APPENDIX U

DUNGOWAN DAM AND PIPELINE EIS

Noise and Vibration Impact Assessment

NSW GOVERNMENT | EMM creating opportunities

Dungowan Dam and pipeline project

Noise and Vibration Assessment

Prepared for Water Infrastructure NSW

September 2022

Dungowan Dam and pipeline project

Noise and Vibration Assessment

Water Infrastructure NSW

J200042 DUN-EMM-EN-RPT-0019

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Version	Date	Prepared by	Approved by	Comments
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Executive Summary

EMM has prepared a Noise and Vibration Impact Assessment for the construction and operation of the Dungowan Dam and pipeline project. The assessment considered the potential for noise and vibration impacts of the proposed works and has been prepared in accordance with the methodology outlined in the *NSW Noise Policy for Industry*, *Interim Construction Noise Guideline*, as well as other relevant guidelines and standards.

Construction noise levels were assessed for the daytime and outside of standard construction hours periods during noise-enhancing meteorological conditions. Predictions indicate that construction noise levels are likely to comply with the relevant legislative noise management levels during proposed dam construction works, however, are likely to be above the noise management levels at times during proposed pipeline construction. These exceedances would be short-term only (no more than five shifts) due to the transient nature of these works. Given that the predictions are conservative in assessing that all equipment would be operating simultaneously, it is likely that actual construction noise levels would be less than those predicted for the majority of the time. Notwithstanding, Water Infrastructure NSW would actively manage construction noise generated by the project with management and mitigation measures provided herein. Only limited low noise activities are expected at night and hence sleep disturbance impacts have not been predicted.

Operational noise levels were assessed for the daytime, evening and night-time periods including consideration of noise-enhancing meteorological conditions. The assessment found that noise impacts from operation of the project are considered unlikely to exceed relevant regulatory requirements. Sleep disturbance impacts from the operation of the project during the night-time period are considered unlikely to exceed relevant regulatory requirements.

The project would result in additional road traffic movements during the construction period. Some marginal road traffic noise increases are predicted to occur on Tamworth-Nundle and Ogunbil Roads. It is of note that the road traffic noise results are based on heavy vehicle movements during the peak construction scenario and hence the assessment of road traffic noise is considered to be conservative. Further, the application of the NSW Road Noise Policy (RNP) (EPA 2011) criteria to construction projects is highly conservative given the NSW Road Noise Policy is designed for permanent scenarios and not temporary impacts related to construction activities. Operational road traffic volumes are expected to be less than 2% of the existing road traffic experienced on the abovementioned roads. As such, adverse noise impacts from operational road traffic noise are considered unlikely.

Blast overpressure and ground vibration levels from the project are predicted to satisfy relevant EPA guidelines. The volumes of Maximum Instantaneous Charge required to ensure compliance are not expected to result in any significant constraints to blasting in the spillway, quarrying and demolition areas. Notwithstanding, Water Infrastructure NSW would actively manage and monitor blast overpressure and vibration in accordance with current best practice.

The assessment considered potential vibration impacts from the project. It is possible that some vibratory activities would occur close to structures during construction and therefore management of vibration levels may be required. Notwithstanding, recommendations have been provided regarding work practices to be considered to minimise construction noise and vibration.

A range of project-specific and standard noise and vibration mitigation and consultation measures have been provided in this Noise and Vibration Impact Assessment. These measures, if integrated with project construction and operational environmental management plans and implemented as intended, would moderate the impact of the project on local receivers to acceptable levels.

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1 Introduction

1.1 The project

The Peel River, part of the Namoi River catchment, provides water for irrigation as well as being the primary water supply for the city of Tamworth. Prompted by the millennium drought, investigations into the future water supply and demand for bulk water were undertaken for the regional city of Tamworth and the Peel Valley water users. The Dungowan Dam and pipeline project (the project) is a critical project to improving long-term water security for the region. The project includes a new dam at Dungowan (new Dungowan Dam) approximately 3.5 km downstream of the existing Dungowan Dam and a new section of pipeline about 32km long between the proposed Dam outlet and the tie in point to an existing pipeline from Dungowan Showground to the Calala Water Treatment Plant (WTP).

In September 2022, the Minister for Planning and Homes declared the project to be Critical State Significant Infrastructure (CSSI) as it is a development that is essential for the State for economic and social reasons. This requires Schedule 5 of the *State Environmental Planning Policy (Planning Systems) 2021* to be updated to reflect the CSSI status of the project. As CSSI, the project is subject to Part 5, Division 5.2 of the *Environmental Planning and Assessment Act 1979* (EP&A Act), which requires the preparation of an environmental impact statement (EIS) and the approval of the NSW Minister for Planning and Homes.

The EIS has been prepared for the planning approval application for the project. This Noise and Vibration Impact Assessment (NVIA) has been prepared to support the EIS.

In addition to requiring approval from the NSW Minister for Planning and Homes, the project has been deemed a controlled action under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and requires approval from the Commonwealth Minister for the Environment. The Minister for the Environment has accredited the NSW planning process for the assessment of the project. Therefore, a single EIS has been prepared to address the requirements set out by the NSW Department of Planning and Environment (DPE) and the Commonwealth Department of Agriculture, Water and Environment.

1.2 Project location

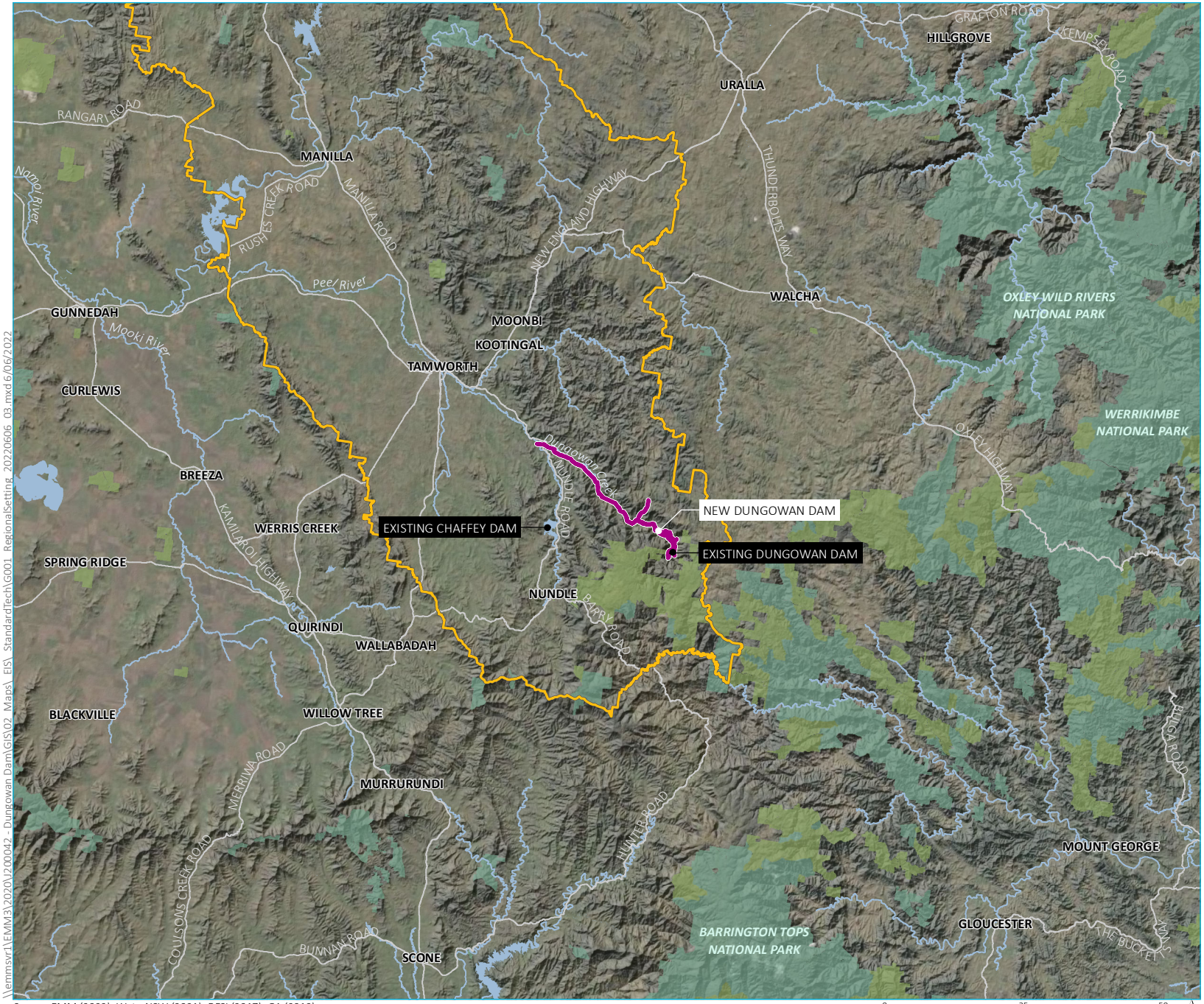
The project is located in the Tamworth Regional local government area (LGA), the New England Tablelands bioregion and part of the New England and North West region of NSW, west of the Great Dividing Range (DPE 2017). The New England and North West region is home to approximately 186,900 people and has a total area of around 99,100 km^2 (ABS 2018).

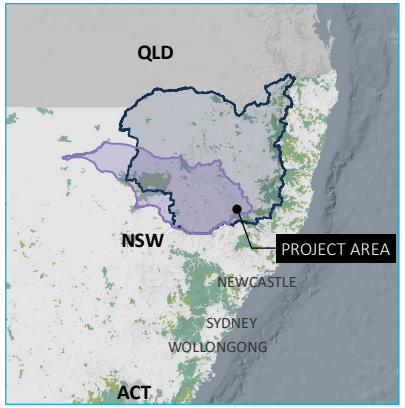
The city of Tamworth is the nearest (and largest) town to the project with over 40,000 residents. Other nearby regional towns include Quirindi (70 km west), Manilla (90 km north-west), Gloucester (90 km south-east), Armidale (100 km north) and Gunnedah (110 km west of the project).

The existing Dungowan Dam is in the Namoi River catchment approximately 50 km south-east of Tamworth in NSW. The Namoi catchment covers 4,700 km^2 and borders the Gwydir and Castlereagh catchments and is bounded by the Great Dividing Range in the east, the Liverpool Ranges and Warrumbungle Ranges in the south, and the Nandewar Ranges and Mount Kaputar to the north.

The existing Dungowan Dam is on Dungowan Creek, which is a tributary of the Peel River. Dungowan Creek is confined by the existing Dungowan Dam, while the Peel River system is regulated by Chaffey Dam, located in the upper catchment near the town of Woolomin, approximately 45 km from Tamworth.

The project's regional setting is shown in Figure 1.1.





KEY

- Project footprint
- Major road
- Named watercourse
- Named waterbody
- NPWS reserve
- State forest
- Tamworth Regional local government area

INSET KEY

- Namoi River catchment
- New England North West region

Source: EMM (2022); WaterNSW (2021); DFSI (2017); GA (2013)

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Regional setting

Dungowan Dam and pipeline project
Figure 1.1

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1.2.1 Project impact areas

In outlining the project, a project footprint has been defined to facilitate the assessment of direct impacts from the project:

- Project footprint: all areas where direct impacts may be experienced during construction and/or operation.

The project footprint has an area of 315 ha and is comprised of the construction and operational footprints, of which there is some overlap:

- Construction footprint: areas where vegetation clearing and/or ground disturbance is required for construction of the dam, pipeline and ancillary facilities, including the area needed to decommission and rehabilitate the existing dam.
- Operational footprint: areas where there will be permanent operational elements or easements, including infrastructure needed to operate the new Dungowan Dam and pipeline. The operation footprint includes the inundation area, being the area defined by the proposed full supply level (FSL) for the project.

The project construction and operational footprints are shown in Figure 1.2.

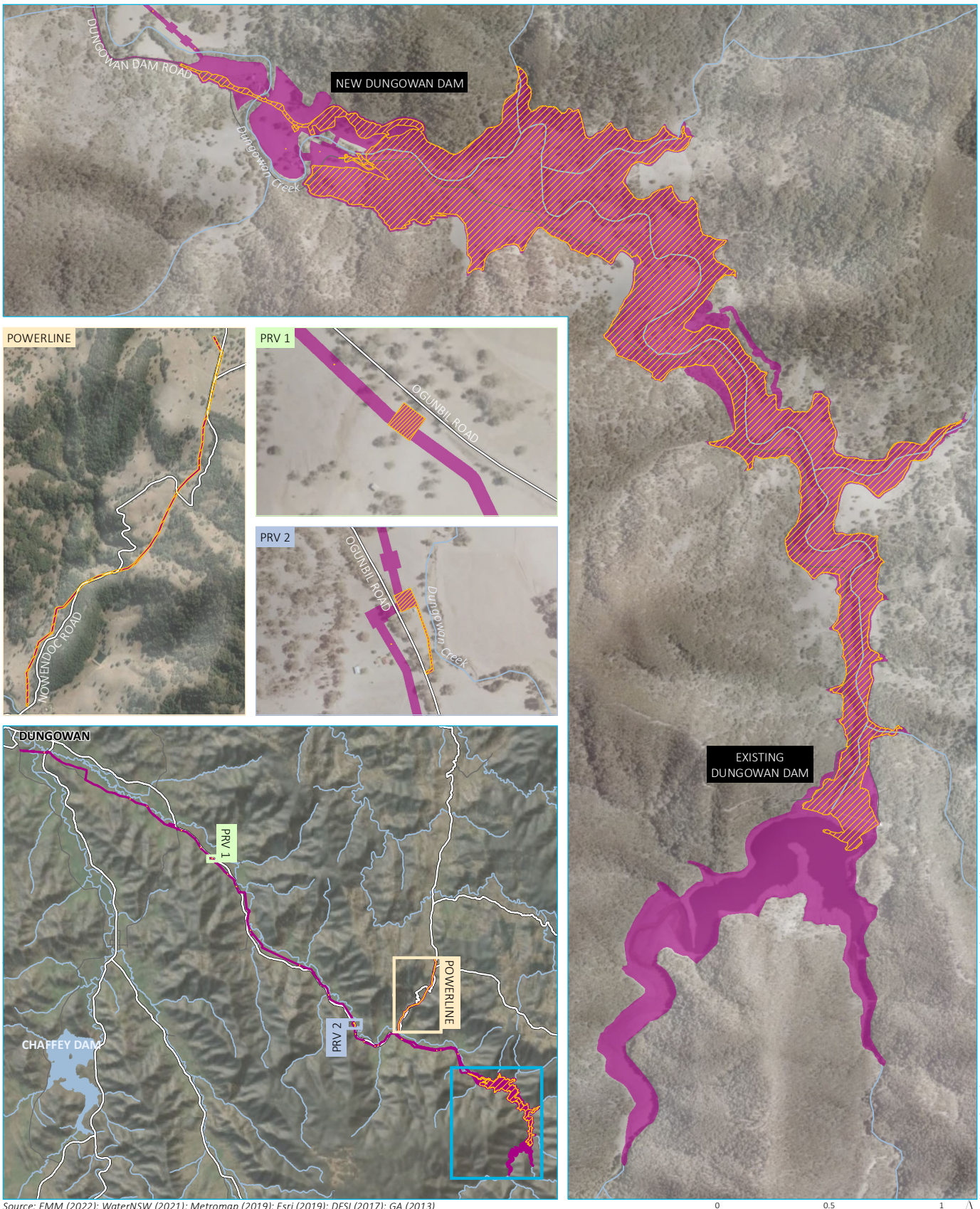
Additional areas outside the project footprint have also been considered where relevant to the assessment of project impacts and include:

- Upstream flood extent: An area above the FSL to the level of a probable maximum flood (PMF) event that would be inundated for relatively short periods during operation associated with extreme rainfall events.
- Project area: A 10 km buffer around the project footprint defined to allow for assessment of potential indirect impacts.
- Downstream impact area: the area where hydrological changes may occur due to the project. This area is discussed in detail in the Surface Water Assessment (EMM 2022) as well as other technical reports subject to changed flow regimes as a result of the new Dungowan Dam operation. The downstream impact area includes Dungowan Creek and also the Peel River downstream of Chaffey Dam.

1.3 Purpose of this report

This NVIA supports the EIS for the project. It documents the potential noise and vibration impacts from the proposed works on the surrounding community (and potential future sensitive receivers) and provides recommendations regarding appropriate mitigation and management measures. It has been prepared in accordance with the relevant governmental assessment requirements, guidelines and policies.

Several technical terms are required for the discussion of noise and vibration. These are explained in the glossary, at the end of this report.



Source: EMM (2022); WaterNSW (2021); Metromap (2019); Esri (2019); DFSI (2017); GA (2013)

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KEY

- Construction footprint
- Operational footprint

Existing environment

- Major road
- Minor road
- Named watercourse
- Named waterbody

Project footprint

Dungowan Dam and pipeline project
Figure 1.2

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1.3.1 Assessment guidelines and requirements

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

- NSW Environment Protection Authority (EPA) 2017, *NSW Noise Policy for Industry* (NPfI);
- NSW Department of Environment and Climate Change (DECC) 2009, *Interim Construction Noise Guideline* (ICNG);
- NSW Environment Protection Authority (EPA) 2011, *NSW 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 Control on Construction, Maintenance and Demolition Sites.

This NVIA has been prepared in accordance with the Secretary's Environmental Assessment Requirements (SEARs) for the Dungowan Dam and pipeline project, as well as relevant government assessment requirements, guidelines and policies, and in consultation with the relevant government agencies.

Table 1.1 lists the matters relevant to this assessment and where they are addressed in this report.

Table 1.1 Relevant matters raised in the SEARs

Requirement	Section/Chapter addressed
DPIE	
The EIS must address the following specific matters: Noise and vibration - including:	-
44. A quantitative assessment of potential demolition, construction, operational and transport noise and vibration impacts of the project. This is to include the identification of existing and potential future sensitive receivers and consideration of approved and/or proposed development in the vicinity.	Chapters 5, 6, 7 and 8
45. Details and justification of proposed noise mitigation and monitoring measures.	Chapters 9 and 10
46. An assessment of blast impacts (if blasting is required) compliance with current guidelines.	Chapter 7

To inform preparation of the SEARs, DPE invited relevant government agencies to advise on matters to be addressed in the EIS. These matters were taken into account by the Secretary for DPE when preparing the SEARs.

1.3.2 Other relevant reports

This NVIA has been prepared with reference to other technical reports that were prepared as part of the EIS. The other relevant reports referenced in this NVIA are listed below.

- Air Quality and Greenhouse Gas Assessment (EMM 2022) – Appended to the EIS; and
- Traffic Impact Assessment (EMM 2022) – Appended to the EIS.

2 Project description

This chapter provides a summary of the Dungowan Dam and pipeline project. It outlines the permanent infrastructure required to operate the project, as well as the key construction elements and activities required to construct the project. A comprehensive and detailed description of the project is provided as Appendix B1 of the EIS, which has been relied upon for the basis of this technical assessment.

2.1 Project overview

Water Infrastructure NSW proposes to build a new dam at Dungowan (new Dungowan Dam) about 3.5 km downstream of the existing Dungowan Dam and an enlarged delivery pipeline from the new Dungowan Dam outlet to the tie in point to the existing pipeline from Dungowan Showground to the Calala WTP. The existing pipeline from Dungowan Showground to the Calala WTP is not part of the Dungowan Dam and pipeline project. A summary of project elements is provided in Table 2.1. An overview of the project is provided in Figure 2.1.

Table 2.1 Overview of the project

Project element	Summary of the project
New Dungowan Dam infrastructure	Earth and rockfill embankment dam with height of ~58 m and a dam crest length of ~270 m.
	Storage capacity of 22.5 GL at full supply level (FSL) of RL 660.2 m AHD.
	The new Dungowan Dam on Dungowan Creek has a catchment size of 175 km^2 and is part of the Peel Valley and Namoi River catchment.
	Inundation extent (to FSL) of 130 ha (1.3 km^2)
	Spillway to the south of the dam wall including an approach channel, uncontrolled concrete ogee crest, chute and stilling basin. Free standing multiple-level intake tower connected with a bridge to the embankment, diversion tunnel with outlet conduit, valve house and associated pipework and valves.
	A permanent access road over the Dam crest to the valve house for operation and maintenance.
	Water diversion works including a diversion tunnel and temporary pipeline and upstream and downstream cofferdams to facilitate construction of the dam wall embankment.
Pipeline infrastructure	31.6 km of buried high density polyethylene (HDPE) pipe between 710 mm to 900 mm nominal diameter.
	Maximum 71 ML/day from the proposed dam to the junction with the pipeline from Chaffey Dam to the Calala Water Treatment Plant, to replace the existing 22 ML/day pipeline. The pipeline would connect to the valve house on the left abutment of the embankment. Valve infrastructure would include control valves installed in two above ground buildings along the pipeline.
	10 m wide easement for the 31.6 km length of the pipeline. The replacement pipeline extends from the new Dungowan Dam to a connection point with the existing pipeline between Dungowan Showground and Calala WTP.
Ancillary infrastructure and works	Road works to improve existing roads to provide construction access, temporary establishment and use of a construction compound, an accommodation camp, two upstream quarries and four borrow areas within the inundation area.
	A new 4.2 km long 11 kV overhead powerline (including a new easement and access track) connecting to an existing overhead line approximately 6 km north west of the dam. The existing overhead line that extends approximately 13.2 km to the Niangala area would also require minor upgrades, including re-stringing of new overhead wiring and replacement of some poles.
Decommissioning of existing Dungowan Dam	Dewatering of existing dam, removal of existing Dungowan Dam infrastructure and full height breach of the existing Dungowan Dam wall. Rehabilitation of inundation area of existing Dungowan Dam.

Table 2.1 Overview of the project

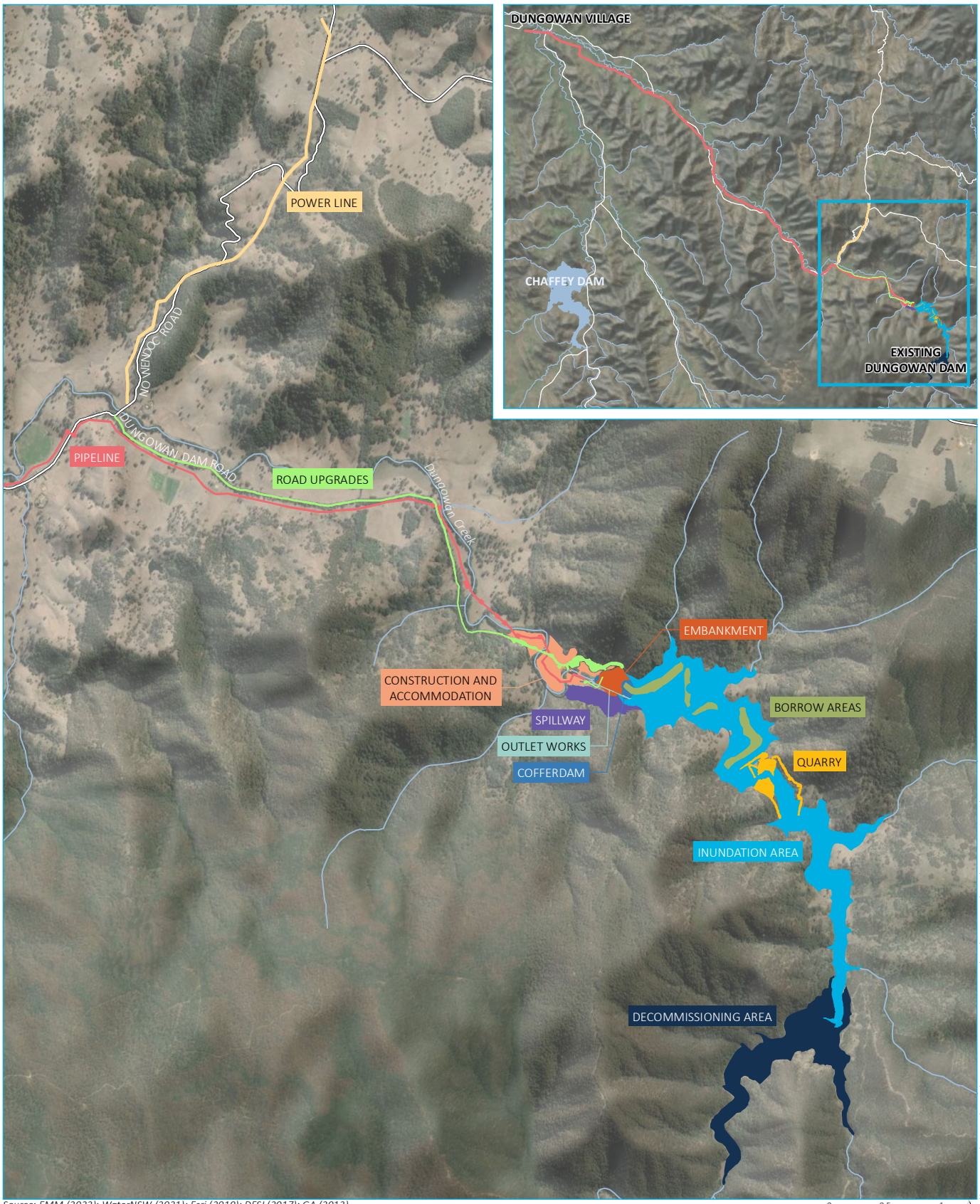
Project element	Summary of the project
Disturbance	Areas of disturbance have been identified based on the direct impacts of the project. There is some overlap in the areas disturbed during construction and operation, with a resulting total disturbance area proposed for the project of 315 ha (project footprint). Disturbance would occur in a staged manner, with construction requiring disturbance of approximately 315 ha (construction footprint). Following construction and once rehabilitation is completed, there would be a permanent disturbance of approximately 158 ha comprising the inundation area and permanent infrastructure (operational footprint).
Construction	Construction duration of approximately 6 years.
	Construction workforce of approximately 125 workers at construction peak.
Operation	WaterNSW will be responsible for management, operation and general maintenance of the new dam. Tamworth Regional Council will be responsible for the management, operation and general maintenance of the pipeline. Public use and access to the dam would not be permitted and there would be no public facilities available during operation.
	One to two new full time workers plus part time work for existing WaterNSW operations team. Due to the new Dungowan Dam being prioritised over Chaffey Dam for Tamworth's future water supply, the water reserved for town water in Chaffey Dam would increase from 14.3 GL to 30 GL to ensure that water is set aside to meet Tamworth's town water supply water demand in years when rainfall is low.
Design life	100 years for zoned earthen embankment, structural concrete elements of the dam and the pipeline. 15 to 50 years for other non-structural project elements and pavements.
Assessment period (operational)	The assessment end point is when the water system performance reaches a level when an additional water supply option or change to the Water Sharing Plan is required. This has been estimated to be when the mean average annual water demand from Tamworth increases to 11 GL/year.

2.2 Construction hours

Construction works would generally be conducted within the hours outlined in Table 2.2. However, it is likely that activities needed to support construction such as spillway concreting (in summer months) would be undertaken 24 hours a day, seven days a week. The project construction environmental management plan (CEMP) would include measures to manage potential impacts of construction activities during non-standard work hours.

Table 2.2 Standard work hours

Work type	Recommended standard hours of work
Normal construction	Monday to Saturday 7 am to 6 pm
	Sundays or public holidays – low noise and low traffic generating work may be carried out 9 am to 5 pm
Blasting	Monday to Saturday 9 am to 5 pm
	No work on Sundays or public holidays



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Source: EMM (2022); WaterNSW (2021); Esri (2019); DFSI (2017); GA (2013)

0 0.5 1 km

GDA 1994 MGA Zone 56

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KEY

- Inundation area
- Borrow areas
- Construction and accommodation camp
- Outlet works
- Cofferdams
- Embankment
- Quarries
- Spillway
- Road upgrade
- Decommissioning area
- Power line footprint
- Pipeline construction footprint

Existing environment

- Major road
- Minor road
- Named watercourse
- Named waterbody

Project overview

Dungowan Dam and pipeline project

Figure 2.1

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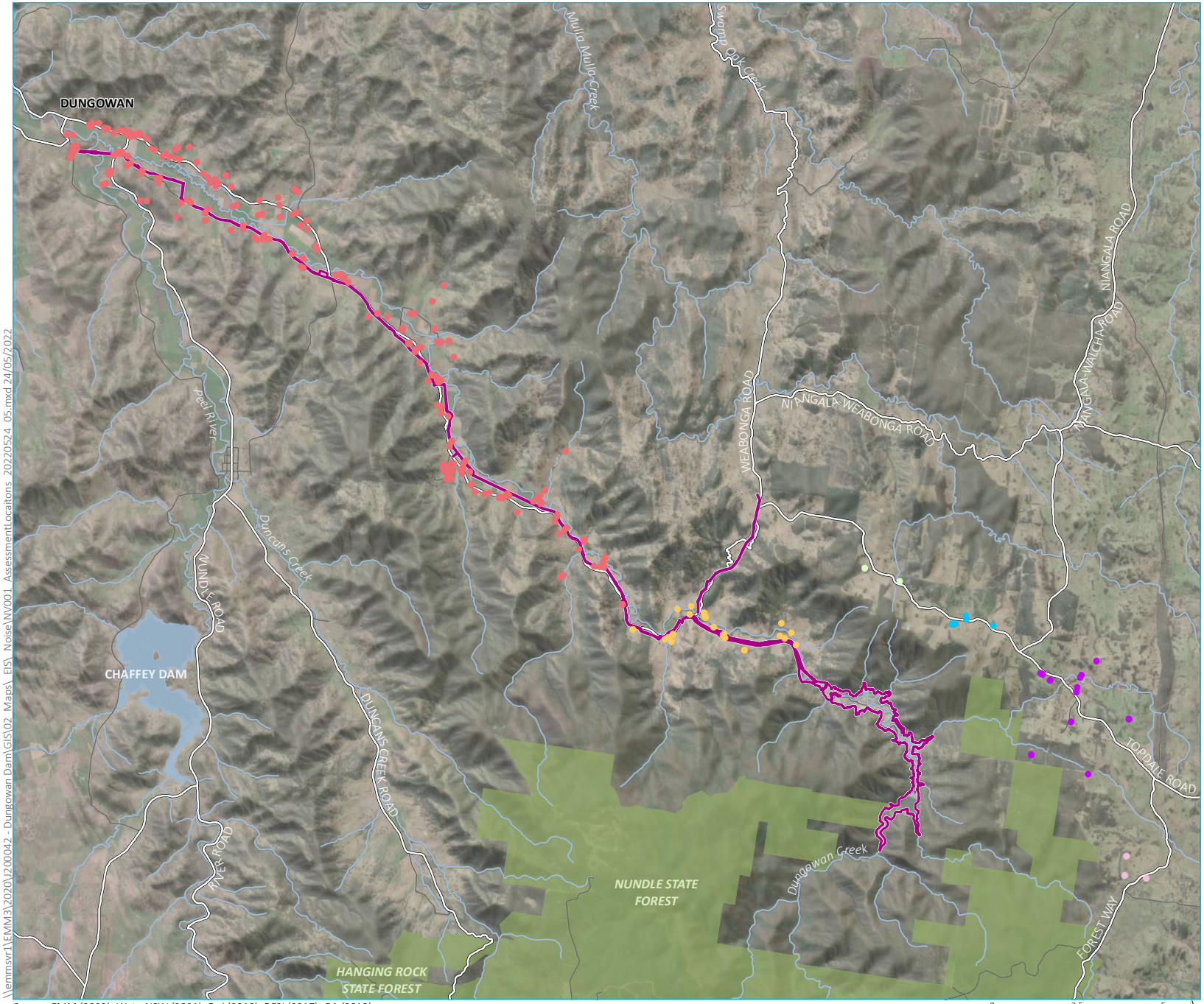
3 Existing noise environment

3.1 Assessment locations

Sensitive receivers, which have the potential to be affected by noise from the project are residential receivers (hereafter referred to as assessment locations) surrounding the proposed inundation area and the pipeline alignment. Due to the number of residential assessment locations, noise catchment areas (NCAs) have been used to provide a logical grouping of receivers affected by the same construction works. Adopted assessment locations are presented in Table 3.1 and shown on Figure 3.1. If noise levels are predicted to satisfy the criteria at all assessment locations, they are expected to satisfy the criteria at all other more distant noise-sensitive receivers.

Table 3.1 Assessment locations

Noise Catchment Area	Assessment locations	Receptor type	Description
NCA 1	R14-R35	Residential	Residences on Dungowan Dam Road/Ogunbil Road (to north west of inundation area)
NCA 2	R36-R37	Residential	Residences on Nowendoc Road (to north of inundation area)
NCA 3	R38-R43	Residential	Residences on Nowendoc Road (to north east of inundation area)
NCA 4	R44-R55	Residential	Residences on Nowendoc Road (to east of inundation area)
NCA 5	R56-R58	Residential	Residences on Nowendoc Road (to south east of inundation area)
NCA 6	R59-R282	Residential	Residences adjacent to the pipeline



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Source: EMM (2022); WaterNSW (2021); Esri (2019); DFSI (2017); GA (2013)

Noise assessment locations

Dungowan Dam and pipeline project
Noise and vibration impact assessment
Figure 3.1

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3.2 Background and ambient noise levels

3.2.1 Noise monitoring

Long-term unattended noise monitoring was completed in the localities of Calala and Loomberah between 12 and 25 June 2020, as part of a Review of Environmental Factors for the replacement pipeline between Dungowan Village and Calala (completed in February 2022). The results of the noise monitoring showed that background noise in the rural residential areas surveyed was below the NPfI minimum background noise levels. It is expected that the rural residential areas relevant to this assessment would also be below the NPfI minimum background noise levels and, as such, the NPfI minimum background noise levels have been applied for the purposes of this assessment. This is a conservative assumption, leading to the most stringent noise criteria available being applied. As a result, no further noise monitoring was conducted as part of this NVIA.

3.3 Meteorology

Noise propagation over distance can be significantly affected by the prevailing weather conditions. Of most interest are source to receiver winds, the presence of temperature inversions and drainage flow effects, as these conditions can enhance received noise levels. To account for these phenomena, the NPfI specifies the following two options in regard to meteorological analysis procedures to determine the prevalent weather conditions:

1. Adopt the noise-enhancing meteorological conditions for all assessment periods for noise impact assessment purposes without an assessment of how often these conditions occur – a conservative approach that considers source-to-receiver wind vectors for all receivers and F class temperature inversions with wind speeds up to 2 m/s at night; or

2. Determine the significance of noise-enhancing conditions. This involves assessing the significance of temperature inversions (F and G class stability categories) for the night-time period and the significance of light winds up to and including 3 m/s for all assessment periods during stability categories other than E, F or G. Significance is based on a threshold of occurrence of 30% determined in accordance with the provisions in this policy. Where noise-enhancing meteorological conditions occur for less than 30% of the time, standard meteorological conditions may be adopted for the assessment.

For the purposes of noise modelling, this assessment has adopted the noise-enhancing meteorological conditions as outlined in the NPfI. This approach provides a conservative assessment.

3.3.1 Adopted meteorological conditions

As a conservative approach, this assessment has adopted the meteorological conditions within the International Standard ISO 9613-2:1996 'Acoustics – Attenuation of sound during propagation outdoors' (ISO 9613). As per Section 1 of ISO 9613:

> The method predicts the equivalent continuous A-weighted sound pressure level (as described in parts 1 to 3 of ISO 1996) under meteorological conditions favourable to propagation from sources of known sound emission.
>
> These conditions are for downwind propagation, as specified in 5.4.3.3 of ISO 1996-2:1987 or, equivalently, propagation under a well-developed moderate ground-based temperature inversion, such as commonly occurs at night.

The ISO 9613 meteorological conditions adopted in this assessment to account for the influence of wind and temperature inversion conditions on modelled noise levels are considered to be equivalent to the 'noise-enhancing' meteorological conditions shown in Table D1 of the NPfI.

A summary of modelled meteorological conditions is shown in Table 3.2.

Table 3.2 Meteorological parameters adopted for the noise modelling

Assessment period[1]	Meteorological conditions	Air temperature	Relative humidity
Day	ISO 9613	20°C	70%
Evening	ISO 9613	10°C	90%
Night	ISO 9613	10°C	90%

Notes: 1. Day: 7 am–6 pm Monday to Saturday; 8 am–6 pm Sundays and public holidays; Evening: 6 pm–10 pm; Night: remaining periods.

4 Assessment criteria

4.1 Construction noise

The ICNG identifies and recommends the following standard time restrictions for construction activities where noise is audible at residential premises:

- Monday to Friday 7 am to 6 pm;
- Saturday 8 am to 1 pm; and
- No construction work on Sundays or public holidays.

It is noted that the project proposed construction hours include work outside of the ICNG standard time restrictions and the construction noise assessment (refer Section 5.2) has applied the relevant criteria for all periods outside of standard construction hours.

These time restrictions are the primary management tool of the ICNG. Table 4.1 was reproduced from the ICNG and provides noise management levels for residential receivers during and outside of the recommended standard construction hours (OOH).

Table 4.1 ICNG residential criteria

Time of day	Management level $L_{Aeq,15\ minute}$	How to apply
Recommended standard hours: Monday to Friday 7 am to 6 pm Saturday 8 am to 1 pm No work on Sundays or public holidays	Noise affected Rating Background Level (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 $L_{Aeq(15min)}$ 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 (A) above the noise affected level, the proponent should negotiate with the community.

Table 4.1 ICNG residential criteria

Time of day	Management level $L_{Aeq,15\ minute}$	How to apply
		For guidance on negotiating agreements, see section 7.2.2.

Note: 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. Noise levels may be higher at upper floors of the noise affected residence.

In summary, the noise goals for residences specified by the ICNG are:

- 10 dB above the existing background levels (RBL + 10 dB) for standard construction hours; and
- 5 dB above the existing background levels (RBL + 5 dB) outside of the standard construction hours, if works are justifiable.

The construction noise management levels (NMLs) for the assessment locations, presented in Table 4.2, are based on the background noise levels outlined in Section 3.2 and in accordance with the ICNG.

Table 4.2 Construction NMLs

Assessment location	Period[2, 3, 4]	RBL[1], dB	NML, $L_{Aeq,15\ minute}$, dB
All residential assessment locations	Day (Standard hours)	35	45 75 (Highly affected)
	Day (Outside of standard hours)	35	40
	Evening	30	35
	Night	30	35

Notes:
1. Minimum assumed RBL as per the NPfI.
2. Standard hours is 7 am-6 pm Monday to Friday, 8 am to 1 pm Saturday.
3. Outside of standard hours is 6 pm to 7 am Monday to Friday and 1 pm Saturday to 7 am Monday.
4. Day: 7 am–6 pm Monday to Saturday; 8 am–6 pm Sundays and public holidays; Evening: 6 pm–10 pm; Night: Remaining periods.

4.2 Operational noise

Noise from industrial sites or processes in NSW are regulated by the local council, DPE and/or the EPA and usually have a licence and/or development consent conditions stipulating noise limits. These limits are normally derived from operational noise levels applied at assessment locations. They are based on EPA guidelines (ie NPfI or previous Industrial Noise Policy) or noise levels that can be achieved at a specific site following the application of all reasonable and feasible noise mitigation.

The objectives of noise trigger levels for industry are to protect the community from excessive intrusive noise and preserve amenity for specific land uses. It should be noted that the audibility of a noise source does not necessarily equate to disturbance at an assessment location.

To ensure these objectives are met, the EPA provides two separate noise trigger levels: intrusiveness and amenity. The fundamental difference being intrusiveness noise levels apply over 15 minutes in any period (day, evening or night), whereas the amenity noise levels apply to the entire assessment period (day, evening or night).

4.2.1 Intrusiveness noise levels

The intrusiveness noise trigger levels require that $L_{Aeq,15\ minute}$ noise levels during the relevant operational periods (ie day, evening and night) do not exceed the RBL by more than 5 dB. The NPfI recommends that the intrusive noise trigger level for evening be set at no greater than the intrusive noise level for daytime and that the intrusive noise level for night-time should be no greater than the intrusive noise level for day or evening.

It is noted that the background noise levels in the vicinity of the project were measured to be below the NPfI minimum background noise levels for all periods. Table 4.3 presents the intrusive noise trigger levels based on the adopted RBLs. Given the rural nature of all assessment locations and the results of sample ambient noise monitoring, it has been assumed that the ambient acoustic environment at all assessment locations is similar and the adopted RBL are consistent with the minimum RBL's provided in the NPfI. It is noted that intrusive noise levels are applicable at residential assessment locations only.

Table 4.3 Project intrusiveness noise levels

Assessment location	Period[1]	Adopted RBL[2], dB	Project intrusiveness noise level dB, $L_{Aeq,15\ minute}$
All residential assessment locations	Day	35	40
	Evening	30	35
	Night	30	35

Notes: 1. Day: 7 am–6 pm Monday to Saturday; 8 am–6 pm Sundays and public holidays; Evening: 6 pm–10 pm; Night: remaining periods.
2. Minimum RBL as per the NPfI has been assumed for all time periods.

4.2.2 Amenity noise levels

The assessment of amenity is based on noise levels specific to the land use. The noise levels relate only to industrial noise and exclude road or rail noise. Where the measured existing industrial noise approaches recommended amenity noise level, it needs to be demonstrated that noise levels from new industry will not contribute to existing industrial noise such that amenity noise levels are exceeded.

To ensure that industrial noise levels (existing plus new) remain within the recommended amenity noise levels for an area, the project amenity noise level for new industrial developments is the recommended amenity noise level (outlined in Table 2.2 of the NPfI) minus 5 dB. This approach was conservatively adopted even though it is unlikely for there to be existing or future industrial sources that could contribute to noise at assessed locations.

Residential assessment locations potentially affected by operation of the project have been categorised in the NPfI rural amenity categories. As per the definitions provided in the NPfI, all residential assessment locations were classified as "rural" since they were deemed to be in "an area with an acoustical environment that is dominated by natural sounds, having little or no road traffic noise and generally characterised by low background noise levels".

The corresponding project amenity noise levels for the sites are given in Table 4.4.

Table 4.4 Amenity noise criteria - Recommended L_{Aeq} noise levels from industrial noise sources

Type of receptor	Indicative noise amenity area	Time of day[1]	Recommended amenity noise level, $L_{Aeq,period}$ dB
Residence	Rural	Day	50
		Evening	45

Table 4.4 Amenity noise criteria - Recommended L_{Aeq} noise levels from industrial noise sources

Type of receptor	Indicative noise amenity area	Time of day[1]	Recommended amenity noise level, $L_{Aeq,period}$ dB
		Night	40

Notes: 1. Day: 7 am–6 pm Monday to Saturday; 8 am–6 pm Sundays and public holidays; Evening: 6 pm–10 pm; Night: remaining periods.

4.2.3 Project noise trigger level

The project-noise trigger level (PNTL) is the lower of the calculated intrusive or amenity noise level and is provided in Table 4.5 for all assessment locations.

Preliminary noise calculations determined that satisfying the intrusive noise level at the most exposed point of residential assessment locations will also satisfy PNTLs at assessment locations further away from the project.

To standardise the time periods for the intrusiveness and amenity noise levels, it has been assumed that the $L_{Aeq,15\ minute}$ will be taken to be equal to the $L_{Aeq,period}$ + 3 decibels (dB). This is consistent with NPfI methodology.

Table 4.5 Project noise trigger levels

Assessment location	Time period	Intrusive noise level dB, $L_{Aeq,15\ minute}$	Amenity noise level[2] dB, $L_{Aeq,15\ minute}$	Project noise trigger level (PNTL), dB
Nearest residence	Day	40	48	40 $L_{Aeq,15\ minute}$
	Evening	35	43	35 $L_{Aeq,15\ minute}$
	Night	35	38	35 $L_{Aeq,15\ minute}$

Notes: 1. Day: 7 am–6 pm Monday to Saturday; 8 am–6 pm Sundays and public holidays; Evening: 6 pm–10 pm; Night: remaining periods.
2. Amenity noise level = NPfI recommended amenity noise level – 5 dB (to account for any additional industrial noise) + 3 dB (to standardise time periods)

Fact sheet C of the NPfI (EPA 2017) provides guidelines for applying modifying factor corrections to account for noise emissions with particular characteristics, such as tonality, intermittence or dominant low-frequency content, that may be considered more annoying than other noise at the same level.

Noise emissions with these characteristics were not identified for the proposed development and hence, modification factors have not been included in noise predictions.

4.2.4 Maximum noise level event assessment

In accordance with the NPfI methodology, the potential for sleep disturbance from maximum noise level events from premises during the night-time period needs to be considered.

The NPfI suggests that a detailed maximum noise level event assessment should be undertaken where the development/premises night-time noise levels at a residential location exceed:

- $L_{Aeq,15\ minute}$ 40 dB or the prevailing RBL plus 5 dB (whichever is the greater); and/or
- L_{Amax} 52 dB or the prevailing RBL plus 15 dB (whichever is the greater).

Guidance regarding potential for sleep disturbance is also provided in the RNP. The RNP calls upon a number of studies that have been conducted into the effect of maximum noise levels on sleep. The RNP acknowledges that, at the current level of understanding, it is not possible to establish absolute noise level criteria that would correlate to an acceptable level of sleep disturbance. However, the RNP provides the following conclusions from the research on sleep disturbance:

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

It is commonly accepted by acoustic practitioners and regulatory bodies that a facade including a partially open window will reduce external noise levels by 10 dB. Therefore, external noise levels in the order of 60 to 65 dB calculated at the facade of a residence are unlikely to cause awakening affects.

Table 4.6 provides the sleep disturbance criteria for the residential assessment locations based on the results of ambient noise monitoring.

Table 4.6 Maximum noise level event screening criteria

Assessment location	Assessment period[1]	Adopted RBL, dB	Maximum noise level event screening criteria, dB	
			$L_{Aeq,15\ minute}$	L_{Amax}
All residential assessment locations	Night	30	40	52

Notes: 1. Night: 10 pm to 7 am Monday to Saturday, 10 pm to 8 am Sundays and public holidays.

Operation of the project infrastructure would produce a relatively low-level, steady-state noise, if any, during the night -time period. Given this and the separation distance to the nearest residences (in the order of 2 km from Dam infrastructure etc.), maximum noise events (L_{Amax}) are unlikely to occur. Hence, sleep disturbance impacts are unlikely to occur and have not been assessed further.

4.3 Road traffic noise

The potential impacts of noise resulting from construction and operational related traffic on public roads are assessed against criteria defined in the RNP (EPA 2011). The application of appropriate road traffic noise criteria for the project has followed the two-step process identifying the assessment and relative increase criteria as outlined in Section 3.4.1 of the RNP.

The nearest residential assessment locations potentially affected by an increase in road traffic as a result of the project are located on the New England Highway, Tamworth-Nundle Road, Ogunbil Road, Dungowan Dam Road, Duri-Dungowan Road, Back Woolomin and Dungowan Creek Road. For the purposes of this assessment the New England Highway, Tamworth-Nundle Road , Duri-Dungowan Road and Ogunbil Road have been classified as arterial or sub-arterial roads, while Dungowan Dam Road, Back Woolomin Road and Dungowan Creek Road have been classified as local roads.

Table 4.7 presents the road noise assessment criteria for residential land uses, reproduced from Table 3 of the RNP.

Table 4.7 Road traffic noise assessment criteria for residential land uses

Road category	Type of project/development	Assessment criteria, dB	
		Day (7 am–10 pm)	Night (10 pm–7 am)
Freeway/arterial /sub-arterial roads	Existing residences affected by additional traffic on existing freeways/arterial/sub-arterial roads generated by land use developments.	$L_{Aeq,15\ hour}$ 60 (external)	$L_{Aeq,9\ hour}$ 55 (external)
Local roads	Existing residences affected by additional traffic on existing local roads generated by land use developments.	$L_{Aeq,1\ hour}$ 55 (external)	$L_{Aeq,1\ hour}$ 50 (external)

Additionally, the RNP states where existing road traffic noise criteria are already exceeded, any additional increase in total traffic noise level should be limited to 2 dB where all feasible and reasonable noise mitigation is considered.

In addition to meeting the assessment criteria, any significant increase in total traffic noise at receptors due to a development must be considered. Receivers experiencing increases in total traffic noise levels above those presented in Table 4.8 should be considered for mitigation.

Table 4.8 Road traffic 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 $L_{Aeq(15\ hour)}$ + 12 (external)	Existing traffic $L_{Aeq(9\ hour)}$ + 12 (external)

*It is noted that the relative increase criteria do not apply to local roads.

4.4 Blasting

Construction blasting may be required as part of the excavation of the spillway, diversion tunnel and/or quarry areas depending on the material encountered. The limits adopted by the EPA for blasting are provided in the Australian and New Zealand Environment Council (ANZEC) guidelines, *Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration*.

The blasting limits address two main effects of blasting:

- airblast noise overpressure; and
- ground vibration.

4.4.1 Airblast

The recommended maximum vibration level for airblast is 115 dB linear peak. The vibration level of 115 dB may be exceeded on up to 5% of the total number of blasts over 12 months. However, the level should not exceed 120 dB linear peak at any time. A summary of airblast limits is provided in Table 4.9.

Table 4.9 Airblast overpressure

Airblast overpressure level dB(L_{peak})	Allowable exceedance
115	5% of the total number of blasts over 12 months
120	0%

4.4.2 Ground vibration

Peak particle velocity (PPV) from ground vibration should not exceed 5 mm/s for more than 5% of the total number of blasts over 12 months. However, the maximum level should not exceed 10 mm/s at any time. A summary of ground vibration limits is provided in Table 4.10.

Table 4.10 Ground vibration limits

PPV (mm/s)	Allowable exceedance
5	5% of the total number of blasts over 12 months
10	0%

4.4.3 Timing and frequency of blasts

As per the ANZEC guidelines, blasting operations should generally only be permitted during the hours of 9:00 am and 5:00 pm Monday to Saturday and should not take place on Sundays or public holidays. Further, the ANZEC guidelines state that blasting should generally take place no more than once per day. The project hours for blasting would be consistent with these guidelines.

4.5 Construction vibration

4.5.1 Human comfort

i Overview

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

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 vibration types and provides direction for assessing and evaluating the applicable criteria. Vibration-generating activities associated with the project include bulk earthworks, demolition and pipeline construction. Hence, of relevance to this assessment is intermittent vibration only due to the nature of the proposed activities.

ii 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 (such as 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 RMS (root mean square) acceleration levels over the frequency range 1 Hz to 80 Hz. The acceptable VDV for intermittent vibration are reproduced in Table 4.11.

Table 4.11 Acceptable VDV for intermittent vibration

Location	Day		Night	
	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. Day is 7 am to 10 pm and night is 10 pm to 7 am.
2. These criteria are indicative only.

There is a low probability of adverse comment or disturbance to building occupants at VDV 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.

4.5.2 Structural vibration criteria

Most commonly specified “safe” structural vibration limits are designed to minimise the risk of threshold or cosmetic surface cracks and are set well below the levels that have potential to cause damage to the main structure.

In terms of the most recent relevant vibration damage criteria, *Australian Standard AS 2187.2 – 2006 Explosives - Storage and Use - Use of Explosives* recommends the frequency dependent guideline values and assessment methods given in the *British Standard BS 7385 Part 2-1993 Evaluation and measurement for vibration in buildings Part 2* be used as they are “applicable to Australian conditions”.

The standard sets guide values for building vibration based on the lowest vibration levels above which damage has been credibly demonstrated. These levels are judged to give a minimum risk of vibration induced damage, where minimal risk for a named effect is usually taken as a 95% probability of no effect.

Sources of vibration that are considered in the standard include demolition, blasting, piling, ground treatments (eg compaction), construction equipment, tunnelling, road and rail traffic and industrial machinery.

The recommended limits (guide values) for transient vibration to ensure minimal risk of cosmetic damage to residential and industrial buildings are presented in Table 4.12 and shown in Figure 4.1.

Table 4.12 Transient vibration guide values - minimal risk of cosmetic damage

Line	Type of building	Peak component particle velocity in frequency range of predominant pulse	
		4 Hz to 15 Hz	15 Hz and above
1	Reinforced or framed structures Industrial and heavy commercial buildings	50 mm/s at 4 Hz and above	
2	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

The standard states that the guide values in Table 4.12 relate predominantly to transient vibration, which does not give rise to resonant responses in structures and low-rise buildings.

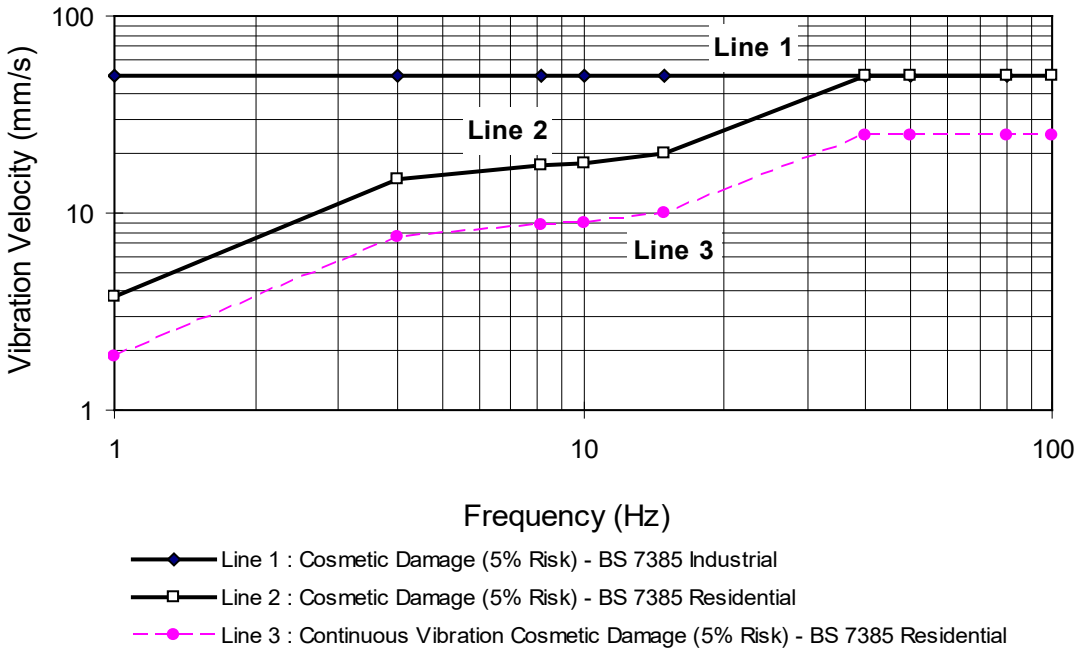

Figure 4.1 Graph of transient vibration guide values for cosmetic damage

In the lower frequencies where strains associated with a given vibration velocity magnitude are higher, the guide values for building types corresponding to Line 2 are reduced. Below a frequency of 4 Hz where a high displacement is associated with the relatively low peak component particle velocity value, a maximum displacement of 0.6 mm (zero to peak) is recommended. This displacement is equivalent to a vibration velocity of 3.7 mm/s at 1 Hz.

The standard also states that minor damage is possible at vibration magnitudes, which are greater than twice those given in Table 4.6, and major damage to a building structure may occur at values greater than four times the tabulated values.

Fatigue considerations are also addressed in the standard and it is concluded that unless calculations indicate that the magnitude and number of load reversals are significant (in respect to the fatigue life of building materials), the guide values in Table 4.6 should not be reduced for fatigue considerations.

In order to assess the likelihood of cosmetic damage due to vibration, AS 2187 specifies that vibration measurements should be undertaken at the base of the building and the highest of the orthogonal vibration components (transverse, longitudinal and vertical directions) should be compared with the criteria curves presented in Table 4.6.

It is noteworthy that extra to the guide values nominated in Table 4.6, the standard states that:

> Some data suggests that the probability of damage tends towards zero at 12.5 mm/s peak component particle velocity. This is not inconsistent with an extensive review of the case history information available in the UK.

Also that:

> A building of historical value should not (unless it is structurally unsound) be assumed to be more sensitive.

5 Noise assessment

5.1 Methodology

5.1.1 Overview

This section presents the methods and base parameters used to model and assess noise emissions from construction and operation of the Dungowan Dam and pipeline project including decommissioning of the existing Dungowan Dam.

Quantitative modelling of operational and construction noise was completed using DGMR Software iNoise noise prediction software. This software calculates total noise levels at receptors from the concurrent operation of multiple noise sources. The model incorporates factors such as:

- the lateral and vertical location of plant and equipment;
- source-to-receptor distances;
- ground effects;
- atmospheric absorption;
- topography; and
- meteorological conditions.

Three-dimensional digitised ground contours of the site and surrounding land were incorporated to model topographic effects. Equipment was modelled at locations and heights representative of typical operating scenarios.

The model was used to predict noise levels at each of the assessment locations identified in Table 3.1 and shown in Figure 3.1. The modelling results were then compared against the relevant noise assessment criteria described in Chapter 4, to determine potential impacts.

5.1.2 Plant and equipment items

The assessment has adopted plant and equipment sound power levels from the Department of Environment, Food and Rural Affairs (DEFRA) 2005, *Update of Noise Database for Prediction of Noise on Construction and Open Sites*, where available. Otherwise data was sourced from an EMM database of similar equipment, which is based on measurements at other construction sites as indicated.

Sound power levels and quantities of plant and equipment adopted for each phase of work for the purpose of predicting noise levels are summarised in Table 5.1. Although not standard, some out-of-hours construction works (eg day, evening and night) would occur.

Table 5.1 Noise source sound power levels

Noise source	Sound power level per unit, L_W, dB	Quantity[1]		
		Day	Evening	Night
Construction - Road upgrades (transient)				
Excavator	110	3	3	3

Table 5.1 Noise source sound power levels

Noise source	Sound power level per unit, L_W, dB	Quantity[1]		
		Day	Evening	Night
Bitumen/asphalt laying truck	112	2	2	2
Articulated dump truck (40t)	107	6	6	6
Road truck (Truck & Dog)	103	4	4	4
Construction – Pipeline and powerline (transient)				
Road truck (Truck & Dog)	103	2	2	2
Vibratory roller	108	1	1	1
Excavator	110	1	1	1
Hand compactor	93	1	1	1
Concrete truck (Agitator)	108	1	1	1
Construction – Accommodation Camp (static)				
Generator	102	4	4	4
Concrete truck (Agitator)	108	4	4	4
Road truck (Truck & Dog)	103	4	4	4
Water cart	109	4	4	4
Elevated work platform	94	4	4	4
Telehandler	107	2	2	2
Upright trench rammer	108	2	2	2
Light tower	93	4	4	4
Bobcat	95	2	2	2
Hand tools	101	8	8	8
Crane (50t)	104	2	2	2
Crane (15t)	98	2	2	2
Construction – Quarrying (static)				
Front end loader	104	2	2	2
Excavator	110	4	4	4
Road truck (Truck & Dog)	103	4	4	4
Dozer	116	2	2	2
Articulated dump truck (40t)	107	6	6	6
Crusher/Screen	114	2	2	2
Drill	116	2	2	2
Construction - Embankment/Spillway (static)				
Concrete truck (Agitator)	108	2	2	2
Shotcrete pump	106	4	4	4
Grout pump	106	2	2	2
Compressor	103	4	4	4

Table 5.1 Noise source sound power levels

Noise source	Sound power level per unit, L_W, dB	Quantity[1]		
		Day	Evening	Night
Generator	102	4	4	4
Hand tools	101	8	8	8
Crane (50t)	104	2	2	2
Crane (15t)	98	2	2	2
Elevated work platform	94	4	4	4
Light tower	93	4	4	4
Telehandler	107	2	2	2
Excavator	110	4	4	4
Construction – Demolition (static)				
Excavator	110	6	6	6
Rock breaker (medium)	117	2	2	2
Dozer	116	2	2	2
Articulated dump truck (40t)	107	8	8	8
Road truck (Truck & Dog)	103	4	4	4
Operations – Maintenance (static)				
Hand tools	101	1	0	0
Road truck (Truck & Dog)	103	1	0	0
Light vehicle	76	2	0	0
Chainsaw	112	1	0	0
Operations – Pipeline (static)				
Control Valve	See Note 2	2	2	2

Notes: 1. Within any 15-minute period.
2. The total sound power level (Lw) emitted from each control valve has been engineered to ensure compliance at the nearest residences. This is discussed further in Section 5.3.2.

5.1.3 Modelling assumptions

In addition to the sound power levels and quantities provided, other noise modelling assumptions adopted are as follows:

- all construction plant is conservatively assumed to operate continuously in any 15 minute period; and
- all on-site vehicle movements are 20 km/hr or less.

5.2 Construction noise

The assessment of construction noise has been separated to address the two different types of construction occurring as follows:

- Static construction – the embankment/spillway, accommodation camp, quarrying and dam demolition areas are static areas that have the potential to generate noise from relatively consistent locations throughout the construction period.

- Dynamic construction – the pipeline, powerline and road upgrades areas would generate transient construction noise, with works progressing along the relevant alignments.

Noise predictions for each type of construction have been separated to ensure that construction noise impacts have been accurately addressed. It is of note that, due to the considerable distances between the static and dynamic construction areas, the likelihood of cumulative noise increasing noise levels above the predictions provided is considered unlikely.

5.2.1 Static construction areas

Construction noise emissions have been predicted at all assessment locations with respect to each construction activity (worst case scenario for each assessment location based on scenarios adopted in Table 5.1). Refer to Table 5.2 for a summary of the results. Given the proposed construction hours of between 7 am and 6 pm Monday to Saturday (and potential 24-hour construction for certain periods), the predicted noise levels have been assessed against the relevant criteria for ICNG standard construction hours and all periods outside of standard construction hours.

Table 5.2 Construction noise predictions

Assessment locations	Period	Predicted maximum construction noise level, $L_{Aeq,15\ minute}$, dB	NML, $L_{Aeq,15\ minute}$, dB	Maximum exceedance, dB
NCA 2	Day (Standard hours)	<45	45	Nil
	Day (OOH)	<40	40	Nil
	Evening	<35	35	Nil
	Night	<35	35	Nil
NCA 3	Day (Standard hours)	<40	45	Nil
	Day (OOH)	<35	40	Nil
	Evening	<35	35	Nil
	Night	<35	35	Nil
NCA 4	Day (Standard hours)	<40	45	Nil
	Day (OOH)	<35	40	Nil
	Evening	<35	35	Nil
	Night	<35	35	Nil
NCA 5	Day (Standard hours)	<40	45	Nil
	Day (OOH)	<35	40	Nil
	Evening	<35	35	Nil
	Night	<35	35	Nil
NCA 6	Day (Standard hours)	<40	45	Nil
	Day (OOH)	<35	40	Nil
	Evening	<35	35	Nil
	Night	<35	35	Nil
NCA 7	Day (Standard hours)	<40	45	Nil
	Day (OOH)	<35	40	Nil
	Evening	<35	35	Nil
	Night	<35	35	Nil

Noise emissions from static construction works are predicted to comply with NMLs at all residential assessment locations both during and outside standard construction hours, where relevant. This is due to the intervening topography and large separation distances between the construction areas and assessment locations.

Notwithstanding compliance with the relevant NMLs, noise mitigation measures and application of good practice noise management should be considered. Noise mitigation measures are discussed in Chapters 9 and 10 of this report along with good practice management measures that would be implemented to minimise potential impacts to the surrounding community.

5.2.2 Dynamic construction areas

Construction of the pipeline, new overhead powerline and upgrade of Dungowan Dam Road is expected to be transient, progressing along each respective alignment.

i Pipeline and powerline construction

The exposure period to such activities and corresponding noise levels would be minimised where possible and while detailed program and construction programming would be further developed in construction and management documentation, it is not expected that receivers would experience noise above the 'highly affected' NML for more than five days. This is due to the transient nature of the works and the fact that the modelled predictions assume simultaneous operation of plant and equipment at the nearest locations to the relevant sensitive receptors, resulting in actual construction noise levels generally being less than those predicted for the majority of the time.

Based on the adopted activities provided in Table 5.1, residential receivers within approximately 30 m of pipeline or powerline construction activities may experience levels above the 'highly affected' noise management level of 75 dB $L_{Aeq,15\ minute}$, prior to any mitigation or management measures being implemented. As mentioned above, it is not expected that receivers would experience noise above the 'highly affected' NML for more than five days. A number of residences located on Ogunbil Road are within 30 metres of the pipeline construction area, while there are no residences within 30 metres of the powerline construction areas. Residential receivers within approximately 730 metres of pipeline or powerline construction activities may experience levels above the standard hours construction noise management level of 45 dB $L_{Aeq,15\ minute}$, prior to any mitigation or management measures being implemented.

ii Dungowan Dam Road upgrade

Residential receivers within approximately 90 metres of the Dungowan Dam Road upgrade works may experience levels above the 'highly affected' noise management level of 75 dB $L_{Aeq,15\ minute}$, prior to any mitigation or management measures being implemented. A number of residences are within 90 metres of the road upgrade works area. Residential receivers within approximately 1,300 metres of the Dungowan Dam Road upgrade works may experience levels above the standard hours construction noise management level of 45 dB $L_{Aeq,15\ minute}$, prior to any mitigation or management measures being implemented. It is not expected that receivers would experience noise above the 'highly affected' NML for more than five days.

Given that the predictions assume simultaneous operation of plant and equipment at the nearest locations to the relevant sensitive receptors, actual construction noise levels would be less than those predicted for the majority of the time. Further, the exposure period to such noise levels would be limited given the transient nature of the works.

Hence, construction noise levels are predicted to exceed the NMLs at the nearest residential assessment locations at some stage during the proposed pipeline construction and Dungowan Dam Road upgrade, both during and outside standard construction hours. This is not an uncommon finding for construction projects in close proximity to rural residential areas with low background noise levels and indicates that feasible and reasonable mitigation practices should be considered and applied. Noise mitigation measures are discussed in Chapters 9 and 10 of this report along with good practice management measures that could be implemented to minimise potential impacts to the surrounding community.

5.3 Operational noise

The two distinct sources of operational noise are:

- Operational maintenance – this incorporates all general maintenance works surrounding the dam including, but not limited to, tree trimming, routine equipment maintenance, etc; and
- Pipeline control valves - the elevation difference between the new Dungowan Dam and Calala Water Treatment Plant requires that pipeline pressure be carefully managed via a system of valve controls.

The assessment of these operational noise sources has been separated since, given the lack of available noise level data for the control valves, each control valve enclosure would need to be engineered to ensure compliance at the nearest residences. Due to the considerable distances between the maintenance area and the pipeline control valves, the likelihood of cumulative noise impacts from both operational activities is considered unlikely.

5.3.1 Operational maintenance

Operational noise emission levels have been predicted for a peak operating scenario during noise enhancing meteorological conditions as relevant (refer to Table 3.2). As modelling was developed to represent noise levels during a peak operational scenario, noise level predictions are considered conservative for assessment purposes.

No modifying factor corrections, as per Fact sheet C of the NPfI (EPA 2017), were found to be applicable to any of the sites operational noise emissions given the quantity and nature of equipment (light vehicles, delivery trucks, power tools, chainsaws, etc) and the large separation distances to the nearest receivers. Hence, modification factors have not been included in the noise predictions.

The modelling results for noise emissions from the projects' operations (see Table 5.1) are provided in Table 5.3. The operational maintenance noise levels are predicted to be below the relevant NPfI noise trigger levels at all assessment locations for noise enhancing meteorological conditions.

Table 5.3 Predicted operational noise levels

Location	Receiver type	Period[1]	Predicted noise level, $L_{Aeq,15\ minute}$, dB	Project noise trigger level (PNTL), $L_{Aeq,15\ minute}$, dB	Exceedance, dB
NCA 2	Residential	Day	<40	40	Nil
		Evening	<35	35	Nil
		Night	<35	35	Nil
NCA 3	Residential	Day	<40	40	Nil
		Evening	<35	35	Nil
		Night	<35	35	Nil
NCA 4	Residential	Day	<40	40	Nil
		Evening	<35	35	Nil
		Night	<35	35	Nil

Table 5.3 Predicted operational noise levels

Location	Receiver type	Period[1]	Predicted noise level, $L_{Aeq,15\ minute}$, dB	Project noise trigger level (PNTL), $L_{Aeq,15\ minute}$, dB	Exceedance, dB
NCA 5	Residential	Day	<40	40	Nil
		Evening	<35	35	Nil
		Night	<35	35	Nil
NCA 6	Residential	Day	<40	40	Nil
		Evening	<35	35	Nil
		Night	<35	35	Nil
NCA 7	Residential	Day	<40	40	Nil
		Evening	<35	35	Nil
		Night	<35	35	Nil

During emergency events, an emergency diesel generator and drawdown valve may be operated, with the potential to generate some short-term noise impacts. However, these emergency events are anticipated to be extremely uncommon and, as such, they have not been assessed further.

5.3.2 Pipeline control valves

Due to the elevation difference between the new Dungowan Dam and Calala WTP, pressure would be carefully managed via a system of valve controls.

The two relevant control valve sites are located in Dungowan and Ogunbil. Noise generated by the operation of these control valves has the potential to impact the surrounding ambient noise environment. The control valves would be located inside an enclosure and would operate intermittently as required throughout the day, evening or night-time periods.

Given the lack of available noise level data for the control valves, a maximum permissible noise level to be emitted from each control valve site has been calculated to ensure compliance with the relevant PNTLs can be maintained at the nearest residences.

The nearest residences are 320 metres from the control valve site located in Dungowan, adjacent to the Ogunbil Road and Thorntons Road intersection. Maximum sound power level of L_{Aw} 92 dB emitted from the control valve enclosure would ensure that this valve would maintain compliance with the relevant PNTLs at these nearest residences.

The nearest residences are 115 metres from the control valve site located in Ogunbil. Maximum sound power level of L_{Aw} 82 dB emitted from the control valve enclosure would ensure that this valve would maintain compliance with the relevant PNTLs at the nearest residences.

6 Road traffic noise assessment

6.1 Methodology

The US Environmental Protection Agency Federal Highway Administration (FHWA) traffic noise model (TNM) for road traffic noise calculations was used for the assessment of road traffic noise for the project. The FHWA TNM calculation method is more sensitive to low traffic volumes (ie <200 vehicles per hour) and hence was adopted for the assessment of road traffic noise for the project. The nearest residential assessment locations potentially affected by an increase in road traffic as a result of the project are located on the New England Highway, Tamworth-Nundle Road, Ogunbil Road and Dungowan Dam Road. For the purposes of this assessment the New England Highway, Tamworth-Nundle Road and Ogunbil Road have been classified as arterial or sub-arterial roads, while Dungowan Dam Road and Dungowan Creek Road have been classified as local roads.

Most employees would either be housed in the proposed accommodation camp or transported by bus, hence only a small number of light vehicle trips would be generated during construction. These would likely occur outside the commuter peak hours.

The average daily heavy vehicles during peak construction periods (60 trips) would generate six trips or 12 in or out movements in a peak hour, assuming 10% of the daily traffic occurs in the peak hour which is a conservative approach.

Transport of construction materials, equipment and personnel to the project area would use one main transport route as described in the EIS. The transport route follows the New England Highway to Nemingha (approximately 7 km south-east of Tamworth) and turns onto the Tamworth-Nundle Road to Dungowan. Vehicles would then turn off Tamworth-Nundle Road at Dungowan onto Ogunbil Road followed by Dungowan Dam Road. In addition to the primary transport route, a number of local roads would also be used to a much lesser extent by the project pipeline construction traffic, namely Duri-Dungowan Road, Back Woolomin Road and Dungowan Creek Road.

It is anticipated that road traffic movements generated during the operational maintenance and monitoring of the project would be significantly less than the generated construction traffic movements. Since road traffic associated with construction is shown (refer to the following sections) to comply with the relevant RNP criteria, then operational road traffic noise impacts are also considered unlikely.

The predicted daily traffic increases due to construction traffic associated with the project are shown in Table 6.1.

Table 6.1 Summary of daily traffic volumes and increases with construction traffic

Road	Existing daily traffic (all vehicles)	Existing daily traffic (Heavy vehicles)	Percentage of heavy vehicles (%)	Additional daily traffic	Increase (%)
New England Highway	8652	742	8.6	60 per day	0.7
Tamworth-Nundle Road	2239	124	5.5	60 per day	2.7
Ogunbil Road	495	66	13.3	60 per day	12.1
Dungowan Dam Road	Not available	Not available	Not available	12 per hour	Unknown
Duri-Dungowan Road	253	11	4.3	15 per day	5.9
Back Woolomin Road	Not available	Not available	Not available	12 per hour	Unknown
Dungowan Creek Road	Not available	Not available	Not available	12 per hour	Unknown

Notes: 1. Existing daily vehicle numbers have been calculated from the peak hourly traffic volumes sourced from the TIA (EMM 2020).

The predicted existing and future road traffic noise levels, inclusive of project-related construction traffic, are presented in Table 6.2. They are based on traffic volumes provided in Table 6.1.

Table 6.2 Predicted road traffic noise levels during construction

Receiver location	Location	Distance from road	Period [2]	RNP criteria	Road traffic noise level, dB	Predicted road traffic noise level, dB		Change, dB
					Existing	Construction	Existing + Construction	
Nearest residence to road	New England Highway	14 metres	Day	60 $L_{Aeq,15\ hour}$	69 $L_{Aeq,15\ hour}$	58 $L_{Aeq,15\ hour}$	69 $L_{Aeq,15\ hour}$	0.3
			Night	55 $L_{Aeq,9\ hour}$	64 $L_{Aeq,9\ hour}$	56 $L_{Aeq,9\ hour}$	64 $L_{Aeq,9\ hour}$	0.7
	Tamworth-Nundle Road	15 metres	Day	60 $L_{Aeq,15\ hour}$	65 $L_{Aeq,15\ hour}$	62 $L_{Aeq,15\ hour}$	67 $L_{Aeq,15\ hour}$	1.7
			Night	55 $L_{Aeq,9\ hour}$	60 $L_{Aeq,9\ hour}$	60 $L_{Aeq,9\ hour}$	63 $L_{Aeq,9\ hour}$	3.0
	Ogunbil Road	15 metres	Day	60 $L_{Aeq,15\ hour}$	59 $L_{Aeq,15\ hour}$	59 $L_{Aeq,15\ hour}$	62 $L_{Aeq,15\ hour}$	2.7
			Night	55 $L_{Aeq,9\ hour}$	53 $L_{Aeq,9\ hour}$	56 $L_{Aeq,9\ hour}$	58 $L_{Aeq,9\ hour}$	4.7
	Duri-Dungowan Road	15 metres	Day	60 $L_{Aeq,15\ hour}$	59 $L_{Aeq,15\ hour}$	48 $L_{Aeq,15\ hour}$	59 $L_{Aeq,15\ hour}$	0.4
			Night	55 $L_{Aeq,9\ hour}$	49 $L_{Aeq,9\ hour}$	43 $L_{Aeq,9\ hour}$	50 $L_{Aeq,9\ hour}$	1.0
	Dungowan Dam Road	75 metres	Day	55 $L_{Aeq,1\ hour}$	Not available	53 $L_{Aeq,1\ hour}$	-	-
			Night	50 $L_{Aeq,1\ hour}$	Not available	53 $L_{Aeq,1\ hour}$	-	-
	Back Woolomin Road	18 metres	Day	55 $L_{Aeq,1\ hour}$	Not available	60 $L_{Aeq,1\ hour}$	-	-
			Night	50 $L_{Aeq,1\ hour}$	Not available	60 $L_{Aeq,1\ hour}$	-	-
	Dungowan Creek Road	18 metres	Day	55 $L_{Aeq,1\ hour}$	Not available	60 $L_{Aeq,1\ hour}$	-	-
			Night	50 $L_{Aeq,1\ hour}$	Not available	60 $L_{Aeq,1\ hour}$	-	-

Notes: 1. Predicted noise level includes a 2.5 dB facade correction as required by the RNP.
2. It is assumed that 85% of construction traffic occurs during the day period (7:00am to 10:00pm) and the remaining 15% occurs during the night-time period (10:00pm to 7:00am).

6.2 New England Highway

Construction traffic noise level predictions demonstrate a road traffic noise increase of less than 1 dB for the nearest residences located on the New England Highway in the vicinity of the project area. The existing road traffic noise levels are calculated to be above the relevant RNP criteria during both the day and night-time periods. As the increase in total road traffic noise levels (existing plus construction) is predicted to be less than 2 dB, it is unlikely that noise impacts from construction traffic would occur at this location according to the RNP.

6.3 Tamworth-Nundle Road

Construction traffic noise level predictions demonstrate a 2-3 dB increase in road traffic noise levels for the nearest residences on Tamworth-Nundle Road. The existing road traffic noise levels are calculated to be above the relevant RNP criteria during both the day and night-time periods. During the day period, road traffic noise levels on Tamworth-Nundle Road are predicted to increase by less than 2 dB, which meets the allowable increase as specified in the RNP. During the night period, road traffic noise levels on Tamworth-Nundle Road are predicted to increase by up to 3 dB. Feasible and reasonable measures must therefore be considered, in the context of the temporary, albeit longer-term nature of the works. These would be addressed in detail in the construction traffic management plan.

6.4 Ogunbil Road

Construction traffic noise level predictions demonstrate a 3-5 dB increase in road traffic noise levels for the nearest residences on Ogunbil Road. During the day period, road traffic noise levels on Ogunbil Road are predicted to increase by up to 3 dB. During the night period, road traffic noise levels on Ogunbil Road are predicted to increase by up to 5 dB. Such changes result in levels above the RNP criteria and hence feasible and reasonable measures must be considered, in the context of the temporary, albeit longer-term nature of the works. These would be addressed in detail in the construction traffic management plan.

6.5 Duri-Dungowan Road

Construction traffic noise level predictions demonstrate a 1 dB increase in road traffic noise levels for the nearest residences on Duri-Dungowan Road. During the day period, road traffic noise levels on Duri-Dungowan Road are predicted to increase by less than 1 dB. During the night period, road traffic noise levels on Duri-Dungowan Road are predicted to increase by up to 1 dB. As such, road traffic noise levels are expected to remain below the RNP criteria.

6.6 Dungowan Dam Road

No existing traffic volumes were available for Dungowan Dam Road, and it is expected to be relatively low to nil. The predicted construction traffic noise level on Dungowan Dam Road is $L_{Aeq,1\ hour}$ 53 dB for the busiest 1-hour period. This level meets the daytime RNP absolute criterion, while is 3 dB above the night-time criterion. Given the road type and locality, it is likely that existing road traffic noise levels on Dungowan Dam Road would be considerably (ie more than 10 dB) less than those predicted for construction traffic. As such, it is unlikely that road traffic noise levels on Dungowan Dam Road would be any higher than predicted. Feasible and reasonable noise mitigation must be considered for the night-time period for residences potentially impacted, in the context of the temporary, albeit longer-term nature of the works. These would be addressed in detail in the construction traffic management plan.

6.7 Dungowan Creek Road

No existing traffic volumes were available for Dungowan Creek Road, and it is expected to be relatively low to nil. The predicted construction traffic noise level on Dungowan Creek Road is $L_{Aeq,1\ hour}$ 60 dB for the busiest 1-hour period. This level is 5 dB above the daytime RNP absolute criterion and 10 dB above the night-time criterion. Given the road type and locality, it is likely that existing road traffic noise levels on Dungowan Creek Road would be considerably (ie more than 10 dB) less than those predicted for construction traffic. As such, it is unlikely that road traffic noise levels on Dungowan Creek Road would be any higher than predicted. Feasible and reasonable noise mitigation must be considered for the night-time period for residences potentially impacted, in the context of the temporary, albeit longer-term nature of the works. These would be addressed in detail in the construction traffic management plan.

6.8 Back Woolomin Road

No existing traffic volumes were available for Back Woolomin Road, and it is expected to be relatively low to nil. The predicted construction traffic noise level on Back Woolomin Road is $L_{Aeq,1\ hour}$ 60 dB for the busiest 1-hour period. This level is 5 dB above the daytime RNP absolute criterion and 10 dB above the night-time criterion. Given the road type and locality, it is likely that existing road traffic noise levels on Back Woolomin Road would be considerably (ie more than 10 dB) less than those predicted for construction traffic. As such, it is unlikely that road traffic noise levels on Back Woolomin Road would be any higher than predicted. Feasible and reasonable noise mitigation must be considered for the night-time period for residences potentially impacted, in the context of the temporary, albeit longer-term nature of the works. These would be addressed in detail in the construction traffic management plan.

It is of note that the road traffic noise results are based on heavy vehicle movements during the peak construction scenario and hence this assessment of road traffic noise is considered to be conservative. Further, the application of the RNP criteria to construction projects is highly conservative given the RNP is designed for permanent scenarios and not temporary impacts related to construction activities.

6.9 Operational road traffic noise

Road traffic movements generated during the operational maintenance and monitoring of the project would be significantly less than that generated by construction traffic movements. Operational road traffic would consist of 1-2 light vehicles and a light truck, conducting routine maintenance around the dam site. These traffic volumes are expected to be less than 2% of the existing road traffic experienced on the abovementioned roads. As such, adverse noise impacts from operational road traffic noise are considered unlikely and have not been assessed further.

7 Blasting assessment

Blasting during the construction period may be required or preferred during construction as part of the excavation of the spillway and borrow areas depending on the material encountered. The design of these blasts would be actively managed by Water Infrastructure NSW.

7.1 Methodology

Predicted blast overpressure and vibration levels have been calculated using the method provided in AS2187-2: *Explosives – Storage and use Part 2: Use of explosives, 2006* and ICI Explosives Blasting Guide, as applicable to blasting in hard rock. This formula has been shown to be conservative in calculating overpressure and vibration.

The relevant formulae are as follows:

- PVS = 500 $(R/Q^{0.5})^{-1.6}$; and
- OP = 164.2 - 24(log10 R - 0.33 log10 Q).

Where:

- PVS = peak vector sum ground vibration level (mm/s);
- OP = peak blast overpressure (dB Linear);
- R = distance between charge and receiver (m); and
- Q = charge mass per delay (kg) or maximum instantaneous charge (MIC).

7.2 Results and discussion

The nearest sensitive receiver (R14) is located approximately 1900 m to the nearest potential construction blasting area (the spillway). Table 7.1 provides the highest MIC value corresponding to overpressure and vibration levels that satisfy the criteria at the nearest receiver to the relevant blasting location based on the conservative formulae provided in Section 7.1. As shown, the limitation on MIC is dictated by overpressure noise criteria, which is often the case.

Table 7.1 Predicted blast overpressure and vibration levels

Blast location	Nearest receiver	Approximate distance (m)	Highest MIC (kg)	Derived overpressure (dB(L)peak)	Derived vibration PPV (mm/s)
Spillway	R14	1900	4856	115.0	2.5
Quarry 4	R38	3250	10,000+	115.0	3.9
Quarry 5	R38	3400	10,000+	115.0	4.0
Existing Dam	R52	3500	10,000+	115.0	4.1

Note: Airblast overpressure criteria 115 dB (L_{inpeak}). Ground vibration criteria 5 (mm/s) Peak Particle Velocity (PPV).

The predicted blast overpressure and vibration levels identify that, when blasting in the spillway area, the use of a MIC of up to 4850 kg is likely to result in compliance with relevant overpressure and vibration criteria at the nearest residence (R14). These quantities of MIC are not expected to result in any significant constraints to blasting in the spillway area. The 5 mm/s PPV criterion would be satisfied if the airblast overpressure target is met.

When blasting in the relevant quarrying areas, MICs of up to 20,000 kg result in overpressure and vibration levels below criteria at the nearest residences. These quantities of MIC are unrealistically high and not expected to result in any significant constraints to blasting in the quarrying areas. Much lower MIC quantities are likely to be adopted in reality.

8 Vibration assessment

8.1 Methodology

Construction activities with the potential to generate vibration include trenching and excavation works.

As a guide, safe working distances for typical items of vibration intensive plant are listed in Table 8.1. These are quoted for both cosmetic damage (BS 7385) and human comfort (BS 6472).

Table 8.1 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
Jackhammer	Hand held	1 m (nominal)	Avoid contact with structure

Source: Transport Infrastructure Development Corporation Construction's Construction Noise Strategy (Rail Projects) (2007).
Notes: 1. Plant and equipment items are indicative to illustrate safe working distances, not all plant items will be used during the proposed works.

The safe working distances in Table 8.1 are indicative and would 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 8.1 relate to continuous vibration and apply at residential receivers. For the proposed works, vibration emissions are intermittent and therefore higher vibration levels occurring over shorter periods are allowed, in accordance with BS 6472.

8.2 Results and discussion

i Dynamic construction areas

The nearest residential facades are located approximately 20 m or greater from the project (ie along the pipeline alignment). Based on the assumed construction equipment list, the most vibration intensive item of plant to be utilised close to residences would be a small sized excavator or vibratory roller. Hence, the risk of cosmetic damage is low given relevant safe-working distances of greater than 7 m and 15 m, respectively.

It is also of note that the Ogunbil shearing sheds (which are of local heritage significance) are approximately 7 m from the project (ie along the pipeline alignment). Given the possibility for vibration generating equipment to be operated with close proximity to these façades, the guide values presented in Table 8.1 should be followed in the first instance. Equipment specification and construction methodology should be carefully chosen to minimise potential vibration impacts on these buildings during construction.

In the first instance the guide values presented in Table 8.1 should be followed. Allowing for the known separation distances between construction activity and nearest receptors, it is unlikely that the project would cause vibration impacts at any surrounding receivers. This would be confirmed and further presented in the CEMP.

ii Static construction area

Given the safe working distances outlined in Table 8.1 and the significant distances between the dam infrastructure (ie static) construction areas and the nearest residences, vibration impacts from the static construction works are considered unlikely.

iii Existing Dungowan dam pipeline

The existing Dungowan dam pipeline would be present through both the static and dynamic construction areas, with construction works likely directly above the existing pipeline. Given the possibility for vibration generating equipment to be operated with close proximity to the existing pipeline, the guide values presented in Table 8.1 should be followed in the first instance. Equipment specification and construction methodology should be carefully chosen to minimise potential vibration impacts on the pipeline during construction.

If vibration intensive works are planned within the relevant safe working distances identified, alternative equipment would be identified where possible and vibration monitoring would be implemented. In some circumstances, construction activity within the safe working distance would be unavoidable due to the construction works required and the site conditions.

For vibration intensive activities that occur within the safe working distances the following management methods should be adopted:

- Equipment size would be selected taking into account the safe working distances and the distance between the area of construction and the existing pipeline. The use of less vibration intensive methods of construction or equipment would be considered where feasible and reasonable when working in proximity to the existing pipeline. Construction equipment would be maintained and operated in an efficient manner, in accordance with manufacturer's specifications, to reduce the potential for adverse vibration impacts.
- Where vibration-intensive construction activity is unavoidable within the relevant safe working distance for cosmetic damage, condition surveys would be undertaken for the existing pipeline prior to the commencement of the construction activity.

- If the use of vibration intensive plant cannot be avoided within the safe working distance for cosmetic damage, construction works would not proceed until operator-attended vibration measurements are undertaken to determine the risk of damage.
- If longer-term construction works are required within the relevant safe working distance for cosmetic damage, a temporary relocatable vibration monitoring system should be installed, to warn operators (via flashing light, audible alarm, short message service (SMS) etc.) when vibration levels are approaching the cosmetic damage objective.

iv Operational vibration

Given that there are no significant vibration generating components included in the operational design of the project, and the significant distances between the dam infrastructure and the nearest residences, vibration impacts from the operation of the project are considered unlikely.

9 Mitigation and management

As provided in Section 5.2, it is likely that noise levels would be above the relevant noise management levels at times during the proposed construction activities for the project.

Section 9.1 provides site-specific noise and vibration mitigation and management measures that are to be adopted during construction works. Subsequent sections provide further good practice recommendations that would also be adopted in this regard.

9.1 Site-specific mitigation and management

The following measures are recommended to be implemented during construction works with the aim of mitigating impacts and reducing construction noise and vibration levels below the relevant goals:

- only low noise and low traffic generating works would be permitted on Sundays or public holidays;
- no blasting would be permitted on Sundays or public holidays;
- a letter box drop for residences in close proximity to the proposed construction to inform residents of planned construction activities, time periods and expected durations, potential impacts and proposed mitigation measures. Notification should be completed at least five days prior to the start of the proposed works;
- conduct community consultation with the nearest noise sensitive receivers to determine the least sensitive work periods;
- minimise the number of plant items operating concurrently when in proximity to receivers;
- consideration of reasonable and feasible mitigation of road traffic noise as described in Chapter 6, including planning deliveries and access to occur quietly and efficiently and organising parking only within designated areas located away from nearby sensitive receivers (where possible);
- planning high noise and vibration generating activities to be carried out in continuous blocks during non-sensitive periods, followed by appropriate respite periods; and
- noise and vibration monitoring may be adopted as a management strategy throughout the construction works.

The following operational measures are to be implemented with the aim of minimising impacts and reducing noise levels below the relevant goals:

- The control valve site located in Dungowan, adjacent to the Ogunbil Road and Thorntons Road intersection, should have a maximum sound power level of L_{Aw} 92 dB emitted from the control valve enclosure; and
- The control valve site located in Ogunbil. should have a maximum sound power level of L_{Aw} 82 dB emitted from the control valve enclosure.

9.2 Standard noise and vibration mitigation measures

Noise and vibration mitigation measures that would be implemented as part of the project CEMP to be approved prior to construction are outlined in Table 9.1 below.

Table 9.1 Noise and vibration mitigation measures

Impact	Ref#	Mitigation Measure	Responsible	Timing
Noise and vibration	NV_01	A Noise and Vibration Management Plan (NVMP) will be prepared and implemented as part of the CEMP. The NVMP will generally follow the approach in the Interim Construction Noise Guideline (DECC, 2009) and identify: • All potential significant noise and vibration generating activities associated with the activity • Feasible and reasonable mitigation measures to be implemented. • A monitoring program to assess performance against relevant noise and vibration criteria • Arrangements for consultation with affected neighbours and sensitive receivers, including notification and complaint handling procedures • Contingency measures to be implemented in the event of non-compliance with noise and vibration criteria. • Arrangement relating to vibration generated by blasting. • Incorporate the site specific mitigation and management outlined in Section 9.1.	Contractor	Pre-construction Construction
Noise and vibration	NV_02	Location and activity specific noise and vibration impact assessments will be carried out prior to (as a minimum) activities: • With the potential to result in noise levels above 75 dBA at any receiver • Required outside standard construction hours likely to result in noise levels in greater than the relevant noise management levels • With the potential to exceed relevant performance criteria for vibration. The assessments will clarify predicted impacts at relevant receivers in the vicinity of the activities to assist with the selection of appropriate management measures.	Contractor	Pre-construction Construction
Noise and vibration	NV_03	An out-of-hours works protocol will be developed for the construction of the project. The protocol will include: • Details of works required outside standard construction hours, including justification of why the activities are required outside standard construction hours • Measures that will be implemented to manage potential impacts associated with works outside standard construction hours • Location and activity specific noise and vibration impact assessment process(es) that will be followed to identify potentially affected receivers, clarify potential impacts and select appropriate management measures • Details of the approval process (internal and external) for works proposed outside standard construction hours.	Contractor	Pre-construction Construction
Notification	NV_04	Neighbours are to be provided, reasonably ahead of time, information such as total building time, what works are expected to be noisy, their duration, what is being done to minimise noise and when respite periods will occur. If there are works outside standard hours, inform affected residents and other sensitive land use occupants within 14 days of commencement.	Contractor	Pre-construction Construction
Monitoring	NV_05	Monitoring will be carried out at the commencement of new noise and vibration intensive activities and works in new locations to confirm that actual noise and vibration levels are consistent with noise and vibration impact predictions and that the management measures that have been implemented are appropriate.	Contractor	Pre-construction Construction

Table 9.1 Noise and vibration mitigation measures

Impact	Ref#	Mitigation Measure	Responsible	Timing
Vibration	NV_06	Blast Management will be addressed under the NVMP, addressing relevant performance criteria and protocols.	Contractor	Construction
Noise and vibration	NV_07	Where reasonable and feasible, operational noise mitigation such as noise barriers, berms and at-property treatments identified during detailed design should be installed early in the project so as to provide a benefit to receivers during the construction phase of the project.	Contractor	Pre-construction Construction
Complaints handling	NV_08	A readily accessible contact point, such as a 24-hour toll-free information and complaints line will be established. Document and maintain a complaints register detailing the following: • date and time • complainants' details • person receiving complaint and person referred to • description of complaint. The Contractor will provide quick response to complaints, with complaint handling staff having both a good knowledge of the works and ready to access information. Compliance monitoring should be undertaken to investigate complaints.	Contractor, WaterNSW	Pre-construction Construction Post Construction

9.3 Adoption of general noise & vibration management practices (AS 2436-2010)

AS 2436-2010 *"Guide to Noise and Vibration Control on Construction, Maintenance and Demolition Sites"* sets out numerous practical recommendations to assist in mitigating construction noise emissions. Examples of strategies that could be implemented during the construction works are listed below.

9.3.1 Universal work practices

These include:

- regular reinforcement (such as at toolbox talks) of the need to minimise noise and vibration;
- regular identification of noisy activities and adoption of improvement techniques;
- avoiding the use of portable radios, public address systems or other methods of site communication that may unnecessarily impact upon nearby residents;
- developing routes for the delivery of materials and parking of vehicles to minimise noise;
- where possible, avoiding the use of equipment that generates impulsive noise;
- minimising the movement of materials and plant and unnecessary metal-on-metal contact; and
- minimising truck movements.

9.3.2 Plant and equipment

Additional measures for plant and equipment include:

- choosing quieter plant and equipment based on the optimal power and size to most efficiently perform the required tasks;

- using temporary noise barriers (in the form of plywood hoarding or similar) to shield intensive construction noise activities from residences;
- operating plant and equipment in the quietest and most efficient manner; and
- regularly inspecting and maintaining plant and equipment to minimise noise and vibration level increases, to ensure that all noise and vibration reduction devices are operating effectively.

9.3.3 Work scheduling

- scheduling activities to minimise impacts by undertaking all possible work during hours that will least adversely affect sensitive receivers and by avoiding conflicts with other scheduled events;
- scheduling noisy activities to coincide with high levels of neighbourhood noise so that noise from the activities is partially masked and not as intrusive;
- optimising the number of deliveries to the site by amalgamating loads where possible and scheduling arrivals within designated hours;
- designating, designing and maintaining access routes to the site to minimise impacts; and
- include contract conditions that include penalties for non-compliance with reasonable instructions by the principal to minimise noise or arrange suitable scheduling.

9.3.4 Relative effectiveness of noise controls

Typical noise reductions achieved by some of the noise controls described above are provided in Table 9.2.

Table 9.2 Relative effectiveness of various forms of noise control

Noise control	Nominal noise reduction possible (dB)
Increase source-to-receiver distance	approximately 6 for each doubling of distance
Screening	normally 5 to 10, maximum 15
Enclosure	normally 15 to 25, maximum 50
Silencing (eg exhaust mufflers)	normally 5 to 10, maximum 20

Source: AS 2436-2010.

10 Community consultation and complaints handling

A programme to engage in active community consultation and maintain positive relations with local residents would be implemented as part of management plans for the project in order to minimise complaints by addressing their concerns.

With regard to potentially offensive noise events associated with construction activities, AS 2436 – 2010 provides the following:

> An effective community relations program is essential to keep the stakeholders informed throughout the project development process, to obtain valuable data related to the project, and to become aware of any project-related impacts in a timely manner. Additionally, the community is likely to be more understanding and accepting of the noise and vibration where the information provided is frank, does not attempt to understate the likely noise and vibration impacts and if commitments made are firmly adhered to.

The same approach can, and would, be taken to events with the potential to cause high levels of vibration at a nearby sensitive receiver.

To effectively manage any requests for information or respond to any public concerns in relation to the proposed construction activities and site operation, the following systems should be maintained:

- supply the relevant governing authorities with the names and appropriate contact numbers for the site construction manager during the construction period and one other senior staff member;
- an emergency after hours contact phone number should be put in place to allow contact with the Water Infrastructure NSW in relation to any environmental matter including those concerned with noise and vibration issues;
- use a complaint handling system to monitor environmental noise and vibration complaints. All information relating to such complaints should be kept in a register. The register should include the following information:
  - date and time of complaint;
  - complainant details (ie full name, address and contact details);
  - nature and source of complaint;
  - action taken; and
  - follow-up with complainant.
- the complaint register should be made available to any relevant regulatory authority upon request; and
- endeavour to respond to any complaint within one working day of its receipt.

Response measures, which could be adopted following complaints regarding noise and/or vibration, include:

- identification of the source that has caused the complaint. This would be done by consultation with the complainant and by conducting a noise and/or vibration survey to quantify the level of disturbance; and

- reassess the mitigation and management techniques employed at the site to reduce the impact of the source in question. Particular attention should be given to the scheduling of activities and the siting of equipment.

Following the adoption of additional or alternative feasible and reasonable mitigation, a further noise and/or vibration survey should be conducted at the complainant's location to demonstrate the effectiveness of the mitigation strategy.

11 Conclusion

EMM has prepared a Noise and Vibration Impact Assessment for the construction and operation of the Dungowan Dam and pipeline project. The assessment considered the potential for noise and vibration impacts of the project and has been prepared in accordance with the methodology outlined in the NPfI, ICNG, as well as other relevant guidelines and standards.

Noise goals for operation and construction of the project have been established based on applying the most stringent background noise level minimum criteria and methodology provided in the NPfI, ICNG (and others).

Findings of the assessment are summarised as follows:

- Construction noise levels were assessed for the daytime and OOH periods during noise-enhancing meteorological conditions. Predictions indicate that construction noise levels are likely to comply with the relevant legislative noise management levels during proposed dam construction works, however, are likely to be above the noise management levels at times during proposed pipeline construction. These exceedances would be short-term only (no more than five shifts) due to the transient nature of these works. This is not unexpected in rural residential areas with low background noise levels and is common for such situations. Given that the predictions are conservative in assessing that all equipment would be operating simultaneously it is likely that actual construction noise levels would be less than those predicted for the majority of the time. Notwithstanding, Water Infrastructure NSW would actively manage construction noise from the site and measures provided herein. Limited construction work is expected at night and hence sleep disturbance impacts have not been predicted.

- Operational noise levels were assessed for the daytime, evening and night-time periods including consideration of noise-enhancing meteorological conditions. The assessment found that noise impacts from operation of the project are considered unlikely to exceed relevant regulatory requirements. Sleep disturbance impacts from the operation of the project during the night-time period are considered unlikely to exceed relevant regulatory requirements.

- The project would result in additional road traffic movements during the construction period. Some marginal road traffic noise increases are predicted to occur on Tamworth-Nundle and Ogunbil Roads. It is of note that the road traffic noise results are based on heavy vehicle movements during the peak construction scenario and hence the assessment of road traffic noise is considered to be conservative. Further, the application of the RNP criteria to construction projects is highly conservative given the RNP is designed for permanent scenarios and not temporary impacts related to construction activities.

- Operational road traffic volumes are expected to be less than 2% of the existing road traffic experienced on the abovementioned roads. As such, adverse noise impacts from operational road traffic noise are considered unlikely.

- Blast overpressure and ground vibration levels from the project are predicted to satisfy relevant EPA guidelines. The volumes of MIC required to ensure compliance are not expected to result in any significant constraints to blasting in the spillway, quarrying and demolition areas. Notwithstanding, Water Infrastructure NSW would actively manage and monitor blast overpressure and vibration in accordance with current best practice.

- The assessment considered potential vibration impacts from the project. It is possible that some vibratory activities would occur close to structures and therefore management of vibration levels may be required. Notwithstanding, recommendations have been provided regarding work practices to be considered to minimise construction noise and vibration.

- A range of project-specific and standard noise and vibration mitigation and consultation measures have been provided in this Noise and Vibration Impact Assessment. These measures, if integrated with project construction and operational environmental management plans and implemented as intended, would moderate the impact of the project on local receivers to acceptable levels.

References

Australian Government, *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)

Australian Standard AS 1055-2018, Acoustics - Description and Measurement of Environmental Noise

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

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Department of Environment, Food and Rural Affairs (DEFRA) 2005, *Update of Noise Database for Prediction of Noise on Construction and Open Sites*

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International Standard ISO 9613-2:1996, Acoustics – Attenuation of sound during propagation outdoors

NSW Department of Environment and Climate Change (DECC) 2009, *Interim Construction Noise Guideline* (ICNG)

NSW Department of Environment and Conservation (DEC) 2006, *Environmental Noise Management – Assessing Vibration: a technical guideline*

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

NSW Environment Protection Authority (EPA) 2000, *NSW Industrial Noise Policy* (INP)

NSW Environment Protection Authority (EPA) 2017, *NSW Noise Policy for Industry* (NPfI)

NSW Government, NSW *Environmental Planning and Assessment Act 1979* (EP&A Act)

NSW Government, NSW *Water Supply (Critical Needs) Act 2019*

US Environmental Protection Agency 1998, Federal Highway Administration traffic noise model

Glossary

Technical terms typically utilised in a noise assessment report are explained in Table G.1.

Table G.1 Glossary of acoustic terms and abbreviations

Abbreviation or term	Description
ABL	The assessment background level (ABL) is defined in the INP as a single figure background level for each assessment period (day, evening and night). It is the tenth percentile of the measured L_{A90} statistical noise levels.
Amenity noise criteria	The amenity noise criteria relate to the overall level of industrial noise. Where existing levels of industrial noise (excluding the subject development) approach the acceptable amenity noise criteria, then noise levels from new industries need to demonstrate that they will not be an additional contributor to existing industrial noise.
A-weighting	There are several different weightings utilised for describing noise, the most common being the 'A-weighting'. This attempts to closely approximate the frequency response of the human ear.
CEMP	Construction environment management plan
Contractor	The company (and its employees) who have been contracted by WINSW to undertake the construction the project.
C-weighting	There are several different weightings utilised for describing noise, with the 'C-weighted' scale typically used to assess low frequency noise and is also utilised in the assessment of occupational noise.
Day period	Monday–Saturday: 7.00 am to 6.00 pm, on Sundays and public holidays: 8.00 am to 6.00 pm.
dB	Noise is measured in units called decibels (dB).
DP&E	Department of Planning and Environment
EA	Environmental assessment
EMM	EMM Consulting Pty Limited
EP&A Act	*Environmental and Planning Assessment Act 1979* (NSW)
EPA	The NSW Environment Protection Authority (formerly the Department of Environment, Climate Change and Water).
Evening period	Monday–Saturday: 6.00 pm to 10.00 pm, on Sundays and public holidays
ICNG	Interim Construction Noise Guideline
INP	Industrial Noise Policy
Intrusive noise criteria	The intrusive noise criteria refer to noise that intrudes above the background level by more than 5 dB. The intrusiveness criterion is described in detail in Section 3.1.1.
L_{A1}	The A-weighted noise level exceeded for 1% of the time.
L_{A10}	The A-weighted noise level which is exceeded 10% of the time. It is roughly equivalent to the average of maximum noise level.
L_{A90}	The A-weighted noise level that is exceeded 90% of the time. Commonly referred to as the background noise level.
L_{Aeq}	The A-weighted energy average noise level. This is the equivalent continuous sound pressure level over a given period. The $L_{Aeq(15\text{-}minute)}$ descriptor refers to an L_{Aeq} noise level measured over a 15 minute period.

Table G.1 Glossary of acoustic terms and abbreviations

Abbreviation or term	Description
Linear peak, L_{peak}	The peak level of an event is normally measured using a microphone in the same manner as linear noise (ie unweighted), at frequencies both in and below the audible range.
L_{Amax}	The maximum A-weighted sound pressure level received during a measurement interval.
Night period	Monday–Saturday: 10.00 pm to 7.00 am, on Sundays and public holidays: 10.00 pm to 8.00 am.
NVMP	Noise and vibration management plan
NPfI	Noise Policy for Industry
OOH	'Out-of-hours', outside of standard construction hours
POEO Act	*Protection of the Environment Operations Act 1997* (NSW)
PNTL	Project noise trigger level
PSNL	The project-specific noise level (PSNL) is criteria for a particular industrial noise source or industry. The PSNL is the lower of either the intrusive noise criteria or amenity noise criteria.
RBL	The rating background level (RBL) is an overall single value background level representing each assessment period over the whole monitoring period. The RBL is used to determine the intrusiveness criteria for noise assessment purposes and is the median of the average background levels.
RNP	Road Noise Policy
SEARs	Secretary's environmental assessment requirements
Sound power level (L_w)	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.
Temperature inversion	A meteorological condition where the atmospheric temperature increases with altitude.

It is useful to have an appreciation of decibels (dB), the unit of noise measurement. Table G.2 gives an indication as to what an average person perceives about changes in noise levels. Examples of common noise levels are provided in Figure G.1.

Table G.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

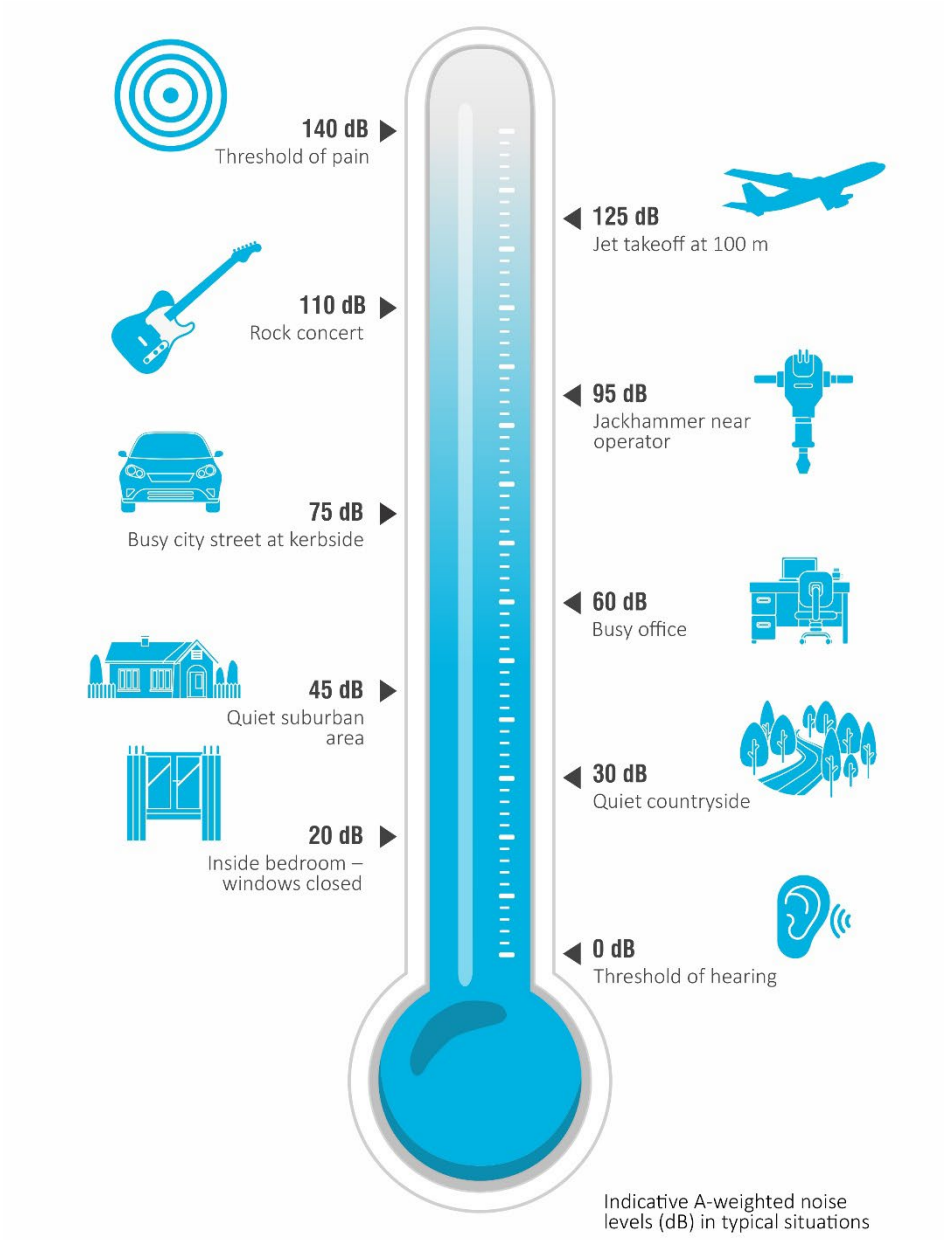

Figure G.1 Common noise levels

Australia

SYDNEY
Ground floor 20 Chandos Street
St Leonards NSW 2065
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NEWCASTLE
Level 3 175 Scott Street
Newcastle NSW 2300
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Spring Hill QLD 4000
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CANBERRA
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15 London Circuit
Canberra City ACT 2601

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Adelaide SA 5000
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MELBOURNE
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Melbourne VIC 3000
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