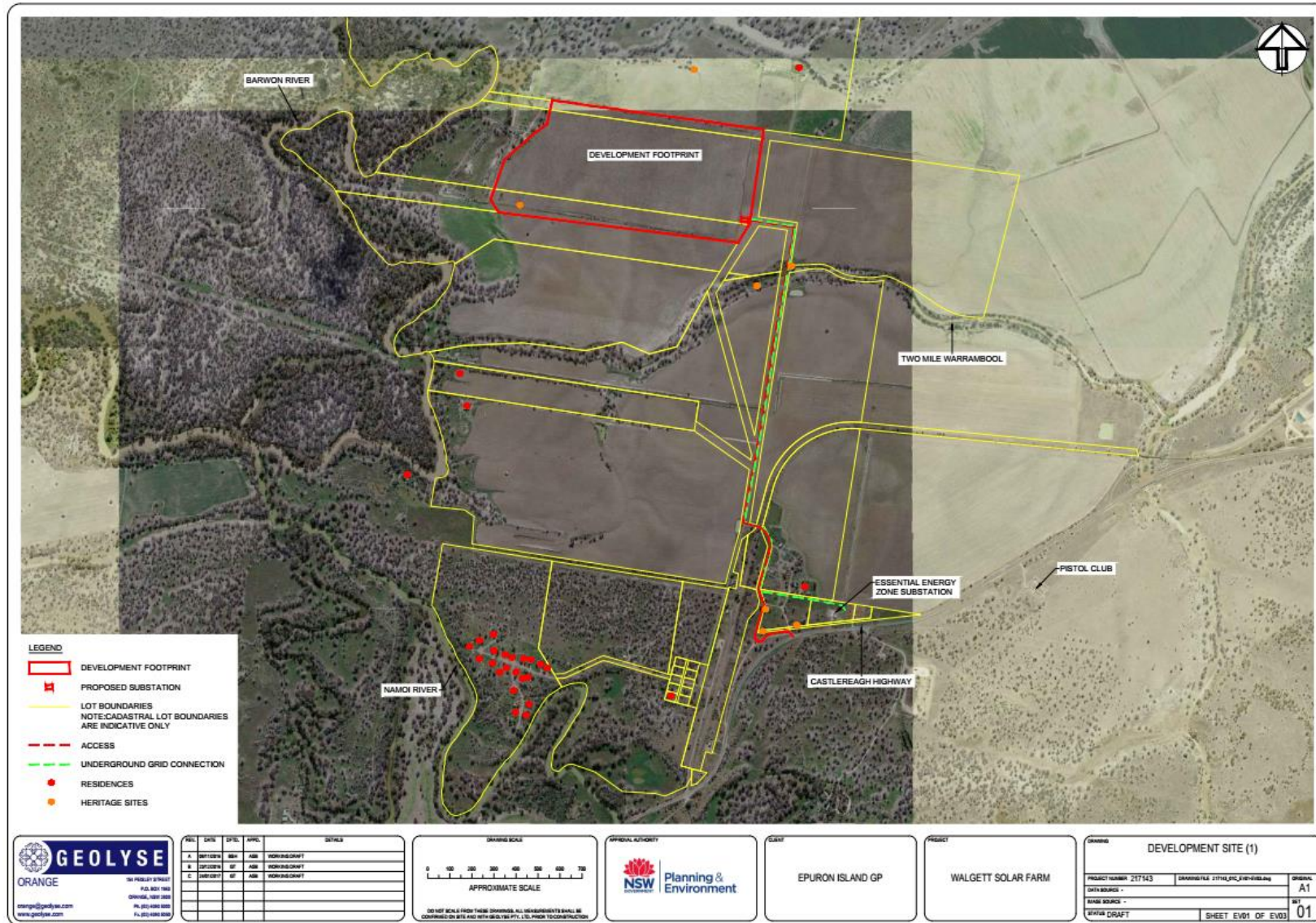


Figure 1: Site Location and Surrounding Landuses

2.2 Nearby Sensitive Receptors

The nearest off-site residential receptors to the proposed Solar Farm include approximately four single existing dwellings located within 2 km to the south of the proposed Solar Farm and a single receptor located approximately 330 m to the north of the subject site.

Table 3 and Figure 2 below provide a summary of the nearest sensitive uses to the proposed Walgett Solar Farm development.

Table 3: Nearby Sensitive Receptors

Receptor ID	Description	Distance to Proposed Development Site
R1	Existing Dwelling	330 m
R2	Existing Dwelling	880 m
R3	Existing Dwelling	1030 m
R4	Existing Dwelling	1470 m
R5	Existing Dwelling	1870 m



Figure 2: Surrounding Landuses and Nearby Sensitive Receptors

3 CONSTRUCTION NOISE ASSESSMENT

3.1 Duration of Construction Works

The construction of the Walgett Solar Farm is expected to take approximately 9 months with a number of different activities undertaken over that time. Table 4 below presents an overview of each of the construction tasks along with their expected duration. It is noted that some of these tasks are likely to occur concurrently (e.g. site preparation and construction of the substation is likely to be undertaken at the same time as installation of the solar PV modules and cabling).

Given the separation distance to the nearest existing sensitive receptors to the subject site there is potential for the duration of construction to be minimised through construction works outside normal hours (as described in Table 5 below). The assessment has therefore considered the potential for adverse amenity impacts associated with construction during both day and night periods.

Table 4: Construction Phases and Expected Duration

Construction Phase	Duration
Site clearing and preparation	Intermittent across construction period
Piling – installation of module mounting structures	3 months
Installation of solar PV modules & inverter assemblies	9 months

3.2 Interim Construction Noise Guideline

Guidance on the assessment and management of construction noise in NSW is provided in the Interim Construction Noise Guideline 2009 (ICNG) published by the NSW EPA.

The main objectives of the Guideline are to:

- promote a clear understanding of ways to identify and minimise noise from construction works;
- focus on applying all 'feasible' and 'reasonable' work practices to minimise construction noise impacts;
- encourage construction to be undertaken only during the recommended standard hours, unless approval is given for works that cannot be undertaken during these hours;
- streamline the assessment and approval stages and reduce time spent dealing with complaints at the project implementation stage;
- provide flexibility in selecting site-specific feasible and reasonable work practices in order to minimise noise impacts; and
- provide guidelines for assessing noise generated during the construction phase of developments.

In achieving these objectives, the guideline provides a framework for the qualitative and quantitative assessment of potential construction noise impacts noting that, for major projects, a quantitative assessment is the preferred approach. Table 5 presents construction noise criteria outlined in the guideline. Noise levels apply at the property boundary that is most exposed to construction noise, and at a height of 1.5 m above ground level. If the property boundary is more than 30 m from the residence, the location for measuring or predicting noise levels is at the most noise-affected point within 30 m of the residence.

Table 5: NSW EPA Construction Noise Criteria – Residential Receivers

Time of Day	Management Level (Free-field)	How to Apply
Recommended standard hours: Monday to Friday, 7 am to 6 pm Saturday, 8 am to 1 pm	Noise affected RBL + 10 dB	The noise affected level represents the point above which there may be some community reaction to noise. Where the predicted or measured $L_{Aeq(15\text{ min})}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.
No work on Sundays or public holidays	Highly noise affected 75 dB(A)	The highly noise affected level represents the point above which there may be strong community reaction to noise. Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account: <ul style="list-style-type: none"> • times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences • if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside recommended standard hours	Noise affected RBL + 5 dB	A strong justification would typically be required for works outside the recommended standard hours. The proponent should apply all feasible and reasonable work practices to meet the noise affected level. Where all feasible and reasonable practices have been applied and noise is more than 5 dB(A) above the noise affected level, the proponent should negotiate with the community.

Where nearby sensitive uses are predicted to be noise affected, the proponent of the project is required to apply reasonable and feasible noise mitigation measures noting that a noise

mitigation measure is feasible if it is capable of being put into practice, and is practical to build given the project constraints.

Selecting reasonable mitigation measures from those that are feasible involves making a judgement to determine whether the overall noise benefit outweighs the overall social, economic and environmental effects.

For construction outside standard hours, the assessment criteria has been determined based on the minimum allowable RBL as provided in the INP. That is, for the purposes of the assessment it is assumed that the RBL is 30 dB(A) for night periods thereby resulting in a noise affected limit of 35 dB(A) for construction outside standard hours.

3.3 Construction Noise Sources

In terms of noise emissions, the site preparation activities and installation of the solar PV modules are expected to represent those with the most significant potential for adverse impacts. For the purposes of the assessment, the cumulative impacts of these two activities have been considered.

It is noted that construction works are expected to progress across the site such that plant and equipment would only be in a single area for a short period of time. Given this, the potential for adverse impacts at any one receptor is expected to only occur for a short period of time.

Table 6 below presents a summary of the plant and equipment likely to be required to complete the on-site construction works. The sound power levels presented have been sourced from published noise emission datasets and the library of source noise levels maintained by Assured Monitoring Group.

Table 6: Construction Phases and Expected Duration

Construction Phase	Plant Item	Number Required	Sound Power Level, dB(A)	Acoustical Usage Factor, %
Site preparation and construction of site substation ^{a)}	Truck & Dog	1	110	40
	Compactor	1	103	20
	Bulldozer	1	109	40
	Excavator	1	106	40
	Mulcher	1	116	20
	Grader ^{c)}	1	108	40
	Water Cart (as required)	1	103	40
	Vibratory Roller	1	103	20
Installation of solar PV modules & inverter assemblies	Piling Drill Rig	1	105	20
	Franna Crane	1	107	16
	Trencher	2	97	40
	Loader	1	107	40
	Generator	1	73	50
	Powered Hand Tools	10	95	50

Construction Phase	Plant Item	Number Required	Sound Power Level, dB(A)	Acoustical Usage Factor, %
a)	Construction plant used intermittently as required. Continuous use not expected.			
b)	Truck movements associated with deliveries assumed to move through site at 10 km per hour as a moving point source.			
c)	Grader required for construction of access tracks, substation, maintenance building, construction offices and car park only.			
d)	Deliveries to site only to occur during standard construction hours.			
e)	The 'Acoustical Usage Factor' represents the percentage of time that a particular item of equipment is assumed to be running at full power while working on site.			

3.4 Assessment of Impacts

For the purposes of predicting impacts associated with noise emissions from the development site on nearby sensitive receptors, noise modelling of the sources was completed using the proprietary software Cadna (version 2017 build 157.4702) developed by DataKustik. Cadna incorporates the influence of meteorology, terrain, ground type and air absorption in addition to source characteristics to predict noise impacts at receptor locations. All predictions have been undertaken in accordance with ISO Standard 9613 (1996) Acoustics - Attenuation of sound during propagation outdoors.

The model is utilised to assess the potential noise emissions from the site under a range of operating scenarios and meteorological conditions. In the event that non-compliance with the assessment criterion is predicted, the noise modelling also allows investigation of possible noise management solutions.

For the construction phase of the proposed project, predictive noise modelling has considered the range of potential impacts likely noting that noise generating activities will progressively move across the site over the duration of construction. As such, the highest noise levels would not be expected to be experienced at a single receptor for more than one day while construction equipment (e.g. piling drill rig) is at the closest point to the receptor.

Table 7 below presents predicted receptor noise levels during the construction phase of the proposed solar farm.

Table 7: Predicted Receptor Noise Levels - Construction Phase, dB(A)

Receptor	Description	Predicted Construction Noise Levels, $L_{Aeq, 15min}$	Noise Management Level		Comply (Y/N)
			Standard Hours	Outside Standard Hours	
R1	Existing receptor	37	40	35	Partial
R2	Existing receptor	21	40	35	Y
R3	Existing receptor	21	40	35	Y
R4	Existing receptor	<10	40	35	Y
R5	Existing receptor	19	40	35	Y

Review of the predicted noise levels confirms that compliance with the noise management level provided in the ICNG is predicted to be achieved for all receptors with the exception of R1 (located approximately 330 m to north of the subject site). For R1, a non-compliance of 2 dB is predicted to occur for construction outside normal hours. It is noted however that the modelling assumes operation of the piling rig at the nearest potential location to receptor R1. Given this, reasonable and feasible mitigation measures have been considered for this receptor where construction outside normal hours is required.

3.5 Mitigation of Construction Noise Levels

Receptor R1 is located within approximately 330 m from the nearest potential on-site construction activities. As noted previously, the construction works expected to generate the highest noise levels are not anticipated to be in close proximity to this receptor for an extended period.

Given the variable and mobile nature of the construction works, the use of permanent or temporary acoustic barriers is not considered feasible. Potential controls available to the construction contractor to minimise potential impacts on Receptor R1 for construction works outside normal hours could include:

- limiting the type and scale of activities undertaken outside normal construction hours;
- consultation with R1 landholder throughout the construction process to inform them on the duration and timing of potentially noisy activities
- staging construction such that activity outside normal hours is limited to works being undertaken at distances of more than 500 m from this receptor);
- using broad-band reversing alarms on all mobile plant and equipment;
- examine different types of machines that perform the same function and compare the noise level data to select the least noisy machine;
- select quieter items of plant and equipment where feasible and reasonable.;
- operating plant in a quiet and efficient manner;
- reduce throttle setting and turn off equipment when not being used; and
- regularly inspect and maintain equipment to ensure it is in good working order. Also check the condition of mufflers.

Overall, given the size of the subject site, there is potential for some construction works to be undertaken outside normal hours subject to the effective implementation of the above reasonable and feasible mitigation measures. Further, given the tendency for agricultural activities to be undertaken during evening and night periods (e.g. during harvest season etc.), construction during these periods, when undertaken concurrently with these agricultural activities is unlikely to represent a significant amenity impact for residences in the area.

4 OPERATIONAL PHASE NOISE ASSESSMENT

4.1 Operational Noise Criteria

4.1.1 Overview

The acoustic assessment has been completed in accordance with the procedure identified in the NSW INP. The INP establishes two separate noise criteria to meet environmental noise objectives: one to account for intrusive noise and the other to protect the amenity of particular land uses.

The derivation of the two sets of criteria are presented below. For residential dwellings, the noise criteria are assessed at the most-affected point (i.e. highest noise level) on or within the property boundary. Where the property boundary is more than 30 metres from the house, then the criteria applies at the most-affected point within 30 m of the house.

4.1.2 Intrusiveness Noise Criteria

Per the INP, intrusive noise refers to noise that exceeds background noise levels (as defined by the Rating Background Level) by more than 5 dB. Given the remote location of the development site and the lack of any significant activity in the area, the impact assessment has assumed baseline noise levels equivalent to the minimum background noise levels provided in the INP. Therefore, Table 8 presents the derivation of the intrusiveness criteria based on the minimum background noise level established by the INP.

Table 8: Derived Intrusiveness Noise Criteria

Receptor	Intrusiveness $L_{Aeq,15-minute}$ Criteria		
	Day	Evening	Night
All nearby residential receptors ^{a)}	35 ^{b)}	35 ^{b)}	35 ^{b)}

a) Receptor noise limit applied at a location 30 m from the dwelling façade.

b) Minimum background noise level established by the INP (30 dB(A)) + 5 dB.

4.1.3 Amenity Criteria

To limit continuing increases in noise levels, the maximum ambient noise level within an area from industrial noise sources should not normally exceed the acceptable noise levels (ANL) specified in Section 2.2 of the INP. The ANL is dependent on the type of area being considered. Table 9 presents ANL values for residential receivers in rural areas.

Table 9: INP Acceptable Noise Levels for Residential Receivers

Type of Receiver	Indicative Noise Amenity Area	Time of Day	Recommended L_{Aeq} Noise Level, dBA	
			Acceptable	Recommended Maximum
Residence	Rural	Day	50	55
		Evening	45	50
		Night	40	45

When the existing industrial noise levels approach the ANL, then the noise level from a new source must be controlled to preserve the amenity of the area. In the absence of the proposed solar farm, no other industrial noise sources have been identified in the area.

In view of this, the assessment has considered the compliance of noise emissions during the operational phase of the project against the (limiting) intrusiveness criteria presented in Section 4.1.2 above.

4.1.4 Sleep Disturbance

NSW EPA have identified the potential for noise emissions from developments to impact on the sleep of residents living in the area. To assist in reducing the potential for these impacts, the EPA released a policy statement in relation to the assessment of the potential for sleep disturbance effects. The following presents an excerpt from this policy statement:

“Peak noise level events, such as reversing beepers, noise from heavy items being dropped or other high noise level events, have the potential to cause sleep disturbance. The potential for high noise level events at night and effects on sleep should be addressed in noise assessments for both the construction and operational phases of a development.”

For the operational phase of the project, loud impact noises associated with sleep disturbance are considered unlikely with all plant and equipment continuous or semi-continuous in its operations. Furthermore, the operation of plant and equipment on-site is expected to only occur during daylight hours where solar energy is available with peak operations.

Given the lack of short-term impact noise sources on site consideration of sleep disturbance impacts for the operational phase of this project is considered unnecessary. Rather, where compliance can be demonstrated with the intrusive noise criteria established for the development, compliance with the sleep disturbance provisions would also be expected.

4.2 Noise Sources

The Walgett Solar Farm is to consist of solar photovoltaic (PV) plant and associated infrastructure producing up to 30 Megawatts of electricity for supply into the grid. It is expected that, at completion, infrastructure installed on site will incorporate:

- a total of 90,909 solar panels;
- up to 14 solar inverters with integrated transformers; and
- a high-voltage step-up transformer.

The PV panels are expected to be mounted onto fixed support structures in one of two manners, these being:

- Single axis tracking panels which track the sun's movement across the day through the use of small motors which rotate the panel arc of the sun to maximise the solar effect;
- Fixed panels tilted to face either the north or east dependent on detailed design.

The selection of the panel mounting option to be adopted for the Walgett Solar Farm will be determined during detailed design. For the purposes of the noise impact assessment however, it has been assumed that single axis tracking panels will be installed. This represents a worst-case assumption with noise emissions from the tracking motors expected to occur for approximately one minute out of each 15-minute period (providing for up to five degrees rotation per hour) during day periods.

Based on the size of the Walgett Solar Farm (30 MW AC generation capacity) it is expected that approximately 1,304 NexTracker tracking motors would be required. For the purposes of the assessment it is assumed that these tracking motors would be evenly distributed across the development area.

Placement of the required inverters is also expected to be finalised during the detailed design phase of the project. It is noted that a number of options are available to the project team for consideration during detailed design. Generally, these include:

- Installation of 14 smaller 2.2 MW inverters (e.g. Sunny Central SC2200); or
- Installation of 6 larger 4.91 MW inverters (e.g. Ingeteam CON40).

For the purposes of the assessment, the potential impacts for both the inverter options has been considered with an inverter located on the boundary of the subject site at the nearest potential location to each of the receptors (for the smaller inverter) and 400 m from the nearest receptor for the larger inverter assembly. It is noted that this represents a conservative assessment with the actual design expected to be evenly spaced across the site to minimise cabling costs.

A single transformer is expected to be required for the proposed solar farm to allow connection of the solar farm to the power grid. At this stage the location of the transformer has not been confirmed however, it is considered likely that it would be located near to the south-eastern corner of the development site to minimise the costs associated with cabling to the existing Essential Energy zone substation.

Table 10: Source Noise Levels

Source	Sound Power Level (dB(A))
NexTracker	58 (each)
Inverter ^{a)}	95 – 102 (each)
Transformer	75
Light Vehicle	88

a) Based on previous experience with similar sources there is potential for tonal influences associated with this source. Therefore, in accordance with the INP, a +5 dB penalty has been applied to this source.

The sound power levels for the plant and equipment presented in the above table are provided by the manufacturer or taken from information held in our library.

4.3 Noise Modelling Methodology

For the purposes of predicting impacts associated with noise emissions from the development site on nearby sensitive receptors, noise modelling of the sources was completed using the proprietary software Cadna (version 2017 build 157.4702) developed by DataKustik. Cadna incorporates the influence of meteorology, terrain, ground type and air absorption in addition to source characteristics to predict noise impacts at receptor locations. All predictions have been undertaken in accordance with ISO Standard 9613 (1996) Acoustics - Attenuation of sound during propagation outdoors.

The model is utilised to assess the potential noise emissions from the site under a range of operating scenarios and meteorological conditions. The noise modelling also allows investigation of possible noise management solutions, in the event that non-compliance with the assessment criterion is predicted.

4.4 Meteorology

The NSW Industrial Noise Policy (INP) presents guidelines for the consideration of meteorological effects on noise propagation. Specifically, temperature inversions and/or gradient winds should be modelled if each factor is a feature of the local environment. The following conditions for modelling temperature inversions or gradients winds are provided:

- temperature inversions:
 - use default parameters for temperature inversions and drainage-flow wind speed where inversions are present for at least 30 percent of the total night time during winter as specified; or
 - use parameters determined by direct measurement. Wind data should be collected at a 10 m height.
- gradient winds:
 - where there is 30 percent or more occurrence of wind speeds below 3 m/s (source-to-receiver component), then the highest wind speed (below 3 m/s) is used instead of the default.
 - where there is less than 30 percent occurrence of wind speeds of up to 3 m/s (source-to-receiver component), wind is not included in the noise prediction calculation.

Given the location of the site, the presence of temperature inversions is considered possible for night-periods. Therefore, in accordance with the requirements of the INP, the following scenarios have been considered:

- Day Periods - Source to receptor wind at 3 m/s representing a worst-case assessment of potential impacts for day-periods; and
- Night Periods - Moderate temperature inversion with light source to receptor winds representing a worst-case assessment of potential impacts for night periods.

4.5 Predicted Noise Levels

Table 11 below presents predicted receptor noise levels during the operational phase of the proposed solar farm. Review of the predicted noise levels confirms that compliance with the intrusive noise criteria established in accordance with the INP can be achieved for all receptors for both day and night periods under worst-case meteorological conditions.

Table 11: Predicted Receptor Noise Levels - Operational Phase, dB(A)

Receptor	Predicted Operational Noise Levels, $L_{Aeq, 15min}$		Intrusive Noise Criteria ^{a)}	Comply (Y/N)
	Day Periods	Night Periods		
R1	35	35	35	Y
R2	29	29	35	Y
R3	28	28	35	Y
R4	22	22	35	Y
R5	12	12	35	Y

a) Intrusive noise criteria for day, evening and night periods

Given the predicted compliance with the noise limits derived in accordance with the INP, no further noise mitigation is considered necessary.

5 ROAD TRAFFIC NOISE ASSESSMENT

5.1 Introduction

Noise impacts associated with vehicle movements during the operational phase of the Walgett Solar Farm project are expected to be negligible given the small number of movements expected (maximum of 4 per day). During the construction phase of the project however, significantly higher traffic volumes are expected for the duration of the construction works.

Construction is expected to be completed over a 9 month period with an expected peak period of 5 months during which a range of construction tasks are concurrently undertaken. During this peak it is anticipated that up to 85 workers would be on-site daily, dropping to 20 workers for the 4 month shoulder periods.

While it is expected that the contractor would provide a shuttle bus service, for assessment purposes it is assumed that only 30% of the 85 workers would participate in some form of carpooling. Therefore, the modelling has assumed an estimated maximum of 60 private light vehicles travelling to and from the site daily for this peak period.

Estimates of total heavy vehicle movements associated with the delivery of farm infrastructure and associated materials and resources to build the WSF are provided in

Table 12 presents estimates of total heavy vehicle movements associated with the delivery of farm infrastructure and associated materials and resources to build the Walgett Solar Farm. The maximum number of heavy vehicles accessing the site during the peak of the construction period is not expected to exceed 20 (i.e. generating a total of 40 heavy vehicle movements in a day).

Table 12 : Construction Phase Traffic Generation

Plant/Equipment	Description	Heavy Vehicles
Modules	The ~90,909 modules, with a combined weight of 2,182 tonne, could be delivered in 44 x 50 tonne B-doubles	44
Mounting frames	The ~16 tonne of mounting frames could be delivered in two (2) semi-trailers	2
Piles	The 39,130 piles could be delivered in 82 x B-doubles	82
Inverter Stations	The 150 tonne of inverter stations (whether it be 14 of the 2.2 MW units or 6 of the 4.92 MW units), could be delivered in 3 x 50 tonne B-doubles.	3
Transformer	One (1) overmass vehicle would be required to deliver transformer for the step-up substation	1
Concrete	Estimate 360 m ³ required for sub-station compound, inverter assembly foundations and security fence, would generate 33 X 11m ³ concrete trucks.	33
Gravel	Estimated 1,800m ³ of gravel (2,700 tonne) for upgrade of access road would be delivered in 54 x 50 tonne truck & dog trailers	54

Plant/Equipment	Description	Heavy Vehicles
Sand	Estimated 500m ³ of sand (~800 tonne) would be delivered in 16 x 50 tonne truck & dog trailers	16
Water	Estimated 3 ML based on 50 kL/day in dry/windy conditions for dust suppression (assumed to be 50% of days during the 5 month construction peak period) delivered in 112 x 27 kL bulk tankers	112
Miscellaneous	Provision for miscellaneous deliveries based on three (3) incidental heavy vehicles a week for the 9 month construction period	108
Total		455

Given this, the assessment has considered the potential impacts associated with noise emissions from the maximum expected 120 light and 40 heavy vehicle movements from the site entry along the local access road onto the Castlereagh Highway as summarised in Table 13 below.

Table 13: Summary of Road Traffic Data

Road Segment	Vehicle Type	Vehicle Speed	Number of Movements	
			Day (7 am to 10 pm)	Night (Peak 1-hour)
Castlereagh Highway	Light	100 km/hr	120	60
	Heavy	100 km/hr	40	0
Local Access Road	Light	60 km/hr	120	60
	Heavy	40 km/hr	40	0

a) Assumes all truck deliveries to site occur during the hours of 7 am to 10 pm.

5.2 Assessment Criteria

The ICNG does not provide criteria for the assessment of construction road traffic during the project. Given this, reference is made to the noise criteria provided in the NSW Road Noise Policy (RNP). Based on the type of roadway, Table 14 below presents the applicable road traffic noise criteria for existing residences affected by traffic on existing roadways generated by land use developments.

Table 14: Applicable Road Traffic Noise Criteria

Road Category	Type of Project & Land Use	Assessment Criteria
Local roads	Existing residences affected by additional traffic on existing local roads generated by land use developments	Day: L _{Aeq,1 hour} 55 dB(A) Night: L _{Aeq,1 hour} 50 dB(A) (external)
Freeway / arterial / sub-arterial road	Existing residences affected by additional traffic on existing freeways/arterial/sub-arterial roads generated by land use developments	Day: L _{Aeq,15 hour} 60 dB(A) Night: L _{Aeq,9 hour} 55 dB(A) (external)

5.3 Noise Modelling Methodology

For the purposes of predicting impacts associated with road traffic noise emissions was completed using the proprietary software Cadna (version 2017 build 157.4702) developed by DataKustik. The model incorporates the influence of terrain, ground type and air absorption in addition to source characteristics to predict noise impacts at receptor locations. All predictions have been undertaken in accordance with Calculation of Road Traffic Noise (CRTN) methodology developed by the UK Department of Transport. In accordance with the requirements of the RNP, the predictive noise modelling incorporated the following assumptions:

- L_{Aeq} values were calculated from the L_{A10} values predicted by the CRTN methodology using the approximation $L_{Aeq,1\text{ hour}} = L_{A10,1\text{ hour}} - 3$.
- Noise source heights were set at 0.5 m above road level for cars, 1.5 m for heavy vehicle engines and 3.6 m for heavily vehicle exhausts.
- Noise from heavy vehicle exhausts is 8 dB lower than the steady continuous engine noise; and
- Corrections established for Australian conditions applied through a negative correction to the CRTN predictions of -1.7 dB for façade-corrected levels (Samuels and Sauders, 1982).

Table 15 below presents predicted noise levels for the nearest potential receptor to the Castlereagh Highway assuming a minimum setback distance of 20 m. It should be noted that this is considered to represent a conservative assumption with the majority of dwellings along Castlereagh Highway noted to be setback considerable further than this.

Review of the predicted noise level presented in Table 15 below confirms that compliance with the RNP is predicted by a considerable margin. Given this, adverse amenity impacts due to peak traffic levels generated by the proposed construction works is considered unlikely.

Table 15: Predicted $L_{Aeq,15\text{ hour}}$ Noise Levels - Road Traffic Noise

Receptor	Setback from Roadway	Period	Parameter	Criteria	Predicted Noise Level	Comply (Y/N)
Nearest to Castlereagh Highway	20 m	Day	$L_{Aeq,15\text{ hour}}$	60 dB(A)	48 dB(A)	Y
		Night	$L_{Aeq,9\text{ hour}}$	55 dB(A)	49 dB(A)	
Nearest to Local Access Roadway (R5)	190 m	Day	$L_{Aeq,1\text{ hour}}$	55 dB(A)	44 dB(A)	Y
		Night	$L_{Aeq,1\text{ hour}}$	50 dB(A)	44 dB(A)	Y

6 VIBRATION ASSESSMENT

6.1 Introduction

A review of the proposal indicates there is potential for impacts as a result of vibration generated by plant and equipment during the construction phase. Given this, an assessment of the potential for vibration impacts has been undertaken. In particular, the assessment has considered the potential for impacts on both human comfort and structural damage for the nearest residence to the construction works.

6.2 Assessment Criteria

The vibration criteria presented in the Environmental Noise Management – Assessing Vibration: A Technical Guide (2006) published by the NSW Department of Environment Climate Change and Water (DECCW) have been adopted for the assessment. The technical guide provides vibration criteria associated with amenity impacts (human annoyance) for the three categories of vibration:

- Continuous vibration (e.g. road traffic, continuous construction activity);
- Impulsive vibration includes less than 3 distinct vibration events in an assessment period (e.g. occasional dropping of heavy equipment); and
- Intermittent vibration includes interrupted periods of continuous vibration (e.g. drilling), repeated periods of impulsive vibration (e.g. pile driving) or continuous vibration that varies significantly in amplitude.

Table 16 and Table 17 present the criteria for continuous and impulsive vibration and intermittent vibration, respectively.

Table 16: Continuous & Impulsive Vibration Criteria for Residences – Peak Velocity

Location	Vibration Type	Preferred Limit (mm/s)	Maximum Limit (mm/s)
Residences	Continuous	0.28	0.56
Residences	Impulsive	8.6	17

Table 17: Intermittent Vibration Criteria for Residences

Location	Assessment Period	Preferred Value (m/s ^{1.75})	Maximum Value (m/s ^{1.75})
Residences	Day-time	0.20	0.40

The above criteria are suitable for assessing human annoyance in response to vibration levels. In order to assess potential damage to buildings, reference has been made to British Standard BS 7385-2: 1993 Evaluation and measurement for vibration in buildings – Part 2: Guide to damage levels from ground borne vibration. Table 18 presents vibration criteria for assessing the potential for building damage.

Table 18: Transient Vibration Guide Values for Cosmetic Damage

Type of Building	Peak Particle Velocity (mm/s)	
	4 Hz to 15 Hz	15 Hz and above
Unreinforced or light framed structures – residential or light commercial type buildings	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz	20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above

6.3 Potential Vibration Sources

Table 19 identifies the vibration source levels for the equipment and likely to be used for the construction of the solar farm.

Table 19: Vibration Source levels – Peak Particle Velocity

Equipment Item	PPV at 10 metres (mm/s)	Source
Piling	1 – 2	Rockhill, D.J. et. al. ^{b)}
Roller	5 – 6	DECCW
7 tonne compactor	5 – 7	DECCW
Loaded trucks (rough surface)	5	USA DT ^{a)}
Loaded trucks (smooth surface)	1 – 2	USA DT ^{a)}
Excavator	2.5 – 4	DECCW

a) Transit Noise and Vibration Impact Assessment, US Department of Transportation, May 2006.

b) Rockhill, D.J., Bolton, M.D. & White, D.J. (2003) 'Ground-borne vibrations due to press-in piling operations'

6.4 Assessment of Potential Impacts

Based on the vibration source levels at 10 metres (presented in Table 19), peak particle velocities have been predicted at various separation distances. The NSW DECCW indicates that in predicting vibration levels, it can be assumed that the vibration level is inversely proportional to distance (with the relationship varying between $d^{-0.8}$ to $d^{-1.6}$ based on field data).

The US Department of Transportation's Transit Noise and Vibration Impact Assessment (May 2006) presents the following construction vibration propagation formula assuming an inverse relationship:

$$PPV@d_2 = PPV@d_1 \times (d_1/d_2)^{1.5}$$

where: d_1 = distance 1 (reference distance for source data) (m)

d_2 = distance 2 (separation distance for predicted PPV) (m)

PPV = peak particle velocity (mm/s)

The above formula has been considered for predicted PPVs at various distances from construction equipment. Based on the above information, Table 20 presents PPV predictions for the various construction equipment.

Table 20: Predicted Peak Particle Velocity at Sensitive Receptors (mm/s)

Distance from Source (m)	Predicted Peak Particle Velocity (mm/s)					
	Roller	7 tonne compactor	Excavator	Piling	Loaded trucks (rough surfaces)	Loaded trucks (smooth surfaces)
10	6.00	7.00	4.00	0.35 - 0.71	5.00	1 – 2
20	2.12	2.47	1.41	0.19 - 0.38	1.77	0.35 – 0.71
30	1.15	1.35	0.77	0.13 - 0.25	0.96	0.19 – 0.38
40	0.75	0.88	0.50	0.09 - 0.18	0.63	0.13 – 0.25
50	0.54	0.63	0.36	0.07 - 0.14	0.45	0.09 – 0.18
60	0.41	0.48	0.27	0.05 - 0.11	0.34	0.07 – 0.14
70	0.32	0.38	0.22	0.04 - 0.09	0.27	0.06 – 0.11
80	0.27	0.31	0.18	0.04 - 0.07	0.22	0.05 – 0.09
90	0.22	0.26	0.15	0.03 - 0.06	0.19	0.04 – 0.07
100	0.19	0.22	0.13	0.02 - 0.03	0.16	0.03 – 0.06
150	0.1	0.12	0.07	0.35 - 0.71	0.09	0.02 – 0.03
Type	Continuous	Continuous	Continuous	Intermittent	Intermittent	Intermittent
Nuisance Criteria	Residential 0.28 (preferred) / 0.56 (max) School 0.56 (preferred) / 1.1 (max)					
Building Criteria	Residential 15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz 20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above					

The predicted vibration levels presented in Table 20 indicate compliance with the continuous preferred vibration nuisance criteria for locations at a separation distance of 50-60 metres. Compliance with the building damage criteria is predicted at 10 metres from construction for each source.

For intermittent vibration associated with haul vehicles and piling, it is difficult to provide an appropriate comparison with the relevant criteria (which is presented as a Vibration Dose Value (VDV) in $m/s^{1.75}$). The calculation of a VDV requires both the overall weighted RMS (root mean square) acceleration (m/s^2) typically obtained from on-site measurements and the estimated time period for vibration events.

It is noted, however, that the piling PPV at distances of 330 m (the distance to the nearest sensitive receptor from potential piling) is predicted to be within the maximum continuous

criteria of 0.56 mm/s. This comparison with the continuous criteria (as a conservative approach) indicates that vibration levels associated with piling are not considered to be significant (which is expected given the significant separation distances).

7 CONCLUSIONS AND RECOMMENDATIONS

Walgett Solar Pty Ltd propose to construct a 30 MW solar farm (to be known as the Walgett Solar Farm) across three land parcels (Lot 49 DP 752271, Lot A DP 418888 and Lot 1 DP 822477).

The area surrounding the proposed development is sparsely populated with dominant activities including a range of agricultural and rural uses.

The impact assessment has considered the potential for adverse impacts resulting from noise (construction, road traffic and operational) and vibration (construction) emissions on nearby residential uses.

The assessment of potential noise impacts has considered both construction during normal hours and outside normal hours. For construction during normal hours, adverse amenity impacts during the construction phase of the project are considered unlikely. For construction works undertaken outside normal hours, significant amenity impacts are considered unlikely where the following management measures are implemented:

- limiting the type and scale of activities undertaken outside normal construction hours;
- limiting deliveries to the site to between the hours of 7 am to 10 pm;
- consultation with RI landholder throughout the construction process to inform him on the duration and timing of potentially noisy activities
- staging construction such that activity outside normal hours is limited to works being undertaken at distances of more than 500 m from this receptor);
- using broad-band reversing alarms on all mobile plant and equipment;
- examine different types of machines that perform the same function and compare the noise level data to select the least noisy machine;
- select quieter items of plant and equipment where feasible and reasonable;
- operating plant in a quiet and efficient manner;
- reduce throttle setting and turn off equipment when not being used; and
- regularly inspect and maintain equipment to ensure it is in good working order. Also check the condition of mufflers.

For the operational phase of the project, adverse amenity impacts are considered unlikely providing the final site layout adopted for the development maintains a minimum separation distance of 400 m between any sensitive receptor and the larger (4.91 MW) solar inverter plant items (where used).

Overall, based on the results of the assessment, the risk of adverse impacts as a result of the proposed Walgett Solar Farm is considered to be low. Hence, from an acoustic perspective, the proposed development site is considered acceptable for the proposed use.

APPENDIX A: GLOSSARY OF TERMS

A-Weighting	A response provided by an electronic circuit which modifies sound in such a way that the resulting level is similar to that perceived by the human ear.
dB (decibel)	This is the scale on which sound pressure level is expressed. It is defined as 20 times the logarithm of the ratio between the root-mean-square pressure of the sound field and the reference pressure (0.00002 N/m ²).
dB(A) or dBA	This is a measure of the overall noise level of sound across the audible spectrum with a frequency weighting (i.e. 'A' weighting) to compensate for the varying sensitivity of the human ear to sound at different frequencies.
Free-field	Refers to a sound pressure level determined at a point away from reflective surfaces other than the ground with no significant contribution due to sound from other reflective surfaces; generally, as measured outside and away from buildings.
L _{Aeq}	This is the equivalent steady sound level in dB(A) containing the same acoustic energy as the actual fluctuating sound level over the given period. Noise levels often fluctuate over a wide range with time. Therefore, when a noise varies over time, the L _{Aeq} is the equivalent continuous sound which would contain the same sound energy as the time varying sound. Many studies show that human reaction to level-varying sounds tends to relate closer to the L _{Aeq} noise level than any other descriptor.