



Appendix B2

Construction Noise and Vibration Management Plan

Project: Keepit Dam Work Package 2 - Post Tensioning Works
Location: Keepit Dam, Namoi River, Northern NSW
Client: WaterNSW
Contract: 04532F31



Construction Noise and Vibration Management Plan

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Abbreviations

Term	Definition
CEMP	Construction Environmental Management Plan
CCLG	Community Construction Liaison Group
CoA	Conditions of Approval
CTP	Compliance Tracking Program
DPE	Department of Planning and Environment
dB(A)	Decibels using the A-weighted scale measures according to the frequency of the human ear.
EA	Environmental Assessment
EMR	Environmental Management Representative
EMS	Environmental Management System
EP&A Act	<i>Environmental Planning and Assessment Act 1979</i>
EP&A Regulation	<i>Environmental Planning and Assessment Regulation 2000</i>
EPA	Environment Protection Authority
EPBC Act	<i>Environment Protection and Biodiversity Conservation 1999</i>
ICNG	Interim Construction Noise Guidelines (ICNG)
INP	Industrial Noise Policy
L_{eq}	Equivalent continuous sound level - the constant sound level which, when occurring over the same period of time, would result in the receiver experiencing the same amount of sound energy.
$L_{Aeq} (15min)$	The A-weighted equivalent continuous (energy average) A-weighted sound pressure level of the construction works under consideration over a 15-minute period and excludes other noise sources such as from industry, road, rail and the community.
$L_A (max)$	The A-weighted maximum noise level only from the construction works under consideration, measured using the fast time weighting on a sound level meter.
L_{90}	The sound pressure level exceeded for 90% of the measurement period. For 90% of the measurement period it was louder than the L_{90} .
LGA	Local Government Area
NCA	Noise Catchment Area
NML	Noise Management Level
NVMP	Noise and Vibration Management Plan
NSW	New South Wales
Project, the	Keepit Dam Work Package 2 – Post Tensioning Works
RBL	Rating Background Level
SoC	Statement of Commitments
SRG	SRG Limited

Construction Noise and Vibration Management Plan

1. Introduction

1.1. Context

This Construction Noise and Vibration Management Plan (NVMP or Plan) is a Sub plan of the Construction Environmental Management Plan (CEMP) for the Keepit Dam Stage 2, Work Package 2 – Post Tensioning Works project (Keepit Dam Post Tensioning Works) (the Project).

This NVMP has been prepared to address the requirements of the Keepit Dam Upgrade Environmental Assessment (PB, 2007), the Keepit Dam Upgrade Submissions Report and Preferred Project Report (PB, 2008), the resulting Project Approval (06_0155) issued for upgrade of Keepit Dam, and all applicable legislation.

1.2. Background

Keepit Dam is situated on the Namoi River, 13 km upstream of its confluence with the Peel River in the north-west of NSW.

The NSW Dams Safety Committee requires that Keepit Dam be upgraded to be able to safely pass the probable maximum flood and to withstand earthquake events. WaterNSW is therefore undertaking dam safety upgrade works to Keepit Dam to comply with the requirements of the NSW Dams Safety Committee.

WaterNSW has adopted a two stage approach to upgrading Keepit Dam:

- Stage 1 - Construction of two fuse plug spillways – completed in 2011.
- Stage 2 - Electrical relocation, post tensioning of the main dam wall and raising of the dam concrete monoliths and the main embankment.

The Stage 2 works have been procured into three separate contract work packages, these being:

1. Electrical relocation works - completed 2015.
2. Post tensioning the main dam wall.
3. Raising of the dam concrete monoliths and main embankment.

This Construction Noise and Vibration Management Plan (NVMP) has been prepared for the Stage 2, Work Package 2; Keepit Dam Post Tensioning Works.

1.3. Environmental Management System Overview

The overall Environmental Management System for the Project is described in the Construction Environmental Management Plan (CEMP).

The NVMP is part of the SRG Limited (SRG) environmental management framework for the Project, as described in Section 4.1 of the CEMP. Management measures identified in this Plan will be incorporated into site or activity specific Environmental Work Method Statements (EWMSs) or Work Method Statements (WMSs) where relevant.

EWMSs / WMSs will be developed and signed off by environment and management representatives prior to associated works, and construction personnel will be required to undertake works in accordance with the identified mitigation and management measures.

Used together, the CEMP, strategies, procedures and EWMSs form management guides that clearly identify required environmental management actions for reference by SRG personnel and contractors.

The review and document control processes for this Plan are described in Section 9 of the CEMP.

Construction Noise and Vibration Management Plan

2. Purpose and objectives

2.1. Purpose

This Construction Noise and Vibration Management Plan describes how SRG will minimise and manage noise and vibration impacts during construction of the Keepit Dam Stage 2, Work Package 2 – Post Tensioning Works project.

2.2. Objectives

The objectives of the NVMP include:

- Minimising potential adverse noise and vibration impacts;
- Ensure appropriate measures are implemented to address the relevant requirements of the Conditions of Approval and Statement of Commitment outlined in Table 3-1 and Table 3-2 of this Plan.
- Ensure appropriate measures are implemented to comply with all relevant legislation and other requirements as described in Section 3.1 of this Plan.

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3. Environmental Requirements

3.1. Legislation

Legislation relevant to noise and vibration management includes:

- *Protection of the Environment Operations Act 1997 (POEO Act).*
- *Protection of the Environment Operations (Noise Control) Regulation 2008.*

Relevant provisions of the above legislation are explained in the register of legal and other requirements included in the CEMP.

3.2. Guidelines and Standards

The main guidelines, specifications and policy documents relevant to this Plan include:

- *NSW Industrial Noise Policy (EPA 2000).*
- *Interim Construction Noise Guideline (ICNG) (DECC 2009).*
- *Environmental Criteria for Road Traffic Noise (ECRTN) (EPA 1999).*
- *NSW Road Noise Policy (DECCW 2011).*
- *Assessing Vibration: A Technical Guideline (DEC 2006).*
- *British Standard 7385: Part 2 "Evaluation and measurement of vibration in buildings".*
- *German DIN 4150: Part 3 – 1999 Effects of Vibration on Structure (DIN 1999).*
- *WaterNSW – Noise Management Procedure.*

3.3. Conditions of Approval

The NVMP has been prepared as a requirement of Condition of Approval (CoA) 6.3(b). The relevant requirements stipulated by the instrument in relation to noise and vibration are detailed in Table 3-1.

Table 3-1 Conditions relevant to the construction noise and vibration

CoA No.	Condition	Where addressed
6.3	As part of the Construction Environmental Management Plan for the project, required under condition 6.2 of this approval, the Proponent shall prepare and implement the following:	CEMP
(b)	A Construction Noise Management Plan to manage noise impacts during construction and to identify all feasible and reasonable noise mitigation measures. The Plan shall include, but not necessarily be limited to:	This document
i)	A review of the assumptions made in documents referred to under conditions 1.1b) and 1.1c) of this approval to the determined calculated noise levels for the construction of the Right Hand Abutment Spillway, Saddle Dams, Subsidiary Dam Wall, Cumulative Works and Main Dam Wall;	Section 5 and 7
ii)	Details of the measures to avoid and / or mitigate the actual noise levels; and	Table 8-1
iii)	Details of the consultation process for noise mitigation measures with any affected residences.	Table 8-1 and CEMP
	As part of the Construction Noise Management Plan, the Proponent shall prepare and implement a Noise Monitoring Program for the project. This program must:	This document and Section 9
	a) Be prepared in consultation with DECC;	

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CoA No.	Condition	Where addressed
	<ul style="list-style-type: none"> b) Be submitted to the Director-General for approval prior to the commencement of construction activities; c) Include a protocol to establish whether the project is complying with the noise criterion identified in condition 2.5. 	
2.1	<p>The Proponent shall only undertake construction activities associated with the project, other than blasting, that would generate an audible noise at any sensitive receiver during the following hours:</p> <ul style="list-style-type: none"> a) 7:00 am to 6:00 pm, Mondays to Fridays, inclusive; b) 8:00 am to 1:00 pm on Saturdays; and c) at no time on Sundays or public holidays. 	Table 8-1
2.2	<p>Notwithstanding condition 2.1, construction works associated with the project, other than blasting, may be undertaken outside the hours specified under that condition in the following circumstances:</p> <ul style="list-style-type: none"> a) the works do not cause construction noise to be audible at any sensitive receiver; or b) for the delivery of materials required by the police or other authorities for safety reasons; or c) where it is required in an emergency to avoid loss of lives, property and/or to prevent harm; or d) As approved through the process outlined in condition 2.3 of this approval. 	Table 8-1
2.3	<p>The hours of construction activities specified under condition 2.1 of this approval may be varied with the prior written approval of the Director-General. Any request to alter the hours of construction specified under condition 2.1 shall be:</p> <ul style="list-style-type: none"> a) considered on a case-by-case basis; b) accompanied by details of the nature and need for activities to be conducted during the varied construction hours; and c) accompanied by written evidence of the DECCs agreement with the proposed variation in construction times, after providing any information necessary for the DECC to reasonably determine that activities undertaken during the varied construction hours will not adversely impact on the acoustic amenity of receptors in the vicinity of the site. 	Table 8-1
2.5	<p>The Proponent shall ensure that the noise generated by the project does not exceed the noise impact assessment criteria of 35dB(A) at all times at any residence on privately owned land.</p> <p>The maximum allowable noise contributions apply under wind speeds up to 3 ms-1 (measured at 10 metres above ground level), and under temperature inversion conditions of up to 3 °c/ 100 metres.</p> <p>However, if the Proponent has a written negotiated noise agreement with any landholder and a copy of this agreement has been forwarded to the Department and DECC, then the Proponent may exceed the noise limits of 35dB(A) in accordance with the negotiated noise agreement.</p>	Table 8-1 and Section 7.1

3.4. Statement of Commitments

Statement of Commitments from the Submissions and Preferred Project Report relevant to noise and vibration are detailed in Table 3-2.

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Table 3-2 Statement of Commitments relevant to noise and vibration

SoC No.	Condition	Where addressed
19.2	<p>The local community and businesses will be advised of Construction activities that could cause disruption. Methods to disseminate this information will be identified in the CEMP. Information to be provided will include:</p> <ul style="list-style-type: none"> a) details of any traffic disruptions and controls; b) construction of temporary detours; and c) work approved to be undertaken outside standard Construction hours, in particular noisy works, before such works are undertaken. 	Table 8-1
29.1	<p>A Construction Noise and Vibration Management Sub Plan will be prepared as part of the CEMP. The Sub Plan will be prepared in consultation with the Relevant Councils and the CLG and include:</p> <ul style="list-style-type: none"> a) an education program for Construction personnel about noise minimisation; b) identification of each Construction activity, including Ancillary Facilities, and their associated noise sources; c) identification of all potentially affected Sensitive Receivers; d) the Construction noise objective specified in this Final Statement of Commitments; e) the Construction vibration criteria specified in this Final Statement of Commitments; f) determination of appropriate noise and vibration objectives for each identified Sensitive Receiver; g) noise and vibration monitoring, reporting and response procedures; h) assessment of potential noise and vibration from each Construction activity including noise from Construction vehicles and any traffic diversions; i) a description of management methods and procedures and specific noise mitigation treatments that will be implemented to control noise and vibration during Construction; j) justification for any activities outside the Construction hours specified in this Final Statement of Commitments. This includes identifying areas where Construction noise would not be audible at any Sensitive Receiver; k) procedures for notifying residents of Construction activities that are likely to affect their noise and vibration amenity; and l) contingency plans to be implemented in the event of non-compliances and/or noise complaints. 	<p>This Plan, Section 8.2</p> <p>CEMP Table 8-1</p> <p>CEMP Appendix C</p> <p>Section 4</p> <p>Section 5</p> <p>Section 5</p> <p>Section 5</p> <p>Section 9</p> <p>Section 7 and CEMP Appendix C</p> <p>Table 8-1</p> <p>CEMP</p> <p>Table 8-1</p> <p>CEMP Section 8.5 and Section 9</p>
30.1	<p>Construction will be restricted to between the hours of 7:00 am to 6:00 pm (Monday to Friday), 8:00 am to 1:00 pm (Saturday) and at no time on Sundays and public holidays except:</p> <ul style="list-style-type: none"> a) for the delivery of materials required outside these hours by the Police or other authorities for safety reasons; or b) where it is required in an emergency to avoid the loss of lives, property and/or to prevent environmental harm; or c) where the work is identified in the Construction Noise and Vibration Management Sub Plan and approved as part of the CEMP. 	Section 5

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SoC No.	Condition	Where addressed
30.2	Local residents will be informed of the timing and duration of work approved under item (c) at least 48 hours before that work commences.	Table 8-1
31.1	<p>The Construction noise objective for the Activity is to manage noise from Construction activities (as measured by a LA10 (15minute) descriptor) so it does not exceed the background LA90 noise level by more than 5 dB(A). Background noise levels are those identified in the Construction Noise and Vibration Management Sub Plan.</p> <p>Any activities that have the potential for noise emissions that exceed the objective will be identified and managed in accordance with the Construction Noise and Vibration Management Sub Plan. All Reasonable and Feasible noise mitigation and management measures will be implemented with the aim of achieving the Construction noise objective.</p>	Section 5 and 6 Table 8-1
31.2	If the noise from a Construction activity is substantially tonal or impulsive in nature (as described in Chapter 4 of the NSW Industrial Noise Policy), 5dB(A) will be added to the measured Construction noise level when comparing the measured noise with the Construction noise objective.	Section 5 and 7
32.1	Public address systems used at any Construction site will not be used outside the Construction hours detailed in this Final Statement of Commitments unless otherwise approved through the Construction Noise and Vibration Management Sub Plan. Public address systems will be designed to minimise noise spillage off-site.	Table 8-1
32.2	No rock breaking, rock hammering, and any similar activities will be undertaken unless otherwise identified in the Construction Noise and Vibration Management Sub Plan, and approved as part of the CEMP.	Table 8-1
32.3	Where Reasonable and Feasible, noise mitigation measures will be erected at the start of Construction (or at other times during Construction) to minimise Construction noise impacts.	Table 8-1
38.2	State Water, where liable, will rectify any property or building damage caused directly or indirectly (for example from vibration) by the Activity's Construction at no cost to the property owner(s). Alternatively State Water may negotiate just compensation for the property damage with the property owner.	Table 8-1

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4. Existing Environment

4.1. Sensitive Receivers

Five sensitive receivers were identified in the area and include:

Table 4-1 Sensitive receivers

No	Property name	Location	Approximate distance (m)
1	1521 Bulga Road	West of main dam	750
2	Illawong	South-west of main dam	1250
3	Mostyn Vale	South of main dam	2500
4	Residential Property A	South-east of main dam	4000
5	Sorrento	East of main dam	4700

Commercial receivers identified in the EA located in the vicinity of the Project include:

Table 4-2 Commercial receivers

No	Property name	Location	Approximate distance (m)
1a	The Gums Caravan Park (now Inland Waters Caravan Park)	South of main dam	1000
2a	Lakeside Caravan Park (now Lake Keepit State Park)	South of main dam	1000
3a	Lake Keepit Sport and Recreation Centre	North-east of main dam	3500
4a	Sailing club	South-east of main dam	1200
5a	Kiosk (now Lake View Café, located at Lake Keepit State Park)	South of main dam	1000
6a	Gliding club hangar	South-east of main dam	3000

In terms of residents, properties 1 and 4 were identified as sensitive receivers with respect to noise and vibration, though that was in relation to all Packages of work.

The closest receivers for Stage 2, Package 2 works are property 1 - 1521 Bulga Road and Property 2 - Illawong.

Three commercial receivers are 1000 metres away from the main dam wall including:

- Commercial receiver 1a – Inland Waters Caravan Park;
- Commercial receiver 2a – Lakeside Caravan Park;
- Commercial receiver 5a – Kiosk.

The location of these sensitive receivers is identified in Figure 4-1.

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Figure 4-1 Sensitive and commercial receivers

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5. Construction Noise and Vibration Criteria

The EPA recommends management levels and goals when assessing construction noise and vibration. These are outlined in:

- The *Interim Construction Noise Guideline* (ICNG), *Assessing Vibration: a technical guideline*.
- The ANZECC, *Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration*.

Relevant elements of these documents are summaries and discussed in this Chapter.

5.1. Construction noise and assessment objectives

The DECC Interim Construction Noise Guideline (ICNG, July 2009) provides guidelines for the assessment and management of construction noise. The ICNG focuses on applying a range of work practices to minimise construction noise impacts rather than focusing on only achieving numeric noise levels.

The main objectives of the ICNG are to:

- Identify and minimise noise from construction works.
- Focus on applying all 'feasible' and 'reasonable' work practices to minimise construction noise impacts.
- Encourage construction during the recommended standard hours only, unless approval is given for works that cannot be undertaken during these hours.
- Reduce time spent dealing with complaints at the project implementation stage.
- Provide flexibility in selecting site-specific feasible and reasonable work practices to minimise noise impacts.

5.2. Quantitative noise assessment criteria

Construction noise assessment goals presented in the ICNG are referenced to noise management levels for residential, sensitive land uses and commercial/ industrial premises.

5.2.1. Residential Premises

Table 5-1 sets out management levels for noise at residences and how they are to be applied.

In Table 5-1 the rating background level (RBL) is used when determining the management level. The RBL is the overall single-figure background noise level measured in each relevant assessment period (during or outside the recommended standard hours). The term RBL is described in detail in the NSW Industrial Noise Policy (EPA, 2000).

As a guide, the difference between the internal noise level and the external noise level is typically 10dB with windows open for adequate ventilation.

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Table 5-2 Noise at residents using quantitative assessment

Time of day	Management Level $L_{Aeq} (15 \text{ min})^*$	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 RBL + 10 dB	<p>The noise affected level represents the point above which there may be some community reaction to noise.</p> <ul style="list-style-type: none"> Where the predicted or measured $L_{Aeq} (15 \text{ min})$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.
	Highly noise affected 75 dB(A)	<p>The highly noise affected level represents the point above which there may be strong community reaction to noise.</p> <ul style="list-style-type: none"> Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account: <ul style="list-style-type: none"> times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside recommended standard hours	Noise affected RBL + 5 dB	<ul style="list-style-type: none"> 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.

* Noise levels apply at the property boundary that is most exposed to construction noise, and at a height of 1.5m above ground level. If the property boundary is more than 30m 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.

5.2.2. Other land uses

Table 5-2 presents management levels for noise at other sensitive land uses based on the principle that the characteristic activities for each of these land uses should not be unduly disturbed.

Internal noise levels are assessed at the centre of the occupied room. External noise levels are assessed at the most affected point within 50 metres of the area boundary. Where internal noise levels cannot be measured, external noise levels may be used. A conservative estimate of the difference between internal and external noise levels is 10dB for buildings other than residences. Some buildings may achieve greater performance,

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such as where windows are fixed (that is, cannot be opened). The management levels in Table 5-2 are 5dB above the corresponding road traffic noise levels in the Environmental Criteria for Road Traffic Noise (EPA 1999) (and the 'maximum' levels in the NSW Industrial Noise Policy (EPA 2000) for commercial and industrial uses) to account for the variable and short-term nature of construction noise.

Table 5-3 Noise at sensitive land uses (non-residents) using quantitative assessment

Land use	Noise assessment location	Noise management level ($L_{Aeq,15min}$)
Classrooms at schools and other educational institutions	Internal	45
Hospitals and operating theatres		
Places of worship		
Active recreation areas ¹	External	65
Passive recreation areas ²	External	60
Community centres	Dependent on intended use	Maximum internal levels recommended in AS2107 for specific use
Industrial premises	External	75
Office, retail outlets	External	70
Other noise sensitive businesses	Investigation to determine suitable noise levels on project-by-project basis	

Notes:

1. Active recreation areas are characterised by sporting activities and activities which generate their own noise or focus for participants, making them less sensitive to external noise intrusion.
2. Passive recreation areas are characterised by contemplative activities that generate little noise and where benefits are compromised by external noise intrusion (eg. reading, meditation).

5.3. Adopted project noise management levels

Noise criteria have been set in accordance with the DECCW 'Interim Construction Noise Guideline' July 2009.

A measured daytime background noise level of 25 dB(A) L_{A90} was established during the unattended noise monitoring program. Guidance from the INP (NSW EPA 2000) has been adopted. Section 3.1.2 of the policy advises that where the background noise level is below 30 dB(A), the background adopted noise level for the purpose of assessment is 30 dB(A) L_{A90} .

The following construction noise goals therefore, apply:

- 'long term' construction work: **35 dB(A)** [L_{Aeq} impacts], $L_{A90, min} + 5$ dB(A).

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Table 5-3 Noise criteria

Receiver	Noise goal
At any residence on privately owned land (except as listed below)	35 dB(A)
Receptors on State Park land ¹	40 dB(A)

1: Max noise level of 40dB(A) is a target calculated as the background noise of 30dB(A) + 10dB(A). This target has been developed in accordance with the DECC 'Interim Construction Noise Guideline' July 2009. This document will be used as a guide to manage and mitigate the effects of the noise for users of State Park facilities.

5.4. Vibration Criteria

Specific vibration criteria set within the Project Approval and Statement of Commitments relate to blasting only. Blasting will not be undertaken for the Stage 2, Package 2 project works.

For other activities undertaken as part of Stage 2, Package 2 works, the effects of ground vibration on buildings resulting from construction may be segregated into the following three categories:

- Human exposure – disturbance to building occupants: vibration in which the occupants or users of the building are inconvenienced or possibly disturbed.
- Effects on building contents – vibration where the building contents may be affected.
- Effects on building structures – vibration in which the integrity of the building or structure itself may be prejudiced.

Vibration criteria relating to human comfort are taken from the DEC (2006) document *Assessing Vibration – A Technical Guideline* and include the following.

- Continuous vibration – from uninterrupted sources (see Table 5-4).
- Impulsive vibration – up to three instances of sudden impact eg dropping heavy items, per monitoring period (see Table 5-5).
- Intermittent vibration – such as from drilling, compacting or activities that would result in continuous vibration if operated continuously (see Table 5-6).

Two standards by which building damage from construction-induced vibration are commonly assessed include:

- British Standard 7385: Part 2-1993 *Evaluation and measurement for vibration in buildings Part 2: Guide to damage levels from ground borne vibration* (BSI 1993)
- German DIN 4150: Part 3 – 1999 *Effects of Vibration on Structure* (DIN 1999).

The German standard provides the most stringent criteria and will be used in this CNVMP. The DIN guideline values for peak particle velocity (mm/s) measured at the foundation of the building are summarised in Table 5-7. The criteria are frequency dependent and specific to particular categories of structure.

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Table 5-4 Continuous vibration acceleration criteria (m/s²) 1-80Hz

Location	Assessment period	Preferred Values		Maximum Values	
		z-axis	x- and y-axis	z-axis	x- and y-axis
Residences	Daytime	0.010	0.0071	0.020	0.014
	Night-time	0.007	0.005	0.014	0.010
Offices, schools, educational institutions and places of worship	Day or night-time	0.020	0.014	0.040	0.028
		0.04	0.029	0.080	0.058
Workshops	Day or night-time	0.04	0.029	0.080	0.058

Table 5-4 Impulsive vibration acceleration criteria (m/s²) 1-80Hz

Location	Assessment period	Preferred Values		Maximum Values	
		z-axis	x- and y-axis	z-axis	x- and y-axis
Residences	Daytime	0.30	0.21	0.60	0.42
	Night-time	0.10	0.071	0.20	0.14
Offices, schools, educational institutions and places of worship	Day or night-time	0.64	0.46	1.28	0.92
		0.64	0.46	1.28	0.92

Table 5-5 Intermittent vibration impacts criteria (m/s²) 1-80Hz

Location	Daytime		Night-time	
	Preferred Values	Maximum Values	Preferred Values	Maximum Values
Residences	0.20	0.40	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

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Table 5-6 Structural damage criteria

Type of Structure	Peak Component Particle Velocity, mm/s			
	Vibration at the foundation at a frequency of			Vibration of horizontal plane of highest floor at all frequencies
	1 Hz to 10 Hz	10 Hz to 50 Hz	50 Hz to 100 Hz*	
Buildings used for commercial purposes, industrial buildings and buildings of similar design	20	20 to 40	40 to 50	40
Dwellings and buildings of similar design and/or use	5	5 to 15	15 to 20	15
Structures that, because of their sensitivity to vibration, do not correspond to those listed in lines 1 and 2 and are of great intrinsic value (e.g. buildings that are under a preservation order)	3	3 to 8	8 to 10	8

* For frequencies above 100Hz, at least the values specified in this column shall be applied.

5.5. Road traffic noise

The EA used the *Environmental Criteria for Road Traffic Noise* (ECRTN)(NSW EPA, 1999) to determine the relevant road traffic noise criteria. The EA advised that the recommended 'base' goals for developments with the potential to create additional traffic on local roads are daytime $L_{Aeq, 1hr}$ levels of 55 dB(A) and night-time $L_{Aeq, 1hr}$ levels of 50 dB(A).

'Allowance' goals are generally established where the 'base' goals are already exceeded. In such circumstances, traffic arising from a development should not lead to an increase in existing noise levels of more than 2 dB(A).

The EA recommended that adopting the allowance criteria was not deemed appropriate for this Project based on the short duration of the increased road vehicle movements.

Construction Noise and Vibration Management Plan

6. Environmental aspects and impacts

6.1. Environmental aspects

Stage 2, Package 2 works will involve construction activities on the main dam wall and use of the compound area for the fabrication of the anchors.

Drilling and coring activities will occur on the main dam wall, however works will be shielded as they will be occurring inside the dam wall itself. Construction activities with the potential to create noise include:

- Site establishment – establishment of the compound, placing air, water and waste lines across the dam wall, installation of air compressors and excavation of the collection ponds.
- Demolition of monoliths.
- Coring and drilling operations – coring and drilling activities on the main dam wall. As the coring rig or drilling rig commences drilling, works will be occurring within the main dam wall;
- Anchor fabrication and installation – anchors to be assembled in the fabrication yard, then trolleyed to the main dam wall for installation.
- Grouting works – anchors to be grouted into place.
- Out of hours works.

The standard working hours for the project are identified in Section 8.1 of this Plan. There will be works required to occur outside of the standard hours to enable, for example, concrete / grout pours to occur when temperatures are suitably low to enable appropriate strength of the concrete to be achieved.

There will be no blasting undertaken as part of Stage 2, Package 2 works.

6.2. Impacts

The potential for noise and vibration impacts on sensitive receivers or structures will depend on a number of factors. Typically these might include:

- The type of equipment in use.
- The number of equipment simultaneously in use.
- Topography and other physical barriers.
- Proximity to sensitive receivers.
- The condition of sensitive receivers.
- Hours/duration of construction works.

Relevant aspects and the potential for related impacts have been considered in a risk assessment in Appendix C of the CEMP.

Section 8 provides a suite of mitigation measures that will be implemented to avoid or minimise impacts on the receiving community and/or built environment.

Construction Noise and Vibration Management Plan

7. Construction Noise and Vibration Assessment

7.1. Construction noise impacts

A review of all assumptions made in the Environmental Assessment, Submissions Report and Preferred Project Report has occurred.

Information relating to noise was located in the Submissions Report and Preferred Project Report, where a noise and vibration assessment has been prepared (Appendix C). In summary the assessment found that compliance with adopted noise goals is expected to be achieved, except for subsidiary dam wall works at Residential Property A and main dam wall and cumulative noise impacts at 1521 Bulga Road. This was in relation to all stages of work.

Predicted construction noise impacts are detailed below.

Table 7-1 Construction noise impacts

	Construction phase
	Predicted noise impacts Infrastructure works $L_{Aeq, 15 \text{ min}}$
Noise criteria 35 $L_{Aeq, 15 \text{ min}}$	
Right hand abutment spillway	<10 – 31
Saddle dams	<10 – 26
Subsidiary dam wall	14 – 37.5
Main dam wall	15.5 – 35.5

The primary assumption for the noise assessment was that general construction works, concrete batching, clay borrow pits and crushing noise impacts were occurring simultaneously.

Stage 2, Package 2 works is only one component of works of the overall Keepit Dam upgrade project. Stage 2, Package 2 does not involve bulk excavation works, nor will it have a batch plant operating. There are also no pit excavation works and there will be no crushing activities which are required.

Examples of other assumptions reviewed in the noise assessment include:

- Individual construction activities are expected to be more than 26 weeks in duration.
- Standard batching plant operations will be conducted.
- Total of two pressure relief valves.
- Reversing alarms for health and safety purposes may be used.
- Feasible plant was assumed to be in cumulative operation for cumulative noise level calculations.
- Excavation of clay expected to occur simultaneously with right hand abutment, subsidiary dam and saddle dam construction works.
- A bulldozer, three excavators, two loaders and four dump trucks were assumed to be operating concurrently for pit excavation works.
- All noise predictions were calculated at ground level.

The review indicates that the findings are likely to represent maximum or worst case scenario noise profiles.

Construction Noise and Vibration Management Plan

For the cumulative works on the main dam wall (location is relevant to Stage 2, Package 2), a predicted noise impact of **15.5 dB(A) - 35.5 dB(A)** was assessed in the EA.

For residential properties this is **0.5dB(A)** above the noise criteria (refer to Table 5-3).

For commercial properties this is **within the noise criteria** goal of 40 dB(A).

To enable landowner agreements to be obtained, an assessment of potential noise impacts from Stage 2, Package 2 works was undertaken (*Noise predictions at noise sensitive receivers located close to Keepit Dam from proposed construction works to install anchors to the Dam*, April 2017). The worst case (resident downwind of works, or temperature inversion), neutral case (no weather effects) and best case (resident upwind of the works) were calculated.

7.1.1. Predicted noise impacts

Table 7-2 below shows the predicted noise levels at the two nearest residences to the proposed works under the best (most favourable), neutral and worst case meteorological conditions.

Table 7-2 Construction noise impacts

Noise sensitive receiver	Meteorological scenario	Predicted noise level dB(A)	Meets 35 dB(A) maximum Noise Level Criterion
1521 Bulga Road, Gunnedah	Worst case (Pasquill Stability Category 6)	47	✘
	Neutral case (Pasquill Stability Category 4)	42	✘
	Best case (Pasquill Stability Category 1)	33	✓
Illawong (or Property 'A' – Violet Banks, Orange Grove Road)	Worst case (Pasquill Stability Category 6)	39	✘
	Neutral case (Pasquill Stability Category 4)	34	✓
	Best case (Pasquill Stability Category 1)	24	✓

The predicted noise levels at the noise sensitive receivers show a wide range of noise levels based on the various meteorological conditions. For instance, the difference in predicted noise level of the proposed works between the best-case and worst-case meteorological conditions is 14 dB and 15 dB for 1521 Bulga Road and Illawong respectively.

The 35 dB(A) criterion is based on a background (LA90) + 5 dB. This 5 dB above the background is usual for long term operational noise levels for new developments. However, it is not considered appropriate for construction noise, which by nature is transient/non-permanent. Added to this, noise is inherent to construction activities by and large and this has led to the development of special construction noise criteria and management measures. The NSW Interim Construction Noise Guideline, sets noise management levels of the background noise level + 10 dB(A), which represents a 40 dB(A) criterion. However, for the purposes of this assessment, 35 dB(A) is taken to be the construction noise target not to be exceeded. As Table 7-2 shows, the 35 dB(A) noise criterion is exceeded at 1521 Bulga Road for the worst and neutral meteorological conditions and at Illawong for the worst-case condition only.

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In accordance with condition 2.5 of the Project Approval, written negotiated noise agreements have been obtained with the residents of 1521 Bulga Road and Illawong (Violet Banks). These agreements are in place for the worst case scenario of 47dB(A).

Noise monitoring will be undertaken to assess compliance with these levels.

7.2. Road traffic noise

Stage 2, Package 2 works will involve the use of light and heavy vehicles to enable site staff to access the project site and to provide for the delivery of goods and materials required for the project works.

The EA included a qualitative assessment of potential noise levels to the adopted ECTRN base noise criteria of 55 dB(A) L_{A1} daytime. The assessment adopted proposed peak road traffic volumes for trucks and heavy vehicles including:

- 50 truck movements per day (one way) on Keepit Dam Road;
- 50 truck movements per day (one way) on Orange Grove Road;
- 50 truck movements per day (one way) on Bulga Road;
- 160 truck movements per day (one way) around the subsidiary dam wall spillway.

The EA included a noise assessment of 1521 Bulga Road and the Caravan Park. Other receivers were expected to comply due to distance and topography.

Noise impacts were assessed on a worst-case scenario (two trucks passing) and the peak traffic movements detailed above.

It was found in the EA that the heavy vehicle received noise levels at the residential properties and the caravan park were expected to comply.

As the truck movements required for Stage 2, Package 2 works are considerably less than those assessed, and would instead average two movements per week (peak volume of ten trucks per day movements per day during establishment), road traffic noise levels for Stage 2, Package 2 works are also expected to comply.



Construction Noise and Vibration Management Plan

8. Environmental Mitigation Measures

A range of environmental requirements and control measures are identified in the various environmental documents, including the EIS, Submissions and Preferred Project Report and Conditions of Approval. Specific measures and requirements to address impacts from noise and vibration are outlined in Table 8-1.

Construction Noise and Vibration Management Plan

Table 8-1 Environmental management measures

ID	Environmental Management Measure	When to implement	Responsibility	Reference
General				
NV1	Construction activities to be undertaken in accordance with the Construction Noise and Vibration Management Sub Plan. The Sub Plan will be prepared in consultation with the Relevant Councils and the CLG.	Construction	SRG's Project Manager / WaterNSW's Project Manager	SoC 29.1
NV2	Training will be provided to all project personnel, including relevant sub-contractors on noise and vibration requirements and in particular the working hours, through inductions and toolboxes.	Pre-construction Construction	Site SQE Representative	Good practice
NV3	Behavioural practices that will be encouraged during project works include: <ul style="list-style-type: none"> - No swearing or unnecessary shouting or loud stereos/radios on site. - No dropping of materials from height, throwing of metal items and slamming of doors. 	Construction	Superintendent	Good practice
NV4	Local residents will be informed of the timing and duration of work at least 48 hours before that work commences.	Pre-construction	WaterNSW's Project Manager	SoC 30.2
NV5	Noise generated by the project is not to exceed 35 dB(A) at any time, at any residence on privately owned land. The maximum allowable noise contributions apply under wind speeds up to 3 ms ⁻¹ (measured at 10 m above ground level) and under temperature inversion conditions of up to 3 C/ 100 m. The noise limit of 35 dB(A) may be exceeded if a written negotiated noise agreement with any landholder is forwarded to DPE and EPA.	Construction	SRG's Project Manager / WaterNSW's Project Manager	CoA 2.5
NV6	The local community and businesses will be advised of construction activities that could cause disruption. Methods to disseminate this information will be identified in the CEMP. Information to be provided will include: <ul style="list-style-type: none"> a) details of any traffic disruptions and controls; b) construction of temporary detours; and c) work approved to be undertaken outside standard Construction hours, in particular noisy works, before such works are undertaken. 	Preconstruction and construction	WaterNSW	SoC 19.2

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ID	Environmental Management Measure	When to implement	Responsibility	Reference
NV7	Public address systems used at any construction site will not be used outside the stated construction hours unless otherwise approved through the Construction Noise and Vibration Management Sub Plan. Public address systems will be designed to minimise noise spillage offsite.	Construction	Superintendent	SoC 32.1
NV8	No rock breaking, rock hammering, and any similar activities will be undertaken unless otherwise identified in the Construction Noise and Vibration Management Sub Plan, and approved as part of the CEMP.	Construction	Project Manager, Site SQE Representative, Superintendent	SoC 32.2
NV9	Where reasonable and feasible, noise mitigation measures will be erected at the start of construction (or at other times during Construction) to minimise construction noise impacts. Larger generators and compressors will be placed in noise suppression cabinets. Drilling and coring works will be undertaken with the addition of water which will assist in reducing potential noise levels.	Construction	SRG's Project Manager / WaterNSW's Project Manager, Site SQE Representative	SoC 32.3 Good practice
NV10	All construction plant and equipment used on the site will be, in addition to other relevant requirements: <ul style="list-style-type: none"> - Fitted with properly maintained noise suppression devices in accordance with the manufacturer's specifications. - Maintained in an efficient condition. - Operated in a proper and efficient manner. 	Construction	Superintendent	Good practice
NV11	State Water, where liable, will rectify any property or building damage caused directly or indirectly (for example from vibration) by the Activity's Construction at no cost to the property owner(s). Alternatively State Water may negotiate just compensation for the property damage with the property owner.	Construction and operation	WaterNSW	SoC 38.2
Construction hours and out of hours work				
NV12	Construction activities associated with the project (other than blasting) that would generate an audible noise at any sensitive receiver, are only to be undertaken during the following hours; <ul style="list-style-type: none"> (a) 7.00 am to 6 pm Mondays to Fridays (b) 8.00 am to 1:00 pm Saturdays (c) At no times on Sundays or public holidays. 	Construction	Project Manager, Site SQE Representative, Superintendent	CoA 2.1

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ID	Environmental Management Measure	When to implement	Responsibility	Reference
NV13	<p>Construction works (other than blasting) will only be undertaken outside the hours specified above in the following circumstances;</p> <ul style="list-style-type: none"> (a) The works do not cause construction noise to be audible at any sensitive receiver, or (b) For the delivery of materials required by the police or other authorities for safety reasons, or (c) Where it is required in an emergency to avoid loss of lives, property and / or to prevent harm, or as approved through the process outlined in conditions of approval; or (d) As approved through the process detailed in condition 2.3 of the Project Approval (refer to NV12). 	Construction	Project Manager, Site SQE Representative, Superintendent	CoA 2.2
NV14	<p>Where works are required to be undertaken out of hours, a request shall be made to Department of Planning and Environment in accordance with condition 2.3 of the Project Approval.</p> <p>Any request shall include:</p> <ul style="list-style-type: none"> a) details of the nature of the activities; b) details of the need for activities to be conducted outside of hours; and c) accompanied by written evidence of the DECCs agreement with the proposed variation in construction times, after providing any information necessary for the DECC to reasonably determine that activities undertaken during the varied construction hours will not adversely impact on the acoustic amenity of receptors in the vicinity of the site. 	Construction	Site SQE Representative	CoA 2.3
Monitoring				
NV15	If deemed necessary, attended compliance noise and vibration monitoring will be undertaken upon receipt of a complaint. In the case that exceedances are detected; the situation would be reviewed in order to identify means to minimise the impacts to residences.	Construction	Site SQE Representative	Good Practice
NV16	Noise monitoring will be undertaken monthly during the first three months, then quarterly thereafter at the locations detailed in Section 9.3.	Construction	Site SQE Representative	CoA 6.3(b)

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8.1. Working hours

The standard working hours for the project are as follows:

- Monday to Friday – 7:00am to 6:00pm;
- Saturday – 8:00am to 1:00pm;
- At no times on Sundays or on public holidays.

There will be works required to occur outside of the standard hours to enable concrete / grout pours to occur when temperatures are suitably low to enable appropriate strength of the concrete to be achieved.

In accordance with condition 2.2 of the Project Approval, works are permitted to occur out of the standard hours in the following circumstances:

1. The works do not cause construction noise to be audible at any sensitive receiver; or
2. For the delivery of materials required by the police or other authorities for safety reasons; or
3. Where it is required in an emergency to avoid loss of lives, property and / or to prevent harm, or as approved through the process outlined in conditions of approval; or
4. As approved through the process detailed in condition 2.3 of the Project Approval (refer to NV12-NV14).

Where works are required to be undertaken out of hours in accordance with item 4 above, a request shall be made to the Director-General of Department of Planning and Environment.

The request shall include:

- a) details of the nature of the activities;
- b) details of the need for activities to be conducted outside of hours; and
- c) accompanied by written evidence of DECCs (now EPAs) agreement with the proposed variation in construction times, after providing any information necessary for the DECC (now EPAs) to reasonably determine that activities undertaken during the varied construction hours will not adversely impact on the acoustic amenity of receptors in the vicinity of the site.

8.2. Consultation process

The NVMP has been prepared in consultation with EPA and relevant Councils, with no comments received. Appendix F of the CEMP includes the Consultation Records and comments which were received. There were no comments received in relation to the NVMP from EPA or relevant Councils.

WaterNSW consulted with the Community Construction Liaison Group (CCLG) in April 2016, December 2016 and March 2017. The CCLG were invited to register interest in conducting an onsite meeting. No responses have been received to date by WaterNSW.

A CCLG Bulletin was issued in December 2016. A Project Bulletin was issued in April 2017.

A letter was issued to residents in March 2017 advising of commencement of Stage 2, Package 2 works.

In accordance with Statement of Commitment 19.2, the local community and businesses will continue to be advised of construction activities that could cause disruption. Information will include:

- details of any traffic disruptions and controls;
- construction of temporary detours; and

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- works approved to be undertaken outside standard construction hours, in particular noisy works, before such works are undertaken.

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9. Compliance Management

9.1. Roles and Responsibilities

The organisational structure and overall roles and responsibilities are outlined in the CEMP. Specific responsibilities for the implementation of environmental controls are detailed in Section 8 of this Plan.

9.2. Training

All employees and contractors working on site will undergo site induction training relating to noise and vibration management issues. The induction training will address elements related to noise and vibration management including:

- Existence and requirements of this sub-plan.
- Relevant legislation.
- Noise and vibration mitigation and management measures.
- Standard working hours.

Further details regarding staff induction and training are outlined in Section 5 of the CEMP.

9.3. Monitoring and Inspections

Weekly inspections will be undertaken with the inspection form provided in Appendix D completed.

9.3.1. Noise monitoring

Noise monitoring will be undertaken at the following receptors:

- 1521 Bulga Road.
- Illawong.
- Sailing club.
- Caravan Park.

The frequency of the monitoring will be as follows:

- Monthly during the first three months.
- Quarterly thereafter.

Noise monitoring will also be undertaken in the event that:

- A complaint is received in relation to noise impacts. In the case that exceedances are detected, the situation would be reviewed in order to identify means to minimise the impacts to residences.
- Works are undertaken out of hours in accordance with Section 8.1, Item 4 (as approved through the process detailed in condition 2.3 of the Project Approval (refer to NV12)).

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9.3.2. Vibration monitoring

If deemed necessary, attended compliance vibration monitoring will be undertaken upon receipt of a complaint. In the case that exceedances are detected, the situation would be reviewed in order to identify means to minimise the impacts to residences.

9.4. Non-conformances

Non-conformances will be managed in accordance with Section 8.5 of the CEMP.

9.5. Audits

Audit requirements are detailed in Section 8 of the CEMP.

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10. Review and Improvement of the NVMP

10.1. Continuous improvement

Continuous improvement of this Plan will be achieved by the ongoing evaluation of environmental management performance against environmental policies, objectives and targets for the purpose of identifying opportunities for improvement.

The continuous improvement process will be designed to:

- Identify areas of opportunity for improvement of environmental management and performance.
- Determine the cause or causes of non-conformances and deficiencies.
- Develop and implement a plan of corrective and preventative action to address any non-conformances and deficiencies.
- Verify the effectiveness of the corrective and preventative actions.
- Document any changes in procedures resulting from process improvement.
- Make comparisons with objectives and targets.

10.2. NVMP update and amendment

The processes described in Section 8 of the CEMP may result in the need to update or revise this Plan. This will occur as needed.

Only the Environmental Site Representative, or delegate, has the authority to change any of the environmental management documentation. In terms of approval of updates or amendments to this Plan, this is to be carried out by the Environmental Management Representative (EMR), with the EMR verifying that the amendments are consistent (or not) with the Project Approval.

A copy of the updated plan and changes will be distributed to all relevant stakeholders in accordance with the approved document control procedure – refer to Section 9 of the CEMP.