Appendix G

Noise and vibration impact assessment

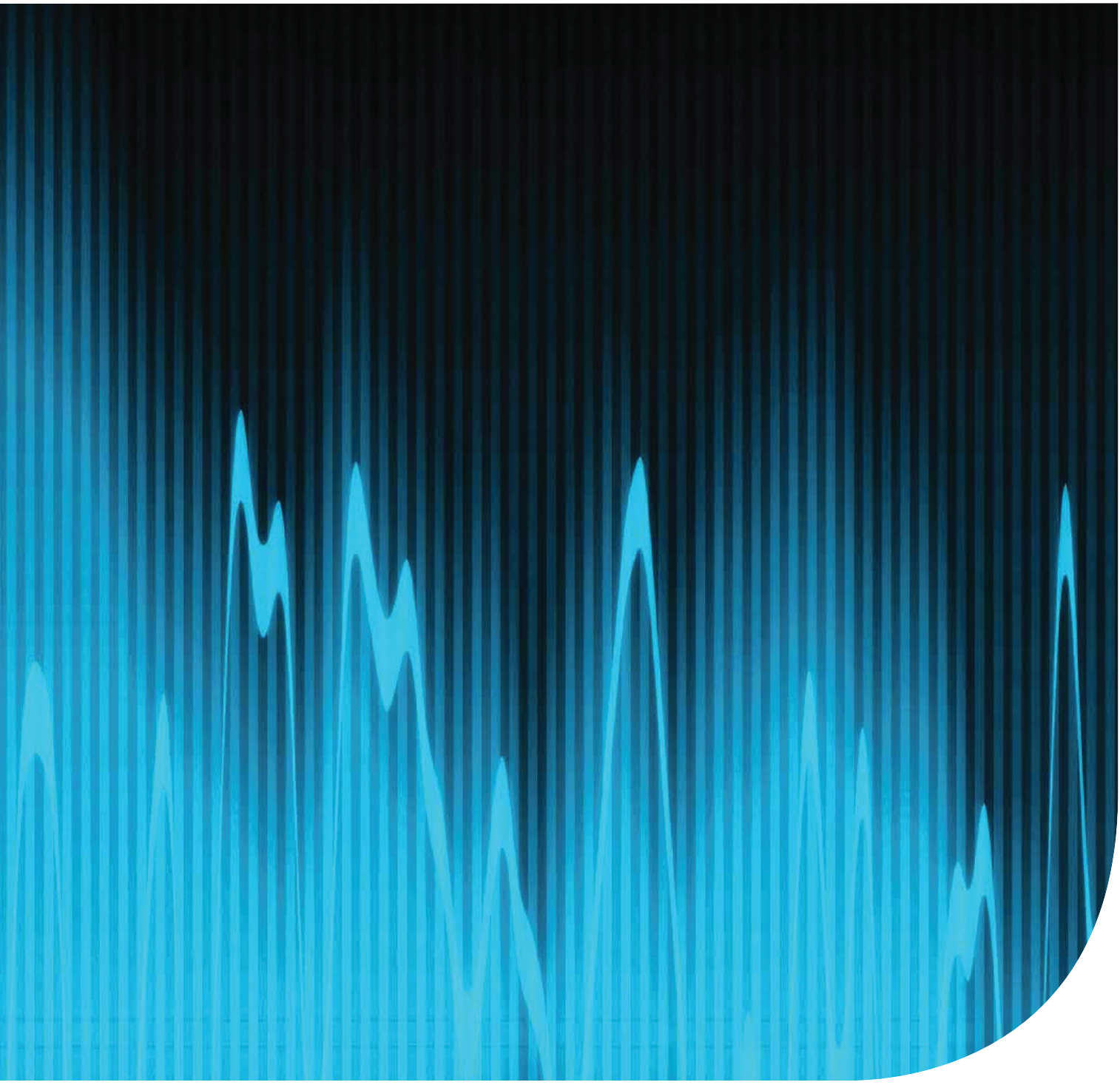
Hillston Sun Farm

Overland Sun Farming

Hillston Sun Farm

Noise and vibration impact assessment

Prepared for OVERLAND Sun Farming Pty Ltd | HΦ June 2017



Hillston Sun Farm

Noise and vibration impact assessment

Prepared for OVERLAND Sun Farming Pty Ltd | 29 June 2017

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Hillston Sun Farm

Final

Report J16135RP1 | Prepared for OVERLAND Sun Farming Pty Ltd | 29 June 2017

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1 Introduction

1.1 Overview

OVERLAND Sun Farming Pty Ltd (OVERLAND) proposes to develop the Hillston Sun Farm, a large-scale solar photovoltaic (PV) generation facility and associated infrastructure in the Riverina region of south-western NSW (the project). OVERLAND proposes to develop the project on a site within the Carrathool Shire local government area (LGA), approximately 3.5 kilometres (km) south of the township of Hillston.

The project is a State significant development (SSD) under the State Environmental Planning Policy (State and Regional Development) 2011 (SRD SEPP). A development application (DA) for the project is required to be submitted under Part 4, Division 4.1 of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act). The NSW Minister for Planning, or the Minister's delegate, is the consent authority.

An environmental impact statement (EIS) is a requirement of the approval process. This noise and vibration impact assessment (NVIA) report forms part of the EIS. It documents the NVIA methods and results, the initiatives built into the project design to avoid and minimise noise and vibration associated impacts, and the additional mitigation and management measures proposed to address any residual impacts not able to be avoided.

1.2 Assessment guidelines and requirements

This NVIA has been prepared in accordance with the relevant governmental assessment requirements, guidelines and policies, and in consultation with the relevant government agencies.

The NVIA was prepared with reference to the methods outlined in:

- NSW Department of Environment and Climate Change (DECC) 2009, *Interim Construction Noise Guideline* (ICNG);
- NSW Environment Protection Authority (EPA) 2000, *NSW Industrial Noise Policy* (INP);
- NSW Department of Environment Climate Change and Water (DECCW) 2011, *Road Noise Policy* (RNP);
- NSW Department of Environment and Conservation (DEC) 2006, *Assessing Vibration: a technical guideline*; and
- Australian Standard AS 2436-2010 *Guide to Noise and Vibration Control on Construction, Maintenance and Demolition Sites*.

The NVIA was prepared in accordance with the requirements of the NSW Department of Planning and Environment (DPE). These were set out in the Secretary's Environmental Assessment Requirements (SEARs) for the project, issued on 14 October 2016. The SEARs identify matters which must be addressed in the EIS. A copy of the SEARs is attached to the EIS as Appendix A, while Table 1.1 lists the individual requirements relevant to this NVIA and where they are addressed in this report.

Table 1.1 Relevant SEAR

DPE requirement	Section addressed
Construction noise impact assessment in accordance with the ICNG	Section 6.4
Construction road traffic noise impact assessment in accordance with the RNP	Section 6.5
Operational noise impact assessment in accordance with the INP	Chapter 8.0
Noise Management Plan if noise is likely to exceed the relevant criteria	Not required - noise from the project is unlikely to exceed the relevant criteria
Cumulative construction noise impact assessment	Section 6.6
Cumulative traffic noise impact assessment	Section 6.6

To inform preparation of the SEARs, DPE invited other government agencies to recommend matters to be addressed in the EIS. These matters were taken into account by the Secretary for DPE when preparing the SEARs. Copies of the government agencies' advice to DPE were attached to the SEARs. However, no additional matters were recommended in regards to noise and vibration.

Several technical terms are required for the discussion of noise and vibration. These are explained in Appendix A.

2 Project and site description

2.1 Project description

The project comprises a large-scale solar photovoltaic (PV) generation facility and associated infrastructure on the site. The project will connect to the Essential Energy 132 kV electricity distribution network that originates at the Hillston Substation.

The project comprises the following key components:

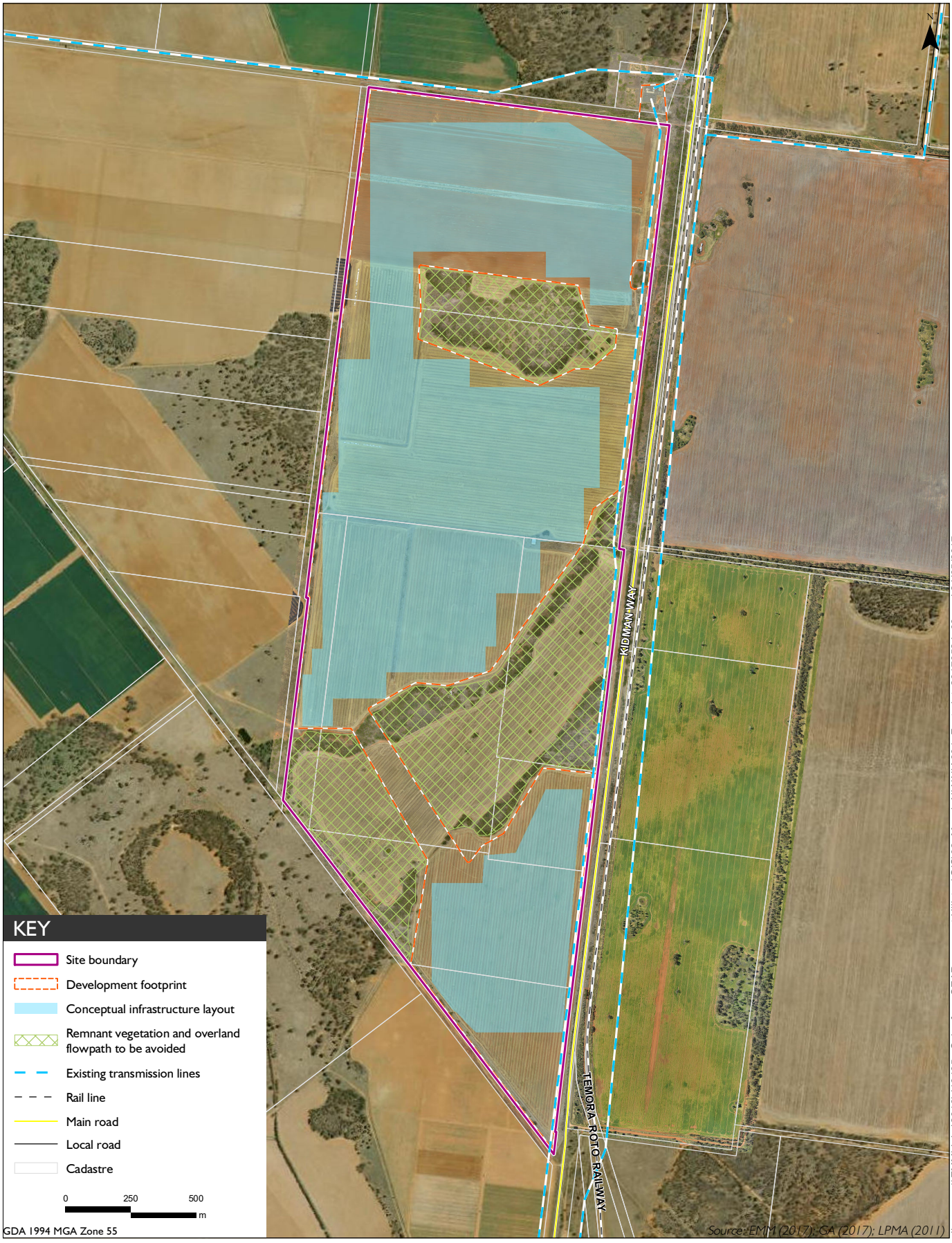
- a network of PV solar panel arrays;
- electrical collection systems, switchyard and control room;
- a management hub, including demountable offices and amenities and equipment sheds;
- parking and internal access roads; and
- easement and connection infrastructure to the Hillston Substation.

The proposed hours of construction activities are Monday to Friday between 7 am to 6 pm and Saturday between 8 am and 1 pm. No work will occur on Sundays or public holidays. It is important to note that these proposed construction hours are consistent with the ICNG recommended standard hours.

The expected total duration of the proposed constructions is estimated to be approximately 12 months.

2.2 Site description

The site is to the west of Kidman Way, 3.5 km south of the township of Hillston, and within the Carrathool Shire Local Government Area (LGA). The site has previously been disturbed through land clearing, cropping and livestock grazing. The development footprint within the site boundary has been refined on the basis of grid connection studies, environmental constraints identification and design of project infrastructure with the objective of developing an efficient project that avoids and minimises environmental impacts. The site boundary and project footprint are shown on Figure 2.1.



Site boundary and project footprint

Hillston Sun Farm

Construction noise and vibration impact assessment

Figure 2.1

EMM

3 Existing environment

3.1 Noise sensitive receivers

The nearest residential receiver is approximately 700 m from the site, with a further seven residential receivers located between approximately 1 km and 2.4 km from site. Noise has been assessed at these sensitive receivers (referred to herein as assessment locations) to quantify potential construction and operational noise levels from the project. No other sensitive land uses have been identified around the project. The assessment locations are presented in Table 3.1 and Figure 3.1.

Table 3.1 Noise assessment locations

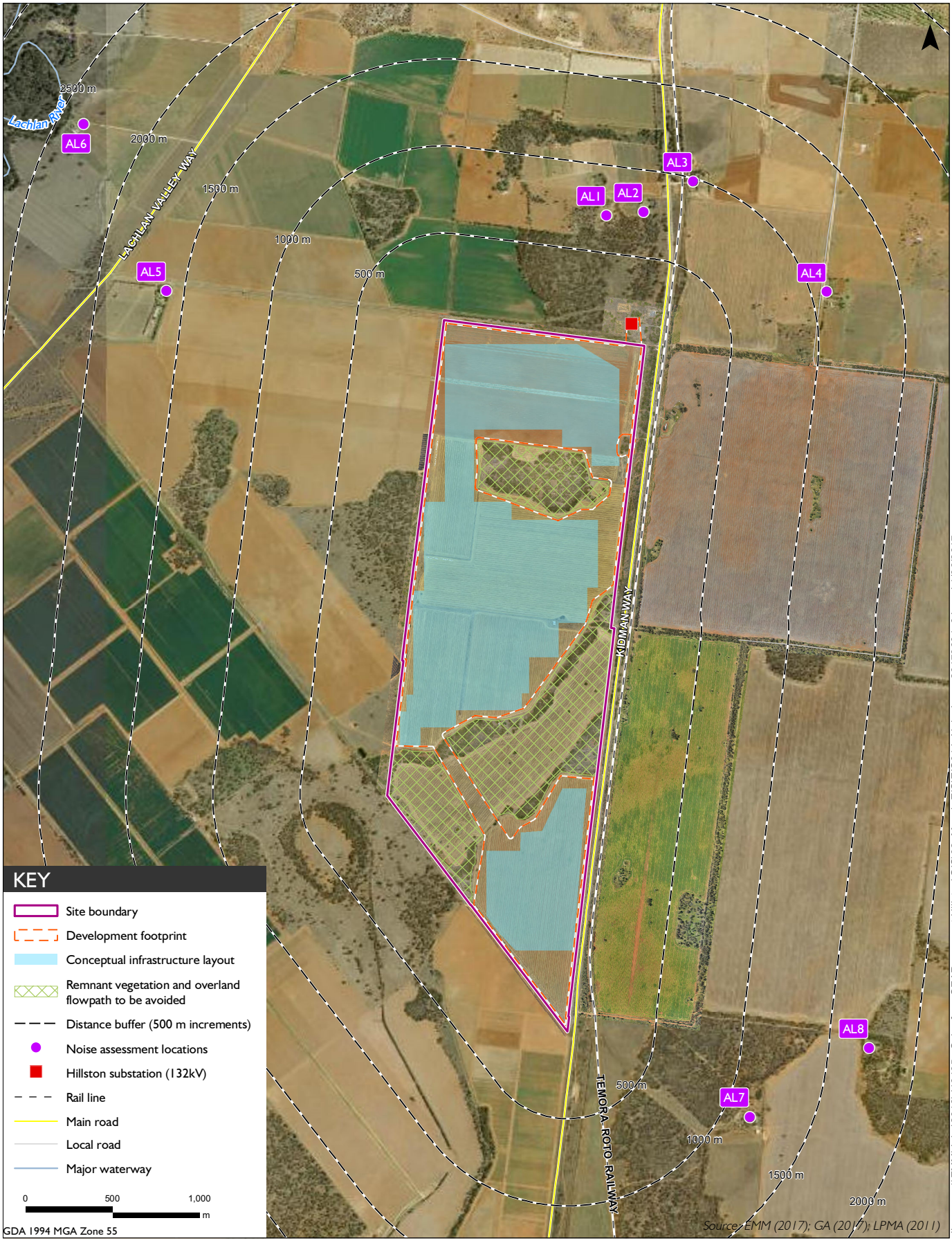
Assessment location ID	Land use[1]	Approximate distance from site boundary (km)
AL1	Residential	0.7
AL2	Residential	0.7
AL3	Residential	1.0
AL4	Residential	1.0
AL5	Residential	1.6
AL6	Residential	2.4
AL7	Residential	1.1
AL8	Residential	1.7

Notes: 1. As defined in the NSW INP and NSW ICNG.

3.2 Acoustic environment

Given the area and surrounding agricultural land uses, existing ambient noise levels at assessment locations are likely to be dominated by rural noise sources and road traffic noise. The rating background noise levels (RBLs) are expected to be relatively low (eg 30 dB) and therefore the INP minimum RBL of 30 dB has been adopted for this assessment.

As described in Chapter 1, the project would adopt the recommended standard construction hours as per the ICNG (DECC 2009) which are Monday to Friday 7 am to 6 pm, Saturday 8 am to 1 pm with no construction work on Sundays or public holidays.



Noise assessment locations

Hillston Sun Farm

Construction noise and vibration impact assessment

Figure 3.1

EMM

4 Construction noise guidelines

4.1 Objectives

Construction noise objectives aim to minimise the noise impacts from construction activities on surrounding sensitive receivers. This section provides a summary of applicable noise objectives for the proposed activities.

These noise objectives were used to derive site specific construction noise management levels that assessed the potential noise levels from the proposed works and guided the requirements for mitigation or management thereof.

4.2 Interim construction noise guideline

The assessment and management of noise from construction works is completed using the ICNG (DECC 2009), which provides two methods for the assessment of construction noise emissions:

- quantitative: suited to major construction projects with typical durations of more than three weeks; and
- qualitative: suited to short term construction activity (less than three weeks).

The method for a quantitative assessment requires a more complex approach, involving noise emission predictions from construction activities to the nearest sensitive receivers, whilst the qualitative assessment methodology is a more simplified approach that relies more on noise management strategies.

Due to the anticipated duration of the proposed construction works (ie greater than three weeks), this study has adopted a quantitative assessment approach. The assessment includes quantification of potential noise impacts at receivers and provides construction noise management levels for activities that are proposed.

The ICNG recommends that where noise levels from construction during out of hours (OOH) periods are above the noise affected level (RBL + 5 dB) all feasible and reasonable mitigation should be adopted. The ICNG requires a strong justification for construction works outside of standard construction hours. However, no OOH construction works or deliveries are expected during the proposed construction works.

Table 4.1 is an extract from the ICNG and provides noise management levels for residential receivers during and outside of standard construction hours.

Table 4.1 ICNG residential noise management levels

Time of day	Management level $L_{Aeq\ (15\ min)}$	How to apply
Recommended standard hours: Monday to Friday 7 am to 6pm Saturday 8 am to 1 pm No work on Sundays or public holidays.	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 LAeq (15 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.
	Highly noise affected 75 dB.	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: i) 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; and ii) 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 above the noise affected level, the proponent should negotiate with the community. • For guidance on negotiating agreements see section 7.2.2.

The project specific construction noise management levels (NMLs) for this assessment have been based on the adopted INP minimum RBL of 30 dB(A) in accordance with the ICNG (DECC 2009). The NMLs are shown in Table 4.2.

Table 4.2 Construction noise management levels

Assessment locations	Period	Adopted RBL, dB(A)	NML, $L_{Aeq(15\text{-}min)}$ (RBL + 10 dB)
AL1-AL8	**Standard hours**[1]	30	40 75 (highly affected)

Notes: 1. Standard hours as per the ICNG are Monday to Friday from 7 am to 6 pm, Saturday from 8 am to 1 pm, no work on Sundays and public holidays.

4.3 Road traffic noise

The principle guidance for assessing the impact of road traffic noise on receivers is in the NSW EPA's RNP (DECCW 2011).

It is anticipated that road trucks will deliver all equipment and material (eg posts, frames, cables, PV solar panels, inverters etc) to site. The site will be accessed from the eastern boundary via Kidman Way, with most vehicles originating from the south, and some from the north of the access road (along Kidman Way).

The sections of Kidman Way leading to the project are classified as an arterial road. Table 4.3 presents the road noise assessment criteria for this road category and are reproduced from Table 3 of the RNP (DECCW 2011). It should be noted that such criteria apply to permanent situations and is therefore conservative for the temporary nature of the construction activities.

Table 4.3 Road traffic noise assessment criteria for residential land uses

Road category	Type of project/development	Assessment criteria, dB(A)	
		Day (7 am to 10 pm)	Night (10 pm to 7 am)
Freeway/arterial/sub-arterial roads	Existing residences affected by additional traffic on existing freeway/arterial/sub-arterial roads generated by land use developments.	$L_{eq(15\text{-}hr)}$ 60 (external)	$L_{eq(9\text{-}hr)}$ 55 (external)

The RNP states that where existing road traffic noise criteria are already exceeded, any additional increase in total traffic noise level should be limited to 2 dB, after consideration of all feasible and reasonable noise mitigation and management measures.

In addition to meeting the assessment criteria, any significant increase in total traffic noise at residences where existing road traffic noise level is low (eg 30 dB(A)) or below the relevant assessment criteria (Refer Table 4.3) must be considered. Residences likely to experience an increase in total traffic noise level above the criteria presented in Table 4.4 should be considered for mitigation. It should be noted that the relative increase criterion does not apply to local roads, as per Section 2.4 of the RNP (DECCW 2011).

Table 4.4 Relative increase criteria for residential land uses

Road category	Type of project/development	Total traffic noise level increase, dB	
		Day (7 am to 10 pm)	Night (10 pm to 7 am)
Freeway/arterial/sub-arterial roads and transit ways	New road corridor/redevelopment of existing road/land use development with the potential to generate additional traffic on existing road.	Existing traffic $L_{Aeq(15\text{-}hr)}$+12 dB (external)	Existing traffic $L_{Aeq(9\text{-}hr)}$+ 12 dB (external)

5 Construction vibration criteria

5.1 Human comfort – Assessing vibration a technical guideline

Environmental Noise Management – Assessing Vibration: a technical guideline (DEC 2006) is based on guidelines contained in *BS 6472 – 2008, Evaluation of human exposure to vibration in buildings (1-80Hz).*

The guideline presents preferred and maximum vibration values for use in assessing human responses to vibration and provides recommendations for measurement and evaluation techniques. At vibration values below the preferred values, there is a low probability of adverse comment or disturbance to building occupants. Where all feasible and reasonable mitigation measures have been applied and vibration values are still beyond the maximum value, it is recommended the operator negotiate directly with the affected community.

The guideline defines three vibration types and provides direction for assessing and evaluating the applicable criteria. Table 2.1 of the guideline provides examples of the three vibration types and has been reproduced in Table 5.1.

Table 5.1 Examples of types of vibration

Continuous vibration	Impulsive vibration	Intermittent vibration
Machinery, steady road traffic, continuous construction activity (such as tunnel boring machinery).	Infrequent: Activities that create up to 3 distinct vibration events in an assessment period, e.g. occasional dropping of heavy equipment, occasional loading and unloading.	Trains, intermittent nearby construction activity, passing heavy vehicles, forging machines, impact pile driving, jack hammers. Where the number of vibration events in an assessment period is three or fewer these would be assessed against impulsive vibration criteria.

The most relevant to the proposed construction activities are continuous and intermittent vibration and these are discussed further in the following sections.

5.1.1 Continuous vibration

Appendix B of the guideline outlines acceptable criteria for human exposure to continuous vibration (in the range 1 Hz to 80 Hz). The criteria are dependent on both the time of activity (usually daytime or night-time) and the occupied place being assessed. Table 5.2 reproduces the preferred and maximum criteria relating to measured peak velocity.

Table 5.2 Criteria for exposure to continuous vibration

Place	Time	Peak velocity (mm/s)	
		Preferred	Preferred
Critical working Areas (eg hospital operating theatres, precision laboratories)	Day or night-time	0.14	0.28
Residences	Day	0.28	0.56
	Night-time	0.20	0.40
Offices	Day or night-time	0.56	1.1

Notes: 1. Root mean square velocity (mm/s) and vibration velocity value (dB re 10^{-9} mm/s).

2. Values given for most critical frequency >8 Hz assuming sinusoidal motion.

5.1.2 Intermittent vibration

Intermittent vibration (as defined in Section 2.1 of the guideline) is assessed using the vibration dose concept which relates to vibration magnitude and exposure time.

Intermittent vibration is representative of activities such as impact hammering, rolling or general excavation work (eg an excavator tracking).

Section 2.4 of the guideline provides acceptable values for intermittent vibration in terms of vibration dose values (VDV) which requires the measurement of the overall weighted root mean square (RMS) acceleration levels over the frequency range 1 Hz to 80 Hz. To calculate VDV the following formula (refer *section 2.4.1* of the guideline) was used:

$$VDV = \left[\int_0^T a^4(t)dt\right]^{0.25}$$

Where VDV is the vibration dose value in $m/s^{1.75}$, *a (t)* is the frequency-weighted RMS of acceleration in m/s^2 and *T* is the total period of the day (in seconds) during which vibration may occur.

The acceptable Vibration Dose Values (VDV) for intermittent vibration are reproduced in Table 5.3.

Table 5.3 Acceptable vibration dose values (VDV) for intermittent vibration (m/s 1.75)

Location	Daytime		Night-time	
	Preferred value, $m/s^{1.75}$	Maximum value, $m/s^{1.75}$	Preferred value, $m/s^{1.75}$	Maximum value, $m/s^{1.75}$
Critical Areas	0.10	0.20	0.10	0.20
Residences	0.20	0.4	0.13	0.26
Offices, schools, educational institutions and places of worship	0.40	0.80	0.40	0.80
Workshops	0.80	1.60	0.80	1.60

Notes: *1. Daytime is 7 am to 10 pm and night-time is 10 pm to 7 am.*

2. These criteria are indicative only, and there may be a need to assess intermittent values against continuous or impulsive criteria for critical areas.

There is a low probability of adverse comment or disturbance to building occupants at vibration values below the preferred values. Adverse comment or complaints may be expected if vibration values approach the maximum values. The guideline states that activities should be designed to meet the preferred values where an area is not already exposed to vibration.

5.2 Structural vibration criteria – DIN 4150

Structural vibration should be assessed at the foundation of a building structure. In the absence of a relevant Australian Standard, the German Standard *DIN 4150 - Part 3: 1999* provides guideline levels of vibration velocity for evaluating the effects of vibration in structures. The limits presented in this standard are generally recognised to be conservative.

The DIN 4150 values (maximum levels measured in any direction at the foundation, or maximum levels measured in (x) or (y) horizontal directions, in the plane of the uppermost floor), are summarised in Table 5.4 and shown graphically in Figure 5.1 in the case of foundation levels. For residential and commercial type structures, the standard recommends safe limits as low as 5 mm/s and 20 mm/s respectively. These limits increase with frequency values above 10 Hz. The operational frequency of construction plant typically ranges between 10 Hz to 30 Hz, and hence according to DIN 4150, the safe vibration criteria range for dwellings is 5 to 15 mm/s. For reinforced commercial type buildings the limit range is 20 to 40 mm/s.

Table 5.4 Structural damage guideline values of vibration velocity – DIN 4150

Line	Type of Structure	Vibration velocity in mm/s			
		At foundation at a frequency of			Plane of floor of uppermost storey
		1 Hz to 10 Hz	10 Hz to 50 Hz	50 Hz to 100 Hz	All frequencies (Hz)
1	Buildings used for commercial purposes, industrial buildings and buildings of similar design.	20	20 to 40	40 to 50	40
2	Dwellings and buildings of similar design and/or use.	5	5 to 15	15 to 20	15
3	Structures that because of their particular sensitivity to vibration do not correspond to those listed in Lines 1 or 2 and have intrinsic value (e.g. buildings that are under a preservation order).	3	3 to 8	8 to 10	8

Notes: *1. "Line" refers to curves in Figure 1 of DIN 4150.*

2. For frequencies above 100 Hz the higher values in the 50 Hz to 100 Hz column should be used.

These levels are 'safe limits', for which damage due to vibration effects is unlikely to occur. 'Damage' is defined in DIN 4150 to include even minor non-structural effects such as superficial cracking in cement render, the enlargement of cracks already present, and the separation of partitions or intermediate walls from load bearing walls.

Should such damage be observed without vibration levels exceeding the safe limits then it is likely to be attributable to other causes. DIN 4150 also states that when vibration levels higher than the safe limits are present, it does not necessarily follow that damage will occur.

As indicated by the criteria in Table 5.4, high frequency vibration has less potential to cause damage than lower frequencies. Furthermore, the 'point source' nature of vibration from plant causes the vibratory disturbances to arrive at different parts of nearby large structures in an out-of-phase manner, thereby reducing its potential to excite in-phase motion of the low order modes of vibration in such structures.

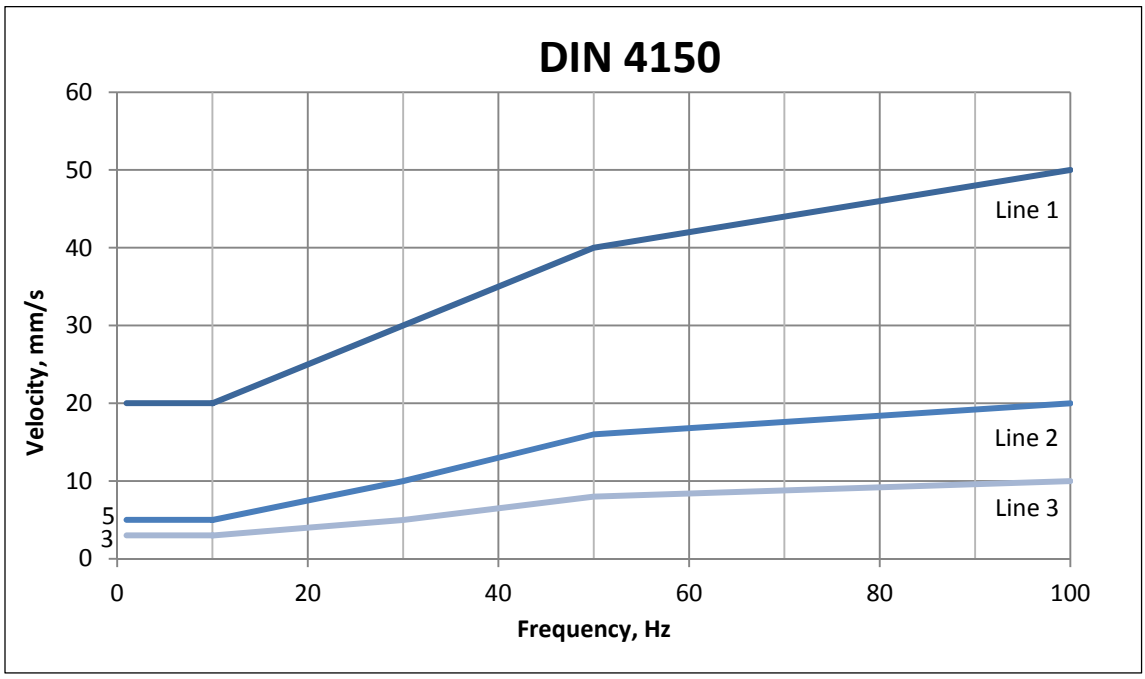


Figure 5.1 DIN 4150 Structural vibration safe limits for buildings

5.3 Ground-borne noise

Ground-borne noise is noise generated by vibration transmitted through the ground into a structure. The ICNG provides guidance on the assessment of ground-borne noise and relevant internal noise levels for the evening and night-time periods above which management actions should be implemented.

The proposed construction works are not expected to occur during the evening or night periods, and as such, ground-borne noise impacts are not expected at the nearest assessment locations.

6 Noise assessment

6.1 Noise modelling methodology

Construction noise levels were modelled using Brüel and Kjær Predictor software. 'Predictor' calculates total noise levels at assessment locations from the concurrent operation of multiple noise sources. The model has considered factors such as:

- the lateral and vertical location of noise sources;
- source to assessment location distances;
- ground effects;
- atmospheric absorption;
- topography of the site and surrounding area; and
- applicable meteorological conditions.

Predicted noise levels over a typical worst case 15-minute scenario were modelled and assessed for comparison against the relevant NMLs.

6.2 Construction plant and equipment

The construction noise impact assessment has adopted sound power levels from the EMM noise database for plant and equipment items used on other construction projects. Plant and equipment items, sound power levels and quantities adopted in the noise modelling are summarised in Table 6.1.

The construction of the solar PV electricity generation facility would comprise the installation of PV solar panels and associated infrastructure. Site preparation would be the starting phase of the construction works, although minimum earthworks are expected to occur due to the relatively flat terrain and predominantly cleared landscape. The site preparation stage would be followed by the installation of the PV solar panels. This would include the driving or screwing of piles into the ground depending on the ground conditions, as well as the preparation of foundations for the inverter blocks. The PV solar panels would be arranged in a series of rows and are expected to be supported by ground-mounted framing. Underground cabling would connect the power from the inverters to the substation. Other activities would include the construction of an electrical switchyard, a management hub and decommissioning of temporary infrastructure once construction works are completed.

Each stage of the construction works on-site will occur separately and hence some of the plant and equipment have been duplicated in for some of the activities (eg crane). However, connection to the Hillston Substation via transmission line may occur concurrently with on-site construction activities.

Table 6.1 Typical construction plant and equipment

Stage	Plant and equipment items	Quantity (worst case per 15-min period)[1]	L_{eq} (A-weighted) sound power level, dB
Site preparation works	Excavator	1	104
	Dozer	1	110
	Light vehicle	4	76
	Front-end loader (FEL)	1	105
	Road truck (deliveries)	1	103
	Dump truck	2	108
	Grader	1	108
	Roller	1	116
	Compactor	1	112
	Crane	1	106
	Forklift	1	106
	Water truck	1	96
	Generator	2	98
Pile driving and foundations	Piling drill rig	1	115
	Road truck (deliveries)	1	103
	Crane	1	106
	Excavator	1	104
	Concrete truck	1	113
	Light vehicle	2	76
Underground cabling	Road truck (deliveries)	1	103
	Cable trenching and laying equipment	1	100
	Light vehicle	2	76
Solar panels full installation	Powered hand tools	1	97
	Compressor	1	108
	Pneumatic wrench	1	117
	Generator	1	98
	Crane	1	106
	Road truck (deliveries)	1	103
	Light vehicle	2	76
Transmission line	Crane	1	106
	Forklift	1	106
	Light vehicle	2	76
	Road truck (deliveries)	1	103
Management hub	Crane	1	106
	Forklift	1	106
	Light vehicle	2	76
	Road truck	1	103
	Generator	1	98

Table 6.1 Typical construction plant and equipment

Stage	Plant and equipment items	Quantity (worst case per 15-min period)[1]	L_{eq} (A-weighted) sound power level, dB
Removal of temporary site compound	Crane	1	106
	Forklift	1	106
	Light vehicle	2	76
	Road truck (deliveries)	1	103

Notes: 1. Standard hours only: Monday to Friday 7 am to 6 pm, Saturday 8 am to 1 pm and no construction work on Sundays or public holidays.

2. Plant and equipment items have been assumed to operate continuously in any 15-minute period.

6.3 Modelled meteorological conditions

Noise propagation over distance can be significantly affected by the prevailing weather conditions. During the daytime period (coinciding with standard construction hours), of most interest are source to receiver winds as these conditions can enhance received noise levels. For permanent activities (ie industrial operations), the INP specifies meteorological analysis procedures to determine the prevalent weather conditions, which recommends consideration of wind effects if they are a "feature" of the area. The INP defines "feature" as the presence of source-to-receiver wind speed (measured at 10 m above ground level) of 3 m/s or less, occurring for 30% of the time in any assessment period and season.

Meteorological data from the nearest Bureau of Meteorology's (BoM) Automatic Weather Station (AWS) was analysed. Data recorded between January 2014 and December 2016 (3 years) from the BoM's Griffith Airport AWS (075041) was used for this assessment. The analysis identified that no winds were found to be a feature of the area during the day, evening or night periods. Therefore only calm meteorological conditions were adopted for the construction noise modelling. Meteorological conditions adopted for the construction noise modelling are presented in Table 6.2.

Table 6.2 Meteorological conditions considered in noise modelling

Assessment period	Meteorological condition	Air temperature	Relative humidity	Wind speed	Wind direction	Stability category (Temperature gradient)
Day[1]	Calm	20°C	70%	0 m/s	n/a	D class

Notes: 1. Corresponds to standards construction hours as per the ICNG.

6.4 Construction noise modelling results

Based on the noise modelling results, the site preparation works have the most potential for noise impacts given the number of plant to be used, their emission levels, duration and relative location of these construction activities, and therefore are the focus for the assessment. Noise from other construction activities would result in off-site noise levels that are below those from site preparation works.

Predicted construction noise levels for the site preparation works during standard construction hours are presented in Table 6.3. Construction noise levels are predicted to satisfy the recommended NMLs at all locations. Therefore, noise levels during all construction activities are expected to satisfy the NMLs at all locations.

Table 6.3 Construction (site preparation) noise predictions

Assessment locations	Land use	Predicted construction noise level $L_{Aeq\ (15\text{-}min)}$, dB	Construction noise management level $L_{Aeq\ (15\text{-}min)}$, dB
		Calm	Standard hours[1]
AL1	Residential	40	40
AL2	Residential	39	40
AL3	Residential	36	40
AL4	Residential	35	40
AL5	Residential	32	40
AL6	Residential	<30	40
AL7	Residential	35	40
AL8	Residential	31	40

Notes: 1. Standard hours only: Monday to Friday 7 am to 6 pm, Saturday 8 am to 1 pm and no construction work on Sundays or public holidays.

6.5 Road traffic noise during construction

The proposed construction works will include the delivery of all construction plant and equipment, infrastructure and project parts (eg solar panels, mounting frames etc) to site by road trucks. Other traffic movements generated by the project will include movements from the construction workforce.

Daily average (and peak) traffic movements generated by construction deliveries and the construction workforce are summarised in Table 6.4. Site generated traffic movements would be travelling via Kidman Way.

Table 6.4 Average daily traffic movements during construction

Construction scenario	Daily workforce movements[1] (light vehicles)	Daily heavy vehicle movements[1]	Total daily movements	Peak hourly workforce movements (light vehicles)	Peak hourly heavy vehicle movements	Total peak hourly movements
Average	60 (30 vehicles)	32 (16 vehicles)	92	16 (8 vehicles)	8 (4 vehicles)	24
Peak	90 (45 vehicles)	56 (28 vehicles)	146	24 (12 vehicles)	12 (6 vehicles)	36

Notes 1. It has been assumed that one daily vehicle trip (to and from site) equates to two vehicle movements.

It is expected that the majority (approximately 80%) of the construction deliveries will arrive from the south on Kidman Way, originating from southern NSW and Victoria, with the remainder of the deliveries (approximately 20%) from the north of site on Kidman Way.

Approximately 60% of the construction workforce is assumed, for the purposes of assessment, to be arriving from the south on Kidman Way. The remaining construction workforce (40%) will be based locally, in and around the township of Hillston, and will be travelling from the north in Kidman Way.

In Hillston, the nearest residential facades (roadside) that could potentially be affected by an increase in road traffic noise are set back approximately 7 m or greater from the road in a 50 km/h speed zone. On Kidman Way, south of the Hillston township and north of the project, the nearest residential facades (roadside) that could potentially be affected by an increase in road traffic noise are set back approximately 120 m or greater from the road in a 100 km/h speed zone. On other parts of the route and south of the project (towards Griffith), nearest residential facades are set back approximately 10m and 15 m (or greater) from the road in a 60 km/h and 100 km/h speed zones respectively. These distances have been adopted for the road traffic noise assessment. Road traffic noise results are based on the peak hourly workforce movements and construction delivery movements during peak construction scenario and hence this assessment of road traffic noise is therefore considered to be conservative.

Existing traffic data for Kidman Way was obtained from the publically available NSW Roads and Maritime Services' online database. The most recent data was used as conservatively as the existing traffic volumes for all roads. The existing average daily traffic volume in Hillston and on Kidman Way are shown in Table 6.5.

Table 6.5 Existing average daily traffic volumes

Road/area	Road section	Total movements	Percentage of heavy vehicle (%)
Hillston	Keats Street/High Street	1,578[1]	Not available[2]
Kidman Way	South of Hillston/north of site	568	22
Kidman Way	South of site	801	13
Kidman Way	South of site	2,648	11

Notes: 1. The lowest of the total existing average daily traffic movements for these road sections was conservatively adopted for this assessment.

2. Due to unavailability of this data for these roads, a conservative 10% was adopted for the assessment.

Table 6.6 shows that road traffic noise levels generated by the site during worst case construction works are predicted to not increase the existing average traffic noise levels. Where existing road traffic noise levels are below the criterion (north of the site access road on Kidman Way), road traffic noise levels generated by the site are not likely to cause future traffic noise levels to increase above the criterion. Where existing road traffic noise levels are above the criterion (in Hillston and south of the site access road on Kidman Way), road traffic noise levels generated by the site are not likely to cause future traffic noise levels to increase by more than 2 dB (ie the RNP allowable increase value). Therefore, road traffic noise levels generated by the site during worst case construction works are predicted to satisfy the relevant criteria at the potentially worse affected residential dwellings on roads north and south of the site.

Table 6.6 Predicted road traffic noise during construction

Stage	Road/area	Distance to road (m)	Speed (km/h)	Existing traffic noise level, $L_{Aeq,period}$, dB	Site generated traffic noise level[1], $L_{Aeq,period}$, dB	Future traffic noise level, $L_{Aeq,period}$, dB	Criterion, $L_{Aeq,period}$, dB	Change, dB
Peak	Hillston	≥7	50	69	50	69	60	0
	Kidman Way - north of site access road	≥120	100	56	41	56	60	0
	Kidman Way - south of site access road	≥15	100	67	56	67	60	0
		≥10	60	71	55	71	60	0

Notes: 1. Based on the peak hourly workforce movements and construction delivery movements during peak construction scenario.

7 Construction vibration assessment

The majority of vibration generating activities associated with the proposed construction works includes the use of a roller and a piling drill rig. As a guide, safe working distances for typical items of vibration intensive plant are listed in Table 7.1. The safe working distances are quoted for both 'Cosmetic Damage' (refer British Standard BS 7385) and 'Human Comfort' (refer British Standard BS 6472-1).

Table 7.1 Recommended safe working distances for vibration intensive plant

Plant item[1]	Rating/description	Safe working distance	
		Cosmetic damage (BS 7385)	Human response (BS 6472)
Vibratory Roller	<50 kN (typically 1–2 tonnes)	5 m	15 to 20 m
	<100 kN (typically 2–4 tonnes)	6 m	20 m
	<200 kN (typically 4–6 tonnes)	12 m	40 m
	<300 kN (typically 7–13 tonnes)	15 m	100 m
	>300 kN (typically 13–18 tonnes)	20 m	100 m
	>300 kN (>18 tonnes)	25 m	100 m
Small hydraulic hammer	(300 kg - 5 to 12 tonne excavator)	2 m	7 m
Medium hydraulic hammer	(900 kg - 12 to 18 tonne excavator)	7 m	23 m
Large hydraulic hammer	(1,600 kg - 18 to 34 tonne excavator)	22 m	73 m
Vibratory pile driver	Sheet piles	2 m to 20 m	20 m
Pile boring	≤800 mm	2 m (nominal)	N/A
Jackhammer	Hand held	1 m (nominal)	Avoid contact with structure

Source: Transport Infrastructure Development Corporation Construction's Construction Noise Strategy (Rail Projects), November 2007.

Notes: 1. Plant items shown are indicative to illustrate safe working distances, not all plant items will be used.

The safe working distances presented in Table 7.1 are indicative and will vary depending on the particular item of plant and local geotechnical conditions. They apply to cosmetic damage of typical buildings under typical geotechnical conditions.

In relation to human comfort response, the safe working distances in Table 7.1 relate to continuous vibration and apply to residential receivers. For most construction activities, vibration emissions are intermittent in nature and for this reason, higher vibration levels, occurring over shorter periods are allowed, in accordance with BS 6472-1.

The nearest residence is approximately 0.7 km from the nearest point of the project footprint area to the north. Given these distances are well outside the safe working distance for cosmetic damage and human comfort, it is therefore anticipated that impact is highly unlikely to occur from the proposed construction works.

8 Operational noise

Noise impact from the general operation of the project was considered at assessment locations AL1-AL8, with the nearest residential receiver approximately 700 m from the site boundary. A semi-qualitative assessment of the potential impact from operational noise was completed.

Noise sources considered during the operational phase of the project include inverters with integrated transformers, tracker motors (PV solar panels) and light vehicles. It is noted that noise from the inverters with integrated transformers is considered to be tonal in nature and therefore a 5 dB penalty has been applied to the predicted noise contributions from this sources in accordance with Table 4.1 of the INP (EPA 2000). Sound power levels for the noise sources considered in this assessment are shown in Table 8.1.

Table 8.1 Operational noise sources sound power levels

Noise source	Quantity	L_{eq} (A-weighted) sound power level per unit, dB
Tracker motors	10,000	78
Inverters with integrated transformers	34	94[1]
Light vehicles	2	76

Notes: 1. A 5 dB penalty is applicable to noise contributions from this source.

The assessment identified that the $L_{Aeq(15\text{-}min)}$ noise levels from the proposed development would satisfy the minimum INP criterion of 35 dB during worst case assessable meteorological conditions (eg F class inversion during the night-time period or 3 m/s source to receiver winds). Therefore, no impact is anticipated during the operational stage of the project.

9 Conclusion

EMM has completed a noise and vibration impact assessment for proposed construction works and infrastructure for the Hillston Sun Farm south of the township of Hillston, NSW.

Modelling has shown that noise levels are predicted to satisfy the relevant NMLs during standard hours construction works at all locations.

Vibration associated with the proposed construction works is highly unlikely to generate impacts at the nearest vibration-sensitive receivers.

Road traffic noise generated by the proposed development is predicted to satisfy relevant criteria and not expected to result in any noticeable increase in average road traffic noise levels at the nearest residential locations north or south of the project.

No noise impacts are anticipated during operation of the Hillston Sun Farm.

References

Australian Standard (AS) 1055-1997, Acoustics - Description and Measurement of Environmental Noise.

Australian Standard (AS) 2436-2010, Guide to Noise and Vibration Control on Construction, Maintenance and Demolition Sites.

NSW Department of Environment, Climate Change and Water (2011) *NSW Road Noise Policy*.

NSW Department of Environment and Conservation (DEC) (2006) *Assessing Vibration: a technical guideline*.

NSW Environment Protection Authority (2000) *NSW Industrial Noise Policy*.

NSW Environment Protection Authority (2009) *NSW Interim Construction Noise Guideline*.

Appendix A

Acoustic terms

Several technical terms discussed in this report are explained in Table A.1.

Table A.1 Glossary of acoustic terms

Term	Description
dB	Noise is measured in units called decibels (dB). There are several scales for describing noise, the most common being the 'A-weighted' scale. This attempts to closely approximate the frequency response of the human ear.
L_{A90}	Commonly referred to as the background noise level. The 'A-weighted' noise level exceeded 90% of the time.
L_{Aeq}	The energy average noise from a source. This is the equivalent continuous 'A-weighted' sound pressure level over a given period. The $L_{Aeq(15\text{-}min)}$ descriptor refers to an L_{Aeq} noise level measured over a 15 minute period.
L_{Amax}	The maximum root mean squared 'A-weighted' sound pressure level (or maximum noise level) received during a measuring interval.
RBL	The Rating Background Level (RBL) is an overall single value background level representing each assessment period over the whole monitoring period.
Sound power level	This is a measure of the total power radiated by a source. The sound power of a source is a fundamental property of the source and is independent of the surrounding environment.
Day period	Monday – Saturday: 7 am to 6 pm, on Sundays and Public Holidays: 8 am to 6 pm.
Evening period	Monday – Saturday: 6 pm to 10 pm, on Sundays and Public Holidays: 6 pm to 10 pm.
Night period	Monday – Saturday: 10 pm to 7 am, on Sundays and Public Holidays: 10 pm to 8 am.

It is useful to have an appreciation of decibels (dB), the unit of noise measurement. Table A.2 gives an indication as to what an average person perceives about changes in noise levels.

Table A.2 Perceived change in noise

Change in sound level (dB)	Perceived change in noise
3	just perceptible
5	noticeable difference
10	twice (or half) as loud
15	large change
20	four times (or quarter) as loud

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