

Appendix C

Air quality and
noise and vibration reports

Keepit Dam Upgrade Noise and Vibration Impact Assessment

September, 2008

State Water



Parsons Brinckerhoff Australia Pty Limited ABN 80 078 004 798

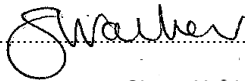
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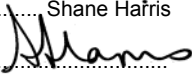
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Glossary of noise terminology

A-weighted sound pressure

The human ear is not equally sensitive to sound at different frequencies. People are more sensitive to sound in the range of 1 to 4 kHz (1000 – 4000 vibrations per second) and less sensitive to lower and higher frequency sound. During noise measurement an electronic “A-weighting” frequency filter is applied to the measured sound level *dB(A)* to account for these sensitivities. Other frequency weightings (B, C and D) are less commonly used. Sound measured without a filter is denoted as linear weighted *dB(linear)*.

Ambient noise

Tonal noise contains one or more prominent tones (and characterised by a distinct frequency components) and is considered more annoying. A 5 *dB(A)* penalty is typically applied to noise sources with tonal characteristics.

Community annoyance

Includes noise annoyance due to:

- character of the noise (e.g. sound pressure level, tonality, impulsiveness, low-frequency content)
- character of the environment (e.g. very quiet suburban, suburban, urban, near industry)
- miscellaneous circumstances (e.g. noise avoidance possibilities, cognitive noise, unpleasant associations)
- human activity being interrupted (e.g. sleep, communicating, reading, working, listening to radio / TV, recreation).

Compliance

The process of checking that source noise levels meet with the noise limits in a statutory context.

Cumulative noise level

The total level of noise from all sources.

EPA Licence

Environment Protection Authority Licence.

Extraneous noise

Noise resulting from activities that are not typical to the area. Atypical activities may include construction, and traffic generated by holiday periods and by special events such as concerts or sporting events. Normal daily traffic is not considered to be extraneous.

Feasible and reasonable measures

Feasibility relates to engineering considerations and what is practical to build; reasonableness relates to the application of judgement in arriving at a decision, taking into account the following factors:

- noise mitigation benefits (amount of noise reduction provided, number of people protected)
- cost of mitigation (cost of mitigation versus benefit provided)
- community views (aesthetic impacts and community wishes)
- noise levels for affected land uses (existing and future levels, and changes in noise levels).

Impulsiveness

Impulsive noise is noise with a high peak of short duration or a sequence of these peaks. Impulsive noise is also considered annoying.

Low frequency

Noise containing major components in the low-frequency range (20 to 250 Hz) of the frequency spectrum.

Noise criteria

The general set of non-mandatory noise levels for protecting against intrusive noise (for example, background noise plus 5 *dB*) and loss of amenity (e.g. noise levels for various land use).

Noise Level (goal)

A noise level that should be adopted for planning purposes as the highest acceptable noise level for the specific area, land use and time of day.

Noise Limits

Enforceable noise levels that appear in conditions on consents and licences. The noise limits are based on achievable noise levels, which the proponent has predicted can be met during the environmental assessment. Exceedance of the noise limits can result in the requirement for either the development of noise management plans or legal action.

Non-compliance

A development is deemed to be in non-compliance with its noise consent / licence conditions if the monitored noise levels exceed its statutory noise limit by more than 2 dB.

NSW DECC

New South Wales Department of Environment and Climate Change.

Performance-based goals

Goals specified in terms of the outcomes/performance to be achieved, but not in terms of the means of achieving them.

Rating background level

The rating background level is the overall single figure background level representing each day, evening and night time period. The rating background level is the median L_{A90} noise level measured over all day, evening and night time monitoring periods.

Receiver

The noise-sensitive land use at which noise from a development can be heard.

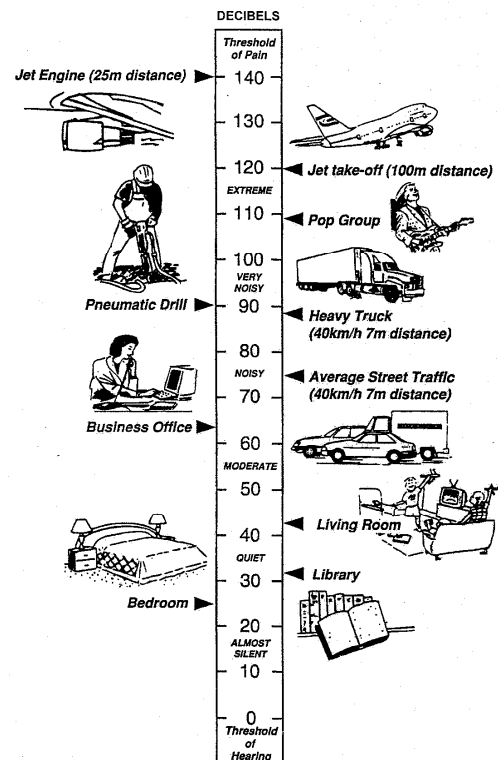
Sleep disturbance

Awakenings and disturbance of sleep stages.

Sound & decibels (dB)

Sound (or noise) is caused by minute changes in atmospheric pressure that are detected by the human ear. The ratio between the quietest noise audible and that which would cause permanent hearing damage is a million times the change in sound pressure. To simplify this range the sound pressures are logarithmically converted to decibels from a reference level of 2×10^{-5} Pa.

The picture below indicates typical noise levels from common noise sources



d

B is the abbreviation for decibel — a unit of sound measurement. It is equivalent to 10 times the logarithm (to base 10) of the ratio of a given sound pressure to a reference pressure.

Sound power level (SWL)

The sound power level of a noise source is the sound energy emitted by the source. Notated as SWL, sound power levels are typically presented in $dB(A)$.

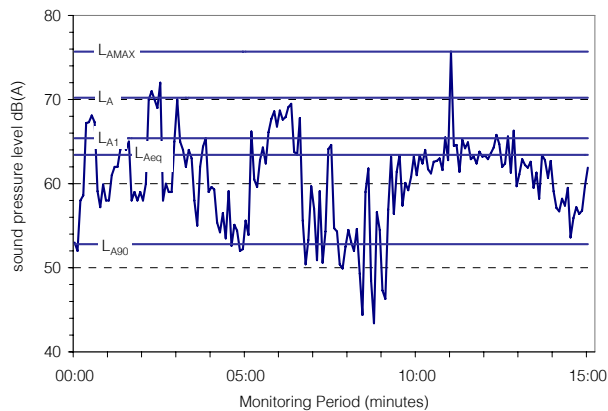
Sound pressure level (SPL)

The level of noise, usually expressed as SPL in $dB(A)$, as measured by a standard sound level meter with a pressure microphone. The sound pressure level in $dB(A)$ gives a close indication of the subjective loudness of the noise.

Statistical noise levels

Noise levels varying over time (e.g. community noise, traffic noise, construction noise) are described in terms of the statistical exceedance level.

A hypothetical example of A weighted noise levels over a 15 minute measurement period is indicated in the following figure:



Key descriptors:

- L_{AMax} Maximum recorded noise level.
- L_{A1} The noise level exceeded for 1% of the 15 minute interval.
- L_{A10} Noise level present for 10% of the 15 minute interval. Commonly referred to the average maximum noise level.
- L_{Aeq} Equivalent continuous (energy average) A-weighted sound pressure level. It is

defined as the steady sound level that contains the same amount of acoustic energy as the corresponding time-varying sound.

- L_{A90} Noise level present for 90% of time (background level). The average minimum background sound level (in the absence of the source under consideration).

Steady state noise level

The steady state noise level is the operator observed baseline noise level where sources influencing the statistical results are determined.

Threshold

The lowest sound pressure level that produces a detectable response (in an instrument/person).

Tonality

Tonal noise contains one or more prominent tones (and characterised by a distinct frequency components) and is considered more annoying. A 5 dB(A) penalty is typically applied to noise sources with tonal characteristics.

Executive summary

This report has been prepared by Parsons Brinckerhoff (PB) on behalf of State Water Corporation to assess the potential noise impacts of the proposed Keepit Dam upgrade (the Project) on the receiving environment. This assessment has focussed primarily on the construction stage emissions and associated impact potential. Operational emissions are not expected to change significantly as a result of the upgrade.

The preferred option for the Project (Option B1) includes the raising of the main and subsidiary dam walls by 3.4 metres, constructing two additional spillways and installing three saddle dams. Concrete for the project will be provided from on-site concrete batching and crushing plants.

Attended (daytime) noise monitoring was carried out at the nearest potentially affected residential receptors to the Project on the 20 March 2007. Unattended noise monitoring was also undertaken at 1521 Bulga Road during the daytime on 20 March 2007.

The measured noise levels were applied to *Environmental Noise Control Manual* (NSW EPA (ENCM), 1994) and *NSW Industrial Noise Policy* (NSW EPA INP 2000) guidance to determine project-specific noise criteria at the nearest potentially affected receptors. A daytime noise criteria of 35 dB(A) $L_{Aeq, 15min}$ was adopted for all construction work including concrete batching plant and aggregate crusher operations.

Noise modelling was undertaken for the construction works assuming the simultaneous operation of a number of dominant noise generating plant.

The following received noise levels at the nearest receptor locations were predicted:

- concrete batching plant and aggregate crusher noise levels were modelled up to 33 dB(A) $L_{Aeq, 15min}$ – no exceedance was predicted
- clay borrow pit works up to 27.5 $L_{Aeq, 15min}$ – no exceedance was predicted
- right hand abutment and peninsula reshaping up to 32 dB(A) $L_{Aeq, 15min}$ – no exceedance was predicted
- saddle dams up to 31.5 dB(A) $L_{Aeq, 15min}$ – no exceedance was predicted
- subsidiary dam wall up to 43 dB(A) $L_{Aeq, 15min}$ with potential short term levels up to 45 dB(A) $L_{Aeq, 15min}$ where works are the north eastern end of the subsidiary dam wall. Potential exceedance of the construction noise limits by 8 - 10 dB(A) at Residential Property A was predicted.
- main dam wall up to 35.5 $L_{Aeq, 15min}$. A potential exceedance of adopted noise goal by 0.5 dB(A) at 152 Bulga Road was predicted.

Cumulative construction activities including all of the above works were also modelled and peak worst-case cumulative noise levels were predicted at the nearest sensitive receptors.

At 1521 Bulga Road, peak cumulative received noise levels of 36 dB(A) $L_{Aeq, 15min}$ during right hand abutment works and 37.5 dB(A) $L_{Aeq, 15min}$ during main dam wall works are potentially 1-2.5 dB(A) exceedance of the adopted noise goal.

The operation of the batching plant, aggregate crusher and the clay borrow pit are not expected to be cumulative with the subsidiary dam wall works due to distance and the intervening topography.

The predicted cumulative construction noise levels are unlikely to occur for the duration of the construction period. This is a function of a number of factors including the geographic separation of the worksites and the distance to nearest receptors.

A construction traffic noise impact assessment was also carried out and determined peak daily truck movements would be compliant with an adopted Environmental Control of Road Traffic Noise (NSW, EPA ECTRN) base noise goal of 55 dB(A) $L_{Aeq, 1hr}$ at nearest receptor locations to traffic routes.

Blasting is proposed to be undertaken. To achieve compliance with the adopted 115 dB(LIN) noise and 5 millimetres per second ground vibration criteria, a maximum charge mass of 350 kilograms is recommended. A separate vibration threshold is necessary to protect the main dam wall from damage during blasting. This level needs to be determined by a competent person prior to construction commencing.

A range of noise and vibration management and mitigation measures are outlined in Section 7 to reduce the potential for impacts and to address potential adverse community response. These measures would be further developed by the construction contractor and detailed in a site-specific noise and vibration management plan for the project. The plan would outline the means by which the contractor would reduce the predicted exceedances to within the nominated noise and vibration design criteria.

State Water have also commenced negotiations with the affected property owners about the predicted noise and vibration levels from construction activity by providing a copy of this report to landowners and discussion with the affected residents on 4 and 5 June 2008. It is understood that the landowner of 1521 Bulga Road is keen to see construction commence. State Water are also in discussion with the owner of Residential Property A, who does not live full-time at the property, about the purchase of a portion of land. State Water intend to seek a negotiated agreement with the owners of these properties regarding the predicted noise and vibration levels. Following any approval granted for the works, State Water will consult further with these property owners to obtain formal agreement for the works.

1. Introduction

This report was prepared by Parsons Brinckerhoff (PB) on behalf of State Water Corporation (State Water) to assess the potential noise and vibration impacts of the proposed Keepit Dam upgrade (the Project) on the receiving environment.

1.1 Background

State Water Corporation (State Water) is the owner and operator of Keepit Dam and is responsible for ensuring that the dam meets the current requirements of the NSW Dams Safety Committee. The NSW Dams Safety Committee requires the upgrade of the dam to withstand extreme natural events.

An Environmental Assessment Report, '*Keepit Dam Upgrade Environmental Assessment – Volumes 1 and 2*' was exhibited by the Department of Planning commencing in December 2007. This report addressed the environmental assessment requirements for the Project issued by the Director-General of the Department of Planning under Part 3A of the *Environmental Planning and Assessment Act 1979* (EP&A Act). In its submission to the exhibition of the Environmental Assessment, the Department of Environment and Climate Change (DECC) requested a detailed assessment of potential noise and vibration impacts on key sensitive receptors.

This assessment has been completed in accordance with the guidelines presented in the *Environmental Noise Control Manual* (NSW EPA ENCM 1994), The NSW *Industrial Noise Policy* (EPA NSW INP 2000), the *Environmental Criteria for Road Traffic Noise* (NSW ECRTN 1999), *Australian Standard 2187.2 Explosives – Storage and Use Part 2: Use of Explosives (AS 2187.2 2006)* and *Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration* (DECC/ANZECC 1990) and other relevant guidelines.

The report presents an assessment of off-site construction noise and vibration issues associated with the proposed upgrade. Operational emissions are unlikely to change as a result of the project.

1.2 Scope

The scope of work for this study was to undertake a noise and vibration impact assessment for the construction phase of the Project, including the following tasks:

- assess the existing ambient noise environment in the study area
- establish noise design objectives and assessment goals for the study area
- provide a detailed assessment of potential noise impacts
- provide an assessment of potential vibration impacts
- assess potential impacts against relevant legislation and guidelines
- compile a concise statement of potential impacts including development of mitigation and management measure(s), where required.

Supporting documentation is included in attachments to this report. Limitations to the scope and use of this assessment are provided in Chapter 10.

2. Project description

2.1 Overview

The proposed Project involves the construction and operation of a combination of additional spillways and raising of the main dam wall and other associated works to safely accommodate extreme flood and earthquake events.

Three dam safety options were examined in the Environmental Assessment, including a combination of raising the main and subsidiary dam walls, provision of additional saddle dams, strengthening the main dam wall and providing additional spillway capacity. A clay borrowpit will be excavated to provide clay material for earth dam construction. Concrete would be provided from an on-site concrete batching plant. Option B1 is the preferred option and is specifically addressed in this assessment.

The construction of the Project is anticipated to occur over a two and half year period.

2.2 Location and setting

Keepit Dam is located off the Oxley Highway approximately 38 kilometres east of Gunnedah and 54 kilometres west of Tamworth in north-west NSW. The dam is situated on the Namoi River, 13 kilometres upstream of its confluence with the Peel River.

The majority of the foreshore area of the dam is designated as a state park (the Lake Keepit State Park). The western side of Lake Keepit is primarily a recreation area, including a caravan park, golf course, boating ramps and sailing and fishing clubs. Located to the eastern side of the lake are camping grounds, a boat ramp and a gliding club.

Local sealed and unsealed roads connect with Rushes Creek Road, the primary route to the Oxley Highway.

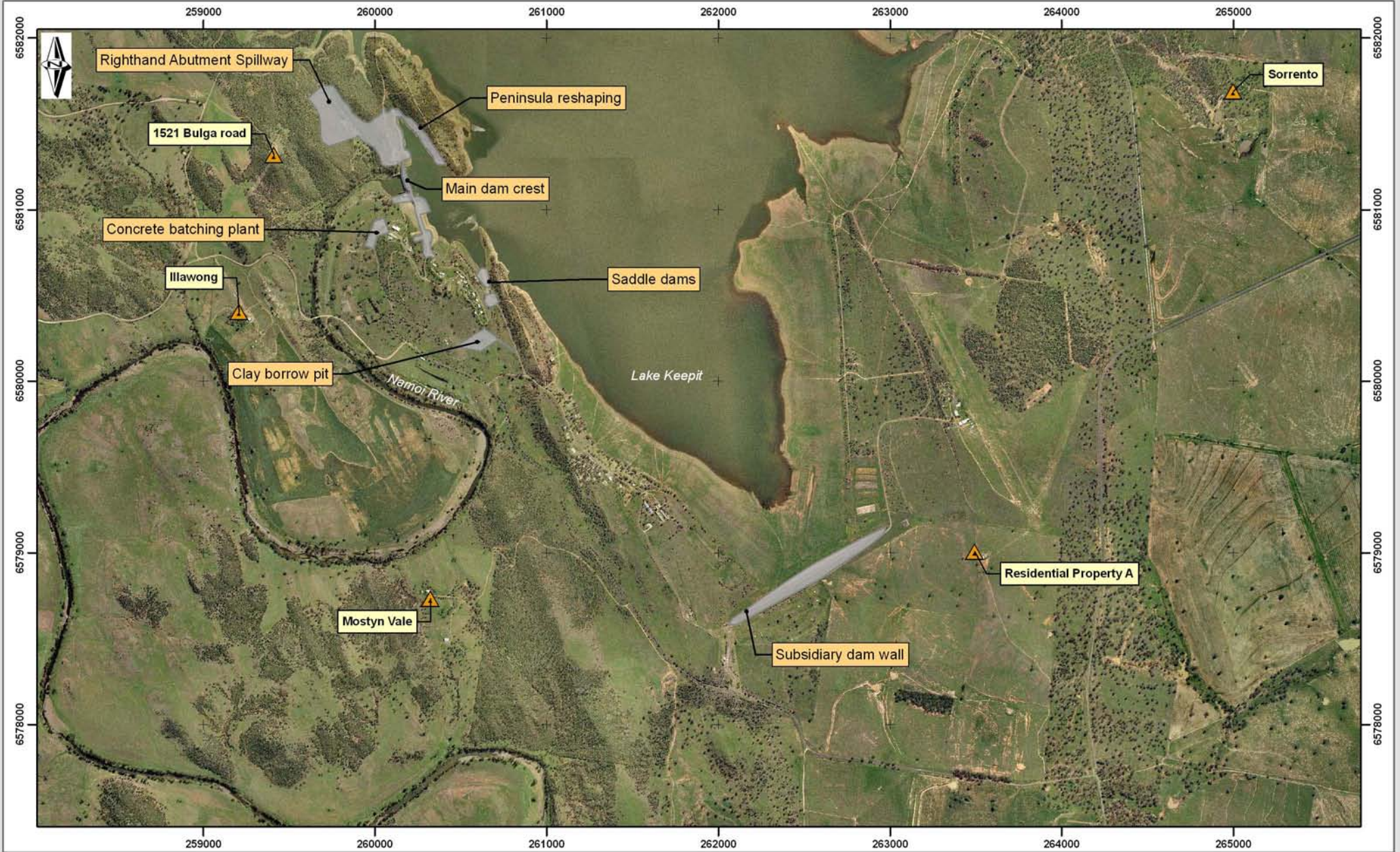
2.3 Sensitive receptors

Existing residential properties are located in the vicinity of Keepit Dam, with the nearest receptor located approximately 600 metres south-east of the subsidiary dam wall.

The nearest potentially affected receptors are listed in Table 2-1 and shown on Figure 2-1.

Table 2-1 Adopted sensitive receptor locations and distance to the project works

Receptor location	Property , coordinate , height (AHD m)	Right hand abutment/ peninsula reshaping	Main dam wall	Saddle dams	Subsidiary dam wall
1	1521 Bulga Rd 259413, 6581320, 370	750	800	1450	4000
2	Illawong 259209, 6580406, 310	1250	1250	1450	3750
3	Mostyn Vale 260323, 6578734, 340	2500	2400	1850	2250
4	Residential Property A 263493, 6579009, 360	4000	3950	3250	900
5	Sorrento 265000, 6581690, 340	4850	4850	4500	3750



- Sensitive receptors
- Construction areas

Figure 2-1: Adopted nearest potentially affected receptors



3. Existing noise environment

This section presents the results of background noise measurements carried out in the Project area. The results were used to develop existing background noise profiles and establish project-specific noise emission design objectives.

3.1 Noise monitoring methodology

This section presents the results of background noise measurements carried out in the Project area. The results were used to develop existing background noise profiles and establish project-specific noise emission design objectives.

Noise measurements were carried out using a RION NA27 Precision Sound Level Meter (operator attended noise monitoring) and Acoustic Research Laboratories statistical environmental noise loggers, type EL-316 16-207-008 (long-term unattended noise monitoring). The instrument sets comply with AS 1259.

Instrument sets were calibrated by a NATA accredited laboratory within two years of the measurement period. Copies of the instrument set calibration certificates are included in Attachment D.

Microphones were positioned 1.5 metres above ground level and were fitted with windsocks. Each instrument was calibrated before and after the measurement period to ensure the reliability and accuracy of results. No significant variances were observed.

3.1.1 Unattended noise monitoring

Unattended noise loggers were established at 1521 Bulga Road considered representative of the existing noise environment. Continuous 15-minute statistical measurements were obtained during the daytime period on Thursday 20 March 2008.

3.1.2 Attended noise monitoring

Attended noise monitoring was undertaken at residential receptors to assist in characterising the existing noise environment. The instrument was set on A-weighted, fast response setting with 15-minute statistical measurements taken. Observations were recorded during the measurement interval for attended noise monitoring. Attended noise monitoring was carried out during the daytime period on Thursday 20 March 2008.

3.1.3 Noise monitoring locations

Noise monitoring locations were selected at nearest potentially affected receptors, representing the indicative worst-case scenario. Noise monitoring locations are identified in Figure 2-1.

Location 1: 1521 Bulga Road

Unattended and attended noise monitoring was undertaken at 1521 Bulga Road. This residential property is considered the nearest potentially affected receptor to the proposed main dam wall works, right hand abutment and peninsula reshaping works.

The property is approximately 0.75 kilometres from the main dam wall.

Location 2: Illawong

Attended noise monitoring was undertaken within 30 metres of the residential property 'Violet Banks'. The receptor location was considered indicative of the noise environment for Illawong.

Illawong is approximately 1.25 kilometres from the main dam wall.

Location 3: Mostyn Vale

The Mostyn Vale community comprises farming and residential properties. Attended noise monitoring was undertaken within 30 metres of the farm house.

Mostyn Vale is approximately 2.4 kilometres from the main dam wall and 2.25 kilometres from the subsidiary dam wall.

Location 5: Subsidiary dam wall

Attended noise monitoring was undertaken at the subsidiary dam wall. The noise environment was considered indicative of the eastern sector of the Keepit State Recreation Area and Residential Property A.

3.2 Unattended noise monitoring

Measured unattended noise levels for the daytime period at Location A, 1521 Bulga Road are detailed in Figure 3-1.

Daytime noise levels of 35 dB(A) L_{Aeq} and 25 dB(A) L_{A90} were determined for the survey period. The noise environment was primarily influenced by local fauna (birds and insects); no industrial or construction influences were noted.

The L_{Aeq} descriptor on Figure 3-1 demonstrates an approximate range in daytime noise levels of 30 to 50 dB(A). The L_{Aeq} descriptor is influenced by all noise events in the local environment. The L_{A90} descriptor is less influenced by short-term and discrete events and is applied for background noise level determination.

The unattended monitoring should be considered in conjunction with observed influences to measured noise levels determined through attended noise measurements.

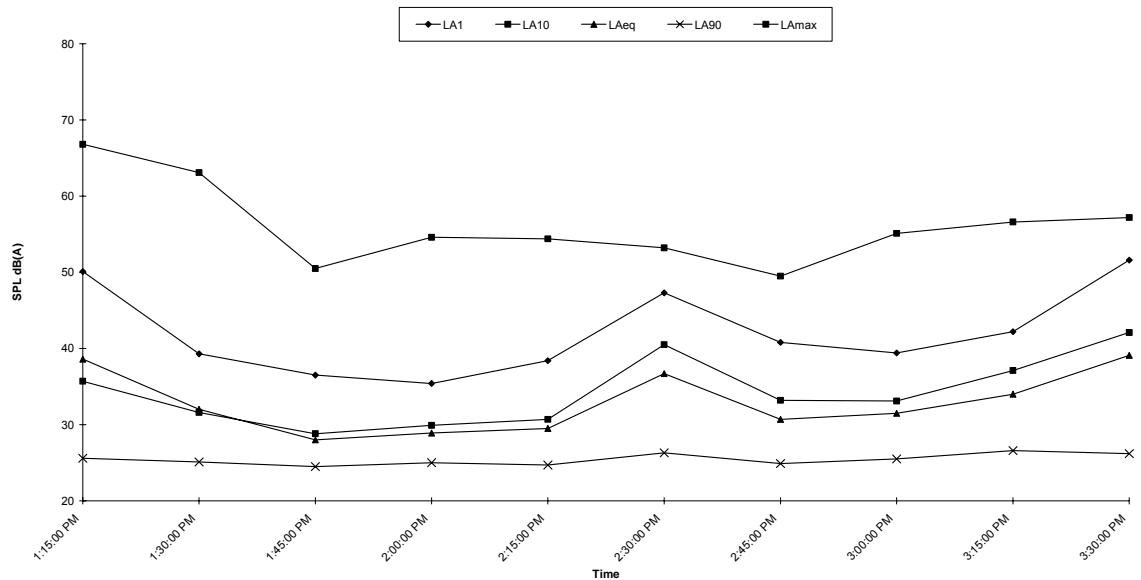


Figure 3-1 Unattended noise monitoring profile — Location 1, 1521 Bulga Road

3.3 Attended noise monitoring

The results of the attended noise monitoring carried out on Thursday 20 March 2008 during the daytime period (7 am to 6 pm) are detailed in Table 3-1.

Table 3-1 Attended measured residential noise levels (daytime)

Location	Time	L _{Aeq}	L _{A10}	L _{A90}	Comments
1521 Bulga Road	11:41	42.5	42.5	30	Fauna (birds and insects) 28 – 35 Residential water tank pumps 26 Steady state 26 – 27
Illawong	12:12	36	39.5	30	Fauna (birds and insects) 29 – 45 Residential activity 32 – 34 Vegetation 'rustling' 31 – 33 Steady state 26 – 28
Mostyn Vale	12:42	39	40.5	30	Fauna (birds and insects) 29 – 44 Vegetation 'rustling' 30 – 34 Steady state 30 – 32
Subsidiary dam wall	13:21	34.5	36	30	Fauna (birds and insects) 30 – 38 Steady state 28 – 29

Notes: Values expressed as dB(A), to nearest 0.5 dB.

L_{A10} Noise level present for 10% of time.

L_{Aeq} Equivalent continuous (energy average) A-weighted sound pressure level. Defined as the steady sound level that contains the same amount of acoustic energy as the corresponding time-varying sound.

L_{A90} Noise level present for 90% of time (background level). The average minimum background sound level (in the absence of the source under consideration).

Steady state measurement made in the presence of minimal influences to noise levels.

Measured daytime ambient noise levels were influenced by local fauna 28 to 45 dB(A), local residential activity 32 to 34 dB(A) and light wind-blown vegetation noise 30 to 34 dB(A). No local road traffic was observed and the gliding club was not operating.

No industrial or existing construction noise sources were audible.

A daytime background noise level of 30 dB(A) L_{A90} was measured at all receptors.

3.4 Meteorological data

Adopting NSW INP (NSW EPA 2000) guidance on representative measurement of environmental noise monitoring should be carried out during periods of nil precipitation and wind speeds of less than 5 metres per second (m/s).

Meteorological conditions during the attended and unattended noise monitoring program were observed to be satisfactory with calm conditions and no precipitation during the daytime period. The observed meteorological conditions were not considered to have had any extraneous effect on the measured noise levels.

4. Adopted noise criteria

4.1 Overview

The *Protection of the Environment Operations Act, 1997* (POEO Act) regulates noise generation and prohibits the generation of 'offensive noise' as defined under the Act.

In addition to the regulatory requirements under the POEO Act, the Department of Environment and Climate Change (DECC) provides guidelines regarding acoustic criteria and noise controls.

4.2 Construction noise criteria

Noise criteria for construction works are established in accordance with Chapter 171 of the ENCM (NSW EPA, 1994). The acoustic design objectives for construction are presented in Table 4-1. The recommended criteria are planning goals only.

The potential noise impacts from construction works should be assessed with respect to additional factors, such as the social benefits of the activity, economic constraints, and the nature and duration of the proposed construction program.

DECC recognises that individuals may accept higher perceived noise impacts for emission sources with a limited duration and an identified end date.

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} .

Table 4-1 Acoustic design objectives for construction activities

Construction period	Acoustic design objective
<4 weeks	Received $L_{A10} \leq L_{A90} + 20$ dB(A)
>4 weeks and <26 weeks	Received $L_{A10} \leq L_{A90} + 10$ dB(A)
>26 weeks	Received $L_{A10} \leq L_{A90} + 5$ dB(A)

Notes: L_{A10} = Noise level 10% of time
 L_{A90} = Noise level 90% of time (background).
 Source: EPA 1994.

Although the final construction schedule and construction method statements were not available at time of this assessment, individual construction activities are expected to be greater than 26 weeks in duration. As such, the appropriate construction criterion for the Keepit Dam site is likely to be:

Received $L_{A10} \leq L_{A90} + 5$ dB(A).

However, given the relatively long-term nature of the works, the small data set of environmental noise information, and DECC's current approach to the assessment of noise impacts, the following construction criterion has been conservatively adopted:

Received $L_{Aeq} \leq L_{A90} + 5 \text{ dB(A)}$.

The approach adopted is consistent with the guiding principles of the INP (NSW EPA, 2000) and the recommended approach for establishing intrusive noise design goals.

Daytime L_{A90} noise levels have been determined to be 30 dB(A). The following construction noise design goals would, therefore, apply:

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

Construction works would be undertaken only during the daytime period (7am to 6 pm on weekdays, 7 am to 1 pm on Saturdays and no work on Sundays or public holidays).

The proposed noise goals would maintain local amenity and be in accord with the existing noise environment at the nearest potentially affected sensitive receptors.

4.3 Blasting emission criteria

Guidance on blasting has been established, adopting the *Australian and New Zealand Environment and Conservation Council (ANZECC) Guidelines Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration*.

The guidelines consider potential human annoyance and discomfort at residential and noise sensitive receptors as a result of blasting activities.

4.3.1 Residential receptor criteria

Residential and commercial receptors are located in the Keepit Dam State Park and the surrounding environment. The ANZECC guidelines provide noise and vibration criteria for residential receptors as outlined below:

Airblast

The recommended maximum noise level for airblast overpressure events is 115 dB (Lin peak).

The level of 115 dB may be exceeded on up to 5% of the total number of blasts over a period of 12 months. However, the level should not exceed 120 dB (Lin peak) at any time.

Ground vibration

The recommended maximum level for ground vibration is 5 millimetres per second (mm/s), peak particle velocity (ppv). The ppv level of 5 mm/s may be exceeded on up to 5% of the total number of blasts over a period of 12 months. The level should not exceed 10 mm/s at any time.

A level of 2 mm/s (ppv) is recommended as a long-term regulatory goal.

Times and frequency of blasting

Blasting should generally only be permitted between the hours of 9 am and 5 pm Monday to Saturday. Blasting should not take place on Sundays or public holidays.

4.4 Vibration criteria

Vibration during construction and concrete batching activities is associated with two main types of impact: disturbance to residents from intermittent vibration, such as from heavy vehicle passage (human comfort); and potential architectural/structural damage to off-site buildings.

Human comfort and structural damage limits vary across the frequency spectrum, although they are generally a constant level across the frequency range generated by most construction activities. Generally, if human disturbance issues are controlled, there is limited potential for structural damage to buildings.

4.4.1 Annoyance/human comfort

DECC *Environmental Noise Management Assessing Vibration: a technical guideline* (2006) provides recommendations for vibration goals from continuous, impulsive and intermittent sources. Construction works associated with the Project are potential sources of vibration, including the daytime movement of heavy vehicles, and operation of compactors and bulldozers. This type of vibration is assessed on the basis of vibration dose levels. Acceptable vibration levels are outlined in Table 4-2.

Table 4-2 Acceptable vibration dose levels for intermittent vibration

Location	Acceptable daytime vibration level ¹ (m/s ^{1.75})	
	Preferred value	Maximum value
Residences	0.20	0.40

Notes: Daytime is the period between 7 am and 10 pm weekdays and 7 am to 1 pm Saturday.

Source: BS 6472-1992.

4.4.2 Structural damage

Although not specified by DECC, German Standard DIN 4150: Part 3-1986 provides guidance on vibration velocity for evaluating potential structural damage. Limits range from 5 mm/s (less than 10 hertz (Hz)), 5-15 mm/s (10-50 Hz) and 15-20 mm/s (50-100 Hz) at the foundation of a residential dwelling. At the uppermost storey floor plane, a vibration limit of 15 mm/s is applicable for a residential dwelling.

4.4.3 Sensitive structures

State Water has adopted a maximum 50mm per second structural vibration limit for the existing dam wall. The limiting vibration criteria to be met at the dam wall should be checked by a competent person and may require the prior approval of State Water and/or the NSW Dams Safety Committee.

4.5 Road traffic noise

Road traffic noise may be associated with the construction of the Project. The ECTRN (NSW EPA, 1999) recommends 'base' and 'allowance' goals.

The recommended 'base' goals for land use 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).

The '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. Adopting the allowance criteria is not deemed appropriate for this Project based on the short duration of the increased road vehicle movements.

5. Concrete batching plant and aggregate crusher noise impact assessment

Concrete for construction works would be supplied from an on-site concrete batching plant. The operation of the concrete batching plant and aggregate crusher may result in noise impacts at receptors. A predictive noise impact assessment for concrete batching plant and crushing operations was therefore undertaken. Standard batching plant operations and equipment were assumed in the modelled scenarios.

5.1 Prediction methodology

A noise propagation model was established for the assessment of potential noise impacts from the concrete batching plant and crusher at the nearest potentially affected receptors. Noise modelling was undertaken through the use of SoundPLAN noise propagation modelling software (Version 6.4). The modelling was based on the following:

- digital land topography 10 metre contours for the immediate Project area
- ground coverage was assumed to be non-reflective
- receptors were established relative to topography, with receiver heights 1.2 metres above the ground
- point and source calculations were assumed for all required plant and equipment
- one-third octave sound power levels for batching and crusher plant (as detailed in Table 5-1)
- worst-case assumptions of associated plant in cumulative operation were adopted
- the concrete batching plant was assumed to operate continuously during core construction hours: 7 am to 6 pm Monday to Friday and 7 am to 1 pm Saturdays
- model runs were performed accounting for neutral and noise enhancing meteorological conditions
- CONCAWE industrial standard model parameters were applied.

5.2 Noise emissions sources

Key noise-generating plant and adopted sound power levels for the concrete batching plant are detailed in Table 5-1.

Table 5-1 Concrete batching plant noise source data

Operational plant	Sound power level dB (A) L_{Aeq}
Slump stand (x 2)	89 ¹ (individual)
Loading area	96
Conveyor (x 2)	84 ¹ (individual)
Pressure relief valve (x 2)	87 ¹ (individual)
Loader	107
Concrete crusher (loaded)	106

Note: All noise levels in dB(A), to nearest 0.5 dB(A) adopted from PB database.

1. Tonal correction applied

Based on previous experience, operational plant such as compressors, pressure relief valves, and conveyors, may have low frequency and/or tonal noise source components. Accordingly, a conservative assessment approach was taken where, adopting NSW INP guidance, a 5 dB(A) addition was included to noise sources with potentially disturbing noise characteristics.

A worst-case 15-minute operational period during loading/unloading was assumed, with all feasible concrete batching plant equipment in cumulative operation.

Predicted operational noise levels consider the frequency of intermittent events. Pressure valve release events were assumed to occur at a frequency of five events per 15-minute assessment period. A total of two pressure relief valves were assumed for the plant.

5.3 Modelling results

Predicted concrete batching plant and aggregate crusher operational noise levels at the identified sensitive receptors are detailed in Table 5-2 and shown in Figure 5-1.

Table 5-2 Predicted received noise levels for batching plant and aggregate crusher

Receptor	Predicted received noise level $L_{Aeq, 15m}$ in neutral conditions
Noise design goal 35 $L_{Aeq, 15min}$	
1521 Bulga Road	33
Illawong	<20
Mostyn Vale	<20
Residential Property A	<10
Sorrento	<10

Note: All noise levels in dB(A), to nearest 0.5 dB(A).

Received noise levels from the concrete batching and crusher plant were predicted to comply with the adopted 35 dB(A) $L_{Aeq, 15min}$ noise design goal at all sensitive receptors.

The nearest sensitive receptor to the concrete batching plant would be 1521 Bulga Road. A predicted received noise level of 33 $L_{Aeq, 15min}$ was determined for this receptor.

Noise management and mitigation measures to reduce the received noise levels from the concrete batching and aggregate crusher are recommended in Chapter 7.

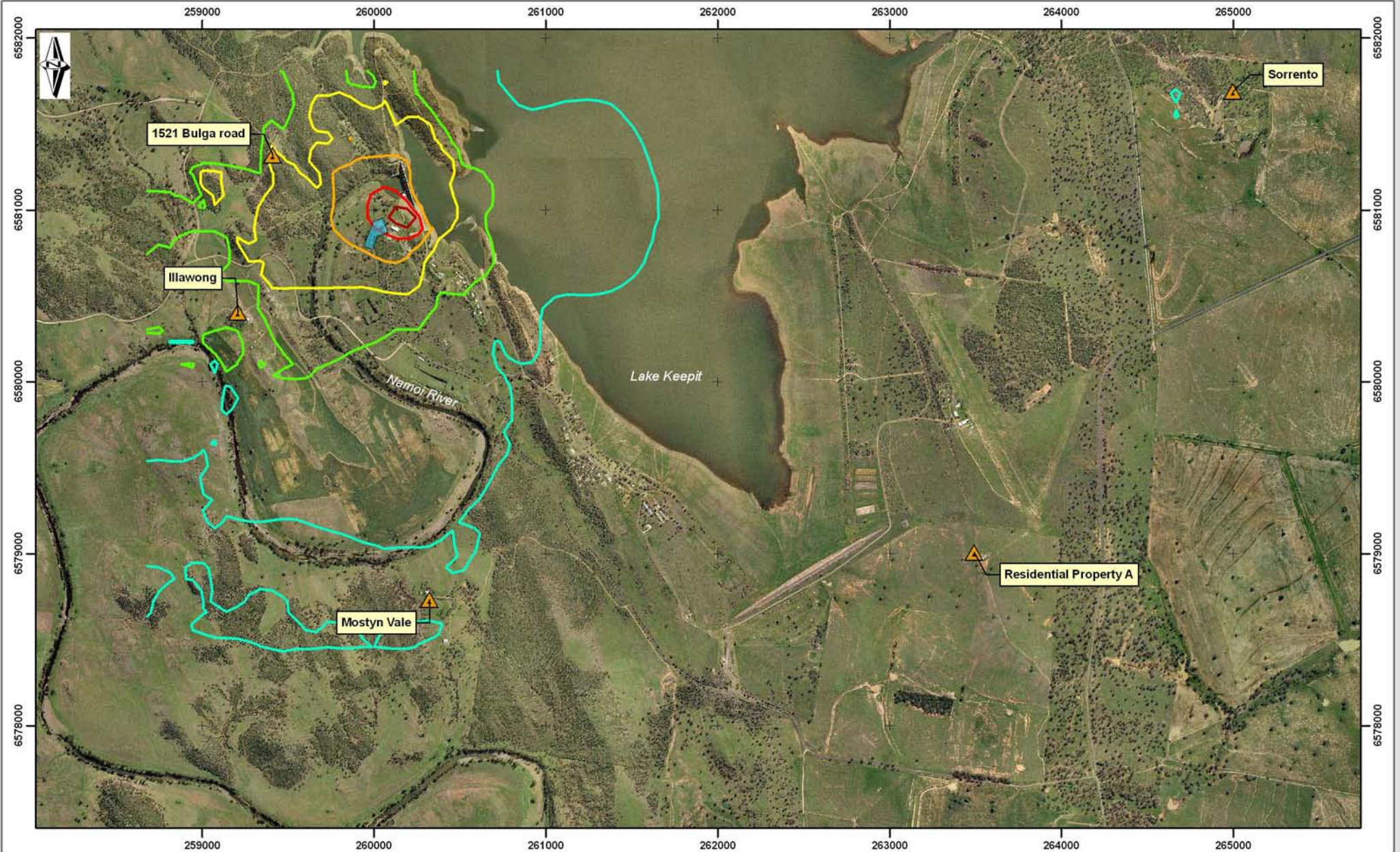


Figure 5-1: Concrete batching plant and crusher predicted operational noise impacts



6. Construction noise impact assessment

The proposed Keepit Dam upgrade requires the construction and development of new infrastructure at a number of geographically separate locations around the dam perimeter. Delivery of materials and construction equipment would also be used. These and other key noise generating activities during the construction phase were assessed.

Construction works at the right hand abutment, subsidiary dam, saddle dam and clay borrow pit locations are likely to be concurrent. Indicative worst-case construction noise impact scenarios have been identified adopting the proposed State Water construction program.

The worst-case scenarios consider construction works requiring the cumulative operation of the greatest noise generating plant in each construction location.

An overall noise design goal of 35 dB(A) L_{Aeq} was adopted for the construction works.

6.1 Prediction methodology

A construction noise propagation model was established for the assessment of potential noise impacts from the construction phases of the Project at the nearest potentially affected receptors. Noise modelling was undertaken through the use of SoundPLAN noise propagation modelling software (Version 6.4). The modelling was based on the following:

- land topography based on 10 metre contour information for the immediate Project area
- ground cover was assumed to be non-reflective
- receptors were established relative to the topography with receiver heights 1.2 metres above the ground
- point and source calculations were assumed for the anticipated plant and equipment
- 1/1 octave sound power levels for the construction plant detailed in Table 6-1, individual plant were modelled at each construction location
- worst-case assumptions of associated plant in cumulative operation were adopted
- model runs were performed accounting for neutral and noise enhancing meteorological conditions
- CONCAWE industrial standard model parameters were applied
- all construction works to be undertaken between 7 am and 6 pm Monday to Friday and 8 am and 1 pm Saturdays. Should works be required outside of standard construction hours prior approval would be sought from the relevant Government agencies.

6.2 Noise emission sources

Construction works are proposed at the right hand abutment, subsidiary dam wall and at saddle dam locations and the main dam wall and clay borrow pit.

The construction program has identified key activities being ground clearance/preparation, excavation and infrastructure construction.

Table 6-1 details the construction plant anticipated at the various construction sites and adopted noise source data.

Operational 1/1 octave noise source data were based on measured noise source data. Where necessary, sound power levels from Australian Standard AS2436 (Australian Standards - 1981) and plant supplier datasheets were sourced.

Table 6-1 Adopted sound power levels for construction plant and equipment

Ground preparation		Excavation		Infrastructure	
Plant	SWL ¹	Plant	SWL ¹	Plant	SWL ¹
Excavator ²	105	Excavator ²	105	Crane ³	109
Bulldozer CAT DH ⁴	114	Dump truck ⁴	107	Dump truck ⁴	107
Backhoe ⁴	114	Bulldozer CAT DH ⁴	114	Hand tools ³	110
Rock breaker ³	120	Backhoe ⁴	114	Bulldozer CAT DH ⁴	114
Vibratory roller ²	99	Rock breaker ³	120	Loader ⁴	107
Compactor ³	116	Loader ³	107		
Grader ⁴	108				
Dump truck ⁴	107				
Loader ⁴	107				

Notes: All noise levels in dB(A), to nearest 0.5 dB(A).
 1. Sound power level.
 2. PB database.
 3. Australian Standard AS 2436 – 1981. For the purpose of this assessment, construction noise sources have been assumed to be constant rather than intermittent.
 4. Construction plant supplier database

Mobile construction plant may use audible reversing alarms for health and safety reasons. Recommendation has been made in Section 7 for the management of reversing alarm noise to minimise potential noise impact at the nearest sensitive receptors.

6.3 Modelling results

6.3.1 General construction works

Noise levels for indicative worst-case construction works scenarios, where all feasible plant are assumed to be in cumulative operation, have been predicted using the construction plant and associated sound power level information outlined in Table 6-1. The peak received noise levels predicted are most likely to occur only during the most intensive construction periods. A reduction in received noise levels would be expected where fewer plant are in cumulative operation and where works do not occur concurrently.

Based on the draft construction program, the following stages of construction works were modelled:

- Stage 1 - the main activities including simultaneous works on the subsidiary wall, right-hand abutment and saddle dams. The majority of blasting activities (approximately 95%) would take place at the right-hand abutment during this stage (refer Section 6.5).
- Stage 2 - the main activities including raising the main dam wall. No blasting would be required for this stage however some overlap with the Stage 1 works is anticipated to occur.

Table 6-2 details the predicted range of construction noise levels received at the nearest sensitive receptors which are discussed briefly below. The receptor specific predicted construction noise levels are provided in Attachment A.

Table 6-2 General construction noise levels at sensitive receptors

	Construction phase (neutral meteorological conditions)		
	Ground preparation	Excavation	Infrastructure works
	noise level $L_{Aeq, 15min}$	noise level $L_{Aeq, 15min}$	noise level $L_{Aeq, 15min}$
Noise design criteria 35 $L_{Aeq, 15min}$			
Right hand abutment spillway	<10 – 32.5	<10 – 25.5	<10 – 31
Saddle dams	<10 – 31.5	<10 – 28	<10 – 26
Subsidiary dam wall	19.5 – 43	14 – 37.5	14 – 37.5
Main dam wall	N/A	N/A	15.5 – 35.5

Note: All noise levels in dB(A), to nearest 0.5 dB(A).
The noise level range quoted indicates the predicted range at the sensitive receptors identified in Table 2-1.

Right hand abutment spillway noise impact

Received noise levels at all sensitive receptors were predicted to comply with the adopted noise criteria. The greatest received noise levels would occur at 1521 Bulga Road, the nearest receptor to the proposed construction site, where received noise levels are predicted to be up to 32.5 dB(A) $L_{Aeq, 15min}$ during ground preparation works.

Saddle dam noise impact

Received noise levels at all sensitive receptors were predicted to comply with the adopted noise criteria. The greatest received noise levels would occur at 1521 Bulga Road estimated to be up to 31.5 dB(A) $L_{Aeq, 15min}$ during ground preparation works.

Subsidiary dam wall noise impact

Residential Property A is the nearest potentially affected receptor to the proposed subsidiary dam wall works. Received noise levels during all work activities of 37.5 – 43 dB(A) $L_{Aeq, 15min}$ were predicted at this location which represents a potential exceedance of the adopted noise criteria of 2.5 – 8 dB(A) L_{Aeq} .

Where construction works are undertaken at the north-eastern end of the worksite (closest to the receiver), received noises levels may increase by an additional 1-2 dB(A) from levels shown in Table 6-2. The worst- case range of exceedances at this receiver may therefore range from 4.5 -10 dB(A) L_{Aeq} .

For all other receptors, received noise levels were predicted to comply with the adopted noise criteria.

Main dam wall noise impact

The main dam wall works are scheduled to be undertaken as part of Stage 2 of the construction and separately from Stage 1 construction works assessed in the preceding sections.

Received noise levels up to 35.5 dB(A) $L_{Aeq, 15min}$ were predicted at the nearest noise sensitive receptor, 1521 Bulga Road, which represents a potential exceedance of 0.5 dB(A) of the adopted noise goal.

For all other receptors, received noise levels were predicted to comply with the adopted noise criteria.

Cumulative construction noise impact

Construction works at the right hand abutment, saddle dams and subsidiary dam wall are scheduled to be undertaken concurrently. As such, the worst case condition would be assessed where all sites are in simultaneous operation. However, given the geographic separation of the worksites, the topography and the scattered and remote location of the sensitive receptors, received noise levels are likely to be dominated only by the nearest worksite. Cumulative assessment is therefore addressed through the noise levels outlined in Table 6-2.

6.3.2 Clay borrow pit

A clay borrow pit to the south and west of the main dam wall would be used to extract clay for the construction of the earth dams and release plugs. The excavation of clay is expected to occur simultaneously with right hand abutment, subsidiary dam and saddle dam construction works.

Potential received noise levels at the identified receptors have been determined for an indicative worst-case $L_{Aeq, 15min}$ period. For the pit excavation works, a bulldozer, excavators (3), loaders (2) and dump trucks (4) were assumed to be operating concurrently. Noise levels have been predicted assuming works are conducted at ground level, however in reality, reduction in received noise levels would occur when construction plant is operating within the pit and below ground level.

Table 6-3 details the predicted received noise levels from clay borrow pit excavations.

Table 6-3 Clay borrow pit excavation predicted noise levels

Location	Predicted received noise level $L_{Aeq, 15min}$
Noise design criteria 35 $L_{Aeq, 15min}$	
1521 Bulga Road	27.5
Illawong	25.5
Mostyn Vale	27.5
Residential Property A	17
Sorrento	<10

Note: All noise levels in dB(A), to nearest 0.5 dB(A).

Predicted received noise levels for the clay borrow pit excavation works are expected to comply with the adopted 35 dB(A) $L_{Aeq, 15min}$ noise criteria

At the State Water offices potential received peak noise levels from clay borrow pit works up to 45 dB(A) $L_{Aeq, 15min}$ have been predicted.

At the Caravan Park, peak received noise levels of 39.5 dB(A) $L_{Aeq, 15min}$ have been predicted, representing a potential 4.5 dB(A) exceedance of the adopted noise goal. Occupancy at the Caravan Park is seasonal and the works will be scheduled to avoid the peak tourist period.

6.3.3 Cumulative construction works, clay borrow pit, concrete batching and aggregate crusher noise impacts

General construction works are expected to occur simultaneously with concrete batching plant, aggregate crusher and clay borrow pit operations. The potential cumulative noise levels from these works were also assessed to determine the total construction noise levels at sensitive receptors.

Considerate of potential received noise levels at the nearest receptor locations from concrete batching and crushing works (Table 5-2), construction works (Table 6-2) and clay borrow pit works (Table 6-2), the following scenarios have been developed indicative of potential worst case received cumulative noise levels.

- Scenario 1: Right hand abutment and batching plant and aggregate crushing (at 1521 Bulga Road).
- Scenario 2: Main dam wall and batching plant and aggregate crushing (at 1521 Bulga Road).
- Scenario 3: Saddle dams and clay borrow pit (at State Water offices and caravan park).

Potential noise from the concrete batching plant, crusher operations and clay borrow pit works would not be expected to additionally influence received dominant construction noise levels at all other receptors.

Table 6-4 details the range of predicted cumulative noise levels (considering construction works, concrete batching plant and crushing) at the identified sensitive receptors.

Table 6-4 Cumulative received noise levels from general construction works, concrete batching and crushing works

	Construction phase (neutral meteorological conditions)		
	Ground preparation	Excavation	Infrastructure works
	$L_{Aeq, 15min}$	$L_{Aeq, 15min}$	$L_{Aeq, 15min}$
Noise design criteria 35 $L_{Aeq, 15min}$			
Scenario 1 (1521 Bulga Road0)	36	33.5	35
Scenario 2 (1521 Bulga Road)	N/A	N/A	37.5

Note: All noise levels in dB(A), to nearest 0.5 dB(A).
 The noise level range quoted indicates the predicted range at the sensitive receptors identified in Table 2-1.

As shown in the table, for scenario 1, cumulative received peak noise levels of up to 36 dB(A) are predicted to be 1 dB(A) in exceedance of the adopted 35 dB(A) $L_{Aeq, 15min}$ noise goal.

For scenario 2, cumulative received peak noise level during the main dam wall works is 37.5 dB(A) $L_{Aeq, 15min}$ or 2.5 dB(A) in exceedance of the adopted noise goal.

For scenario 3, cumulative received peak noise levels at State Water offices of up to 51 dB(A) $L_{Aeq, 15min}$ and 41 dB(A) $L_{Aeq, 15min}$ at the nearest location at the Caravan Park have been predicted. Potential exceedance of the adopted noise goal by up to 6 dB(A) may occur at the Caravan Park. The works program would be scheduled to avoid the peak tourist season; and therefore undertaken when the Caravan Park is mostly unoccupied.

Reductions in received worst case noise levels predicted in Table 6-4 would be expected where works are not undertaken concurrently, fewer plant are in cumulative operation, where batching and crusher operations are less intense and borrow pit works are undertaken within a pit.

Figure 6-1 shows the noise level contours for cumulative ground preparation works at the right hand abutment spillway, saddle dams and subsidiary dam wall concurrent with concrete batching plant, aggregate crusher and clay borrow pit excavation works.

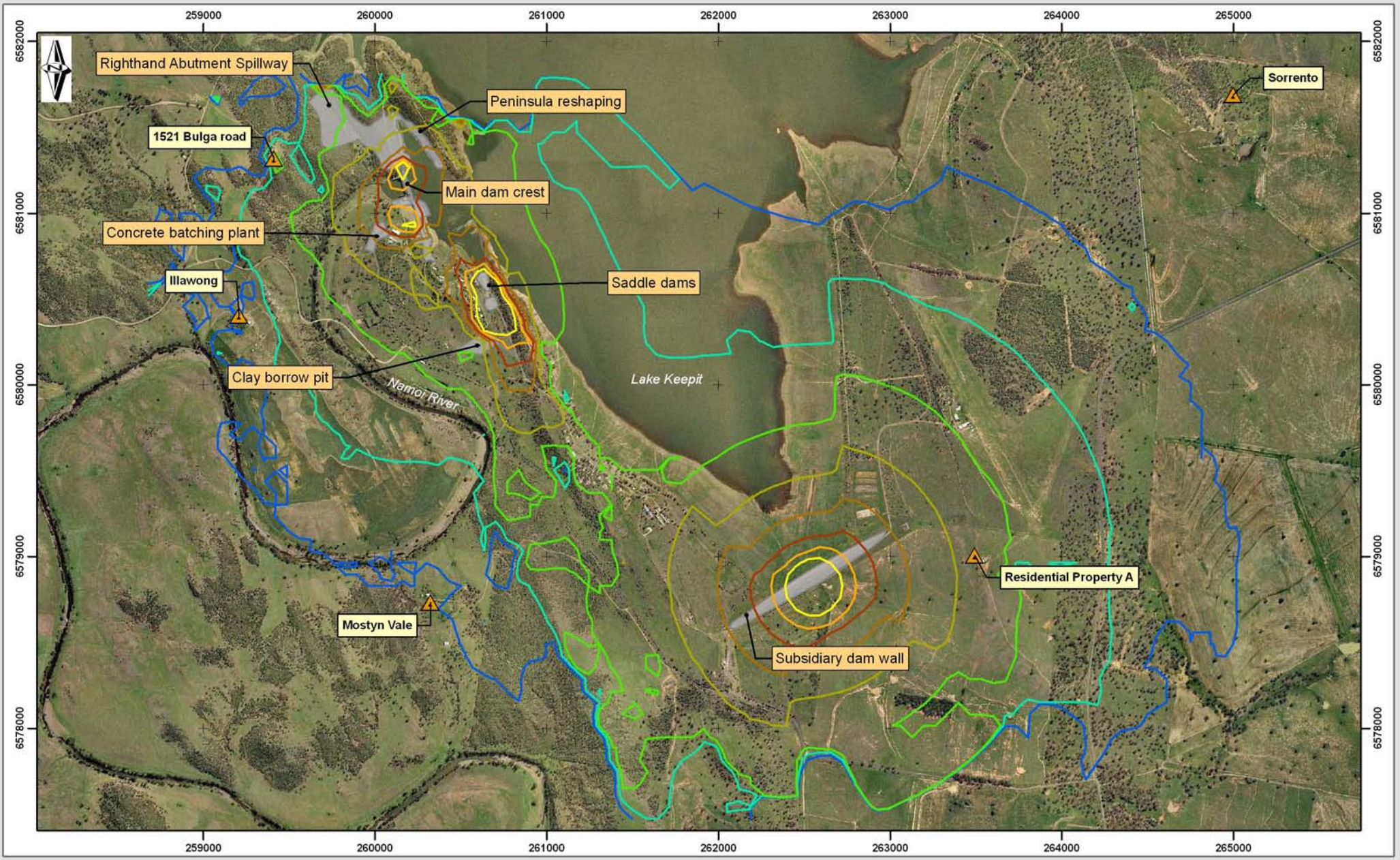


Figure 6-1: Predicted noise impacts for cumulative ground clearance works and concrete batching plant operations



6.3.4 Potential noise enhancing meteorological conditions

The NSW INP requires assessment of wind effects or temperature inversions where they are a feature of an area. Wind effects are a feature in areas where source-to-receiver wind speeds of 3 m/s or below occur 30% of the time in any assessment period in any season. Temperature inversions are a feature when they occur for at least 30% (approximately two nights per week) of the total night-time in winter, with inversions considered to be present during F-class stability conditions and wind speeds less than 2 m/s.

Analysis of regional meteorological patterns (see Attachment C) indicates that daytime noise enhancing conditions are not a feature of the Project area.

6.4 Road traffic noise

The construction programme requires the operation of light and heavy vehicles for the delivery of personnel, supply of concrete and transfer of equipment, spoil and aggregate on the local public roads within the Keepit Dam Reserve.

A qualitative assessment of potential received noise levels has been undertaken to the adopted ECTRN base noise criteria of 55 dB(A) L_{A1} daytime. The assessment has adopted proposed peak road traffic volumes for trucks and heavy vehicles as shown in Figure 6-2.

Considerate of identified nearest receptor locations to proposed traffic routes, the road traffic noise assessment has been undertaken at 1521 Bulga Road, Residential Receptor A and the Caravan Park. The separation distances and intervening topography between the proposed haul roads and the receptors at Sorrento, Illawong and Mostyn Vale are such that potential received noise levels are expected to comply with the adopted criteria. Relative to the volume of heavy vehicles, the expected volume of light vehicle movements is also considered to be much less and accordingly, light vehicle volumes are not considered to result in noise levels above the adopted ECTRN base noise criteria.

Noise generated by heavy vehicle movements has been determined based on a worst-case combination of two trucks passing each other (1 truck loaded, 1 unloaded) and using the peak traffic movements as shown in Figure 6-2. In order to determine potential road traffic noise impacts, Calculation of Road Traffic Noise (CORTN, HMSO 1988) guidance has been applied. CORTN provides the following method for determining basic hourly road traffic noise levels, for planning purposes:

- basic noise level hourly $L_{A10} = 42.2 + 10\log q$ (where q = hourly flow rate).

A correction factor addition is provided for the inclusion of heavy vehicles in the calculation procedure, this is determined by the following formula:

- correction = $33\log(V + 40 + 500/V) + 10\log(1 + 5p/V) - 68.8$ (where V = velocity in km/h and p = percentage of heavy vehicles).

A conservative approach has been adopted where p represents 100% of traffic flow from heavy vehicles.

Hourly L_{A10} levels for truck movements have been determined based upon an assumed speed of 50 kilometres per hour and peak expected heavy vehicle movements.

The road routes at the nearest receptors have been identified and the closest separation distance between the receptors and the route road centre line determined.

A CORTN distance correction to the nearest receptor has been applied to the basic noise levels. $L_{A10, 1hr}$ noise levels have been corrected by -3 dB(A) for $L_{Aeq, 1hr}$ noise levels.

Predicted received noise levels are provided in Table 6-5.

Table 6-5 Predicted peak heavy vehicle received noise levels

Location	Nearest road route	Received basic noise level $L_{Aeq, 1 hr}$
Noise design criteria 55 $L_{Aeq, 1 hr}$		
1521 Bulga Road	Orange	42
	Yellow	43
Caravan Park	Green + Brown	52
Residential receptor A	Purple	53

Note: All noise levels in dB(A) to nearest 0.5 dB(A).

Heavy vehicle received noise levels are predicted to comply with the adopted noise design criteria at the assessed sensitive receptors. Received noise levels at the caravan park would also be expected to comply.

Peak truck pass-by events are not expected to be continuous, therefore the received noise level for average vehicle movements would be expected to be reduced from levels detailed in Table 6-5.

Trucks manoeuvring at construction sites and the loading and unloading of spoil and equipment were considered as part of the construction noise impact assessment.

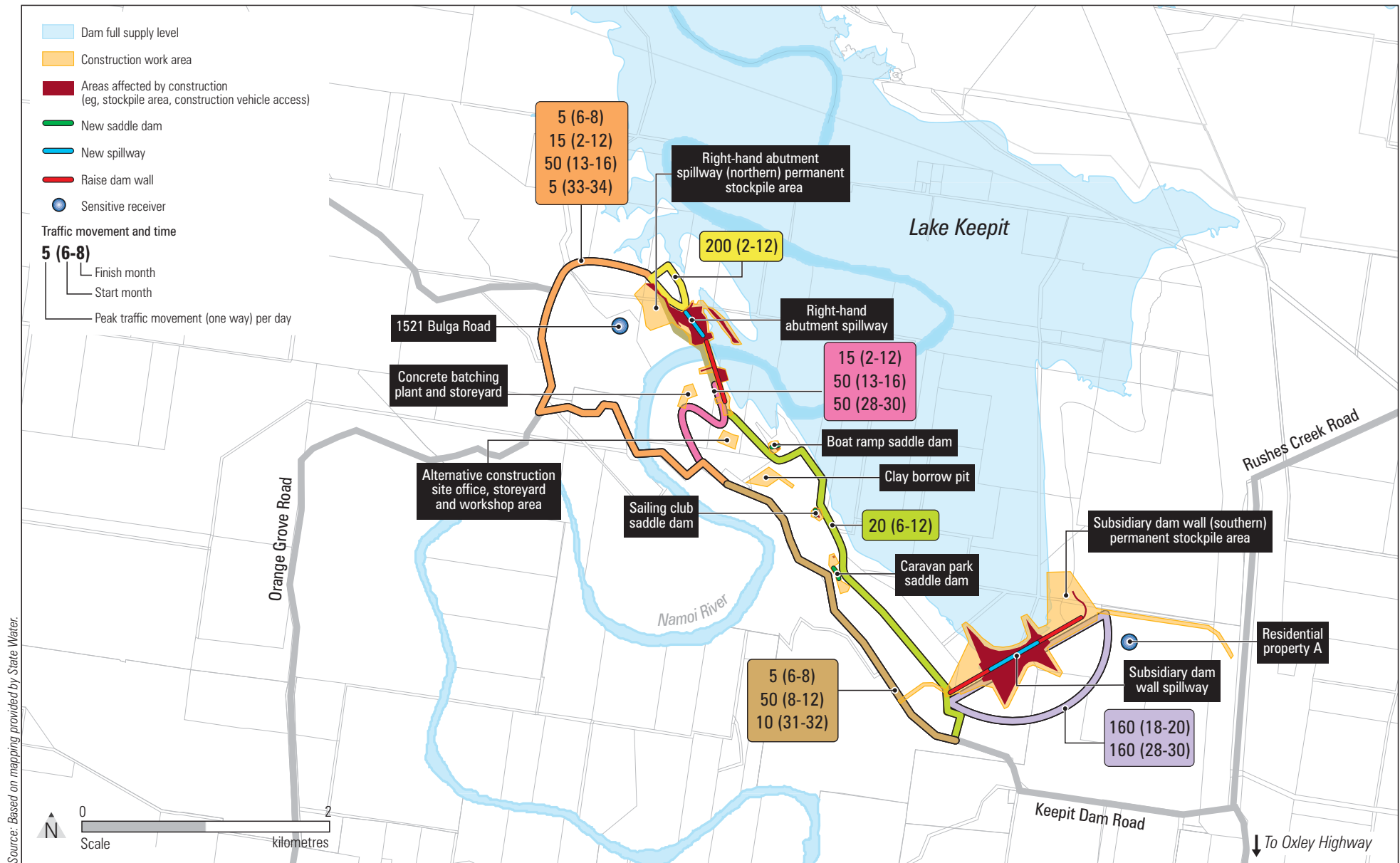


Figure 6-2 Summary of construction traffic movements and routes

6.5 Blasting impact assessment

Predicted blasting noise and vibration levels can be determined for potential annoyance and disturbance, applying blasting conditions and separation distances between the blasting site and the nearest identified sensitive receptors.

Blasting charge masses had not been determined at the time of this assessment. Applying emission model calculations, blasting conditions have been recommended to achieve compliance with adopted noise and vibration criteria at the nearest receptors.

Blasting has been proposed for the right hand abutment and peninsula reshaping works to the north of the main dam wall. A blasting frequency of 1 to 2 blasting events per day has been proposed.

6.5.1 Blasting noise assessment

The potential received noise level from airblast overpressure can be determined adopting the cube root scaled distance site law from *Australian Standard 2187.2 - 2006 Explosives storage and use Part 2 Use of explosives* (2006):

$$P = K_a \left(\frac{R}{Q^{1/3}} \right)^a \quad \text{equation 1}$$

P = pressure in kilopascals for 115 dB criteria

Q = explosive charge mass in kilograms

R = distance from charge in metres

Ka = site constant

a = site exponent

AS 2187.2 references a site exponent (a) of -1.45, which corresponds to an approximate 8.6 dB(Lin) reduction in received noise level with a doubling of distance from the blast source.

AS 2187.2 recommends a site constant (Ka) of 10 to 100 for confined charge mass blasts.

Adopting the recommended exponent and constant values and separation distances for the identified nearest receptor locations, recommended charge masses have been determined to achieve the desired noise criteria of 115 dB at the receptor locations.

Table 6-6 details predicted distances from the blast location required to achieve airblast overpressure criteria for varying charge size.

Table 6-6 Predicted charge mass for blasting events for potential noise levels

Effective charge mass per delay (kg)	Distance to achieve airblast over pressure less than 115 dB(Lin) (m)
10	233
50	398
100	502
250	681
350	762
400	796
500	858

The nearest residential receptor location at 1521 Bulga Road is 0.75 kilometres from the right hand abutment works. A mass charge per delay of less than 350 kilograms is recommended.

The State Water offices are the nearest commercial receptors, within 0.67 kilometres of the proposed blasting locations, a maximum mass charge per delay of less than 250 kilograms is recommended.

6.5.2 Blasting vibration assessment

Ground vibration levels from blasting depend on the maximum instantaneous charge. AS 2187.2 provides guidance to estimate ground vibration levels from blasting events applying the following relationship:

$$V = K_g \left(\frac{R}{Q^{1/2}} \right)^{-B} \quad \text{equation 2}$$

- V = ground vibration peak particle velocity in mm/s
- R = distance between the charge and the receptor location in metres
- Q = maximum instantaneous charge in kilograms
- K_g, B = constants relating to site and rock properties.

Estimated vibration levels are for free-face blasting and are indicative of average blasting conditions.

Table 6-7 has been adopted from AS 2817.2 and details the predicted distance from the blast location required to achieve vibration criteria for varying mass charge size.

Table 6-7 Estimated received vibration levels from blasting events

Effective charge mass per delay (kg)	Distance to achieve vibration level less than 5 mm/s (m)
10	94
50	210
100	298
250	471
350	557
400	595
500	666

The nearest residential receptor, 1521 Bulga Road, is approximately 0.75 kilometres from the right hand abutment. To achieve compliance with the 5 mm/s adopted vibration annoyance criteria, a charge mass of less than 635 kilograms is recommended.

To minimise occupant disturbance from blasting vibration at the State Water offices, which may be occupied during blasting events, a maximum mass charge per delay of approximately 500 kilograms is recommended.

In assessing the potential for structural damage to buildings to result from blasting-related vibration, guideline values for the avoidance of ‘cosmetic damage’ have been adopted from *AS 2187.2 Explosives storage and use Part 2 Use of explosives (2006)*. The standard recommends that peak particle velocity (ppv) groundbourne vibration from individual blast events at the nearest receptors not exceed the values identified in Table 6-8.

Table 6-8 Limiting vibration levels for the avoidance of ‘cosmetic damage’ from individual blasting events

Building type	Peak component particle velocity in frequency range of predominant pulse	
	4 Hz – 15 Hz	15 Hz and above
Reinforced or framed structures. Industrial and heavy commercial buildings	50 mm/s at 4 Hz and above	-
Unreinforced or light framed structure. 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

Notes: Values referred to are at the base of the building
For unreinforced buildings at frequencies below 4 Hz, a maximum displacement of 0.6 mm (zero to peak) should not be exceeded.
Source: AS 2187.2 (2006)

The relatively close location of the existing dam wall to the areas where blasting is required will likely govern the maximum acceptable level of ground vibration during blasting events. Water retaining structures such as dams are particularly sensitive to vibration and therefore require strict protection measures to ensure their integrity.

State Water has adopted a maximum 50 millimetres per second structural vibration limit for the existing dam wall. Applying the blasting vibration formula, a maximum effective charge mass of 1250 kilograms is allowable, however the limiting vibration criteria to be met at the dam wall should be checked by a competent person and may require the approval of State Water and/or the NSW Dams Safety Committee.

6.6 Construction vibration assessment

The main source of construction vibration would be the excavation works required at key construction locations. Received vibration levels are influenced by the specific construction equipment used, geological conditions and generated vibration frequency spectrum.

The nearest potentially affected receptors to construction locations are approximately 0.75 kilometres from the work sites. It is considered that the separation distances between the construction sites and nearest potentially affected receptors are sufficient to limit the potential for any perceived vibration levels.

Source vibration levels are not expected to result in received vibration levels in exceedance of the defined annoyance and structural limits.

7. Recommended noise and vibration management and mitigation measures

This section details recommended measures for mitigating or reducing received noise levels to achieve compliance with the adopted noise criteria established for the construction phase of the Project.

7.1 Concrete batching plant and aggregate crusher

The concrete batching plant design had not been confirmed at the time of this noise assessment. Adopting previous experience in concrete batching plant operations, predicted noise levels at the nearest affected receptors have been determined to comply with the adopted noise design criteria of 35 dB(A) $L_{Aeq, 15min}$ for neutral meteorological conditions.

Measures applicable during the design stage for management of noise sources include:

- undertaking equipment procurement with consideration of potential noise emissions, i.e. lower noise generating plant would be selected where feasible
- using stockpiles of aggregate and materials as screening for ground level noise sources between the concrete batching plant and nearest receptor locations
- enclosing or shrouding conveyor systems, in particular elevated sections
- minimising noise events through reducing drop heights from conveyors and loaders, and lining or enclosing conveyor back plates with absorptive material
- managing site entry and exit to limit the need for reversing
- regular maintenance would be undertaken on all plant and machinery used throughout the operation of the concrete batching plant
- minimising the number of valve release events and sourcing low noise valves.

7.2 General construction works

The construction noise impact assessment has identified a potential exceedance of construction noise criteria of 8-10 dB(A) L_{Aeq} for construction activities at the right hand abutment and at the subsidiary dam wall. A lower level of exceedance is predicted for cumulative construction work. This noise impact potential is consistent with short-term construction activities undertaken in proximity to existing residential receptors. Reductions in received noise levels would occur where the number or combination of plant modelled are not operating simultaneously.

In order to reduce peak received noise levels and achieve ENCM compliance at nearest receptors, all reasonable and feasible noise mitigation measures and construction work management practices are required. As a first step, construction plant and equipment noise level source data should be confirmed by the construction contractor as part of detailed construction planning. Where possible, lower noise generating plant should be used.

The following principles and proactive noise management measures are recommended prior to construction:

- Construction noise management measures be formulated as part of the development of the Noise and Vibration Management Sub-Plan. Noise control options, including site mitigation (such as enclosures or screening) and the investigation of low noise plant to be detailed in the plan and direction provided for the delivery of best practice noise management on site.
- Construction works to adopt best management practice and best available technology economically achievable as outlined in current acoustic guidelines. Best management practice includes some of the factors discussed within this report, but also includes encouraging a general staff attitude to reducing noise emissions. Contractors should be made aware of the problems associated with noise. Best available technologies economically achievable involves incorporating the most advanced and affordable technology to minimise noise emissions. All plant should be selected considering noise emissions.
- Due to the elevation of the receptors nearest to the proposed construction sites, screening and fencing is unlikely to have a measureable effect on received construction noise levels.
- Information should be provided to potentially affected local residents prior to commencement of construction works. Construction methods and the duration and timing of events should be outlined. Often with short-term construction works, the provision of information to potentially affected residents reduces the propensity for enquiry and complaint.
- Temporary and permanent construction sites to display appropriate signage, including Project information and relevant contact details for public information and enquiry.
- Standard construction noise mitigation techniques should be applied, as a minimum, to include the following measures:
 - Any excessively loud activities to be scheduled to avoid early morning periods when the daytime noise environment is likely to be most sensitive. This would reduce the potential for cumulative noise levels (relating to worst-case elevated operations).
 - Residential class mufflers, and where applicable, engine shrouds (acoustic lining) to be used. All equipment to be maintained in good order, including mufflers, enclosures and bearings to ensure unnecessary noise emissions are eliminated.
 - Construction works to be restricted to between 7 am and 6 pm Monday to Friday, and between 8 am and 1 pm Saturdays, with no works on Sundays or Public Holidays.
 - Construction activities to be undertaken in accordance with AS 2436-1981 Guide to Noise Control on Construction, Maintenance and Demolition Sites. All equipment used on site would be required to demonstrate compliance with the noise levels recommended within AS 2436-1981.
 - Engines not to be started and on-site activities (including entry or departure from the site) for heavy vehicles not to be undertaken outside of the specified construction hours unless for approved activities or contingency events.

- Appropriate use of all plant and equipment, with reasonable work practices applied, including no extended periods of 'revving', idling or 'warming up' in proximity to existing residential receivers.
- A speed limit of 50 kilometres per hour is proposed for heavy vehicles operating on the haul roads.
- Intensive works within the caravan park would be undertaken during the tourist 'low season' to minimise noise impact on users of the State Park.
- Minimising reversing alarm noise emissions from mobile plant and transport truck operations should be considered, provided occupational health and safety requirements are satisfied. The feasibility of installing reversing alarm systems such as smart alarms (ambient influenced) or broadband frequency alarms (reduced disturbance tone) should be investigated.
- Noise monitoring is recommended at locations within the Keepit Dam Reserve for the measurement of potential noise levels from construction and blasting. The provision of data will assist in the management and mitigation of potential noise levels and the programming of blasting events.
- The measurement of noise and vibration from blasting events should be undertaken adopting monitoring equipment and methodologies recommended in J3.2.1 of AS 2187.2.
- In the event of adverse community comment or complaint, the CEMP should outline procedures to determine the received level of noise level.

7.2.1 Consultation and negotiation with affected landowners

Predicted noise and vibration levels from construction activities were communicated to affected landowners by sending them a copy of a draft noise and vibration impact assessment report and telephone discussions on 4 and 5 June 2008. It is understood that the landowner of 1521 Bulga Road is keen to see construction commence. State Water are also in discussion with the owner of Residential Property A, who does not live full-time at the property, about the purchase of a portion of land.

Further consultation between State Water and these landowners would be undertaken to ensure an understanding of the works to be conducted, the mitigation procedures and measures applied and the residual noise and vibration levels. State Water intend to reach agreement with these parties regarding the residual noise and vibration levels prior to construction commencing.

7.3 Clay borrow pit

The construction works associated with the clay borrow pit are indicative of the intensive excavation works that may be required to meet demand for the construction of the earth dams.

Some attenuation of noise levels would be expected to occur during the excavation program where plant is operational below ground level or where excavated pit faces provide a barrier to the transmission of noise to nearest potentially affected receptors. Received noise levels may be reduced by up to 10 dB(A) depending on construction plant location, relative ground heights and intervening topography at the pit and the receptors.

7.4 Blasting noise and vibration

Adopting ANZECC guidance, the maximum overpressure noise level from blasting events is recommended to be less than 115 dB (Lin peak). A maximum received vibration level from blasting of 5 mm/s is also recommended.

The following measures should be incorporated to manage noise and vibration from blasting at the nearest potentially affected receptors:

- A maximum charge mass of 350 kilograms is recommended to achieve compliance with the airblast overpressure and vibration criteria at the nearest sensitive receptors.
- A maximum charge mass of 250 kilograms is recommended to achieve compliance with noise and vibration criteria at the State Water offices.
- A maximum charge mass of 1250 kilograms is allowable in relation to the limiting blasting vibration criteria of 50 mm/s at the main dam wall. This criterion should be checked by a competent person prior to blasting commencing.
- Unconfined blasting should be avoided, where feasible.
- Blasting design should incorporate appropriate delays and accommodate alternative charge drilling patterns to reduce received levels.
- Delaying blast events during noise enhancing wind conditions should be considered, wind speed and temperature inversion effects should be accounted for in potential received levels.
- Blast faces should be orientated to, where feasible, not face directly towards receptor locations.
- Blasting face heights should be kept to a practical minimum.

8. Conclusion

A noise and vibration impact assessment has been undertaken for the construction of the proposed Keepit Dam upgrade.

Potential noise and vibration impacts have been identified from the associated construction works, including blasting and the operation of an on-site concrete batching plant and aggregate crusher.

A noise design criteria of 35 dB(A) $L_{Aeq, 15min}$ has been adopted for all construction works.

8.1 Concrete batching plant and aggregate crusher

Predicted received noise levels from the concrete batching plant and aggregate crusher have been predicted to be compliant at the nearest potentially affected receptors.

The separation distances and intervening topography between the concrete batching plant and the receptors are sufficient to result in received noise levels at all other receptors to comply with the adopted noise design criteria.

8.2 General construction works

Received noise levels from the subsidiary dam wall construction works are predicted to potentially exceed the adopted 35 dB(A) $L_{Aeq, 15min}$ noise criteria at Residential Property A. Maximum noise levels of 43 - 45 dB(A) $L_{Aeq, 15min}$ are predicted, which represent potential exceedance by up to 10 dB(A) L_{Aeq} .

For the main dam wall works, a potential 0.5 dB(A) $L_{Aeq, 15min}$ exceedance of the noise goal has been predicted at 1521 Bulga Road.

For all other construction works, individual received noise levels for the nearest potentially affected receptors are within the adopted noise criteria.

Scenarios for feasible cumulative construction activity and concrete batching, aggregate crusher and clay borrow pit works were applied for the determination of peak worst-case cumulative noise levels at the nearest receptors.

At 1521 Bulga Road, a 1 - 2.5 dB(A) potential peak exceedance of the adopted noise goal has been predicted where concrete batching and aggregate crusher operations are cumulative with the right hand abutment and main dam wall works phases.

Potential peak received cumulative noise levels at the State Water office and the Caravan Park has been predicted in exceedance of the adopted noise goal. Construction works within the Caravan Park will be undertaken during the tourist low season when the park is unoccupied.

Indicative of dominant construction works, intervening separation distances and topography, potential cumulative influence from concrete batching or clay borrow pit operations have been determined to result in no additional influence to received construction noise levels at all other receptors.

A range of noise management and mitigation measures are proposed (see Chapter 7), designed to reduce received noise levels from construction works, where the desired outcome is to achieve compliance with the adopted noise criteria. State Water intend to seek an agreement with the landowners of properties where the residual noise and vibration levels are predicted to exceed the adopted noise and vibration criteria.

Given the separation distances from the construction works sites and the concrete batching plant and the nearest potentially affected receptors, source vibration emissions are not expected to result in received ground vibration levels in exceedance of annoyance or structural criteria.

8.3 Clay borrow pit

Received noise levels from the excavation works undertaken at the clay borrow pit are predicted to be compliant for an indicative worst-case scenario of all feasible plant operating.

8.4 Blasting noise and vibration

Blasting is required at the right hand abutment and peninsula reshaping area, at a frequency of one to two blast events per day.

Predictive assessment of potential airblast overpressure noise and ground vibration has been undertaken adopting AS 2187.2 guidance. ANZECC guidance has been applied in determining a blasting noise criteria of 115 dB(Lin peak) and a vibration criteria of 5 mm/s.

Adopting separation distances between the blasting location and nearest potentially affected receptors, a maximum blasting charge mass of 350 kilograms has been recommended to achieve compliance with both the adopted noise and vibration criteria at nearest residential receptor locations.

To achieve compliance with noise and vibration criteria at the State Water offices a maximum mass charge of 250 kilograms is recommended.

A range of measures have been proposed for consideration during the blasting events to reduce potential received noise and vibration levels.

8.5 Road traffic noise

A conservative assessment of potential received noise levels from truck movements associated with the construction works has been undertaken adopting potential peak daily traffic movements on construction routes at the nearest receptor locations 1521 Bulga Road, Residential Receptor A and the Caravan Park.

Received noise levels have been predicted to be compliant with adopted ECTRN base criteria of 55 dB(A) $L_{Aeq, 1hr}$ daytime.

9. References

AS 2436-1981 *Guide to Noise Control on Construction, Maintenance and Demolition Sites*

AS 2187.2 – 2006 *Explosives – Storage and Use Part 2: Use of explosives*

ANZECC *Technical Basis for Guidelines to Minimise Annoyance Due to Blasting Overpressure and Ground Vibration*

DIN 4150-3 1999 *Structural Vibration Part 3 Effects of Vibration on Structures*

NSW DEC Environmental Noise Management Assessing Vibration: a technical guideline (2006)

NSW EPA *Environmental Noise Control Manual* (1994)

NSW EPA *Industrial Noise Policy* (2000)

10. Limitations

Scope of services and reliance of data

This noise impact study ('the study') has been prepared in accordance with the scope of work/services set out in the contract, or as otherwise agreed, between Parsons Brinckerhoff (PB) and the Client. In preparing this noise impact study, PB has relied upon data, surveys, analyses, designs, plans and other information provided by the Client and other individuals and organisations, most of which are referred to in the noise impact study ('the data'). Except as otherwise stated in the noise impact study, PB has not verified the accuracy or completeness of the data. To the extent that the statements, opinions, facts, information, conclusions and/or recommendations in this noise impact study ('conclusions') are based in whole or part on the data, those conclusions are contingent upon the accuracy and completeness of the data. PB will not be liable in relation to incorrect conclusions should any data, information or condition be incorrect or have been concealed, withheld, misrepresented or otherwise not fully disclosed to PB.

Study for benefit of client

This noise impact study has been prepared for the exclusive benefit of the Client and no other party. PB assumes no responsibility and will not be liable to any other person or organisation for or in relation to any matter dealt with in this noise impact study, or for any loss or damage suffered by any other person or organisation arising from matters dealt with or conclusions expressed in this noise impact study (including without limitation matters arising from any negligent act or omission of PB or for any loss or damage suffered by any other party relying upon the matters dealt with or conclusions expressed in this noise impact study). Other parties should not rely upon the noise impact study or the accuracy or completeness of any conclusions and should make their own inquiries and obtain independent advice in relation to such matters.

Other limitations

To the best of PB's knowledge, the proposal presented and the facts and matters described in this noise impact study reasonably represent the Client's intentions at the time of printing of the noise impact study. However, the passage of time, the manifestation of latent conditions or the impact of future events (including a change in applicable law) may have resulted in a variation of the Proposal and of its possible noise impact.

PB will not be liable to update or revise the noise impact study to take into account any events or emergent circumstances or facts occurring or becoming apparent after the date of the noise impact study

Attachment A

Predicted construction noise
impacts

Table A-1 Construction noise impacts

Location	Construction phase (neutral met conditions)		
	Ground preparation $L_{Aeq, 15min}$	Excavation $L_{Aeq, 15min}$	Infrastructure works $L_{Aeq, 15min}$
Noise design criteria 35 $L_{Aeq, 15min}$			
Receptor: 1512 Bulga Road			
RH Abutment Spillway	32.5	25.5	31
Saddle Dams	31.5	28	26
Subsidiary Dam Wall	22	16.5	16.5
Cumulative works	35	30	32.5
Main Dam Wall	44	38	36.5
Receptor: Illawong			
RH Abutment Spillway	24	21	20
Saddle Dams	23	16.5	16
Subsidiary Dam Wall	19.5	14	14
Cumulative works	27.5	23	22
Main Dam Wall	31	24	25
Receptor: Mostyn Vale			
RH Abutment Spillway	27.5	25	24
Saddle Dams	20	13.5	13
Subsidiary Dam Wall	21.5	15.5	15.5
Cumulative works	29	25.5	25
Main Dam Wall	29.5	23.5	21.5
Receptor: Residential Property A			
RH Abutment Spillway	19	17	16
Saddle Dams	10.5	-	-
Subsidiary Dam Wall	43	37.5	37.5
Cumulative works	43	37.5	37.5
Main Dam Wall	22	15	13.5
Receptor: Sorrento			
RH Abutment Spillway	10	-	-

Saddle Dams	-	-	-
Subsidiary Dam Wall	23.5	17.5	17.5
Cumulative works	23.5	17.5	18
Main Dam Wall	18.5	11.5	10

Note: All noise levels in dB(A) to the nearest 0.5 dB.

Noise levels under 10 dB(A) have not been reported and considered unlikely to influence local noise environments at the receptors.

Table A-2 Predicted construction noise impacts inclusive of concrete batching plant and clay borrow pit works

Location	Construction phase (neutral met conditions)		
	Ground preparation	Excavation	Infrastructure works
	noise impact $L_{Aeq, 15min}$	noise impact $L_{Aeq, 15min}$	noise impact $L_{Aeq, 15min}$
Noise design criteria 35 $L_{Aeq, 15min}$			
Receptor: 1512 Bulga Road			
RH Abutment Spillway	39	39	39
Saddle Dams	40	39	39.5
Subsidiary Dam Wall	37	36	36
Cumulative works	43.5	43	42.5
Main Dam Wall	47	47	47
Receptor: Illawong			
RH Abutment Spillway	26.5	28	26.5
Saddle Dams	28	28	24.5
Subsidiary Dam Wall	26.5	26.5	21.5
Cumulative works	32	32.5	29.5
Main Dam Wall	37.5	37.5	30.5
Receptor: Mostyn Vale			
RH Abutment Spillway	32.5	31.5	28.5
Saddle Dams	23.5	23.5	22.5
Subsidiary Dam Wall	31.5	23.5	22.5
Cumulative works	35.5	32.5	30.5
Main Dam Wall	32	32	27.5

Receptor: Residential Property A

RH Abutment Spillway	24	24	21
Saddle Dams	16	16	13
Subsidiary Dam Wall	38	38	41
Cumulative works	38	38	41
Main Dam Wall	23.5	23.5	19.5

Receptor: Sorrento

RH Abutment Spillway	15	15	-
Saddle Dams	-	-	-
Subsidiary Dam Wall	28.5	28.5	21.5
Cumulative works	28.5	28.5	21.5
Main Dam Wall	19	19	15.5

Note: All noise levels in dB(A) to the nearest 0.5 dB.

Noise levels under 10 dB(A) have not been reported and considered unlikely to influence local noise environments at the receptors.

Attachment B

Sample SoundPLAN output file

Table B-1 Sample SoundPLAN output file

Source	SrcType	Lw	Lw'	KI	KT	Ko	s	Adiv	Agr	Amisc	Abar	Aatm	DI	Re	Ls	LD	LN
		dB(A)	dB(A)	dB	dB	dB	m	dB	dB	dB	dB	dB	dB	dB(A)	dB(A)	dB(A)	dB(A)
Name 1512 Bulga Road																	
Batching Loader	Point	107	107	0	5	0	860.53	69.7	5.2		0.5	4.3	0		32.3	32.3	32.3
RH Abutment Rock breaker /	Point	120.2	120.2	0	0	0	747.75	68.5	5.5		13.8	0.9	0		31.5	31.5	31.5
Clay Quarry Bulldozer	Point	114.3	114.3	0	5	0	1543.8	74.8	5.7		13.7	2.9	0		22.2	22.2	22.2
RH Abutment Loader	Point	107	107	0	5	0	738.34	68.4	5		15.3	1.2	0		22.2	22.2	22.2
RH Abutment Bulldozer	Point	114.3	114.3	0	0	0	730.3	68.3	4.5		18.8	2.7	0		20	20	20
RH Abutment Compactor	Point	115.6	115.6	0	0	0	754.34	68.5	4		20	4.5	0		18.6	18.6	18.6
Clay Quarry Dump Truck 4	Point	107.6	107.6	0	5	0	1548.2	74.8	5.7		9.8	4.1	0		18.3	18.3	18.3
Clay Quarry Dump Truck 2	Point	107.6	107.6	0	5	0	1557.3	74.8	5.7		9.7	4.1	0		18.2	18.2	18.2
Clay Quarry Truck 1	Point	107.6	107.6	0	5	0	1547.6	74.8	5.7		10.8	3.7	0		17.6	17.6	17.6
RH Abutment Backhoe	Point	113.1	113.1	0	0	0	730.55	68.3	4.5		19.4	3.5	0		17.4	17.4	17.4
Clay Quarry Loader 2	Point	107	107	0	5	0	1536.9	74.7	6		11.6	2.9	0		16.8	16.8	16.8
Clay Quarry Dump Truck 3	Point	107.6	107.6	0	5	0	1553.6	74.8	5.7		13	3.2	0		15.9	15.9	15.9
Clay Quarry Loader	Point	107	107	0	5	0	1538.3	74.7	6		12.9	2.6	0		15.7	15.7	15.7
Clay Quarry Excavator 2	Point	105	105	0	5	0	1555.1	74.8	6		10.3	4.2	0		14.7	14.7	14.7
RH Abutment Excavator	Point	105	105	0	0	0	747.51	68.5	5		15.4	1.7	0		14.4	14.4	14.4
Clay Quarry Excavator 3	Point	105	105	0	5	0	1547.3	74.8	6		10.9	4	0		14.3	14.3	14.3
RH Abutment Dump truck	Point	107.6	107.6	0	0	0	738.28	68.4	4.6		18.3	2.4	0		14	14	14
RH Abutment Grader	Point	107.6	107.6	0	0	0	756.5	68.6	4.2		17.6	3.4	0		13.8	13.8	13.8
Clay Quarry Excavator 1	Point	105	105	0	5	0	1552.2	74.8	6		13.5	3.5	0		12.2	12.2	12.2
Batching Slump Stand 2	Point	89.2	89.2	0	5	0	853.57	69.6	3.6		0	8.9	0		12	12	12
Batching Slump Stand	Point	89.2	89.2	0	5	0	857.27	69.7	3.6		0	8.9	0		12	12	12
Batching Conveyor 2	Point	84.1	84.1	0	5	0	849.07	69.6	1.3		0	9.5	0		8.7	8.7	8.7
Batching Conveyor	Point	84.1	84.1	0	5	0	852.63	69.6	1.3		0	9.6	0		8.6	8.6	8.6
Batching Valve 2	Point	86.5	86.5	0	5	0	843.97	69.5	1		0	15	0		5.9	5.9	5.9
Batching Valve 1	Point	86.5	86.5	0	5	0	848.47	69.6	1		0	15.1	0		5.8	5.8	5.8
RH Abutment Vibratory roller	Point	99.4	99.4	0	0	0	739.8	68.4	7.5		16.1	1.7	0		5.7	5.7	5.7
Batching Loading Bay	Point	95.9	95.9	0	0	0	863.53	69.7	4		16.7	5.1	0		0.4	0.4	0.4

Attachment C

Meteorological analysis

Noise enhancing wind conditions

The NSW INP has been referenced in relation to assessing meteorological conditions in potential noise impacts. The Policy states:

“Wind effects need to be assessed where wind is a feature of the area. Wind is considered to be a feature where source-to-receiver wind speeds (at a 10m height) of 3m/s or below occur for 30 percent of the time or more in any assessment period (day, evening, night) in any season.”

An analysis of regional wind enhancing noise conditions was undertaken as part of this assessment. This included an assessment of all hours of recorded wind flow patterns. The detailed assessment of noise enhancing meteorological conditions was based on wind speed data obtained for the Tamworth (2001) Bureau of Meteorology data set. The data were separated into the four seasons and then into the day time assessment period.

The data has been tabulated for wind speeds of between 0.1 – 3 m/s and detailed below.

Percentage occurrence of 0.1 – 3 m/s wind frequencies (values expressed as %)				
Direction (Blowing From)	Summer Day	Autumn Day	Winter Day	Spring Day
N (337.5° - 22.5°)	3.5	6	8	5
NE (22.5° - 67.5°)	1.5	2	3	2
E (67.5° - 112.5°)	2	4	3.5	2.5
SE (112.5° - 157.5°)	3	6	6.5	3
S (157.5° - 202.5°)	3.5	4	6	2.5
SW (202.5° - 247.5°)	2	2	2.5	1.5
W (247.5° - 292.5°)	0.5	2	3	0.5
NW (292.5° - 337.5°)	2	2	3	1

Review of the above data indicates that there are no gradient or drainage wind flow regime present for more than 30% of the time (on consideration of both directional and vector some wind patterns).

Noise enhancing wind conditions require no further consideration.

Attachment D

Calibration certificates

Sound Level Meter Test Report

Report Number : 07146.doc

Date of Test : 15/05/2007

Report Issue Date : 16/05/2007

Equipment Tested: ARL Noise Logger

Model Number: EL-316

Serial Number: 16-207-008

Client Name : Parsons Brinckerhoff

Ernst & Young Centre, Level 27, 680 George St

Sydney NSW 2000

Contact Name : Shane Harris

Tested by : Morgan Rae

Approved Signatory :



Ken Williams

Date : 16th May 2007.



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Sound Level Meter Test Report

Report Number : 07235

Date of Test : 26/06/2007

Report Issue Date : 03/07/2007

Equipment Tested: **Rion Sound Level Metre**

Model Number: NA-27

Serial Number: 10552408

Client Name : Parsons Brinckerhoff

Level 27; Ernst & Young Centre; 680 George Street

Sydney NSW 2000

Contact Name : Shane Harris

Tested by : Morgan Rae

Approved Signatory :



Ken Williams

Date : 3rd July 2007

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