CONSTRUCTION NOISE AND VIBRATION MANAGEMENT PLAN

Powerhouse Museums Discovery Centre

2 Green Road, Castle Hill NSW 2154

PREPARED FOR
Taylor
Level 13
157 Walker Street
North Sydney NSW 2060
Tel: 02 8736 9000

Ref: SY181569-AUR03
Rev: 2
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Construction Noise and Vibration Management Plan

Revision Schedule

Date	Revision	Issue	Prepared By	Approved By
23.07.2021	1	Preliminary for review	I. Adlington	J. Ameli
28.07.2021	2	For issue	I. Adlington	J. Ameli

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1. Executive Summary

Northrop Consulting Engineers Pty Ltd (Northrop Acoustics) have been engaged by Taylor to provide a Construction Noise and Vibration Management Plan for the new works at Museums Discovery Centre at 2 Green Road, Castle Hill, NSW.

A Construction Noise and Vibration Management Plan is a site specific plan developed to ensure that appropriate work practices are implemented during the demolition, excavation and construction to minimise noise and vibration impact upon the surrounding buildings. This document provides a construction noise management plan so as to comply with the relevant consent conditions and the Interim Construction Noise Guideline.

Procedures for engagement of the neighbouring community to keep noise and vibration affected neighbours informed are addressed in this construction noise management plan. Procedures on dealing with community complaints are also outlined in this construction noise management plan.

Providing our recommendations are implemented, it is expected that any construction Noise & Vibration impact upon the surrounding buildings will be minimised in accordance with NSW Interim Construction Noise Guidelines.

2. Referenced Documents

This assessment has been prepared considering the following documentation:

Consent authority, design guidelines and standards:

- SSD 10472 Development Consent Conditions B29 and C6-C9
- *NSW Noise Policy for Industry* (NPfI), 2017, issued by NSW Environmental Protection Authority
- *Noise Guide for Local Government*, 2013, issued by NSW Environmental Protection Authority
- *NSW Interim Construction Noise Guideline* (ICNG), 2009, issued by NSW Department of Environment, Climate Change and Water
- AS 2436:2010: Guide to Noise and vibration control on construction demolition sites, 2010, issued by Standards Australia
- AS 2670:2001: Vibration and shock – Guide to the evaluation of human exposure to whole body vibration, 2001, issued by Standards Australia
- Update of Noise Data Base for the Prediction of Noise on Construction Sites, 2005, issued by UK Department for Environment Food and Rural Affairs

Project documents:

- *SY181569-AUR01-7 Museums Discovery Centre Upgrade - Acoustic Report for SSDA,* issued by Northrop

3. Site Description

The existing site is located at 2 Green Road, Castle Hill. The project involves addition of a new building to the existing site. The site is bound by Showground Road to the south, existing Museums Discovery Centre Site to the west, Castle Hill TAFE to the east, residences and playground/public park to the north.

The location of the site is shown in Figure 1.

Figure 1: Aerial view of site, the proposed building and noise measurement locations

3.1 Nearest Affected Sensitive Receivers

The nearest potentially affected neighbouring buildings are shown in Table 1, below.

Table 1: Nearest affected receivers and typical worst-case distances from the Site

Reference	Location	Typical worst case distance from the Site (m)
R1	10 Sunderland Avenue	47
R2	2 Peppertree Place	63
E1	TAFE Buildings	13

4. Relevant Acoustic Criteria

The following criteria is relevant to the project during construction phase. This section outlines the requirements of the criteria, documents and consent conditions relevant to construction noise and vibration for this project.

Construction site operators must comply with construction noise and vibration control requirements of the NSW statutory requirements and the conditions set out in the NSW Critical State Significant Infrastructure Standard Secretary's Environmental Assessment Requirements (SEARs) 2015.

The Protection of the Environment Operations Act 1997 (NSW) Act is the key piece of environment protection legislation, and the Protection of the Environment Operations (Noise Control) Regulation 2008 (NSW) provides for inspection and testing of noise emissions.

The "Interim Construction Noise Guidelines" (2009) published by the NSW Environment Protection Authority (EPA), deals with the assessment of noise from construction activities and advises on best practice approaches to minimise noise impacts. It is aimed at managing noise from construction works regulated by Office of Environment and Heritage and is used to set statutory conditions in licences or other regulatory instruments.

The "Assessing vibration: A Technical Guideline" (2006) published by the NSW EPA, is based on guidelines contained in BS 6472-1992, and presents preferred and maximum vibration values for use in assessing human responses to vibration and provides recommendations for measurement and evaluation techniques. It does not address motion sickness, occupational vibration, blasting vibration effects or vibration-induced damage to buildings or structures.

4.1 Consent Conditions

Consent Condition B29 stipulates the following:

The Construction Noise and Vibration Management Sub Plan (CNVMSP) must address, but not be limited to, the following:

- *(a) Be prepared by a suitably qualified and experienced noise expert*
- *(b) Incorporate recommendations of the Acoustic Report for state Significant Development Application revision 6 prepared by Northrop, dated 20.02.2021*
- *(c) Describe procedure for achieve the noise management levels in EPA's Interim Construction Noise Guideline (DECC, 2009)*
- *(d) Hours of construction in accordance with Conditions C6 to C9*
- *(e) Outline regular community liaison with sensitive receivers around the site*
- *(f) Outline how noise and vibration impacts would be monitored during construction*
- *(g) Describe the measures to be implemented to manage high noise generating works, in close proximity to sensitive receivers*
- *(h) Include a complaints management system that would be implemented for the duration of the construction; and*
- *(i) Include a program to monitor and report on the impacts and environmental performance of the development and the effectiveness of the management measures*

4.2 NSW EPA Interim Construction Noise Guideline

Construction noise is a major environmental noise issue in NSW and it is well accepted that this activity can adversely affect, sleep, concentration and learning performance and mental and physical health. While construction noise is temporary in nature, its impacts need to be controlled.

The NSW Interim Construction Noise Guideline (ICNG) is specifically aimed at managing noise from construction works. From a regulatory perspective, the local Council is the appropriate regulatory authority for non-scheduled construction activities.

Table 2: GCN noise criteria at residences, using quantitative assessment, L_{Aeq}

Time of Day	Management Level – $L_{Aeq\ (15min)}$	How to apply
Recommended Standard Hours: Monday to Friday 7am to 5pm Saturday 8am to 1pm No work on Sundays or public holidays	Noise affected RBL + 10 dB	The noise affected level represents the point above which there may be some community reaction to noise. Where the predicted or measured $L_{Aeq\ (15min)}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration as well as contact details.
	Highly noise affected 75 dB(A)	The highly noise affected level represents the point above which there may be strong community reaction to noise. Where noise is above this level, the relevant authority (consent, determining, regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account: Times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences) If the community is prepared to accept longer period of construction in exchange for restrictions on construction times.
Outside recommended standard hours	Noise affected RBL + 5 dB	A strong justification would typically be required for work outside the recommended standard hours The proponent should apply all feasible and reasonable work practices to meet the noise affected level Where all feasible and reasonable practices have been applied and noise is more than 5 dB(A) above the noise affected level, the proponent should negotiate with the community For guidance on negotiating agreements see Section 7.2.2 (NSW Interim Construction Noise Guideline)
Passive recreation areas	60 dB(A)	When in use

Table 3 of the construction Noise Guideline (excerpt in Table 3, below) provides recommended noise management levels for sensitive land uses other than residences.

Table 3: Noise at sensitive land uses (other than residences) using quantitative assessment

Land use	Management level, $L_{Aeq\ (15\ min)}$ (applies when properties are being used)
Classrooms at schools and other educational institutions	Internal noise level 45 dB(A)

4.3 Road Noise Policy

Noise from the vehicles associated with the development will be assessed using NSW Road Noise Policy. Table 4 presents the noise assessment criteria for land use developments with potential to create additional traffic on existing local and sub-arterial roads.

Table 4: Noise levels - Road Noise Policy

Road category	Type of project/Land use	Assessment criteria, dB(A)	
		Day	Night
Local roads	Existing residences affected by additional traffic on existing local roads generated by land use development	$L_{Aeq,1hr}$ 55 (External)	$L_{Aeq,1hr}$ 50 (External)
Freeway/arterial/sub-arterial roads	Existing residences affected by additional traffic on existing freeway/arterial/sub-arterial roads generated by land use development	$L_{Aeq,15hr}$ 60 (External)	$L_{Aeq,9hr}$ 55 (External)

- RNP recommends that "Where feasible, existing noise levels should be mitigated to meet the noise criteria. In this regard, the RNP states that for existing roads there is limited potential for noise control as the development is not linked to road improvements. It does however advise that applicable strategies include appropriate location of private access roads, regulating time of use, using clustering, and using barriers and acoustic treatments".
- Section 3.4.1 of the RNP specifies a limit of 2 dB for vehicular noise level increase over existing noise level of local roads for such developments/projects.

4.4 Construction Vibration Limits

The following criteria are considered applicable when assessing vibration emission levels from the construction works.

The effects of ground vibration on buildings near construction sites may be broadly defined by the following three categories:

1. Disturbance to building occupants - Vibration in which the occupants or users of the building are inconvenienced or possibly disturbed,
2. Effects on building contents - Vibration where the building contents may be affected, and,
3. Effects on building structures - Vibration in which the integrity of the building or structure itself may be prejudiced.

In general, vibration criteria for human disturbance (1) are more stringent than vibration criteria for effects on building contents (2) and building structural damage (3). Hence, compliance with the more stringent limits dictated by Category 1, would allow for compliance to be achieved for the other two categories.

For disturbance to human occupants of buildings, we refer to the EPA's *'Assessing Vibration; a technical guideline'*, published in February 2006. This document provides criteria which are based on the British Standard BS 6472-1992, *'Evaluation of human exposure to vibration in buildings (1-80Hz)'*.

Vibration sources are defined as C*ontinuous, Impulsive or Intermittent.* Section 2 of the technical guideline defines each type of vibration as follows:

*'**Continuous** vibration continues uninterrupted for a defined period (usually throughout the day-time and/or night-time).*

***Impulsive** vibration is a rapid build-up to a peak followed by a damped decay that may or may not involve several cycles of vibration (depending on frequency and damping). It can also consist of a sudden application of several cycles at approximately the same amplitude, providing that the duration is short, typically less than 2 seconds.*

***Intermittent** vibration can be defined as interrupted periods of continuous or repeated periods of impulsive vibration that varies significantly in magnitude'.*

The criteria are to be applied to a single weighted root mean square (rms) acceleration source level in each orthogonal axis. Section 2.3 of the guideline states:

'Evidence from research suggests that there are summation effects for vibrations at different frequencies. Therefore, for evaluation of vibration in relation to annoyance and comfort, overall weighted rms acceleration values of the vibration in each orthogonal axis are preferred (BS 6472).'

Preferred and maximum values for continuous and impulsive vibration are defined in below in Table 5 extracted from "Table 2.2 of the guideline" and the values for residential type buildings are reproduced below.

Table 5: Preferred and Maximum Weighted RMS Values for Continuous and Impulsive Vibration Acceleration (m/s^2) 180Hz

Location	Assessment period	Preferred values		Maximum values	
		z axis	x & y axis	z axis	x & y axis
Continuous vibration					
Residences	Daytime (7am-10pm)	0.010	0.0071	0.020	0.014
Impulsive vibration					
Residences	Daytime (7am-10pm)	0.30	0.21	0.60	0.42

Intermittent vibration is to be assessed using vibration dose values (VDVs). The VDV method is a fourth power approach which is more sensitive to peaks in the acceleration waveform and makes corrections to the criteria based on the duration of the source's operation.

The VDV can be calculated using the overall weighted rms acceleration of the vibrating source in each orthogonal axis and the total period during which the vibration may occur. Weighting curves are provided in each orthogonal axis in the guideline.

Preferred and maximum VDV values are defined in Table 6 below extracted from "Table 2.4 of the guideline" and VDV values for residential type buildings are reproduced below.

Table 6: Preferred and Maximum VDV Values

Location	Daytime (7am-10pm)		Night-time (10pm-7am)	
	Preferred values	Maximum values	Preferred values	Maximum values
Residences	0.20	0.40	0.13	0.26

4.5 Site Specific Criteria

Measurements were undertaken as to determine the noise criteria in accordance with the Noise Policy for Industry for the boundary of the nearest affected receiver. Measurement locations are shown in Figure 1, and details of the measurement results can be found in the Acoustic Report for State Significant Development Application prepared by Northrop entitled "*SY181569-AUR01-7 Museums Discovery Centre Upgrade - Acoustic Report for SSDA*". Based on the ambient measurements undertaken in accordance with NSW Industrial Noise Policy the project construction noise criteria at the boundary of the nearest affected residences at Peppertree Place and Sunderland Avenue are shown in Table 7, below.

Table 7: Noise Criteria and Noise Management Levels

Period	Rating Background Noise Level (RBL) – $L_{Aeq,15min}$, dB(A)	Construction Noise Criteria (RBL + 10) – $L_{Aeq,15min}$, dB(A)
Day	44	54

The criteria for Highly Noise Affected Level is 75 dB(A) and is independent of the background RBL level.

Operator attended measurements were also undertaken at the site, the details and results of which can be found in the Acoustic Report for SSDA.

5. Acoustic Assessment

At this stage, the proposed nature of construction works and activity has not been finalised and will be subject to final input by the construction contractor. We have assumed typical plant and activity will entail the following stages and typical plant items as follows:

- Demolition and excavation works – trucks, site excavation works, loaders, skid steer, truck and dog, tree mulcher, chain saws and concrete saws
- Structural works – main structural works, crane hoists, concrete pumps, concrete saws, grinding, hammering
- Fit out works – mainly enclosed finishing works using hand tools. For the purposes of this assessment we have assumed a typical shielding loss of 20 dB.

Representative plant and plant sound power levels have been derived from the UK Department for Environment Food and Rural Affairs (DEFRA 2005) *'Update of Noise Data Base for the Prediction of Noise on Construction Sites'* and TfNSW *'Construction Noise & Vibration Strategy (CNVS)'*.

Noise from construction activities has been predicted at nearest sensitive noise receivers. A 25dB(A) facade attenuation has been applied for the TAFE buildings as the assessment criteria is for internal spaces.

Results are shown in Tables 8-10, below.

Table 8: Predicted construction noise levels at "R1": 10 Sunderland Avenue

Construction Activity	SWL, dB(A)	Predicted Noise Level at R1, dB(A)	Complies with Noise Affected Level?	Complies with Highly Affected Level?
Demolition and excavation				
Truck delivery	107	66	No	Yes
Excavator	107	66	No	Yes
Loaders	112	71	No	Yes
Skid steer	110	69	No	Yes
Truck and dog	108	67	No	Yes
Mulcher	116	75	No	Yes
Chain saws	114	73	No	Yes
Concrete saws	107	66	No	Yes
Structural works				
Excavator	107	66	No	Yes
Truck delivery	107	66	No	Yes
Concrete pump	108	67	No	Yes
Concrete saws	107	66	No	Yes
Mobile crane	104	63	No	Yes
Angle grinder	108	67	No	Yes
Hammer	97	56	No	Yes
Fit Out				
Angle grinder	108	47	Yes	Yes
Hammer	97	36	Yes	Yes
Truck delivery	107	66	No	Yes

Table 9: Predicted construction noise levels at "R2": 2 Peppertree Place

Construction Activity	SWL, dB(A)	Predicted Noise Level at R2	Complies with Noise Affected Level?	Complies with Highly Affected Level?
Demolition and excavation				
Truck delivery	107	63	No	Yes
Excavator	107	63	No	Yes
Loaders	112	68	No	Yes
Skid steer	110	66	No	Yes
Truck and dog	108	64	No	Yes
Mulcher	116	72	No	Yes
Chain saws	114	70	No	Yes
Concrete saws	107	63	No	Yes
Structural works				
Excavator	107	63	No	Yes
Truck delivery	107	63	No	Yes
Concrete pump	108	64	No	Yes
Concrete saws	107	63	No	Yes
Mobile crane	104	60	No	Yes
Angle grinder	108	64	No	Yes
Hammer	97	53	Yes	Yes
Fit Out				
Angle grinder	108	44	Yes	Yes
Hammer	97	33	Yes	Yes
Truck delivery	107	63	No	Yes

Table 10: Predicted internal construction noise levels at "E1": TAFE buildings

Construction Activity	SWL, dB(A)	Predicted Noise Level at E1, dB(A)	Complies with internal Management Level?
Demolition and excavation			
Truck delivery	107	52	No
Excavator	107	52	No
Loaders	112	57	No
Skid steer	110	55	No
Truck and dog	108	53	No
Mulcher	116	61	No
Chain saws	114	59	No
Concrete saws	107	52	No
Structural works			
Excavator	107	52	No
Truck delivery	107	52	No
Concrete pump	108	53	No
Concrete saws	107	52	No
Mobile crane	104	49	No
Angle grinder	108	53	No
Hammer	97	42	Yes
Fit Out			
Angle grinder	108	33	Yes
Hammer	97	22	Yes
Truck delivery	107	52	No

The above summary results indicate that for residences most activities/noise levels comply with the Highly Noise Affected Levels but mostly exceed the Noise Affected Level. The Interim Construction Noise Guideline proposes that noise levels not exceeding the Noise Affected Level i.e. background noise levels (RBL for day – see Table 7) by 10 dB are considered acceptable for construction works. However, for those exceeding the above and exceeding the Highly Noise Affected Level, it's expected that community will have a strong reaction.

The acoustic assessment results at the worst-case distances are as follows:

- At R1, exceedances up to 21dB(A) over the Noise Management Level are predicted. Exceedance of the Highly Noise Affected Level is not expected.
- At R2, exceedances up to 18dB(A) over the Noise Management Level are predicted. Exceedance of the Highly Noise Affected Level is not expected.
- At E1, exceedances up to 16dB(A) over the internal Noise Management Level are predicted.

Given predicted exceedences, suitable mitigation and management measures will be required for the project.

6. Recommended Construction Noise & Vibration Mitigation and Management Strategies

6.1 Construction Noise Mitigation

Information in Table 11 referenced from AS 2436:2010 details the potential noise reduction of standard engineering mitigation measures, typically utilised on construction and demolition sites.

Table 11: AS 2436:2010 – Construction noise mitigation measures

Noise mitigation measure	Typical noise reduction, L_p – dB(A)
Distance attenuation	6 dB per doubling of distance
Screening and barriers	Typically, 5 to 10 dB(A) maximum 15 dB(A)
Enclosure	Typically, 15 to 25 dB(A) maximum 50 dB(A)
Silencing	Typically, 5 to 10 dB(A) maximum 20 dB(A)

Feasible and reasonable work practices should be implemented to reduce the noise impact to the nearest affected receivers. The following is recommended to reduce the noise impact as much as possible:

- Locate the noisiest equipment as far from the residences and TAFE buildings as possible, preferably to the south of the site near Showground Road where possible. Increasing the distance to over 150m from the residences and over 60m from the TAFE buildings will result in an audible difference in noise levels (predicted exceedance of up to 10dB(A) for residences and 3dB(A) for TAFE buildings), reducing the noise impact. It is recommended that in particular the tree mulcher is used only to the south of the site, as far from the residential and TAFE buildings as possible. Where possible, trees are recommended to taken off site to be mulched.
- It is recommended that local acoustic barriers are used for noisy equipment identified in Tables 8-10. Barriers are recommended to be installed for the duration of the use of the equipment, surrounding the location of each piece of equipment such that line of site between the equipment and residences and classrooms is blocked. Barriers shall be minimum R_w 25 such as “Flexshield” curtains supported by temporary fencing, plywood of fibre cement, minimum 2.1m in height with no gaps, including to the bottom. Barriers are most effective when they are installed as close to the noise source as possible.

6.2 Standard Hours for Construction Work

Conditions C6 to C9 stipulate the permitted construction hours for the project as follows:

C6. Construction, including the delivery of plant, equipment and any materials to and from the site, may only be carried out between the following hours:

(a) between 7 am and 5 pm, Mondays to Fridays inclusive; and
(b) between 8 am and 1 pm, Saturdays.
(c) No work may be carried out on Sundays or public holidays.

C7. Construction activities may be undertaken outside of the hours in Condition C6:

(a) if required by the Police or a public authority for the delivery of vehicles, plant or materials; or
(b) in an emergency to avoid the loss of life, damage to property or to prevent environmental harm; or

(c) where the works are inaudible at the nearest sensitive receivers.

C8. Notification of such construction activities as referenced in Condition C7 must be given to affected residents before undertaking the activities or as soon as is practical afterwards.

C9. Rock breaking, rock hammering, sheet piling, piledriving and similar activities may only be carried out between the following hours:

(a) 9.00 am to 12.00 pm, Monday to Friday:
(b) 2.00 pm to 5.00 pm, Monday to Friday; and
(c) 9.00 am to 12.00 pm, Saturday.

The highly noise affected level represents the point above which there may be strong community reaction to noise. Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account:

- Times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences)
- If the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.

6.3 Operational Practices to Minimise Construction Noise Impacts

The Highly Noise Affected level represents the point above which there may be strong community reaction to noise. The construction noise mitigation measures detailed in Section 6.1 above do not provide sufficient attenuation to achieve construction noise levels compliant with the ICNG criteria, therefore, noise from construction activity must be managed to minimise the temporary loss of acoustic amenity on the nearest affected receivers and surrounding community. Noise management can be achieved through activities such as scheduling, community engagement and operational practices to minimise noise impact.

The Interim Construction Noise Guideline notes that there may be some community reaction to noise from major construction projects where this is more than 10 decibels above the background noise level for work during the daytime. This recognises that construction noise is generally temporary with the community having a slightly higher tolerance for it.

The best management practices involve adopting particular operational procedures that minimise noise while retaining production efficiency. Some common general noise reduction strategies include:

- Changing the activity to reduce the noise impact or disturbance (e.g. reorganising the way the activity is carried out).
- Replacement of noisy equipment by less noisy equipment / operations. For example at close distances, jack hammering should be replaced by saw cutting or impact piling to be replaced by screw piling,
- Choosing a suitable time — schedule noisy activity to less sensitive times of the day. There are sensitive times of the day for different people, for example, schools during the day, times of religious services, and residences during evenings and night. Where several noisy pieces of equipment are used, their operation should be scheduled to different times to minimise impacts.

- Keeping neighbours informed of a planned noisy activity, its duration and the reasons for the activity. Neighbours may be more accepting of temporary noise if they know when and why the noise is happening, and how long it will last.
- Educating staff and contractors about noise and quiet work practices. This could include signage, for example, some construction sites have signs reminding contractors to consider neighbours and be quiet, and not to start noisy work too early (e.g. before 7.00 am).

Noise can be controlled in the transmission path by using separation distances, barriers and sound absorptive materials.

- Increasing the separation distance (distance attenuation) between the noise source and receiver reduces the noise level. As a rule of thumb, each doubling of the distance from a noise source equates to a reduction of sound pressure level of 6 dB (the inverse square law). This does not apply close to a loud noise source.
- Careful site selection for a new noisy activity can help minimise noise impacts where it is possible to provide adequate separation distances.
- Barriers are most effective when they are located close to the noise source, or close to the noise receiver and block the line of sight between the source and receiver. The amount of noise reduction achieved depends on the height and mass of the barrier and the frequency of the noise (barriers are less effective for low-frequency noise). Noise barriers should have no gaps. Use of absorptive material on the side of the barrier facing the noise source can also help to reduce noise levels by reducing noise reflections. Trees or other vegetation do not provide an effective noise barrier. Some limited attenuation may be gained where trees are densely planted but little attenuation is achieved for low frequencies.
- Sound-absorptive materials reduce the level of reflected sound. They are porous materials such as glass fibre, wool and mineral wool. Thin layers are capable of absorbing only high frequencies, whereas thicker layers can absorb a wider frequency range.

6.4 Construction Truck and Traffic Management

Taylor has advised the following regarding truck access to the site throughout the construction:

Consistent with the Transport Impact Assessment prepared by JMT Consulting, it is imperative that vehicles travelling to the site enter and exit in a left turn in / left turn out pattern via the Showground Road entry. There will be strictly no access to the site via Green Road or Castle Hill TAFE.

Vehicles such as truck and dog trailers which will be used to export spoil material, will be able to complete a U-turn on the benched pad of Building J. A similar U-turn pattern for semi-trailer vehicles will not be possible as the project progresses as new structure such as footings & retaining walls will block access to the central area of the site. As such, Taylor, through consultation with all required stakeholders, would organise for entry via Showground Road and exit via Windsor Road (or vice versa) as per the marked-up plan from JMT Consulting's report below. Such a route will only be utilised for particular circumstances such as precast or structural steel delivery or on a concrete pour day where vehicle traffic entering and exiting site would be higher than usual.

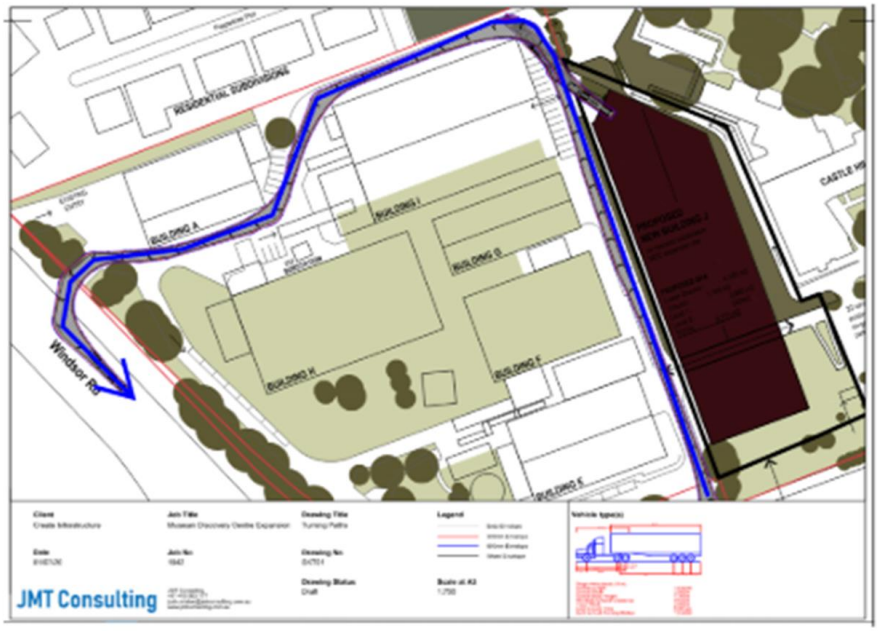

Figure 2: Alternative truck route – note use of this route is expected to be limited.

A traffic controller will also be used to manage entry and exit into site along with the management of pedestrian flows both entering site and those travelling to adjacent buildings and along existing paths. During peak periods, an additional traffic controller will be used to manage traffic flows within site boundaries.

All truck movement should be limited to the approved construction hours in Section 6.2.

In general, surrounding residences along the route will be subject to passing truck noise. To minimize any noise impact the contractor should train and instruct the truck drivers to exercise caution to keep the noise to a minimum. The following is recommended for truck activity at the Site:

- Drivers should avoid unnecessary idling and switch off engines during loading/unloading of the trucks, and whenever trucks are stopped. Signage to be displayed along the route to and within the loading dock to notify drivers to switch off engines during loading/unloading and whenever trucks are stopped
- Limit speed to 10km/hr within the delivery route, signage to be displayed enforcing speed limit
- Broadband “quacker” reverse alarms are recommended to be used over tonal reverse alarms
- Trucks should be properly maintained and have proper silencers fitted to control engine noise. Brake noise not to be emitted

Additionally, any residences neighbouring the route between Showground and Windsor Roads shall be given reasonable notice of any truck movements scheduled on that route.

For trucks travelling on the surrounding road network the noise impact will be assessed against the requirements of NSW Road Noise Policy (RNP). At this stage, the exact truck numbers are not known. Trucks will predominantly be entering and exiting via Showground Road, as stipulated above.

For generated traffic associated with such developments the RNP allows 2 dB(A) increase on local and collector roads. In order for a road noise level to increase by 2 dB(A), a significant increase in traffic volume would be needed. A 2 dB(A) increase in noise levels will require a 66% increase in traffic volume (note: the addition of noise is on logarithmic basis. A doubling in traffic volume corresponds to a noise increase of 3 dB(A)).

From experience with similar projects, it is estimated that the number of trucks travelling to Site will be approximately 8-10 per day. Assuming that the truck movements are spread evenly throughout the day, there will be 1-2 truck entering or leaving the Site in each hour.

Considering the high volume of traffic on Showground and Windsor Roads, the addition of 1-2 truck/hour, will be well below 66% volume increase hence will not result in a perceptible difference in noise level. The resulting noise increase will be well within the 2 dB(A) limit increase, hence will comply with RNP noise requirements.

6.5 Respite Periods

The following construction-related noise-generating activities have been identified by the ICNG as having particularly annoying or intrusive characteristics

- Use of power saws, such as used for cutting timber, rail lines, masonry, road pavement or
- Steel work
- Grinding metal, concrete or masonry
- Rock drilling
- Line drilling
- Vibratory rolling
- Jackhammering, rock hammering or rock breaking
- Impact piling

It is recommended that respite periods are exercised for the above activities such that:

- They are only undertaken after 8.00 am,
- They are only undertaken over continuous periods not exceeding 3 hours with at least a 1 hour respite every three hours ('Continuous' means any period during which there is less than an uninterrupted 60 minute respite between temporarily halting and recommencing any of the intrusive and annoying work referred to in section 4.5 of ICNG.)

6.6 Community Engagement

For the construction works, contact with the nearest affected community is desirable once approval has been given to commence works and should be undertaken prior to any work beginning. The type of community engagement should relate to the likelihood and extent of noise and vibration impacts from the construction works.

The aim of community engagement is to:

- Establish good working relationships between the development owner, builder, the community and other stakeholders in relation to the construction project
- Receive feedback on the project's environmental performance, discuss community concerns and identify opportunities for the resolution of community complaints and concerns
- Gain advice on how best to communicate relevant information on the project and its environmental performance to the broader community
- Work cooperatively towards outcomes of benefit to the project, immediate neighbours and the local and regional community.

The Project Manager shall nominate the construction site manager as a community liaison officer for the project as a point of contact for the community regarding issues related to the construction of the development, including issues relating to noise and vibration. Any formal complaints

received regarding noise and vibration matters at the construction site shall be passed on to the Project Manager for the complaints to be addressed and resolved.

Being up-front with the noise affected community from the outset can assist in transferring information to the affected community. An example of being up-front is to present noise and vibration related information on the construction works to noise affected community before commencing works.

6.6.1 Dealing with Community and Public Complaints during Construction

Complaints from the community and public can arise when accidental or unintentional noise and/or vibration are generated due to unforeseen circumstances or error of judgement made by the construction team. The community and public generally understand when this happen once or not too often. The complaints must be handled in a serious and respectful way. The complaints should be recorded and logged in a noise and vibration complaints log book and followed up by the construction site manager. Noise monitoring may be an appropriate response to a compliant, to determine whether noise levels are consistently exceeding predicted noise levels. Noise and vibration monitoring details are provided in Section 6.8.

Following resolution of the noise or vibration problem, the complainant should be informed of the remedial actions taken before the complaint can be recorded as being resolved.

6.6.2 Training

The site manager shall implement appropriate training and induction in the requirements of this construction noise management plan. All employees, contractors and utility staff working on site will undergo site induction training which includes Environmental Due Diligence Training. The induction will address:

- This Construction Noise Management Plan
- The existence of noise legislation and what this means for the project, i.e. OEH and Noise Management Levels
- Delivery hours and locations.
- Reporting and recording environmental incidents related to noise and vibration.
- Noise and vibration minimisation measures.
- The importance of regular maintenance noise and vibration generating plant.

Records will be kept of all personnel undertaking the site induction and training, including the contents of the training, date and name of trainer/s. Key staff will undertake more comprehensive training relevant to their position and/or responsibility. This training may be provided as “toolbox” talk training.

6.7 Vibration Mitigation and Management

The management objective for the site is to limit vibration from construction activities so as to avoid building damage and human discomfort associated with the construction works. It is noted that buildings in the vicinity of development are residential. Vibration impacts on the buildings and their occupants should be considered for the assessment of structural damage and human annoyance, respectively.

Typical vibration levels from construction plant equipment most likely to cause significant vibration are summarised in Table 12 below.

Table 12: Typical ground vibration generated by construction plant

Activity	Typical ground vibration
Bulldozers/ Excavators	Typical ground vibration from bulldozers range from 1mm/s to 2mm/s at distances of approximately 5m and at distances greater than 20m, vibration levels are usually below 0.2mm/s.
Jack Hammers	Typical ground vibrations from jack hammers are generally greater than 5mm/s at distances of 1m and no more than 2mm/s for distances of 5m or more.
Truck traffic	Typical vibration from heavy trucks passing over normal (smooth) road surfaces generate relatively low vibration in the range 0.01-0.2mm/s at the footings of buildings located 10-20m from a roadway. In general ground vibration from trucks is usually imperceptible in nearby buildings.

Therefore, vibration management strategies implemented on site shall consider these items of plant and construction activities involving these items of plant.

6.7.1 Buffer Distances for Vibration Control

The relationship between vibration and the probability of causing human annoyance or damage to structures is complex. This complexity is mostly due to the magnitude of the vibration source, the particular ground conditions between the source and receiver, the foundation-to-footing interaction and the large range of structures that exist in terms of design (i.e. dimensions, materials, type and quality of construction and footing conditions).

The intensity, duration, frequency content and number of occurrences of a vibration, all play an important role in both the annoyance caused and the strains induced in structures.

As the pattern of vibration radiation is very different to the pattern of airborne noise radiation, and is very site specific, below are some indicative minimum 'buffer' distances determined for some common construction plant with data available from recent projects, which assist to avoid human discomfort in terms of perceptible (or tactile) vibration during daytime construction hours.

Table 13: Recommended Minimum Buffer Distances for Construction Plant

Plant Item	Recommended Minimum Buffer Distance (m)
CFA (Continuous Flight Auger) Piling rig	10
Excavators	10
Jack hammers	5
Vibratory rollers	30

6.7.2 Vibration Management Measures

Where vibration generating equipment work occurs within the buffer distances, to ensure vibration impacts are minimised during the construction period, the following vibration management control measures are recommended:

1. The proper implementation of a vibration management plan is required to avoid adverse vibration disturbance to affected occupancies. Consultation with occupants and property owners is recommended and should be aimed at providing a communication path directly to the Project Manager.
2. A management procedure will be implemented to deal with vibration complaints. Each complaint will be investigated and where vibration levels are established as exceeding the set limits, appropriate amelioration measures shall be put in place to mitigate future occurrences

3. Where vibration is found to be excessive, management measures shall be implemented to ensure vibration compliance is achieved. Management measures may include modification of construction methods such as using smaller units, establishment of safe buffer zones and if necessary, time restrictions for the most excessive vibration activities. Time restrictions are to be negotiated with affected receivers.

The residential and TAFE buildings are not within the Buffer Distances of CFA, excavator and jack hammer hence these equipment do not need any specific measures.

If vibratory rollers are to be used, the buffer distances should be considered and a small suitable unit to be selected to avoid vibration impacts.

Note that the museum buildings E, F, G and I are in the vicinity of the construction site. If there is any excavation close to the buildings or if the buildings fall within the Buffer distances of any equipment, the above rules and mitigations should be strictly observed to avoid damage to the buildings.

6.8 Monitoring Program

At the discretion of the Council, regular noise and/or vibration monitoring may be required during the construction period.

If required, noise and/or vibration monitoring shall be undertaken by a suitably qualified acoustic consultant. Reports shall be provided stating the measurement methodology and results of monitoring, and any recommendations for mitigation.

Where noise or vibration impacts are likely to occur (i.e. vibration generating equipment working within the buffer distance), it is recommended that regular noise or vibration checks, monitoring or inspections are undertaken during the construction period. Where monitoring indicates that measured noise levels consistently exceed the predicted noise level by more than 3dB, additional mitigation measures will be implemented to reduce the noise levels.

Noise and vibration monitoring shall be undertaken by a suitably qualified acoustic consultant in accordance with Table 14. Reports shall be provided stating the measurement methodology and results of monitoring, and any recommendations for mitigation. Long term noise monitoring data shall be acquired over a period of minimum 10 days, excluding rain and excessive wind events using 15-minute A frequency weighted measurements and broadband levels for L_{Aeq}, L_{A10}, L_{A90}, L_{Amax} and L_{Amin} shall be recorded.

Spot checks using a hand-held Type 1 integrating sound level meter with octave band filters may be undertaken to check equipment noise levels against manufacturers specifications and to check worst-case noise impacts at the commencement of high noise generating activities. Operator attended measurements shall be 15-minute A frequency weighted measurements and record octave band levels for L_{Aeq}, L_{A10}, L_{A90}, L_{Amax} and L_{Amin}. Reports shall be provided stating the measurement methodology and results.

Table 14: Recommended noise and vibration monitoring program

Monitoring condition		Frequency	Monitoring Location
Noise monitoring	During high noise construction activities	Monthly	Nearest affected receiver
	Where a complaint has been received and monitoring is considered an appropriate response to determine whether noise levels are consistently exceeding predicted noise level by more than 3dB	As required	At address of complainant
Vibration monitoring	Vibration generating works undertaken at distances less than the buffer distances presented in Table 13	As required	Nearest affected receiver
	Where a compliant has been received and monitoring is considered an appropriate response to determine whether noise levels are consistently exceeding vibration criteria shown in Table 5	As required	At address of complainant

7. Conclusion

A Construction Noise and Vibration Management Plan is a site specific plan developed to ensure that appropriate work practices are implemented during the demolition, excavation and construction to minimise noise and vibration impact upon the surrounding buildings. This document provides a construction noise management plan so as to comply with the relevant consent conditions and the Interim Construction Noise Guideline.

Procedures for engagement of the neighbouring community to keep noise and vibration affected neighbours informed are addressed in this construction noise management plan. Procedures on dealing with community complaints are also outlined in this construction noise management plan.

Providing our recommendations are implemented, it is expected that any construction Noise & Vibration impact upon the surrounding buildings will be minimised in accordance with NSW Interim Construction Noise Guidelines.