Harbour Control Tower, Barangaroo

Deconstruction Works Noise and Vibration Assessment

SYDNEY
A: 9 Sarah St Mascot NSW 2020
T: (02) 8339 8000
F: (02) 8338 8399

SYDNEY MELBOURNE BRISBANE CANBERRA
LONDON DUBAI SINGAPORE GREECE

www.acousticlogic.com.au
ABN: 11 068 954 343

DOCUMENT CONTROL REGISTER

Project Number	20160184.1
Project Name	Harbour Control Tower, Barangaroo
Document Title	Deconstruction Works Noise and Vibration Assessment
Document Reference	20160184.1/1502A/R1/YK
Issue Type	Email
Attention To	Liberty Industrial Mr Michael Muller

Revision	Date	Document Reference	Prepared By	Checked By	Approved By
0	15/02/2016	20160184.1/1502A/R0/YK	YK		VF
1	23/02/2016	20160184.1/1502A/R1/YK	YK		VF

TABLE OF CONTENTS

1 EXECUTIVE SUMMARY

Noise and vibration impacts arising from the proposed deconstruction of the Sydney Harbour Control Tower at Barangaroo Reserve have been assessed.

Noise and vibration levels arising from the proposed works have been predicted at the surrounding receivers. The NSW Environment Protection Authority's (EPA) Interim Construction Noise Guideline (ICNG) and other relevant standards have been used to establish noise and vibration management levels for receivers located around the site. The predicted levels have been assessed in against these management levels.

This assessment has identified the receivers potentially impacted by the proposal (amenity and risk damage to structures), and the demolition activities producing these impacts, so that these impacts can be appropriately addressed and managed.

The assessment indicates that:

- Noise impacts will primarily be limited to the residential properties located along Merriman and Bettington Streets. Noise Management Level exceedances at these residences are predicted to occur during all stages of the program. However, exceedance of the Highly Noise Affected Management Level is only predicted from the mobile crane operations along Merriman Street (during the preparatory works stage and intermittently during phase 1 of deconstruction stage).

  If hammering operations are required for the demolition of the tower (as a result of the pulverisers unable to crush concrete), this operation will also result in exceedance of the NML at the residences along Dalgety Road, Hickson Road and Towns Place in addition to Merriman and Bettington Streets. However, exceedance of the HANML from the hammering operations are only predicted for the residential receivers along Merriman Street.

- Ground vibration generated by the proposed activities would not impact nearby railway infrastructure, and are unlikely to impact nearby residential or commercial buildings. Notwithstanding, recommendations are made to safeguard existing residences along Merriman Street due to hammering operations both proposed (for the removal of tower footing) and contingent (for demolition of the tower if pulveriser operations are unable to crush concrete).

A Preliminary Noise and Vibration Management Plan (NVMP) has been devised that will be developed and used by Liberty Industrial to manage the identified impacts. The plan outlines the development of controls and safeguards that would be applied to all activity proposed on site. The objective of these controls is to ensure that all work is carried out in a highly controlled and predictable manner that will minimise emissions and protect the amenity of the sensitive receivers surrounding the site.

The preliminary NVMP is based on a conceptual demolition strategy. The plan will need to be developed by Liberty Industrial into a project NVMP, to address the selected strategy. It would specifically identify the controls and safeguards to be applied to the works to minimise noise and vibration impacts in line with the objectives of the plan. Further reviews of the project NVMP would be undertaken through the demolition period as required, in response to revised

methods and equipment, as well as in response to the monitoring and evaluation of actual impacts.

The NVMP describes the ongoing noise and vibration monitoring that would be carried out to record and verify the noise and vibration levels being achieved at sensitive receiver locations.

The processes adopted in the plan will minimise noise and vibration emissions to meet the overall objectives of ICNG, minimising and ameliorating any impacts caused by these activities to the extent that it is feasible and reasonable.

2 INTRODUCTION

This document presents a noise and vibration assessment of the activities that are likely to occur during the deconstruction of the Sydney Harbour Control Tower (HCT), and the management plan that will be used to manage this demolition related noise and vibration.

3 PROJECT DESCRIPTION

The Sydney Harbour Control Tower is located on the eastern edge of the recently developed Barangaroo Reserve and is bounded by Merriman Street to the east and Clyne Reserve to the North. The 87m high concrete and steel tower ceased operation in 2011, following the relocation of the Sydney Ports Communication Centre to Port Botany. The tower consists of a reinforced concrete column (incorporating an internal lift and stair) with a steel and glass observation deck and operations centre.

As part of the Headland Park and Northern Cove development works, it was proposed to modify the main works consent to include the demolition of the HCT. Following approval last year, it is proposed to commence deconstruction works towards the end of March 2016, extending over an approximate 29 week period.

A number of demolition methodologies have been considered based on the location and height of the HCT, proximity to public infrastructure and existing properties. These include:

- Induced Collapse.
- Structural demolition.
- Structural dismantling.

The induced collapse option is not possible due to the constraints imposed by the adjoining boundaries to public and private properties, preventing an adequate exclusion zone (at least one and a half times the height of structure). Of the remaining methodologies, the structural dismantling option will result in the lowest number of demolished elements, minimising the overall risk exposure to surrounding community, number of exclusion zones and noise impacts to surrounding receivers, and hence is the preferred option.

The methodology proposed by Liberty Industrial involves the use of robot pulverisers in conjunction with a mast climbing work platform to dismantle the HCT in stages, starting from the top. This methodology negates the use of noisy tower cranes at a constant and also concrete cutting tools. The staged methodology is detailed below;

- Stage 1 – Site Establishment – this includes establishment of hoarding, fencing, isolation zones, site facilities and loading locations.

- Stage 2 – Preparation Works – this includes all works required for the installation of the XL platform and Alimak hoist, followed by the installation.

- Stage 3 – Deconstruction of Main Tower and Roof – this stage is proposed to occur over three phases:

    - Phase 1 – Top slab/deck and Roof Removal – this will include internal stripout of the three work levels, removal of roof structure, glazed elements and any other external cladding to the top slab level.

    - Phase 2 – Demolition of remainder of slab – this will include removal of the remainder of the façade materials on the lower level slab, followed by the demolition of the slab to the top of the concrete core.

    - Phase 3 – Demolition of main slab and concrete core – this will include demolition of the main slab and beams, followed by demolition of the tower core to the basement level of the cultural space.

- Stage 4 – Removal of the Core Footing – this will include cracking the base slab using PCF charges followed by the demolition and removal of rubble.

A brief description of the works proposed during each stage is detailed below. Refer to *Harbour Control Tower – General Methodology* Work Method Statement (WMS) document prepared by Liberty Industrial (revision 00, dated 2 November 2015), for a detailed description of the proposed works.

Stage 1 – Site Establishment

- Establish hoarding, fencing and isolation zones. Figure 1 below illustrates the general area of the site requiring fencing and footpath closures.

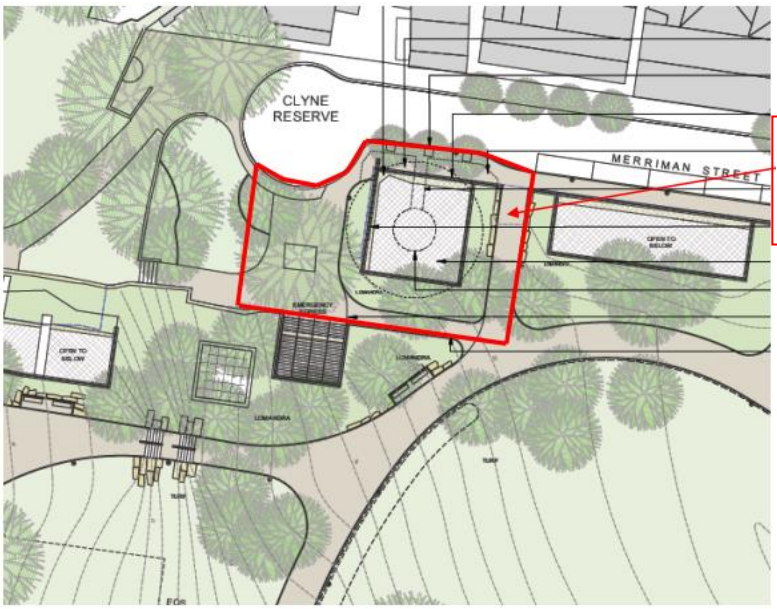


Figure 1 – Proposed Works Area

- The works area will extend into the basement of the Cultural Space. This area will be cordoned off from the cultural space using a full height (floor to slab) dust proof enclosure.
- The site amenities (toilets and lunchrooms) will be positioned in the basement opposite the works area.

<u>Stage 2 – Preparation Works</u>

- Preparation works to facilitate the installation of the platform system, which will include;
    - Demolition of the plant and pump rooms located in the basement of the cultural space, adjoining the tower structure.
    - Removal of the lift car from the structure.
    - Construction of a chute and materials handling area at the base of the tower.
- Installation of the XL Platform System and Alimak Hoist, which will include;
    - Installation of support beams and scaffolding at Merriman Street level, beams bolted to the concrete core.
    - Mobile cranes working on Merriman Street.
    - Erection of the XL Platform system.
    - Erection and installation of the Alimak hoist.
    - Installation of scaffold access stairs from the basement to the Alimak hoist for worker access.

- Installation of lightweight perimeter scaffolding onto the platform to assist in the removal of the roof, glazing panels and façade.

Stage 3 – Deconstruction of Main Tower and Roof

At the completion of the installation activities, the XL Platform system will be motorised to the top of the structure and placed into position (access to the platform from then on will only be via the Alimak hoist).

Phase 1 – Top slab/deck and Roof Removal

- Internal stripout of all three working levels. All materials will be removed via the Alimak, lowered to the basement works area and removed off site via tipper trucks.
- Removal of the roof by cutting and lowering manageable sections, able to be handheld by men.
- Mobile cranes may be used to lower some section of the roof and glazing, positioned along Merriman Street.
- Demolition of the lift motor room and slab using 2 x Brokk 180 excavators.

Phase 2 – Demolition of remainder of slab

- Removal of the scaffold structure on top of the deck, with the platform lowered to the next level of works.
- Demolition of remainder of slab using 2 x Brokk 180 excavators. The excavators will be located on the slab and demolish the concrete allowing the rubble to fall to the level below. The rubble will then be placed into the lift shaft as demolition progresses.
- The platform will be lowered as required to facilitate the façade removal activities.

Phase 3 – Demolition of main slab and concrete core

- Demolition of the main slab and beams using 2 x Brokk 180 excavators working from the platform deck.
- This will be followed by the progressive demolition of the main tower core in a systematic manner, working half of the tower each.
- Removal of the Alimak hoist when demolition works reach Merriman Street.
- Demolition of the remainder of core into the basement level, to the core footings.

Stage 4 – Removal of the Core Footing

- Dismantle and removal of the platform.
- Demolition of the core footing using the following techniques;
    - Drilling holes in the slab using a tracked mounted drill rig.

- Packing holes with PFC charges to fracture the slab.
- Demolition and removal of fractured slab using 20 -30t excavator with a hammer attachment.

- Removal of all hoarding, fences, site sheds and plant. Preparation works for concrete slab reinstatement.

3.1 TRAFFIC GENERATION ON LOCAL ROADS

All traffic associated with the deconstruction works (passenger and heavy vehicles) will only access the main works area located within the basement cultural centre space. Access to the basement cultural centre space is via the loading dock entrance at the end of Towns Place. Some truck movements may occur on Merriman Street during the site establishment and preparation stages, however these will only be a one off for material drop/delivery.

A minimal number of vehicle movements (passenger and heavy vehicles) are expected to be produced by the deconstruction activities due to the nature of the proposed works. It is expected that the average number of heavy vehicles would be less than 3 per day (with a maximum of 5 movements expected during roof demolition stage). Additionally, 5 staff/delivery/service vehicles are expected per day with 2 traffic controls vehicles. This will result in peak generation of approximately 10 per day and average of 8 per day.

3.2 SURROUNDING RECEIVERS

A site survey was conducted by this office, to identify the potentially nearest affected receivers. They are as follows:

- Residential properties along Merriman and Bettington Streets
- Residential properties along Dalgety & Hickson Roads and Towns Place
- Residential properties along High Street
- Residential properties on Balmain Peninsula
- Residential and commercial properties (including outdoor seating areas of cafés & restaurants) along Argyle Place
- Residential and commercial properties along Windmill Street
- Port Authority of New South Wales

Figure 2 below illustrates location of the general site area and surrounding affected receivers.

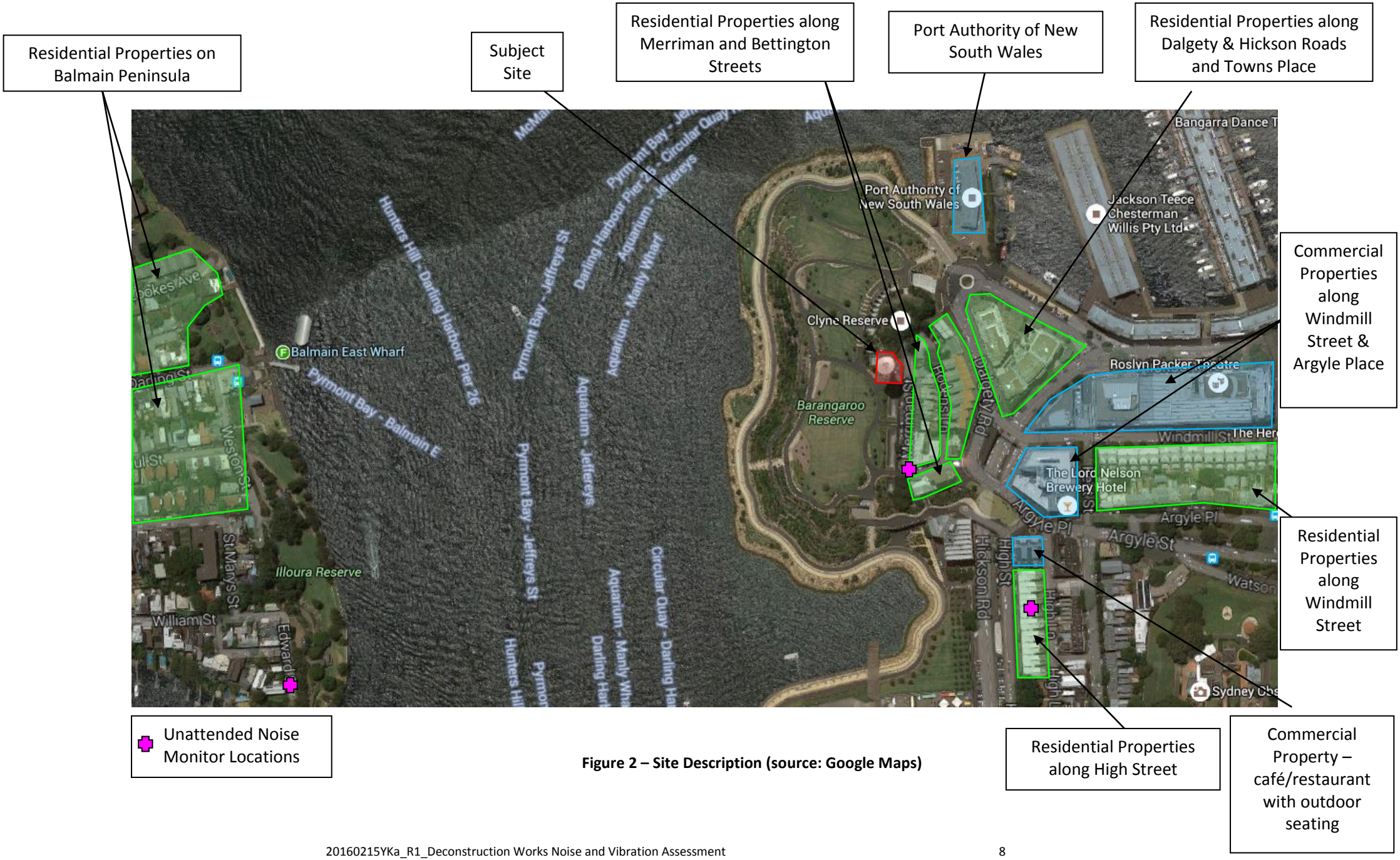


Figure 2 – Site Description (source: Google Maps)

4 HOURS OF WORK

Clause 2 of Condition B22 of the *Barangaroo Headland Park and Northern Cove – Main Works* approval (application no: 10_0048) outlines the following approved hours for construction:

All construction work at the premises must be conducted between 7am and 6pm Monday to Friday and between 8am and 3pm Saturdays and at no time on Sundays and public holidays, unless inaudible at any residential premises. Works outside these hours are not permitted except as explicitly specified below or in other conditions and include:

(a) the delivery of materials which is required outside these hours as requested by Police or other authorities for safety reasons;

(b) emergency work to avoid the loss of lives, damage to property and/or to prevent environmental harm;

(c) other works expressly approved by the Director General of the Department of Planning;

(d) Out of standard hours works identified in a CNVMP approved by the Director General of the Department of Planning.

It is proposed to extend the approved hours of work on Saturdays from 8am – 3pm to 8am – 5pm, in line with the category 1 (regarded as standard hours) hours of construction outlined in the City of Sidney Council's "*Construction Hours/Noise within the Central Business District Code of Practice (1992)*" document. Please refer to section 4.1 below.

5 NOISE AND VIBRATION GOALS

Noise and vibration requirements in the existing approval for the Main Works (application no: 10_0048) have been attached in Appendix 1. Broadly they require compliance with:

- Compliance with NSW EPA Interim Construction Noise Guideline;
- Compliance with NSW EPA *Assessing Vibration – a technical guideline*; and
- Liberty Industrial to develop a detailed Noise and Vibration Management Plan (NVMP).

5.1 NOISE MANAGEMENT GUIDELINES AND STANDARDS

The applicable guidelines and standards are:

- *NSW EPA Interim Construction Noise Guideline* – This guideline nominates a methodology for assessing and managing construction noise (and vibration) impacts.

  A quantitative assessment is undertaken involving the prediction of likely noise levels from activities at sensitive receivers, and these noise levels are compared to noise management goals. This process identifies the processes causing emissions that may exceed the goals, so that feasible and reasonable management of those processes can be assessed and implemented to these processes.

- *Australian Standard 2436-1981 "Guide to Noise Control on Construction Maintenance and Demolition Site*" – In particular, the requirements stipulated in Section 3 of the standard will be followed.

  Section 3 of AS 2436 states that care shall be taken in applying criteria that normally would be used to regulate noise emitted from industrial, commercial and residential premises to construction, particularly for those activities which are transitory and of short duration.

  For the control and regulation of noise from construction sites AS2436 nominates the following:

  - That reasonable suitable noise criterion is established.
  - That all practicable measures be taken on the building site to regulate noise emissions, including the siting of noisy static processes on parts of the site where they can be shielded, selecting less noisy processes, and if required regulating construction hours.
  - The undertaking of noise monitoring where non-compliance occurs to assist in the management and control of noise emission from the building site.

- The City of Sydney council also has a comprehensive code for the regulation of noise emissions from construction sites "*Construction Hours/Noise within the Central Business District Code of Practice (1992)*". This code divides the week into different categories corresponding to different times. Category 1 is regarded as standard hours, up to Category 4 hours which covers the most sensitive periods. Different noise assessment goals apply for the different categories:

- Category 1 - Monday to Friday 7am to 7pm and Saturday 8am to 5pm – Background + 5 dB(A) + 5 dB(A) (10dB(A) total). The extra 5 dB(A) is applied on a case by case basis and is usually included unless there is a specific noise sensitive occupancy impacted.

- Category 2 - Monday to Friday 7pm to 11pm and Saturday 5pm to 11pm – Background + 5 dB(A).

- Category 3 – Sundays and Public Holidays 7am to 5pm – Background + 3 dB(A).

- Category 4 – All other times– Background + 0 dB(A)

In assessing the methodologies in these documents, for "normal" construction hours:

- All the standards indicated above adopt a broadly similar approach – construction noise emissions should be managed to meet established management goals where feasible and reasonable.

- For residential receivers, EPA, City of Sydney and the demolition approval all adopt a general noise management goal based on a 10 dB(A) exceedance of the background noise level for the bulk of the proposed demolition times. City of Sydney adopts a more stringent goal between 7am and 8am Monday to Friday and Saturdays, which are outside the approved hours of work.

- For commercial receivers, the EPA guideline adopts an external or internal amenity goal (independent of background noise level), whereas the City of Sydney and the previous demolition approval use a background + 10 dB(A) approach, as for residential receivers.

- Additionally, it is proposed to extend the approved hours of work on Saturdays from 8am – 3pm to 8am – 5pm. This period falls with the category 1 designation of the City of Sydney council's code of practice and nominates a management level of background + 10 dB(A).

The EPA guideline will be used to set management goals for the project. However, the other guideline documents will also be used where there are project specific situations/receiver types that are not specifically defined in the EPA guideline.

The following procedure will be used to assess noise emissions (based on these guidelines):

- Predict noise levels produced by the proposed deconstruction activities at the sensitive receivers.

- Define a "Noise Affected" Management" level for each receiver type using the methodology outlined in the EPA ICNG. Where there are not specific recommendations in the ICNG, or where these are not seen as appropriate, use other guideline documents to determine an appropriate management level.

- Where levels exceed "Noise Affected Management Level" (NAML), investigate and implement all reasonable and feasible techniques to limit noise emissions.

- For residential receivers, if noise levels exceed EPA "Highly Noise Affected" Management Level (75dB(A)) after applying all practical engineering controls to limit noise emissions investigate time management and other techniques to further mitigate noise emissions.

5.2 VIBRATION MANAGEMENT GUIDELINES AND STANDARDS

The following vibration guidelines have been adopted to assess vibration impacts:

- German Standard DIN 4150-3 (1999-02): "*Structural Vibration – Effects of Vibration on Structures*" – which will be used to assess and limit building damage risk.

- EPA Interim Construction Noise Guideline – which contains guidelines to assess and limit impacts on building occupant's amenity based on the "Assessing Vibration: A Technical Guide".

The criteria and the application of these guidelines/standards are discussed in separate sections below.

5.2.1 Structure Damage

German Standard DIN 4150-3 (1999-02) provides vibration velocity guideline levels for use in evaluating the effects of vibration on structures. The criteria presented in DIN 4150-3 (1999-02) are presented in the table below.

It is noted that the peak velocity is the absolute value of the maximum of any of the three orthogonal component particle velocities as measured at the foundation, and the maximum levels measured in the x- and y-horizontal directions in the plane of the floor of the uppermost storey.

Table 1 - DIN 4150-3 (1999-02) Safe Limits for Building Vibration

	TYPE OF STRUCTURE	PEAK PARTICLE VELOCITY (mms^{-1})			
		At Foundation at a Frequency of			Plane of Floor of Uppermost Storey
		< 10Hz	10Hz to 50Hz	50Hz to 100Hz	All Frequencies
1	Buildings used in commercial purposes, industrial buildings and buildings of similar design	20	20 to 40	40 to 50	40
2	Dwellings and buildings of similar design and/or use	5	5 to 15	15 to 20	15
3	Structures that because of their particular sensitivity to vibration, do not correspond to those listed in Lines 1 or 2 and have intrinsic value (e.g. buildings that are under a preservation order)	3	3 to 8	8 to 10	8

5.2.2 Assessing Amenity (Human Comfort)

For the type of vibration producing activities proposed (excavator hydraulic hammer and drilling for the crane base) vibration induced within the occupied levels of the adjacent residential properties along Merriman Street, is likely to impact amenity well before the structural damage limits are reached.

The NSW Environment Protection Authority's (EPA) publication "*Assessing Vibration: A Technical Guideline*" (Feb 2006), outlines vibration criteria to assess the effects on human exposure to vibration from industry, transportation and machinery. This will ensure the amenity of occupants within surrounding residential properties is not adversely impacted.

This document classifies vibrations in buildings into continuous (with magnitudes varying or remaining constant with time), impulsive (such as shocks) or intermittent (with the magnitude of each event being either constant or varying with time). Criteria stipulated in this publication is based on the type of vibrations generated by the source.

Criteria relevant to the proposed excavation and construction activities on site are detailed below.

Table 2 – EPA Recommended Human Comfort Vibration Criteria

		RMS acceleration (m/s^2)		RMS velocity (mm/s)		Peak velocity (mm/s)	
Place	**Time**	**Preferred**	**Maximum**	**Preferred**	**Maximum**	**Preferred**	**Maximum**
Continuous Vibration							
Residences	Daytime	0.01	0.02	0.2	0.4	0.28	0.56
Offices		0.02	0.04	0.4	0.8	0.56	1.1
Workshops		0.04	0.08	0.8	1.6	1.1	2.2
Impulsive Vibration							
Residences	Daytime	0.3	0.6	6.0	12.0	8.6	17.0
Offices		0.64	1.28	13.0	26.0	18.0	36.0
Workshops		0.64	1.28	13.0	26.0	18.0	36.0

Note 1: Continuous vibration relates to vibration that continues uninterrupted for a defined period (usually throughout the daytime or night-time), e.g. continuous construction or maintenance activity. (DECC, 2006)

Note 2: Impulsive vibration relate to vibration that builds up rapidly to a peak followed by a damped decay and that may or may not involve several cycles of vibration (depending on frequency and damping), with up to three occurrences in an assessment period, e.g. occasional loading and unloading, or dropping of heavy equipment. (DECC, 2006)

6 PROJECT SPECIFIC NOISE AND VIBRATION MANAGEMENT LEVELS

6.1 AMBIENT NOISE MONITORING

In order to establish noise goals, background noise levels were measured at locations representing the most sensitive receiver groups.

Extensive background noise monitoring was undertaken for the Headland Park Main Works Application based on a combination of attended and unattended monitoring. Because of the influence of construction activities currently occurring on the Barangaroo site, it is not possible to undertake background noise monitoring at this time to confirm that levels have not changed significantly since the last study. As there is no reason why background noise levels would have changed significantly during that period, the background noise levels and noise management goals used in the previous main works assessment will be adopted.

6.2 NOISE MANAGEMENT LEVELS

6.2.1.1 Residential Receiver Noise Goals

At residential receivers, noise generated by plant and equipment operating during normal hours throughout the duration of the project will be managed to generally comply with the background + 10dB(A) goal, and where that is exceeded noise will be managed in strict compliance with AS2436 and the EPA ICNG.

Table 3 – Residential Receivers Noise Affected Management Level

Location	Noise Affected Management Level dB(A) $L_{eq(15\ min)}$*	Highly Noise Affected Management Level dB(A) $L_{eq(15\ min)}$
Residential properties along Merriman and Bettington Streets	54	75
Residential properties along Dalgety & Hickson Roads and Towns Place	63	75
Residential properties along Windmill Street	61	75
Residential properties along Argyle Place	62	75
Residential properties along High Street	61	75
Residential properties along Balmain Peninsula	58	75

***Background noise level + 10 dB(A)**

For plant that may need to operate 24 hours per day, the noise criterion will be set at 5 dB(A) above the night time background noise level as determined from the long term monitoring locations, in accordance with the EPA ICNG.

Table 4 - Noise Criteria for Plant Operating 24 hours per Day/7 Days per Week

Location	Noise Level dB(A) L_{eq}
Residences on Merriman and Bettington Streets	42
Residences on High Street	45*
Residences Balmain Peninsula	44

*** Noise level will be limited to 45 dB(A), equal to the urban night time amenity level in the EPA INP.**

6.2.2 Commercial and Other Receivers

The ICNG adopts the following external management levels for commercial and industrial receivers:

- Commercial (offices, retail outlets) – 70 dB(A) $L_{eq(15min)}$.
- Industrial – 75 dB(A) $L_{eq(15\ min)}$.
- Other occupancies – Project specific based on type of occupancy, perhaps using "maximum" recommended level in AS 2107 to assist in determining relevant internal levels.

For the commercial receivers around the site the "standard" 70 dB(A) external noise goal may not be appropriate. For example:

- Some commercial receivers around the site are not located outside buildings, or are in buildings that provide almost no attenuation. For these receivers, the standard noise goal proposed in the ICNG may need to be made more stringent in order to appropriately manage impacts at these receivers.

- Some of the receivers are commercial properties (primarily office buildings) that have fixed, high performance glazing (or glazing that is normally closed) and are air conditioned. For these buildings the application of external noise goals may be excessively stringent. Internal noise goals will be adopted for these receivers rather than the external noise level.

In these instances the ICNG recommended external noise level will be used as an initial screening test, and these will be modified, or internal noise goals used, where appropriate.

6.2.2.1 Internal Noise Goals – General Commercial Receivers

As indicated above, some of the commercial receivers potentially impacted have modern, sealed facades that achieve a high level of external noise reduction. In these cases simply using the external noise goal would result in unnecessarily restrictive goals.

It is noted that the standard ICNG external noise goal of 70 dB(A) L_{eq} would typically result in internal noise levels of:

- 60 dB(A) L_{eq} in buildings that are not air conditioned and have openable windows.

- 50 dB(A) L_{eq} in buildings with a closed facade but with standard, unsealed windows.

The ICNG refers to setting internal noise goals using the AS 2107 “maximum” recommended level for guidance. AS 2107 nominates a noise level of 45 dB(A) L_{eq} for general office areas.

The levels that would occur in typical commercial buildings based on the ICNG 70 dB(A) external level would exceed the 45 dB(A) L_{eq}.

In our experience of managing demolition/construction noise from the Barangaroo site and within the Sydney CBD indicates that:

- A significant level of complaints of excessive construction noise in office situations are unlikely when the level of construction noise is less than 55 dB(A) within commercial spaces.
- This is the level typically adopted when assessing noise to the City of Sydney Construction Noise Code.
- A 55 dB(A) goal was successfully adopted for the management of noise from the Demolition of Structures on the Barangaroo site.

Notwithstanding EPA has requested that the lower 45 dB(A) level be adopted as an internal management goal. At this level, construction noise will be clearly acceptable within commercial tenancies and there would be minimal impact.

6.2.2.2 Noise Goals – Port Authority of New South Wales

It is understood that the building is primarily used as an office building, with boat maintenance works undertaken at the berths on the eastern side of the building. General maintenance related activities are also carried out around the building.

This building is a historic sandstone building that is unlikely to have a high performance façade acoustically. Hence a Noise Affected Management Level (NAML) of 70 dB(A) $L_{eq(15\ mins)}$ outside the building is applicable in accordance with EPA guidelines.

The EPA Management Level applying for the external maintenance activities is 75 dB(A) $L_{eq(15\ mins)}$.

Given the moorings will be largely screened from the demolition activities by the existing building on site and the headland, and the higher management level for the maintenance activities, the 70 dB(A) external management level for the operations building will be the governing requirement.

6.2.2.3 Noise Goals – External Cafes

The proposed works may affect cafes with external seating.

For these receivers, a 70 dB(A) $L_{eq(15\ mins)}$ external level may be unacceptable especially during peak use periods around lunch time. For these occupancies it is proposed to set the management level during these periods at 10 dB(A) above the prevailing background noise level, and in any case not exceeding 70 dB(A).

6.2.3 Summary of Noise Goals

The following table provides a summary of the noise management levels for all deconstruction operations occurring during the approved hours of work.

Table 5 – Summary of Applicable Noise Management Levels (operation during approved hours)*

Location/Receiver	Noise Affected Management Level dB(A) L_{eq}	Highly Noise Affected Management Level Limit	Comment
Residential properties along Merriman and Bettington Streets	54	75	
Residential properties along Dalgety & Hickson Roads and Towns Place	63	75	
Residential properties along Windmill Street	61	75	
Residential properties along Argyle Place	62	75	
Residential properties along High Street	61	75	
Residential properties along Balmain Peninsula	58	75	
External Cafes around Argyle Place	62/70	-	Lower goal applies during peak use periods
Commercial Buildings Generally	70 externally 45 internally if 70 level exceeded.	-	
Port Authority NSW	70 externally 45 internally if 70 level exceeded.	-	

*** Assessed at the most affected part of the occupancy.**

The following table provides a summary of the noise management levels for operations occurring 24 hours a day at the most impacted receivers.

Table 6 – Noise Management Levels 24 hours operation*

Location/Receiver	Noise Criterion dB(A) L_{eq}
Residences on Merriman and Bettington Streets	42
Residences on High Street	45
Residences Balmain Peninsula	44

*** Assessed at the most affected part of the occupancy.**

6.3 VIBRATION MANAGEMENT LEVELS

6.3.1 Damage Limits

Project specific vibration limits have been developed based on:

- The recommendations in Table 1.
- The construction and type of building potentially impacted.

The following table summarises the recommended limits applied to sensitive structures around the site.

Table 7 – Project Specific Damage Vibration Limits

Building	Recommended Damage Limits
Terrace Houses along Merriman Street and Rhodes Lane	Category 3
Modern Residential buildings along Dalgety Road and Towns Place	Category 2

6.3.2 Assessing Amenity

Table 8 – Project Specific Human Comfort Vibration Criteria

		RMS acceleration (m/s^2)		RMS velocity (mm/s)		Peak velocity (mm/s)	
Place	**Time**	**Preferred**	**Maximum**	**Preferred**	**Maximum**	**Preferred**	**Maximum**
Continuous Vibration							
Residences	Daytime	0.01	0.02	0.2	0.4	0.28	0.56
Offices		0.02	0.04	0.4	0.8	0.56	1.1
Impulsive Vibration							
Residences	Daytime	0.3	0.6	6.0	12.0	8.6	17.0
Offices		0.64	1.28	13.0	26.0	18.0	36.0

7 ACTIVITIES TO BE CONDUCTED AND ASSOCIATED NOISE SOURCES

We have been advised of the following typical equipment/processes anticipated to be used for the proposed deconstruction works;

- ***Stage 1 – Site Establishment***
    - Portable hand tools (electric)
    - Power generator (100 kva)
- ***Stage 2 – Preparation Works***
    - Brokk 180 Excavators (pulveriser attachment for demolition of plat room and pump rooms)
    - Mobile Cranes
    - Trucks
    - Portable hand tools (electric)
    - Power generator (100 kva)
- ***Stage 3 – Deconstruction of Main Tower and Roof***
    - Brokk 180 Excavators x 2 (pulveriser attachment – contingency for use of hammer attachment if pulverisers are unable to crush the concrete)
    - Mobile Cranes (if required, intermittent operation)
    - Access Equipment (Alimak hoist etc.)
    - Oxy Cutting
    - Disposal Trucks
    - Portable hand tools (electric)
    - Power generator (100 kva)
- ***Stage 4 – Removal of the Core Footing***
    - Tracked mounted drill rig
    - 20-30t excavator with hammer attachment
    - PFC charges
    - Portable hand tools (electric)
    - Power generator (100 kva)
    - Disposal Trucks

The A-weighted sound power levels for the typical loudest equipment/processes to be used during these stages are outlined in the table below.

Table 9 – Sound Power Levels

EQUIPMENT /PROCESS		SOUND POWER LEVEL dB(A)
Stage 1 – Site Establishment		
Portable hand tools (electric)		102*
Power Generator (100 kva – located in the basement works area)		105
Stage 2 – Preparation Works		
Brokk 180 excavator (pulveriser head attachment)		100
Mobile Crane		104
Portable hand tools (electric)		102*
Power Generator (100 kva – located in the basement works area)		105
Trucks		108
Stage 3 – Deconstruction of Main Tower and Roof		
Phase 1 – Top slab/deck and Roof Removal	Brokk 180 excavator (pulveriser head attachment)	100
	Brokk 180 excavator (hammer head attachment) – **contingency in place only if pulverisers cannot be used to crush the concrete**	115
	Mobile Crane	104
	Oxy cutting	105
	Access Equipment (hoists) - electric	92
	Portable hand tools (electric)	102*
	Power Generator (100 kva – located in the basement works area)	105
	Disposal Trucks	108
Phase 2 – Demolition of remainder of slab	Brokk 180 excavator (pulveriser head attachment)	100
	Brokk 180 excavator (hammer head attachment) – **contingency in place only if pulverisers cannot be used to crush the concrete**	115
	Access Equipment (hoists) - electric	92
	Portable hand tools (electric)	102*
	Power Generator (100 kva – located in the basement works area)	105
	Disposal Trucks	108

Table 9 – Sound Power Levels (continued)

EQUIPMENT /PROCESS		SOUND POWER LEVEL dB(A)
Phase 3 – Demolition of main slab and concrete core	Brokk 180 excavator (pulveriser head attachment)	100
	Brokk 180 excavator (hammer head attachment) – **contingency in place only if pulverisers cannot be used to crush the concrete**	115
	Access Equipment (hoists) - electric	92
	Portable hand tools (electric)	102*
	Power Generator (100 kva – located in the basement works area)	105
	Disposal Trucks	108
Stage 4 – Removal of Core Footing		
Track mounted drill rig		103
20-30t excavator (hammer head attachment)		115
Portable hand tools (electric)		102*
Power Generator (100 kva – located in the basement works area)		105
Disposal Trucks		108

*** Predictions were made with 5 dB(A) added to tabled noise levels to account for tonality or impulsive character.**

The noise levels presented in the previous table are derived from the following sources:

1. On-site measurements
2. Table D2 of Australian Standard 2436-1981 & Table A1 of Australian Standard 2436-2010.
3. Data held by this office from other similar studies.

8 ASSESSMENT OF POTENTIAL NOISE EMISSIONS

8.1 PREDICTED NOISE LEVELS

Deconstruction works noise levels at various locations representing the range of potentially affected receivers around the site have been predicted for each stage. A range of worst case noise levels corresponding to different works location (from top to bottom of the tower) has been assessed.

The cumulative worst case noise level was calculated by adding the individual contributions from the demolition noise sources occurring concurrently.

This form of presentation is used to identify those plant items /activities significantly contributing to noise levels or cause exceedances of the noise goals. The ICNG requires that conceptual treatment of those noise sources be considered, which is included in the attached Preliminary NVMP.

Where noise emissions to all receivers located in a group would be attenuated by existing built or natural barriers this attenuation has been included. Otherwise, the noise predictions represent worst case noise levels (without screening). Using this methodology, the worst case noise levels are presented: those receivers benefiting from additional screening would receive correspondingly lower noise levels.

8.1.1 Residential Properties along Merriman and Bettington Streets

Existing residential properties located along Merriman Street will potentially be the nearest affected receivers from the proposed demolition of the Harbour Control Tower.

The western façade of single and double storey townhouses (refer Figure 1 above) along this street will have a direct, unrestricted view of the Control Tower and associated plant. The sandstone cliff of the Barangaroo Reserve will screen these receivers from the works area and activities proposed in the basement space. Residences located along Bettington Street will also be impacted by the proposed activities on site, but not to the same extent as the Merriman Street receivers. There receivers are located further away from the proposed demolition equipment (distance attenuation) and will also be screened by the Merriman Street properties.

Deconstruction works noise emission predictions are detailed in the table below.

Table 10 – Predicted Noise Levels – Residential Receivers along Merriman and Bettington Streets

Equipment/Process	Predicted Noise Level at Receiver dB(A)$L_{eq(15mins)}$	Cumulative Noise Level at Receiver dB(A)$L_{eq(15min)}$	Noise Affected Management Level dB(A)$L_{eq(15min)}$
Stage 1 – Site Establishment			
Portable hand tools (electric)	52 – 74	52 – 74 Little to no impact is expected from this stage of works. Some intermittent noise impacts can be expected by the boundary fence erection activities on Merriman Street Level, however this will be minimal and is unlikely to impact on the amenity of these receivers.	54
Power Generator (100 kva)	40 – 56		
Stage 2 – Preparation Works			
Brokk 180 excavator (pulveriser head attachment)	42 – 53	62 – 79 Cumulative impacts are highly unlikely during this phase of works. Demolition of the ancillary rooms in the basement level and construction of chute and works area will occur first. These works are unlikely to exceed the noise affected management levels. Some cumulative impacts are expected during the erection of support structure, work platform and hoist. Mobile crane will be the only constant with hand held tools used intermittently for the install of these elements.	54
Mobile Crane	60 – 76		
Portable hand tools (electric)	54 – 74		
Power Generator (100 kva)	40 – 56		
Trucks	54 – 70		

Equipment/Process		Predicted Noise Level at Receiver dB(A)$L_{eq(15mins)}$	Cumulative Noise Level at Receiver dB(A)$L_{eq(15min)}$	Noise Affected Management Level dB(A)$L_{eq(15min)}$
Stage 3 – Deconstruction of Main Tower and Roof				
Phase 1 – Top slab/deck and Roof Removal	Brokk 180 excavator (pulveriser head attachment)	50 – 55	62 – 76 (if pulverisers used to crush concrete) 67 – 77 (if hammers used to crush concrete) Cumulative impacts during this phase of works are not expected. Internal stripout works and removal of the roof structure will be carried out using held tools operating intermittently. This will then either be craned down or transported to the chute/works area using the hoist. The Brokk pulverisers/hammers will operate independently and will be largely intermittent.	54
	Brokk 180 excavator (hammer head attachment) – **contingency in place only if pulverisers cannot be used to crush the concrete**	65 – 70		
	Mobile Crane	60 – 76		
	Oxy cutting	55 – 61		
	Access Equipment (hoists) - electric	44 – 61		
	Portable hand tools (electric)	52 – 58		
	Power Generator (100 kva)	40 – 56		
	Disposal Trucks	33 – 49		

Equipment/Process		**Predicted Noise Level at Receiver dB(A)$L_{eq(15mins)}$**	**Cumulative Noise Level at Receiver dB(A)$L_{eq(15min)}$**	**Noise Affected Management Level dB(A)$L_{eq(15min)}$**
Phase 2 – Demolition of remainder of slab	*Brokk 180 excavator (pulveriser head attachment)*	50 – 56	55 – 66 (if pulverisers used to crush concrete) 65 – 72 (if hammers used to crush concrete) Cumulative impacts during this phase of works are not expected. The Brokk pulverisers/hammers will operate independently and will be largely intermittent. Upper level scaffold will be removed using hand held tools and transported down using the hoist.	54
	*Brokk 180 excavator (hammer head attachment) – **contingency in place only if pulverisers cannot be used to crush the concrete***	65 – 71		
	Access Equipment (hoists) - electric	45 – 61		
	Portable hand tools (electric)	52 – 60		
	Power Generator (100 kva)	40 – 56		
	Disposal Trucks	33 – 49		
Phase 3 – Demolition of main slab and concrete core	*Brokk 180 excavator (pulveriser head attachment)*	55 – 75	62 – 78 (if pulverisers used to crush concrete) 70 – 90 (if hammers used to crush concrete) Cumulative impacts during this phase of works are not expected. The Brokk pulverisers/hammers will operate independently and will be largely intermittent. Upper level scaffold will be removed using hand held tools and transported down using the hoist.	54
	*Brokk 180 excavator (hammer head attachment) – **contingency in place only if pulverisers cannot be used to crush the concrete***	70 – 90		
	Access Equipment (hoists) - electric	50 – 64		
	Portable hand tools (electric)	60 – 74		
	Power Generator (100 kva)	40 – 56		
	Disposal Trucks	33 – 49		

Equipment/Process	Predicted Noise Level at Receiver dB(A)$L_{eq(15mins)}$	Cumulative Noise Level at Receiver dB(A)$L_{eq(15min)}$	Noise Affected Management Level dB(A)$L_{eq(15min)}$	Noise Affected Management Level dB(A)$L_{eq(15min)}$
Stage 4 – Removal of Core Footing				
Track mounted drill rig		40 – 56	53 – 69 Cumulative impacts during this phase of works are not expected. Drilling of the footing to install the charges is proposed to occur over a weeklong period followed by controlled explosion on one day. This will then be followed by removal of the rubble using the excavator and trucking away from site.	54
20-30t excavator (hammer head attachment)		52 – 68		
Portable hand tools (electric)		37 – 53		
Power Generator (100 kva)		40 – 56		
Disposal Trucks		33 – 49		

The predictions indicate that in worst case situations, a majority of the activities associated with the demolition of the Harbour Control Tower will exceed the noise affected management level at these receivers. Noise impacts to these receivers from these activities should be managed in accordance with the NVMP contained in Appendix 2. With the exception of the operation of the mobile cranes along Merriman Street (during the preparation stage and intermittently during phase 1 of deconstruction works), none of the operations would produce exceedances of the HANML.

If hammering operations are required for the demolition of the tower core (as a result of the pulverisers unable to crush concrete), these operations will also exceed the HANML at these receivers.

8.1.2 Residential Properties along Dalgety & Hickson Roads and Towns Place

These receivers are located approximately 50m to the east of the Harbour Control Tower. The existing residential properties along Merriman Street and Rhodes Lane will screen these receivers from the Merriman Street level activities. However, these receivers will have line of site to the activities associated with the demolition of the upper work platform and tower shaft (between Merriman Street Level and the upper amenities level).

Deconstruction works noise emission predictions are detailed in the table below.

Table 11 – Predicted Noise Levels – Residential Receivers along Dalgety & Hickson Roads and Towns Place

Equipment/Process	Predicted Noise Level at Receiver dB(A)$L_{eq(15mins)}$	Cumulative Noise Level at Receiver dB(A)$L_{eq(15min)}$	Noise Affected Management Level dB(A)$L_{eq(15min)}$
Stage 1 – Site Establishment			
Portable hand tools (electric)	39 – 45	40 – 46	63
Power Generator (100 kva)	35 – 40		
Stage 2 – Preparation Works			
Brokk 180 excavator (pulveriser head attachment)	<30	44 – 50	63
Mobile Crane	41 – 47		
Portable hand tools (electric)	39 – 45		
Power Generator (100 kva)	35 – 40		
Trucks	35 – 41		

Equipment/Process		Predicted Noise Level at Receiver dB(A)$L_{eq(15mins)}$	Cumulative Noise Level at Receiver dB(A)$L_{eq(15min)}$	Noise Affected Management Level dB(A)$L_{eq(15min)}$
Stage 3 – Deconstruction of Main Tower and Roof				
Phase 1 – Top slab/deck and Roof Removal	Brokk 180 excavator (pulveriser head attachment)	50 – 53	58 – 62 (if pulverisers used to crush concrete) 66 – 69 (if hammers used to crush concrete) Exceedances are predicted from the contingent hammering operations. Individual and cumulative impacts from the proposed methodology complies with the NAML.	63
	Brokk 180 excavator (hammer head attachment) – **contingency in place only if pulverisers cannot be used to crush the concrete**	65 – 68		
	Mobile Crane	41 – 47		
	Oxy cutting	55 – 59		
	Access Equipment (hoists) - electric	39 – 47		
	Portable hand tools (electric)	52 – 56		
	Power Generator (100 kva)	35 – 40		
	Disposal Trucks	<30		
Phase 2 – Demolition of remainder of slab	Brokk 180 excavator (pulveriser head attachment)	50 – 56	54 – 60 (if pulverisers used to crush concrete) 65 – 70 (if hammers used to crush concrete) Exceedances are predicted from the contingent hammering operations. Individual and cumulative impacts from the proposed methodology complies with the NAML.	63
	Brokk 180 excavator (hammer head attachment) – **contingency in place only if pulverisers cannot be used to crush the concrete**	65 – 70		
	Access Equipment (hoists) - electric	45 – 61		
	Portable hand tools (electric)	52 – 60		
	Power Generator (100 kva)	35 – 40		
	Disposal Trucks	<30		

Equipment/Process	Predicted Noise Level at Receiver dB(A)$L_{eq(15mins)}$	Cumulative Noise Level at Receiver dB(A)$L_{eq(15min)}$	Noise Affected Management Level dB(A)$L_{eq(15min)}$	Noise Affected Management Level dB(A)$L_{eq(15min)}$
Phase 3 – Demolition of main slab and concrete core	Brokk 180 excavator (pulveriser head attachment)	46 – 57	50 – 60 (if pulverisers used to crush concrete) 61 – 72 (if hammers used to crush concrete) Exceedances are predicted from the contingent hammering operations. Individual and cumulative impacts from the proposed methodology complies with the NAML.	63
	Brokk 180 excavator (hammer head attachment) – **contingency in place only if pulverisers cannot be used to crush the concrete**	61 – 72		
	Access Equipment (hoists) - electric	35 – 46		
	Portable hand tools (electric)	45 – 56		
	Power Generator (100 kva)	35 – 40		
	Disposal Trucks	<30		
Stage 4 – Removal of Core Footing				
Track mounted drill rig		30 – 35	44 – 49	63
20-30t excavator (hammer head attachment)		42 – 47		
Portable hand tools (electric)		32 – 37		
Power Generator (100 kva)		35 – 40		
Disposal Trucks		<30		

The predictions indicate that even in worst case situations, exceedance of the noise affected management level at these receivers is unlikely from the proposed methodology. If hammering operations are required for the demolition works (**as a result of the pulverisers unable to crush concrete**), this operations will exceed the NAML at these receivers but will not exceed the HANML.

8.1.3 Residential Properties along Argyle Place and Windmill Street

These receivers are located approximately 190m to the east of the Harbour Control Tower. The existing residential properties along Merriman Street and Dalgety Road and the commercial properties at 8 Windmill Street and 1 Kent Street will screen these receivers from the Merriman Street level activities. These receivers will have line of site to the activities associated with the demolition of the upper work platform and tower shaft (between Merriman Street Level and the

Deconstruction works noise emission predictions are detailed in the table below.

Table 12 – Predicted Noise Levels – Residential Receivers along Argyle Place and Windmill Street

Equipment/Process	Predicted Noise Level at Receiver dB(A)$L_{eq(15mins)}$	Cumulative Noise Level at Receiver dB(A)$L_{eq(15min)}$	Noise Affected Management Level dB(A)$L_{eq(15min)}$
Stage 1 – Site Establishment			
Portable hand tools (electric)	<30	<35	61
Power Generator (100 kva)	<30		
Stage 2 – Preparation Works			
Brokk 180 excavator (pulveriser head attachment)	<30	31 – 35	61
Mobile Crane	<30		
Portable hand tools (electric)	<30		
Power Generator (100 kva)	<30		
Trucks	<30		

Equipment/Process		Predicted Noise Level at Receiver dB(A)$L_{eq(15mins)}$	Cumulative Noise Level at Receiver dB(A)$L_{eq(15min)}$	Noise Affected Management Level dB(A)$L_{eq(15min)}$
Stage 3 – Deconstruction of Main Tower and Roof				
Phase 1 – Top slab/deck and Roof Removal	Brokk 180 excavator (pulveriser head attachment)	41 – 46	50 – 54 (if pulverisers used to crush concrete) 57 – 62 (if hammers used to crush concrete) Very marginal exceedance is predicted from the contingent hammering operations. Individual and cumulative impacts from the proposed methodology complies with the NAML.	61
	Brokk 180 excavator (hammer head attachment) – **contingency in place only if pulverisers cannot be used to crush the concrete**	56 – 61		
	Mobile Crane	<30		
	Oxy cutting	47 – 51		
	Access Equipment (hoists) - electric	31 – 35		
	Portable hand tools (electric)	44 – 48		
	Power Generator (100 kva)	<30		
	Disposal Trucks	<30		
Phase 2 – Demolition of remainder of slab	Brokk 180 excavator (pulveriser head attachment)	42 – 46	46 – 50 (if pulverisers used to crush concrete) 57 – 61 (if hammers used to crush concrete)	61
	Brokk 180 excavator (hammer head attachment) – **contingency in place only if pulverisers cannot be used to crush the concrete**	57 – 61		
	Access Equipment (hoists) - electric	31 – 35		
	Portable hand tools (electric)	44 – 48		
	Power Generator (100 kva)	<30		
	Disposal Trucks	<30		

Equipment/Process	Predicted Noise Level at Receiver dB(A)$L_{eq(15mins)}$	Cumulative Noise Level at Receiver dB(A)$L_{eq(15min)}$	Noise Affected Management Level dB(A)$L_{eq(15min)}$	Noise Affected Management Level dB(A)$L_{eq(15min)}$
Phase 3 – Demolition of main slab and concrete core	Brokk 180 excavator (pulveriser head attachment)	34 – 45	39 – 48 (if pulverisers used to crush concrete) 49 – 60 (if hammers used to crush concrete)	61
	Brokk 180 excavator (hammer head attachment) – **contingency in place only if pulverisers cannot be used to crush the concrete**	49 – 60		
	Access Equipment (hoists) - electric	<35		
	Portable hand tools (electric)	33 – 44		
	Power Generator (100 kva)	<30		
	Disposal Trucks	<30		
Stage 4 – Removal of Core Footing				
Track mounted drill rig		<30	35 – 39	61
20-30t excavator (hammer head attachment)		33 – 37		
Portable hand tools (electric)		<30		
Power Generator (100 kva)		<30		
Disposal Trucks		<30		

The predictions indicate that even in worst case situations, exceedance of the noise affected management level at these receivers is unlikely from the proposed methodology. If hammering operations are required for the demolition works (**as a result of the pulverisers unable to crush concrete**), this operation will result in a very marginal exceedance of the NAML during the phase 1 portion of deconstruction works.

8.1.4 Residential Properties along High Street

These receivers are located approximately 200m to the south-east of the Harbour Control Tower. The existing residential properties along Merriman and Bettington Streets will screen these receivers from the Merriman Street level activities. However, these receivers will have line of site to the activities associated with the demolition of the upper work platform and tower shaft (between Merriman Street Level and the upper amenities level).

Deconstruction works noise emission predictions are detailed in the table below.

Table 13 – Predicted Noise Levels – Residential Receivers along High Street

Equipment/Process	Predicted Noise Level at Receiver dB(A)$L_{eq(15mins)}$	Cumulative Noise Level at Receiver dB(A)$L_{eq(15min)}$	Noise Affected Management Level dB(A)$L_{eq(15min)}$
Stage 1 – Site Establishment			
Portable hand tools (electric)	<30	<30	61
Power Generator (100 kva)	<30		
Stage 2 – Preparation Works			
Brokk 180 excavator (pulveriser head attachment)	<30	$\underline{<}$ 35	61
Mobile Crane	<30		
Portable hand tools (electric)	<30		
Power Generator (100 kva)	<30		
Trucks	<30		

Equipment/Process		Predicted Noise Level at Receiver dB(A)$L_{eq(15mins)}$	Cumulative Noise Level at Receiver dB(A)$L_{eq(15min)}$	Noise Affected Management Level dB(A)$L_{eq(15min)}$
Stage 3 – Deconstruction of Main Tower and Roof				
Phase 1 – Top slab/deck and Roof Removal	Brokk 180 excavator (pulveriser head attachment)	42 – 46	50 – 54 (if pulverisers used to crush concrete) 58 – 62 (if hammers used to crush concrete) Very marginal exceedance is predicted from the contingent hammering operations. Individual and cumulative impacts from the proposed methodology complies with the NAML.	61
	Brokk 180 excavator (hammer head attachment) – **contingency in place only if pulverisers cannot be used to crush the concrete**	57 – 61		
	Mobile Crane	<30		
	Oxy cutting	47 – 51		
	Access Equipment (hoists) - electric	<35		
	Portable hand tools (electric)	44 – 48		
	Power Generator (100 kva)	<30		
	Disposal Trucks	<30		
Phase 2 – Demolition of remainder of slab	Brokk 180 excavator (pulveriser head attachment)	43 – 46	47 – 50 (if pulverisers used to crush concrete) 58 – 61 (if hammers used to crush concrete)	61
	Brokk 180 excavator (hammer head attachment) – **contingency in place only if pulverisers cannot be used to crush the concrete**	58 – 691		
	Access Equipment (hoists) - electric	<35		
	Portable hand tools (electric)	45 – 48		
	Power Generator (100 kva)	<30		
	Disposal Trucks	<30		

Equipment/Process	Predicted Noise Level at Receiver dB(A)$L_{eq(15mins)}$	Cumulative Noise Level at Receiver dB(A)$L_{eq(15min)}$	Noise Affected Management Level dB(A)$L_{eq(15min)}$	Noise Affected Management Level dB(A)$L_{eq(15min)}$
Phase 3 – Demolition of main slab and concrete core	Brokk 180 excavator (pulveriser head attachment)	34 – 46	39 – 49 (if pulverisers used to crush concrete) 49 – 61 (if hammers used to crush concrete)	61
	Brokk 180 excavator (hammer head attachment) – **contingency in place only if pulverisers cannot be used to crush the concrete**	49 – 61		
	Access Equipment (hoists) - electric	<35		
	Portable hand tools (electric)	33 – 45		
	Power Generator (100 kva)	<30		
	Disposal Trucks	<30		
Stage 4 – Removal of Core Footing				
Track mounted drill rig		<30	36 – 39	61
20-30t excavator (hammer head attachment)		34 – 37		
Portable hand tools (electric)		<30		
Power Generator (100 kva)		<30		
Disposal Trucks		<30		

The predictions indicate that even in worst case situations, exceedance of the noise affected management level at these receivers is unlikely from the proposed methodology. If hammering operations are required for the demolition works (**as a result of the pulverisers unable to crush concrete**), this operation will result in a very marginal exceedance of the NAML during the phase 1 portion of deconstruction works.

8.1.5 Residential Properties on Balmain Peninsula

These receivers are located approximately 600m to the west of the Harbour Control Tower, across the Harbour. Residential properties along Weston Street will be the potentially worst affected receivers on this peninsula, with the eastern façade of these receivers having line of sight to the Barangaroo construction site. A screen has been constructed along the western boundary of the Barangaroo Headland Park and Northern Cove construction site, which will screen these receivers from the activities proposed along the foot of the control tower and also along Merriman Street.

However, noise emissions from activities associated with the demolition of the upper work platform and tower shaft (between Merriman Street Level and the upper amenities level) may still impact these receivers.

Deconstruction works noise emission predictions are detailed in the table below.

Table 14 – Predicted Noise Levels – Residential Receivers on Balmain Peninsula

Equipment/Process	Predicted Noise Level at Receiver dB(A)$L_{eq(15mins)}$	Cumulative Noise Level at Receiver dB(A)$L_{eq(15min)}$	Noise Affected Management Level dB(A)$L_{eq(15min)}$
Stage 1 – Site Establishment			
Portable hand tools (electric)	38 – 39	38 – 39	58
Power Generator (100 kva)	<30		
Stage 2 – Preparation Works			
Brokk 180 excavator (pulveriser head attachment)	<30	42 – 43	58
Mobile Crane	40 – 41		
Portable hand tools (electric)	38 – 39		
Power Generator (100 kva)	<30		
Trucks	<30		

Equipment/Process		Predicted Noise Level at Receiver dB(A)$L_{eq(15mins)}$	Cumulative Noise Level at Receiver dB(A)$L_{eq(15min)}$	Noise Affected Management Level dB(A)$L_{eq(15min)}$
Stage 3 – Deconstruction of Main Tower and Roof				
Phase 1 – Top slab/deck and Roof Removal	Brokk 180 excavator (pulveriser head attachment)	36 – 37	45 – 46 (if pulverisers used to crush concrete) 52 – 53 (if hammers used to crush concrete)	58
	Brokk 180 excavator (hammer head attachment) – **contingency in place only if pulverisers cannot be used to crush the concrete**	51 – 52		
	Mobile Crane	40 – 41		
	Oxy cutting	41 – 42		
	Access Equipment (hoists) - electric	<30		
	Portable hand tools (electric)	38 – 39		
	Power Generator (100 kva)	<30		
	Disposal Trucks	<30		
Phase 2 – Demolition of remainder of slab	Brokk 180 excavator (pulveriser head attachment)	36 – 37	40 – 41 (if pulverisers used to crush concrete) 51 – 52 (if hammers used to crush concrete)	58
	Brokk 180 excavator (hammer head attachment) – **contingency in place only if pulverisers cannot be used to crush the concrete**	51 – 52		
	Access Equipment (hoists) - electric	<30		
	Portable hand tools (electric)	38 – 39		
	Power Generator (100 kva)	<30		
	Disposal Trucks	<30		

Equipment/Process	Predicted Noise Level at Receiver dB(A)$L_{eq(15mins)}$	Cumulative Noise Level at Receiver dB(A)$L_{eq(15min)}$	Noise Affected Management Level dB(A)$L_{eq(15min)}$	Noise Affected Management Level dB(A)$L_{eq(15min)}$
Phase 3 – Demolition of main slab and concrete core	Brokk 180 excavator (pulveriser head attachment)	39 – 40	42 – 43 (if pulverisers used to crush concrete) 54 – 55 (if hammers used to crush concrete)	54
	Brokk 180 excavator (hammer head attachment) – **contingency in place only if pulverisers cannot be used to crush the concrete**	54 – 55		
	Access Equipment (hoists) - electric	<30		
	Portable hand tools (electric)	38 – 39		
	Power Generator (100 kva)	<30		
	Disposal Trucks	<30		
Stage 4 – Removal of Core Footing				
Track mounted drill rig		<30	30 – 31	54
20-30t excavator (hammer head attachment)		<30		
Portable hand tools (electric)		<30		
Power Generator (100 kva)		<30		
Disposal Trucks		<30		

The predictions indicate that even in worst case situations, exceedance of the noise affected management level at these receivers is unlikely from the proposed activities.

8.1.6 Commercial Receiver – 8 Windmill Street, 4-12Argyle Place & 1 Kent Street

The commercial properties located at 8 Windmill Street, 4-12 Argyle Place and 1 Kent Street will potentially be the nearest affected commercial receivers. These receivers are located approximately 120m to the south/south-east of the Harbour Control Tower, across the Harbour. The existing residential properties along Merriman and Bettington Streets will screen these receivers from the ground level (Merriman Street level), part Stage 4 (at Merriman Street level and below) and Stage 5 activities on site.

However, these receivers will have line of site to the activities associated with the demolition of the upper work platform and tower shaft (between Merriman Street Level and the upper amenities level).

Deconstruction works noise emission predictions are detailed in the table below.

Table 15 – Predicted Noise Levels – Commercial Receivers at 8 Windmill Street, 4-12Argyle Place & 1 Kent Street

Equipment/Process	Predicted Noise Level at Receiver dB(A)$L_{eq(15mins)}$	Cumulative Noise Level at Receiver dB(A)$L_{eq(15min)}$	Noise Affected Management Level (external) dB(A)$L_{eq(15min)}$
Stage 1 – Site Establishment			
Portable hand tools (electric)	<30	32 – 36	70
Power Generator (100 kva)	30 – 34		
Stage 2 – Preparation Works			
Brokk 180 excavator (pulveriser head attachment)	<30	35 – 39	70
Mobile Crane	30 – 34		
Portable hand tools (electric)	27 – 31		
Power Generator (100 kva)	30 – 34		
Trucks	<30		

Equipment/Process		Predicted Noise Level at Receiver dB(A)$L_{eq(15mins)}$	Cumulative Noise Level at Receiver dB(A)$L_{eq(15min)}$	Noise Affected Management Level (external) dB(A)$L_{eq(15min)}$
Stage 3 – Deconstruction of Main Tower and Roof				
Phase 1 – Top slab/deck and Roof Removal	Brokk 180 excavator (pulveriser head attachment)	46 – 49	54 – 57 (if pulverisers used to crush concrete) 62 – 65 (if hammers used to crush concrete)	70
	Brokk 180 excavator (hammer head attachment) – **contingency in place only if pulverisers cannot be used to crush the concrete**	61 – 64		
	Mobile Crane	30 – 34		
	Oxy cutting	51 – 55		
	Access Equipment (hoists) - electric	35 – 39		
	Portable hand tools (electric)	48 – 51		
	Power Generator (100 kva)	30 – 34		
	Disposal Trucks	<30		
Phase 2 – Demolition of remainder of slab	Brokk 180 excavator (pulveriser head attachment)	46 – 50	50 – 54 (if pulverisers used to crush concrete) 61 – 65 (if hammers used to crush concrete)	70
	Brokk 180 excavator (hammer head attachment) – **contingency in place only if pulverisers cannot be used to crush the concrete**	61 – 65		
	Access Equipment (hoists) - electric	35 – 39		
	Portable hand tools (electric)	48 – 52		
	Power Generator (100 kva)	30 – 34		
	Disposal Trucks	<30		

Equipment/Process	Predicted Noise Level at Receiver dB(A)$L_{eq(15mins)}$	Cumulative Noise Level at Receiver dB(A)$L_{eq(15min)}$	Noise Affected Management Level dB(A)$L_{eq(15min)}$	Noise Affected Management Level (external) dB(A)$L_{eq(15min)}$
Phase 3 – Demolition of main slab and concrete core	Brokk 180 excavator (pulveriser head attachment)	38 – 49	50 – 60 (if pulverisers used to crush concrete) 53 – 64 (if hammers used to crush concrete)	70
	Brokk 180 excavator (hammer head attachment) – **contingency in place only if pulverisers cannot be used to crush the concrete**	53 – 64		
	Access Equipment (hoists) - electric	27 – 38		
	Portable hand tools (electric)	37 – 48		
	Power Generator (100 kva)	30 – 34		
	Disposal Trucks	<30		
Stage 4 – Removal of Core Footing				
Track mounted drill rig		<30	39 – 43	70
20-30t excavator (hammer head attachment)		37 – 41		
Portable hand tools (electric)		27 – 31		
Power Generator (100 kva)		30 – 34		
Disposal Trucks		<30		

The predictions indicate that even in worst case situations, exceedance of the noise affected management level at this receiver is unlikely from the proposed activities.

8.1.7 Commercial Receiver – Port Authority of NSW

The Port Authority of NSW building is located approximate 125m to the north-east of Harbour Control Tower. This building is primarily used as an office building with boat maintenance berths located along its eastern boundary. The sandstone cliff at Clyne Reserve and residential properties on Dalgety Avenue will screen this receiver from the Merriman Street level activities.

However, these receivers will have line of site to the activities associated with the demolition of the upper work platform and tower shaft (between Merriman Street Level and the upper amenities level).

Deconstruction works noise emission predictions are detailed in the table below.

Table 16 – Predicted Noise Levels – Port Authority of NSW

Equipment/Process	Predicted Noise Level at Receiver dB(A)$L_{eq(15mins)}$	Cumulative Noise Level at Receiver dB(A)$L_{eq(15min)}$	Noise Affected Management Level (external) dB(A)$L_{eq(15min)}$
Stage 1 – Site Establishment			
Portable hand tools (electric)	<35	33 – 36	70
Power Generator (100 kva)	<35		
Stage 2 – Preparation Works			
Brokk 180 excavator (pulveriser head attachment)	<30	35 – 38	70
Mobile Crane	30 – 34		
Portable hand tools (electric)	<30		
Power Generator (100 kva)	31 – 33		
Trucks	<30		

Equipment/Process		Predicted Noise Level at Receiver dB(A)$L_{eq(15mins)}$	Cumulative Noise Level at Receiver dB(A)$L_{eq(15min)}$	Noise Affected Management Level (external) dB(A)$L_{eq(15min)}$
Stage 3 – Deconstruction of Main Tower and Roof				
Phase 1 – Top slab/deck and Roof Removal	Brokk 180 excavator (pulveriser head attachment)	46 – 49	54 – 57 (if pulverisers used to crush concrete) 62 – 65 (if hammers used to crush concrete)	70
	Brokk 180 excavator (hammer head attachment) – **contingency in place only if pulverisers cannot be used to crush the concrete**	61 – 64		
	Mobile Crane	30 – 34		
	Oxy cutting	51 – 54		
	Access Equipment (hoists) - electric	35 – 38		
	Portable hand tools (electric)	48 – 51		
	Power Generator (100 kva)	31 – 33		
	Disposal Trucks	<30		
Phase 2 – Demolition of remainder of slab	Brokk 180 excavator (pulveriser head attachment)	46 – 49	50 – 54 (if pulverisers used to crush concrete) 61 – 64 (if hammers used to crush concrete)	70
	Brokk 180 excavator (hammer head attachment) – **contingency in place only if pulverisers cannot be used to crush the concrete**	61 – 64		
	Access Equipment (hoists) - electric	35 – 39		
	Portable hand tools (electric)	48 – 52		
	Power Generator (100 kva)	31 – 33		
	Disposal Trucks	<30		

Equipment/Process	Predicted Noise Level at Receiver dB(A)$L_{eq(15mins)}$	Cumulative Noise Level at Receiver dB(A)$L_{eq(15min)}$	Noise Affected Management Level dB(A)$L_{eq(15min)}$	Noise Affected Management Level (external) dB(A)$L_{eq(15min)}$
Phase 3 – Demolition of main slab and concrete core	Brokk 180 excavator (pulveriser head attachment)	38 – 50	42 – 53 (if pulverisers used to crush concrete) 53 – 65 (if hammers used to crush concrete)	70
	Brokk 180 excavator (hammer head attachment) – **contingency in place only if pulverisers cannot be used to crush the concrete**	53 – 65		
	Access Equipment (hoists) - electric	27 – 39		
	Portable hand tools (electric)	37 – 49		
	Power Generator (100 kva)	31 – 33		
	Disposal Trucks	<30		
Stage 4 – Removal of Core Footing				
Track mounted drill rig		<30	40 – 42	70
20-30t excavator (hammer head attachment)		38 – 40		
Portable hand tools (electric)		<30		
Power Generator (100 kva)		31 – 33		
Disposal Trucks		<30		

The predictions indicate that even in worst case situations, exceedance of the noise affected management level at this receiver is unlikely from the proposed activities.

8.1.8 Railway Assets

The nearest operational railway tunnels are located under the Bradfield Highway and under York Street, and are at least 600m from any activities. Given the distance separation, noise (and vibration) from the proposed activities would not impact upon this infrastructure.

8.2 DISCUSSION

Without management or mitigation, the following receivers would receive noise levels exceeding the management goals for the proposed methodology;

- Residential properties Along Merriman and Bettington Streets

For all other residential and commercial receivers the worst case predicted noise levels do not exceed the Noise Affected Management Level. Therefore, these receivers would not be adversely impacted by the proposed activities.

Additionally, noise emissions have also been predicted from the contingent hammering operations, which may be required if the proposed pulverising operations are unable to demolish the concrete. **It should be noted that the hammering operations will only occur in the event pulverising operations are unable to crush the concrete, and not to expedite the demolition works.** The following receivers would receive noise levels exceeding the management goals if hammering operations are required;

- Residential properties along Merriman and Bettington Streets;
- Residential properties along Dalgety, Hickson Roads and Towns Place; and
- Residential properties along Windmill Street, Argyle Place and High Street (cumulative impacts resulting in a very marginal exceedance of 1dB. Individual impacts will comply with the NML).

Due to their proximity to the works, the residential properties along Merriman Street will be the most affected receivers. Exceedances of the NML are predicted for these residences from a number of the operations. However, with the exception of the operation of the mobile cranes along Merriman Street (during the preparation stage and intermittently during phase 1 of deconstruction works), none of the operations proposed as part of the proposed methodology would produce exceedances of the HANML.

If hammering operations are required for the demolition of the tower (as a result of the pulverisers unable to crush concrete), this operation will also result in exceedance of the NML at the residences along Dalgety Road, Hickson Road and Towns Place in addition to Merriman and Bettington Streets. A very marginal cumulative exceedance during the upper work platform demolition phase of works (phase 1 of stage 3) is also predicted for the residential properties located along Windmill Street, High Street and Argyle Place, however this is in the order of 1dB (which is not perceptible to the human ear) and will comply with the NML as an individual activity. Exceedance of the HANML from the hammering operations are only predicted for the residential receivers along Merriman Street.

A preliminary noise and vibration management plan has been developed which would be used post approval to manage plant and equipment that may exceed the management levels and noise limits.

8.3 ASSESSMENT OF POTENTIAL NOISE EMISSIONS – 24 HRS OPERATION

Works outside approved Main Works hours of construction would be limited to activities that are required to be undertaken outside normal construction hours, for example dewatering of the site (if required) and emergency maintenance activities. A separate assessment would need to be undertaken by the Demolition Contractor as required by the Noise and Vibration Management Plan.

9 ASSESSMENT OF VIBRATION

The potentially most impacted receivers are the residential receivers on Merriman Street due to the proximity of these receivers to the activities. Safeguards are recommended for these receivers.

Vibration will be minimised by the use of pulverisers. Notwithstanding this, demolition works within the basement level (for the removal of the plant and pump rooms) and hammering operations for the removal of the HCT footings will have the potential to produce perceptible ground vibration at the residential properties along Merriman Street.

In the event hammering operations are required for the demolition of the tower (as a result of the pulverisers unable to crush concrete), hammering of the tower core near Merriman Street Level and proceeding down into the basement cultural space, will also have potential to produce perceptible vibration at the residential properties along Merriman Street.

In order to protect the sensitive structures and amenity, monitoring to confirm vibration levels at the Merriman Street residences is recommended, as described in the Noise and Vibration Management Plan.

10 TRAFFIC NOISE GENERATION

The proposal would generate a minimal number of heavy vehicle or passenger vehicle movements. Therefore, no adverse impacts are expected from movements on local roads. Noise emissions from trucks manoeuvring in the construction zone have been assessed as part of the demolition noise emissions assessment.

11 CONCLUSION

A noise and vibration assessment has been undertaken of the proposed deconstruction of the Sydney Harbour Control Tower to identify whether these activities would impact sensitive receivers around the site.

EPA Interim Construction Noise Guide guidelines have been used to establish noise and vibration management levels for the receivers around the site.

Noise and vibration emissions from the proposed works have been predicted at potentially impacted commercial and residential receivers. The predictions indicate that:

- Noise impacts will primarily be limited to the residential properties located along Merriman and Bettington Streets. Noise Management Level exceedances at these residences are predicted to occur during all stages of the program. However, exceedance of the Highly Noise Affected Management Level is only predicted from the mobile crane operations along Merriman Street (during the preparatory works stage and intermittently during phase 1 of deconstruction stage).

  If hammering operations are required for the demolition of the tower (as a result of the pulverisers unable to crush concrete), this operation will also result in exceedance of the NML at the residences along Dalgety Road, Hickson Road and Towns Place in addition to Merriman and Bettington Streets. However, exceedance of the HANML from the hammering operations are only predicted for the residential receivers along Merriman Street.

- Ground vibration generated by the proposed activities would not impact nearby railway infrastructure, and are unlikely to impact nearby residential or commercial buildings. Notwithstanding, recommendations are made to safeguard existing residences along Merriman Street due to hammering operations both proposed (for the removal of tower footing) and contingent (for demolition of the tower if pulveriser operations are unable to crush concrete).

A Preliminary Noise and Vibration Management Plan has been devised that will be developed and used by the contractor to manage impacts. The plan outlines the development of controls and safeguards that would be applied to all activity on the site. The objective of these controls is to ensure that all work is carried out in a highly controlled and predictable manner that will minimise emissions and protect the amenity of the sensitive receivers surrounding the site.

The controls and safeguards implemented as a result of the analysis recommended in the plan would be reviewed at a number of stages as required to respond to local conditions, revised methods and equipment, as well as in response to the monitoring and evaluation of actual impacts. This management plan outlines the procedures that would be adopted during the planning and execution phases by the contractor.

Yours faithfully,

Acoustic Logic Consultancy Pty Ltd
Yogendra Kalkunte

APPENDIX 1
NOISE AND VIBRATION RELATED CONDITIONS – MAIN WORKS APPROVAL EXTRACT

2. A detailed plan for in-situ classification of waste material, including the sampling locations and sampling regime that will be employed to classify the waste, particularly with regards to the identification of contamination hotspots.
3. A commitment to retaining all sampling and classification results for the life of the project to demonstrate compliance with DECCW's Classification Guidelines.
4. Details in relation to the "Concrete Crushing and Screening Plant" to be installed at the site and its use, including (at a minimum):
    a. Location and specifications of the concrete crushing and screening plant;
    b. Estimated quantities of concrete to be crushed per day;
    c. Measures that will be employed to prevent or minimise the emission of dust from the crushing activity; and
    d. Measures that will be employed to prevent or minimise the emission of noise from the crushing activity.
5. Details in relation to the transport of waste material around the site (on-site) and from the site, including (at a minimum):
    a. A traffic plan showing transport routes from the southern to the northern end of the site;
    b. Location of the stockpiles at each stage as they migrate from the southern end of the site to the northern end of the site;
    c. Details of any garden waste mulching processes and garden waste stockpiles, including considerations for odour generation;
    d. A commitment to retain waste transport details for the life of the project to demonstrate compliance with the Protection of the Environment Operations Act; and
    e. The name and address of each licensed facility that will receive waste from the Barangaroo site (if appropriate);
6. Details of the de-watering process, including the specifications for any on-site water treatment plant.
7. A contingency plan for any event that may affect excavation and contaminated soil treatment operations at the site, particularly in relation to the expected volumes materials excavated/generated at the site.

B22 NOISE AND VIBRATION

1. The proponent must prepare and implement a detailed Construction Noise and Vibration Management Plan (CNVMP), to be approved by the Director General of the Department of Planning before commencement of works, that includes but is not necessarily limited to;
    (a) identification of the specific activities that will be carried out and associated noise sources at the premises,
    (b) identification of all potentially affected sensitive receiver locations,
    (c) quantification of the rating background noise level (RBL) for sensitive receivers, as part of the CNVMP, or as undertaken in the EA,
    (d) the construction noise, ground-borne noise and vibration objectives derived from an application of the DECCW Interim Construction Noise Guideline (ICNG), as reflected in conditions of approval,
    (e) prediction and assessment of potential noise, ground-borne noise (as relevant) and vibration levels from the proposed construction methods expected at sensitive receiver premises against the objectives identified in the ICNG and conditions of approval,
    (f) where the objectives are predicted to be exceeded, an analysis of feasible and reasonable noise mitigation measures that can be implemented to reduce construction noise and vibration impacts,
    (g) description of management methods and procedures, and specific noise mitigation treatments / measures that will be implemented to control noise and vibration during construction,

(h) where the objectives cannot be met, additional measures including, but not necessarily limited to, the following should be considered and implemented where practicable; reduced hours of construction, the provision of respite from noisy / vibration intensive activities, acoustic barriers / enclosures, alternative excavation methods or other negotiated outcomes with the affected community,

(i) where night time noise management levels cannot be satisfied, a report shall be submitted to the Director General outlining the mitigation measures applied, the noise levels achieved and justification that the outcome is consistent with best practice,

(j) measures to identify non-conformances with the requirements of the CNVMP, and procedures to implement corrective and preventative action,

(k) suitable contractual arrangements to ensure that all site personnel, including sub-contractors, are required to adhere to the noise management provisions in the CNVMP,

(l) procedures for notifying residents of construction activities that are likely to effect their noise and vibration amenity,

(m) measures to monitor noise performance and respond to complaints,

(n) measures to reduce noise related impacts associated with offsite vehicle movements on nearby access and egress routes from the site,

(o) procedures to allow for regular professional acoustic input to construction activities and planning; and,

(p) effective site induction, and ongoing training and awareness measures for personnel (e.g. tool box talks, meetings etc).

2. All construction work at the premises must be conducted between 7am and 6pm Monday to Friday and between 8am and 3pm Saturdays and at no time on Sundays and public holidays, unless inaudible at any residential premises. Works outside these hours are not permitted except as explicitly specified below or in other conditions and include:

   (a) the delivery of materials which is required outside these hours as requested by Police or other authorities for safety reasons;

   (b) emergency work to avoid the loss of lives, damage to property and/or to prevent environmental harm;

   (c) other works expressly approved by the Director General of the Department of Planning;

   (d) Out of standard hours works identified in a CNVMP approved by the Director General of the Department of Planning.

3. Construction noise management levels (NML) derived in accordance with the DECCW Interim Construction Noise Guidelines apply to this project, and are required to be identified in an approved CNVMP. Any activities that have the potential for noise emissions that exceed the NMLs must be identified and managed in accordance with the CNVMP. The Proponent must implement all Reasonable and Feasible noise mitigation and management measures with the aim of achieving the NMLs.

4. Vibration caused by Construction and received at any sensitive receiver outside the project must be assessed against the guidelines contained in the DECCW publication "Environmental Noise Management - Assessing Vibration: a technical guideline" and in accordance with the CNVMP.

   In addition to the conditions above, it is normal practice for DoP to impose "Construction Noise Management" conditions, for example conditions 31-34 in the project approval for the City West Cable Tunnel (http://www.planning.nsw.gov.au/asp/pdf/05_0178_dgreport.pdf). These conditions are also recommended for imposition in any project approval for the Barangaroo site.

5. All mechanical plant and equipment associated with post-construction facilities at Headland Park (e.g. air conditioning plant, generators, chillers, pump stations, treatment plants etc) are to not emit noise more than 5dBA above background, in accordance with the NSW Government's Industrial Noise Policy.

PART D - DURING CONSTRUCTION

D1 NOISE AND VIBRATION

The proponent must monitor noise levels at the most affected receiver location during rock hammering, rock sawing, rock breaking and any other such noisy activities. If levels exceed LAeq, (15 minute) 70 dB(A) for 12 consecutive fifteen minute periods (3 hours) within the approved hours of works, the proponent must incorporate respite periods of 1 hour every 3 hours.

D2 ARCHAEOLOGICAL DISCOVERY DURING EXCAVATION

(a) The recommendations of the nominated site archaeologists should be carried out, including determining whether any further site archaeological monitoring is required during excavation works.

(b) Should any historical relics likely to be of significance be unexpectedly discovered on the site during excavation, all excavation or disturbance to the area is to stop immediately and the Heritage Council of NSW should be informed in accordance with section 146 of the *Heritage Act 1977*.

(c) Should any Aboriginal relics be unexpectedly discovered then all excavation or disturbance of the area is to stop immediately and the National Parks and Wildlife Service is to be informed in accordance with Section 91 of the *National Parks and Wildlife Act 1974*.

(d) Any relics found on site that are capable of being included in the site's heritage interpretation or public art, are to be kept safe for consideration of their incorporation into site fixtures.

D3 VEHICLE FOOTWAY CROSSING

A separate application is to be made to, and approved by, the relevant road authority for the construction of any proposed vehicle footway crossing or for the removal of any existing crossing and replacement of the footpath formation where any such crossings are no longer required.

All disused or redundant vehicle crossings and laybacks must be removed and footway and kerb reinstated in accordance with design and construction details as prepared by a suitably qualified Civil Engineer, to suit the adjacent finished footway and edge treatment materials, levels and details. All construction and replacement works are to be completed in accordance with the approved plans prior to the issue of a final Occupation Certificate.

D4 COVERING OF LOADS

All vehicles involved in the excavation and/or demolition process and departing the property with demolition materials, spoil or loose matter must have their loads fully covered before entering the public roadway.

D5 TRAFFIC IMPACT ASSESSMENT & CONSTRUCTION TRAFFIC MANAGEMENT PLAN

(a) Construction works will be undertaken generally in accordance with the Traffic Impact Assessment & Construction Traffic Management Plan prepared by Halcrow, Issue 1.3 dated 26 October 2010, except where modified elsewhere in this condition.

(b) Under the current legislation the use of lengthy vehicles in the CBD is prohibited within certain time frames. All lengthy vehicles must comply with this regulation as stipulated in the NSW Road Rules. A map indicating the prohibited area and definitions of lengthy vehicles are included in the Road Rules.

(c) Personnel using stop/slow signage are not permitted in Hickson Road or Sussex Street on weekdays between the hours of 7.00am to 9.00am and 4.00pm to 7.00pm. However, personnel using stop/slow signage will be permitted on Hickson Road, north of the intersection of Hickson Road and Napoleon Street, when it is required to ensure safe truck access at designated site access points, provided that vehicle queue lengths generated as a result of the traffic control do not exceed more than six vehicles in either direction.

(d) Truck movements should be staged and coordinated to prevent trucks circling CBD streets whilst awaiting access to the site. There should be holding areas outside the CBD on the fringes or sufficient space within the site to store trucks and heavy vehicles.

(e) To minimise impacts on public transport, trucks should avoid where possible the use of York Street to access the development site between 2.00pm to 8.00pm Monday to Friday.

(f) The Proponent is also to enter into an 'Operational Protocol' regarding the traffic management arrangements where the haul route between the Stage 1 excavation site and

APPENDIX 2
NOISE AND VIBRATION MANAGEMENT PLAN

MANAGING DIRECTORS
MATTHEW PALAVIDIS
VICTOR FATTORETTO

DIRECTORS
MATTHEW SHIELDS
BEN WHITE

Harbour Control Tower, Barangaroo

Deconstruction Works Noise and Vibration Management Plan

SYDNEY
A: 9 Sarah St Mascot NSW 2020
T: (02) 8339 8000
F: (02) 8338 8399

SYDNEY MELBOURNE BRISBANE CANBERRA
LONDON DUBAI SINGAPORE GREECE

www.acousticlogic.com.au
ABN: 11 068 954 343

DOCUMENT CONTROL REGISTER

Project Number	20160184.1
Project Name	Harbour Control Tower, Barangaroo
Document Title	Deconstruction Works Noise and Vibration Management Plan
Document Reference	20160184.1/1702A/R1/YK
Issue Type	Email
Attention To	Liberty Industrial Mr Michael Muller

Revision	Date	Document Reference	Prepared By	Checked By	Approved By
0	17/02/2016	20160184.1/1702A/R0/YK	YK		VF
1	23/02/2016	20160184.1/1702A/R1/YK	YK		VF

TABLE OF CONTENTS

1 EXECUTIVE SUMMARY

This Noise and Vibration Management Plan (NVMP) outlines the development of controls and safeguards that would be applied to all activity on the site by Liberty Industrial. The objective of these controls is to ensure that all work is carried out in a highly controlled and predictable manner that will minimise emissions and protect the amenity of the sensitive receivers surrounding the site.

Likely noise and vibration emissions from likely processes and activities have been assessed. The assessment identified the activities likely to exceed noise and/or vibration goals. The noise and vibration management plan will be used to manage impacts from all activities, with particular reference to those activities that might generate emissions greater than the noise goals.

The controls and safeguards implemented would be reviewed at a number of stages during the extraction period in response to revised methods and equipment, or monitoring and evaluation of actual impacts. This management plan outlines the procedures that would be adopted by Liberty Industrial during the detailed planning and execution phases.

2 INTRODUCTION

This document presents the NVMP that will be used to manage noise and vibration impacts from the proposed activities associated with the deconstruction of the Sydney Harbour Control Tower.

3 HOURS OF WORK

Clause 2 of Condition B22 of the *Barangaroo Headland Park and Northern Cove – Main Works* approval (application no: 10_0048) outlines the following approved hours for construction:

All construction work at the premises must be conducted between Tam and 6pm Monday to Friday and between 8am and 3pm Saturdays and at no time on Sundays and public holidays, unless inaudible at any residential premises. Works outside these hours are not permitted except as explicitly specified below or in other conditions and include:

(a) the delivery of materials which is required outside these hours as requested by Police or other authorities for safety reasons;

(b) emergency work to avoid the loss of lives, damage to property and/or to prevent environmental harm;

(c) other works expressly approved by the Director General of the Department of Planning;

(d) Out of standard hours works identified in a CNVMP approved by the Director General of the Department of Planning.

It is proposed to extend the approved hours of work on Saturdays from 8am – 3pm to 8am – 5pm, in line with the category 1 (regarded as standard hours) hours of construction outlined in the City of Sidney Council's "*Construction Hours/Noise within the Central Business District Code of Practice (1992)*" document. Please refer to section 4.1 *Harbour Control Tower Deconstruction Works Noise and Vibration Assessment* report prepared by this office (reference: 20160184.1/1502A/R0/YK).

4 CONSTRUCTION NOISE AND VIBRATION GOALS

The noise and vibration goals for the proposed activities are indicated in Section 5 of the *Harbour Control Tower Deconstruction Works Noise and Vibration Assessment* report prepared by this office (reference: 20160184.1/1502A/R0/YK).

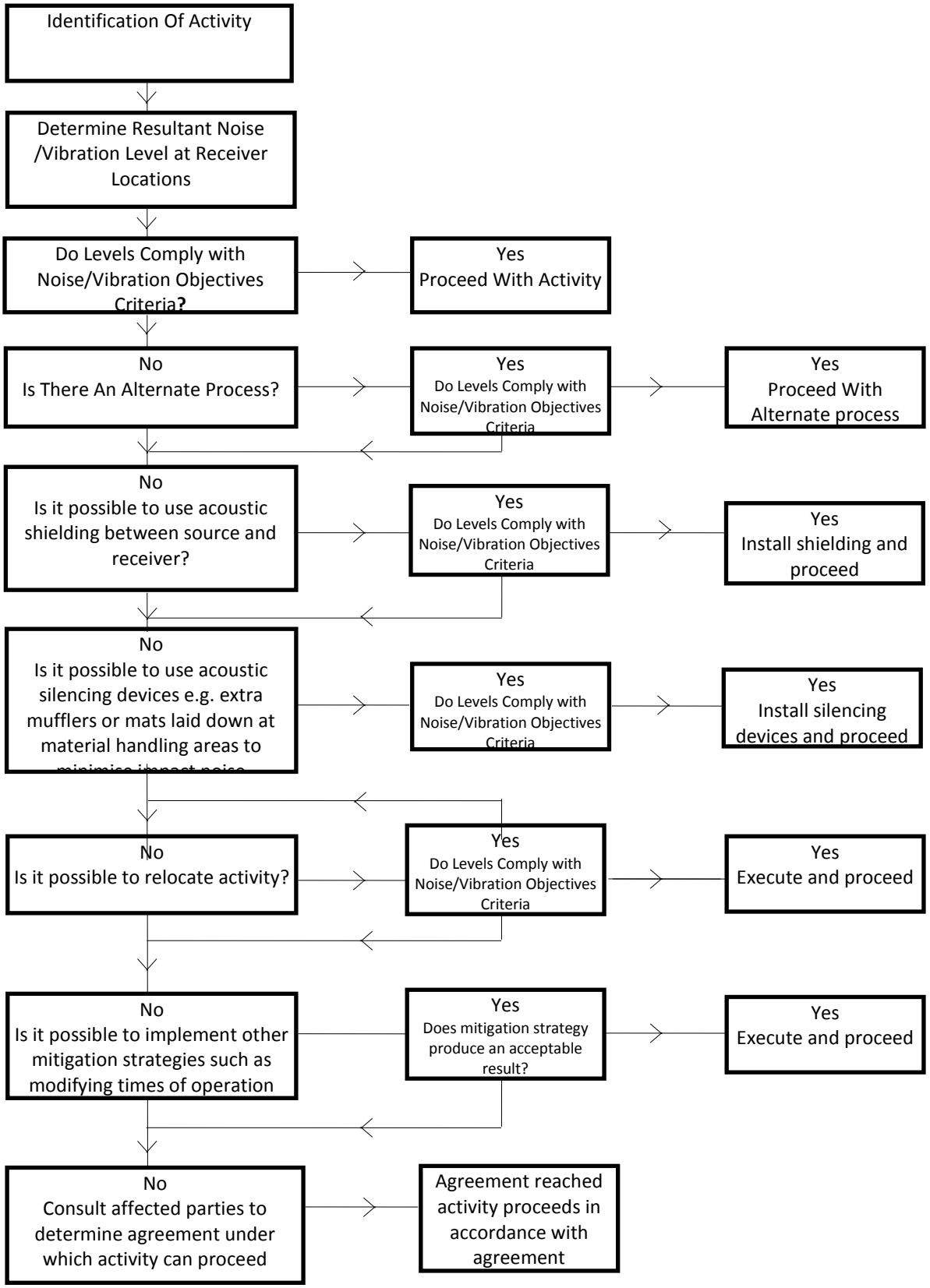
5 ASSESSMENT METHODOLOGY

5.1 NOISE ASSESSMENT PROCESS

The flow chart that follows illustrates the process followed to assess extraction and construction activities.

Measures to mitigate sources causing exceedances of the noise and vibration goals have been determined based on the analysis noise and vibration emissions and the process indicated in the following sections. The recommended noise control measures are indicated in the following tables for the various times and operations.

CONTROL OF NOISE FLOW CHART



5.2 GENERAL NOISE CONTROL / MITIGATION METHODS

The determination of appropriate noise control measures will be dependent on the particular activities and extraction appliances. This section provides an outline of available methods.

5.2.1 Selection of Alternate Appliance or Process

Where a particular activity or appliance is found to generate noise levels that exceed the criteria, it may be possible to select an alternative approach or appliance. For example; the use of a hydraulic hammer on certain areas of the site may potentially generate high levels of noise. By carrying this activity by use of pneumatic hammers, bulldozers ripping and/or milling machines lower levels of noise will result.

5.2.2 Acoustic Barriers

Barriers or screens can be an effective means of reducing noise. Barriers can be located either at the source or receiver.

The placement of barriers at the source is generally only effective for static plant (tower cranes). Placing barriers at the source cannot effectively attenuate equipment which is on the move or working in rough or undulating terrain.

Barriers can also be placed between the source and the receiver. The degree of noise reduction provided by barriers is dependent on the amount by which line of sight can be blocked by the barrier. If the receiver is totally shielded from the noise source reductions of up to 15 dB(A) can be effected. Where only partial obstruction of line of sight occurs, noise reductions of 5 to 8 dB(A) may be achieved. Where the barrier does not obstruct line of sight, generally no noise reduction will occur.

As barriers are used to provide shielding and do not act as an enclosure, the material they are constructed from should have a noise reduction performance which is approximately 10 dB(A) greater than the maximum reduction provided by the barrier. In this case the use of a material such as 10 or 15mm plywood would be acceptable for the barriers.

5.2.3 Silencing Devices

Where construction process or appliances are noisy, the use of silencing devices may be possible. These may take the form of engine shrouding, or special industrial silencers fitted to exhausts.

5.2.4 Material Handling

The installation of rubber matting over material handling areas can reduce the sound of impacts due to material being dropped by up to 20dB(A).

5.2.5 Treatment of Specific Equipment

In certain cases it may be possible to specially treat a piece of equipment to reduce the sound levels emitted. These may take the form of engine shrouding, or special industrial silencers fitted to exhausts.

5.2.6 Establishment of Site Practices

This involves the formulation of work practices to reduce noise generation. This includes locating fixed plant items as far as possible from residents as well as rotating plant and equipment to provide respite to receivers.

Construction vehicles accessing the site should not queue in residential streets and should only use the designated construction vehicle routes. Loading of these vehicles should occur as far as possible from any sensitive receiver.

As part of the development of the detailed plans and methods for the works to be carried out, noise emissions of the proposed methods and/or equipment should be reviewed in reference to the noise assessment. Noise emissions requirements for major noise producing plant should be included (where possible) as part of plant procurement requirements and confirmed on site.

5.2.7 Strategic Positioning of Processes On-Site

Where practicable, particular processes of activities can be located in particular positions on site to minimise noise to surrounding sensitive receivers.

For example, stationary plant may be positioned where direct line of sight shielding can be achieved using natural barriers, or may maximise the distance to the nearest sensitive receiver.

5.2.8 Combination of Methods

In some cases it may be necessary that two or more control measures be implemented to minimise noise emissions.

5.2.9 Establishment of Direct Communication with Affected Parties

In order for any construction noise management programme to work effectively, continual communication is required between all parties that may be potentially impacted upon, the builder and the regulatory authority. This establishes a dynamic response process that allows for the adjustment of control methods and criteria for the benefit of all parties.

The objectives of the consultation process are to:

- Inform and educate the groups about the project and the noise controls being implemented.
- Increase understanding of all acoustic issues related to the project and the options available.
- Identify group concerns generated by the project, so that they can be addressed.

It is recommended that a community liaison forum/group be established to facilitate the free flow of information and feedback between the parties. This group would meet at regular intervals (as agreed by the group). The forum also establishes points of contact and channels of communication within affected organisations.

5.2.10 Management Training

All site managers should be made aware of noise and vibration limits, applicable control measures and methods. They should ensure that all agreed noise and vibration measures are carried out by employees and sub-contractors.

5.3 SPECIFIC NOISE CONTROL/MITIGATION METHODS

Potential noise impacts and mitigation methods have been assessed in accordance with the procedures outlined above. Following are the recommended specific actions arising from our analysis (including analysis of 24 hr noise sources) to mitigate noise from these activities predicted to significantly exceed the noise management levels. It is noted that noise emissions from other less significant sources will still be subject to analysis using the Control of Noise Flow Chart. However this would be undertaken when more detailed planning regarding including possible actual plant locations, actual plant being used etc. are known.

5.3.1 Activities

The noise and vibration assessment indicates that a number of operations proposed for the deconstruction works, would produce noise levels exceeding the management goal at the residential receivers along Merriman & Bettington Streets.

The selection of the preferred demolition methodology has already considered potential noise impacts by:

- Minimising any percussive demolition until required, proposed at this stage only for the removal of fractured slab footing at the base of the tower, where the hammering point will be screened from sensitive receivers.
- Using PFC charges to fracture the footing slab, thereby reducing the intensity and overall duration of hammering proposed for the removal of the footings.
- Using pulveriser head attachment for the proposed robotic excavators in place of a hammer head attachment.
- Minimising street level crane operations by:
    - the installation of a materials hoist; and
    - selecting a demolition methodology where debris and rubble is collected within the tower and transported down the shafts to the basement works area and removed from site.
- Restricting all truck and construction traffic to the basement cultural centre space, which will result in significantly lower impacts to the residential receivers on Merriman Street than the use of Merriman Street.

Hammering should only be undertaken where non-percussive extraction method is not feasible or reasonable and performed according to the following:

- Using the smallest equipment as is practical and provides benefits in terms of the noise/time to complete balance. (In other words a smaller hammer may be quieter but may result in significantly extended period of operation, leading to no overall benefit.)
- The local community should be informed via a liaison committee (or other method as appropriate) as to the nature, period and times of hammering.

5.3.2 Activities – 24 HR Operations

It is only proposed to undertake operations outside the normal project construction hours in case of emergency or where it is unavoidable (e.g. dewatering). Additional safeguards are proposed for these periods, as follows:

- Dewatering plant would (and other plant) that needs to operate on a 24 hours per day basis to clear groundwater from the site would be located and treated so that noise emissions would be reduced to levels required for permanently operating plant as per the EPA Industrial Noise Policy.

Plant should be located as far as practical or in locations that are screened from residential receivers to minimise noise emissions, notwithstanding that items may not exceed the noise goals.

5.3.3 Traffic Movements

There will be heavy vehicle movements primarily to transport demolished material from the site. Average daily movements are expected to be low (less than 3) and no specific mitigation of impacts is likely to be required.

6 VIBRATION

The only activities potentially generating vibration at the surrounding structures are:

- Hammering at the base of the tower using an excavator mounted hammer.
- Demolition of pump and plant room structures within the basement cultural centre space.

Due to the vertical and horizontal distance separation, it is unlikely that the receiver vibration goals will be exceeded by the hammering operations. While excessive vibration levels are not expected, safeguards are recommended for these activities given the age, significance and form of construction of the residential properties along Merriman Street.

It is recommended that vibration levels and regenerated noise levels within the nearby buildings be measured to confirm these levels and to establish “safe” working distances that prevent damage or adverse amenity impacts. This should occur at the commencement of the two operations identified above.

7 COMPLAINTS HANDLING

A register of noise complaints should be maintained within the site office and be made available to interested parties listing the source of the complaint, time and nature of the complaint.

The following procedure should be adopted where complaints are received.

- The particular activity causing the complaint should be suspended pending further investigation.
- Noise and/or vibration monitoring of the activity should be carried out on a trial basis.

- Where monitoring indicates that the noise or vibration emission goal is exceeded then additional noise or management control should be investigated in accordance with the flow chart.
- The activity should proceed with the additional mitigation methods in place and the resultant noise impact reassessed.

8 MONITORING

Monitoring would be conducted:

- As an ongoing indicator of noise/vibration emissions from the site, similar to the monitoring regime established during the Main Works (development of Barangaroo Reserve).
- In response to complaints.
- Where specific monitoring is needed. For example where ground vibration is produced near sensitive structures to confirm safe working as indicated in Section 6.

Attended or unattended long term monitoring may be used as appropriate.

Monitoring should identify the levels of noise/vibration emitted from the site and the noise/vibration sources present, and comment on the measured levels in relation to the established goals.

Where works may be needed to occur within established safe working zones, an additional targeted monitoring regime should be established that should include some form of continuous monitoring of structures.

9 CONCLUSION

The management plan outlines the development of controls and safeguards that would be applied to all activity on the site. The objective of these controls is to ensure that all work is carried out in a highly controlled and predictable manner that will minimise emissions and protect the amenity of the sensitive receivers surrounding the site.

The plan provides a framework for ongoing management of the site including:

- Ongoing assessment and management of processes and activities including selection of processes and mitigation.
- Responding to unforseen processes not included in this plan as required in response to changed circumstances or in response to monitoring or community reaction.
- Community communication and liaison.
- Training
- Monitoring
- Complaints Handling

The controls and safeguards implemented as a result of the analysis recommended in the plan would be reviewed at a number of stages in response to revised methods and equipment, and to the monitoring and evaluation of actual impacts. This management plan outlines the procedures that would be adopted during the detailed planning and execution phases by the contractor.

We trust this information is satisfactory. Please contact us should you have any further queries.

Yours faithfully,

Acoustic Logic Consultancy Pty Ltd
Yogendra Kalkunte